JTA Ferry Vessel Replacement Feasibility Study

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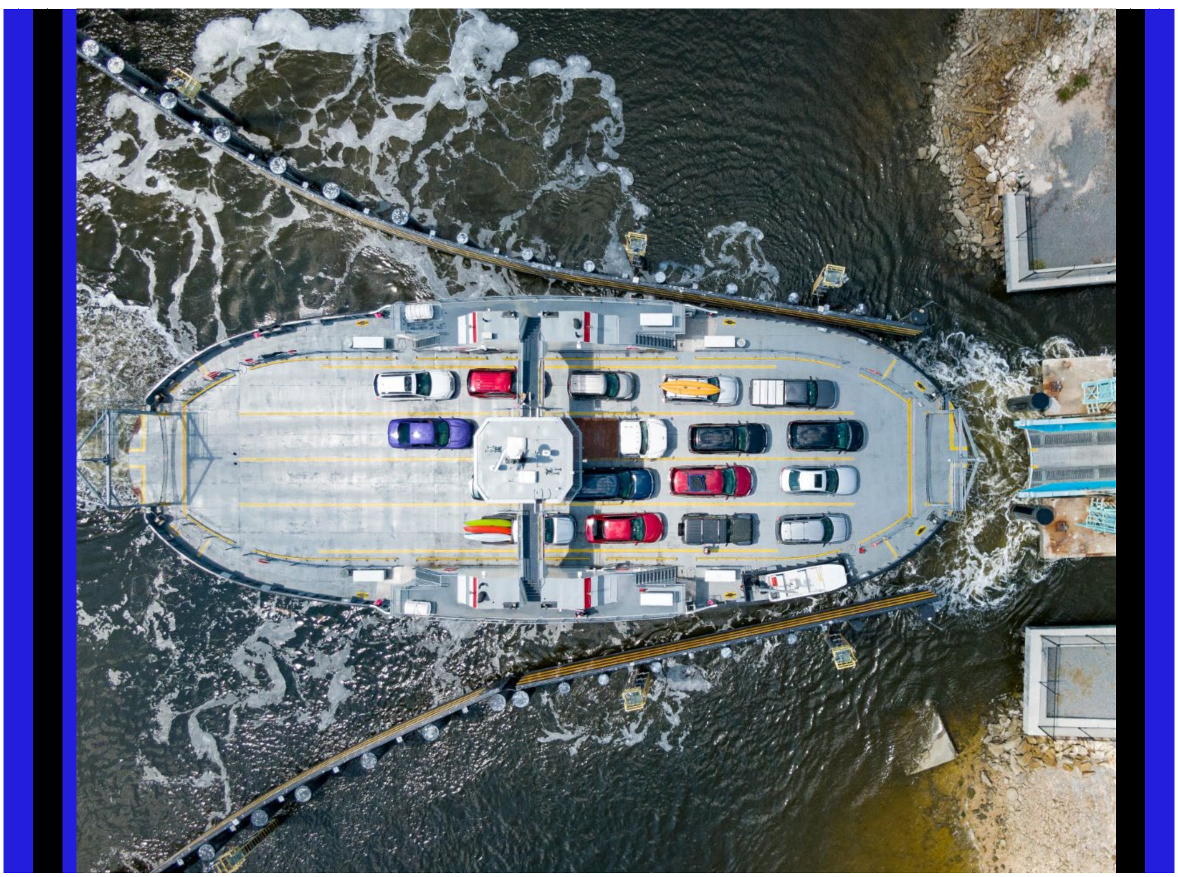
JTA

Ferry Vessel Replacement Feasibility Study
July 2, 2024



JTA Ferry Vessel Replacement Feasibility Study

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1. Executive Summary

The JTA operates the St. Johns River Ferry service which connects SR A1A from the Village of Mayport on the south side of the river to Fort George Island on the north side of the river. This ferry service has a history dating back to 1874, with the state road department developing a permanent service in 1948. The route of the ferry has remained unchanged from the original of the permanent service with the use of the same landings today. Over the years various agencies have operated the ferry service including FDOT, the City of Jacksonville and JAXPORT.

The JTA took over the ferry service in March of 2016 and continues to operate the ferry today. The JTA has worked to improve the safety, reliability and level of service offered by improving the infrastructure on both sides of the river and proactively maintaining the aging ferry, Jean Ribault. Understanding that the vessel has a limited service life, the JTA is proactively planning the replacement of this vessel.

The JTA obtained council approval and received local option gas tax funds in 2021. As part of the half billion-dollar program, the JTA committed to obtaining the replacement vessel for the St Johns River Ferry. To meet it's net zero carbon emissions goals by 2050, the JTA committed that the replacement boat will be a low- to zero-emissions ferry vessel. Thus, the JTA needed to determine the feasibility of the ferry vessel and begin the planning for acquiring the vessel. This study represents the effort to determine the feasibility of replacing the vessel.

The goals of the study are to provide decision guidance to the JTA as they move forward with the development of a new vessel for the ferry service. The goal is to balance the most cost-effective solution with the need to meet JTA's net zero 2050 goals. This can be achieved in a number of different ways with the understanding that the technologies will evolve, and the achievement of the net zero goals does not have to occur at the inception of the project but rather can be achieved over time with step wise improvements to the ferry emissions profile.

This study investigated:

1. Baseline Infrastructure and Vessel Characteristics
2. Baseline Operations
3. New Ferry Design Criteria
4. Alternative Fuels
5. Fueling Infrastructure Requirements
6. Jean Ribault Repowering
7. Layberth Requirements

The study investigated several alternatives for the shipboard power systems and alternative fuels for the new vessel. Table 1-1 below represents the various alternatives that the study investigated.

The study focused on three power platforms, Internal Combustion Engine Mechanical Platforms, ICE Electrical Platforms and All Electrical Platforms. Each of these three platforms could be fueled by a number of different fuel types and sources.

Table 1-1 - Summary of Alternatives Investigated

	Alternative Number	Vessel Platform
Internal Combustion Engine Mechanical Systems	ICE-1	Diesel ICE Mechanical
	ICE-2	BioDiesel ICE Mechanical
	ICE-3	Renewable Diesel ICE Mechanical
	ICE-4	CNG ICE Mechanical
	ICE-5	LNG ICE Mechanical
	ICE-6	Methanol ICE Mechanical
	ICE-7	Bio Methanol ICE Mechanical
Internal Combustion Engine Electric Systems	E-ICE-1	Diesel Electric Drive
	E-ICE-2	Bio Diesel Electric Drive
	E-ICE-3	Renewable Diesel Electric Drive
	E-ICE-4	CNG Electric Drive
	E-ICE-5	LNG Electric Drive
	E-ICE-6	Methanol Electric Drive
	E-ICE-7	Bio methanol Electric Drive
Electric Systems	E-1	Battery Electric
	E-2	Diesel Plug In Hybrid Electric
	E-3	Hydrogen Fuel Cell

An ordinal ranking system was developed to score these alternatives against the stated goals of the project. The scoring system balanced cost and qualitative factors related to the fuel, emissions, and operational considerations. For the ranking system, a lower score is better.

The final scoring of the options can be seen in Table 1-2 below. This ranking shows that electric ferries are a desirable alternative. Although they have higher capital costs, their lower annual maintenance costs and lower annual electricity costs make them a viable alternative. The alternative fuel driven diesel generator alternatives are also scored highly on the analysis. The fuels presented benefit from achieving net zero carbon status through carbon credits. Existing shoreside infrastructure is not required to be upgraded for these and the Jean Ribault can effectively run on these same fuels in a relief vessel capacity with few modifications.

Table 1-2 - Final Ordinal Rankings of Alternatives

Alternative Number	Vessel Platform	Total Cost Ordinal	Qualitative Evaluation Factor Ordinal	Combined Ordinal
E-1	Battery Electric	7.00	2.30	9.30
E-2	Diesel Plug In Hybrid Electric	7.67	2.15	9.82
E-ICE-3	Renewable Diesel Electric Drive	8.00	2.85	10.85
E-ICE-2	Bio Diesel Electric Drive	7.67	3.50	11.17
ICE-3	Renewable Diesel ICE Mechanical	8.33	2.85	11.18
E-ICE-5	LNG Electric Drive	7.33	4.00	11.33
ICE-2	BioDiesel ICE Mechanical	8.00	3.50	11.50
E-ICE-4	CNG Electric Drive	8.00	3.65	11.65
ICE-5	LNG ICE Mechanical	8.00	4.00	12.00
E-ICE-1	Diesel Electric Drive	6.67	5.35	12.02
E-ICE-6	Methanol Electric Drive	8.00	4.30	12.30
ICE-6	Methanol ICE Mechanical	8.33	4.30	12.63
ICE-1	Diesel ICE Mechanical	7.33	5.35	12.68
E-ICE-7	Bio methanol Electric Drive	9.33	3.35	12.68
ICE-7	Bio Methanol ICE Mechanical	9.67	3.35	13.02
ICE-4	CNG ICE Mechanical	10.00	3.65	13.65
E-3	Hydrogen Fuel Cell	17.00	4.65	21.65

The study was further refined to develop recommendations based on three scenarios. These scenarios were Net Zero from Day One Scenario, Low-Cost Scenario and the Cost and Net Zero Conformance Scenario. The top ranked systems from the overall ordinal ranking were placed into each of the three recommendation scenarios to further assist the decision making related to both cost and policy-based criteria.

These systems were presented to the Executive Leadership Team (ELT) on April 23, 2024. The ELT selected the diesel electric hybrid solution to present to the JTA Board of Directors. In addition, the ELT proposed that renewable diesel be used to power the generators to enhance the emissions reductions further. On May 22, 2024, the JTA Board of Directors selected this system as the basis for the new ferry vessel.

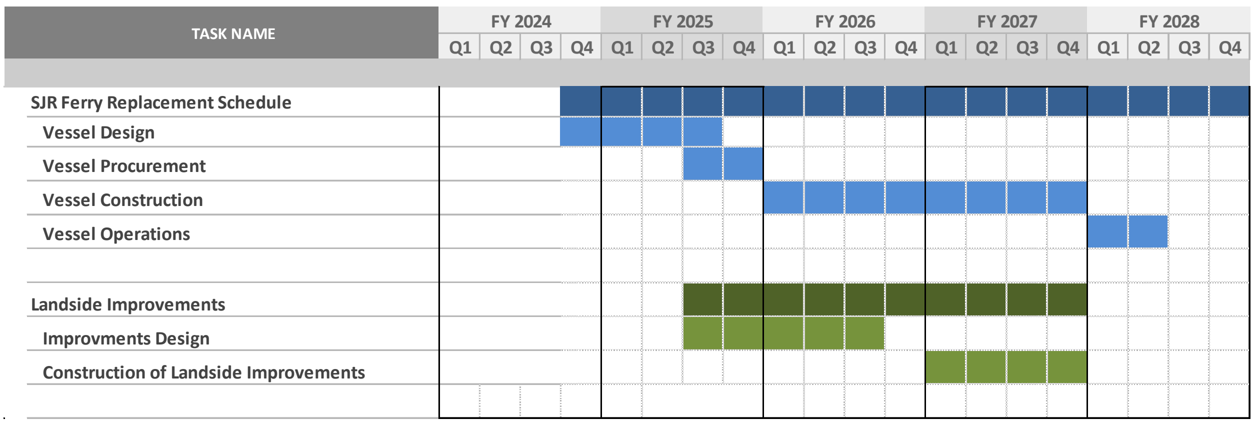
The project will proceed through conceptual design and vessel procurement. A Request for Information will be issued to the industry to gather input as to the current marketplace trends related to vessel design and procurement. This input will be used to drive the project forward.

The overall development time for the vessel is 54 months from the procurement of a naval architect, through the construction, and through the shake down and crew training periods.

The design of the upland improvements required to support the vessel will begin shortly after the final vessel concept is developed. It is anticipated that the design and construction of these features can be performed during the course of the vessel construction and therefore will not be on the critical path for the project.

Figure 1-1 - Project Schedule

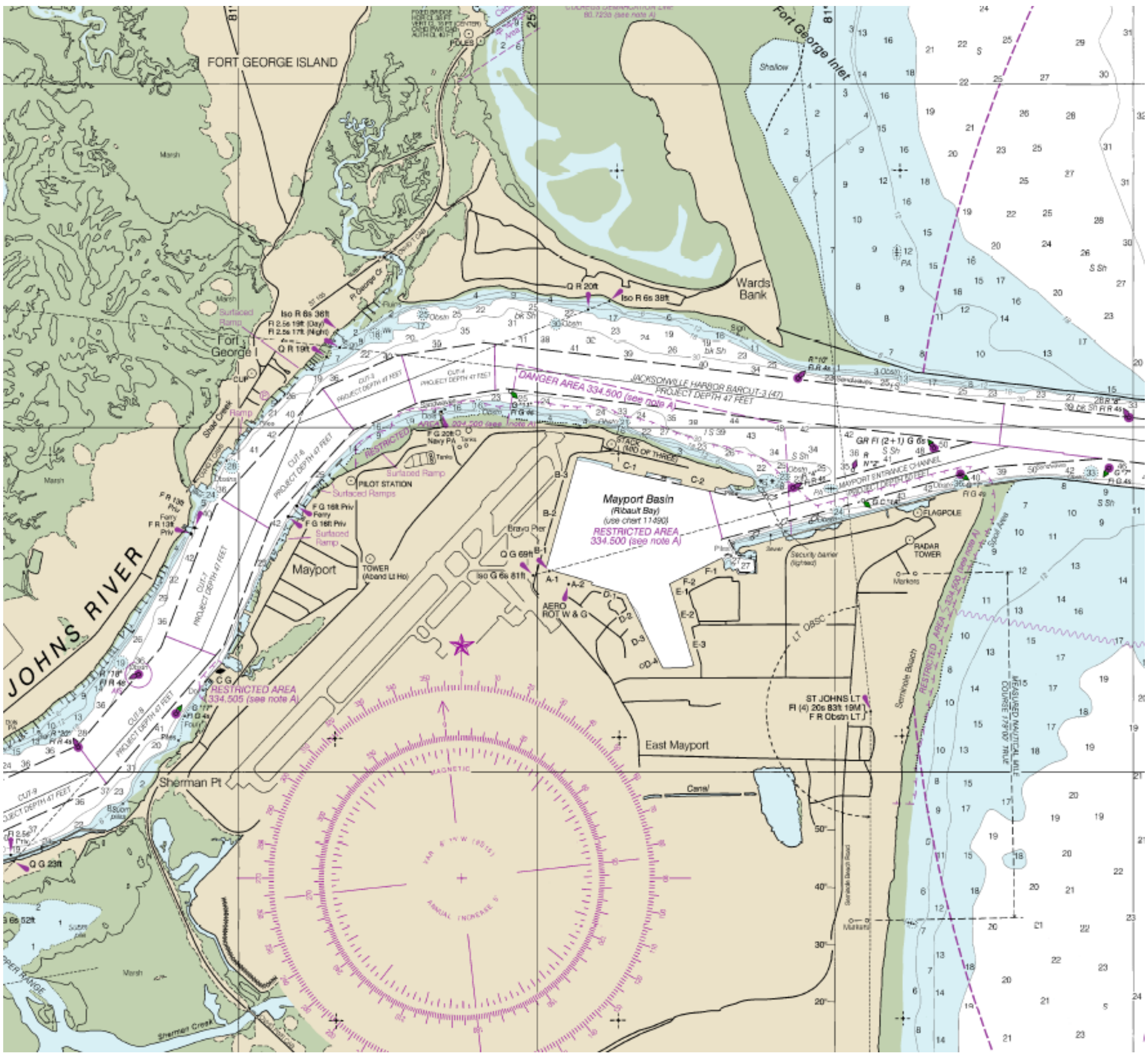
JTA LOGT Ferry Vessel Replacment Program Schedule



2. Background and Project Need

The JTA operates the St. Johns River Ferry service which connects SR A1A from the Village of Mayport on the south side of the river to Fort George Island on the north side of the river. This ferry service has a history dating back to 1874, with the state road department developing a permanent service in 1948. The route of the ferry has remained unchanged from the original of the permanent service with the use of the same landings today. Figure 2-1 presented below shows the context of the route that the ferry travels. One the south side, Mayport Naval Station can be seen.

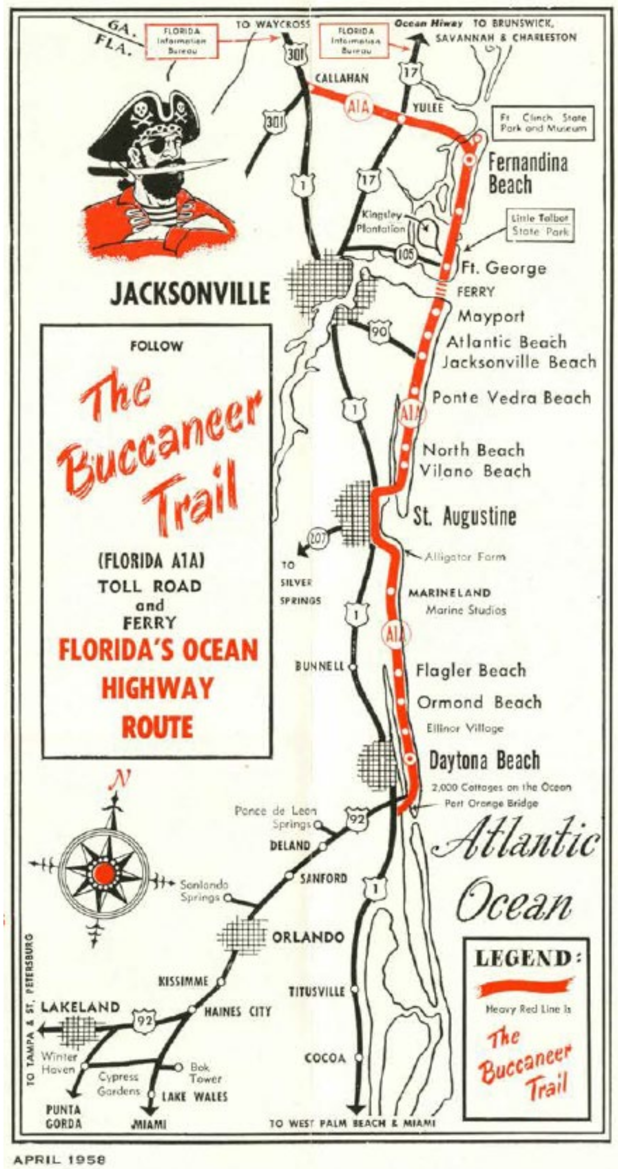
Figure 2-1 - Ferry Route Context



The route is approximately 0.4 miles across the river, with most of the route perpendicular to the flow of the river.

The current ferry service began in September of 1950 as part of the Buccaneer Trail alignment of S.R. A1A. The alignment of the Buccaneer Trail can be seen in Figure 2-2 Below.

Figure 2-2 The alignment of the Buccaneer Trail in 1958



(Courtesy of Brochure: The Buccaneer Trail, Florida A1A Avoid City Congestion Travel Florida's New Seashore Route – Along the East Coast. 1958. Regional and Rare Materials. University of North Florida, Thomas G. Carpenter Library Special Collections and Archives. UNF Digital Commons)

The ferry service utilized two ferries in a rotation, the Buccaneer that carried 36 cars and the Jean Lafitte which carries 21 cars. The ferry was an integral link connecting A1A across the river. In 1963, The Jean Lafitte was retired and replaced by the ferry Blackbeard. The Buccaneer and the Blackbeard were used in tandem until the mid 1990's when the Jean Ribault was put into service, replacing the Buccaneer.

The ferry service was operated by the Florida Department of Transportation from its inception to the mid 1990's when the operation of the service shifted to the City of Jacksonville. The city operated the ferry until 2007, when its operations were assumed by the Jacksonville Port Authority. During this time, the Jean Ribault was the main ferry in operation with the Blackbeard being utilized as a relief vessel when the

Jean Ribault was out of service for maintenance. It was decided to retire the Blackbeard in 2008, leaving the Jean Ribault as the only vessel operating the ferry service. Having a single vessel operating the service has caused some issues over the years as the service would need to be suspended when the Jean Ribault required maintenance.

The JTA took over the ferry service in March of 2016 and continues to operate the ferry today. The JTA has worked to improve the safety, reliability and level of service offered by improving the infrastructure on both sides of the river and proactively maintaining the aging ferry, Jean Ribault. Understanding that the vessel has a limited service life, the JTA is proactively planning the replacement of this vessel.

2.1 Existing Ferry Service Constraints

In discussions with the ferry operator and the JTA, the existing ferry service is operating well with the frequency of the service and capacity is not at issue. The service departs from each landing every 30 minutes, which meets the demands of the services users. The largest issue facing the ferry service at this time is when the only ferry vessel, the Jean Ribault is out of service. When the vessel is pulled from service for maintenance, the overall ferry service must be suspended.

The current ferry vessel, the Jean Ribault was launched in 1996. It was constructed at Atlantic Marine and Dry Dock (now BAE Shipyards). The vessel was originally used in conjunction with the Blackbeard to maintain the ferry service. The vessels were rotated and used in conjunction until the retirement of the Blackbeard in 2008. The two-vessel rotation allowed for the continued operations when one ferry was undergoing maintenance.

As noted above, the Jean Ribault was launched in 1996. The age of the vessel is closing in on 30 years. The expected life of this vessel can be in the 40-to-50-year range. The Blackbeard was in daily operation from 1956 to 1996 when it was relegated to the relief vessel status. It was repowered in 1998 and continued as the relief vessel until its final retirement in 2008. Overall, the vessel was 52 years old when it was retired. With the Jean Ribault continuing to age, plans to replace the vessel need to be developed.

At this time, The Jean Ribault is the only vessel used on the ferry service. This means that when it is taken out of service for maintenance the ferry service is suspended. The Jean Ribault recently went through an extensive maintenance operation and the ferry service was suspended for 14 weeks from January 25, 2023 to May 3, 2023. When the service is suspended, the detour is approximately 24 miles by car via I-295 over the Dame Point Bridge.

2.2 Commitment to Net Zero Green House Gas Emissions by 2050

As part of the Authority's commitment to reaching the goal of 90% reduction of green house gas emissions from 2005 levels by 2050 in alignment with Federal priorities, JTA will pursue the development of a no-emission or low-emission vessel. Globally, marine traffic is responsible for 3% of the world's GHG emissions. Marine vessels and their engine technologies typically use less refined fuel oils and diesel for power and the typically power demands are much larger than rolling vehicles due to the nature of marine transport. This makes vessels like the ferry significant GHG emitters. Developing a new ferry vessel with a no or low emissions profile would greatly contribute to meeting emissions reduction goals.

2.3 Study Objectives

The JTA obtained council approval and received local option gas tax funds in 2021. As part of the half billion dollar program, the JTA committed to obtaining the replacement boat for the St Johns River Ferry. The JTA estimated the cost of the ferry vessel and associated upland infrastructure development to be

$16.8M. However, the JTA committed that the replacement boat will be a low- to zero-emissions ferry vessel. Thus, the JTA needed to determine the feasibility of the ferry vessel and begin the planning for acquiring the vessel.

Considering the above topics, the purpose of the study is multi-faceted. First, with the Jean Ribault approaching 30 years in service, a plan to replace this vessel has been developed. The geometric and power requirements for the new vessel have been established. A baseline analysis of the existing infrastructure, the existing vessel operations and the space constraints of the ferry landings have also been studied. The basis of design for the new ferry can will be developed based on the established criteria.

The new vessel has the opportunity to utilize modern and cutting edge no and low emissions marine power technologies. The use of alternative liquid fuels, electric power, and hydrogen power for the main shipboard power has been studied. In addition, the shore side support systems for each fueling alternative will have been studied and their development costs are understood and were used in the evaluation of the alternatives.

With a new vessel in service, there is an opportunity to re-task the Jean Ribault as a relief vessel for the new main vessel. This is similar to the changing of the role of the Blackbeard as mentioned above. The Jean Ribault could be repowered to match the power systems of the new ferry, reducing the GHG emissions of the vessel. If a two vessel system is desired, layberth facilities will need to be developed that can accommodate the idle ferry safely and securely. Costs and conceptual layouts for a layberth have been developed as part of this study.

Finally, the study reviewed the existing administrative and maintenance facilities of the ferry service and options were investigated to optimize and combine them to one landing location. Currently, the administration building and fueling infrastructure are on the Mayport side and the Maintenance warehouse and crew break room are on the Ft. George side. Available real estate and open spaces at each landing have also been evaluated for the ability to support this option.

In summary, this feasibility study investigated:

1. Baseline Infrastructure and Vessel Characteristics
2. Baseline Operations
3. New Ferry Design Criteria
4. Alternative Fuels
5. Fueling Infrastructure Requirements
6. Layberth Requirements

The information gathered in the above tasks were used to compare the vessel platform alternatives in an overall alternatives matrix that considered quantitative costs along with qualitative metrics regarding ease of operations and percentage of emissions reductions.

A final recommendation for the new ferry, upland infrastructure and layberth is summarized at the end of this report and a total cost for the alternative will be outlined and explained.

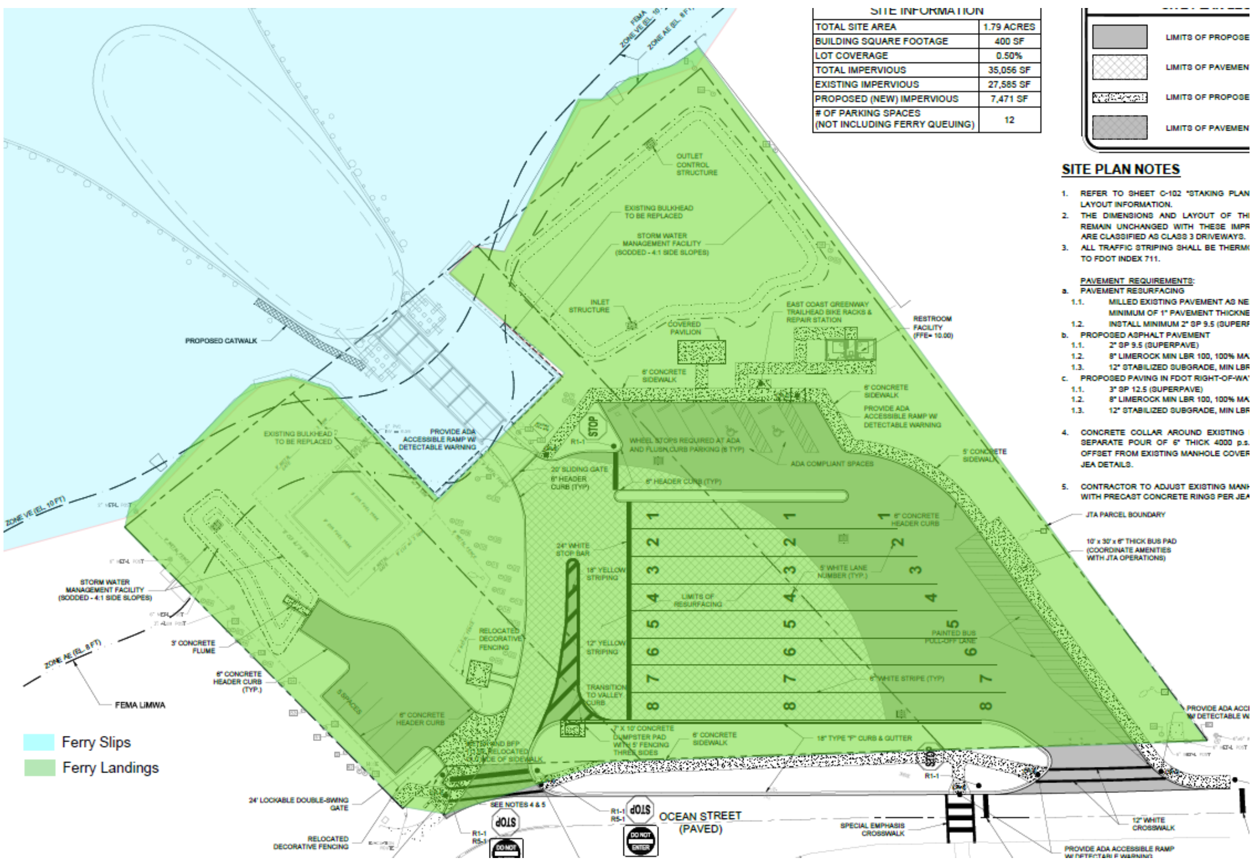
Finally, a path forward for the development of the recommended alternative will be explained. This will include discussions about procurement methodologies, funding opportunities and overall project schedule.

3. Baseline Analysis

The ferry service in its current form has been in operations since 1948. The method of operation and infrastructure has been upgraded over the years to improve safety, quality and timeliness of the ferry's operations. To look at the feasibility of improvements over the existing operational methodologies, the existing conditions should be understood. The baseline conditions for the facility will be analyzed as will the current operational service modes.

For the purposes of the discussions throughout the documents, the term ferry slips will refer to the marine structures, ramp assemblies and bulkheads associated with the docking of the ferry. The term ferry landing will refer to the upland infrastructure including the parking, queuing, buildings, and other upland open spaces associated with the ferry. In Figure 1 below, the division between the ferry slips (blue shading) and the ferry landings (green shading) is shown.

Figure 3-1 - Example showing designation of ferry slips and ferry landings.



3.1 Recent Infrastructure Upgrades and Repairs

The JTA has undertaken a series of improvements to the ferry slips and ferry landings since their assumption of the service from the Jacksonville Port Authority. This development was performed in various phases, I, II, III and IV. Phase V design documents are currently under development. Phases I-III included replacement of the slipwalls and repairs to the ramps or link spans, as well as improvements and repairs to the ramp gantries and gantry pile caps. Phase IV included a myriad of upland developments, including storage buildings, breakroom and bathroom improvements, queuing areas and other general site improvements to the landings.

Phase V will include construction of bulkhead walls along the shorelines at both the Mayport and Ft. George ferry landings.

A summary of the infrastructure improvements can be seen in Table 3-1 Below.

Table 3-1 – St. Johns River Ferry Improvements Projects Through 2023

Phases	Scope
I (Complete)	Demolition of pile boxes, fender systems, walkways, lights and ancillary components, and design and construction of new ferry slipwalls, fender piles, rescue ladders and lights.
II (Complete)	Removal of existing terminal bridges along with design and construction of rehabilitated or new bulkheads, replacement of terminal bridges and installation of stopping mechanisms.
III (Complete)	Removal of existing terminal bridges along with design and construction of rehabilitated or new bulkheads, replacement of terminal bridges and installation of stopping mechanisms.
IV (Complete)	Addition of Ultra High Molecular Weight vertical panels to the slipwalls, site safety and ADA improvements at Ferry terminals including new bulkheads and new public restrooms, increased vehicle queuing capacity at Mayport, and a warehouse facility at Ft George.
V (In Progress)	Extension of bulkhead walls at both the Mayport and Ft George landings, catwalk access and mooring bollards at Ft George, warehouse equipment and systems, improved signage, bridge gantry preservation and rehabilitation and Ft George breakroom renovations.

3.2 Existing Ferry Slips

The ferry slips at Mayport and Fort George have been in their current alignment since the inception of the modern ferry service Mayport. The marine structures have varied over the years, from timber dolphins to steel and timber fender structures, and currently utilizing modern composite fiber reinforced polymer (FRP) materials. The principals of the slipwall geometry have remained unchanged. They provide a wide area to begin the docking navigation and allow for the ferry to proceed towards the ramp and are ultimately guided into the final location by the narrowing slipwalls. The ramp is lowered onto the deck sill of the ferry and the vehicles unload.

The ramps are supported by gantry structures that allow for the ramp to be raised and lowered to match the draft of the vessel and tidal conditions. The ramp structures are classified as a movable bridge and are required to be inspected biannually as part of the National Bridge Inventory.

As the ramp must span a considerable length to accommodate a drivable and walkable slope the land side of the bridge is set back from gantry and a basin was formed. The basin requires bulkhead structures to separate the backlands from the dredged basin.

3.2.1 Mayport Slips

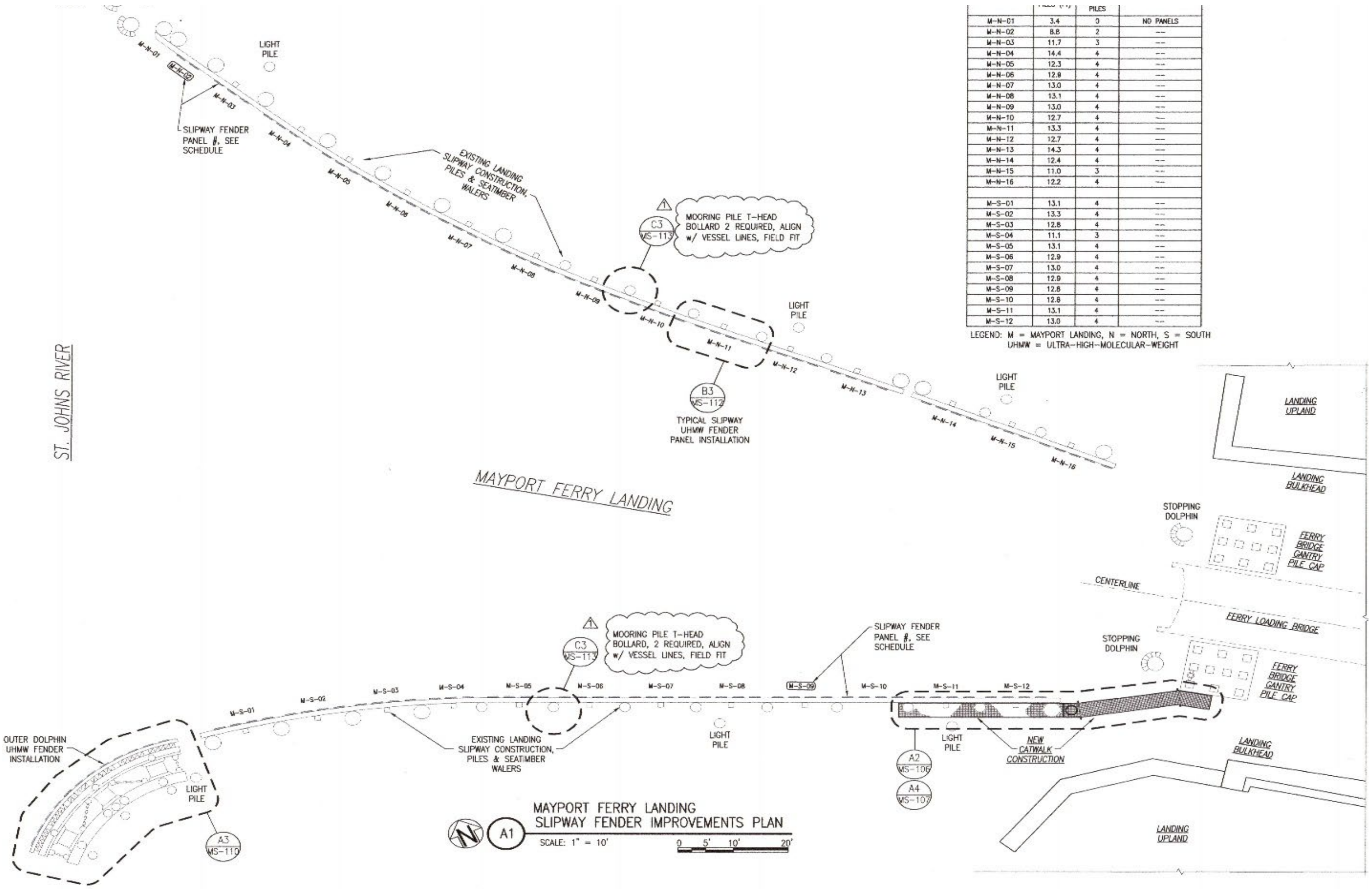
The Mayport slips were almost completely reconstructed during the slip replacement project, with only one dolphin remaining from the existing structure. The new structure consists of vertical composite piles aligned into two slipwalls with composite timbers spanning horizontally to serve as the breasting surface for the vessel. The slip wall alignment can be seen below in Figure 3-2. There is a steel pile supported curved dolphin at the northern most end of the west slipwall that was constructed during the last major ferry slip maintenance project in 1996.

The gantries, gantry pilecaps and the ramp structures were all rehabilitated in the Phase IV slip reconstruction project. The steel gantries were repaired and repainted with the mechanical hoists being repaired as well. The concrete gantry pile caps were repaired. The ramp itself underwent extensive rehab, being removed from its position and repaired on land and repainted. The bearings were rehabbed as well before the bridge was replaced.

In addition, the bulkheads around the ramp basin were reconstructed, extended and a new concrete cap was constructed. An overview of the Mayport ferry slip can be seen in the photo in Figure 3-3.

The slipway includes mooring hardware to allow for the layberth mooring inside the slip.

Figure 3-2 - Overall Layout of Mayport Slips



		PILES	
M-N-01	3.4	0	NO PANELS
M-N-02	8.8	2	--
M-N-03	11.7	3	--
M-N-04	14.4	4	--
M-N-05	12.3	4	--
M-N-06	12.8	4	--
M-N-07	13.0	4	--
M-N-08	13.1	4	--
M-N-09	13.0	4	--
M-N-10	12.7	4	--
M-N-11	13.3	4	--
M-N-12	12.7	4	--
M-N-13	14.3	4	--
M-N-14	12.4	4	--
M-N-15	11.0	3	--
M-N-16	12.2	4	--
M-S-01	13.1	4	--
M-S-02	13.3	4	--
M-S-03	12.8	4	--
M-S-04	11.1	3	--
M-S-05	13.1	4	--
M-S-06	12.9	4	--
M-S-07	13.0	4	--
M-S-08	12.9	4	--
M-S-09	12.8	4	--
M-S-10	12.8	4	--
M-S-11	13.1	4	--
M-S-12	13.0	4	--

Figure 3-3 - View of Mayport Slipwalls after Phase IV

Phase V plans are currently under development and portions of the construction have begun. The main features of Phase V include spot repairs of the slipwall timbers and minor repairs to the gantry.

Based on visual inspections and conversations with the ferry operator, the slipwalls, ramps, gantry and other marine structures are performing well. There were conversations had regarding the extents of the horizontal timbers above and below the waterline. At extreme tide conditions, the belting around the Jean Ribault can wedge under the lower timber and get hung up on the upper timber. Future vessels and modifications to the slip should take this into account.

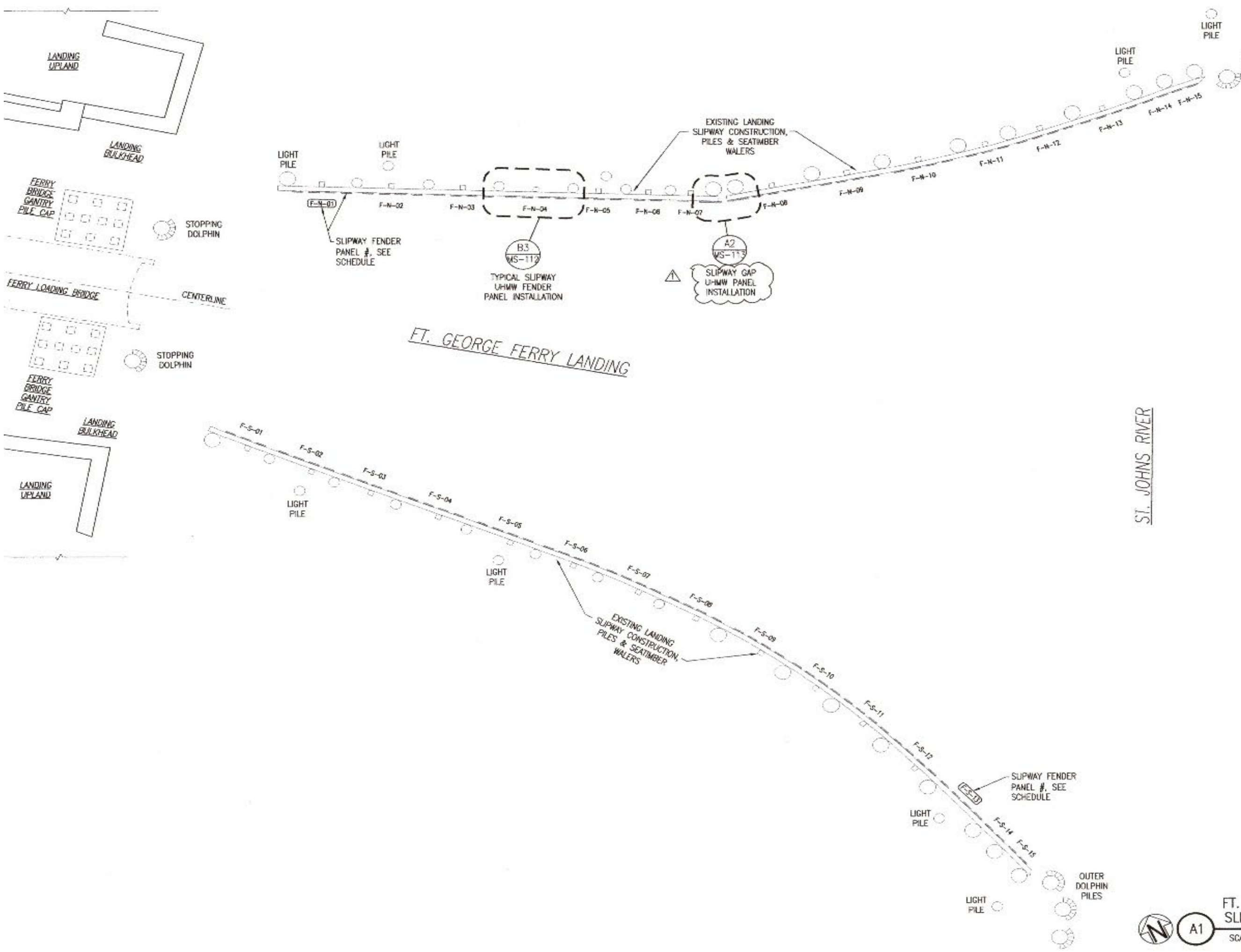
3.2.2 Fort George Slips

The Fort George slips were completely reconstructed during the slip replacement project. The new structure consists of vertical composite piles aligned into two slipwalls with composite timbers spanning horizontally to serve as the breasting surface for the vessel. The slip wall alignment can be seen below in Figure 3-4.

The gantries, gantry pilecaps and the ramp structures were all rehabilitated in the Phase IV slip reconstruction project. The steel gantries were repaired and repainted with the mechanical hoists being repaired as well. The concrete gantry pile caps were repaired. The ramp itself underwent extensive rehab, being removed from its position and repaired on land and repainted. The bearings were rehabbed as well before the bridge was replaced.

In addition, the bulkheads around the ramp basin were reconstructed, extended and a new concrete cap was constructed. An overview of the Fort George ferry slip can be seen in the photo in Figure 3-5.

Figure 3-4 - Overall Layout of Fort George Slips



SLIPWAY FENDER UHMW PANEL SCHEDULE
FT. GEORGE FERRY LANDING

SLIPWAY FENDER PANEL MARK	PANEL WIDTH BETWEEN PILES (FT)	PANELS @ 3' O.C. CENTERED BETWEEN PILES	REMARKS
F-N-01	12.8	4	---
F-N-02	13.2	4	---
F-N-03	12.4	4	---
F-N-04	13.6	4	---
F-N-05	9.8	3	---
F-N-06	8.1	3	---
F-N-07	7.9	1	SEE GAP REPAIR
F-N-08	14.4	4	SEE GAP REPAIR
F-N-09	13.1	4	---
F-N-10	14.5	4	---
F-N-11	9.7	3	---
F-N-12	12.7	4	---
F-N-13	12.2	4	---
F-N-14	6.0	2	---
F-N-15	5.9	2	---
F-S-01	11.1	3	---
F-S-02	12.9	4	---
F-S-03	12.3	4	---
F-S-04	13.9	4	---
F-S-05	13.7	4	---
F-S-06	12.5	4	---
F-S-07	12.7	4	---
F-S-08	12.9	4	---
F-S-09	14.5	4	---
F-S-10	11.6	4	---
F-S-11	12.6	4	---
F-S-12	12.6	4	---
F-S-13	12.5	4	---
F-S-14	6.0	2	---
F-S-15	6.8	2	---

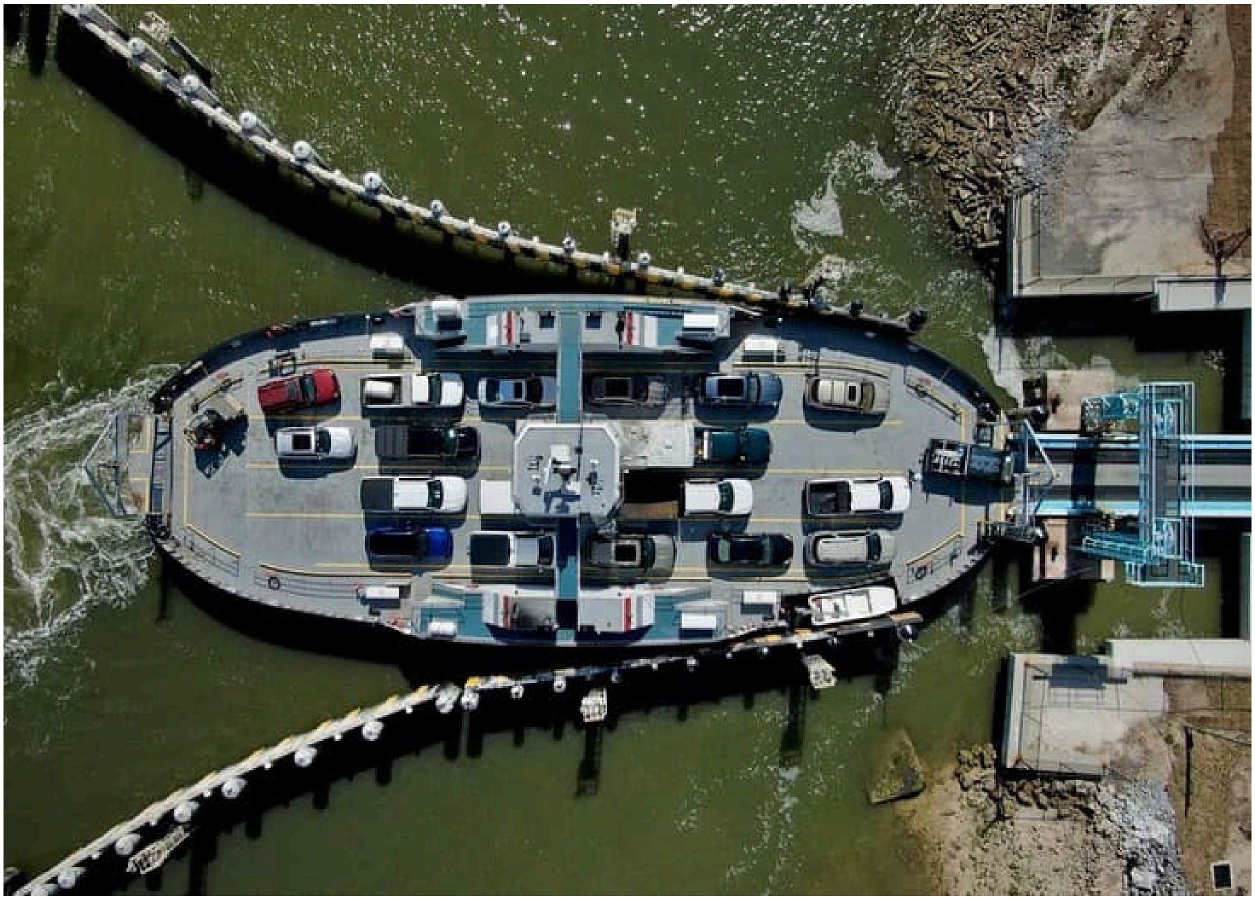
LEGEND: F = FT GEORGE LANDING, N = NORTH, S = SO
UHMW = ULTRA-HIGH-MOLECULAR-WEIGHT

GENERAL NOTES

1. FIELD VERIFY ALL CONSTRUCTION SHOWN AS EXISTING INC DIMENSIONS, ANGLES AND ELEVATIONS PRIOR TO COMMENC
2. ALL FORMED EXPOSED CONCRETE CORNERS ¾" CHAMFER.

A1 FT. GEORGE FERRY LANDING
SLIPWAY FENDER IMPROVEMENTS PLAN
SCALE: 1" = 10'

Figure 3-5 - Ft. George Slip Aerial View



Phase V plans are currently under development and portions of the construction have begun. The main features of Phase V include spot repairs of the slipwall timbers and minor repairs to the gantry.

Based on visual inspections and conversations with the ferry operator, the slipwalls, ramps, gantry and other marine structures are performing well. There were conversations had regarding the extents of the horizontal timbers above and below the waterline. At extreme tide conditions, the belting around the Jean Ribault can wedge under the lower timber and get hung up on the upper timber. Future vessels and modifications to the slip should take this into account.

3.3 Existing Ferry Landings Infrastructure

The ferry landings are the upland areas adjacent to each slipway and ramp structure. The landings contain operational areas such as the fueling areas, the maintenance storage, the queuing lanes for vehicles waiting to board, and other utilities. They contain amenity areas including restrooms, shelters for pedestrians, bike repair furniture, benches and other passenger amenities. These facilities were developed over the course of several different projects and the landings were improved significantly during the Phase IV improvements project. Each landing area is described below.

3.3.1 Mayport Landing

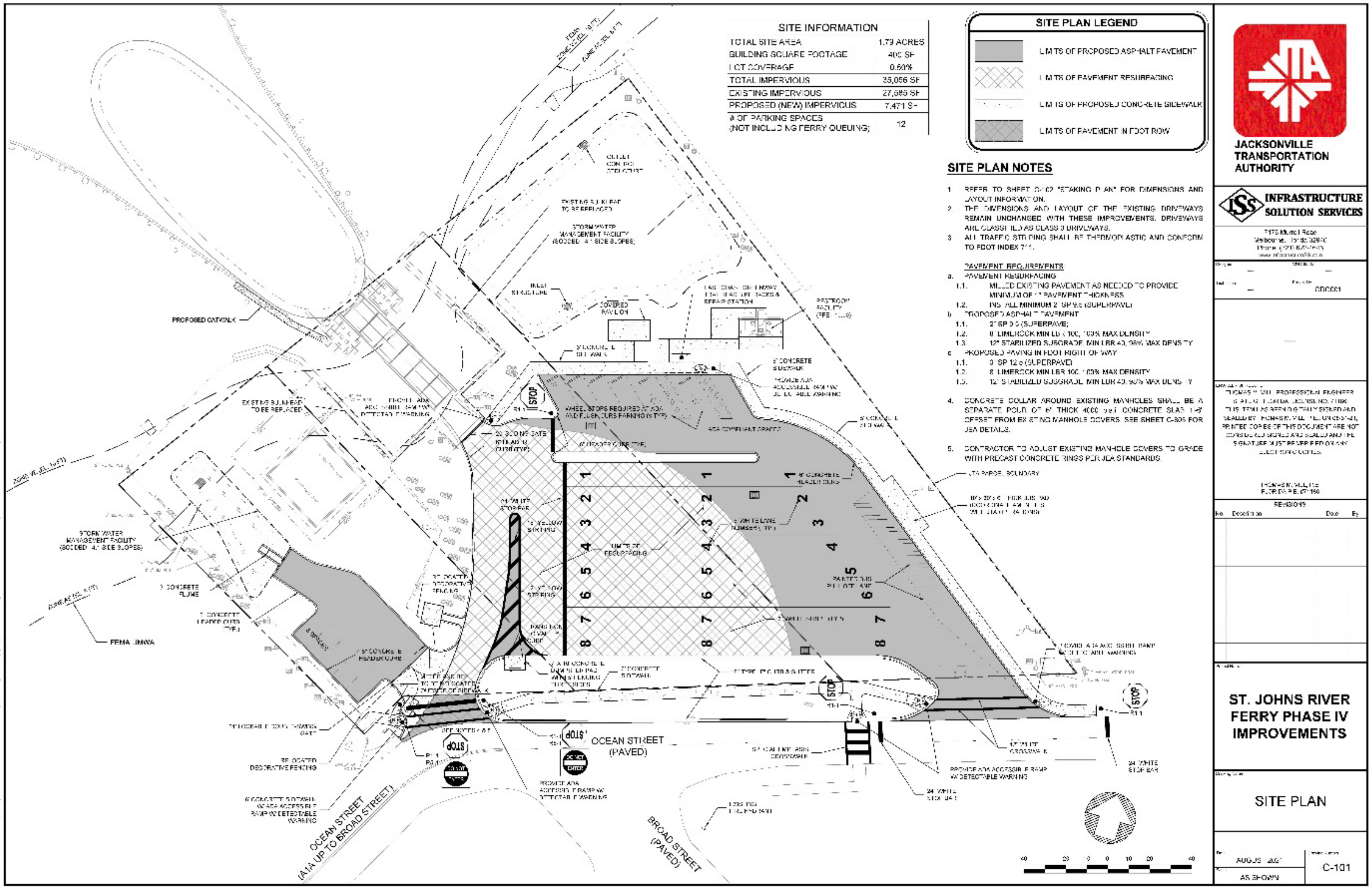
The Mayport ferry landing has an overall acreage of 1.79 acres. The impervious area is 35,056 square feet. There are 975 linear feet of queuing lanes and 12 permanent parking spaces. There is a bus stop on the east end of the site. The majority of the open space is covered by 9,700 square feet of dry retention ponds.

There are three building type structures on the site including an enclosed bathroom that is approximately 185 square feet, a covered pavilion that is 200 square feet, and a small storage building that is 50 square feet.

Overall there are two areas on the site that would be suitable for additional development. These areas are both on either side of the diesel fuel tank. These areas are 1,300 and 1,500 square feet respectively. If the fuel tanks are removed to accommodate a new fueling system, an area of approximately 5,000 square feet of contiguous space would be available for development.

The existing condition is reflected by the Phase IV development plans shown below in Figure 3-6.

Figure 3-6 - Mayport Ferry Landing Existing Condition



The Phase V improvements show the construction of a sheet pile bulkhead along the entirety of the waterfront at this site. This new wall will help with stabilizing the shoreline, preventing erosion and improving safety to the users of the upland areas. In addition, it can potentially increase the developable upland areas specifically related to areas near the ferry slips which will be an ideal location for fueling infrastructure.

Overall, there is reasonable room to develop the needed upland support infrastructure for potential fueling operations. If the drainage detention dry ponds are reworked and deepened, sufficient space for other potential administrative facilities can be developed. It might also be possible to construct an elevated, pile supported structure at the site over the top of the drainage ponds to better utilize the site.

3.3.2 Fort George Landing

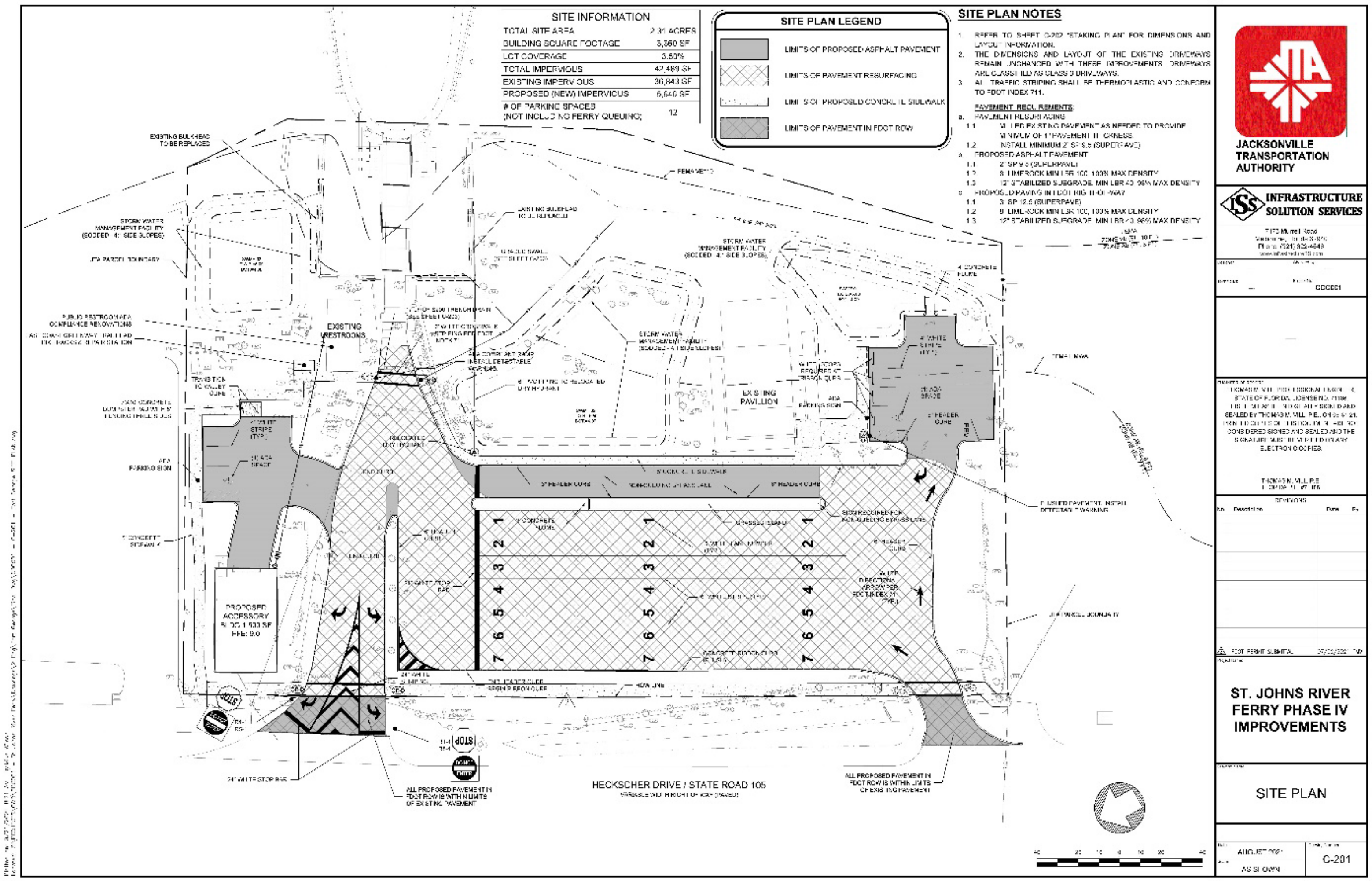
The Fort George ferry landing has an overall acreage of 2.31 acres. The impervious area is 42,489 square feet. There are 1,246 linear feet of queuing lanes and 12 permanent parking spaces. There is a parking area supporting a large, covered pavilion. There is a bypass lane to allow the pavilion users to avoid getting caught in the queuing traffic. The majority of the open space is covered by 13,595 square feet of dry retention ponds.

There are three building type structures on the site including a bathroom and crew breakroom that is approximately 550 square feet, a covered pavilion that is 1,310 square feet, and a storage building that is 1,500 square feet.

Overall there is one area on the site that would be suitable for additional development. This area is west of the ferry ramp basin, along the property shoreline and south of the pond detention structure. This area is approximately 5,000 square feet.

The existing condition is reflected by the Phase IV development plans shown below in Figure 3-7.

Figure 3-7 - Fort George Landing Existing Conditions



The Phase V improvements show the construction of a sheet pile bulkhead along the entirety of the waterfront at this site. This new wall will help with stabilizing the shoreline, preventing erosion and improving safety to the users of the upland areas. In addition, it can potentially increase the developable upland areas specifically related to areas near the ferry slips which will be an ideal location for fueling infrastructure.

Overall, there is reasonable room to develop the needed upland support infrastructure for potential fueling operations. If the drainage detention dry ponds are reworked and deepened, sufficient space for other potential administrative facilities can be developed. It might also be possible to construct an elevated, pile supported structure at the site over the top of the drainage ponds to better utilize the site.

3.4 Existing Utility and Fueling Infrastructure

On the Mayport Side, there are power manholes and a transformer at the east end of the property. Any new power going to site features would likely come from this location.

The existing diesel fuel tanks are at the western edge of the property, contained in a fenced in area. The tanks are on raised cradles supported by a foundation and slab that is 34' x 32' in dimension. There is a two foot high solid containment wall around the perimeter to the slab. A 6" diameter fuel line crosses the top of the bulkhead cap and connects the fuel tanks to a manifold on the gantry pile cap that is used to connect a line for fueling of the ferry.

The tanks are 10,000 gallons each, for a total of 20,000 gallons of on-site diesel storage. The tanks are in good condition and the mechanical pumping equipment and other electrical sensoring is in good working order. These tanks would be suitable for re use with other liquid fuels such as bio diesel and renewable bio diesels. Methanol would require the tanks to be upgraded to stainless steel as methanol is highly corrosive.

3.5 Jean Ribault Configuration

The existing Jean Ribault is 153.6' in length with a beam of 56'. The operational draft is approximately 7.5'. The vessel is an open decked, double ended vessel with the licensed capacity of 38 Personally Operated Vehicles (POV) and 200 passengers. The vessel is considered to be a ROPAX ferry with accommodations for "Roll on Roll Off" (RO) and pedestrian passengers (PAX).

The POV's are accommodated in 4 vehicles lanes on the deck. The two center lanes are approximately 115' in length and two outer lanes are 110' in length for a total of 450 lane feet on the vessel. An overhead aerial view of the vessels can be seen in Figure 3-8 below. The lanes are marked by the yellow stripes on the deck.

Passengers can be accommodated in standing areas on the perimeter of the vessel and with seated areas inside the bridge superstructure on either side of the deck. The deck house allows for the passengers to escape inclement weather, but the space is not conditioned as the vessel trip is very short. The photo in Figure 3-9 below, shows the deck, deck house and bridge configurations.

The captain pilots the vessel from an overhead bridge deck that spans the open vehicle deck below. The bridge is a double-sided structure allowing for operations of the ferry in both directions from the same bridge. See Figure 3-10 below for a close-up view of the bridge house.

The ferry propulsion consists of a 67" screw and rudder at each end of the vessel. The power is provided by two EMD 645E, 975 HP, V-8 Diesel engines. Ship hoteling power is provided by 2, Detroit Diesel 4-71 model 1044-7002 at 60 kW each. There is also a 30kW emergency generator. In the refit of the vessel in 2015, the engines were upgraded to tier II emissions compliance.

Figure 3-8 - Aerial view of Jean Ribault

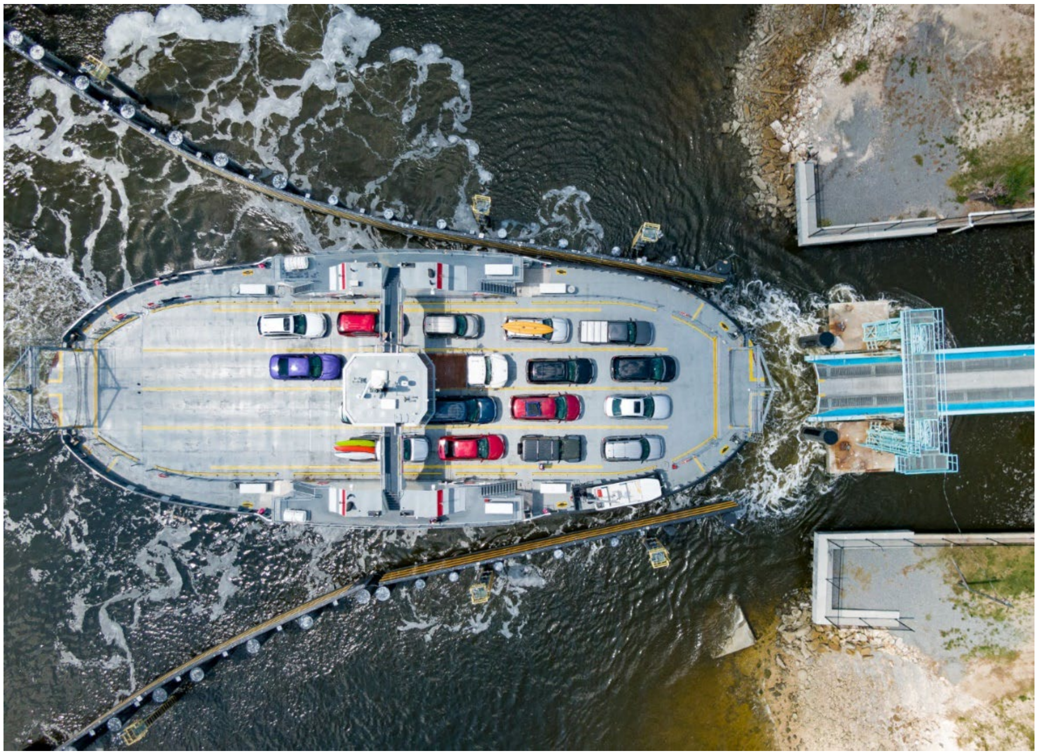
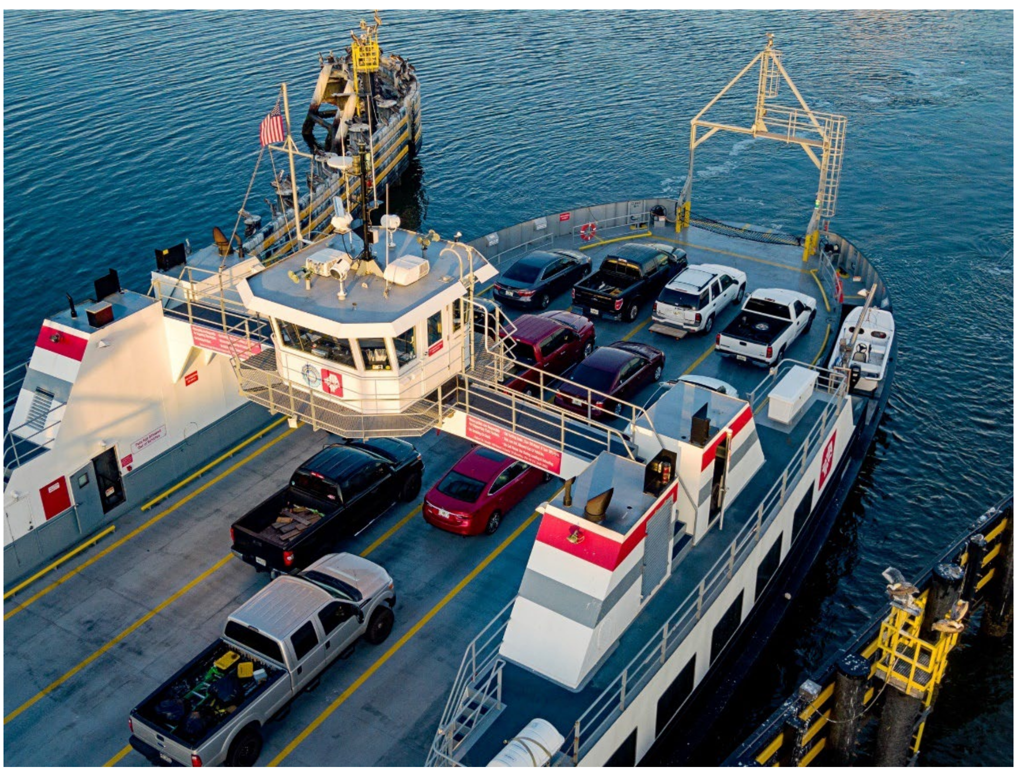


Figure 3-9 - View of Jean Ribault, Open Deck and Deck House

Figure 3-10 - Jean Ribault Bridge House



The latest refurbishment of the ferry took place between January and May of 2023. The vessels was pulled from the water and major hull maintenance was undertaken. See Figure 3-11 for a photo of the vessel out of the water during its last dry docking. Note that major rehab and full painting of the vessels hull was conducted.

Figure 3-11 - Jean Ribault during Dry Docking January to May 2023

According to the ferry operator, Hornblower Marine Services, regarding the vessels power demands and maneuverability the navigation of the crossing, though short, is complex due to the significant and variable currents that the vessel encounters during the crossing. Working back against the current on the approach to the slips allows the vessel to be closely controlled and minimizes the amount of contact that the vessel has with the slipways. This requires a significant amount of power to perform the docking maneuvers in this manner. In the past, previous ferries were heavy and underpowered as compared to the Jean Ribault, requiring extreme precision and frequent slipwall contact was expected. The ebb current at this location can reach 6 feet per second, with the flood current reaching 5 feet per second.

The ferry is operated engaging both engines at the same time, with a pushing operation from the stern propeller and a pulling operation from the bow propeller. The bow propeller will be engaged during the final docking to act as a bow thruster to both align the bow and perform braking to slow the vessel on its final approach.

HMS has stated that matching the power of the new vessel to the power of the Jean Ribault is sufficient to meet the most demanding navigational needs of the crossing and will allow them to match the speed and performance of the existing crossing. Therefore a 2000 HP platform will be considered the minimum for the new vessel. See the photo in Figure 3-12 of the Jean Ribault working back upriver when approaching the Mayport slips for a demonstration of the navigational techniques used.

Figure 3-12 - Jean Ribault on approach to Mayport Slips on Ebb current

3.6 Existing Grant Analysis

As changes are contemplated to the vessel and the upland infrastructure, it is important to understand the limitations related to redeveloping the infrastructure that was funded by previous grants. Infrastructure that was built by grant funding can not be demolished or removed until it reaches the end of its useful life without reimbursement of the original grant funding.

An analysis of the documentation for grants received for construction and maintenance of the ferry vessel and the ferry landside infrastructure was performed. The JTA reviewed the documents to understand the grants, grant periods of performance, and the useful life of the infrastructure constructed with grant funding. A summary table was developed that lists the grants, the period of performance and the infrastructure components The entirety of the table is shown in Appendix B at the end of this report.

The infrastructure elements are shown in the table and their useful life is shown in parentheses following the description. The highlighted items in the table are elements that will be reaching and passing their useful life. This analysis will be used as a guide during the development of the infrastructure with the intent to minimize impacts to the grant funded infrastructure. This will allow the JTA to maximize the use of new funding sources without the requirement to reimburse for the grants.

The highlighted infrastructure are features that are near the end of their useful life and will likely not be affected by any changes made to the facility during this project.

4. Operational Analysis

4.1 Schedule Overview

The ferry currently runs 7 days a week with varying operating times. See Table 4-1 below for the starting and ending trip times from each destination. The ferry will begin its first trip at the time shown and subsequent trips from each landing will be every 30 minutes.

The schedule is based on a 15 minute voyage including loading, unloading, docking, and transit times. The vessel idles in the slipway for approximately 5 minutes during the loading and unloading process. Once the vessel is loaded with cars and passengers, the ferry will begin to navigate under near full power to leave the slipway and travel to the main channel. The ferry will then travel across the river to the opposite slip under a reduced power. As the ferry approaches the opposite dock, the ferry will begin to navigate under full power as the ferry approaches the slip. Once, docked, the ferry will idle under low power while the loading and unloading process takes place.

Table 4-1 - Ferry Operating Times

Day of Week	Mayport First Trip	Mayport Last Trip	Fort George First Trip	Fort George Last Trip
Monday-Thursday	06:00	19:00	06:15	19:15
Friday	06:00	20:30	06:15	20:45
Saturday – Sunday	07:00	20:30	07:15	20:45

The time that the ferry is in the slipway is approximately 5 minutes. Any type of power charging during this time frame will need to be fast charging and will need to be accomplished in this short period of time.

4.2 Round Trip Timing and Power Requirements

The power demands from the propulsion vary at different times during the idle times at the dock, navigating, and then cruising across the route. A summary of power demands over a typical voyage is shown in Table 4-2 below.

Table 4-2 - Power Profile Average Trip

Time (min.)	Stage	Power Requirement (% Max Power)	Power Requirement (kW)	Energy Requirement (kWh)
1	Idle in Slip	10%	149.2	2.49
2	Idle in Slip	10%	149.2	2.49
3	Idle in Slip	10%	149.2	2.49

Time (min.)	Stage	Power Requirement (% Max Power)	Power Requirement (kW)	Energy Requirement (kWh)
4	Idle in Slip	10%	149.2	2.49
5	Idle in Slip	10%	149.2	2.49
6	Leaving Dock	85%	1268.2	21.14
7	In Transit	50%	746	12.43
8	In Transit	50%	746	12.43
9	In Transit	50%	746	12.43
10	Arriving Dock	85%	1268.2	21.14
11	Idle in Slip	10%	149.2	2.49
12	Idle in Slip	10%	149.2	2.49
13	Idle in Slip	10%	149.2	2.49
14	Idle in Slip	10%	149.2	2.49
15	Idle in Slip	10%	149.2	2.49
			Total Power per Trip	**104.44**

4.3 Number of Trips and Total Power Usage

The current operating hours for the St. Johns River Ferry service are shown in table 4-3 below along with the number of trips that are completed on the average day, based on a 15 minute trip time. A total energy demand for the ferries operation is shown in the last column.

Table 4-3 - Total Trips and Daily Energy Requirements

Day of the Week	Hours of Operation	Number of Trips	Energy Requirements (kWh)
Monday	0600-1930	54	5639.76
Tuesday	0600-1930	54	5639.76
Wednesday	0600-1930	54	5639.76
Thursday	0600-1930	54	5639.76

Day of the Week	Hours of Operation	Number of Trips	Energy Requirements (kWh)
Friday	0600-2100	60	6266.40
Saturday	0700-2100	56	5848.64
Sunday	0700-2100	56	5848.64

The energy shown above will be used for the baseline energy requirement for all various sources of energy.

4.4 Existing Fueling Study

The Jean Ribault is fueled with low sulfur diesel every two weeks, with an average fuel onload between 5,000 and 6,000 gallons. Assuming a 6,000 gallon burn over 14 days, an average daily consumption of approximately 429 gallons is calculated. The total energy expended by the ferry during the average day to compare to the energy requirements calculated in Table 4-3. The Table 4-4 below shows the computed values of this energy.

Table 4-4 - Fuel Consumption Study

Number of Gallons per Day	Conversion of Diesel gallons to (kWh) (37 kWh/gallon)	Engine Efficiency	Power to Shaft (kWh)
429	15900	40%	6360

The value of the power to the shafts based upon an overall energy conversion efficiency of 40% is approximately 6,360 kWh. This compared favorably to the power and energy requirements model above. Therefore, using 6,300 kWh as the energy requirements for the ferry propulsion and daily operations is reasonable.

5. New Ferry Criteria

5.1 Geometric Configuration

The proposed new ferry's geometry needs to be similar, if not identical to the existing configuration of the Jean Ribault. The ferry slips and importantly, the link spans have a fixed geometry. It is most cost effective to develop a new ferry to match this existing infrastructure. The ferry will be a double ended ferry with curved ends that match the link spans.

The beam of the ferry is currently ~56'-0". The new ferry will need to match this dimension as the ferry slipwalls are infrastructure elements that were constructed with a grant (FL-2016-023-00) and are still within their useful life. Modifications to the slipwalls may require repayment of parts of the grant. In addition, the slipwalls are performing well and any significant vehicle capacity increases can be accomplished by lengthening the ferry. Therefore, modifications to the slipwalls are not recommended at this time. This means that any capacity increases will need to be accomplished via lengthening of the ferry only.

The draft of the ferry vessel is currently between 7' and 8'. The depth of the slips are approximately 20' and offer no restrictions to the draft of any future ferry vessel. Moderate increases in draft are likely to be required to accommodate battery technology, but this may also be accomplished by widening the hull. For the purposes of this study, a maximum vessel draft of 8' will be considered.

The ferry length is primarily affected by the vehicle carrying capacity. A discussion of the capacity requirements is below. The current length of the ferry is approximately 153.6'. The ferry slipwalls can accommodate a longer vessel with similar width and shape. A discussion of the length will follow in the section below regarding capacity.

5.2 Car and Passenger Capacities

The jean Ribault has a vehicle (POV) capacity of approximately 38 with four vehicle lanes on the vessel. The passenger capacity is 200 with a crew of 7. Based on ridership data, the ferry currently sails under capacity on most trips and that it is not anticipated that additional capacity will be required.

To increase the POV capacity, the ferry will need to be lengthened by approximately 20'-0" to add additional lane length. Additional lanes can only be added with a significant vessel widening and based on the discussions above, this is not feasible at this time. A four POV increase can be accomplished with this lengthening. This represents a 10% increase in POV capacity. Significant costs related to lengthening don't provide significant increases in capacity. Therefore, it is recommended that a new vessel will have approximately the same length and POV capacity as the Jean Ribault.

5.3 Power Requirements

The existing power train is rated at 1500 HP total power and is adequate for the current navigational demands. The actual engine capacity is closer to 1950 HP. The engines power a straight drive shaft turning propellers at each end. The ferry operator has requested that the new vessel have as much or more power than the Jean Ribault. For the purposes of this study, it is recommended that the power demands for the ferry be 2000 HP. This

For the various fueling systems and the potential use of electric motors or azimuthing pod drives (azipods) the power will need to be nearly the same or slightly higher. For the purposes of this study, a proposed total power of 2,000 HP will be used to evaluate the alternative systems. As the program progresses the power requirements will be optimized.

It should be noted that the weight of the various power systems will vary. For example, the full battery stacks are heavy in comparison to an internal combustion engine (ICE). The electrical motors are relatively light compared to mechanical transmissions. Fuels to power ICE alternatives add weight to the vessels. The different systems will have different weights, but the performance of these systems will be similar and for the purposes of this study, the weight differences are negligible.

5.4 Ferry Propulsion

The Jean Ribault uses mechanically driven straight shaft propulsion, with props and rudders at each end of the vessels. The vessel is pushed with the stern propeller and pulled with the forward propeller for crossings and docking operations. The forward propeller is used in reverse during maneuvering as a braking propeller aiding in turning the ship vessel at slow speeds.

Maneuverability is paramount for the Jjean Ribault and will be for the future vessel. As the direction of the study is to investigate no or low emission technologies, it is likely that electrically driven propulsion will be the most effective source of propulsion. For the purposes of this study, electrically driven propulsion will be investigated. Two electrically driven azipods, one at each end of the vessel, will be studied.

5.5 Summary of Design Criteria

Table 5-1 below presents a summary of the design criteria for a new vessel that will be used throughout this study.

Table 5-1 - Vessel Characteristics for Basis of Study

Criteria	Jean Ribault	New Vessel
Length	153.6’	154’
Beam	56’-0”	56’-0”
Draft	7’-0”	8’-0”
POV Capacity	36	36
PAX Capacity	205	205
Power	1950 HP	2000 HP
Propulsion	Twin Propeller, Straight Shaft	Fore and Aft Azipod (2 total)

It should be noted that the criteria above is idealized criteria that will serve as the basis for comparison for this study. Changes may still occur over the course of the project’s development.

5.6 Jean Ribault Repower Analysis

The JTA has expressed a desire to potentially maintain the Jean Ribault as a relief vessel once the new ferry has been commissioned and is operational on the route. If the new ferry is powered by a fueling system that is different from the Jean Ribault, the complexity of maintaining two ferry vessels increases as maintenance personnel are required to understand two different systems to effect repairs and even routine maintenance. It would be recommended to repower the Jean Ribault to a system that is compatible with the new ferry.

The Jean Ribault is powered by two ESD 645e Diesel engines that drive a straight propeller shaft via a transmission. These engines could be modified to work with some alternative fuels but would need to be replaced if any electrical power system (battery, hybrid, or hydrogen) is used. If an electrically based system is used the diesel engines would need to be replaced with electric motors and a new power source to match the technologies.

The costs related to the repowering of the Jean Ribault will vary based on the system implemented. For the purposes of this study, the maximum repower cost will be determined and used as an upper limit for this cost. The upper bound cost will reflect the conversion of the ferry to an electric hybrid type vessel.

The upper bound conversion scenario will include the following updates:

1. Remove existing engines and install electric motors for driving the existing transmission and shafts.
2. Install on board battery bank and diesel generator set to power electric motors.
3. Install power management system to control the charging and control the power mode between battery bank and genset.

Technically, it is feasible to update the power systems on the Jean Ribault to accommodate battery driven systems. The weight of 400 kWh batteries and auxiliary genset is approximately 16,000 pounds. The weight of the EMD engines are approximately 20,000 pounds each. The weights for the newer system would be less and the remainder of the weight budget can be used for additional control systems and electrical management systems (EMS) weights. The overall stability of the vessel will be computed and modifications to the structure made if required during the refit. This design cost in included below.

The costs for this are independent of the alternatives analysis presented in Section 8. The breakdown of these costs in rough orders of magnitude (ROM) are shown in Table 5-2 below.

Table 5-2 - Jean Ribault Repower ROM Costs

Element	Qty.	Units	Unit Cost	Total Cost	Low Range	High Range
Electric Motors	2	EA	$ 250,000.00	$ 500,000.00	$ 450,000.00	$ 750,000.00
Battery Bank	2	EA	$ 600,000.00	$ 1,200,000.00	$ 1,080,000.00	$ 1,800,000.00
Aux Genset	2	EA	$ 350,000.00	$ 700,000.00	$ 630,000.00	$ 1,050,000.00
EMS	1	EA	$ 292,600.00	$ 292,600.00	$ 263,340.00	$ 438,900.00
			Subtotal	**$ 2,692,600.00**	**$ 2,423,340.00**	**$ 4,038,900.00**
			Design (10%)	$ 269,260.00	$ 242,334.00	$ 403,890.00
			Contingency (10%)	$ 269,260.00	$ 242,334.00	$ 403,890.00
			Total	**$ 3,231,120.00**	**$ 2,908,008.00**	**$ 4,846,680.00**

The cost estimate above is in 2023 dollars. Note that there are two battery banks and two gensets in this configuration.

6. Alternative Power Analysis

The basis for the selection for the configuration of the new ferry vessel is centered on the source of power utilized by the vessel. There are three main categories of power systems that are going to be investigated in this. Internal combustion engine (ICE) mechanical drive, ICE electric drive, and Full Electric drive.

The first is a conventional Diesel or other Internal Combustion Engine mechanical system. In this situation, an ICE is operated, generating mechanical forces that are used to drive the propulsion system. The ICE has a conversion rate of energy stored in the fuel to energy to the prop (well to wake) of approximately 40%. This is the basis for the development of fuel costs in this study. The fuels that may be utilized in this arrangement are diesel, bio diesel, renewable diesel, Liquid Natural Gas (LNG), Compressed Natural Gas (CNG), methanol, and biomethanol.

The second power platform is the Diesel/ICE electric drive. In this arrangement, there are multiple ICE generator sets installed on the vessel. When operated, instead of generating mechanical energy to drive the propulsion system, they generate electricity that powers electric motors driving the propulsion. The main advantage to this system is its flexibility. The power source can be changed and upgraded relatively easily and it provides a pathway to full emissions free electric systems. The disadvantage of this system is that there is a loss of energy conversion efficiency from conventional diesel. The well to wake efficiency is 35% for this configuration. This is the metric that will be used for the basis of fuel costs for the alternatives analysis.

The third power platform is the electric and hybrid electric platforms. These include the full battery powered ferry, the electric hybrid ferry, and the hydrogen fuel cell powered ferry. These platforms get a majority of their power from stored electric sources and from fuel cells. The hybrid platform will have smaller ICE gensets to provide supplemental power to the systems. These are differentiated from the other platforms in that the fueling costs are based primarily upon electrical charging.

The background on each type of fuel or power source are outlined below. These sections below are a general discussion of the fuels themselves and what the general requirements may be for their use as a marine fuel. The specific discussions regarding the marine power platforms and the costs for each alternative are discussed in Section 8 of this report.

6.1 Electrical Based Systems

6.1.1 Battery Electric

A battery electric power system for a ferry vessel, also known as a Battery Electric Ferry, is designed to provide propulsion and onboard power using electricity stored in rechargeable batteries. Here's a general overview of the components that comprise this system.

Energy Storage: The heart of the system is the battery bank, which stores electrical energy for use by the ferry. These batteries are typically advanced lithium-ion batteries or other high-capacity battery technologies. The size and capacity of the battery bank depend on the ferry's power requirements, desired range, and charging infrastructure. For the ferry service, a lithium ion solution is ideal as the system may need to be frequently charged due to the short time idle in the slip. Lithium ion batteries can handle frequent, rapid charging.

Propulsion System: The electric power from the battery bank is used to drive electric motors that provide propulsion to the ferry. These motors are connected to propellers or water jets, enabling the vessel to move through the water. Electric propulsion systems offer several advantages, including high efficiency, quiet operation, and zero emissions. As previously discussed, the propulsion system used for the new ferry may be direct drive or azipod based solutions.

Energy Management System: An energy management system (EMS) plays a vital role in monitoring and optimizing the performance of the battery electric power system. The EMS ensures efficient use of the available energy, manages power flow between the battery, propulsion system, and onboard systems, and helps maintain battery health and longevity.

Auxiliary Power and Range Extension: To extend the operating range of the all-electric ferry, back up generators are employed. These generators are typically diesel-powered or can use other conventional fuels. They are connected to alternators or generators that produce electricity to recharge the battery bank while the vessel is in operation. This will also allow for transport of an all-electric ferry to a remote maintenance or safe port although the overall travel speeds will be slower than normal. A backup generator can be added to the shore charging system to allow for charging during grid failures.

Onboard Systems: In addition to propulsion, the battery electric power system powers various onboard systems, including lighting, heating, ventilation, air conditioning, navigation equipment, communication systems, and passenger amenities. These systems rely on the electricity stored in the battery bank, reducing or eliminating the need for auxiliary diesel generators.

6.1.2 Hybrid Electric

In addition to the battery electric ferry system presented above, a plug in electric hybrid system is a viable alternative to replace the existing vessel. A hybrid system offers both operational efficiency, low maintenance and operating costs and significant emissions reduction from the existing diesel platform. This hybrid system allows for use of electric power under light demand conditions and the combined use of electric power and diesel power under heavy load conditions. The diesel gen set on board will recharge the batteries as well as providing power to the vessel for propulsion.

Similar to a battery electric ferry, an electric diesel hybrid ferry incorporates a battery bank to store electrical energy. The battery bank is typically smaller than that of a pure battery electric system since it primarily serves as a supplementary power source and energy buffer.

Propulsion System: The propulsion system of an electric diesel hybrid ferry consists of both an electric motor and a diesel engine. The electric motor is connected to propellers or water jets and is powered by the battery bank. It provides primary propulsion during low-speed or maneuvering operations, maximizing energy efficiency. The diesel engine serves as a secondary propulsion source and also charges the battery bank when needed.

Charging and Power Generation: The diesel engine in an electric diesel hybrid ferry acts as a power generator. When the battery bank requires recharging, the diesel engine engages and drives an alternator, which produces electricity. This electricity is used to power the vessel's onboard systems and charge the batteries simultaneously.

Energy Management System: An energy management system is essential in an electric diesel hybrid ferry to optimize power flow and manage the switching between the electric motor and the diesel engine. The EMS determines the most efficient operating mode based on factors such as speed, power demand, battery state of charge, and environmental conditions. It ensures the seamless integration of both power sources for optimal efficiency and performance.

Onboard Systems: The electrical power from the battery bank and the diesel engine supports the operation of various onboard systems, including propulsion, lighting, heating, ventilation, air conditioning, communication systems, and passenger amenities. The electric motor driven by the battery bank provides quiet and emission-free propulsion during low-power requirements, such as when maneuvering in ports or cruising at low speeds.

The electric diesel hybrid ferry offers several advantages, including reduced fuel consumption, lower emissions, and improved operational flexibility. By utilizing both electric and diesel power sources, it can optimize efficiency and adapt to different operational conditions. The diesel engine provides extended range and faster refueling options, making it suitable for longer routes or areas with limited charging infrastructure. The battery bank complements the diesel engine, allowing for reduced emissions, improved fuel efficiency, and reduced noise levels during low-power operations.

The operating profile of the hybrid system may be adjusted as well based on the performance requirements of each river crossing. The system may run all electric until the batteries reach a certain threshold and then have the diesel generators assume the power generation load.

Overall, an electric diesel hybrid ferry serves as a transitional solution that combines the benefits of electric propulsion with the flexibility and range of a conventional diesel engine, offering a more environmentally friendly alternative compared to traditional diesel-only ferries. This type of vessel can be seen as an interim step between conventional diesel and full electric operations. Future repowering operations can involve replacing or downsizing the diesel generators to add additional battery capabilities and convert the vessel to all electric operations.

6.2 Hydrogen Fuel Cell Systems

Hydrogen fuel cells generate energy through an electrochemical reaction without combustion, converting fuel directly into electricity and heat. There are several fuel cell technologies available, but one of the most promising is the proton exchange membrane fuel cell, which converts hydrogen's chemical energy into electricity through an electrochemical reaction with oxygen, emitting only clean water and heat. Fuel cells have higher efficiency than combustion engines, and the technology allows energy to be concentrated more densely than in petroleum fuels. If renewables are used to produce the hydrogen fuel, the entire energy chain will be clean, providing a true zero-emission fuel.

In a marine application, hydrogen is stored in high-pressure tanks on board the vessel. When the hydrogen fuel cell system is activated, hydrogen is supplied to the anode of the fuel cell, where it is split into protons and electrons by a catalyst. The protons are then transported through an electrolyte to the cathode, while the electrons flow through an external circuit, generating an electric current. This electrical power is then used to drive the vessel's electric motor or to charge a battery bank, which in turn powers the electric motor. Hydrogen fuel cells have the potential to provide sustainable and efficient power for a wide range of marine vessels, from small recreational boats, to ferries, and even large cargo ships. As the technology advances and becomes more widely available, it could play a significant role in reducing the environmental impact of the marine industry.

The use of hydrogen fuel cells in marine vessels presents several potential benefits. First, it provides a zero-emission alternative to traditional fossil fuel-based marine propulsion systems, reducing the environmental impact of marine vessels. Hydrogen fuel cells are highly efficient, providing longer range and higher energy density than traditional batteries. Additionally, hydrogen fuel cells can be refueled quickly, reducing downtime compared to battery charging. As a result, hydrogen fuel cell technology could improve the performance and reliability of marine vessels while reducing their environmental impact, contributing to the global effort to combat climate change.

Here are a few examples of hydrogen fuel cell ferries. The "Hydroville" commuter ferry in Belgium was the world's first certified passenger vessel powered by hydrogen fuel cells. It was launched in 2017 and can carry up to 16 passengers. The vessel has a range of up to 100 km on a single tank of hydrogen and emits only water vapor. The "Water-Go-Round" ferry in California is another example of a hydrogen fuel cell-powered passenger vessel. It was launched in 2019 and operates in the San Francisco Bay Area. The vessel has a range of up to 300 miles on a single tank of hydrogen and emits only water. The "Norled" ferry in Norway is powered by a combination of batteries and hydrogen fuel cells. It was launched in 2019 and operates on a route between Stavanger and Tau. The vessel has a range of up to 400 km on a single tank of hydrogen and can carry up to 299 passengers. Hydrogen is very efficient and may be an excellent choice for long range ferries and other long range vessels.

One of the key challenges with implementing hydrogen fuel cell technology is the lack of infrastructure to support it. The production, storage, and distribution of hydrogen are still in the early stages of development, which make it challenging to ensure availability and supply of fuel for vessels. Cost is another large concern. Hydrogen fuel cell technology is still expensive compared to other propulsion systems. The cost of hydrogen fuel cell systems, as well as the cost of hydrogen production and infrastructure, must come down to make the technology more affordable and accessible for marine vessels. Safety is always a top concern with any fuel system. The handling and storage of hydrogen can pose safety risks, and vessel operators need to be trained in proper handling and safety protocols. Designing and implementing safety measures is critical to ensuring the safe operation of vessels powered by hydrogen fuel cells.

Currently, there are a limited number of commercial vessels that are powered by hydrogen fuel cells. Major players in the marine industry, including shipbuilders, engine manufacturers, and fuel cell companies, are investing in the development and commercialization of hydrogen fuel cell use in marine vessels. The use of hydrogen fuel cells in marine vessels is seen as a promising solution for reducing emissions and improving the sustainability of the shipping industry. However, there are still several challenges that need to be addressed to realize the full potential of hydrogen fuel cells and make them a safe and reliable fuel source.

6.3 Liquid and Compressed Gas Fuels

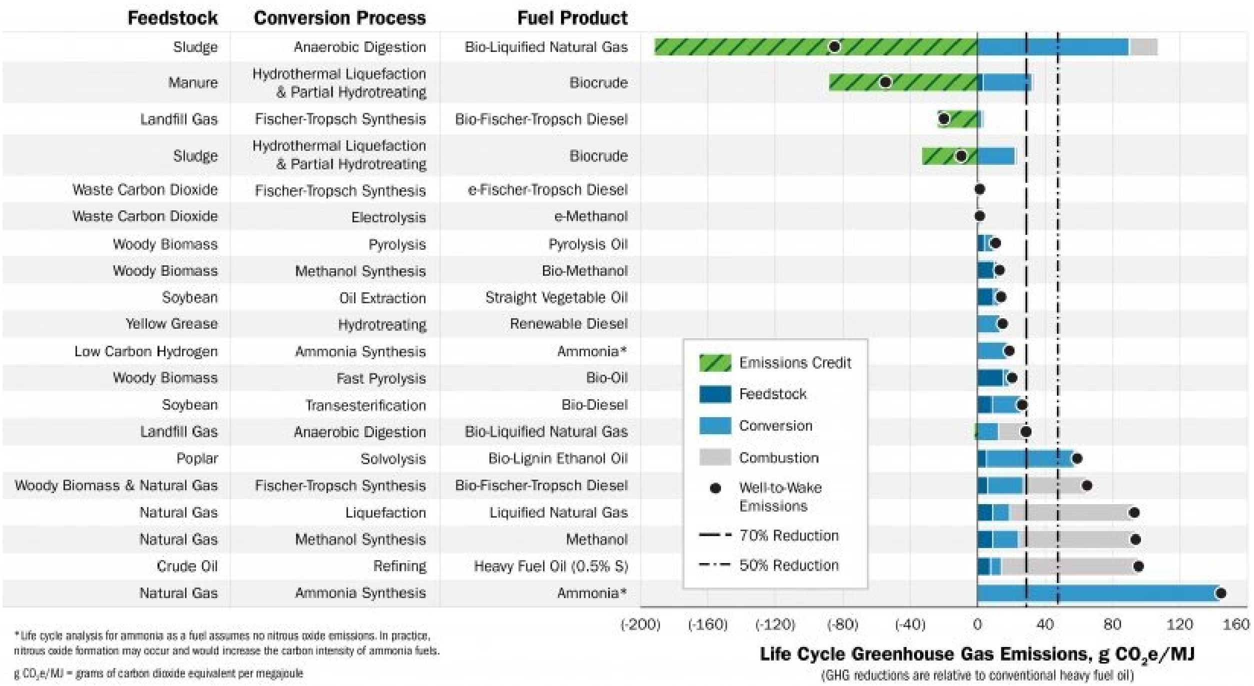
Liquid fuels are historically the most efficient means of providing marine power as the energy densities versus the liquid or compressed gas volumes are high. Energy rich liquid fuels balance the energy output with weights and volumes that can affect the stability of marine vessels. Marine vessels, unlike other terrestrial vehicles cannot refuel as often due to the nature of marine travel.

Of particular interest for this study are the amount of emissions reduction provided by a number of different marine power platforms. A project goal is to work towards JTA's overall commitment to meet a net zero emissions goal by the year 2050. The use of alternative fuels for the new ferry vessel should be included in these efforts.

To meet net zero goals, consideration of feed stocks, manufacturing process, the final fuel product and combustion emissions need to be considered. Part of the evaluation process that is discussed in Section 8 of this documents are the qualitative assessment of emissions reductions. Figure 6-1 below lists various liquid marine fuels and their associated emissions reductions as compared to Marine Fuel Oil (MFO). This table is published by the Bioenergy Technologies Office of the Department of Energy. This data will be used in the alternatives analysis.

It should be noted, that some fuels show emissions credit in the Figure 6-1. These fuels still have carbon combustion products, but they also capture significant caron and GHG gases during the manufacturing of these products. In turn, these products have a net zero rating in that they convert harmful GHG gasses such as methane into CO2 during combustion. This provides a net positive reduction in GHG emissions throughout the fuel supply chain.

Figure 6-1 - Comparison of GHG emissions for various Marine Fuels. Source - https://www.energy.gov/eere/bioenergy/sustainable-marine-fuels



This table includes a broad range of potential marine fuels that are being investigated for scaled usage. This study will focus on fuels that are currently available in the marketplace with the understanding that these fuels in ICE mechanical engines and ICE electric configurations. The discussions of these fuel types are shown below.

It should be noted that most of the liquid and even CNG fuels can be used in dual fuel marine engines. This means that the ICE based platforms for the replacement ferry can support a variety of the fuels listed below. This is an advantage when using some of the higher cost lower availability biofuels come in to play. The biofuels can be used when available and other more available fuels can be used in their place until the supply chain of the biofuel can be fully developed and becomes consistent and stable.

6.3.1 Diesel, Bio Diesel, and Renewable Diesel

Diesel fuel has long been the standard choice for marine vessels due to its high energy density and efficient combustion properties. Derived from crude oil through a refining process, diesel fuel provides reliable power and is widely available. However, the use of diesel fuel contributes to greenhouse gas emissions and air pollution, which has led to the exploration of alternative marine fuel options.

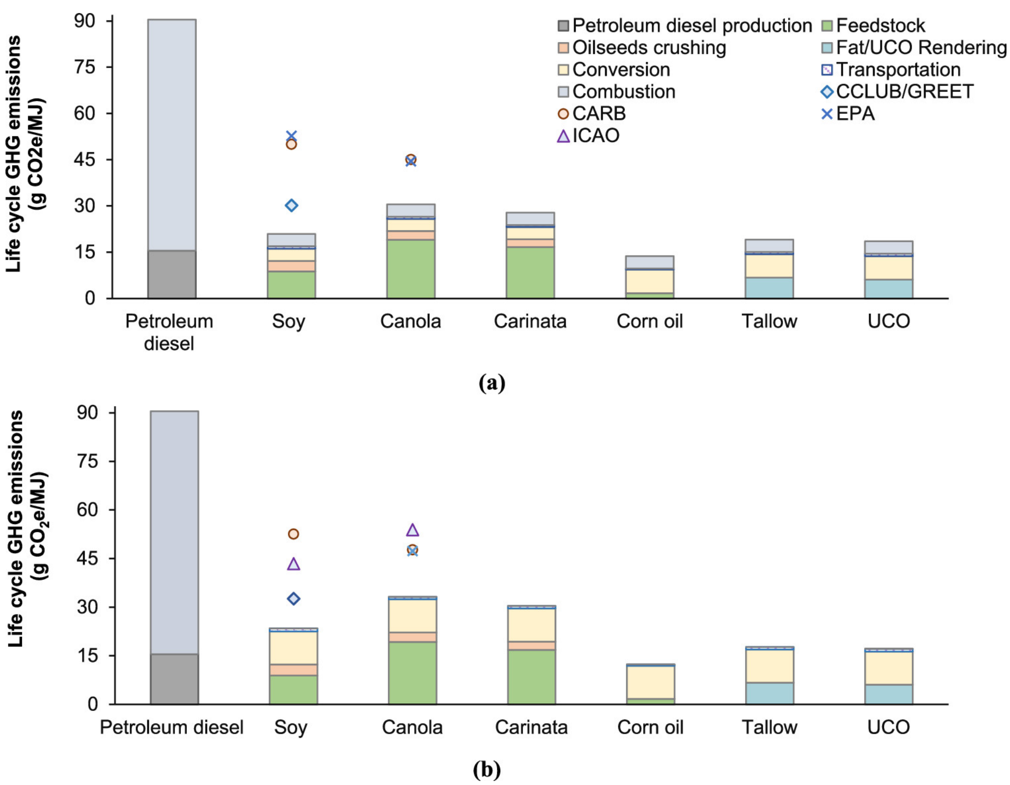
Biodiesel, a renewable fuel, offers a promising solution for reducing the environmental impact of marine operations. Produced from sustainable feedstocks such as vegetable oils, animal fats, or recycled cooking oil, biodiesel can be used as a blend with diesel fuel or as a standalone fuel. The production process, known as transesterification, converts the feedstock oil or fat into biodiesel and glycerin. Biodiesel has lower emissions of particulate matter, sulfur, and certain greenhouse gases compared to diesel fuel. It is biodegradable, non-toxic, and helps reduce dependence on fossil fuels. However, biodiesel's energy density is slightly lower than that of diesel fuel, which may result in a slight reduction in power and range.

Another alternative is renewable diesel, also known as hydrotreated vegetable oil (HVO) or green diesel. Renewable diesel is produced through a hydrotreating process that removes oxygen and impurities from various renewable feedstocks, including vegetable oils, animal fats, or algae. This process results in a drop-in replacement for petroleum diesel, meaning it can be used in existing diesel engines without modifications. Renewable diesel offers significant emission reductions, including lower particulate matter, sulfur, and greenhouse gas emissions compared to diesel fuel. It has a higher energy density than biodiesel, making it more comparable to petroleum diesel in terms of power and range. Renewable diesel provides a sustainable alternative to diesel fuel and can be produced from a variety of renewable sources.

When considering the choice between biodiesel and renewable diesel for marine applications, several factors come into play. The availability of feedstocks, compatibility with existing infrastructure and engines, emissions requirements, and sustainability goals are all important considerations. Biodiesel's advantage lies in its ability to be produced from various sustainable feedstocks and its relatively simple production process. Renewable diesel, on the other hand, offers a drop-in replacement for diesel fuel with higher energy density, making it a more seamless transition for vessel operators.

The infrastructure requirements for using these fuels for the ferry are discussed in Section 7 of this report.

Figure 6-2 - GHG Emissions for Diesel, Bio Diesel and Renewable Diesel



Life Cycle Greenhouse Gas Emissions of Biodiesel and Renewable Diesel Production in the United StatesHui Xu, Longwen Ou, Yuan Li, Troy R. Hawkins, and Michael Wang, Environmental Science & Technology 2022 56 (12), 7512-7521

6.3.2 Compressed Natural Gas (CNG) and Liquid Natural Gas (LNG)

As the maritime industry seeks cleaner and more sustainable fuel options, Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) have emerged as promising alternatives. These fuels offer environmental benefits and are becoming increasingly popular in marine applications.

CNG, which involves compressing natural gas to high pressures, provides a viable solution for marine propulsion. However, CNG has a lower energy density compared to liquid fuels like diesel or LNG, meaning larger storage volumes are required to hold the same amount of energy. Nonetheless, advancements in compression technology have improved CNG's energy density, making it a viable option for marine vessels.

To utilize CNG as a marine fuel, specially designed or modified engines are required. These engines can be dual-fuel engines, capable of running on both natural gas and diesel fuel, or dedicated natural gas engines. With the necessary engine configuration in place, vessels can take advantage of the cleaner combustion properties of CNG.

Handling and storing CNG on marine vessels involve high-pressure storage tanks made of composite materials or steel. These tanks need to adhere to safety standards and be securely mounted on the vessel. The handling process includes the use of compressors to fill the storage tanks and pressure regulation systems to supply the fuel to the engine. To refuel CNG-powered vessels, onshore compression stations or specialized bunkering facilities are necessary.

LNG, on the other hand, offers a more energy-dense and compact storage solution compared to CNG. Natural gas is cooled to cryogenic temperatures, transforming it into a liquid form. This cryogenic liquefaction process significantly increases the energy density of natural gas, allowing vessels to carry larger amounts of energy in a smaller space.

LNG can be used in marine engines through dual-fuel engines or dedicated LNG engines. Dual-fuel engines provide flexibility by allowing vessels to run on either LNG or diesel fuel. Dedicated LNG engines, on the other hand, are specifically designed to operate solely on LNG. Both options offer cleaner combustion and reduced emissions compared to traditional diesel engines.

Storing LNG onboard marine vessels requires cryogenic storage tanks designed to handle the extremely low temperatures of LNG. These tanks must be well-insulated and equipped with safety features to prevent leaks or releases. LNG fueling infrastructure includes liquefaction plants, storage facilities, and bunkering stations. LNG bunkering can occur at dedicated facilities or through truck-to-ship operations, ensuring vessels have access to the fuel they need.

When considering CNG and LNG as marine fuels, safety is of utmost importance due to the flammable nature of natural gas. Adhering to proper handling procedures, safety protocols, and comprehensive training is essential to minimize risks and ensure safe operations.

Investments in fueling infrastructure, including onshore compression stations, liquefaction plants, and bunkering facilities, are crucial for the widespread adoption of CNG and LNG as marine fuels. Furthermore, compliance with regulations and standards governing safety, emissions, storage, and fueling procedures is necessary to ensure the safe and environmentally sound use of these fuels.

JTA has significant experience with CNG and the required fueling systems having CNG powered buses in their fleet. CNG fueling technologies for the ferry vessel will be similar to that of fueling buses, although on a much larger scale. A specific storage and fueling system can be developed to allow for the periodic fueling of the vessel. Storage aboard the vessel will need to be large enough to allow for a round trip to and from the safe harbor during storm events.

LNG is a unique marine fuel that does require special and costly equipment. Fortunately, there are private fuel companies that operate in the St. Johns River that provide LNG bunkering services for LNG powered vessels. This is the preferred methodology to refuel an LNG ferry.

There is a potential to reach net zero utilizing bio natural gas in either LNG or CNG form. Bio Natural gas is developed from waste products such as landfill gas and animal waste. The gas is refined from natural waste sources and is fed into the gas transportation pipelines run by TECO gas, the local natural gas utility. The gas is purchased through a secondary exchange and the purchaser is given emissions credits related to the use of the bio natural gas. This credit can be used to offset the LNG or CNG combustion emissions.

6.3.3 Methanol and Bio Methanol

Methanol and bio methanol are alternative fuels that can be used in marine transportation, including for passenger ferries. Methanol is a clear, colorless liquid that is typically produced from natural gas or coal, while bio methanol is produced from renewable biomass sources, such as wood chips, agricultural waste, or even carbon dioxide. These fuels are considered "green" because they emit fewer harmful pollutants and greenhouse gases compared to traditional marine fuels like diesel. Methanol and bio methanol are also readily available, and can be stored and transported easily, making them attractive options for marine vessels. Methanol and bio methanol are potential marine fuels for passenger ferries due to their unique properties and characteristics but with every alternative there are advantages and disadvantages.

Firstly, they have lower energy densities compared to traditional marine fuels like diesel, meaning more fuel is required to achieve the same power output. However, their lower emissions and potential for cost savings can offset this disadvantage. Secondly, both methanol and bio methanol are highly flammable and require special handling and storage procedures for safety. Nevertheless, they have a lower risk of explosion than traditional marine fuels like diesel. Thirdly, methanol is highly corrosive and can cause damage to certain materials in marine engines and fuel systems. On the other hand, bio methanol is less corrosive and may be more compatible with existing marine infrastructure. Fourthly, methanol is widely available and can be produced from various sources, including natural gas and coal, while bio methanol is produced from renewable biomass sources, making it a more sustainable option. Lastly, methanol and bio methanol emit lower levels of pollutants and greenhouse gases compared to traditional marine fuels like diesel, with potential to reduce harmful emissions like sulfur oxides and nitrogen oxides. Overall, while there are some unique properties and challenges with methanol and bio methanol as marine fuels, they offer several potential benefits, including lower emissions and cost savings. However, their safe handling and storage are crucial to prevent damage to marine engines and fuel systems.

Bio methanol is a renewable and sustainable type of methanol. Bio methanol had disadvantages, including higher production costs due to the higher costs associated with processing renewable biomass feedstocks. Moreover, the limited availability of bio methanol feedstocks can lead to supply chain issues and potentially higher costs. The production process for bio methanol is also more complex and energy-intensive than conventional methanol, which can lead to technical challenges and higher production costs. Finally, bio methanol may not be compatible with all existing marine infrastructure, which can require additional investments in infrastructure and may result in higher costs. The existing liquid fueling infrastructure at the Mayport ferry landing will need to be completely replaced as methanol requires different storage and handling equipment than diesel.

Currently, there are a limited number of passenger ferries that use bio methanol as a fuel. One example is the M/S Mariella, a passenger ferry that operates in the Baltic Sea between Helsinki, Finland, and

Stockholm, Sweden. The M/S Mariella uses bio methanol produced from forest residues and has been in operation since 2013. Another example is the M/S Viking Grace, which operates in the same region and has been using bio methanol produced from waste materials since 2021. These ferries are considered pioneers in the use of bio methanol as a marine fuel and serve as a proof of concept for the technology. However, it is worth noting that the adoption of bio methanol as a marine fuel is still in its early stages and is not yet widely used in the passenger ferry industry.

Methanol and bio methanol can both offer environmental benefits as marine fuels compared to traditional marine fuels such as diesel. Methanol combustion produces lower levels of harmful pollutants like particulate matter, nitrogen oxides (NOx), and sulfur oxides (SOx), which can help improve air quality and reduce the negative impact on human health. Bio methanol is an even more sustainable and environmentally friendly option, as it is produced from renewable biomass sources and can significantly reduce greenhouse gas emissions.

Compared to diesel, methanol can reduce particulate matter emissions by up to 98%, NOx emissions by up to 60%, and SOx emissions by up to 100%. Bio methanol can reduce greenhouse gas emissions by up to 94% compared to diesel, according to some studies. This reduction is achieved because the carbon dioxide released during bio methanol combustion is absorbed by the plants that were used to create the biomass feedstock, creating a closed carbon cycle.

There are several economic and market considerations to consider when it comes to the use of methanol as a marine fuel. Firstly, the cost of methanol production and distribution can vary depending on the source of the fuel, with natural gas-derived methanol typically being cheaper than bio methanol. However, the cost of producing methanol from renewable sources like biomass may decrease as production methods become more efficient and widely adopted. Methanol can also be blended with other fuels, allowing for flexibility in fuel choice and reducing the need for costly infrastructure upgrades.

Compared to traditional marine fuels like diesel, both methanol and bio methanol have the potential to significantly reduce greenhouse gas emissions and improve air quality. This is due to their renewable and sustainable nature, as well as their ability to produce fewer harmful emissions such as sulfur and particulate matter.

6.3.4 Ammonia

Ammonia is a colorless gas with a pungent odor that is composed of nitrogen and hydrogen. It has long been used as a fertilizer and industrial chemical, but in recent years, it has emerged as a potential alternative marine fuel. Ammonia has several properties that make it attractive as a fuel, including a high energy density, low greenhouse gas emissions, and the ability to be produced from renewable energy sources. It can also be stored and transported relatively easily, although it does require specialized handling and safety precautions due to its toxicity. While the use of ammonia as a marine fuel is still in the early stages of development, it has the potential to be a key component of a sustainable, low-carbon fuel source.

Ammonia has several physical and chemical properties that make it a promising alternative marine fuel. Firstly, ammonia has a high energy density, meaning it contains a large amount of energy per unit of volume, making it an attractive option compared to traditional fuels with lower energy densities. Secondly, ammonia has the potential to produce very low greenhouse gas emissions when produced from renewable energy sources such as wind, solar, or hydro power. As the production process does not emit carbon dioxide (CO_2), a major contributor to climate change, ammonia is an environmentally sustainable fuel option. Early studies suggest that using ammonia as a fuel can result in a reduction of up to 99% in greenhouse gas emissions compared to traditional fuels. Additionally, ammonia can be stored and transported relatively easily, either as a gas or in a liquid state, which is ideal for marine vessels with limited storage space. Lastly, ammonia can be produced using renewable energy sources, such as wind, solar, or hydro power, which makes it an attractive and sustainable fuel. While there are challenges to overcome before ammonia can be widely used as a marine fuel, such as safety concerns and limited infrastructure, its physical and chemical properties make it an attractive option for the industry as it seeks to transition to a more sustainable future.

Ammonia-based propulsion technologies are being explored as a potential alternative to traditional marine fuels for passenger ferries. Among the different technologies that are currently being developed and tested, combustion engines, fuel cells, dual-fuel engines, and ammonia synthesis on board are the most promising. Ammonia can be used as a fuel in combustion engines like those used with traditional fuels, but modifications are required to account for the differences in fuel properties. Ammonia combustion requires a higher temperature than traditional fuels to ensure complete combustion. Fuel cells offer high efficiency and low emissions but require additional equipment and infrastructure compared to combustion engines. Dual-fuel engines can be modified to use a combination of ammonia and diesel or LNG as a fuel, offering flexibility and mitigating some of the challenges associated with using ammonia as a single fuel source. Some proposals for ammonia-based propulsion systems involve synthesizing ammonia on board the vessel using renewable energy sources. This would allow the vessel to produce its own fuel, eliminating the need for fuel deliveries and reducing emissions associated with fuel transport. Although these technologies are still in the development and testing stages, early results show that ammonia-based propulsion systems have the potential to reduce greenhouse gas emissions and improve overall sustainability. However, challenges such as safety risks associated with handling and storing ammonia, and the need for additional infrastructure and regulations to support the use of ammonia as a marine fuel, must be addressed.

The adoption of ammonia as a marine fuel is dependent on several factors, including cost and availability, infrastructure requirements and investment costs, and market outlook and potential for adoption. The cost and availability of ammonia as a fuel will depend on the demand for it in the marine industry. At present, the cost of ammonia as a fuel is high compared to traditional marine fuels, but it is expected to decrease as production scales up and demand increases. The adoption of ammonia as a fuel will require significant investments in infrastructure, including storage and transport facilities. The cost of building new infrastructure and modifying existing infrastructure will be a significant investment for the marine industry. However, the long-term benefits of using ammonia as a sustainable fuel source may outweigh the initial costs. The market outlook for ammonia as a marine fuel is positive, with increasing demand for sustainable fuels. The adoption of ammonia as a fuel will depend on regulatory frameworks, infrastructure investments, and the cost and availability of the fuel. Early adoption is expected in regions with strong government support and a willingness to invest in new infrastructure. However, the rate of adoption will depend on how quickly the industry can address the challenges associated with using ammonia, including safety concerns, infrastructure requirements, and cost.

Ammonia has been proposed as a low greenhouse gas emission alternative fuel for passenger ferries. However, it may not be a suitable option due to several reasons. Firstly, ammonia is highly toxic, which poses safety risks, especially in passenger ferry operations. Specialized handling and storage procedures would be necessary to ensure safe use, adding additional costs and complexity to ferry operations. Additionally, ammonia combustion produces nitrogen oxide (NOx) emissions, which can have negative health impacts on passengers and crew, requiring the use of selective catalytic reduction (SCR) systems, adding maintenance requirements and costs.

Moreover, there are concerns regarding the availability and cost of ammonia as a fuel for passenger ferries, as ammonia is primarily produced for other industrial applications, not as a fuel. It may be better to utilize other alternative fuel options, such as electric and biofuels, that have been proven safe and efficient. Overall, while ammonia may have potential as a marine fuel in some applications, its high toxicity and the additional costs and complexities associated with its use make it not recommended for passenger ferries.

7. New Infrastructure Requirements

7.1 Fueling Infrastructure

7.1.1 Battery Charging

7.1.1.1 Charging Operations

Both the battery electric and the hybrid electric ferries will require shore side charging infrastructure. An overnight, slow charging system can be used to perform a full battery charge while the ferry is docked. This will ensure that the ferry has 100% battery capacity at the beginning of operations the next day. During daily operations, the ferry can receive a battery charge through a dockside fast charger.

Overnight Charging: When the ferry is not in operation, it can be connected to shore power or charging stations at the dock. This allows for a slow, overnight charging process that fully replenishes the battery bank for the next day's operations. It also takes advantage of off peak utility rates. Both of the electric systems can

Fast Charging: In cases where the ferry has limited downtime between trips, fast-charging solutions can be employed. These charging systems provide high-power charging stations at the dock, allowing the batteries to be charged quickly during shorter breaks. Fast charging typically requires specialized infrastructure and high-power connections. The fast charging system will require a battery energy storage system on land (BESS) that can accumulate energy for rapid discharge.

Opportunity Charging: For ferry routes with frequent stops, opportunity charging can be utilized. Charging stations can be placed at both sides of the river and the ferry connects to them for a rapid charge during the brief time it spends at each stop. This charging is not as robust as the fast charging but can allow for extended battery use for the hybrid ferry system without the need for a rapid recharging system.

7.1.1.2 Battery Charging Infrastructure

The shoreside electrical infrastructure will consist of a step-down transformer and a series of modular switch gear to convert the AC currents to DC currents for rapid charging. For the plug-in hybrid system, an AC charging system may be the most appropriate.

For the full electric ferry, rapid charging will be required to allow for the charging to take place during a regular docking operation. The charging could occur once per round trip, or may be scheduled to occur at a given frequency throughout the day.

Due to variations in grid capacity, a rapid charge directly from the grid would likely cause instability and it is likely that it would not be a viable methodology for charging. To stabilize the grid and allow for rapid charging, a Battery Electric Storage System (BESS) should be employed. This system allows for the grid to furnish power to shoreside batteries at a stable rate that can be accommodated by the grid. The batteries can discharge their stored energy into the ferry batteries without drawing from the grid. To make this feasible, the vessel batteries must be large enough to sustain travel for multiple round trips between charges. This will give the BESS time to recharge the shore side batteries.

In addition to pulling power from the grid to charge the BESS, other methods of power generation may be used to charge the BESS. This includes the use of photovoltaic solar arrays, wind power generation, and potentially small scale tidal power generators. These could be used individually or in concert to provide power to the BESS, limiting the grid demands and thus power costs.

An opportunity for this type of renewable power generation involves the use of a solar array canopy over the queuing lanes. Based on preliminary calculations this would generate approximately 5% of the daily power demand on average.

The power connection between the ferry and the shore power charging system can take many forms. There are conventional cable connection with cam locks similar to Navy cold ironing systems. A manifold of multiple cables can be lowered into a receiver on the side of the vessels and a connection can be made. Accommodation of vessel movements and tides are taken by the slack in the charging cables.

The speed of the rapid charging shore connection is important in for the ferry service. The vessel has a quick turnaround time and a limited deck crew. The system should be automatic or easily actuated and free from crew intervention. The rapid charger is not intended to give the batteries a full charge, but to supply the electrical energy for additional trips.

There are automated systems that use pantograph type connections that mirrors the movement of the vessel and automatically connects. The point of connection can vary along the side of the vessel, however, to achieve a fast connection, the charging apparatus should be on a part of the slip that registers with the ferry while it is at dock. The ferry and ramp have a consistent relationship while the vessel is being loaded and unloaded. The rapid charger could be placed near this point of connection.

The transformers, switch gear, and the BESS can be located at various locations throughout the property, though having these near the berth is preferred to minimize costs and minimize the loss of power through heat. The shore side portions of the system take up nearly the same footprint as a 20′ shipping container and are frequently contained within one. The BESS is about half the size of a 20′ container and requires a cooling system to maintain battery temperatures at heir operational levels.

7.1.1.3 Sizing of Shipboard Battery Banks

Balancing the size of an onboard battery bank with the size of an onshore battery storage system for rapid charging requires careful consideration of various factors. As this project progresses, precise calculations can be performed to accurately estimate the size of the batteries based on the performance profile. For the purposes of this study, the battery bank size for the all-electric ferry is 1,100 kWh and the battery bank for the hybrid electric ferry is 850 kWh. This represents the size required for 8-10 trips without the need for charging. Ideally, this will require approximately 6 -7 charges a day on average. This value also includes some allowance for battery capacity degradation over time. As the batteries degrade, additional charging operations may take place. Also, it is important to have a lower end buffer on the batteries to prevent damage to them if the charge is too low.

For the purposed of this study, it is assumed that 13 charging operations occur per day, which is roughly one every two round trips. For a power requirement of 6,270 kWh, a charge of 6,270 kWh/13 = 482 kWh is required every charge.

7.1.1.4 Sizing of BESS Battery Banks

Based on the estimates above a BESS with a battery capacity of approximately 500 kWh is estimated. The charging operation occurs every one hour.

To assure that the BESS on land will have enough capacity, the size of the shore batteries need to take into consideration the amount of electricity available from JEA. If 1,000 kW of power is available for charging, the time it will take to fully charge a 500 kWh battery bank is 500 kWh / 1000 kW = .5 hours or 30 minutes. This falls within the operational ranges of the assumed battery sizes. This allows for a range of available power for charging of 500 kW to 1000 kW. If the grid does not have this power, the frequency of the charging or the overall size of the shipboard batteries can be increased. It should be noted, that the rapid charging of the vessel takes a short period of time and the charging can be accomplished during the course of a normal docking and turnaround. It is anticipated that the charge can be transmitted in less than 5 minutes.

7.1.2 Hydrogen

Fueling the vessel with hydrogen can be done in two ways. A dedicated hydrogen storage and fueling infrastructure on shore can be constructed and the ship can be fueled from portable on shore equipment. Hydrogen can be stored in two forms, liquid hydrogen and gaseous hydrogen.

The shore side hydrogen filling station is involved and requires insulated storage tanks to keep the hydrogen in its liquid form. The liquid will be pumped and stored on board in liquid hydrogen format. Based on calculations, the ferry will consume approximately 400 kg of hydrogen during an average day's operation. The onboard storage capacity can be estimated at 1,200 kg – 2,000 kg. This means that the ferry will need refueling every few days. Based on the ability store liquid hydrogen without refrigeration, a two day fueling cycle is estimated. With adequate buffers and additional capacity, this means that approximately 1,200 kg of hydrogen will need to be stored on land to fuel the vessel and will require frequent refilling itself.

The refilling of the hydrogen is considered to be from tanker trucks. The development of an electrolytic hydrogen generator is extremely expensive and resource intensive undertaking. For the refilling station for the ferry, the costs will be for on-site storage and fueling infrastructure.

Based on the frequency of the refueling needed, there needs to be a steady supply chain for hydrogen. Also, to meet emissions reduction goals, the source of the hydrogen should be from low emissions sources. There are projects underway in the geography to establish hydrogen generation, storage and transportation infrastructure. By the time that the ferry is developed, constructed and put in service, commercially available clean hydrogen supply chain will likely be in place.

7.1.3 Diesel, Bio Diesel, and Renewable Diesel

The infrastructure required for these options are currently in place at the Mayport ferry landing. There are two 10,000 gallon fuel tanks located adjacent to the slipway in a 5,000 SF fenced area. The tanks are sufficient for the current operation and thus will be sufficient for similar function in the future. There may be some modifications required to take on bio-diesel, with updating minor components at the fuel tanks. The costs for these minor modifications will be included in the shore side infrastructure costs for the bio diesel option.

7.1.4 CNG

CNG fueling has two different options. The first is to deliver CNG to the vessel via tanker truck and fill the vessel while it is in the slipway. This option requires the vessel to be filled more frequently than current diesel fueling due to the increased volume of fuel consumption due to the lowered energy density of the CNG. It is assumed that a frequency of filling will be at maximum once a week. This increased frequency may be operationally challenging as the supply chain can be complex.

The second way to fuel the vessel with be through the use of an on-site compressing and filling station. The facility will require and inbound gas feed or large storage tank as a source of the gas. The gas will be compressed on site and either stored for the periodic refueling of the vessel or directly connected to the vessel for overnight for a time filling or slow filling operation. The slow filling operation would most likely need to be done every night after a day's operations, due to the time it takes for the filling to occur.

The costs shown in the alternatives matrix will be for a slow filled station on shore with storage tanks to hold the compressed gas.

7.1.5 LNG

As this point in time, LNG gasification, and storage are expensive and usually done on a large scale for ocean transport. LNG fuel is dispensed in a super cooled liquified gas so the storage and dispensing facilities must be insulated, and special PPE and training is required to dispense the fuels.

There are three main types of fueling stations for LNG: Permanent fixed stations with large storage, containerized stations with less storage, and mobile filling from tanker trucks. A unique feature of the port of Jacksonville is the presence of a barge to vessel LNG bunkering service. This service will allow the ferry to potentially be fueled from the water via this bunkering service.

For the purposes of the study, the costs for LNG fueling will be for delivery and fueling via the bunker fueling service.

7.1.6 Methanol and Bio Methanol

As stated above, the fueling systems for methanol and bio methanol are different from that of diesel type fuels. Methanol is a corrosive liquid fuel that requires tanks protected from this. Methanol is a fuel that is liquid at ambient temperature, and it has a long history and proven methods for transportation, storage and dispensing.

The shoreside fueling stations will be look similar to the exiting diesel tank setup at the Mayport ferry landing. The existing tanks may not be able to be retrofitted to accommodate methanol fuels, resulting in the need to completely update the infrastructure. The costs for a new storage and fueling station will be included in the costs for the methanol and bio methanol options.

7.2 Other Support Infrastructure Requirements

In addition to the updates that some fueling systems may require, there are additional support facilities that will need to be constructed. Construction of administrative offices for the ferry service and the layberth marine structures are discussed below.

7.2.1 Administrative Offices

Currently the ferry operator utilizes an office trailer set up at 4675 Ocean Street in the Village of Mayport. The property is owned by the JEA. See Figure 7-1 below for a view of the existing ferry administration building. There is a desire by JTA and Hornblower to consolidate the ferry operation by moving the administrative office to the same side of the river as the maintenance warehouse. Currently the warehouse is on the Fort George side of the river, meaning that the logical location of the administration building is at the Fort George landing. Relocation of the warehouse to the Mayport side would require payback of grant funding received in the 5307h Passenger Ferry Discretionary Grant in 2020. The useful life of this structure is considered to be 20+ years. Further, the landing on the Mayport side has less developable space and relocation of the warehouse and the construction of a new administration building is not feasible due to these constraints.

Figure 7-1 - Existing Ferry Administration Building

The existing administrative building si 56'-0" x 22'-0" feet with a square footage of 1,232 SF. The proposed maintenance building is approximately 1,600 SF. The building would include offices, crew facilities, restrooms and additional maintenance areas.

The new building footprint could fit within the site as shown below. The building could fit within the footprint of the existing pavilion area as well and the pavilion area could be relocated. The building outline shown in green in Figure 7-2 below is 30'-0" x 54'-0". It is shown in this location to give a sense of scale. The new bulkhead will provide a larger building platform along the waterfront. The building could be pile supported and fit just east of the pavilion. This location would require reworking of the dry pond to increase the capacity, but this is feasible at this time.

The cost of this structure is independent of the alternatives analysis in Section 8, thus it is presented here independently. The costs, in terms of rough orders of magnitude (ROM), are shown as total average costs, with a -10% (Low Range) and a +50%(High Range) to portray the variability that can occur in today's market. See Table 7-1 for cost estimate breakdown.

Figure 7-2 -Possible location of Administration Building

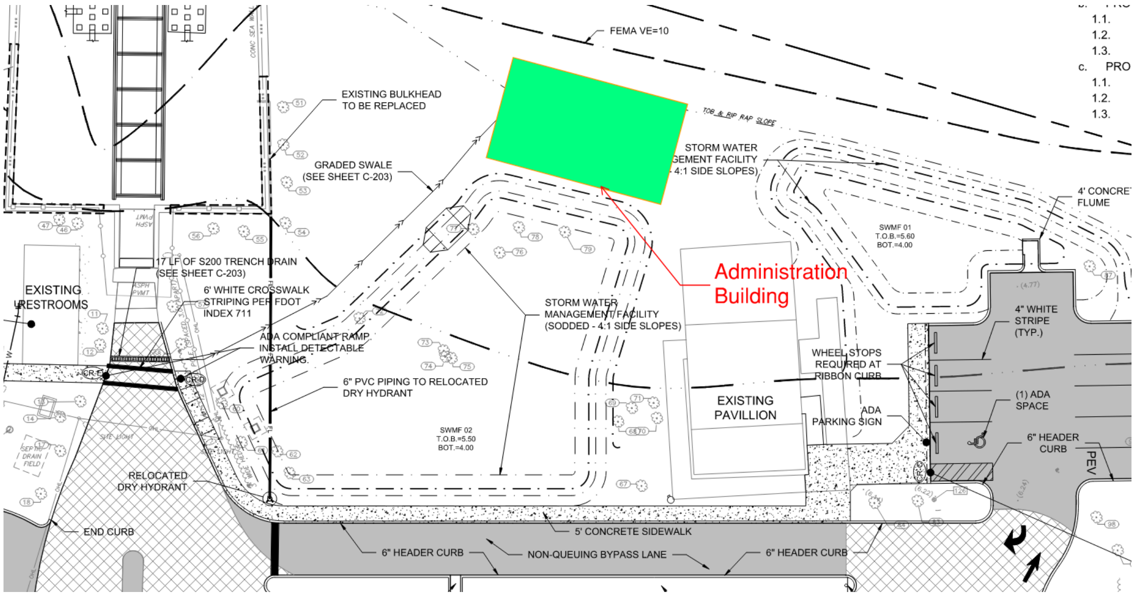


Table 7-1 - Administration Building ROM Costs

Work Item	Qty.	Units	Unit Cost	Total Cost	Low Range	High Range
Exterior						
Site Work	2000	SF	$ 30.00	$ 60,000.00	$ 54,000.00	$ 90,000.00
Pile Foundation	480	LF	$ 80.00	$ 38,400.00	$ 34,560.00	$ 57,600.00
Pile Caps	53	CY	$ 900.00	$ 48,000.00	$ 43,200.00	$ 72,000.00
CMU Shell	1920	SF	$ 16.00	$ 30,720.00	$ 27,648.00	$ 46,080.00
Roof	1900	SF	$ 20.00	$ 38,000.00	$ 34,200.00	$ 57,000.00
Building Envelope	1	EA	$ 10,000.00	$ 10,000.00	$ 9,000.00	$ 15,000.00
			Exterior Total	**$ 225,120.00**	**$ 202,608.00**	**$ 337,680.00**
Interior						
Flooring	1600	SF	$ 10.00	$ 16,000.00	$ 14,400.00	$ 24,000.00
Wall Finishes	1280	SF	$ 5.00	$ 6,400.00	$ 5,760.00	$ 9,600.00
Ceiling	1600	SF	$ 20.00	$ 32,000.00	$ 28,800.00	$ 48,000.00
Electrical	1	EA	$ 10,000.00	$ 10,000.00	$ 9,000.00	$ 15,000.00
Plumbing	1	EA	$ 20,000.00	$ 20,000.00	$ 18,000.00	$ 30,000.00
HVAC	1	EA	$ 15,000.00	$ 15,000.00	$ 13,500.00	$ 22,500.00
FFE	1	EA	$ 50,000.00	$ 50,000.00	$ 45,000.00	$ 75,000.00
			Interior Total	**$ 149,400.00**	**$ 134,460.00**	**$ 224,100.00**
			Construction Cost Total	**$ 374,520.00**	**$ 337,068.00**	**$ 561,780.00**
			Design (15%)	$ 56,178.00	$ 50,560.20	$ 84,267.00
			Pemitting (5%)	$ 18,726.00	$ 16,853.40	$ 28,089.00
			Contingency (15%)	$ 56,178.00	$ 50,560.20	$ 84,267.00
			Total	**$ 505,602.00**	**$ 455,041.80**	**$ 758,403.00**
			SF Costs	**$ 316.00**	**$ 284.40**	**$ 474.00**

7.2.2 Layberth

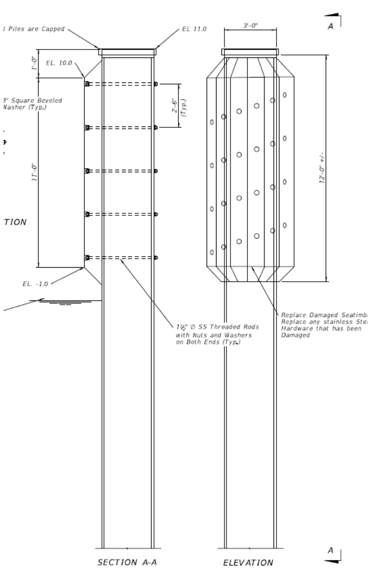
As addressed in sections above, if the existing ferry is maintained for use as a relief vessel, a layberth facility must be developed to allow for the safe mooring of the vessel while it is not in service. The layberth should also allow for access to the vessel by means of a dock to allow for personnel to easily and safely access the vessel. It is preferred to moor the ship parallel to the flow of the river as the environmental forces generated by the current are much less when the current is longitudinal to the vessel.

Based on the site assessment performed for both the Mayport and the Fort George landings, providing a parallel to shore mooring can only occur in one location. The shoreline west of the ferry slip on the Fort George side could provide approximately 270'-0" of unimpeded shoreline that could be used as a layberth for the vessel. The vessel fits in the property line limits so the riparian rights belong to the JTA, meaning permitting this berth would be much simpler. Based on this, it is recommended to develop the layberth on the Fort George side. In addition, with the potential to construct the administration building on this side, and with the potential to develop the fueling facilities for the chosen platform on this side of the river, the location of the layberth in complimentary to the other development.

A layberth for the ferry vessel would need to include mooring and breasting structures provide a surface to rest against and bollards to receive head lines and spring lines. It is envisioned that the breasting structures may be similar to the stopping dolphins adjacent to the ramp structure. These are composite monopiles with an array of sea timbers around the perimeter. The energy absorption or active fendering is provided by cantilever deflection of the monopile. See Figure 7-3 below for the concept for the breasting structures.

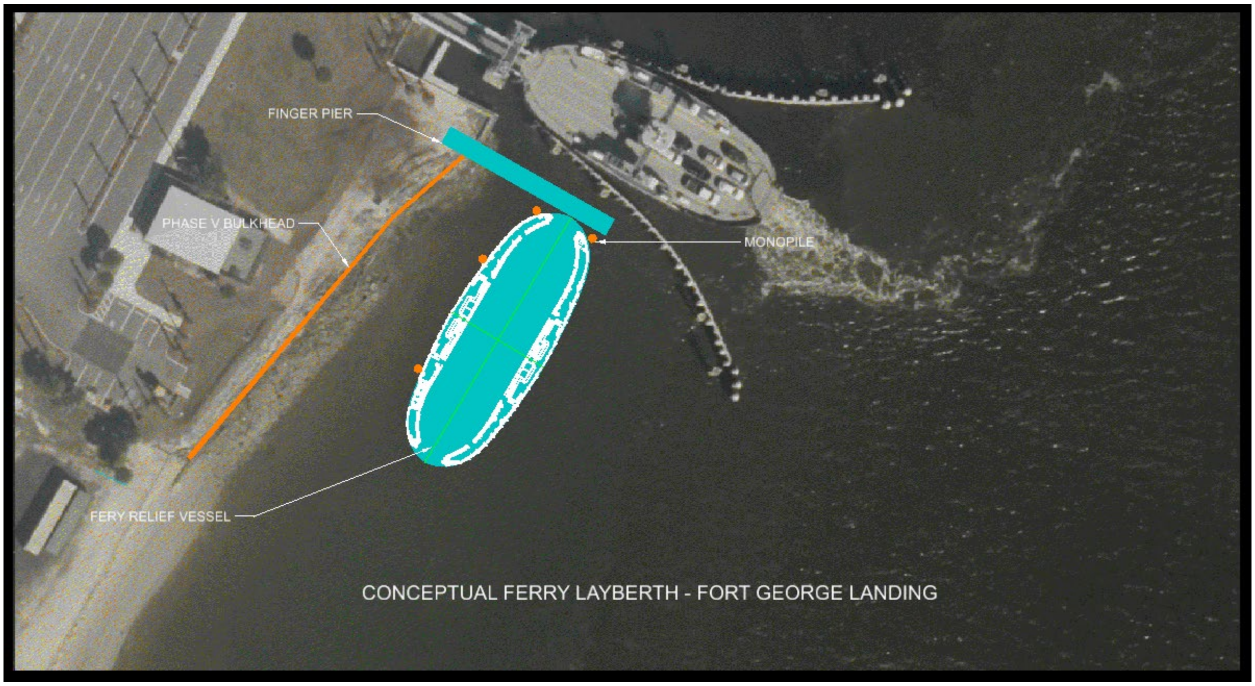
A small finger pier should be developed at the nose of the vessel to allow for pedestrian access to the vessel itself. This dock could be 10'-0" wide and be pile supported. See the overall layberth concept sketch below in Figure 7-4 for a generalized layout of the layberth.

Figure 7-3 - Breasting Dolphin Concept



The tops of these dolphins may receive bollards to receive mooring lines. Three breasting structure shown above could be used, one fore, one midships and one aft. The mooring lines should be easy to attach and done by the deck hands on the vessel.

Figure 7-4 - Conceptual Ferry Layberth at Fort George Landing



The cost of the layberth is independent of the alternatives analysis in Section 8, thus it is presented here independently. The costs in Table 7-2 below are shown as total average costs, with a -10% (Low Range) and a +50%(High Range) to portray the variability that can occur in today's market.

Table 7-2 - Conceptual Cost Estimate for Ferry Layberth

Element	Qty.	Units	Unit Cost	Total Cost	Low Range	High Range
Monopiles	4	EA	$ 15,000.00	$ 60,000.00	$ 54,000.00	$ 90,000.00
Finger Pier	1000	SF	$ 275.00	$ 275,000.00	$ 247,500.00	$ 412,500.00
			Subtotal	**$ 335,000.00**	**$ 301,500.00**	**$ 502,500.00**
			Design (15%)	$ 50,250.00	$ 45,225.00	$ 75,375.00
			Pemitting (5%)	$16,750.00	$ 15,075.00	$ 25,125.00
			Contingency (15%)	$50,250.00	$ 45,225.00	$ 75,375.00
			Total	**$ 452,250.00**	**$ 407,025.00**	**$ 678,375.00**

7.3 Real Estate Opportunities

Based on our initial analysis of the site and the needs of the fueling systems, administration buildings and other space requirements, all of these elements can fit on the existing properties and new properties will not be necessary. However, if there are additional needs beyond the ferry operations there are vacant properties that are immediately adjacent to the ferry slips with one property on the Mayport side and one property on the Fort George side.

The property on the Mayport side adjacent to the ferry slips is 1.17 acres and is located at 4738 Ocean Street. There are now structures on the site, but there are remnants of a building foundation. The property is not currently on the market, and if needed an approach to owner would need to be made.

Additionally, there are various City of Jacksonville owned parcels along Ocean Street within close proximity to the Mayport Landing that could be used for various purposes. However, most of these properties do not have enough contiguous waterfront footage that could support a layberth so their utility is limited.

On the Fort George side, there is a property immediately to the east of the Fort George Ferry landing that is currently on the market. 9636 Heckscher Drive is listed for purchase for a price of $2,590,000. This property is 1.18 Acres and contains a 2-story building close to 5,000 SF total. The building is a subdivided into separate offices, but currently there are no tenants leasing space here. While this property is larger than what is required to support the ferry admin operations, there is the potential to have additional uses for JTA beyond the ferry service administration. It could be possible to rent portions of the building to the tourism industry or concessionaires that are directly associated with the ferry.

8. Alternative Analysis and Costs

The previous sections of this report address the technical feasibility of utilizing various fuels to power a new replacement ferry for the ferry service. Each alternative power system has both advantages and disadvantages as well as varying costs for both the shipboard equipment and the shore side infrastructure. The goal of this feasibility study is to rank these various technology platforms to determine the systems that can be implemented in the time frame required for the replacement program, provide a reliable platform for the ferry service, and offer the emissions reductions desired by JTA. The sections below describe the methodology to develop the ranking of the alternatives based on quantitative and qualitative methods.

8.1 Alternatives Analysis Methodology

To objectively analyze each alternative, a ranking system was developed that considers both cost and subjective evaluation factors. An ordinal based scoring system will be used to score the cost of each alternative and the qualitative evaluation factors of each alternative as well. A separate ordinal ranking for both cost and qualitative factors will be developed. These two ordinal rankings will be combined to represent the overall score of each alternative. The alternatives with lower overall scores will be considered the most desirable.

An explanation of how both the cost ranking and the qualitative ranking are shown below.

8.1.1 Cost Criteria

A main point of comparison between each system is cost. Capital costs to design and construct the new ferry vessel will vary based on the power system that is utilized. In addition to the capital costs, yearly operations and maintenance costs will be compared. This O&M cost will include fuel costs as well.

Each alternative will also include capital costs related to the shore side infrastructure required to support the fueling and operations of the vessel. These costs should also include any periodic maintenance that is required for the shore side systems such as replacement of batteries in the BESS.

The costs for both construction and shore side infrastructure will be calculated for each alternative. The alternatives will be ranked from lowest cost to highest cost and an ordinal ranking will be given. The range of the ordinal ranking will be from 1-17.

Table 8-1 - Cost Ranking Criteria, Ordinal Range and Weight

Criteria (Cn)	Criteria Name	Ordinal Range	Weight (Wn)
C1	Vessel and Landside Capital Costs	1-17	33%
C2	Vessel O+M Costs	1-17	33%
C3	Yearly Fuel Costs	1-17	33%

8.1.2 Qualitative Evaluation Factor Criteria

In addition to the quantitative properties related to capital and maintenance costs in the previous section, the selection of both feasible and preferred systems is also significantly based on qualitative or soft factors that cannot easily be monetized. These include the value of emissions reductions, the presence of a viable supply chain, the ability of the alternative to be resilient to fuel availability in the marketplace and reliability of the underlying technology. These elements can greatly affect the outcomes of the recommendations offered in this study.

To capture the influence of these elements, the study used an ordinal ranking system for each alternative with respect to each of the qualitative factors. Each of the qualitative factors has an overall importance ranking as determined by JTA to reflect the importance of each topic with respect to the values and goals of the organization. A summary table of the qualitative review factors and their importance factors is shown below in Table 8-2.

Table 8-2 - Qualitative Evaluation Factor Criteria, Ordinal Range and Weights

Criteria (Qn)	Criteria Name	Ordinal Range	Weight (Xn)	Comment
Q4	Availability / Reliability of Fuel Source	1-9	35%	Relates to the ability to have a stable, reliable service to the traveling public. Also considers volatility of fuel pricing
Q5	Carbon Neutrality	1-9	35%	Relates to the overall emissions reduction for the full well to wake life cycle including the feedstock, production process and transportation of the fuel.
Q6	Path to Zero Emissions	1-9	15%	The ease at which the technology platform can be transitioned to zero emissions from well to wake.
Q7	Crew Familiarity	1-9	10%	The familiarity of the existing operations crew with the alternative and the necessity to retrain for new technology.
Q8	Maturity of Technology	1-9	5%	Involves the rate of adoption of the technologies and thus the related maintenance parts and skill sets present in the marketplace

This table shows ordinal rankings that are 1-9 for all categories. It should be noted that many of the alternatives may be similar in ranking and therefore ties in the rankings were used in some situations.

8.1.3 Ranking Formula

The overall score formula is shown below:

$Overall\ Score = \sum(Cn * Wn) + \sum(Qn * Xn)$

Where:

Cn = Cost Criteria Score

Wn = Cost Criteria Weight

Qn = Qualitative Criteria Score

Wn = Qualitative Criteria Weight

This is the formula that is used to calculate the overall scores for each of the alternatives.

8.2 Alternatives and Alternatives Matrix

There are multiple configuration variables which control the scoring of each alternative across the three criteria. These varying criteria are entered into a matrix for comparison between all alternatives. The full alternatives matrix is shown in Appendix A of this study. Each row of the matrix is an individual alternative. The columns contain either information related to the specific configuration of an element, cost information, or ordinal rankings.

The alternatives for the study are broken into three main categories based on the power and propulsions systems included in the alternatives. These three main groups are Internal Combustion Engines (ICE) Mechanical Drive, ICE Electric Drive, and Electric Drive system. Each of these categories are explained below.

8.2.1 ICE Mechanical Drive

The internal combustion engine remains the most predominant means of marine power today. Marine ICE's can burn a variety of fuels to produce power. The power produced by the engine is transferred to the transmission and then the transmission turns the drive shaft, spinning the propeller. This is how the ferry Jean Ribault is powered and how more than 97% of all other ferries currently in operation in the US are powered.

The proposed new ferry will have two engines, one at each end of the ferry. Two separate power trains are used to power the independent propulsion units at each end.

The advantages for this platform are many. This is platform is well tested and many reliable vendors for the engines and mechanical drive components exist to provide maintenance. The current crew is familiar with this system from an operations and maintenance perspective as well. There are nuances related to the individual fuels, but the principles are the same.

The downside for this system is that if there is a desire to repower this platform in the future, it will require an extensive change to the powertrain to make this change.

For this study, the specific alternatives for ICE Mechanical Drive systems are shown in Table 8-3 below.

Table 8-3 - ICE Mechanical Drive Alternatives

	Alternative Number	Vessel Platform
Internal Combustion Engine Mechanical Systems	ICE-1	Diesel ICE Mechanical
	ICE-2	BioDiesel ICE Mechanical
	ICE-3	Renewable Diesel ICE Mechanical
	ICE-4	CNG ICE Mechanical
	ICE-5	LNG ICE Mechanical
	ICE-6	Methanol ICE Mechanical
	ICE-7	Bio Methanol ICE Mechanical

Each of the liquid or gas fuels discussed in Section 6 are included in this grouping.

8.2.2 ICE Electrical Drive

The ICE Electric Drive alternatives differ from the mechanical drive alternative listed above. The power is still generated by an ICE, but the power is converted to electricity. The electricity produced is used to power electrical motors which in turn drive the propulsion. The advantage of this system is that multiple generator sets are used to provide the power, meaning there is enhanced redundancy across the system as these generators will power the overall DC power bus which powers both propulsion units at the same time. This allows for lower peak loading across all generators, lowering the wear and tear.

An additional advantage of this platform is that the electric motors which drive the propulsion are 'agnostic' to the source of power. The platform can be upgraded or repowered to a lower emitting type system much easier. The generator sets could be replaced by cleaner burning ICE engines or non-emitting electric sources such as batteries or fuel cells in the future. They offer an upgrade path that is less expensive then repowering a mechanical drive as shown above. The electric motors all are more responsive than mechanically driven propulsion and can reverse almost immediately. This can lead to improved navigational safety and efficiency.

The downside for this system is that there is an overall loss of efficiency in the conversion of energy due to the intermediate step converting combustion power to electricity prior to powering the motors. This yields an approximately 5% less efficiency for this platform.

For this study, the specific alternatives for ICE Electrical Drive systems are shown in Table 8-4 below.

Table 8-4 - ICE Electrical Drive Alternatives

	Alternative Number	Vessel Platform
Internal Combustion Engine Electric Systems	E-ICE-1	Diesel Electric Drive
	E-ICE-2	Bio Diesel Electric Drive
	E-ICE-3	Renewable Diesel Electric Drive
	E-ICE-4	LNG Electric Drive
	E-ICE-5	CNG Electric Drive
	E-ICE-6	Methanol Electric Drive
	E-ICE-7	Bio methanol Electric Drive

Again, each of the liquid or gas fuels discussed in Section 6 are included in this grouping.

8.2.3 Electrical Drive

The full electrical drive alternatives are those that drive most or all of their propulsion power from electricity either stored in batteries or a product of fuel cells. These options include battery electric technologies, plug in hybrid electric technologies and hydrogen fuel cell technologies.

The advantages of all electrical platforms are their overall emissions profiles. The vessel will operate nearly emissions free, with the life cycle emissions mostly related to the source of the produced electricity.

The disadvantages related to these options are cost. The cost of the batteries and the fuel cells are high and repowering of the battery powered solutions are high as well. The fuel cells also have a high yearly maintenance cost related to the fuel cell membrane replacements. The fuel cells useful life are longer than batteries, but their replacement costs are high.

Table 8-5 - Electrical Systems Alternatives

	Alternative Number	Vessel Platform
Electric Systems	E-1	Battery Electric
	E-2	Diesel Plug In Hybrid Electric
	E-3	Hydrogen Fuel Cell

8.2.4 Constants Across all Alternatives

To provide an accurate comparison across all alternatives, some of the ferry configuration variables are constant. These include the overall dimension of the ferry, the hoteling power loads, the passenger and POV capacity and the propulsion. The structure and propulsion costs are the same across all platforms. There are minor weight differences between the systems, but the short route and refueling/charging opportunities do not require significant changes to the vessel structure.

8.3 Cost Criteria Evaluation

As stated above, the main differentiator between each system will be the capital and operations and maintenance costs related to the vessels. The costs are compared, and an ordinal value is developed based on the overall cost for the capital expenditures related to the ferry platform and the average operations and maintenance costs for one year.

The capital costs for the alternative platforms are shown below in Table 8-6. The table shows the total capital costs for the vessel and required landside infrastructure for each alternative, it shows yearly fuel costs associated with the ongoing operations, and it shows the yearly maintenance costs for each alternative. To note, the maintenance costs include the repower costs for each alternative over the life of the vessel divided by a 30-year vessel life. Ordinal values for each metric are averaged to develop the final ordinal for costs. The lower the average ordinal value, the lower the total operations and maintenance costs.

The rankings indicate that battery electrical and electric hybrid ferries are desirable from a cost perspective. The higher capital costs are offset by lower yearly fuel and maintenance costs. The conventional diesel and diesel electric are highly ranked as well with the lowest capital cost overall.

The biomethanol and the hydrogen systems are the lowest ranked. The hydrogen systems have high capital and maintenance costs while the biomethanol has a high yearly fuel costs.

Table 8-6 - Summary of Costs Developed for Each Alternative and Ordinal Rankings

	Alternative Number	Vessel Platform	Total Vessel Capital Costs	Land Side Capital Costs	Total Capital Costs	Yearly Fuel Costs	Total Maintenance Costs	Capital Cost Ordinal	Maintenace Cost Ordinal	Annual Fuel Cost Ordinal	Average Ordinal For Costs
Internal Combustion Engine Mechanical Systems	ICE-1	Diesel ICE Mechanical	$ 13,353,432.00	$ 10,000.00	$ 13,363,432.00	$ 640,356.00	$ 177,000.00	1	10	12	**7.67**
	ICE-2	BioDiesel ICE Mechanical	$ 13,353,432.00	$ 10,000.00	$ 13,363,432.00	$ 891,127.22	$ 177,000.00	1	10	15	**8.67**
	ICE-3	Renewable Diesel ICE Mechanical	$ 13,353,432.00	$ 10,000.00	$ 13,363,432.00	$ 682,732.50	$ 177,000.00	1	10	13	**8.00**
	ICE-4	CNG ICE Mechanical	$ 13,499,632.00	$ 500,000.00	$ 13,999,632.00	$ 348,429.00	$ 194,000.00	7	14	3	**8.00**
	ICE-5	LNG ICE Mechanical	$ 13,499,632.00	$ 40,000.00	$ 13,539,632.00	$ 392,375.00	$ 190,000.00	4	13	7	**8.00**
	ICE-6	Methanol ICE Mechanical	$ 13,608,432.00	$ 60,000.00	$ 13,668,432.00	$ 353,137.50	$ 208,000.00	5	15	5	**8.33**
	ICE-7	Bio Methanol ICE Mechanical	$ 13,608,432.00	$ 60,000.00	$ 13,668,432.00	$ 549,325.00	$ 208,000.00	5	15	9	**9.67**
Internal Combustion Engine Electric Systems	E-ICE-1	Diesel Electric Drive	$ 14,492,262.00	$ 10,000.00	$ 14,502,262.00	$ 714,816.00	$ 119,000.00	8	1	14	**7.67**
	E-ICE-2	Bio Diesel Electric Drive	$ 14,492,262.00	$ 10,000.00	$ 14,502,262.00	$ 994,746.67	$ 119,000.00	8	1	16	**8.33**
	E-ICE-3	Renewable Diesel Electric Drive	$ 14,492,262.00	$ 10,000.00	$ 14,502,262.00	$ 613,200.00	$ 119,000.00	8	1	11	**6.67**
	E-ICE-4	CNG Electric Drive	$ 14,564,172.00	$ 500,000.00	$ 15,064,172.00	$ 348,429.00	$ 139,000.00	14	7	3	**8.00**
	E-ICE-5	LNG Electric Drive	$ 14,564,172.00	$ 40,000.00	$ 14,604,172.00	$ 392,375.00	$ 135,000.00	11	5	7	**7.67**
	E-ICE-6	Methanol Electric Drive	$ 14,640,312.00	$ 60,000.00	$ 14,700,312.00	$ 353,137.50	$ 148,000.00	12	8	5	**8.33**
	E-ICE-7	Bio methanol Electric Drive	$ 14,640,312.00	$ 60,000.00	$ 14,700,312.00	$ 549,325.00	$ 148,000.00	12	8	9	**9.67**
Electric Systems	E-1	Battery Electric	$ 15,642,732.00	$ 3,900,000.00	$ 19,542,732.00	$ 296,165.29	$ 129,500.00	16	4	1	**7.00**
	E-2	Diesel Plug In Hybrid Electric	$ 15,555,132.00	$ 3,125,000.00	$ 18,680,132.00	$ 325,193.53	$ 136,175.00	15	6	2	**7.67**
	E-3	Hydrogen Fuel Cell	$ 20,782,272.00	$ 1,300,000.00	$ 22,082,272.00	$ 1,518,400.00	$ 471,666.67	17	17	17	**17.00**

8.4 Qualitative Evaluation Factor Criteria

The subjective or qualitative factors for each system were analyzed as described in section 8.1.2 above. To accurately capture the variations between the alternatives, the evaluation of these factors focused primarily on the fuel sources and types. As the ICE platforms use the same fuel in two different means, it was deemed repetitive to show ranking for each platform. Each subjective ranking is discussed below.

8.4.1 Fuel Type Availability

One of the main factors that will affect the ferry service is the availability of the fuel source. The evaluation of this criteria focuses on the current availability of the fuel in the marketplace as well as the ease at which this fuel is transported to the site. It will also look forward to capture the proposed further development of the fueling infrastructure and thus the availability of the fuels in the future. It also captures the ability of each fuel to be stored and available on demand at the ferry landing to match the current fueling frequency. The fuel type availability scoring is shown below in Table 8-7.

Table 8-7 - Fuel Type Availability Ordinals

Fuel Type	Ordinal Rank	Comment
Electricity	1	Transmitted directly to site
Diesel	2	Brought in Via Truck
Bio Diesel	3	Harder to source, brought in via truck
Renewable Diesel	5	Hardest to source Diesel, fuel supply chain not yet strong
CNG	3	Need gas line feed to site
LNG	3	Bunkered from Dames Point
Methanol	3	Production limited; supply chain underdeveloped
Bio Methanol	5	Production very limited, supply chain underdeveloped
Hydrogen	5	No current regional supply chain, but one in development in South Georgia

Electricity is highly ranked as an available fuel source, with the viable electrical grid connectivity present on both sides of the river. Diesel is currently delivered to the site on a regular basis and the supply chain is strong. A natural gas pipeline is present on both sides of the river, facilitating the development of CNG compression stations.

Methanol and Hydrogen are harder to obtain as the supply chain for these are not fully developed yet.

8.4.2 Carbon Neutrality

One of the main goals of this study is to determine the overall reductions in emissions related to the use of alternative fuels and the overall lifecycle GHG emissions related to each fuel source. Each fuel type is reviewed and the overall life cycle amount of CO2e is compared and given an ordinal ranking. The amount of CO2e released by some fuels is very dependent on the feedstock used. A comment related to the feedstock is shown in the table as well.

Table 8-8 - Carbon Neutrality of Fuel Ordinals

Fuel Type	GHG gCO2e/MJ	Ordinal Rank	Comment
Electricity	20	3	Existing Power Grid
Diesel	102	9	
Bio Diesel	30	4	Used Cooking Oil (UCO) as primary feedstock
Renewable Diesel	15	1	Pure vegetable oil feedstock
CNG	78	6	
LNG	85	7	
Methanol	85	7	
Bio Methanol	15	1	
Hydrogen	35	5	Average of Blue, Green and Grey Hydrogen usage.

The amount of emissions created by the fuels is specific importance to the JTA as it relates to their stated 2050 net zero GHG emissions goals. The highest ranked fuels provide immediate reduction in GHG's. Renewable fuels and those generated from GHG producing waste streams provide emission reduction by offsetting combustion emissions with carbon or GHG capture during their manufacturing. For electricity as a fuel, emissions related to power generation are included in the evaluation of this criteria.

Electricity and renewable combustion fuels are highly ranked and provide great GHG reductions.

8.4.3 Path to Zero Emissions

This ranking is used to capture the future changes as each of the fuel types continue to develop in manufacturing techniques with regards to sustainability and lifecycle GHG emissions. It is anticipated that over the life of the vessel, there will be changes in the availability and reduction of emissions in the fuel supply chain. The potential for this improvement is captured here. Of primary importance is the maturation of the electrical supply, not just for battery vessels, but also the use of cleaner power to produce hydrogen.

Table 8-9 - Future Carbon Neutrality of Fuels

Fuel Type	Future Potential GHG gCO2e/MJ	Ordinal Rank	Comment
Electricity	10	2	Assumes future nuclear power supply of power grid
Diesel	102	9	
Bio Diesel	30	6	UCO as primary feedstock
Renewable Diesel	15	4	Pure vegetable oil feedstock
CNG	0	1	Biogas
LNG	0	1	Biogas
Methanol	10	1	Assumes adoption of eMethanol, produced by electrolysis from low carbon power
Bio Methanol	15	4	
Hydrogen	10	2	Green Hydrogen

Electrical power and green hydrogen emissions will be based on the power generating source of the public utility. The utility will continually improve its emissions over time as non-emitting sources are likely to be included in the regional power generation infrastructure.

CNG and LNG rank highly here as the availability of renewable natural gas as a fuel increases. Renewable natural gas (RNG) includes a significant amount of GHG reduction related to capture and reuse of methane from organic waste streams. RNG is currently available in structured markets but is cost prohibitive. As the availability of this gas increases, the costs will decrease.

8.4.4 Maturity of Technology and Crew Familiarity

The final two rankings are based on each individual alternative and not specifically related to the fuel that is used. These rankings are presented below in Table 8-10.

The first ranking is the Maturity of the Technology. This is a measure of the penetration of the system into the commercial ferry and marine marketplace. If a technology is mature, like diesel mechanical drive, there will be a variety of vendors to provide the parts and familiarity of the market with respect to maintenance requirements. The lower the ranking indicates a more currently popular system and overall reliability of the service will be enhanced.

The second is the familiarity of the crew to the anticipated operational requirements of the new vessel. The crew must understand the current docking and fueling of the Jean Ribault. The new vessel may require advanced understanding of electrical vessel operations or more sophisticated fueling techniques like slow filling of CNG tanks. If additional crew is required for the operation, this ordinal may be higher.

Table 8-10 - Maturity of Technology and Crew Familiarity Ordinals

	Alternative Number	Vessel Platform	Maturity of Technology	Crew Familiarity
Internal Combustion Engine Mechanical Systems	ICE-1	Diesel ICE Mechanical	1	1
	ICE-2	BioDiesel ICE Mechanical	1	1
	ICE-3	Renewable Diesel ICE Mechanical	1	1
	ICE-4	CNG ICE Mechanical	3	2
	ICE-5	LNG ICE Mechanical	3	2
	ICE-6	Methanol ICE Mechanical	7	3
	ICE-7	Bio Methanol ICE Mechanical	7	3
Internal Combustion Engine Electric Systems	E-ICE-1	Diesel Electric Drive	1	1
	E-ICE-2	Bio Diesel Electric Drive	1	1
	E-ICE-3	Renewable Diesel Electric Drive	1	1
	E-ICE-4	CNG Electric Drive	3	2
	E-ICE-5	LNG Electric Drive	3	2
	E-ICE-6	Methanol Electric Drive	7	3
	E-ICE-7	Bio methanol Electric Drive	7	3
Electric Systems	E-1	Battery Electric	4	4
	E-2	Diesel Plug In Hybrid Electric	3	3
	E-3	Hydrogen Fuel Cell	7	5

The scoring is indicative of the current maturity of the technologies in the marketplace with diesel leading the way as the most prevalent fuel in use today. LNG as a marine propulsion fuel is growing in acceptance and usage globally, making the ecosystem around operation and maintenance more robust. Marine engines running methanol based fuels are in the early stages of development and thus the technology is not as robust.

Hydrogen fuel cells at the scale required for marine propulsion are relatively new to the market. The operations and maintenance of the fuel cells would require specialized technicians that aren't available in the marketplace.

From a crew familiarity standpoint, it should be noted that the introduction of any new system will require training. The extent of the training will vary based upon the complexity of the activities that are required to be undertaken. Diesel is the standard against which the other systems are measured. CNG and LNG require some additional training for fueling operations.

The electrical system are fairly complex to operate and maintain as there are numerous technologies to understand, particularly on the rapid charging battery electric ferry. Hydrogen as a fuel is complex in that regular maintenance of the fuel cell membranes will require specific expertise.

8.5 Combined Rankings

Table 8-11 below presents the overall ordinal rankings for cost, qualitative evaluation factors, and the combined ordinal ranking for each alternative. The columns with the highlighted rows represent these ordinal rankings. The calculations were made in accordance with the formula shown in Section 8.1.3 above. These calculations used the weighting factors shown in Tables 8-1 and 8-2.

The combined ordinal rankings represent the scoring of each alternative against all evaluation criteria. As stated above, lower ordinal scores represent a more desirable option are related to the evaluation criteria.

A detailed discussion of the recommended platform and power source can be found in Section 9 of this study.

Table 8-11 - Overall Ordinal Rankings of Alternatives

	Alternative Number	Vessel Platform	Capital Cost Ordinal	Maintenace Cost Ordinal	Annual Fuel Cost Ordinal	Total Cost Ordinal	Maturity of Technology	Availability of Fuel	Carbon Neutrality	Provide Path to Zero Emissions	Crew Familiarity	Qualitative Evaluation Factor Ordinal	Combined Ordinal
Internal Combustion Engine Mechanical Systems	ICE-1	Diesel ICE Mechanical	1	10	11	**7.33**	1	2	9	9	1	**5.35**	**12.68**
	ICE-2	BioDiesel ICE Mechanical	1	10	13	**8.00**	1	3	4	6	1	**3.50**	**11.50**
	ICE-3	Renewable Diesel ICE Mechanical	1	10	14	**8.33**	1	5	1	4	1	**2.85**	**11.18**
	ICE-4	CNG ICE Mechanical	13	14	3	**10.00**	3	3	6	1	2	**3.65**	**13.65**
	ICE-5	LNG ICE Mechanical	4	13	7	**8.00**	3	3	7	1	2	**4.00**	**12.00**
	ICE-6	Methanol ICE Mechanical	5	15	5	**8.33**	7	3	7	1	3	**4.30**	**12.63**
	ICE-7	Bio Methanol ICE Mechanical	5	15	9	**9.67**	7	5	1	4	3	**3.35**	**13.02**
Internal Combustion Engine Electric Systems	E-ICE-1	Diesel Electric Drive	7	1	12	**6.67**	1	2	9	9	1	**5.35**	**12.02**
	E-ICE-2	Bio Diesel Electric Drive	7	1	15	**7.67**	1	3	4	6	1	**3.50**	**11.17**
	E-ICE-3	Renewable Diesel Electric Drive	7	1	16	**8.00**	1	5	1	4	1	**2.85**	**10.85**
	E-ICE-4	CNG Electric Drive	14	7	3	**8.00**	3	3	6	1	2	**3.65**	**11.65**
	E-ICE-5	LNG Electric Drive	10	5	7	**7.33**	3	3	7	1	2	**4.00**	**11.33**
	E-ICE-6	Methanol Electric Drive	11	8	5	**8.00**	7	3	7	1	3	**4.30**	**12.30**
	E-ICE-7	Bio methanol Electric Drive	11	8	9	**9.33**	7	5	1	4	3	**3.35**	**12.68**
Electric Systems	E-1	Battery Electric	16	4	1	**7.00**	4	1	3	2	4	**2.30**	**9.30**
	E-2	Diesel Plug In Hybrid Electric	15	6	2	**7.67**	3	1	3	2	3	**2.15**	**9.82**
	E-3	Hydrogen Fuel Cell	17	17	17	**17.00**	7	5	5	2	5	**4.65**	**21.65**

9. Recommendations

9.1 Final Ordinal Rankings

The complete ordered list of rankings are shown below in Table 9-1. The rankings reflect capital costs, operations costs and the evaluation factors compared for each alternative.

Table 9-1 - Final Ordinal Rankings

Alternative Number	Vessel Platform	Total Cost Ordinal	Qualitative Evaluation Factor Ordinal	Combined Ordinal
E-1	Battery Electric	**7.00**	**2.30**	**9.30**
E-2	Diesel Plug In Hybrid Electric	**7.67**	**2.15**	**9.82**
E-ICE-3	Renewable Diesel Electric Drive	**8.00**	**2.85**	**10.85**
E-ICE-2	Bio Diesel Electric Drive	**7.67**	**3.50**	**11.17**
ICE-3	Renewable Diesel ICE Mechanical	**8.33**	**2.85**	**11.18**
E-ICE-5	LNG Electric Drive	**7.33**	**4.00**	**11.33**
ICE-2	BioDiesel ICE Mechanical	**8.00**	**3.50**	**11.50**
E-ICE-4	CNG Electric Drive	**8.00**	**3.65**	**11.65**
ICE-5	LNG ICE Mechanical	**8.00**	**4.00**	**12.00**
E-ICE-1	Diesel Electric Drive	**6.67**	**5.35**	**12.02**
E-ICE-6	Methanol Electric Drive	**8.00**	**4.30**	**12.30**
ICE-6	Methanol ICE Mechanical	**8.33**	**4.30**	**12.63**
ICE-1	Diesel ICE Mechanical	**7.33**	**5.35**	**12.68**
E-ICE-7	Bio methanol Electric Drive	**9.33**	**3.35**	**12.68**
ICE-7	Bio Methanol ICE Mechanical	**9.67**	**3.35**	**13.02**
ICE-4	CNG ICE Mechanical	**10.00**	**3.65**	**13.65**
E-3	Hydrogen Fuel Cell	**17.00**	**4.65**	**21.65**

For the alternatives analysis, the top ranked system is alternative E-1, the battery electric system. In general, the electrical drive systems were more favorable than mechanical systems and systems with lower overall GHG emissions were more favorable than conventional combustion fuel systems. This analysis demonstrates the commitment of JTA to developing a system that balances low overall life cycle costs and low GHG emissions.

In depth discussions of the recommended propulsion platforms and the recommend power platforms are below.

9.2 Recommended Platforms

This study focused on finding the optimal power platform and propulsion platform for the new ferry vessel. As in evident in Table 9-1, the electric drive propulsion platform (alternatives E-X and E-ICE-X) is favorable with 4 of the top 5 ranked alternatives utilizing electric drive. This is based on the relatively low annual maintenance costs of the electric motor system compared to the mechanical drive systems. The electric drive propulsion platforms provide for the most flexibility when considering repowering over the life of the vessels. The ability to repower the vessel while minimizing the costs allow for the vessel to support multiple fuel technologies during its life. Low carbon fuel technologies are constantly improving, and fuel refining and manufacturing techniques are improving. These platforms will give the most flexibility over the life of the vessel and provide lower annual maintenance costs.

9.3 Recommended Fuels

The analysis above considered many factors regarding the fuel types to be considered. The availability and the reduced emissions of the fuels are of great importance to the JTA and these two metrics were evident in the final rankings.

Electric powered vessels are efficient, low maintenance and have overall low GHG emissions. The lifetime emissions are primarily due to the source of the power and as power generation becomes more sustainable and lower emitting itself, so will the ferry vessel's total emissions. The power grid in NE Florida may continue to become lower emitting with the addition of unit 3 and 4 of JEA's Project Vogtle coming online within the life of the ferry. It should be noted that the battery technologies recommended for utilization here are Lithium Ion (Li-ion). The production of Li-ion batteries, including the mining of the minerals for these batteries can be GHG intensive. These GHG emissions are not considered in this analysis. It should also be noted that mining, manufacturing of steel and aluminum are required for conventional power elements (i.e. diesel engines) and those are not considered in the analysis either.

The ICE liquid fuel recommendations center around fuels that have low lifecycle emissions overall. Renewable Diesel and Bio Diesel are fuels which still have combustion emissions but the lifecycle balance of carbon emissions and sequestration remain very low. This fact makes them very competitive in the criteria, despite higher per gallon costs. The price used for renewable diesel in the analysis is $6 per gallon. As production and availability improves and the market's capabilities to provide these fuels continue to evolve, the price performance will get lower.

9.4 Stakeholder Involvement Discussion

The study team developed and participated in a series of stakeholder and public engagement efforts to support the development of the study and to guide the eventual decision making. The series of events included:

1. Meeting with HMS, the current ferry operator – October 20, 2023
2. Mayport Waterfront Partnership Presentation – November 14, 2023
3. Feasibility Study Public Forum – November 30, 2023

The stakeholder input from these meetings was used in developing the study and was used in the decision making. An in-depth summary of the public involvement process is included in Appendix C.

9.5 Grants Discussion

The funding for this ferry may come a variety of sources. The Local Option Gas Tax (LOGT) funds will provide support to the ferry replacement program as will other Federal grants available for ferry systems. As shown in section 3.5 of this report, the existing ferry system has been supported by grant funding for many years. It is anticipated that as new grant funding opportunities emerge, JTA will continue to pursue these grants. There are several grant programs that this project may qualify for and new sources of grant funding are expected to be released in the future. The discussion in this study covers two of the known sources of grants funding that are upcoming.

9.5.1 Section 5307 Grant Program

This program provides competitive grants to ferry systems operating in urban areas. The program, offered by the US DOT Federal Transit Association (FTA), provides funding to purchase, replace, or rehabilitate passenger ferries. This grant will provide funding for vessels unrelated to the power or propulsion systems. A grant application is being prepared for this grant program for the 2023 NOFO.

9.5.2 IIJA Electric or Low-Emitting Ferry Pilot Program

Beginning in 2022, the Infrastructure Investment and Jobs Act (IIJA) provided funds for the Electric or Low-Emitting Ferry Pilot Program. From the NOFO for this program, the funding for this program "provides funding for the purchase of electric or low-emitting ferries, the electrification of or other reduction of emissions from existing ferries, and related charging or other fueling infrastructure (for which the applicants will maintain satisfactory continuing control) to reduce emissions or produce zero onboard emissions under normal operation."

Although there was no notice of funding opportunity for FY 2023, A NOFO is anticipated in FY 2024. Once the specific ferry platform is decided upon, the applicability of this program should be investigated.

9.6 Future Program Steps

Now that the analysis has been performed, the selection of the final alternative and platform needs to be made by JTA for the project to proceed. The path forward for this project involves progressing the design, selecting the procurement methodology and then executing the work. The primary first steps are discussed below and a conceptual schedule is also shown. This schedule shows project duration from an assumed Notice To Proceed (NTP) for the conceptual design of the project.

9.6.1 Conceptual Design

To progress the design, it is recommended that JTA proceed to procure the services of a licensed naval architectural firm that specializes in the development of ROPAX ferries. A conceptual design is needed to refine the overall costs, further define the shipboard systems, begin conceptual design of the upland infrastructure, and provide input to the grant application process.

The conceptual design will need to be performed regardless of the chosen procurement method. It is anticipated that the conceptual design will take approximately 12 months. This is reflected in the overall project schedule shown in 9.5.3.

9.6.2 Procurement Methods

The final design and construction of the vessel and the landside infrastructure can be procured in a number of different ways. The methods may also be different for each project element. The conventional method of procurement for vessels would include the full development of the structure and systems plans and specifications by a Naval Architect. These plans and specifications would be bid and the vessel constructed by a ship builder.

For a design build procurement, the Naval Architect would produce a design criteria package that is submitted to shipyards for bid. The shipyards would prepare the final designs for review by the Naval Architect and then they could construct the vessel.

The selection of the procurement process for the vessel can depend on the complexity of the systems selected and the schedule required for the procurement. A consideration for this procurement is that the vessel will need to be constructed by an American shipyard under the regulations of the Jones Act and the Passenger Vessel Services Act. This can limit the pool of constructors, so the procurement decisions will need to consider this.

It is anticipated that a design bid build procurement and the bid build procurement would have similar durations with the bid build project taking approximately 6 additional months of construction time. The schedule shown in Section 9.5.3 is based on a design build procurement schedule and is shown with a duration of 54 months.

The upland infrastructure development can follow the conventional Design-Bid-Build process or the Design Build process as well. Previous ferry infrastructure development has been Design-Bid-Build. It is recommended that this process be used for any improvements as these improvements will need to tightly integrate with the design of the vessel. The overall duration of the upland infrastructure development is approximately 36 months and can be performed concurrently with the development of the vessel.

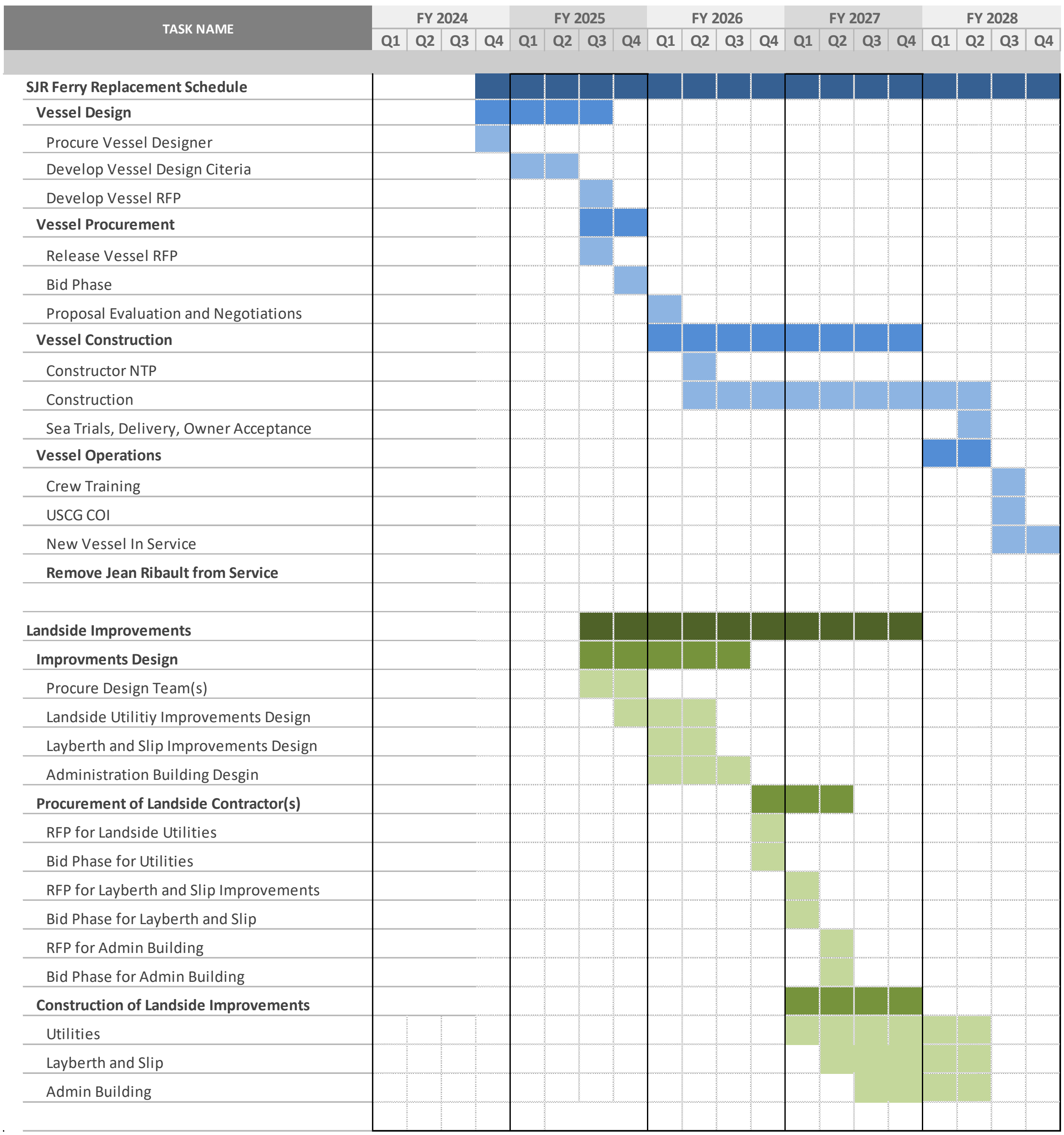
Embedded in the activities for the landside construction are the utility connections required for fueling the ferry. Electrical power and gas service are available in the area and the connection of these utilities to the new facility will be achievable in the durations shown on the project schedule. Permitting will be required for the land development as well as any required marine infrastructure. The durations shown on the schedule include time for this as well.

9.6.3 Project Schedule

The project schedule presented below in figure 9-1 is a duration based schedule with an assumed start date for the program development of October 1, 2023. The schedule assumes the recommended procurement method of design build for the ferry vessel and design bid build for the landside infrastructure.

Figure 9-1 - Presumptive Project Schedule

JTA LOGT Ferry Vessel Replacment Program Schedule



10. Conclusions

10.1 Summary of Study

The goals of the study are to provide decision guidance to the JTA as the move forward with the development of a new vessel for the ferry service. The goal is to balance the most cost-effective solution with the need to meet JTA's net zero 2050 goals. This can be achieved in a number of different ways with the understanding that the technologies will evolve, and the achievement of the net zero goals does not have to occur at the inception of the project but rather can be achieved over time with step wise improvements to the ferry emissions profile.

10.1.1 Discussion of Fuels

The next zero emissions goal can be met through two main pathways. First, the ferry can be developed using a low emissions power platform from its inception. This would mean using a power platform that uses electricity as the fuel. While not fully net zero, electricity is the least emitting fuel that is currently available and cost competitive as evidenced by the final rankings shown in Section 9.

The second way is to use a combustible fuel that has a net zero GHG footprint through its entire supply chain. The combustible fuels that meet these needs are renewable diesel products and biogas products. These fuels have significant carbon emissions credits available due to the carbon sequestration that occurs during their manufacture. These fuels are still more expensive and they are not widely available yet. It is anticipated that the availability of the fuels will increase, driving down the costs for these fuels. As these fuels are based on a carbon credit system, there is no technical need to change the actual equipment on the ferry, only a need to purchase the fuels and credits through a renewable fuel market place.

10.1.2 Discussion of Costs

Costs played a significant role in the final ranking shown in Section 9. The costs were evaluated based on the initial capital outlay for the vessels, upland improvement needs to support the new vessel, operations and maintenance costs, and yearly fuel costs. The ordinal rankings for the capital costs showed that conventional systems, utilizing liquid combustible fuels are the least expensive, while systems using the all electric power platforms were the most expensive. This is primarily due to the costs related to the upland infrastructure requirements for charging systems.

Maintenance costs were clear in that the alternatives that utilize the electric propulsion platform had lower annualized operations and maintenance costs as compared to mechanically driven propulsion. The mechanical systems require maintenance on the power generator as well as the mechanical drive train and transmissions, where the electrical drive requires only significant maintenance on the power generators themselves.

The annual fueling costs show the biggest differential between the options. The electricity required to run the battery electric and hybrid electric ferries is less expensive than the other fuels per kWh. The price for electricity is also much less volatile than the combustible fuels as there are regulatory controls built into what the utility companies may charge and rate of increase to their rates. Diesel remains as one of the most reliable marine fuels available with significant energy density and market availability.

10.2 Recommendations

As the study evolved, it became important to chose the ferry systems based on technical criteria as well as criteria based on the policy direction of the JTA executive team and the board of directors. An additional analysis was performed based on three specific implementation scenarios. This analysis allowed for the board to choose the best system for overall implementation. The ordinal scoring and system costs were used as a basis for this analysis. The

10.2.1 Power Platform Recommendations

JTA has a goal to develop a net zero solution for the new ferry vessel and have the net zero approach in place from commencement of the vessel's deployment into service. The date of the commencement of service will need to be considered when selecting the system. The goal of the ferry program is to have the new ferry in service by the time of the next required dry docking and inspection of the existing ferry vessel. This is anticipated to occur in the spring of 2028. The maturation of the technology and importantly the implementation of the fuel supply chain need to occurs prior to the new vessel being in service.

The JTA has options to determine which Power Platform will support their goals for the Ferry to power the propulsion described above. The following options outline different options for JTA to reach all their new ferry vessel goals.

10.2.1.1 Net Zero from Day One Scenario

To meet this criteria, the vessel must have zero emissions from day one. True zero point emissions options as well as a net zero emissions option are recommended here. Based on the current level of maturity in the marketplace, and the availability/reliability of electricity along both sides of the river, a **battery electric ferry** is the primary recommendation in this category. It has zero vessel emissions and the move to fully zero emissions can happen as the grid power becomes carbon neutral with the introduction of nuclear power to the grid. This scenario does not require redundancy during a power outage that may occur during a hurricane.

The **hydrogen fuel cell platform** is second in this category based on the lack of maturity in the green hydrogen market in NE Florida. The future development and reliability of this fueling solution is based primarily on the availability of hydrogen fuel. If measures are taken by the JTA to develop green hydrogen fuels for their entire fleet, this option may become more viable and is truly net zero based on the renewable energy used to create green hydrogen.

A **conventional diesel power solution** fueled by a renewable drop in diesel product can also be considered net zero due to the carbon sequestration that occurs with the growth of the feed stock vegetation. Renewable diesel products are mature in the marketplace though are getting more difficult to come by and pricing of the fuel does fluctuate.

10.2.1.2 Low-Cost Scenario

For this scenario, recommendations are made first for the lowest cost alternatives that still meet the net-zero goals, but where net zero conformance may be implemented in phases. This phased approach can allow flexibility with funding availability and give the JTA the ability to see which net zero solutions develop over time be a reliable option for marine power. In each of these options, it is recommended that the vessel be designed to allow change or add to the existing power production on the vessel to provide flexibility for the power solutions as the market for renewable energies matures. This may include designing for the weight of batteries or fuel cells in the future.

The primary recommendation here is the **renewable diesel platform**. The construction of this vessel can be accomplished using existing lower cost technologies and net zero functionality can be achieved. The cost of upland modifications is low compared to other net zero options. In addition, if the vessel is designed with future accommodations for hydrogen fuel cells or battery banks, this will provide the JTA with the flexibility to easily modify the vessel to accommodate different fuels in the future.

The second recommendation here is the **Diesel hybrid battery electric system**. This configuration utilizes diesel generators on board the vessel in concert with battery stored electricity to power the electrical motors for propulsion. This specific power platform will allow for phased development of the vessel which can minimize upfront capital costs. It also provides an important back up for the power systems in the event of electric grid failures or fuel delivery issues associated with natural disasters. For instance, the ferry could continue to operate in post hurricane conditions, allowing for a vital link between across the river. Also, this alternative provides the JTA with additional flexibility and the ability to get closer to net zero by operating the vessel in full electric mode. This system is in use in many other ferry systems and performance and maintenance requirements are widely known.

10.2.1.3 Cost and Net Zero Conformance Scenario

In this scenario, recommendations are made for the systems that blend cost and net zero conformance and offer a balance of these criteria.

The primary recommendation here is the **Diesel hybrid battery electric system** that was described in the previous section. It offers net zero capabilities with the use of electric power, and it also can be made net zero when in diesel mode by using net zero fuels such as renewable diesel. It offers flexibility in operation which can help with supply chain issues related to alternative liquid fuels and grid power availability during storm events. The daily operations of the vessel can be performed in electric power mode, offering zero carbon emissions from the vessel.

In addition, the full battery electric ferry is recommended for this option. It is less costly than the hydrogen option and offers a pathway to net zero emissions.

10.2.1.4 JTA Board System Selection

After staff presentations to the board, and after board considerations, the diesel hybrid battery electric ferry system was selected. Further, the use of renewable diesel fuels was also adopted for the ferry service starting with the launch of the new vessel.

10.2.2 Summary of Configuration

It is recommended that the new ferry vessel be configured to match the existing ferry vessel in geometry, capacity and power. The existing vessel is more than adequate for most of the operational conditions and can safely navigate the crossing. It is recommended that the new ferry use electrically driven azipods for propulsion. The recommended power platform selected by the JTA board meets the combination of the cost and net zero goal scenarios.

JTA has solicited public feedback on the St Johns River Ferry Feasibility Study by attending and hosting in-person events and collecting survey responses. In general, members of the public are concerned about service reliability and frequency, citing outages when the sole existing ferry vessel must undergo maintenance. Most believe a second ferry would ameliorate this issue and overall benefit the community. There is limited concern on the type of propulsion and fuel except as related to perceived reliability.

An in-depth discussion of the configuration can be seen in the sections below.

10.2.3 Geometric Configuration

The current physical infrastructure at the ferry slips requires that the new ferry vessel is of the same shape and size to the existing ferry vessel. The slipwalls were constructed using grant funding and any modifications to the slipwalls would require reimbursement of the grant by JTA. In addition, it is desired to maintain and utilize the existing ferry vessel as a secondary vessel for when the new ferry vessel is out of service for maintenance or to potentially utilize both vessels at the same time for additional service. Making both ferries the same size and shape eliminates the need to change the configuration of the slipwalls. The recommended ferry geometry, to match the existing, is:

Criteria	New Vessel
Length	154’
Beam	56’-0”
Draft	8’-0”
POV Capacity	36
PAX Capacity	205
Power	2000 HP
Propulsion	Fore and Aft Azipods

10.2.4 Propulsion

The recommended propulsion system for the new ferry vessel consists of electrically driven azipods. The electrical drive used to drive the propulsion can receive electricity from a number of different power sources. The electric motors are sealed and require less maintenance than mechanically driven propulsion. The electric motors provide instant power and can be quickly reversed. This provides for superior maneuverability and navigational safety.

The azipods will be located at each end of the vessel and can consist of either one or two azipods at each end. Further design by a naval architect is required to determine the number of azipods. Two azipods on each end will provide a redundancy in the event of the failure of one of the azipods. The total output from these motors will be 2000 HP.

Appendix A – Alternatives Matrix

	Alternative Number	Vessel Platform	Length	Beam	Draft	POV Capacity	PAX Capacity	Propulsion	Power	Fuel	Conversion Efficiency*	Daily Electrical	kW per unit	Daily Fuel Consumption**	Cost per fuel per DGE	Daily Fuel Cost	Yearly Fuel Costs	Emmisions Reduction ***
Internal Combustion Engine Mechanical Systems	ICE-1	Diesel ICE Mechanical	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	750 kW Diesel Marine Engines x 2	Low Sulphur Marine Diesel	40%		37 /Gal.	430	$ 4.08	$ 1,754.40	$ 640,356.00	0%
	ICE-2	BioDiesel ICE Mechanical	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	750 kW Diesel Marine Engines x 2	B100 Bio Diesel	40%		35 /Gal.	478	$ 5.11	$ 2,441.44	$ 891,127.22	70%
	ICE-3	Renewable Diesel ICE Mechanical	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	750 kW Diesel Marine Engines x 2	Renwable Diesel (Drop-in)	40%		37 /Gal.	430	$ 6.00	$ 2,580.00	$ 941,700.00	80%
	ICE-4	CNG ICE Mechanical	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	750 kW Diesel Marine Engines x 2 (Dual Fuel)	Compressed Natural Gas	40%		22 /Gal.	826	$ 2.22	$ 954.60	$ 348,429.00	20%
	ICE-5	LNG ICE Mechanical	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	750 kW Diesel Marine Engines x 2 (Dual Fuel)	Liquid Natural Gas	40%		22 /Gal.	826	$ 2.50	$ 1,075.00	$ 392,375.00	15%
	ICE-6	Methanol ICE Mechanical	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	750 kW Diesel Marine Enginers x 2 (Dual Fuel)	Methanol	45%		17 /Gal.	832	$ 2.25	$ 967.50	$ 353,137.50	10%-80%
	ICE-7	Bio Methanol ICE Mechanical	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	750 kW Diesel Marine Enginers x 2 (Dual Fuel)	Methanol from Biomass	45%		17 /Gal.	832	$ 3.50	$ 1,505.00	$ 549,325.00	80%
Internal Combustion Engine Electric Systems	E-ICE-1	Diesel Electric Drive	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	599 bkW Tier 3 Diesel Engines x 3	Low Sulphur Marine Diesel	35%		37 /Gal.	480	$ 4.08	$ 1,958.40	$ 714,816.00	0%
	E-ICE-2	Bio Diesel Electric Drive	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	599 bkW Tier 3 Diesel Engines x 3	B100 Bio Diesel	35%		35 /Gal.	533	$ 5.11	$ 2,725.33	$ 994,746.67	70%
	E-ICE-3	Renewable Diesel Electric Drive	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	599 bkW Tier 3 Diesel Engines x 3	Renwable Diesel (Drop-in)	35%		37 /Gal.	480	$ 6.00	$ 2,880.00	$ 1,051,200.00	80%
	E-ICE-4	CNG Electric Drive	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	599 bkW Dual Fuel Engines x 3 CNG Genset	Cmpressed Natural Gas	35%		22 /Gal.	826	$ 2.22	$ 954.60	$ 348,429.00	20%
	E-ICE-5	LNG Electric Drive	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	599 bkW Dual Fuel Engines x 3 LNG Genset	LNG (Natural Gas)	35%		22 /Gal.	826	$ 2.50	$ 1,075.00	$ 392,375.00	15%
	E-ICE-6	Methanol Electric Drive	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	599 bkW Dual Fuel Engines x 3 Dual Fuel	eMethanol	40%		17 /Gal.	832	$ 2.25	$ 967.50	$ 353,137.50	10%-80%
	E-ICE-7	Bio methanol Electric Drive	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	599 bkW Dual Fuel Engines x 3 Dual Fuel	Methanol from Biomass	40%		17 /Gal.	832	$ 3.50	$ 1,505.00	$ 549,325.00	80%
Electric Systems	E-1	Battery Electric	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	550 kWh Battery Bank x 2, with 1 599 bkW Genset back up power	Electricity	85%	7376 kWh	1		$ 0.11	$ 811.41	$ 296,165.29	100%
	E-2	Diesel Plug In Hybrid Electric	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	400 kwH Battery Bank x 2, with 2 599 kWH Genset	Low Sulphur Marine Diesel and Electricity	80%	5318 kWh	1, 37 / Gal.	75	$ 0.11	$ 890.94	$ 325,193.53	85%
	E-3	Hydrogen Fuel Cell	154	56	8	40	205	750 kW Z-Drive Azimuthing Pod x 2	FC Wave 200 kW Fuel cells x 10, 599 kWh Genset x 1	Hydrogen Gas	60%			320	$ 13.00	$ 4,160.00	$ 1,518,400.00	85%

Alternative Number	Structure and Outfitting Cost	Propulsion Costs	Power and Systems Costs	Total Vessel Capital Costs	Power System Cost Notes	Maintenance Costs per Year	Repower Costs	Number of Repower Overhauls over Life of Vessel	Total Repower Costs	Descirption of Land Side Systems	Land Side Capital Costs	Landside Systems Maintenance Costs Per Year	Total Capital Costs	Total Maintenance Costs
ICE-1	$ 9,170,000.00	$ 805,650.00	$ 3,377,782.00	$ 13,353,432.00	Conventional engines, well known technology	$ 125,000.00	$ 750,000.00	2	$ 1,500,000.00	Existing Diesel Fuel Tanks	$ 10,000.00	$ 2,000.00	$ 13,363,432.00	$ 177,000.00
ICE-2	$ 9,170,000.00	$ 805,650.00	$ 3,377,782.00	$ 13,353,432.00	Conventional engines, well known technology	$ 125,000.00	$ 750,000.00	2	$ 1,500,000.00	Existing Diesel Fuel Tanks	$ 10,000.00	$ 2,000.00	$ 13,363,432.00	$ 177,000.00
ICE-3	$ 9,170,000.00	$ 805,650.00	$ 3,377,782.00	$ 13,353,432.00	Conventional engines, well known technology, fuel is drop in compatible with diesel	$ 125,000.00	$ 750,000.00	2	$ 1,500,000.00	Existing Diesel Fuel Tanks	$ 10,000.00	$ 2,000.00	$ 13,363,432.00	$ 177,000.00
ICE-4	$ 9,170,000.00	$ 805,650.00	$ 3,523,982.00	$ 13,499,632.00	Can use dual fuel engines, 10% premium on diesel engine costs	$ 135,000.00	$ 825,000.00	2	$ 1,650,000.00	CNG Fueling Compression Station	$ 2,000,000.00	$ 4,000.00	$ 15,499,632.00	$ 194,000.00
ICE-5	$ 9,170,000.00	$ 805,650.00	$ 3,523,982.00	$ 13,499,632.00	Can use dual fuel engines, 10% premium on diesel engine costs	$ 135,000.00	$ 825,000.00	2	$ 1,650,000.00	LNG Bunkering from Bunker Barge	$ 40,000.00	$ -	$ 13,539,632.00	$ 190,000.00
ICE-6	$ 9,170,000.00	$ 805,650.00	$ 3,632,782.00	$ 13,608,432.00	Special modified engines are required, 20% premium on diesel engine costs	$ 145,000.00	$ 900,000.00	2	$ 1,800,000.00	New liquid fuel storage system, pumps and loading hoses.	$ 60,000.00	$ 3,000.00	$ 13,668,432.00	$ 208,000.00
ICE-7	$ 9,170,000.00	$ 805,650.00	$ 3,632,782.00	$ 13,608,432.00	Special modified engines are required, 20% premium on diesel engine costs	$ 145,000.00	$ 900,000.00	2	$ 1,800,000.00	New liquid fuel storage system, pumps and loading hoses.	$ 60,000.00	$ 3,000.00	$ 13,668,432.00	$ 208,000.00
E-ICE-1	$ 9,170,000.00	$ 766,350.00	$ 4,555,912.00	$ 14,492,262.00	Conventional engines, well known technology, additional electricla motor costs	$ 67,000.00	$ 750,000.00	2	$ 1,500,000.00	Existing Diesel Fuel Tanks	$ 10,000.00	$ 2,000.00	$ 14,502,262.00	$ 119,000.00
E-ICE-2	$ 9,170,000.00	$ 766,350.00	$ 4,555,912.00	$ 14,492,262.00	Conventional engines, well known technology, additional electricla motor costs	$ 67,000.00	$ 750,000.00	2	$ 1,500,000.00	Existing Diesel Fuel Tanks	$ 10,000.00	$ 2,000.00	$ 14,502,262.00	$ 119,000.00
E-ICE-3	$ 9,170,000.00	$ 766,350.00	$ 4,555,912.00	$ 14,492,262.00	Conventional engines, well known technology, additional electricla motor costs	$ 67,000.00	$ 750,000.00	2	$ 1,500,000.00	Existing Diesel Fuel Tanks	$ 10,000.00	$ 2,000.00	$ 14,502,262.00	$ 119,000.00
E-ICE-4	$ 9,170,000.00	$ 766,350.00	$ 4,627,822.00	$ 14,564,172.00	Can use dual fuel engines, 10% premium on diesel engine costs, additional costs for e-motors	$ 80,000.00	$ 825,000.00	2	$ 1,650,000.00	CNG Fueling storage tanks	$ 2,000,000.00	$ 4,000.00	$ 16,564,172.00	$ 139,000.00
E-ICE-5	$ 9,170,000.00	$ 766,350.00	$ 4,627,822.00	$ 14,564,172.00	Can use dual fuel engines, 10% premium on diesel engine costs, additional costs for e-motors	$ 80,000.00	$ 825,000.00	2	$ 1,650,000.00	LNG Bunkering from Bunker Barge	$ 40,000.00	$ -	$ 14,604,172.00	$ 135,000.00
E-ICE-6	$ 9,170,000.00	$ 766,350.00	$ 4,703,962.00	$ 14,640,312.00	Special modified engines are required, 20% premium on diesel engine costs, additional costs for e-motors	$ 85,000.00	$ 900,000.00	2	$ 1,800,000.00	New liquid fuel storage system, pumps and loading hoses.	$ 60,000.00	$ 3,000.00	$ 14,700,312.00	$ 148,000.00
E-ICE-7	$ 9,170,000.00	$ 766,350.00	$ 4,703,962.00	$ 14,640,312.00	Special modified engines are required, 20% premium on diesel engine costs, additoinal costs for e-motors	$ 85,000.00	$ 900,000.00	2	$ 1,800,000.00	New liquid fuel storage system, pumps and loading hoses.	$ 60,000.00	$ 3,000.00	$ 14,700,312.00	$ 148,000.00
E-1	$ 9,170,000.00	$ 766,350.00	$ 5,706,382.00	$ 15,642,732.00	E-motors are used, costs for battery bank and EMS and auxilliary generator	$ 47,000.00	$ 825,000.00	3	$ 2,475,000.00	Transformer, Switchgear and 500 kWh BESS, Charging Connectors	$ 3,900,000.00	$ 66,666.67	$ 19,542,732.00	$ 129,500.00
E-2	$ 9,170,000.00	$ 766,350.00	$ 5,618,782.00	$ 15,555,132.00	E-motors are used, costs for battery bank and EMS and diesel generators	$ 54,000.00	$ 821,750.00	3	$ 2,465,250.00	Transformer, Switchgear and 500 kWh BESS, Charging Connectors	$ 3,125,000.00	$ 66,666.67	$ 18,680,132.00	$ 136,175.00
E-3	$ 9,170,000.00	$ 766,350.00	$ 10,845,922.00	$ 20,782,272.00	E-motors are used, costs for hydrogen fuel cells, EMS and auxilliary generator	$ 200,000.00	$ 4,000,000.00	2	$ 8,000,000.00	Replace Fuel Cells 12 Years	$ 1,300,000.00	$ 5,000.00	$ 22,082,272.00	$ 471,666.67

Alternative Number	Maturity of Technology	Availability of Fuel	Carbon Neutrality	Provide Path to Zero Emissions	Crew Familiarity	Qualitative Evaluation Factor Ordinal	Capital Cost Ordinal	Maintenace Cost Ordinal	Annual Fuel Cost Ordinal	Total Cost Ordinal	Combined Ordinal
ICE-1	1	2	9	9	1	**5.35**	1	10	11	7.33	**12.68**
ICE-2	1	3	4	6	1	**3.5**	1	10	13	**8.00**	**11.50**
ICE-3	1	5	1	4	1	**2.85**	1	10	14	**8.33**	**11.18**
ICE-4	3	3	6	1	2	**3.65**	13	14	3	**10.00**	**13.65**
ICE-5	3	3	7	1	2	**4**	4	13	7	**8.00**	**12.00**
ICE-6	7	3	7	1	3	**4.3**	5	15	5	**8.33**	**12.63**
ICE-7	7	5	1	4	3	**3.35**	5	15	9	**9.67**	**13.02**
E-ICE-1	1	2	9	9	1	**5.35**	7	1	12	**6.67**	**12.02**
E-ICE-2	1	3	4	6	1	**3.5**	7	1	15	**7.67**	**11.17**
E-ICE-3	1	5	1	4	1	**2.85**	7	1	16	**8.00**	**10.85**
E-ICE-4	3	3	6	1	2	**3.65**	14	7	3	**8.00**	**11.65**
E-ICE-5	3	3	7	1	2	**4**	10	5	7	**7.33**	**11.33**
E-ICE-6	7	3	7	1	3	**4.3**	11	8	5	**8.00**	**12.30**
E-ICE-7	7	5	1	4	3	**3.35**	11	8	9	**9.33**	**12.68**
E-1	4	1	3	2	4	**2.3**	16	4	1	**7.00**	**9.30**
E-2	3	1	3	2	3	**2.15**	15	6	2	**7.67**	**9.82**
E-3	7	5	5	2	5	**4.65**	17	17	17	**17.00**	**21.65**

* Efficiency is the net effiecincy of energy tranfer from source to propulsion
*** Reduction in C02 emmisions from Current Ferry
** Units in each column

	Alternative Number	Vessel Platform
Electric Systems	E-1	Battery Electric
	E-2	Diesel Plug In Hybrid Electric
	E-3	Hydrogen Fuel Cell

Appendix B – Grant Analysis Table

Table 3-1, Previous Grants

Award Name	Grant Award Number	Award (Tot/Fed Share)	Period of Performance	Infrastructure Components (Useful Life)
FY 13-14 St. Johns River Ferry Fender/Slip Wall Replacement	FL-2016-023-00	$4.97M/3.97M	2/6/15-12/31/17	Rehabilitation and renovation of the slipwall/ferry fender replacement system (20 yrs)
FY 16 Passenger Ferryboat Dock and Ramps Grant	FL-2016-039-00	$1,045,943/$836,755	6/1/16-12/31/18	Lighting and cameras (5 yrs for the camera security equipment)
				Ferry entrance fence and gates (20 yrs)
				Dock and ramp improvements for Jacksonville St. Johns River Ferry at Mayport (20 yrs)
St. Johns River Ferry Fender System Replacement Phase II	FL-2016-050-00	$7.5M/$6M	5/26/16-12/31/18	Replacement of the seawalls/docks and ramps and either Option 1 or 2 below:
				1) replace existing bulkheads and existing moveable/terminal bridges with new (20 yrs)
				2) replace existing bulkhead and an overhaul to the existing bridge (10 yrs)
				Both options include ped access walkway with 42" solid plated platform (useful life of walkway not stated)
FY 15 -16 Construction and Rehab of Dock/Ramp Improvements for Jax. St. Johns Ferry Mayport	FL-2017-102-00	$455,660/$364,528	8/10/17-6/30/19	Security camera and lighting enhancements (5 yrs)
				Installation of Pile Jackets & Pile Platform Rehabilitation (20 yrs for guideway elements))
FY 17/18 St. Johns River Ferry Publicly Owned Terminal & Vessels	FL-2018-097-00	$397,698/$318,158	9/4/18-3/30/23	Approx 20 lighting/cameras and other security enhancements (5 yrs)
				ADA and site safety improvements (20 yrs for guideway elements)
FY 2017 Sec 5307 Passenger Ferry Grant; Jacksonville FLA	FL-2018-116-00	$4.2M/$3.36M	9/19/18-3/30/25	Vessel haul out and rehabilitation (4 yrs)
				Ferry slip wall fender panel rehab/Addition of vertical panels to the slipwalls (additional 30 yrs for the fender panels from the date rehab is complete)
				Mayport Landing Safety Improvements:
				Resurfacing/Reconfiguring Queuing Area and the Pavement Marking (15 yrs).

Award Name	Grant Award Number	Award (Tot/Fed Share)	Period of Performance	Infrastructure Components (Useful Life)
				Sidewalk (20 yrs) Functional Landscaping and irrigation (20 yrs) Signage (20 yrs)
5307 FLEX, St. Johns River Ferry Improvements; JTA; Jacksonville, FL	FL-2019-084-00	$459,195/$367,356	9/4/19-3/30/23	Lighting, camera and other security enhancements (approx. 15) for the Mayport and Ft. George terminals (5 yrs) Asphalt resurfacing, functional landscaping, drainage, ADA improvements, wayfinding and signage (10 yrs) and slipwall infrastructure enhancements. Guideway elements above (20 yrs). All other items useful life not stated.
5307h Passenger Ferry Discretionary Grant; JTA, Jacksonville, FL	FL-2020-015-00	$5.62M/$3.94M	4/17/20-3/30/24	Mayport Landing Heavy Mooring Bollards rehab (20 yrs). Fort George Catwalk Access rehab (20 yrs). Mayport Landing Catwalk Access rehab (20 yrs). Fort George Landing Bulkhead rehab (20 yrs). Mayport Landing bulkhead rehab (20 yrs) Mayport Landing Public Restroom (10-40 yrs): Structure (40 yrs) Electrical (20 yrs) Fire System (10 yrs) Floors (10 yrs) HVAC (10 to 20 yrs) Plumbing (20 yrs) Roof (15 yrs) Security System (10 yrs) Telecomm (10 yrs) Water Treatment (20 yrs) Windows (20 yrs) Doors (15 yrs) Signage (10 yrs) Fort George Landing Maintenance Warehouse (10-40 yrs):

Award Name	Grant Award Number	Award (Tot/Fed Share)	Period of Performance	Infrastructure Components (Useful Life)
				Structure (40 yrs) Electrical (20 yrs) Fire System (10 yrs) Floors (10 yrs) HVAC (10 to 20 yrs) Plumbing (20 yrs) Roof (15 yrs) Security System (10 yrs) Telecomm (10 yrs) Water Treatment (20 yrs) Windows (20 yrs) Doors (15 yrs) Signage (10 yrs)
5307 FLEX, St. Johns River Ferry Improvements; JTA; Jacksonville, FL	FL-2020-022-00	$428,496/$342,797	5/7/20-3/30/24	N/A Design only for Phase IV improvements
FY 2020 5307h Passenger Ferry Discretionary Grant; JTA, Jacksonville, FL	FL-2021-020-00	$7.49M/$5.24M	5/12/21-3/30/25	Renovation of restroom and break area at Fort George: Structure (40 yrs) Electrical (20 yrs) Fire System (10 yrs) Floors (10 yrs) HVAC (10 yrs) Plumbing (20 yrs) Roof (15 yrs) Security System (10 yrs) Telecomm (10 yrs) Water Treatment (20 yrs) Windows (20 yrs) Doors (15 yrs) Structural steel and concrete rehabilitation work for the ramp and bridge pier at Mayport and at Fort George (20 yrs) Rehabilitation and preservation of bridge gantries at Mayport and Fort George (15 yrs). Electronic signage at Mayport and Fort George (5 yrs).

Award Name	Grant Award Number	Award (Tot/Fed Share)	Period of Performance	Infrastructure Components (Useful Life)
				Storage system and equipment handling system at Fort George storage space (10 yrs for warehouse equipment systems).
				Two mooring bollards rehab at Ft. George Landing (20 yrs).
				Catwalk Access at Ft. George (20 yrs).
				323 LF of bulkhead at Shoreline of Ft. George Landing (30 yrs).
				205 LF bulkhead at the Shoreline of Mayport Landing (30 yrs).
				Vessel Haul out and Rehabilitation (4 yrs)

Appendix C – Summary of Public Involvement

Appendix C – St Johns River Ferry Community Engagement

Public Outreach Events

Mayport Waterfront Partnership Meeting

Event Summary

The Mayport Waterfront Partnership (MWP) is a community advocacy group dedicated to preserving the Village of Mayport's traditional commercial fishing industry and cultural heritage, while expanding opportunities for eco-tourism and revitalizing the town center. It views the acquisition of a second ferry as a vital component of the Village's long-term development plan.

JTA attended the Partnership's monthly meeting on November 14th, 2023 to present an update on the ferry feasibility study. Topics covered included estimated cost, power platform alternatives, and fuel options. JTA did not request public comments but invited participants to attend its November 30th public forum to solicit feedback on the feasibility study.

Feasibility Study Public Forum

Event Summary

JTA held a public forum on November 30th, 2023 to provide information on the St Johns River Ferry Feasibility Study to the public and gather feedback. Participants were presented with a summary of the study, including the following information:

- Specifications on the new ferry vessel compared to the existing vessel.
- An alternatives analysis comparing three power platforms for the new vessel – internal combustion engine mechanical, internal combustion engine electric, and all electric – and different types of fuel.
- A final ordinal ranking among alternatives.
    - The battery electric vessel was the highest ranked option, followed by the diesel plug-in electric hybrid and the renewable diesel electric drive.

Attendees

Fourteen members of the public participated in the meeting. A table of attendees is included below:

Name	Organization	Zip Code
Mark McManus	US Navy/Mayport	
Mitch Reeves	Mayport Weatherport Partnership	32233
Claudia Estes	Mayport Weatherport Partnership	32233
Janet Torelli	Historian	32233
George Arnau	Stronghold Poymers	32257
Denny Luke	HMS Ferries	32233
Joe Floyd		32233
Conchinta Robinson	C Robinson Associates	32207
Regine Denis	C Robinson Associates	32204
Colin Moore	City of Neptune Beach	
Anyce Decher	Mayport Weatherport Partnership	32082
George Register	Stronghold Polymers	32225
Alec Newell	Resident	32233
Matt Stewart	Mayport Weatherport Partnership	32266

Event Photos

<u>Public Comment</u>

Survey Results

To gather feedback on the St Johns River Ferry Feasibility Study, JTA created a survey that was presented in-person at the November 30th public forum and distributed by email to members of the Mayport Weatherport Partnership. The vast majority of respondents were very aware of the ferry service, with only one survey participant saying they were "not at all aware". Additionally, most respondents were supportive of an electric propulsion system, with some insistent that JTA should lead the way as an early adopter of the technology (although some had concerns about the safety and reliability of the technology). Most also agreed that improving reliability should be a priority and believed that a second vessel would help maintain regular service. Opinion was more divided on whether fares are too high, the cost of the

service, and the impact improvements would have on the community and tourism. Fourteen responses were collected in person and twenty were collected digitally.
A summary of survey responses is included below:[1]

Question	Public Comment
How aware are you of the ferry service?	• *"Extremely aware, 100%"* • *"Very, ferry continues to be an important part of the Mayport and beaches"* • *"Very aware. My family uses the ferry infrequently."* • *"Very aware, high level of interest."* • *"Very"* • *"Very aware: I helped build the current ferry and worked for the ferry service 1968-69."* • *"Yes. Very high level of interest and concern for safety"* • "Extremely aware" (17 responses) • "Very aware" (2 responses) • "Not at all aware" (1 response)
In what ways do you think the additional ferry could benefit the community? Are there specific needs or challenges in the community that the ferry could help address?	• *"Stopping the only ferry for maintenance is unacceptable – we always had a second ferry."* • *"Improve quality of service and preventing shut down of service during repairs."* • *"I am old enough to remember two boats in service two boats will ensure service."* • *"Having the second ferry will allow for the ferry to be in service 12 months/year and travel more frequently during peak hours."* • *"Will keep route of the East Coast Greenway open without disruption."* • *"An additional ferry may service wait times or if it's just replacing it would never need to shut down."* • *"Emergency exits, easy access to Ft. George Island."* • *"There has always been 2 ferries. Too much wear on a single ferry places overall cost of repairs and loss prolonged downtime."* • "It would keep the route open when the ferry needs service. Not sure there's a need for additional capacity." • "As a Ferry Ambassador I have seen the impact of the ferry on our community. Not just the local population, but from people just passing through. I conducted a ridership survey that showed riders from 43 states and 13 foreign countries. Because of the periodic mandatory U.S. Coast Guard maintenance and inspection requirements which places the ferry out of service for extended periods of time. This in conjunction with the occasional mechanical breakdowns that are bound to happen, this places an unreasonable hardship on regular riders and visitors alike. Just the impact on traffic between BAE and NS Mayport would surely justify another ferry to maintain service while service outages are required."

[1] Comments in italics were collected in-person; all others were collected virtually.

	• "Especially on busy weekends it would eliminate wait time BUT more importantly it will help when one ferry is out of commission." • "A second Ferry eliminates the down time when the current single Ferry is out of service - whether required Coast Guard inspections or mechanical problems." • "Making sure there is always an available ferry is the main benefit." • "The ferry enhances the Jax beaches as more Nassau county visitors shop/dine our new stores and restaurants without having to drive through downtown Jax." • "Less waiting would be wonderful. If the ferry is missed on one side, most people I know just drive around rather than wait." • "Saves time and when the ferry is repaired will allow the service to continue." • "Do not need." • "It would greatly assist people getting to and from work along with a huge benefit to tourists along the Greenway." • "Increase access to Mayport north." • "It could provide greater customer capacity during peak usage periods or during a hurricane evacuation crisis." • "Ease the delays on river crossings caused by events at the national, state and city parks - Amelia Island Concours d'elegance, Fernandina Shrimp festival, Jax Bch weekend events. Also back up for a much older Ferry operating today." • "Provide a backup if the one ferry breaks, reduce wait times." • "Better access to fernandina, parks, and numerous events." • "2nd ferry would reduce wait times on high traffic days making the crossing more efficient for time conscious travelers." • "It would ensure continuous service during times when one of ships require service." • "It will eliminate the periodic disruption of service, which is more than an inconvenience to those who depend upon it for work. Especially as the area becomes revitalized a reliable, consistent ferry is essential." • "With the new Greenway coming through, I think an additional ferry would help in bringing people across the river."
How accessible is the ferry terminal for members of the community? Are there concerns about the accessibility for individuals with disabilities?	• *"Most people (except people that cross over for their jobs) don't even know they get to ride the ferry."* • *"No issue."* • *"Access is good at this time."* • *"I'm not sure of that."* • *"Access is fine, the fares are expensive."* • *"Accessible when it is up and running"* • "No, it's accessible, but then I'm not disabled."

	• "With the new renovations to the terminal areas on both side of the river, I believe the question of accessibility has been answered. As a disabled person myself, I find no complaints." • "No, very accessible." • "The Ferry Terminals are easily accessible to all members of the Public, walk-ons, bicyclists, motorcyclists, cars, trucks and RV's. Disabilities aren't really an issue." • "It's very accessible. I am not aware of any accessibility concerns." • "Easily accessible." • "No." (2 responses) • "Yes." • "Reasonable, but I haven't heard of any major concerns." • "Very Nonr Improve bike access" • "Fine, it's already part of A-1-A." • "Excellent recent additions." • "The ADA guidelines are met." • "Accessible and no." • "No concerns." • "The ferry is well thought out." • "Very accessible."
What would be the ideal schedule for ferry trips to meet the community's needs? How frequently do you or someone in your household use the ferry?	• *"Stay open longer!! Remember it's A1A- People could go to Fernandina for dinner or shopping."* • *"No issue."* • *"Monthly."* • *"Every 15 minutes, not very frequently."* • *"Schedule is good, I use it 2-3 times a month to access Fort George Island and East Coast Greenway by biking and running"* • *"I'm not aware of the problem."* • *"No problem with existing schedule."* • *"7 days a week, enough to accommodate individuals working early to late hours – several times a week."* • "Weekly." • "I actually believe that the newly adopted schedule is a significant improvement. When I worked at BAE I used the ferry daily. Now not so much, but I am happy it is there when I want to travel to the restaurants on the Fort George side or Amelia Island/Fernandina Beach. The 22 mile trip around Dames Point has surely deterred trips when it is out of service. I'm sure the people on the Fort George side appreciate access to the south bank a well." • "I think hours are good. I rarely use ferry." • "6:00 AM - 8:15 PM in the Winter. 6:00 AM - 9:15 PM in the Summer." • "The current schedule seems sufficient." • "Increased trips on weekends, we use the ferry weekly for work." • "Every 15 minutes instead of every 30 minutes works attract more users. I use the ferry as an Atlantic Beach resident 2-3 times a week to visit and care for family."

	• "I live in the Village and use the ferry a few times a month. I have seen the line to get on all the way down Broad St in the summer! If another ferry ran, ideally leave at the same time from each side every 15 minutes. Only one needs to run on Sunday evenings when it appears to have the lowest ridership." • "Use it on the weekends." • "Never." • "We have a workforce with the federal government with 30 employees who regularly use the ferry every day some times multiple times a day. Ideal schedule would be every 15 minutes." • "6:30 am 8 pm Frequently." • "I am fine with the ferry's current schedule." • "3 to 4 times a week if available. And often on weekends." • "Weekly." • "15 minute wait time, longer hours. Make the ferry the preferred route for Fernandina-Jax Beaches traffic." • "Current schedule is fine. The new extended closing time definitely helps to utilize businesses across the river in the evening." • "I use the ferry a few times per year." • "I do not have a daily need for the ferry so I feel unqualified to answer this."
What are your thoughts on the ferry fares? Are there concerns about the affordability of ferry services for community members?	• *"I want the state of Florida to operate financially – using small amount of gas tax + small amount of federal funds. Texas operates 7 ferries free of charge."* • *"Just do not increase"* • *"Public transit, bridges, highways, ferries, are a public service, they do not need to make a profit"* • *"$1 Pedestrians/bikes $3 Motorcycle $5 Car"* • *"$1 is a good fare for bikes and pedestrians"* • *"They are affordable."* • *"Too high to use regularly."* • *"It is A1A State Rd. so individuals should not have to pay. Texas runs 7 ferries and the fee for passengers is free."* • "The fares have gone up. Everything goes up for as long as I can remember. Unavoidable!!" • "I have travels across the country and ridden ferries in several locations. The St. Johns River Ferry is unique in that it is an actual connection of a Federal Highway. For lack of a better term, it is a floating bridge where a conventional bridge can't be built." • "Fares are too high." • "Probably need to be lowered a little to encourage additional ridership." • "I would love to see Duval County resident discounts. I have also heard about the high costs for commercial fishermen. There could be multi-ride passes offering discounts to fishermen as part of helping promote the commercial fishing industry in the Village." • "It varied based on the price of gas honestly."

	• "I use the app which I feel is more affordable." • "Yes, holy cow $14 round trip on the weekends?! I'd rather drive around and do if I'm going to the northside from the Village. I only take the ferry if I'm going to Huguenot and north on A1A and I live two blocks away." • "Ferry seems expensive but with gas prices rising it's not as bad. However, we use it just weekends and not for the day-to-day commute." • "Too expensive." • "No I think the price is fair." • "Cheap." • "If the fares weren't so high, more people would ride it." • "Fares for public transit should always be low, but the Ferry is unique - rate is currently acceptable." • "It should be free." • "Fares are too expensive. They should be reduced and better subsidized by local option gas tax as was originally contemplated." • "Little high, affordable vs the alternative of driving around but I think most avoid it until necessity demands it." • "No concerns." • "I think that residents of Mayport Village should have access to a reduced rate. Possibly a ferry pass that could be purchased annually." • "It's just stay affordable. Especially for bicyclist."
Are there specific environmental considerations that could be addressed?	• *"Absolutely – operation of ferry is paramount – research best way!!!"* • *"None."* • *"Continued focus on clean energy"* • *"Electric ferry seems like it would be a good alternative."* • *"I am very worried about experiences and safety issues of a battery-operated ferry."* • *"Emission b.s. is not safe nor is safety considered. Emissions are still being used to acquire components for lithium batterie (dangerous in wrong environment) Biodiesels aren't any better."* • "None that I know of." • "I don't think there are any direct environmental issues with the operation of the ferry." • "No." (6 responses) • "There are no Environmental Issues with Ferry operations." • "I like the idea of the new ferry using a sustainable power source if it is not cost-prohibitive." • "Compare the carbon emissions of the ferry running to the same amount of vehicles it holds and those vehicles driving around." • "An electric, battery operated ferry could come with a SERIOUS risk of fire hazards and environmental clean-up issues as well as becoming a serious navigational hazard if it were to sink, and who would be held liable for those financial impacts?"

	• "Of course a "green" alternative would be great - but not at any cost. It seems to me duplicating the current ferry is the business approach - known element requiring little infrastructure spending!" • "Go electric by 2025." • "Safety with shipping traffic is a first priority that should be emphasized along with better advertising of the service and far better signage at access points for the entire route. Adequate signage would go a long way to increasing ridership." • "At the presentation made to the Mayport Waterfront Partnership it seemed that genuinely alternative fuel options were not being seriously considered as they were only mentioned in passing. I'd like our city to distinguish itself by being among early adopters of an electric option. https://apnews.com/article/sweden-stockholm-electric-ferry-b7d6fd1e974c6fa129bb9f0fbfd899e9 https://www.cntraveler.com/story/electric-ferries https://www.king5.com/article/news/local/first-hybrid-ferry-to-set-sail-in-2024-washington-state-electric/281-c141654f-9ef6-42a7-b68a-f4219210b2fc" • "Keep it as clean as possible."
How do you think the ferry service integrates with other modes of transportation in the area? Are there concerns about connectivity with existing transportation infrastructure?	• *"It is A1A- Very important."* • *"Ferry service is an important part of 'Greenway' and tourist travel along 1st coast."* • *"I do not see any current integration needs."* • *"Bike connectivity could be better – would like to see East Coast Greenway signage on the ferry and in terminals."* • *"I'm not familiar with this but depending on the activities at the beaches or downtown a bus schedule that takes people to the event."* • *"Ferry service is crucial. It is cost effective to use same BAE ferry blueprint. Diesel engines are easier to maintain and run. Much safer and cost effective when everything is weighed out. Hydro generated battery system needs to be entertained for this ferry's location."* • "It's great. The biggest issue that I would like addressed is the lack of bicycle lanes on the stretch of A1A just south of the ferry." • "Having JTA Bus Service to the Mayport Termial is a limited plus. I am not familiar with such related service on the Ft. George side." • "Having bus stop nearby in Mayport is good." • "The Ferry is our Eastern 'Outer Loop' especially for the Beach communities in Duval and Nassau Counties." • "I view the ferry service as a continuation of A1A, and it seems well integrated into the existing infrastructure." • "It is so important to have when the bridges get shut down in certain emergency situations." • "Not sure." • "No." (2 responses) • "Declared connecting bike paths to and from ferry." • "The ferry is already part of A-1-A."

	• "No comment." • "The ferry is an essential connector in the iconic A1A scenic roadway." • "The lack of adequate signage and advertising the service is what creates concerns about connectivity and is easily solved." • "No concerns." • "I'd like to see a rideshare opportunity built in on both sides of the river as Mayport Village becomes more populated commercially so a tourist in the area would not have to rent a car to get to the array of tourist attractions on both sides of the St. Johns River."
What do you believe will be the economic impact of the ferry on local businesses and employment? Are there opportunities for local economic development associated with the ferry?	• *"The ferry has always provided an economic impact"* • *"Very important to the village, somewhat to the total beaches."* • *"Currently, no, though if affordable housing existed in the area, both the bus and ferry could provide transportation to hospitality, etc. jobs."* • *"With completion of East Coast Greenway to the Jacksonville beaches, impact from bike tourism will definitely increase."* • *"Transportation access-small business appointments."* • *"Not interested in tourist impact."* • "Unsure." • "With the continued expansion of the BAE facilities there is a built in expectation of continued growth in ridership. Also the continued growth of the Amelia Island communities, and the associated efforts increase of tourism there can only lead to greater use by tourists expanding the range of their exploration throughout the entire First Coast region." • "Local restaurants will benefit and I know the boat yard and navy uses it." • "The Ferry has tremendous economic impact in Duval and Nassau Counties, especially for businesses along the A1A route." • "Since there are so few retailers in the Village now, it's hard to know, but I do think it is symbiotic. People take the ferry to the places that are here and would come more often if there was more to see and do. To help make the ferry 'a thing' outside of people needing to use it or just happening upon it, a select number of items promoting the ferry should be offered for sale, such as T-shirts, sweatshirts, caps, mugs, stickers, magnets, etc. People who travel through the Village going to Fernandina or come from the other side of the river going down A1A could help promote the ferry outside of this area." • "It is huge for the National Park." • "More accessible times will encourage the use of the ferry. If you miss it the next one will come sooner." • "Sure, if people can get to work faster across the river, it'll open up more opportunities. Time is our greatest asset. If a commute can be cut in half, it would be great.

	MWP has plans to develop the Village more ushering more opportunities for everyone." • "Tourism." • "Yes positive with Mayport growing and business coming to the area." • "Could be significant driver of bicycle, ecotourism." • "Until docking facilities are restored to Mayport's displaced shrimp fleet. It doesn't the shrimp fleet is restored." • "Mayport Village is going thru an economic growth program where tourism and eco-tourism are significant opportunities. Matty is the mid- point between St Augustine and Fernandina. The Ferry will benefit." • "Yes, sponsor a monthly ferry cruise w open bar, music & dancing." • "Definite advantages to local commerce all along the route north and south east and west." • "Obvious benefit for local businesses. More traffic equals more exposure and potential sales." • "I believe the ferry is a vital aspect of the Mayport Village economy that currently exists and that which will come. It can never be discontinued or diminished as it was when JPA operated it irresponsibly." • "It would be easier for me to get across the river to go to restaurants in Fernandina Beach. And also restaurants, and perhaps shops in the village of Mayport."
What safety measures do you think should be in place for ferry passengers? Are there concerns about security at the ferry terminal?	• *"History should tell if there have been any problems."* • *"No concerns."* • *"Keep all lighting working"* • *"Security guard/police presence (nights/holidays/events)."* • *"No battery-operated ferry."* • *"No LNG! No lithium! No biodiesel! UNSAFE!"* • "No." (7 responses) • "I don't have any safety concerns for the passengers. I think the recent upgrades at the terminals have adequately addressed any security questions." • "There are no Security Issues. Current Rules and Regulations already address concerns." • "I have no security concerns." • "Safety measures are adequate. Maybe an actual wall that could collapse to prevent cars lurching forward and aft rather than a net." • "Again, fire safety measures could be an issue with an electric ferry. The Coast Guard is ALREADY concerned about allowing electric cars to even board Ferries and car carriers already in service." • "No concerns." (2 responses) • "There are concerns about publicizing how ferry traffic is coordinated with shipping traffic, but no concerns about safety at the ferry terminal that I know of." • "I have never experienced safety concerns and I often traveled on the ferry with my students for field trips."

How would you like the community to be involved in decisions related to the ferry service? Are there suggestions for community engagement and communication regarding the ferry?	• *“Operating the ferry by JTA has been excellent from my experiences! They can answer this.”* • *“Be more active communications with beaches organizations/clubs”* • *“Frequent communication to the community (both sides) and to employment centers whose employees use the ferry.”* • *“Probably just times for departure.”* • *“Frequent and transparent updates on the planning”* • *“Safety vs low emissions need to be discussed and community needs to be educated further.”* • “I would love to see the Ferry Ambassador program reinstituted. We were a valuable asset providing tourists with information about things to see and do.” • “Meetings schedules at Mayport community center and Heckscher Drive Community Club.” • “Many folks don't know the importance of the Ferry in Jacksonville's Transportation System. An Educational Outreach Program, or JTA ads including the Ferry, might help.” • “Regular participation in the Mayport Waterfront Partnership meetings and other community meetings should continue and is appreciated.” • “Attend a meeting receive ride vouchers.” • “QR code at the ferry for passengers to keep up to date and leave comments.” • “Have community meetings at the Mayport Community Center or attend the Mayport Meetings Tuesday Mornings at 8 AM and provide updates if you don't already.” • “Adequate now.” • “Design for the ferry and its propulsion system might best left to marine engineers rather than to grant writers and public opinion polls.” • “Absolutely – any project of this magnitude, in cost and impact to business and commuters should be well vetted.” • “Surveys like this.” • “Regular public hearing concerning rate increases, increases and major changes in service provision. Better publication of improvements in the service and Changes of the slip.” • “Responsible leadership weighing cost to value of services while being considerate of the fact that none of it is your money but taxpayer $$.” • “Having a Ferry Hotline posted visibly on each side of the river and on the ferry that would directly link to JTA would capture in realtime the suggestions or concerns of riders which would be a great practice.” • “Community should have a voice. And perhaps do presentation at the various beach, city, commission meetings, and with any military personnel that might use.”

How might the ferry service impact tourism and recreational activities in the community? Are there opportunities to promote the ferry as a tourist attraction?	• *"By ADVERTISING, no advertising has ever been done!!"* • *"Advertise and promote."* • *"I thought having a history brief in the parking lot is a good idea"* • *"Definitely with the improved infrastructure, picnic areas, food trucks, etc."* • *"Yes greater coordination w/ East Coast Greenway, COJ, state, and national parks, and Ocean Island Trail Scenic highway would be great."* • *"Not interested in tourist."* • "When we were operating the Ferry Ambassdors program I can assure you, we saw a lot of regular bicycle traffic, both local and tourism related. Without the ferry to get across the river at Mayport/Ft.George, the only legal place to cross the river is to travel by bicycle all the way into downtown and use the Main Street Bridge. The Dames Point, Matthews, Hart, Acosta, and Fuller Warren, are all State or Federal Highways and not safe or suitable for bicycle traffic. This doesn't even address the 29 miles of extra travel needed to get back to the Beaches communities. We tried to get a new map created that recognizes the importance of the ferry to our transportation system. The Duval Tourist Board paid lip service with promises, but nothing ever came from it." • "We've been trying for years to create a map of A1A for distribution at a welcome center." • "The reason we have the Ferry is because of Tourism and Tourist Dollars. Without the Ferry, the communities up and down A1A will be financially, adversely and negatively impacted. The Ferry also links, Federal, State, and Local Parks and recreational lands." • "I definitely think there is an opportunity to promote the ferry as a tourist attraction. Looking at other similar ferries around the country and how they are marketed is a first step." • "We promote it as an essential part of visiting Timucuan Preserve." • "Nassau county residents are always looking for easier ways to get to Jax. Using the ferry is much nicer than driving." • "Could link park admission with a ride. Huguenot, Hanna, Talbot or local business sponsor coupons. Free apps or drinks from local restaurants." • "Yes the Ferry goes through a national park unit the Timucuan Preserve yet no one really understands that when they are on the Ferry. It connects Federal, State and City Parks in the largest urban park system in the US." • "Eco bicycle tourism." • "Until Mayport's displaced shrimping fleet has dockage space restored, tourist dollars would not compensate the village for those lost, private industry jobs." • "See above, the answer is absolutely. I believe the ferry will become a huge attraction in the future - if advertised

	by the scenic highway, visit Jax and Visit Florida – this route will increase as it becomes a preferred tourist route. Marketing will drive the growth in combo with attractions and the ferry as a unique river crossing." • "Yes, sponsor a monthly ferry cruise w open bar, music & dancing." • "The ferry in and of itself is one of the best tourist attractions in all of Duval and Nassau County. It should be publicized regularly as such and have a place for an extensive spread on Visit Jacksonville and VISIT FLORIDA's websites." • "No." • "Mayport Waterfront Partnership would be one among several groups who see the ferry as a tourist attraction in itself, in addition to being an enhancement on the way to other sites of interest. MWP's Eco-tourism committee would welcome an ongoing dialogue on promoting the ferry." • "I think ferries are unique, and if properly advertised could increase tourism and recreational activities, especially with the Greenway."
What infrastructure improvements or facilities do you think are necessary for the successful expansion of the ferry service?	• *"JTA can answer that only 2 ferries would be needed with advertising"* • *"Restrooms on both sides of river is a plus."* • *"Accessible restrooms, food trucks, park benches, picnic tables."* • *"An actual multiuse path connection (10' wide) to East Coast Greenway"* • *"To never have a disruption during existing service."* • *"Leads to the downiness could become a problem."* • "The only thing I see at this time, would be better utilization of the pavilion building on the Ft. George side as a community activities center, such as a place for community groups to hold meetings." • "None." • "A second Ferry is absolutely necessary. In preparation for it, a new dock must be built since losing the dock in Mayport." • "I have no clue, but I am sure there are some depending on the new fuel source, etc." • "Comfort for the passengers and crew could be addressed. A covered deck would be a tremendous benefit for crew and riders. Shaded and out of the direct elements. It's brutal for the crew and riders would rather stay in the car on a blistering hot day and daily summer storms. I cannot fathom why a restroom is not available onboard. Even a 10-15 ride, someone could have an emergency." • "Better Restrooms on both sides of the Ferry." • "Connecting safe wide bicycle paths." • "I would hate to see any more public funds misdirected to projects that may have short time benefits for local contractors or those few who would have management positions in governmental programs, but we are on the

	edge of a 33.8 trillion dollar deficit which Washington is funding with printed money. I am reminded of the Jacksonville Skyway and must question the wisdom of funding more special interest projects with money borrowed against our children's futures.” • “Contact Mayport Waterfront Partnership for the a complete conversation on plans to bring the village into a popular stop over when traveling north or south.” • “Riverfront cafe & bar at the ferry dock.” • “Dockage has to be found for the second ferry. That may be a major issue because I don’t believe there is any room on the Mayport side any longer with the advent of Osearch. A public hearing to provide information about this issue would also be helpful.” • “None.” • “I think the upgrades recently completed were comprehensive and I am currently highly satisfied with JTA's provisions. I only echo my earlier concern: please lead the way with an electric ferry.”