Dataw Island Bridge Replacement Study for

Dataw Island Owners Association

Final Report – April 2024

Dataw Island Bridge Replacement Study

D|F Job No.: 14177-00

PREPARED FOR:

Dataw Island Owners Association

121 Dataw Drive

Saint Helena Island, SC 29920

PREPARED BY:

Davis & Floyd, Inc.

2712 Bull Street, Suite A

Beaufort, SC 29902

(843) 379-2222

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1.0 – Introduction

The Dataw Island Owners Association is evaluating the need to replace the existing bridge and causeways over the marsh that connect the island community to Polawana Island and the mainland. The current configuration of the crossing includes an approximately 550-foot-long causeway (Causeway A), a 175-foot-long bridge that connects Polawana Island to Bobb Island, where the security gate for the community is located, and an approximately 300-foot-long causeway (Causeway B) that connects Bobb Island to Dataw Island. This bridge and system of causeways serves as the only access point to Dataw Island for vehicular traffic and is the primary way residents, visitors, and emergency service providers access the island. The inability to utilize this access is not acceptable to the community and its closure would cause significant disruption and financial hardship to the community.

Figure 1-1: Aerial View of Existing Crossing

Based on multiple recent bridge inspections and repairs completed by others, there is concern that the existing bridge has deteriorated, and is nearing a deterioration level that requires replacement. A study to evaluate multiple alternatives related to the need to replace the existing bridge has been completed. The purpose of this study is to provide recommendations to the Dataw Island Community that are objective and consider a multitude of factors. When evaluating each alternative, the study considered the following factors: Primary Purpose and Need, Resiliency & Safety, Community Impacts, Environmental Impacts, Bridge Design, Roadway Design, Utility Impacts, Bridge Hydraulics, Constructability, and Estimated Costs & Schedule. Each alternative was measured against each of these factors to determine if they meet the minimum criteria, and if so how well they meet the criteria.

Figure 1-2: Existing Bridge Looking East

The different alternatives evaluated in this study include: performing no work on the bridge (no build), rehabilitation of the existing bridge, replacing the bridge on the existing alignment, replacing the bridge on a parallel alignment, and replacing the bridge on a new alignment. All alternatives that considered replacing the bridge assumed that the security gate and associated guardhouse currently on Bobb Island would be relocated to Polawana Island prior to the construction of the replacement bridge. The findings and recommendations of this study are outlined within this report.

2.0 – Existing Bridge & Causeway

The existing bridge and causeways were constructed in the early to mid-1980s as part of the initial development of the Dataw Island community. The existing bridge and causeways replaced a previously constructed single lane timber bridge and causeways. The original causeways were partially excavated and rebuilt with a combination of filter fabric, geogrid (soil reinforcement), and fill. A roadway width of 22-feet with 6-foot shoulders is provided on the existing causeways. Based on the current causeway design drawings and field observations there are multiple utilities located within the causeway footprint to include a 12” potable water line, a 10” non-potable water line for irrigation, a 10” sewer force main, irrigation water lines, electrical supply lines for landscape lighting and several telecommunications lines. Utility markings at the site indicate that adjacent to the causeway on the east side is a buried electrical line that supplies power to the island. The side slopes of the causeways were designed to be 2:1, with a rip rap facing up to the top of the slope. Causeway A appears to maintain these original slopes; however, at Causeway B a sheet pile wall has been installed approximately 14-feet from the edge of pavement to replace the original 2:1 slopes with a rip rap facing.

Causeway A has multiple timber headwall structures on each side that include landscaping features. These timber headwall structures are located at each end of the bridge and are spaced approximately 110-feet apart. Based on the original design drawings, a 36-inch diameter pipe was provided in the causeway at each headwall structure location not adjacent to the bridge or at the end of the causeway. These help equalize the water levels on each side of the causeway. The pipes also help reduce the speed of tidal flows around the bridge and causeway. During the field investigation, it could not be determined if these pipes were installed or if they are functioning as intended due to limited access to the face of the timber headwalls. The owner reported that repairs have been made to the headwalls in the past due to deterioration. A portion of the original timber headwall has been replaced with a sheet pile wall near the end of the causeway at Bobb Island.

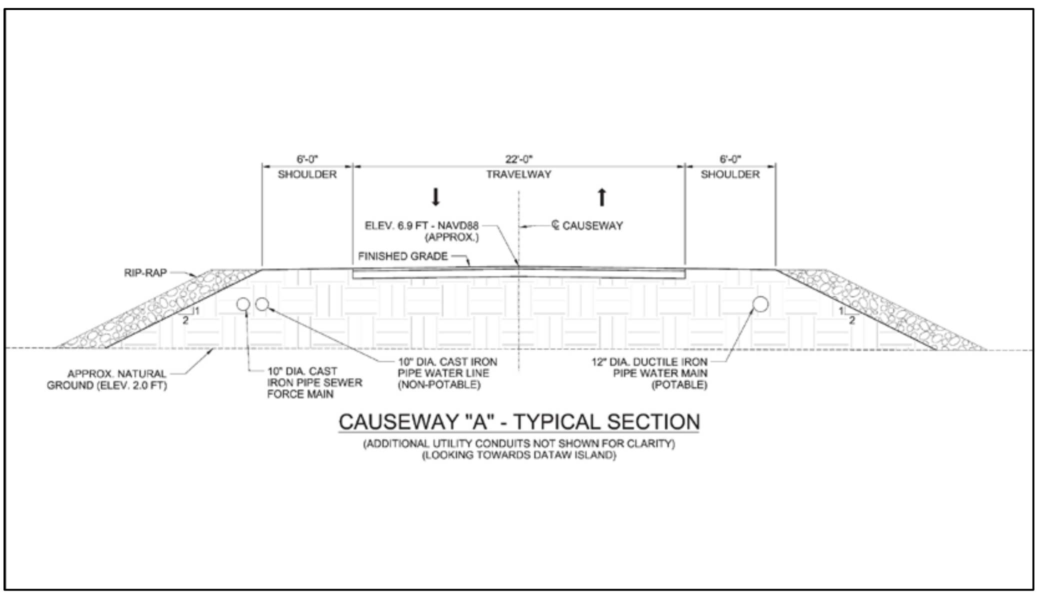

Figure 2-1: Existing Causeway A Typical Section

Causeway B originally had timber headwalls similar to Causeway A, but the 36” diameter equalizing pipe was replaced with two 42-inch diameter pipes. The original timber headwalls in Causeway B have been replaced with sheet pile walls. The originally designed equalizer pipes do not appear to have been retained in Causeway B, and no equalizer pipes were observed.

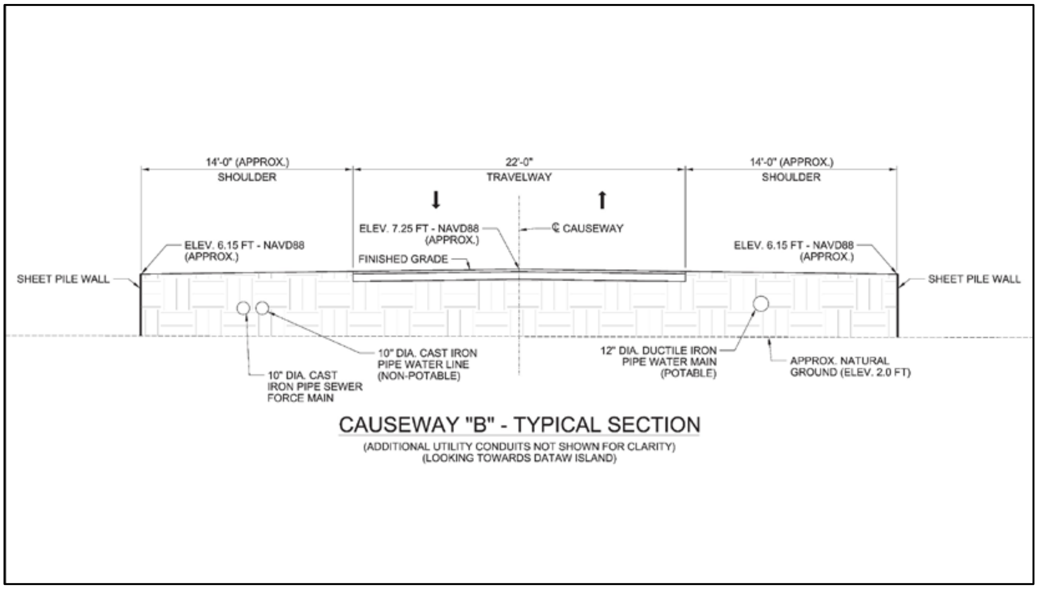

Figure 2-2: Existing Causeway B Typical Section

The existing bridge consists of seven (7) prestressed concrete box beams that are 4-feet wide by 17-inches deep. These beams are bearing on 3-feet wide by 2.5-feet deep reinforced concrete caps that are supported by five (5) 14-inch square prestressed concrete piles. The bridge is 28-feet wide and 175-feet long with five (5) 35-feet spans. A 12-inch-high concrete curb is provided on each edge of the bridge and the distance between the face of curbs is 26-feet. A decorative timber truss is provided on each side of the bridge. This timber truss does not contribute to the load carrying capacity of the bridge, but does function as part of the traffic barrier system. The timber truss rests on the reinforced concrete caps and is connected to the box beams and concrete curb with galvanized bolts. The bridge deck drainage system consists of 4-inch diameter pipes spaced approximately 17.5-feet apart along the curblines. The water and sewer utilities are supported by reinforced concrete caps. Multiple PVC conduits are attached to the bridge and supported by a combination of the exterior box beams and timber truss.

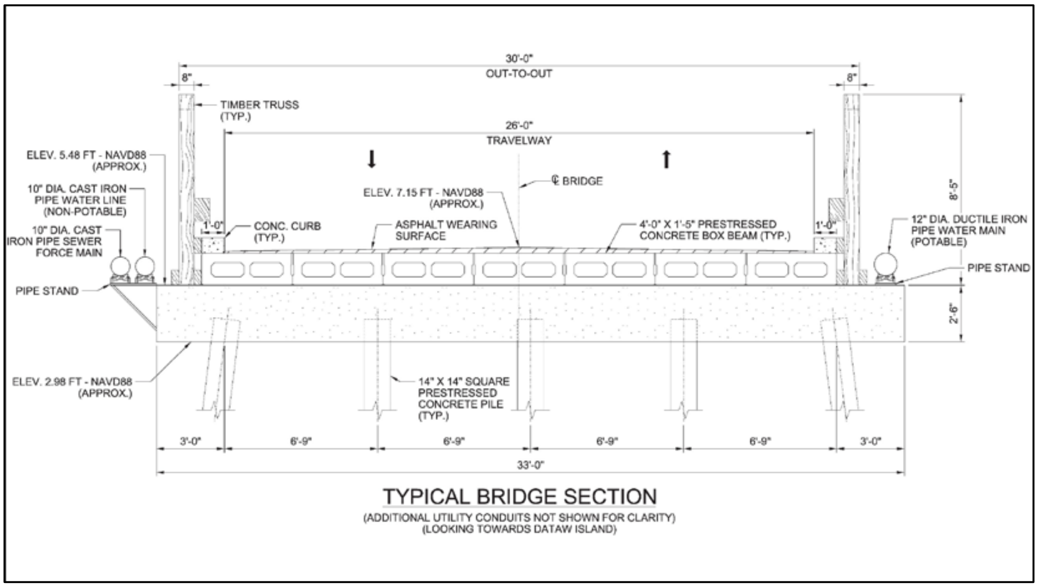

Figure 2-3: Existing Bridge Typical Section

The existing bridge is exposed to highly corrosive conditions due to its location and relative elevations compared to the mean high-water elevation and storm surges. Based on survey information provided and the existing bridge drawings, the bridge has the following approximate elevations (NAVD88): Riding Surface – 7.1-feet, Bottom of box beams/top of cap – 5.5-feet, and bottom of cap – 3.0-feet. These elevations result in the reinforced concrete caps being exposed to near daily partial submersion in salt water during high tides, and the box beams having routine exposure from saltwater spray, tidal surges, and waves. These highly corrosive conditions typically lead to accelerated deterioration of concrete bridges compared to bridges in less corrosive conditions. Recent bridge inspections have documented the effects of the highly corrosive conditions on the bridge.

Past inspections of the bridge have found several areas of deterioration requiring multiple series of repairs (2015 & 2022) to be completed. Repairs have been completed to the reinforced concrete caps and the concrete box beams. During the inspections and repairs, "*extensive corrosion*" has been found within multiple bridge elements. Deterioration has been found in a large portion of the box beams throughout the bridge and appears to be continuing to expand in quantity and severity with each inspection. It is anticipated that due to the highly corrosive environment, the deterioration and rate of expansion will continue to increase and may increase exponentially in the future.

Due to extensive corrosion, a bridge load rating analysis was performed in 2023 by others. The load rating analysis concluded that the structure has a reduced load capacity; however, the reduced capacity was not significant enough to warrant additional corrective action or posting for load restriction at that time. Although the load rating analysis was stated to have been performed "*in general accordance with the policies and procedures defined in SCDOT's publication "Load Rating Guidance Document" (SCLRGD) and the AASHTO MBE [Manual for Bridge Evaluation]*", the analysis report did not provide enough information to verify several of the key assumptions of the analysis. These factors include the supplemental loads and load distribution factors used and the controlling limit states and locations where they occur. The analysis calculations and modeling files were also not available for review to determine this information. It should be noted that the reported rating factor (RF) for one of the emergency vehicle loads (EV3) that approximately represents a dual axle fire truck was 1.01, very near the minimum limit of 1.0. The load rating analysis also utilized a non-standard and less conservative limit of tension stress (cracking stress) for this area of the state, which is expected to have significantly contributed to the RF being slightly above 1.0. As an alternative as standard procedure of the SCLRGD, the load rating analysis could have utilized a different load rating method, the Load Factor Rating (LFR) method due to the age of the structure. This method may or may not have produced similar results and conclusions.

3.0 – Alternative Development Considerations

In order to evaluate each alternative, several factors are to be considered. For each factor a rating scale is utilized to determine how well the alternative meets the needs of the community. The basic rating scale is outlined in Table 3-1.

Table 3-1: Evaluation Rating Scales

Rating	Description
A	Exceeds the minimum requirements with significant additional benefits.
B	Exceeds the minimum requirements with additional benefits.
C	Meets the minimum requirements with limited additional benefits.
D	Meets the minimum requirements
F	Fails to meet the minimum requirements.

If an alternative has a rating of "F" for any factor, it is deemed to be fundamentally flawed and is not recommended to be considered as a reasonable alternative. The higher the rating of an alternative, the more beneficial it is to the community. The following factors outlined in Table 3-2 will be considered when evaluating each alternative.

Table 3-2: Evaluation Factors

Factor	Description
Purpose & Need	Does the alternative meet the purpose and need of the community?
Resiliency & Safety	Does the alternative provide a resilient and safe crossing for the community, specifically related to daily use and use associated with earthquakes and hurricanes?
Community Impacts	How does the alternative impact the community access to the island?
Environmental Impacts	How does the alternative impact the environment and can it be permitted?
Bridge Design	Does the alternative meet the bridge design needs of the community, specifically related to load carrying capacity and long-term durability?
Roadway Design	Does the alternative meet the roadway design needs of the community, specifically related to the geometric design of the roadway and cross-sectional elements?
Utility Impacts	How does the alternative impact the existing utilities?
Bridge Hydraulics	Does the alternative meet the bridge hydraulic design needs of the community, specifically related to the anticipated tidal elevations, storm surge and wave heights, and future sea level rise?
Constructability	Is the alternative constructable to the needs of the community?
Estimated Costs & Schedule	Does the alternative meet the cost and schedule needs of the community?

Utilizing this objective and measurable approach will enable bridge owners to consider multiple alternatives and document each alternative's effectiveness at meeting the needs of the bridge users. This will ultimately support the decision of the bridge owner in selecting a preferred alternative. Additional descriptions of each factor and their specific rating scales are outlined in the following sections.

3.1 – Purpose & Need

The purpose of this crossing is to meet the need of the community for direct vehicular connection to Polawana Island. Without this connection, the island would be significantly less accessible to the point that residents and visitors would not be able to freely move to and from the island. Ultimately it would be expected that a majority of the residents would no longer live on the island and that property values on the island would significantly drop. Table 3-3 provides the specific rating scale that will be utilized when evaluating each alternative.

Table 3-3: Purpose & Need Rating Scale

Rating	Description
A	Unrestricted vehicular access to the island is provided. Additional access for pedestrians and cyclists and an additional lane are provided.
B	Unrestricted vehicular access to the island is provided. Additional access for pedestrians or cyclists or an additional lane is provided.
C	Unrestricted vehicular access to the island is provided.
D	Continued vehicular access to the island is provided, however restrictions on the type of vehicles that can access the island may apply.
F	Alternative does not provide continued access to the island.

Continued vehicular access with restrictions on the type of vehicles is defined as: access to the island by non-commercial vehicles (personal vehicles) and commercial vehicles weighing less than 7 tons for the foreseeable future. Commercial vehicles weighing less than 7 tons are expected to include most vehicles that routinely access the island, including ambulances. This does not include large delivery vehicles, dump trucks, most construction equipment on trailers, and fire trucks. Unrestricted vehicular access is defined as access to the island by all legal vehicles. Additional access for pedestrians is defined as a dedicated raised sidewalk (4.5-feet minimum width) or barrier separated path (5-feet minimum width). Additional access for cyclists is defined as dedicated bike lanes (5-feet minimum width), a raised multi-use path (10-feet minimum), or a barrier separated path (10-feet minimum).

3.2 – Resilience & Safety

Evaluation of each alternative for resilience and safety of the crossing considers how the crossing is expected to perform during daily fluctuations in the tides and during or after an extreme natural event (earthquake or hurricane). Failure of the crossing during or after an extreme natural event is a major concern, as it is the only location that vehicles can access the island.

Due to the lack of an alternative crossing (detour), if a new bridge was designed at this site per the South Carolina Department of Transportation (SCDOT) design standards it would be given the highest operational classification for seismic design. As a comparison, the seismic design of a new bridge at this location per these standards would have similar seismic design requirements as the recently replaced US 21 bridge over the Harbor River located approximately 8 miles east of Dataw Island due to the lack of an available detour. Although the crossing is not located within the highest seismic risk area of South Carolina, there is still significant risk to the crossing from a seismic event. The most notable risks include but are not limited to: damage to the bridge substructure elements (piles & concrete caps) which reduces their load capacity, damage to the connection of the bridge superstructure (box beams) to the substructure, potentially allowing the superstructure to become dislodged from the caps and lose bearing support, and liquefaction induced settlement of the bridge and causeway that damages the crossing so that vehicles cannot utilize the bridge.

Similar to earthquakes, hurricanes are a risk to the bridge and causeways. Inundation of the causeway and damage to the causeway or bridge due to wave action and storm surge are the primary risks associated with hurricanes. The primary way to mitigate this risk is by constructing the bridge and causeway above a specified elevation that considers predicted storm surge with waves, as well as protecting earth slopes with rip rap or other engineered erosion control armoring systems. Current common practice in South Carolina is to design new bridges so that the lowest point of the bridge superstructure (low chord) and the traveled way including shoulders of causeways are 2-feet above the 10-year storm surge elevation including wave height.

The resilience and safety of the crossing should meet the minimum needs of the community, which have been defined as uninterrupted access to the island on a daily basis for residents and emergency personnel. Daily access does not include access to the island after an earthquake or hurricane. Access to the island after an earthquake or hurricane will be considered as a higher rating during the evaluations of the alternatives. Table 3-4 provides the specific rating scale that will be utilized when evaluating each alternative.

Table 3-4: Resilience & Safety Rating Scale

Rating	Description
A	Alternative is expected to provide immediate access to the island for emergency personnel after an earthquake and during a major hurricane.
B	Alternative is expected to provide immediate access to the island for emergency personnel after an earthquake or after a major hurricane.
C	Alternative is expected to provide immediate access to the island after a hurricane and limited access after an earthquake for emergency personnel.
D	Alternative provides daily uninterrupted access to the island for residents and emergency personnel. Access to the island may be impaired after an earthquake or a hurricane.
F	Alternative does not provide daily uninterrupted access to the island for residents and emergency personnel for the foreseeable future.

Uninterrupted access to the island is defined as: residents and emergency personnel having daily access to the island that is not influenced by routine tides or load restrictions of the bridge. Impaired access to the island after an earthquake or hurricane is defined as an extended closure of the crossing due to damage to the bridge and/or causeway that make the utilization of the crossing unsafe. Access for emergency personnel may be restored within days, however public access may not be restored for an extended period (months to years).

Limited access to the island for emergency vehicles after an earthquake or a hurricane is defined as: access is provided for select emergency vehicles, such as four-wheel drive trucks and other high clearance vehicles immediately after the event with access for other types of emergency vehicles being restored within days or weeks. Public access may not be restored for an extended period (weeks to months).

Immediate access to the island for emergency vehicles is defined as: access is provided for the majority of emergency vehicle types immediately after or during the event. Public access would be expected to be restored within days of the event.

3.3 – Community Impacts

Evaluation of each alternative for community impacts of the crossing considers how the alternative is expected to affect the access to the island for the community. Table 3-5 provides the specific rating scale that will be utilized when evaluating each alternative.

Table 3-5: Community Impacts Rating Scale

Rating	Description
A	Alternative is not anticipated to have impacts to the accessibility of the island for the community.
B	Alternative is anticipated to have minor impacts to the accessibility of the island for the community.
C	Alternative is anticipated to have impacts to the accessibility of the island for the community.
D	Alternative is anticipated to have significant impacts to the accessibility of the island for the community.
F	Alternative is anticipated to have unacceptable impacts to the accessibility of the island for the community.

Significant impacts to the accessibility of the island for the community have been defined as: a temporary interruption of access that prevents a resident, visitor, employee, or emergency service provider from accessing the island for a short duration of time, such as closure of the causeway or bridge for a duration of up to 15 minutes during the day or 2 hours at night. Unacceptable impacts to the accessibility of the island for the community has been defined as: a prolonged interruption of access that prevents access to the island for durations longer than those considered a significant impact.

Minor impacts to the accessibility of the island for the community have been defined as: temporary lane closures that utilize flagging operations to control traffic that limit access to the island, but do not prevent access. If a prolonged lane closure that utilizes a temporary signal is required, it will be considered an impact to the accessibility of the island for the community.

3.4 – Environmental Impacts

Environmental compliance and permitting is anticipated to be one of the biggest challenges and risks associated with any alternative that improves the causeway or replaces the existing bridge. Obtaining permits for construction or placement of fill within critical areas (marsh) is historically difficult and is typically a lengthy and complicated permitting process. Attempts were made by the Bridge Replacement Study team to reach out to the anticipated permitting agencies to discuss the potential project with them; however, the agencies provided limited additional information due to the number of unknowns related to the expected path forward of the project, and requested design drawings be developed in order to have more specific conversations.

It should also be noted that the South Carolina Department of Health and Environmental Control (SCDHEC) is restructuring and becoming two separate agencies on July 1, 2024. This restructuring is not expected to result in a gap of services; however, it is possible that delays may occur during and/or shortly after the restructuring, along with changes in regulations and permitting processes. Any permits issued after July 1, 2024, will be issued by and coordinated through the South Carolina Department of Environmental Services (SCDES). Further references to SCDHEC in this bridge replacement study report are considered to be interchangeable with SCDES.

Depending on the alternative and its design, permits, certifications or applications needed may include but are not limited to: SCDHEC Critical Area Permit for Major Activities, SCDHEC 401 Water Quality Certification, SCDHEC Coastal Zone Consistency Application, US Army Corp of Engineers (USACE) Individual Permit, USACE 404 Permit, and a US Coast Guard (USCG) Bridge Permit. Each permit and application process requires its own unique set of forms and information to be submitted. This can be initiated at different stages of the alternative design process. It is recommended that pre-application meetings and early coordination with each permitting agency be conducted so that the agency has a better understanding of the project prior to submittal of applications, and that the design team is aware of any special documentation or information that the reviewing agency may need to aid in their review of the permit application.

Coordination with the USCG is required because the bridge is located within a tidally influenced area. If the channel below the bridge is determined to be navigable by the USCG a bridge permit issued by the USCG will be required to be obtained. In order to determine if the channel is navigable, the USCG requires additional information about the proposed bridge design that cannot be provided until additional design is completed.

In order for new fill to be placed within the critical area, a mitigation plan will be required to be submitted and approved. For the mitigation plan to be approved, impacts to the critical area are to be avoided to the extent feasible through bridging rather than fill placement. This requirement is anticipated to require any alternative that does not utilize the existing horizontal alignment. This includes a bridge that spans the majority of the critical area and is significantly longer than the existing bridge. If fill placement within the critical area cannot be avoided to the extent feasible, then mitigation of the impacted areas will be required.

Mitigation is typically provided through the purchase of mitigation credits from a mitigation bank or through the restoration or creation of critical areas. There are currently two mitigation banks that service this project area and have credits available to be purchased. It should be noted that the number of credits available is not constant and that they are allocated on a first come first served basis. Although credits are available to be purchased at this time, they may not be available in the future. An alternative to purchasing credits is to restore degraded critical areas or create new critical areas. Restoration of degraded critical areas is most commonly done through the removal of previously placed fill in critical areas. If an alternative does not utilize one or both of the existing causeways it is anticipated that it can be removed to provide critical area restoration and mitigation for new fill in the critical area. The ratio of restored critical area to new fill in critical area is a minimum of 1.5 to 1 and is typically greater. The number of credits or restoration of critical areas needed is determined on a case-by-case basis and cannot be determined until additional information is gathered, preliminary design plans are developed, and additional coordination with permitting agencies has occurred.

Another environmental consideration is how endangered species are impacted. There are several endangered species within the project region that are to be considered, including but not limited to: bald eagles, manatees, and sea turtles. Impacts to endangered species are not anticipated on this project due to the location of the bridge, shallow water around the bridge, and lack of previous observations. During the design and permitting stage of each alternative, a more in-depth review of endangered species will be conducted to verify if any endangered species are present and if any special design elements or precautions are needed during construction.

The environmental impacts of the crossing should meet the minimum needs of the community which have been defined as: acceptable environmental impacts to permitting agencies that allow all necessary permits to be obtained. Table 3-6 provides the specific rating scale that will be utilized when evaluating each alternative.

Table 3-6: Environmental Impacts Rating Scale

Rating	Description
A	Alternative has no environmental impacts and environmental permits are not expected to be required.
B	Alternative has a net decrease in environmental impacts and previously filled critical area is restored.
C	Alternative has minimal environmental impacts and environmental permits are expected to be obtainable.
D	Alternative has environmental impacts and environmental permits should be obtainable.
F	Alternative has unacceptable environmental impacts and is not expected to be able to obtain the required environmental permits.

3.5 – Bridge Design

Evaluation of each alternative for the crossing's bridge design considers what design standards are utilized in the design of the bridge, and if additional design criteria is utilized to improve durability or increase the design life of the bridge. Current bridge design standards specify a design life of 75 years. The minimum needs of the community have been defined as: a bridge design that is free from structural deficiencies which would cause the anticipated need for the bridge to be posted for load restrictions for emergency vehicles or closure within the next 10 years. Table 3-7 provides the specific rating scale that will be utilized when evaluating each alternative's bridge design.

Table 3-7: Bridge Design Rating Scale

Rating	Description
A	Alternative provides a new bridge with improved design requirements that significantly improve the durability or increase the anticipated service life of the bridge.
B	Alternative provides a new bridge with improved design requirements that improve the durability or increase the anticipated service life of the bridge.
C	Alternative provides a new bridge using the current bridge design standards of the SCDOT.
D	Alternative provides a bridge that is free from structural deficiencies which would cause the anticipated need for the bridge to be posted for load restrictions for emergency vehicles or closure within the next 10 years.
F	Alternative does not provide a bridge that is free from structural deficiencies causing the anticipated need for the bridge to be posted for load restrictions for emergency vehicles or closure within the next 10 years.

Structural deficiencies that would cause the anticipated need for the bridge to be posted for load restrictions for emergency vehicles or closure within the next 10 years include but are not limited to: severe corrosion of prestressing strands or steel reinforcement. These deficiencies are commonly preceded by cracking, spalling, or delamination of the concrete and are accelerated in the presence of highly corrosive environments such as crossings over saltwater marshes. For existing structures with these deficiencies, repairs such as external reinforcement, external post-tensioning, fiber reinforcement wraps, and the addition of new load carrying members can be utilized to strengthen the structure. The rate of corrosion can be reduced through the use of specialized coatings on the corroded items and the inclusion of sacrificial anodes within the structural members. It should be noted that these methods to reduce the rate of corrosion will not fully stop the corrosion and some corrosion will continue over time.

The current bridge design standards used for the majority of public bridge designs are the AASHTO LRFD Bridge Design Specifications. This design standard is written in such a way that provides the minimum criteria for bridge designs to have an acceptable level of safety for the general public, but provides the bridge owner the opportunity to implement optional criteria that may improve the durability or increase the design life of the bridge. The current SCDOT bridge design standards incorporate the AASHTO LRFD Bridge Design Specifications along with state-specific criteria and details shown to be suitable for bridge designs in the state.

Design requirements that improve the durability or increase the design life of the bridge are defined as: the utilization of the current SCDOT bridge design standards along with additional design criteria established by the owner. Examples of additional design criteria that can be established by the owner to improve durability or increase the design life of the bridge include but are not limited to: increasing concrete cover over reinforcement, restrictions on the elevations of bridge elements related to high tide elevations, or additional criteria for concrete mix designs.

Design requirements that significantly improve the durability or increase the design life of the bridge are defined as: the utilization of the current SCDOT bridge design standards along with multiple additional design criteria established by the owner. Examples of additional design criteria that can be established by the owner to significantly improve durability or increase the design life of the bridge include but are not limited to: the use of corrosion resistant reinforcing bars (galvanized, epoxy coated, GFRP), increased restrictions on the tension stress in bridge members, or any of the previously mentioned additional design criteria.

3.6 – Roadway Design

Evaluation of each alternative for the crossing's roadway design considers the roadway cross section and the design characteristics of its horizontal and vertical alignment. Table 3-8 provides the specific rating scale that will be utilized when evaluating each alternative's bridge design.

Table 3-8: Roadway Design Rating Scale

Rating	Description
A	Alternative provides a significantly improved roadway cross section or alignment design characteristics as the existing crossing.
B	Alternative provides an improved roadway cross section and alignment design characteristics as the existing crossing.
C	Alternative provides an improved roadway cross section or alignment design characteristics as the existing crossing.
D	Alternative provides an equal roadway cross section and alignment design characteristics as the existing crossing.
F	Alternative does not provide an equal or better roadway cross section or alignment design characteristics as the existing crossing.

The existing roadway cross section includes a 22-feet wide travel way (two 11-feet wide lanes) with 6-feet shoulders on Causeway A. However, the travel way on the bridge is equivalent to a roadway cross section that includes only 2-feet shoulders. The existing horizontal alignment is nearly tangent along the causeways and bridge with multiple curves on Bobb Island. The vertical alignment is nearly flat throughout the crossing. The horizontal and vertical alignments appear to be satisfactory for the speed of the vehicles utilizing the existing crossing.

If the roadway was designed utilizing SCDOT criteria, it would most likely be categorized as a Group 4 Urban Local Road with a minimum lane width of 11-feet and a 6-feet shoulder with 2-feet of the shoulder being paved or 2-feet curb and gutter in lieu of the shoulder. The existing roadway cross section appears to meet these design criteria excluding the 2-feet portion of the paved shoulder.

An alternative that has an improved roadway cross section will maintain the roadway shoulder width across the bridge. An alternative that has a significantly improved roadway cross section provides larger lanes and shoulders than required by typical design standards.

3.7 – Utility Impacts

Evaluation of each alternative for the crossing's utility impacts considers how the alternative will impact the existing utilities servicing the island. Table 3-9 provides the specific rating scale that will be utilized when evaluating each alternative's utility impacts.

Table 3-9: Utility Impacts Rating Scale

Rating	Description
A	Alternative does not have any anticipated utility impacts
B	Alternative is anticipated to have minor impacts to a select few utilities servicing the island
C	Alternative is anticipated to have a variety of impacts to multiple utilities servicing the island.
D	Alternative is anticipated to have major impacts to majority of utilities servicing the island.
F	Alternative prevents utilities from maintaining service to the island.

Alternatives that are anticipated to have minor impacts to a select few utilities are not expected to impact the sewer line or waterlines attached to the existing bridge nor the buried power line to the east of the existing bridge and Causeway A. Impacts may occur to other utilities but should be limited in scope. Alternatives that are anticipated to have major impacts to the majority of utilities are expected to require the relocation of all utilities attached to the existing bridge and possibly the buried powerline.

An alternative that provides a new bridge may be able to accommodate some utility relocations on the new bridge. Utilities typically attached to new bridges are usually limited to telecommunications; however, accommodations can be made to attach waterlines and sewer lines to a new bridge if needed. These attachments require special coordination with the utility companies and sequencing of the bridge construction and utility relocation can be a significant challenge in these instances.

3.8 – Bridge Hydraulics

Evaluation of each alternative for the crossing's bridge hydraulics considers the elevations of the bridge elements and top of causeway relative to predicted water surface elevations. Bridge and causeway elevations relative to predicted water surface elevations have a significant influence in determining the impacts to the crossing from daily tidal fluctuations and storm surge.

The Dataw Drive bridge and causeway are located within a FEMA Special Flood Hazard Area (SFHA). Within the vicinity of the roadway, AE and VE Flood Zones are identified, with designated 100-year return period base flood elevations ranging from 11 to 13 feet NAVD88. The 10-year tidal surge is estimated at 6.0 feet NAVD88 with an approximate wave height of 2.5 feet. Based on a review of nearby tide data, the Mean Higher-High Water (MHHW) elevation is approximately 3.3 feet NAVD88 and the Highest Astronomical Tide (HAT) is estimated to be 5.1 feet NAVD88. These tidal predictions are consistent with local accounts of the recurrent submergence of bridge caps during high tides, periodic high tides nearing the top of the causeway and bridge, and the causeway and bridge overtopping during recent hurricanes and tropical storms.

Based on the NOAA 2022 Sea Level Rise Technical Report (*Global and Regional Sea Level Rise Scenarios for the United States*), sea levels are "*expected to rise on average as much over the next 30 years (2020-2050) as it has over the last 100 years (1920-2020).*" The scenarios outlined in the report predict sea levels within this area of the country to rise between 0.9 feet and 1.6 feet by the year 2050 and 1.6 feet and 6.9 feet by the year 2100 relative to the year 2000 sea levels, see Figure 3-1 [source: NASA Interagency Sea Level Rise Scenario Tool, Regional projections, Southeast Coast (Interagency Sea Level Rise Scenario Tool – NASA Sea Level Change Portal)]. The current sea level rise trend appears to be between the intermediate and intermediate-high scenarios outlined in the report with an observed year 2020 sea level rise of 0.4 feet and an extrapolation sea level rise is 1.3 feet by year 2050, relative to the year 2000 sea levels.

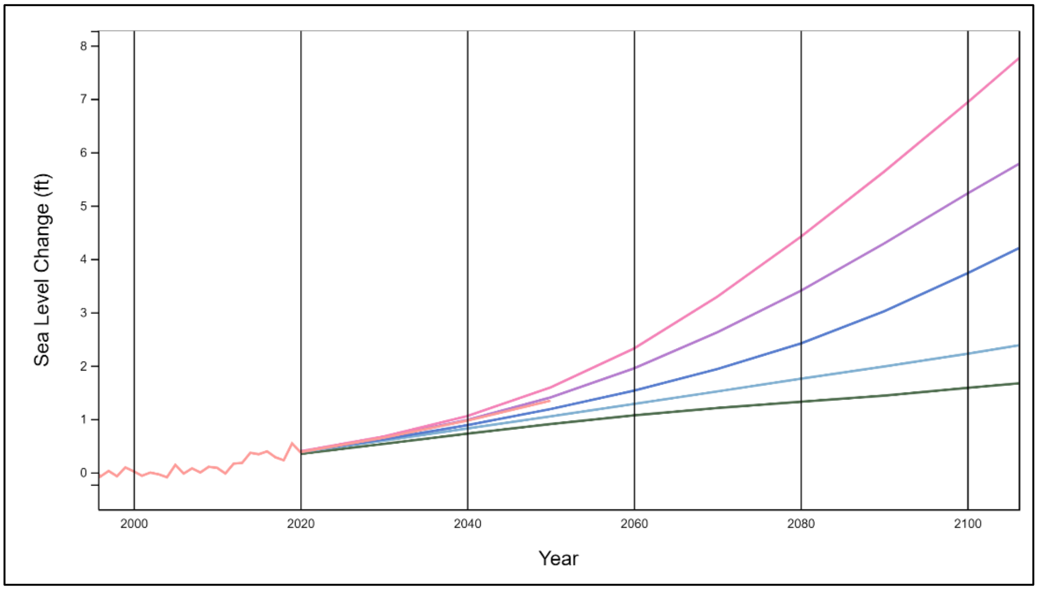

Figure 3-1: Projected Sea Level Rise

Because this is a tidally influenced waterway, the current design standards of SCDOT for a newly constructed bridge recommend the low chord elevation of the proposed bridge and the top of the causeway to be a minimum of 2 feet above the 10-year tidal surge plus wave height. This requirement corresponds to an elevation of 10.5 feet NAVD88. SCDOT does not have specific requirements or recommendations related to the location of substructure elements relative to the anticipated tide elevations; however, common practice is to construct the caps so that the bottom of cap is above the MHHW elevation and preferably above the HAT elevation. Bridges constructed at the recommended low chord elevation typically meet this common practice. Table 3-10 summarizes the expected water surface elevations (NAVD88) with considerations to the expected sea level rise (SLR).

Table 3-10: Expected Water Surface Elevations

Expect Water Surface	Current Year (2024)	2050 w/ Min. Expected SLR	2050 w/ Max. Expected SLR	2050 w/ Observed Extrapolated SLR	2100 w/ Min. Expected SLR	2100 w/ Max. Expected SLR
SLR [feet]	0.4	0.9	1.6	1.3	1.6	6.9
MHHW [feet]	3.3	3.8	4.5	4.2	4.5	9.8
HAT [feet]	5.1	5.6	6.3	6.0	6.3	11.6
10-year Storm Surge w/ Wave Height [feet]	8.5	9.0	9.7	9.4	9.7	15.0
Recommended Bridge Low Chord [feet]	10.5	11.0	11.7	11.4	11.7	17.0

The bridge hydraulics of the crossing should meet the minimum needs of the community which have been defined as: hydraulic performance equal to the existing conditions of the crossing. Table 3-11 provides the specific rating scale that will be utilized when evaluating each alternative.

Table 3-11: Bridge Hydraulics Rating Scale

Rating	Description
A	Alternative provides significantly better hydraulic performance compared to the existing crossing and takes into consideration predicted sea level rise.
B	Alternative provides better hydraulic performance compared to the existing crossing and takes into consideration predicted sea level rise.
C	Alternative provides better hydraulic performance compared to the existing crossing.
D	Alternative provides equals hydraulic performance compared to the existing crossing.
F	Alternative does not provide equal or better bridge hydraulic performance compared to the existing crossing.

An alternative that provides equal hydraulic performance compared to the existing crossing has a bridge that maintains the existing bridge length and low chord elevation as well as the existing causeway length and elevation. An alternative that provides better hydraulic performance would have higher bridge low chord and causeway finished grade elevations compared to the existing conditions.

An alternative that provides better hydraulic performance and takes into consideration predicted sea level rise would have bridge low chord and causeway finished grade elevations equal to or higher than the SCDOT recommendation of 2-feet above the 10-year storm surge including wave height and the minimum predicted sea level for 2050. An alternative that provides significantly better hydraulic performance and takes into consideration predicted sea level rise would have bridge low chord and causeway finished grade elevations equal to or higher than the SCDOT recommendation of 2 feet above the 10-year storm surge including wave height and the maximum predicted sea level for 2100.

3.9 – Constructability

Evaluation of each alternative for the crossing's constructability considers the required construction methods of the alternative, including the need for temporary structures or staged construction. Table 3-12 provides the specific rating scale that will be utilized when evaluating each alternative's constructability.

Table 3-12: Constructability Rating Scale

Rating	Description
A	Alternative is constructable with standard construction practices with limited construction complexities or environmental impacts.
B	Alternative is constructable with standard construction practices.
C	Alternative is constructable but requires a temporary bridge or multiple construction stages.
D	Alternative is constructable to the minimum needs of the community but requires more difficult construction methods than typically used.
F	Alternative is not constructable to the minimum needs of the community.

The minimum constructability needs of the community have been defined as: construction that does not prevent vehicular access to the island and does not require cost prohibitive construction practices, such as the use of highly specialized equipment, materials, or designs. Examples of cost prohibitive construction practices include but are not limited to: cable stayed or suspension bridges and single span segmental concrete bridges. Difficult construction methods include but are not limited to: post tensioning of concrete, the use of specialized equipment such as an oversized crane or non-typical crane, work required to be completed by hand that typically is not, and unique temporary construction methods to maintain traffic.

An alternative that has limited construction complexities or environmental impacts includes but is not limited to: one that does not require barges or construction mats within the critical area, can be constructed from existing causeways, or can be constructed utilizing the top-down method of construction. The top-down method of construction allows the construction of a bridge to be completed from the top of the adjacent span. Once the construction of the new span is completed, construction equipment is moved on to that span and the next span is constructed. The span lengths of bridges constructed utilizing the top-down method are limited by the size of the required equipment. Span lengths greater than 50 feet have been utilized with this construction method, however, special care during design is required.

3.10 – Estimated Costs & Schedules

For each alternative, the estimated cost and schedule of the project will be determined. The cost and schedule of each alternative are difficult to estimate at this time due to the limited design completed to date and the influence of factors beyond the control of the community and bridge replacement study team, such as regulatory agencies, future economic conditions, and available funding sources. These factors should be considered as an order of magnitude cost and schedule and not a detailed cost or schedule estimate. All cost values will be estimated in current dollars with contingencies included for future cost increases in construction.

The alternative cost estimates will include square foot estimates of the bridge and causeway as applicable. The per square foot costs will be based on recent construction cost values. Cost estimates will also be provided for final design engineering and construction engineering and inspection oversite. A contingency will be added to each alternative's cost estimate due to the numerous uncertainties related to the costs at this time.

The schedule estimate for each alternative will provide an estimate of the duration of the design and permitting phase along with the construction phase. Depending on how the community plans to select a contractor for the project, additional time may be needed for contractor selection. If the contractor is selected through open bids, without prequalification, or by invitation only this is estimated to add 5 to 9 months to the project duration from the time the final design plans are completed until the contractor is provided the notice to proceed with construction. If the contractor is selected through a two-step process with contractors shortlisted through a submittal of qualifications and then awarded based on bids received from the shortlisted contractors, this is estimated to add 7 to 11 months to the project duration. This two-step selection process can begin prior to the final design plans being completed and reduce the estimated additional time down to 4 to 6 months. The community will also have the ability to select a contractor and negotiate the construction cost directly with them. This option is the fastest; however, the construction cost may be slightly higher as it is not competitive. The preselection option is estimated to add 2 to 4 months to the project duration from the time the final design plans are completed until the contractor is provided the notice to proceed with construction.

4.0 – Developed Alternatives & Evaluations

A total of five different alternatives including two separate sub-alternatives have been evaluated as part of this study. Table 4-1 provides a brief description of each alternative.

Table 4-1: Alternatives Descriptions

Alternative	Description
1 – No Build	Existing bridge and causeways are retained and no repairs or modifications are performed, only routine maintenance.
2 – Rehabilitate of Existing Bridge	Existing bridge and causeways are retained, and repairs are made to the bridge to correct structural deficiencies found during recent inspections to improve its load carrying capacity and extended its remaining service life.
3 –Bridge Replacement on Existing Alignment	The existing bridge is replaced on the existing alignment and a temporary bridge is utilized to maintain traffic during construction.
4 –Bridge Replacement on Adjacent Alignment	A new bridge is built on a parallel alignment and the existing bridge and causeways are removed.
5a – Bridge Replacement on New Alignment to Dataw Island	A new bridge is built on a new alignment from Polawana Island (mainland) directly to Dataw Island and the existing bridge and causeways are removed.
5b – Bridge Replacement on New Alignment to Bobb Island	A new bridge is built on a new alignment from Polawana Island (mainland) to Bobb Island retaining Causeway B and the existing bridge and Causeway A are removed.

The sections below provide additional details for each alternative, as well as an evaluation of the alternative for each factor considered in the study including the assigned rating for the factor.

4.1 – Alternative 1 – No build

4.1.1 – Alternative Overview

In this alternative, no repairs or improvements are planned to be made to the bridge or causeways and only routine maintenance is planned to be performed, such as removal of debris and unclogging of drains. The existing bridge and causeway are anticipated to be inundated by flood waters by tropical storms and hurricanes with return periods of less than 10-years. Access to the island is expected to be impaired after an earthquake due to anticipated damage to the bridge and liquefaction of the soils beneath the causeways. This alternative is considered the base line for the bridge replacement study to which all other alternatives are ultimately compared.

4.1.2 – Alternative Evaluation

An evaluation of this alternative for each factor being considered in the study is outlined in the following subsections. It should be noted that this alternative received multiple ratings of “F” resulting in the alternative being considered fundamentally flawed and is therefore not considered to be a reasonable alternative.

4.1.2.1 – Purpose & Need

This alternative is not anticipated to provide continued access to the island for vehicles that weigh less than 7 tons for the foreseeable future. This is due to the deteriorated condition of the bridge and the additional deterioration that has been found each of the most recent bridge inspections. As a result, this alternative is provided a rating of “F” for this evaluation factor.

4.1.2.2 – Resiliency & Safety

This alternative is not anticipated to provide daily uninterrupted access to the island for residents and emergency personnel due to the deteriorated condition of the bridge and the additional deterioration that has been found each of the most recent bridge inspections. These findings lead to the likelihood that the bridge will need to be posted for load restriction in the foreseeable future. As a result, this alternative is provided a rating of “F” for this evaluation factor.

4.1.2.3 – Community Impacts

This alternative is not anticipated to have temporary impacts on the accessibility of the island. As a result, this alternative is provided a rating of “A” for this evaluation factor. It should be noted that this alternative is expected to require that the bridge be load restricted in the foreseeable future, which will have long-term impacts on the accessibility of the island.

4.1.2.4 – Environmental Impacts

This alternative is not anticipated to have any environmental impacts or require environmental permits due to the lack of construction activities. This alternative is provided a rating of “A” for this evaluation factor.

4.1.2.5 – Bridge Design

This alternative does not provide a bridge that is free from structural deficiencies and is anticipated to require posting for load restrictions within the next 2-10 years if no additional repair work is done. As a result, this alternative is provided a rating of “F” for this evaluation factor.

4.1.2.6 – Roadway Design

This alternative utilizes the existing roadway cross section and alignment. This alternative is provided a rating of “D” for this evaluation factor.

4.1.2.7 – Utility Impacts

This alternative does not impact any utilities or require utility relocations due to the lack of construction activities. This alternative is provided a rating of “A” for this evaluation factor.

4.1.2.8 – Bridge Hydraulics

This alternative maintains the existing bridge and causeways therefore providing equal hydraulic performance to the existing conditions. This alternative is provided a rating of “D” for this evaluation factor.

4.1.2.9 – Constructability

This alternative maintains the existing bridge and causeways without any improvement therefore construction is not needed. As a result, there is no rating provided for this evaluation factor.

4.1.2.10 – Estimated Costs & Schedule

This alternative does not have any immediate design or construction cost to the community. However, the alternative is not sustainable and will require that the community implement one of the following alternatives, or a similar alternative, in the future.

Based on the information provided and gathered to date, it is estimated that with only routine maintenance performed, the bridge can remain in its current condition without load restrictions for the next 2-10 years. Predicting the remaining life of a structure is difficult and has a large degree of uncertainty. It should be noted that the timeline provided is an estimate only.

4.2 – Alternative 2 – Rehabilitation of Existing Bridge

4.2.1 – Alternative Overview

In this alternative, repairs and improvements are made to the existing bridge to increase its load carrying capacity and extend its estimated remaining service life. Modifications are not anticipated to be made to the causeways and no new fill placement within the critical area is expected. The bridge and causeways are anticipated to continue to be inundated by flood waters from tropical storms and hurricanes with return periods of less than 10-years. Access to the island may be impaired after an earthquake due to anticipated damage to the bridge and liquefaction of the soil beneath the causeways.

Based on the previous bridge inspections and observations during bridge repairs, a portion of the reinforcement and prestressing strands within the bridge beams have severe corrosion reducing the load carrying capacity of the bridge. Several strands have also been observed to be broken during a previously completed repair. This corrosion is not uncommon for bridges located in this environment and built within the time period that the existing bridge was. It is anticipated that the concrete has become or is nearly saturated with chlorides due to its environment, and that corrosion of the prestressing strands and reinforcing will continue and possibly accelerate.

There are multiple bridge rehabilitation and strengthening methods currently available, and new innovations and methods are developed regularly. Current common strengthening methods include supplemental external post tensioning, near surface stainless steel, titanium, or fiber reinforced bars, surface mounted fiber reinforced polymer plates or strips, and fiber reinforced polymer wraps applied to the external surface. There are benefits and limitations of each method that will need to be further evaluated if the alternative is selected. Of the strengthening methods listed, the two that appear to be more suitable for this structure are near surface stainless steel, titanium, or fiber reinforced bars and fiber reinforced polymer strips. The design of the rehabilitation will depend on how much strengthening of the bridge is desired and how much load carrying contribution of the existing prestressing strands and steel reinforcement is considered in the design.

Utilization of near surface titanium bars is expected to provide the greatest potential increase in strength and load carrying capacity of the existing bridge. This method of strengthening has been successfully used to strengthen concrete bridges over the past decade, and has recently published design recommendations and guides specifically for bridges (*AASTHO Guide for Design and Construction of Near- Surface Mounted Titanium Alloy Bars for Strengthening Concrete Structures, 1st Ed*.). The general installation of these bars requires a groove to be cut into the concrete member and holes drilled at each end of the groove. The ends of the titanium bar are then bent at the appropriate length, and epoxy is placed into the previously cut groove and drilled holes. The titanium bar is then inserted into the groove and holes and additional epoxy is applied to cover the titanium bar. There are several benefits to using titanium bars compared to other materials including their ease of installation, high corrosion resistance, high strength, and high ductility (ability to deform prior to fracture).

As an alternative to near surface titanium bars, fiber reinforced polymer strips can be installed on the bottom of the beams. Fiber reinforced polymer strips have been successfully utilized to strengthen a variety of concrete structures, including bridges. The general installation of these strips includes blast cleaning the surface to remove contaminants and unsound concrete, filling any uneven surfaces, and performing random pull-off tests to verify the adhesive strength of the concrete. Once the adhesive strength of the concrete is verified to be adequate, the surface is primed and sealed, and a resin is applied followed by the fiber reinforced polymer strip. This rehabilitation system is intended to be installed by a specially trained contractor. One of the challenges with utilizing this method of rehabilitation is that previous repairs to the beams have resulted in a non-uniform surface elevation along the bottom of the beams. This non-uniformity will most likely need to be corrected through the placement of additional concrete material on the bottom of the beams. This overhead installation of concrete material is difficult and requires specialized products that are significantly more expensive than traditional concrete products and will ultimately increase the anticipated cost of this alternative.

4.2.2 – Alternative Evaluation

An evaluation of this alternative for each factor being considered in the study is outlined in the following subsections.

4.2.2.1 – Purpose & Need

This alternative is anticipated to provide continued access to the island for vehicles that weigh less than 7 tons for the foreseeable future, however the bridge may require load restrictions in the future. Depending on the bridge rehabilitation designs and amount of future deterioration, unrestricted access without load restrictions may be able to be maintained for the remaining life of the structure. This alternative is provided a rating of “D” for this evaluation factor due to the uncertainty related to if unrestricted access can be maintained.

4.2.2.2 – Resiliency & Safety

This alternative is anticipated to provide daily uninterrupted access to the island for residents and emergency personnel, however access may be impaired after an earthquake or hurricane. This alternative is provided a rating of “D” for this evaluation factor.

4.2.2.3 – Community Impacts

This alternative is anticipated to require prolonged lane closures that utilize temporary signals to control traffic in order for the bridge rehabilitation to be made. This alternative is provided a rating of “C” for this evaluation factor.

4.2.2.4 – Environmental Impacts

This alternative is not anticipated to have any environmental impacts or require environmental permits as long as new fill is not placed within the critical area, and the vertical clearance below the bridge is not decreased. As a result, this alternative is provided a rating of “A” for this evaluation factor. It should be noted that a maintenance and repair notice will need to be submitted to SCDHEC for their concurrence.

4.2.2.5 – Bridge Design

The alternative is anticipated to provide a bridge that is free from structural deficiencies that would cause the need to post the bridge for load restrictions for emergency vehicles within the next 10 years. This alternative is provided a rating of “D” for this evaluation factor.

4.2.2.6 – Roadway Design

This alternative utilizes the existing roadway cross section and alignment. This alternative is provided a rating of “D” for this evaluation factor.

4.2.2.7 – Utility Impacts

This alternative is not anticipated to impact any utilities or require utility relocations. The construction activities for the bridge rehabilitations will most likely be limited to the bottom of the bridge beams and possibly the bridge caps, but not the sides of the bridge beams. This alternative is provided a rating of “A” for this evaluation factor.

4.2.2.8 – Bridge Hydraulics

This alternative maintains the existing bridge and causeways therefore providing equal hydraulic performance to the existing conditions. This alternative is provided a rating of “D” for this evaluation factor.

4.2.2.9 – Constructability

This alternative is anticipated to require specialized construction equipment, materials and a specialty contractor. As a result, this alternative is provided a rating of “D” for this evaluation factor.

4.2.2.10 – Estimated Costs & Schedule

The cost to implement this alternative is currently difficult to estimate, as it depends on the type and quantity of repairs made to the bridge, which is not known at this time. In order to develop an estimated cost, two rehabilitation scenarios have been considered.

The first scenario is concrete spalls and significant cracks are repaired, and near surface titanium bars are installed to the bottom of the beams. This scenario is anticipated to have an order of magnitude construction cost of $1,350,000 and a design cost of $100,000. The onsite repair work timeline for this scenario is estimated to be 3 months or less. Full time construction observations and engineering support during construction are estimated to cost $90,000. The total cost for this scenario is estimated to be approximately $1,500,000.

The second scenario is concrete spalls and significant cracks are repaired, and fiber reinforced polymer strips are applied to the bottom of the beams. This scenario is anticipated to have an order of magnitude construction cost of $3,250,000 and a design cost of $130,000. The onsite repair work timeline for this scenario is estimated to be 3 months or less and be performed by a specially trained contractor. Full time construction observations and engineering support during construction are estimated to cost $90,000. The total cost for this scenario is estimated to be approximately $3,500,000.

It is estimated that the design phase of the project will have a duration of approximately 6 months to 1 year. Based on the anticipated types of rehabilitations required to increase the load carrying capacity of the bridge, a specialized bridge repair contractor will most likely be needed to perform the work. This need leads to the community most likely needing to select a contractor through a two-step selection process, or by preselecting a contractor and negotiating the construction cost directly with them. This process can take between 2-11 months depending on the contractor selection process. The actual construction duration of the rehabilitation is estimated to be less than 1-year and could be as little as a few months of onsite work.

4.3 – Alternative 3 – Bridge Replacement on Existing Alignment

4.3.1 – Alternative Overview

In this alternative, a replacement bridge is built on the existing alignment and the existing causeways are retained while maintaining traffic on a temporary detour bridge. The causeways are anticipated to continue to be inundated by flood waters from tropical storms and hurricanes with return periods of less than 10-years. The new bridge is not designed to meet the SCDOT seismic design standards due to the utilization of the existing causeways as part of the final design configuration. Access to the island is expected to be impaired after an earthquake due to possible damage to the bridge and liquefaction of the soils beneath the causeways. During an earthquake, the soils below causeways are anticipated to liquefy causing the causeways to settle. The amount of settlement is unknown without a detailed analysis of the causeway and will be dependent upon the size of the potential earthquake.

There are two locations that have been considered for the temporary detour bridge. The preferred location depends upon if the guardhouse is relocated prior to construction. The first location is to the east of the existing bridge. The benefit of this location is that the existing Bobb Island guardhouse is not relocated prior to construction. Also, additional space is provided for the connection of the temporary roadway to the existing roadway on Bobb Island before the guardhouse, and relocation of the emergency generator that supplies the guardhouse is not required prior to construction. The most significant disadvantage of this location is that it will most likely require the relocation of the underground power line to the east of the existing bridge and Causeway A be completed prior to the start of construction. The second location is to the west of the existing bridge. The benefit of this location is if the existing guardhouse is relocated prior to construction, relocation of the underground power line to the east of the existing bridge and Causeway A will not be required. For the evaluation of this alternative, it has been assumed that the guardhouse will be relocated prior to construction and that the temporary bridge will be constructed to the west of the existing bridge.

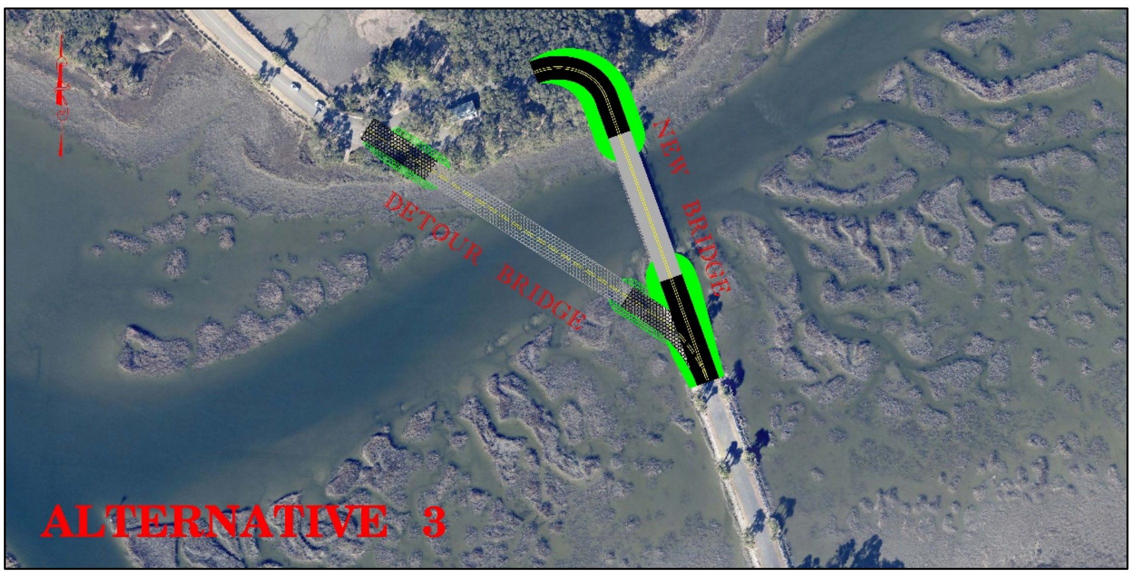

Figure 4-1: Alternative 3 Layout

A bridge superstructure design that utilizes either precast concrete cored slabs/ box beams or cast-in-place concrete flat slabs should allow the bridge to be constructed utilizing the top-down construction method to aid in minimizing environmental impacts. The superstructure is anticipated to be supported by cast-in-place concrete caps with prestressed concrete piles driven into the marsh. Because the bridge is not designed to meet the SCDOT seismic design standards, the use of prestressed concrete piles is anticipated to meet the bridge design criteria. It may also be possible to utilize a precast concrete cap in lieu of the cast-in-place concrete cap. Utilization of precast concrete caps is not common in South Carolina because most bridges are designed per SCDOT standards which prohibit precast concrete caps; however, precast concrete caps are utilized in other areas of the country and should reduce the bridge construction duration.

The existing roadway lane (11-feet) and shoulder (6-feet) widths will be maintained on the new bridge. The roadway horizontal alignment will maintain the existing alignment. The vertical alignment will be raised at the bridge location and require grades steeper than the existing in order to meet the bridge elevation requirements. The grades and lengths of transitions associated with the changes in grade are anticipated to be within the standard roadway design criteria for local roads. It may also be possible to increase the elevation of the existing causeways to reduce the likelihood of inundation by flood waters from tropical storms and hurricanes; however, this will cause more potential environmental impacts due to additional fill placement within the critical area that would be required for the entire length of Causeway A. For the evaluation of this alternative, it has been assumed that the elevations of the existing causeways will not be increased except as needed for the bridge construction.

The bottom of caps of the new bridge are proposed to be at elevation 6.0-feet which is approximately equal to the expected HAT elevation including the year 2050 observed extrapolated sea level rise. Utilization of minimum cap elevations at this height will result in a new bridge low chord elevation of approximately 9-feet and the top of bridge elevation at the beginning and end of bridge of approximately 11.5-feet. This is a rise of approximately 4.5 feet above the existing bridge and causeways. The proposed bridge low chord elevation is above the existing 10-year storm surge plus wave height elevation and is an improvement compared to the existing bridge,; however, it does not provide the SCDOT recommended 2-feet additional freeboard for the existing sea levels and is equal to or below the 10-year storm surge plus wave height elevation if sea level rise is considered.

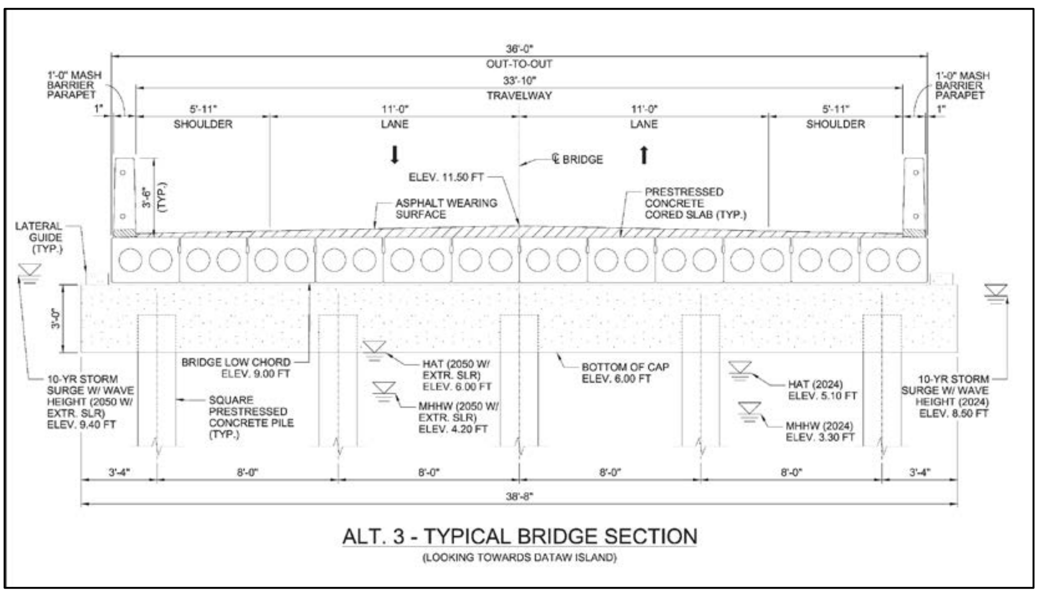

Figure 4-2: Alternative 3 Typical Bridge Section

The durability of the new bridge can be increased through the adoption of improved bridge design criteria and the utilization of corrosion resistant materials. The allowable tension stress in the design of prestressed concrete elements (cored slabs, box beams or precast caps) can be reduced or specified to be zero. This improved design criteria can be satisfied through the inclusion of additional prestressing in the elements for a relatively low cost increase and should minimize the chances of cracks forming in these elements. This would reduce the ability of chlorides to enter the concrete and cause steel reinforcing or prestressing strand corrosion. Another improved design criteria that can be utilized is the specification of increased concrete cover compared to the minimum cover listed in design specifications as shown in Table 4-2. This improved design criteria has been utilized on recent projects within this area. Additionally, the utilization of corrosion resistant reinforcing bars or prestressing strands such as galvanized, epoxy coated, or fiber reinforced polymer can be specified. In order to reduce the ability of concrete to absorb chlorides which cause corrosion of reinforcing steel and prestressing strands, the permeability of the concrete can be reduced through specifying lower water to cement ratios, or by using specialized admixtures in the concrete mix design such as SIKA WT-240 P Permeability Reducing Admixture.

Table 4-2: Improved Concrete Cover Comparison

Element	Existing Bridge Minimum Cover	Standard Design Minimum Cover	Improved Design Minimum Cover
Substructure Concrete within Splash 12-feet of MHHW or Water	2”	4”	4 ½”
Concrete Cast Against and Permanently Exposed to Earth	2”	3”	4 ½”
Substructure Concrete Exposed to Earth	2”	2”	4”
Prestressed Concrete Piles	1”	2 ¼”	3”
Drilled Shafts	n/a	4”	6”

Temporary and permanent environmental impacts are expected for this alternative. Permanent impacts will occur due to the placement of new fill within the critical area around the ends of the new bridge due to the increased bridge elevation and width. Because the construction of the new bridge requires a temporary detour bridge and causeway shift, temporary environmental impacts will also occur. In order to mitigate these impacts, a mitigation plan will need to be developed in coordination with and approved by the permitting agencies (SCDHEC & USACE). In order to mitigate these impacts, mitigation credits will need to be purchased and/or a portion of the previously placed Causeway A will need to be removed and the bridge length increased. It is anticipated that a combination of these two mitigation strategies will be required, however the exact amount each mitigation strategy is utilized cannot be determined at this time without additional design and coordination with permitting agencies.

The construction of the bridge is anticipated to require the relocation of utilities within the existing causeways to be completed prior to the start of the replacement bridge construction. Construction of the temporary detour bridge can begin prior to the relocation of utilities. This should reduce the overall project duration. It may also be possible to attach several of the utilities to the new bridge. If utilities are attached to the new bridge, this will need to be coordinated during the bridge design process so that the appropriate accommodations are made.

4.3.2 – Alternative Evaluation

An evaluation of this alternative for each factor being considered in the study is outlined in the following subsections.

4.3.2.1 – Purpose & Need

This alternative is anticipated to provide unrestricted access to the island for legal vehicles. This alternative is provided a rating of “C” for this evaluation factor.

4.3.2.2 – Resiliency & Safety

This alternative is anticipated to provide daily uninterrupted access to the island for residents and emergency personnel; however, access may be limited after an earthquake due to the bridge not being designed to SCDOT seismic standards and the utilization of the existing causeways in the final design configuration. As a result, this alternative is provided a rating of “C” for this evaluation factor.

4.3.2.3 – Community Impacts

This alternative requires a temporary detour bridge during construction. This alternative is provided a rating of “D” for this evaluation factor.

4.3.2.4 – Environmental Impacts

This alternative is anticipated to have several temporary environmental impacts during construction due to the temporary bridge and fill placement, along with a relatively low amount of permanent impacts in the form of new fill placed within the critical area at each end of the bridge. The existing Causeway A can be partially removed, and the marsh restored to its previous condition which should be viewed as a benefit to the permitting agencies and aid in obtaining the necessary permits. This alternative is provided a rating of “D” for this evaluation factor.

4.3.2.5 – Bridge Design

This alternative provides a new bridge with improved design requirements that increase the durability of the bridge compared to the minimum design requirements of bridges. This alternative is provided a rating of “B” for this evaluation factor.

4.3.2.6 – Roadway Design

This alternative maintains the roadway lane and shoulder widths along the bridge as well as the existing roadway alignments. This alternative is provided a rating of “C” for this evaluation factor.

4.3.2.7 – Utility Impacts

This alternative replaces the existing bridge and will require all attached utilities, including the water lines and sewer line to be relocated. The existing utilities will be required to be relocated prior to the start of the replacement bridge construction. This alternative is provided a rating of “D” for this evaluation factor.

4.3.2.8 – Bridge Hydraulics

This alternative provides improved hydraulic performance compared to the existing crossing, however it does not provide the SCDOT recommended 2-feet freeboard above the 10-year storm surge including wave height. As a result, this alternative is provided a rating of “C” for this evaluation factor.

4.3.2.9 – Constructability

This alternative is anticipated to utilize standard construction practices. This alternative is provided a rating of “C” for this evaluation factor.

4.3.2.10 – Estimated Costs & Schedule

This alternative is anticipated to have an order of magnitude construction cost of $5,500,000, and a design cost of $400,000. Allowances of $250,000 and $300,000 have been included in the construction cost estimate for bridge aesthetic features and environmental permitting, respectively. The on-site construction work for this scenario is estimated to be 27 months or less. Full time construction observations and engineering support during construction are estimated to cost $810,000. The total cost for this alternative is estimated to be approximately $6,700,000.

It is estimated that the design and permitting phase of the project will have a duration of approximately 2years due to the need for multiple permits. Based on the anticipated design, the community can select a contractor through any of the means previously discussed. In order to develop an estimated project schedule, this process has been assumed to be 6 months to 1 year. The actual construction duration is estimated to be 2 to 2.5 years.

4.4– Alternative 4 – Bridge Replacement on Adjacent Alignment

4.4.1 – Alternative Overview

In this alternative, a replacement bridge is built on an adjacent alignment and a portion of the existing Causeway A and all of Causeway B are retained while maintaining traffic on the existing bridge during construction of the replacement bridge. The causeways are anticipated to continue to be inundated by flood waters from tropical storms and hurricanes with return periods of less than 10-years. The new bridge is not designed to meet the SCDOT seismic design standards due to the utilization of the existing causeways as part of the final design configuration. Access to the island is expected to be impaired after an earthquake due to possible damage to the bridge and liquefaction of the soils beneath the causeways. During an earthquake, the soils below causeways are anticipated to liquefy causing the causeways to settle. The amount of settlement is unknown without a detailed analysis of the causeway and will be dependent upon the size of the potential earthquake.

Two locations have been considered for the replacement bridge and adjacent alignment, similar to Alternate 3. For the evaluation of this alternative, it has been assumed that the guardhouse will be relocated prior to construction and that the replacement bridge will be constructed to the west of the existing bridge. This location provides the benefit of not requiring the underground power line to the east of the existing bridge to be relocated prior to construction and is anticipated to require slightly less new fill be placed within the critical area. Additionally, there is flexibility in the location of the new alignment that allows the design team the ability to better balance the environmental impacts and mitigation needs of the project by adjusting the location of the bridge and departure of the adjacent alignment from the existing Causeway A alignment.

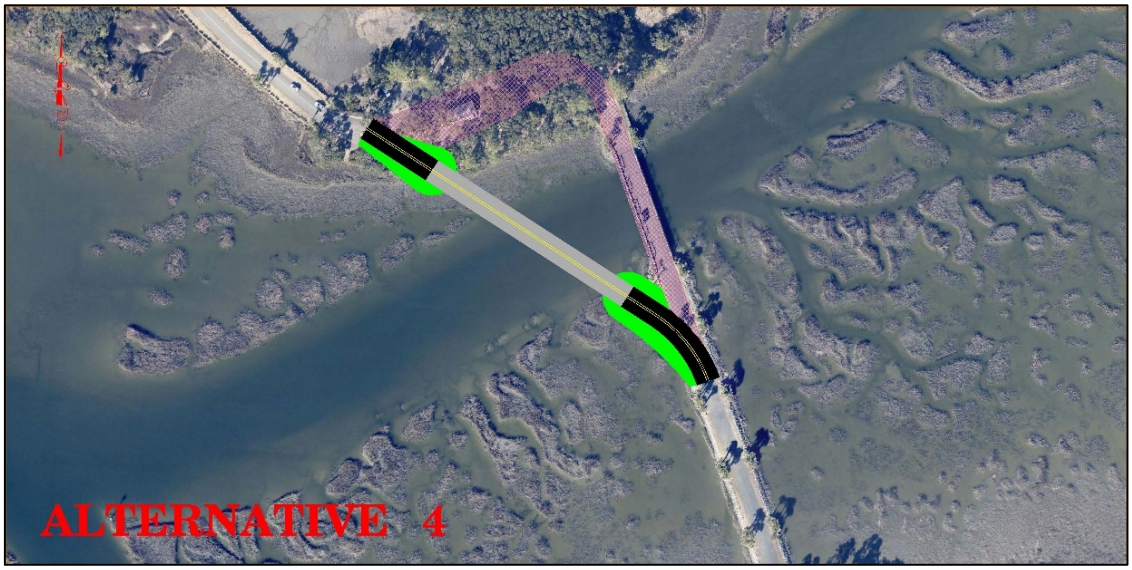

Figure 4-3: Alternative 4 Layout

A bridge superstructure design that utilizes either precast concrete cored slabs/ box beams or cast-in-place concrete flat slabs should allow the bridge to be constructed utilizing the top-down construction method to aid in minimizing environmental impacts. The superstructure is anticipated to be supported by cast-in-place concrete caps with prestressed concrete piles driven into the marsh. Because the bridge is not designed to meet the SCDOT seismic design standards, the use of prestressed concrete piles is anticipated to meet the bridge design criteria. It may also be possible to utilize a precast concrete cap in lieu of the cast-in-place concrete cap. Utilization of precast concrete caps is not common in South Carolina because most bridges are designed per SCDOT standards which prohibit precast concrete caps; however, precast concrete caps are utilized in other areas of the country and should reduce the bridge construction duration.

The existing roadway lane (11-feet) and shoulder (6-feet) widths will be maintained on the new bridge. The existing roadway horizontal alignment will be retained on Causeway B and for a portion Causeway A at its southern end. The alignment will be modified prior to the bridge on Causeway A and shifted to the west of the existing bridge. The new alignment and bridge will be angled slightly in relation to the existing bridge. This slight angle will reduce the need for new fill within the critical area and provide an improved roadway horizontal alignment compared to the existing that minimizes the quantity of small radius curves in the roadway. The vertical alignment will be raised at the bridge location and require grades steeper than existing in order to meet the bridge elevation requirements. The grades and lengths of transitions associated with the changes in grade are anticipated to be within the standard roadway design criteria for local roads. It may also be possible to increase the elevation of the existing causeways to reduce the likelihood of inundation by flood waters from tropical storms and hurricanes, however this will cause more environmental impacts due to additional fill placement within the critical area that would be required for the entire length of Causeway A that remains. For the evaluation of this alternative, it has been assumed that the elevations of the existing causeways will not be increased except as needed for the bridge construction.

The bottom of caps of the new bridge are proposed to be at elevation 6.0-feet which is approximately equal to the expected HAT elevation including the year 2050 observed extrapolated sea level rise. Utilization of minimum cap elevations at this height will result in a new bridge low chord elevation of approximately 9-feet and the top of bridge elevation at the beginning and end of bridge of approximately 11.5-feet. This is a rise of approximately 4.5 feet above the existing bridge and causeways. The proposed bridge low chord elevation is above the existing 10-year storm surge plus wave height elevation and is an improvement compared to the existing bridge; however, it does not provide the SCDOT recommended 2-feet additional freeboard for the existing sea levels and is equal to or below the 10-year storm surge plus wave height elevation if sea level rise is considered.

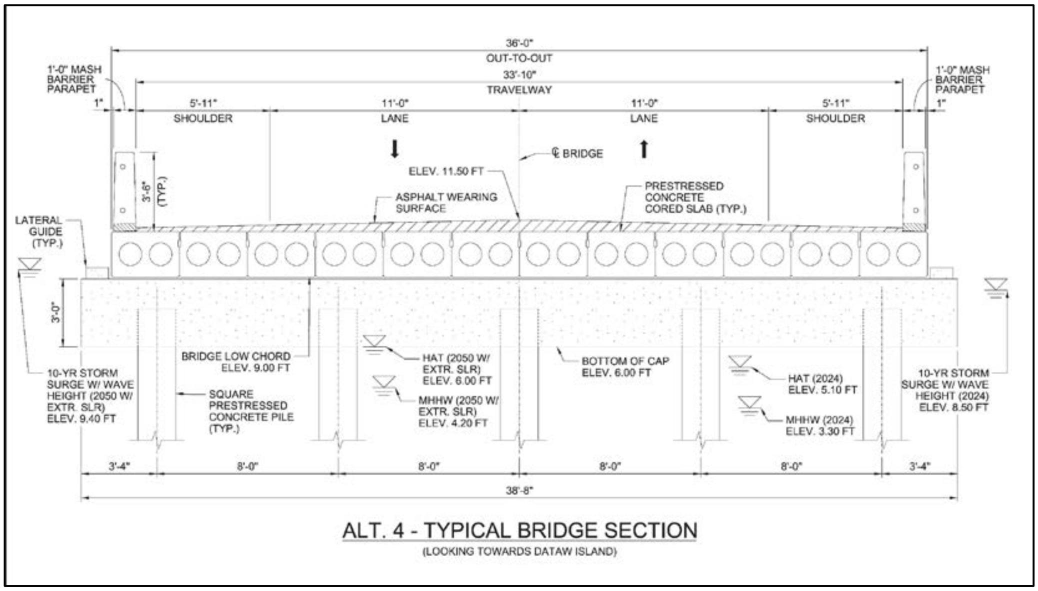

Figure 4-4: Alternative 4 Typical Bridge Section

The durability of the new bridge can be increased through the adoption of improved bridge design criteria and the utilization of corrosion resistant materials similar to those discussed in Alternative 3.

Environmental impacts are expected for this alternative. Impacts will occur due to the placement of new fill within the critical area around the ends of the new bridge due to the new alignment. In order to mitigate these impacts, a mitigation plan will need to be developed in coordination with and approved by the permitting agencies (SCDHEC & USACE). In order to mitigate these impacts, mitigation credits will need to be purchased and/or a portion of the previously placed Causeway A will need to be removed. It is anticipated that a combination of these two mitigation strategies will be required, however the exact amount each mitigation strategy is utilized cannot be determined at this time without additional design and coordination with the permitting agencies.

The construction of the bridge is not anticipated to require the relocation of utilities within the existing causeways to be completed prior to the start of the replacement bridge construction. Utility relocations will need to be completed prior to the demolition of the existing bridge and the portion of Causeway A to be removed. It may also be possible to attach several of the utilities to the new bridge. If utilities are attached to the new bridge this will need to be coordinated during the bridge design process so that the appropriate accommodations are made.

4.4.2 – Alternative Evaluation

An evaluation of this alternative for each factor being considered in the study is outlined in the following subsections.

4.4.2.1 – Purpose & Need

This alternative is anticipated to provide unrestricted access to the island for legal vehicles. This alternative is provided a rating of "C" for this evaluation factor.

4.4.2.2 – Resiliency & Safety

This alternative is anticipated to provide daily uninterrupted access to the island for residents and emergency personnel, however access may be limited after an earthquake due to the bridge not being designed to SCDOT seismic standards and the utilization of the existing causeways in the final design configuration. This alternative is provided a rating of "C" for this evaluation factor.

4.4.2.3 – Community Impacts

This alternative is anticipated to require prolonged lane closures that may utilize temporary signals to control traffic in order tie the new roadway alignment into the existing. As a result, this alternative is provided a rating of "C" for this evaluation factor.

4.4.2.4 – Environmental Impacts

This alternative is anticipated to have minor environmental impacts with a relatively small amount of new fill placed within the critical area. A portion of the existing Causeway A is also proposed to be removed and the marsh restored to its previous condition. This alternative is provided a rating of "B" for this evaluation factor.

4.4.2.5 – Bridge Design

This alternative provides a new bridge with improved design requirements that increase the durability of the bridge compared to the minimum design requirements of bridges. This alternative is provided a rating of "B" for this evaluation factor.

4.4.2.6 – Roadway Design

This alternative maintains the roadway lane and shoulder widths along the bridge and provides an alignment that reduces the amount of small radius curves for an improved alignment. This alternative is provided a rating of "B" for this evaluation factor.

4.4.2.7 – Utility Impacts

This alternative replaces the existing bridge and will require all attached utilities, including the water lines and sewer line to be relocated. As a result, this alternative is provided a rating of “D” for this evaluation factor. It should be noted that although this alternative has the same rating factor as Alternative 3, the utility relocations are not anticipated to be required to be completed prior to the start of construction of the replacement bridge.

4.4.2.8 – Bridge Hydraulics

This alternative provides improved hydraulic performance compared to the existing crossing, however it does not provide the SCDOT recommended 2-feet freeboard above the 10-year storm surge including wave height. This alternative is provided a rating of “C” for this evaluation factor.

4.4.2.9– Constructability

This alternative is anticipated to utilize standard construction practices and has the ability to utilize the top-down method of construction which will reduce environmental impacts. This alternative is provided a rating of “A” for this evaluation factor.

4.4.2.10 – Estimated Costs & Schedule

This alternative is anticipated to have an order of magnitude construction cost of $5,500,000 and a design cost of $400,000. Allowances of $250,000 and $200,000 have been included in the construction cost estimate for bridge aesthetic features and environmental permitting, respectively. The on-site construction work for this scenario is estimated to be 15 months. Full time construction observations and engineering support during construction is estimated to cost $450,000. The total cost for this alternative is estimated to be approximately $6,400,000.

It is estimated that the design and permitting phase of the project will have a duration of approximately 2 years due to the need for multiple permits. Based on the anticipated design, the community can select a contractor through any of the means previously discussed. In order to develop an estimated project schedule, this process has been assumed to be 6 months to 1 year. The actual construction duration and demolition of the existing bridge and portion of Causeway A is estimated to be 1 to 1.5 years.

4.5 – Alternative 5a – Bridge Replacement on New Alignment to Dataw Island

4.5.1 – Alternative Overview

In this alternative, a replacement bridge is built on a new alignment to the west of the existing bridge and Causeway A, and to the east of Causeway B allowing two lanes of traffic to be maintained on the existing bridge and causeways during construction. The new bridge spans from Polawana Island, over the west end of Bobb Island, and then to Dataw Island. The new bridge is designed to meet the SCDOT seismic design standards due to the existing causeways not being utilized as part of the final design configuration. Once the construction of the new crossing and all required utility relocations are complete, the existing bridge and causeways will be removed, and the marsh restored to its original condition.

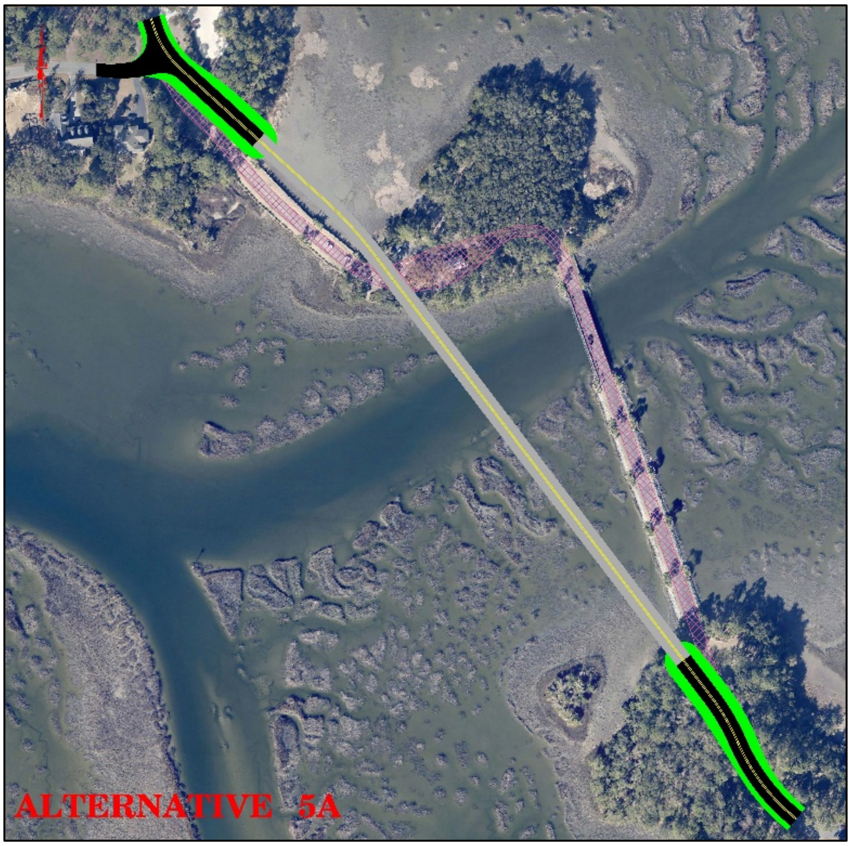

Figure 4-5: Alternative 5a Layout

In order to minimize new fill in the critical area and provide adequate area adjacent to the existing roadway to construct the bridge, a total bridge length of approximately 1,350' is anticipated. Due to the seismic design criteria of the bridge, oversized drilled shafts (shafts with a diameter at least 2-feet greater than the columns they support) are anticipated to be needed so that damage from an earthquake is limited to above grade locations. In order to minimize the number of large drilled shafts, and to reduce the overall cost of the bridge, the span lengths are anticipated to be longer than other alternatives. The bridge superstructure design is expected to utilize either large precast concrete box beams or prestressed concrete girders with a cast-in-place concrete deck due to the longer span lengths. The top-down method of construction is not anticipated to be the preferred construction method, and a temporary work trestle and/or a combination of barges and mats will be needed to construct the bridge.

In order to maintain traffic and limit impacts to access of the island, the bridge span that will be over the existing road on Bobb Island should be constructed last and only after all other work has been completed to the extents possible. Once this span is installed, access to the island is expected to be limited to vehicles with heights less than

11-feet until traffic is moved to the new bridge due to the reduced vertical clearance of the new bridge over the existing road on Bobb Island. This reduced vertical clearance should allow for ambulances and smaller fire trucks to maintain access to the island but may prevent access for larger fire trucks such as pumper trucks and ladder trucks temporarily. Coordination with local emergency officials related to the temporary vertical clearance should be conducted during the design phase in order to provide accommodations for local emergency vehicles to the extents possible. The duration of this limited access will depend on the bridge design and roadway design, as well as the construction sequence of the contractor but is estimated to be between 2 weeks and 3 months.

The existing roadway lane (11-feet) and shoulder (6-feet) widths will be maintained on the new bridge. The new roadway horizontal alignment is to be established utilizing standards for low-speed urban streets with a design speed of 20 mph or greater. The vertical alignment will require grades steeper than the existing in order to meet the bridge elevation requirements, but the grades and lengths of transitions associated with the changes in grade are anticipated to be within the standard roadway design criteria for local roads.

The bottom of caps of the new bridge are proposed to be at elevation 7.0-feet which is approximately 0.7-feet above the expected HAT elevation, including the year 2050 maximum expected sea level rise and the year 2100 minimum expected sea level rise. Utilization of minimum cap elevations at this height will result in a new bridge low chord elevation of approximately 11.0-feet and the top of bridge elevation at the beginning and end of bridge of approximately 15.0-feet. This is a minimum rise of approximately 8.0 feet above the existing bridge and causeways. The approximate proposed bridge low chord elevation is more than 2-feet above the existing 10-year storm surge plus wave height elevation and is an improvement compared to the existing bridge; however, it does provide a less than 2-feet freeboard when the predicted sea level rise is considered. It is still above the expected 10-year storm surge plus wave height elevation excluding the year 2100 maximum expected elevation.

The durability of the new bridge can be increased through the adoption of improved bridge design criteria and the utilization of corrosion resistant materials similar to those discussed in Alternative 3.

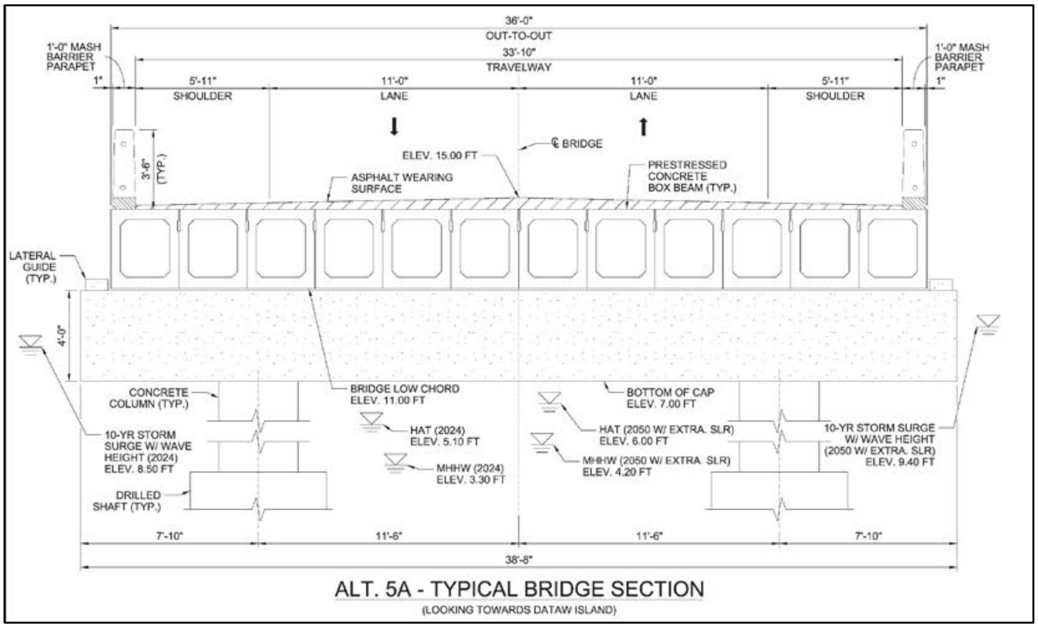

Figure 4-6: Alternative 5a Typical Bridge Section

The construction of the bridge is not anticipated to require the relocation of utilities within the existing causeways nor for the relocation of the guard house to be completed prior to the start of bridge construction. The existing below grade power line to the east of Causeway B will need to be relocated prior to construction. If the waterlines and sewer lines are also located within the area to the east of Causeway B, they will need to be relocated prior to construction. The utilities attached to the existing bridge can remain in service and relocations can be performed during or after the construction of the new bridge. It may also be possible to attach several of the utilities to the new bridge. If utilities are to be attached to the new bridge, this will need to be coordinated during the bridge design process so that the appropriate accommodations are made.

4.5.2 – Alternative Evaluation

An evaluation of this alternative for each factor being considered in the study is outlined in the following subsections.

4.5.2.1 – Purpose & Need

This alternative is anticipated to provide unrestricted access to the island for legal vehicles. This alternative is provided a rating of "C" for this evaluation factor.

4.5.2.2 – Resiliency & Safety

This alternative is anticipated to provide daily uninterrupted access to the island and provide immediate access to the island for emergency personnel after an earthquake or hurricane. As a result, this alternative is provided a rating of "B" for this evaluation factor. It should be noted that although immediate access to the island is expected by this crossing, there are most likely causeways and bridges at other locations within the county that will limit access to the island for emergency personnel after an earthquake or hurricane.

4.5.2.3 – Community Impacts

This alternative is anticipated to require multiple temporary interruptions of access to the island for residents and emergency personnel when the beams or girders of the span over the road on Bobb Island are installed. A reduced vertical clearance that may prevent some emergency services vehicles from accessing the island for a duration of a few weeks to months is also to be expected. This alternative is provided a rating of “D” for this evaluation factor.

4.5.2.4 – Environmental Impacts

This alternative is anticipated to have several temporary environmental impacts during construction with a relatively small amount permanent impacts in the form of new fill placed within the critical area at each end of the bridge. The existing causeways are proposed to be removed and the marsh restored to its previous condition, which should be viewed as a benefit to the permitting agencies and aid in obtaining the necessary permits. This alternative is provided a rating of “C” for this evaluation factor.

4.5.2.5 – Bridge Design

This alternative provides a new bridge with improved design requirements that increase the durability of the bridge compared to the minimum design requirements of bridges. This alternative is provided a rating of “B” for this evaluation factor.

4.5.2.6 – Roadway Design

This alternative maintains the roadway lane and shoulder widths along the bridge. This alternative is therefore a rating of “C” for this evaluation factor.

4.5.2.7 – Utility Impacts

This alternative replaces the existing bridge and will require all attached utilities, including the water lines and sewer line to be relocated. A portion of the existing utilities will be required to be relocated prior to the start of the bridge construction to the east of Causeway B. This alternative is provided a rating of “D” for this evaluation factor.

4.5.2.8 – Bridge Hydraulics

This alternative provides improved hydraulic performance compared to the existing crossing, provides the SCDOT recommended 2-feet freeboard above the 10-year storm surge including wave height, and takes into consideration predicted sea level rises. This alternative is provided a rating of “B” for this evaluation factor.

4.5.2.9 – Constructability

This alternative is anticipated to utilize standard construction practices. In order to construct the bridge within the critical area, a temporary work trestle and/or a combination of barges and mats will be needed. The construction sequence will also be further complicated by the installation of the new bridge span over the existing road on Bobb Island. This alternative is provided a rating of “C” for this evaluation factor.

4.5.2.10 – Estimated Costs & Schedule

This alternative is anticipated to have an order of magnitude construction cost of $19,500,000 and a design cost of $950,000. Allowances of $400,000 and $500,000 have been included in the construction cost estimate for bridge aesthetic features and environmental permitting, respectively. The on-site construction work for this scenario is estimated to be 24 months or less. Full time construction observations and engineering support during construction are estimated to cost $720,000. The total cost for this alternative is estimated to be approximately $21,000,000.

It is estimated that the design and permitting phase of the project will have a duration of approximately 2years due to the need for multiple permits. Based on the anticipated design, the community can select a contractor through any of the means previously discussed. In order to develop an estimated project schedule, this process has been assumed to be 6 months to 1 year. The actual construction duration and demolition of existing bridge and Causeway A is estimated to be 1.5 to 2.5 years.

4.6 – Alternative 5b – Bridge Replacement on New Alignment to Bobb Island

4.6.1 – Alternative Overview

In this alternative, a replacement bridge is built on a new alignment to the west of the existing bridge and Causeway A, allowing two lanes of traffic to be maintained on the existing bridge and causeways during construction. The new bridge spans from Polawana Island to the west end of Bobb Island and utilizes the existing Causeway B to access Dataw Island from Bobb Island. The existing Causeway B is anticipated to be inundated by flood waters from tropical storms and hurricanes with return periods of less than 10-years. The new bridge is not to be designed to meet the SCDOT seismic design standards due to the utilization of the existing Causeway B as part of the final design configuration. Access to the island is expected to be impaired after an earthquake due to possible damage to the bridge and liquefaction of the soils beneath the causeways. During an earthquake, the soils below Causeway B are anticipated to liquefy causing the causeway to settle. The amount of settlement is unknown without a detailed analysis of the causeway and will be dependent upon the size of the potential earthquake. Once construction of the new crossing and all required utility relocations is complete, the existing bridge and Causeway A will be removed and the marsh in that area restored to its original condition.

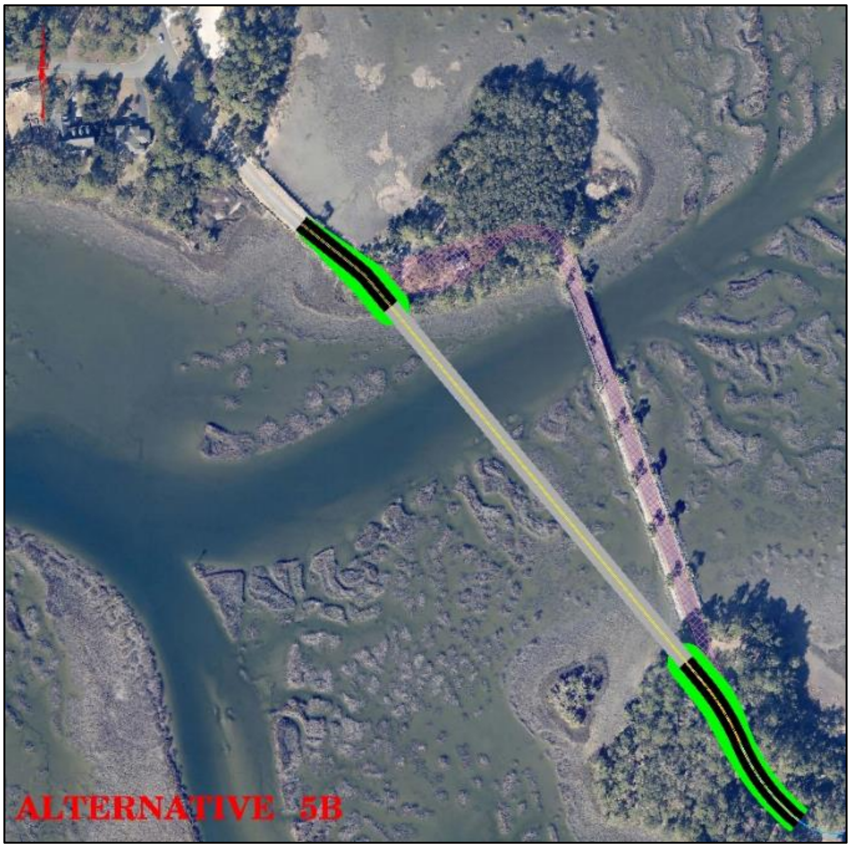

Figure 4-7: Alternative 5b Layout

In order to minimize new fill in the critical area and provide adequate area adjacent to the existing roadway to construct the bridge, a total bridge length of approximately 900' is anticipated. A bridge superstructure design that utilizes either precast concrete cored slabs/ box beams or cast-in-place concrete flat slabs should allow the bridge to be constructed utilizing the top-down construction method to aid in minimizing environmental impacts. The superstructure is anticipated to be supported by cast-in-place concrete caps with prestressed concrete piles driven into the marsh. Because the bridge is not designed to meet the SCDOT seismic design standards, the use of prestressed concrete piles is anticipated to meet the bridge design criteria. It may also be possible to utilize a precast concrete cap in lieu of the cast-in-place concrete cap. Utilization of precast concrete caps is not common in South Carolina because most bridges are designed per SCDOT standards which prohibit precast concrete caps; however, precast concrete caps are utilized in other areas of the country and should reduce the bridge construction duration.

The existing roadway lane (11-feet) and shoulder (6-feet) widths will be maintained on the new bridge. The new roadway horizontal alignment is to be established utilizing standards for low-speed urban streets with a design speed of 20 mph or greater. The vertical alignment will require grades steeper than the existing in order to meet the bridge elevation requirements, but the grades and lengths of transition associated with the changes in grade are anticipated to be within the standard roadway design criteria for local roads. Additionally, it may be possible to raise the roadway surface on the existing Causeway B approximately 2-feet to reduce the likelihood of inundation by flood waters from tropical storms and hurricanes without the need for additional environmental impacts. This will need to be further investigated during design to verify that the existing sheet pile walls have adequate capacity for the increased load, and that settlement of the causeway from the additional fill is within acceptable limits.

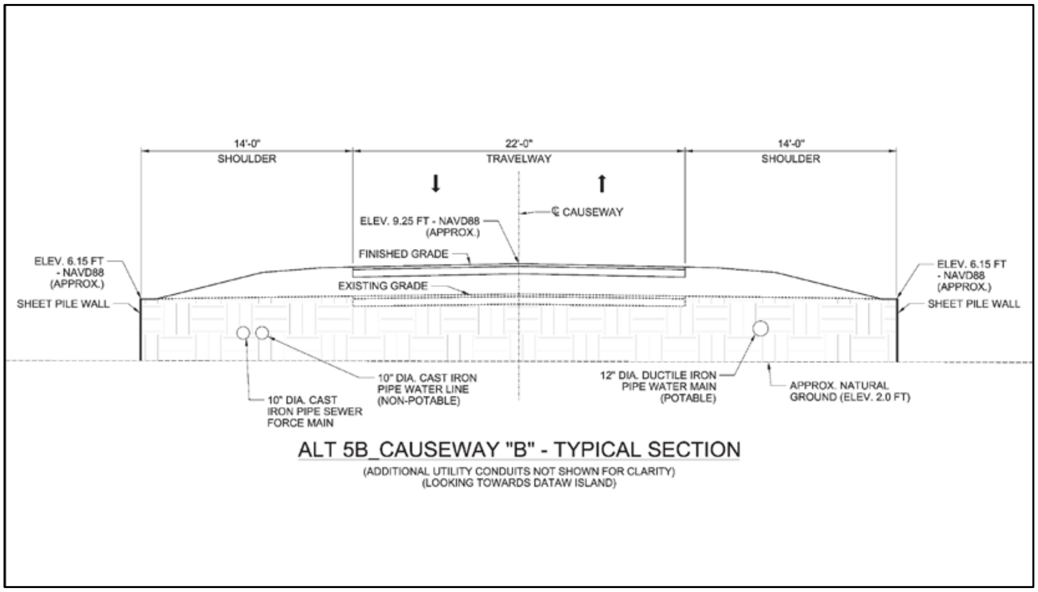

Figure 4-8: Alternative 5b Causeway B Typical Section

The bottom of caps of the new bridge are proposed to be at elevation 7.0-feet which is approximately 0.7-feet above the expected HAT elevation including the year 2050 maximum expected sea level rise and the year 2100 minimum expected sea level rise. Utilization of minimum cap elevations at this height will result in a new bridge low chord elevation of approximately 10.5-feet and the top of bridge elevation at the beginning and end of bridge approximately 13.0-feet. This is a rise of approximately 6.0 feet above the existing bridge and causeways. The proposed bridge low chord elevation is above the 10-year storm surge plus wave height elevation and is an improvement compared to the existing bridge; however, it does not provide the SCDOT recommended 2-feet additional freeboard for the existing sea levels or when the predicted sea level rise is considered.

The durability of the new bridge can be increased through the adoption of improved bridge design criteria and the utilization of corrosion resistant materials similar to those discussed in Alternative 3.

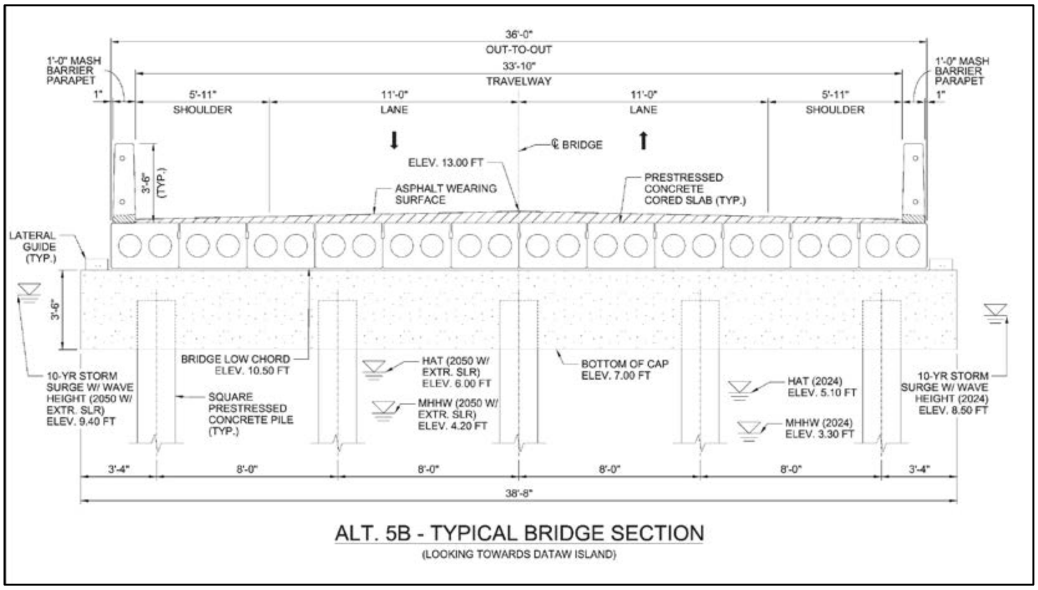

Figure 4-9: Alternative 5b Typical Bridge Section

The construction of the bridge is not anticipated to require the relocation of utilities within the existing causeways, nor relocation of the guardhouse to be completed prior to the start of bridge construction. The utilities attached to the existing bridge can remain in service and relocations be performed during or after the construction of the new bridge. This should reduce the overall project duration. It may also be possible to attach several of the utilities to the new bridge. If utilities are to be attached to the new bridge, this will need to be coordinated during the bridge design process so that the appropriate accommodations are made.

4.6.2 – Alternative Evaluation

An evaluation of this alternative for each factor being considered in the study is outlined in the following subsections.

4.6.2.1 – Purpose & Need

This alternative is anticipated to provide unrestricted access to the island for legal vehicles. This alternative is provided a rating of "C" for this evaluation factor. An additional benefit of this alternative compared to alternative 5a is that it maintains access to Bobb Island.

4.6.2.2 – Resiliency & Safety

This alternative is anticipated to provide daily uninterrupted access to the island for residents and emergency personnel, however access may be limited after an earthquake due to the bridge not being design to SCDOT seismic standards and utilization of the existing Causeway B in the final design configuration. This alternative is provided a rating of "C" for this evaluation factor.

4.6.2.3 – Community Impacts

This alternative is anticipated to require prolonged lane closures that may utilize temporary signals to control traffic in order tie the new roadway alignment into the existing. This alternative is provided a rating of “C” for this evaluation factor.

4.6.2.4 – Environmental Impacts

This alternative is anticipated to have minor environmental impacts with a relatively small amount of new fill placed within the critical area. The existing Causeway A is also proposed to be removed and the marsh restored to its previous condition. This alternative is provided a rating of “B” for this evaluation factor.

4.6.2.5 – Bridge Design

This alternative provides a new bridge with improved design requirements that increase the durability of the bridge compared to the minimum design requirements of bridges. This alternative is provided a rating of “B” for this evaluation factor.

4.6.2.6 – Roadway Design

This alternative maintains the roadway lane and shoulder widths along the bridge and provides an alignment that reduces the amount of small radius curves for an improved alignment. It is also possible that the elevation of Causeway B can be raised approximately 2-feet and reduce the likelihood of inundation by flood waters from tropical storms and hurricanes. This alternative is provided a rating of “A” for this evaluation factor.

4.6.2.7 – Utility Impacts

This alternative replaces the existing bridge and will require all utilities attached to it including the water lines and sewer line to be relocated. This alternative is provided a rating of “D” for this evaluation factor. It should be noted that although this alternative has the same rating factor as Alternative 3, the utility relocations are not anticipated to be required to be completed prior to the start of construction on the new bridge.

4.6.2.8 – Bridge Hydraulics

This alternative provides improved hydraulic performance compared to the existing crossing; however, it does not provide the SCDOT recommended 2-feet freeboard above the 10-year storm surge including wave height. As a result, this alternative is provided a rating of “C” for this evaluation factor.

4.6.2.9 – Constructability

This alternative is anticipated to utilize standard construction practices and has the ability to utilize the top-down method of construction which will reduce environmental impacts. This alternative is provided a rating of “A” for this evaluation factor.

4.6.2.10 – Estimated Costs & Schedule

This alternative is anticipated to have an order of magnitude construction cost of $10,500,000 and a design cost of $530,000. Allowances of $300,000 and $350,000 have been included in the construction cost estimate for bridge aesthetic features and environmental permitting, respectively. The on-site construction work for this scenario is estimated to be 16 months or less. Full time construction observation and engineering support during construction are estimated to cost $480,000. The total cost for this alternative is estimated to be approximately $11,500,000.

It is estimated that the design and permitting phase of the project will have a duration of approximately 2 years due to the need for multiple permits. Based on the anticipated design, the community can select a contractor through any of the means previously discussed. In order to develop an estimated project schedule, this process has been assumed to take 6 months to 1 year. The actual construction duration and demolition of the existing bridge and Causeway A is estimated to be 1 to 1.5 years.

5.0 – Alternative Comparisons

5.1.1 – Purpose & Need

Based on the evaluation of each alternative as summarized in Table 5-1, it has been shown that most alternatives exceed the minimum purpose and need of the community and provide unrestricted vehicular access to the island.

Table 5-1: Purpose & Need Evaluation Summary

Alternative	Rating
1 – No Build	F
2 – Rehabilitation of Existing Bridge	D
3 – Replace Existing Bridge	C
4 – New Bridge Adjacent	C
5a – New Bridge to Dataw Island Non-Parallel	C
5b – New Bridge to Bobb Island non-Parallel	C

Alternative 1 (No Build) is provided a rating of "F" and does not meet the minimum purpose and need of the community. Alternative 2 (Rehabilitation of Existing Bridge) is provided a rating of "D" and meets the minimum purpose and need of the community.

5.1.2 – Resiliency & Safety

Based on the evaluation of each alternative as summarized in Table 5-2, it has been shown that most alternatives exceed the minimum resiliency and safety needs of the community and are expected to provide immediate access to the island after a hurricane and limited access after an earthquake for emergency personnel.

Table 5-2: Resiliency & Safety Evaluation Summary

Alternative	Rating
1 – No Build	F
2 – Rehabilitation of Existing Bridge	D
3 – Replace Existing Bridge	C
4 – New Bridge Adjacent	C
5a – New Bridge to Dataw Island Non-Parallel	B
5b – New Bridge to Bobb Island non-Parallel	C

Alternative 1 (No Build) is provided a rating of "F" and does not meet the minimum purpose and need of the community. Alternative 2 (Rehabilitation of Existing Bridge) is provided a rating of "D" and meets the minimum purpose and need of the community, but access after an earthquake or hurricane may be impaired. Alternative 5a (New Bridge to Dataw Island) is provided the highest rating of "B" for any alternative because the new bridge is designed to provide immediate access to the island after an earthquake unlike any other alternative.

5.1.3 – Community Impacts

Based on the evaluation of each alternative as summarized in Table 5-3, it has been shown that all alternatives meet or have less than the minimum acceptable community impacts.

Table 5-3: Community Impacts Evaluation Summary

Alternative	Rating
1 – No Build	A
2 – Rehabilitation of Existing Bridge	C
3 – Replace Existing Bridge	D
4 – New Bridge Adjacent	C
5a – New Bridge to Dataw Island Non-Parallel	D
5b – New Bridge to Bobb Island Non-Parallel	C

Alternative 1 (No Build) is provided the highest rating of "A" for any alternative because there are no construction activities associated that impact the community. Alternative 3 (Replace Existing Bridge) requires the use of temporary bridge, and Alternative 5a (New Bridge to Dataw Island) requires temporary interruptions to access of the island and a duration of limited vertical clearance. Those alternatives have therefore been provided a rating of "D". The remaining Alternatives are anticipated to impact the community during construction; however, the impacts are anticipated to be limited to lane closures only.

5.1.4 – Environmental Impacts

Based on the evaluation of each alternative as summarized in Table 5-4, it has been shown that all alternatives meet or have less than the minimum acceptable environmental impacts.

Table 5-4: Environmental Impacts Evaluation Summary

Alternative	Rating
1 – No Build	A
2 – Rehabilitation of Existing Bridge	A
3 – Replace Existing Bridge	D
4 – New Bridge Adjacent	B
5a – New Bridge to Dataw Island Non-Parallel	C
5b – New Bridge to Bobb Island non-Parallel	B

Alternative 1 (No Build) and Alternative 2 (Rehabilitation of Existing Bridge) are provided the highest rating of "A" because they are not anticipated to have any environmental impacts or require any environmental permits. Alternative 3 (Replace Existing Bridge) is anticipated to have the most environmental impacts that consist of both temporary and permanent impacts. These are due to its utilization of a temporary bridge and raising the low chord of the bridge to improve its durability and hydraulic performance. This alternative has been provided a rating of "D". Alternative 5a (New Bridge to Dataw Island) has been provided a rating of "C" and is anticipated to require a temporary work trestle and/or a combination of barges and mats during construction. The existing causeways are planned to be removed however, and this will aid in offsetting the environmental impacts. Alternative 4 (New Bridge Adjacent) and Alternative 5b (New Bridge to Bobb Island) are provided a rating of "C" and are anticipated to be able

to utilize the top-down construction method and minimize environmental impacts. The existing Causeway A will be either partially or completely removed.

5.1.5 – Bridge Design

Based on the evaluation of each alternative as summarized in Table 5-5, it has been shown that most alternatives exceed the minimum bridge design needs of the community.

Table 5-5: Bridge Design Evaluation Summary

Alternative	Rating
1 – No Build	F
2 – Rehabilitation of Existing Bridge	D
3 – Replace Existing Bridge	B
4 – New Bridge Adjacent	B
5a – New Bridge to Dataw Island Non-Parallel	B
5b – New Bridge to Bobb Island non-Parallel	B

Alternative 1 (no-build) is provided a rating of “F” and does not meet the minimum bridge design needs of the community. Alternative 2 (Rehabilitation of Existing Bridge) is provided a rating of "D” and meets the minimum bridge design needs of the community. The remaining alternatives have been provided a rating of “B” because they provide a new bridge that is design to current minimum standards and have the ability to incorporate improved bridge design requirements that will improve the durability or increase the anticipated service life of the bridge.

5.1.6 – Roadway Design

Based on the evaluation of each alternative as summarized in Table 5-6, it has been shown that all alternatives meet or exceed the minimum roadway design needs of the community.

Table 5-6: Roadway Design Evaluation Summary

Alternative	Rating
1 – No Build	D
2 – Rehabilitation of Existing Bridge	D
3 – Replace Existing Bridge	C
4 – New Bridge Adjacent	B
5a – New Bridge to Dataw Island Non-Parallel	C
5b – New Bridge to Bobb Island non-Parallel	A

Alternative 1 (No Build) and Alternative 2 (Rehabilitation of Existing Bridge) are provided a rating of “D” because they maintain the existing roadway cross section and alignment. Alternative 3 (Replace Existing Bridge) and Alternative 5a (New Bridge to Dataw Island Non-Parallel) have been provided a rating of “C” because they maintain the roadway cross section (lane and shoulder widths) across the new bridge. Alternative 4 (New Bridge Adjacent) has been provided a rating of “B” because it maintains the roadway cross section (lane and shoulder widths) across the new bridge and reduces the amount of small radius curves for an improved alignment. Alternative 5b (New Bridge to Bobb Island Non-Parallel) has been provided a rating of “A” because it maintains the roadway cross

section (lane and shoulder widths) across the new bridge, reduces the amount of small radius curves for an improved alignment, and provides the opportunity to raise the elevation of Causeway B without additional environmental impacts, reducing the likelihood that it is inundated by flood waters from tropical storms and hurricanes.

5.1.7 – Utility Impacts

Based on the evaluation of each alternative as summarized in Table 5-7, it has been shown that all alternatives meet or have less than the minimum acceptable utility impacts.

Table 5-7: Utility Impacts Evaluation Summary

Alternative	Rating
1 – No Build	A
2 – Rehabilitation of Existing Bridge	A
3 – Replace Existing Bridge	D
4 – New Bridge Adjacent	D
5a – New Bridge to Dataw Island Non-Parallel	D
5b – New Bridge to Bobb Island non-Parallel	D

Alternative 1 (No Build) and Alternative 2 (Rehabilitation of Existing Bridge) are provided the highest rating of “A” because they are not anticipated to have any utility impacts. The remaining alternatives are provided a rating of “D” because they replace the existing bridge and will require relocation of all attached utilities. Alternative 3 (Replace Existing Bridge) will require the relocation of all utilities prior to the start of construction of the new bridge, while the other alternatives only require the relocation of the utilities after the construction of the new bridge is complete and prior to the demolition of the existing bridge.

5.1.8 – Bridge Hydraulics

Based on the evaluation of each alternative as summarized in Table 5-8, it has been shown that all alternatives meet or exceed than the minimum bridge hydraulic design needs of the community.

Table 5-8: Bridge Hydraulics Evaluation Summary

Alternative	Rating
1 – No Build	D
2 – Rehabilitation of Existing Bridge	D
3 – Replace Existing Bridge	C
4 – New Bridge Adjacent	C
5a – New Bridge to Dataw Island Non-Parallel	B
5b – New Bridge to Bobb Island non-Parallel	C

Alternative 1 (No Build) and Alternative 2 (Rehabilitation of Existing Bridge) are provided a rating of “D” because they maintain the existing bridge and its hydraulic constraints (bridge length and low chord elevation). Alternative 5a (new bridge to Dataw Island) is provided the highest rating of “B” for any alternative because the new bridge is designed to provide the SCDOT recommended 2-feet freeboard above the 10-year storm surge including wave

height and takes into consideration predicted sea level rises. The remaining alternatives are provided a rating "C" because they provided improved hydraulic performance compared to the existing bridge by providing a longer bridge length and a higher low chord elevation.

5.1.9 – Constructability

Based on the evaluation of each alternative as summarized in Table 5-9, it has been shown that all alternatives meet or exceed than the minimum constructability needs of the community.

Table 5-9: Constructability Evaluation Summary

Alternative	Rating
1 – No Build	n/a
2 – Rehabilitation of Existing Bridge	D
3 – Replace Existing Bridge	C
4 – New Bridge Adjacent	A
5a – New Bridge to Dataw Island Non-Parallel	C
5b – New Bridge to Bobb Island non-Parallel	A

Alternative 1 (no-build) is not provided a rating because there is no construction associated with that alternative. Alternative 2 (Rehabilitation of Existing Bridge) is provided a rating of "D" because the Rehabilitation work will need to be performed by a specialized contractor and access to perform the Rehabilitation work will be difficult. Alternative 4 (New Bridge Adjacent) and Alternative 5b (New Bridge to Bobb Island) have been provided a rating of "A" because they are anticipated to be able to utilize the top-down construction method, which should simplify the construction and minimize environmental impacts. Alternative 3 (Replace Existing Bridge) requires the use of a temporary bridge and Alternative 5a (new bridge to Dataw Island) requires the use of a temporary work trestle and/or a combination of barges and mats during construction. These alternatives have therefore been provided a rating of "C".

5.1.10 – Estimated Costs & Schedule

The estimated cost and durations of each alternative is summarized in Table 5-10.

Table 5-10: Estimated Cost & Schedule Evaluation Summary

Alternative	Estimated Cost (millions of $)	Estimated Design, Permitting, & Procurement Duration	Estimated Construction Duration
1 – No Build	$0	n/a	n/a
2 – Rehabilitation of Existing Bridge	$1.5-$3.5	1 year	1 year
3 – Replace Existing Bridge	$6.7	2-3 years	1-2 years
4 – New Bridge Adjacent	$6.4	2-3 years	1-1.5 years
5a – New Bridge to Dataw Island Non-Parallel	$21	2-3 years	1.5-2.5 years
5b – New Bridge to Bobb Island non-Parallel	$11.5	2-3 years	1-1.5 years

The estimated cost of each alternative that utilizes a new bridge is largely based on the ability of the alternative to utilize the existing causeways and the alternative's proposed bridge length. Although Alternative 3 (Replace Existing

Bridge) is expected to have the shortest replacement bridge and utilize the existing causeways the most, it does not have the lowest estimated cost due to the need for a temporary detour bridge. These typically have a high cost and is often almost equivalent in cost to a permanent bridge. Alternative 5a has a significantly higher cost than other alternatives due to the bridge length and the bridge being design per the SCDOT seismic design standards. The estimated cost to rehabilitate the existing bridge is the only alternative provided with a range of costs. The range is provided due to multiple Rehabilitation options, as well as a large degree of uncertainty related to the Rehabilitation scope and costs.

In order to provide an improved perspective of value of the cost for each alternative, the estimated cost of the alternative can be divided by the estimated service life of the alternative. Alternative 2 (Rehabilitation of Existing Bridge) is estimated to extend the service life of the bridge 5-15 years, while the alternatives that provide a new bridge (Alternatives 3, 4, 5a, & 5b) are estimated to provide a bridge with a service life of 75 years or more, depending on if improved bridge design requirements are implemented. Table 5-11 provides the estimated cost to service life ratio for each alternative. For Alternative 2 (Rehabilitation of Existing Bridge) the average of the cost and service life ranges are utilized when developing the cost to service life ratio.

Table 5-11: Alternative Cost to Service Life Ratio

Alternative	Cost to Service Life Ratio
1 – No Build	n/a
2 – Rehabilitation of Existing Bridge	$250,000/yr.
3 – Replace Existing Bridge	$89,000/yr.
4 – New Bridge Adjacent	$85,000/yr.
5a – New Bridge to Dataw Island Non-Parallel	$280,000/yr.
5b – New Bridge to Bobb Island non-Parallel	$153,000/yr.

The estimated design and permitting durations for the design of a new bridge (Alternatives 3, 4, 5a, & 5b) are consistent for all alternatives and are expected to be between 2 and 3 years. The design duration for rehabilitations to the existing bridge is anticipated to be 1 year due to the lack of anticipated need for environmental permitting and limited scope of work. The construction duration of each alternative has more variation and is largely dependent upon the need for a temporary detour bridge and the length of bridge.

5.1.11 – Overall Summary & Comparison

In order to aid in determining how each alternative compares to the others, an Evaluation Factor Score has been developed. The Evaluation Factor Score for each alternative has been developed by assigning a numerical value to each rating within the rating scale as shown in Table 5-12, then totaling the values for each alternative. A value has not been provided for the “F” rating because if an alternative has a rating of “F” for any factor, it is deemed to be fundamentally flawed and is not recommended to be considered as a reasonable alternative.

Table 5-12: Evaluation Factor Rating Score

Rating	Value
A	5
B	3
C	1
D	0
F	n/a

A summary of the evaluation of all alternatives, along with their associated Evaluation Factor Score is provided in Table 5-13.

Table 5-13: Evaluation Summary

Evaluation Factor	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5a	Alt. 5b
Purpose & Need	F	D	C	C	C	C
Resiliency & Safety	F	D	C	C	B	C
Community Impacts	A	C	D	C	D	C
Environmental Impacts	A	A	D	B	C	B
Bridge Design	F	D	B	B	B	B
Roadway Design	D	D	C	B	C	A
Utility Impacts	A	A	D	D	D	D
Bridge Hydraulics	D	D	C	C	B	C
Constructability	n/a	D	C	A	C	A
Evaluation Factor Score	**n/a**	**11**	**8**	**18**	**13**	**20**
Estimated Costs (millions of $)	**$0**	**$1.5-$3.5**	**$6.7**	**$6.4**	**$21**	**$11.5**
Estimated Design & Construction Duration	n/a	2-3 years	4.5-5.5 years	3.5-4.5 years	4-5.5 years	3.5-4.5 years
Estimated Service Life	2-10 years	5-15 years	+75 years	+75 years	+75 years	+75 years
Cost to Service Life Ratio ($/year)	**n/a**	**$250,000/yr.**	**$89,000/yr.**	**$85,000/yr.**	**$280,000/yr.**	**$153,000/yr.**

There are multiple methods of determining the preferred alternative, such as the lowest estimated cost, the lowest cost to service life ratio, the highest Evaluation Factor Score, or a combination of each. The alternative with the lowest estimated cost that is not considered fundamentally flawed is Alternative 2 (Rehabilitation of Existing Bridge); however, it does not have the lowest cost to service life ratio or the highest Evaluation Factor Score. Alternative 4 (New Bridge Adjacent) has the lowest cost to service life ratio, closely followed by Alternative 3 (Replace Existing Bridge). Alternative 5b (New Bridge to Bobb Island) has the highest Evaluation Factor Score, closely followed by Alternative 4 (New Bridge Adjacent).

If a combination of methods is used to determine the preferred alternative, a weighted criteria score can be utilized with the highest score being the preferred alternative. The weighted criteria score outlined in Table 5-14 has been utilized in determining the preferred alternative that uses a combination of criteria. The weighted criteria score points can be adjusted based on the preference of the community.

Table 5-14: Weight Criteria Score Points

Criteria	Weighted Score Points
Evaluation Factor Score	40
Estimated Cost	25
Cost to Service Life Ratio	35

In order to determine the weighted criteria scores the following equations were utilized:

Equation 5-1: Weighted Evaluation Factor Score

$$Weighted\ Evaluation\ Factor\ Score = \frac{Alternative\ Evaluation\ Factor\ Score}{Maximum\ Evaluation\ Factor\ Score} \times Weighted\ Score\ Points$$

Equation 5-2: Weighted Estimated Cost Score

$$Weighted\ Estimated\ Cost\ Score = \frac{Minimum\ Estimated\ Cost}{Alternative\ Estimated\ Cost} \times Weighted\ Score\ Points$$

Equation 5-3: Weighted Cost to Service Life Ratio Score

$$Weighted\ Cost\ to\ Service\ Life\ Score = \frac{Minimum\ Cost\ to\ Service\ Life}{Alternative\ Cost\ to\ Service\ Life} \times Weighted\ Score\ Points$$

The scores for each alternative were determined as shown in Table 5-15 by applying the weighted criteria method as outlined. The alternative with the highest weighted criteria score is Alternative 4 (New Bridge Adjacent).

Table 5-15: Weighted Criteria Scores

Evaluation Factor	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5a	Alt. 5b
Evaluation Factor Score	n/a	11	8	18	13	20
Weighted Evaluation Score	n/a	22.0	16.0	36.0	26.0	40.0
Estimated Costs (millions of $)	$0	$2.5	$6.7	$6.4	$21	$11.5
Weighted Estimated Cost Score	n/a	25.0	9.3	9.8	3.0	5.4
Cost to Service Life Ratio ($/year)	n/a	$250,000/yr.	$89,000/yr.	$85,000/yr.	$280,000/yr.	$153,000/yr.
Weighted Cost to Service Life Score	n/a	11.9	33.4	35.0	10.7	19.5
Total Weighted Criteria Score	**n/a**	**58.9**	**58.8**	**80.8**	**39.6**	**64.9**

6.0 - Recommendations

It has been determined through the detailed review of Alternative 1, in which the existing bridge is maintained in its existing condition, that the alternative is fundamentally flawed and is not recommended to be considered as a reasonable alternative. This alternative does not meet the purpose and needs of the community, is not anticipated to provide daily uninterrupted access to the island for residents and emergency personnel, and has current bridge conditions that do not meet the minimum needs of the community. Although the existing bridge is currently not posted for load restrictions and the load rating analysis performed by others concluded that a load restriction was not warranted at this time, the rating factor of one of the emergency vehicles analyzed in the load rating was only 1% above the minimum rating factor limit for recommending load restriction considering the observed bridge corrosion and deterioration. Due to the severe and expanding corrosion and the load rating analysis of the bridge, rehabilitation or replacement of the bridge, which serves as the only vehicular access point for the island is recommended to be a high priority for the community.

Based on the detailed review of each alternative that has considered multiple evaluation criteria, such as community impacts, environmental impacts, utility impacts, bridge and roadway design criteria, existing and predicted sea levels, estimated timelines, and estimated costs, the alternative that appears to be the best value for the community is Alternative 4. In this alternative, the existing bridge is replaced with a new bridge on an alignment to the west of the existing bridge and Causeway A. This alternative has the highest weighted criteria score as shown in Table 5-15 with a score of 80.8 out of 100, with the next highest score being 64.9 for Alternative 5b. Alternative 4 also has the lowest cost to service life ratio, meaning that the cost of the alternative has the most long term return on investment for the community. Alternative 4 is not the least expensive alternative when compared to rehabilitation of the existing bridge; however, it is the least expensive alternative that provides a new bridge. Alternative 4 has the second highest Evaluation Factor Score of 18 and is only 2 points below the highest score of 20 for Alternative 5b. Alternative 5b has an estimated cost of almost twice that of Alternative 4. It is recommended that the community consider moving forward with the design of Alternative 4 immediately so that the risks posed by the existing bridge are mitigated as soon as possible.

In order to provide improved durability of the replacement bridge and increase its anticipated service life, it is recommended that the community utilize improved bridge design criteria to reduce the risk of corrosion. In order to reduce the risk of corrosion, it is recommended that additional concrete cover be provided over reinforcing steel, the service tensile stress in prestressed concrete members be limited to zero, the utilization of galvanized reinforcing steel and prestressing stands be considered, and that a permeability reducing admixture be utilized in concrete mix designs.

It is also recommended that the community consider incorporating the additional resilience and safety benefits, as well as the roadway design benefits of Alternative 5b by raising the causeways approximately 2-feet above their existing elevations. This rise in causeway elevation is not anticipated to have additional environmental impacts at Causeway B and is anticipated to require a relatively small amount of additional environmental impacts at Causeway A by widening the causeway approximately 4-feet on each side for a total increase of 8-feet. By raising the causeways, the likelihood of the causeways being inundated by flood waters from tropical storms and hurricanes is reduced because their elevations would be above the existing 10-year storm surge plus wave height elevation and approximately equal to that elevation when considering the year 2050 minimum expected sea level rise.