Ocean Drive (CR 621) Upgrades & Bridge Improvements
Local Concept Development Study
Township of Lower, Cape May County, New Jersey

Final Concept Development Report

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Table of Contents

Appendices

A. Bridge Reports
B. As-Built Plans and Straight Line Diagrams
C. Traffic Counts and Analysis
D. Public Involvement Action Plan, Stakeholders List and Survey Summary
E. Purpose and Need Statement
F. Tax Maps
G. Conceptual Geotechnical Report
H. Complete Streets Checklist
I. ADA Checklists
J. Drainage and Stormwater Management Existing Conditions Memorandum
K. Hydrodynamic Study Report
L. Utility Letters and Utility Risk Assessment Plan
M. Background Growth Rate Memorandum
N. USCG PNCD Letter and Navigation Impact Report
O. Crash Data and Crash Analysis
P. Environmental Screening and Environmental Constraints Map
Q. Public Outreach Communications
R. Resolution of Support
S. Community Profile
T. Conceptual Plans
U. Cost Estimates
V. Alternatives Matrix
W. Risk Register
X. Preliminary Engineering Scope Statement
Y. Design Communications Report (DCR)
Z. Area of Potential Effects Letter
AA. Modified Bridge Rehabilitation Alternative – In Compliance with SOI Standards Memorandum
BB. Value Engineering Report
CC. IRC Approval to Advance to Local Preliminary Engineering Letter

The appendices are not included within this document. If you are interested in obtaining one or more of the above appendices, please contact SJTPO at info@sjtpo.org.

I. INTRODUCTION

The Ocean Drive (County Road 621) causeway has linked the communities of Cape May and the Wildwoods (the Cities of Wildwood and North Wildwood, Wildwood Crest and West Wildwood Boroughs, and Diamond Beach, Lower Township) since 1939. This route provides a critical link and coastal evacuation route that connects NJ Route 109 and access to the mainland and Garden State Parkway with the barrier island containing the Wildwoods, a popular summer attraction and economic center. This length of roadway includes three bridges over Mill Creek (300' long concrete T-beam bridge), Upper Thorofare (350' long concrete T-beam bridge), and Middle Thorofare (1,039' long that includes a movable bascule span). The Middle Thorofare Bridge serves as the 'southern gateway' to the Intracoastal Waterway in NJ.

Currently, portions of Ocean Drive are below the 100-year flood zone elevation, and prone to occasional flooding. As it exists today, the roadway could become impassible in a hurricane or significant storm event. This presents a major concern as Ocean Drive is a designated emergency coastal evacuation route for the southern end of the Wildwoods. Ocean Drive is also an important linkage which provides access to the commercial fishing facilities on the mainland side, one of which is considered to be the third largest fishing seafood processing facility on the entire eastern seaboard.

The Mill Creek and Upper Thorofare bridges are currently deemed functionally obsolete due to their narrow widths and have low sufficiency ratings. The Upper Thorofare Bridge is also currently listed as structurally deficient due to the substructure being listed in poor condition. The Middle Thorofare Bridge is deemed functionally obsolete due to its narrow width and structurally deficient due to its inability to carry loads greater than 15 tons, prohibiting bus and truck traffic.

Additionally, the width of the bascule bridge opening is 50', limiting larger vessels from entering the Intracoastal Waterway. These deficiencies restrict the growth of the nearby commercial fishing industry due to vehicle and vessel size restrictions. The narrow bridge opening has also contributed to on average three to four large vessels per year colliding with the bridge as they attempt to navigate the channel. The collisions have resulted in the bridge being closed for costly and inconvenient emergency repairs.

Since the Middle Thorofare Bridge is movable, it experiences 20 to 40 openings per day for the passage of maritime traffic including Cape May's commercial fishing fleet. These openings, which last about 10 minutes each, cause between 200 and 400 minutes of roadway closures each day, causing significant negative impacts to the capacity of this critical travel link.

Ocean Drive traverses through an environmentally sensitive area consisting largely of tidal waterways, coastal wetlands, public lands, and habitat for numerous state and federally listed species and is also considered a major migratory bird pathway. Additionally, numerous cultural resources are also present in the study area. The NJ State Historic Preservation Office (SHPO) has identified the Middle Thorofare Bridge as eligible for listing on the National Register of Historic Places.

This report documents the results of the Local Concept Development (CD) Study for the upgrade and improvements to Ocean Drive Causeway (CR 621) as well as three deficient bridges along the 2.7-mile corridor between NJ Route 109 and Madison Avenue from Milepost (MP) 0.00 to MP 2.75 (northbound and southbound).

A. Foreword

The project consists of two Cape May County-owned bridges and one Cape May County Bridge Commission-owned bridge located on Ocean Drive (CR 621). The bridges on the causeway are Mill Creek, Upper Thorofare and Middle Thorofare. The limits of this CD Study include Ocean Drive

from NJ 109 to Madison Avenue. The southern terminus of the study limits is located at the signalized intersection of NJ 109 and Ocean Drive (MP 0.00) in the Township of Lower. The northern terminus of the study limits is located at the intersection of Ocean Drive and Madison Avenue (MP 2.75) in the Township of Lower. Mill Creek Bridge is located at approximately MP 0.80, Upper Thorofare Bridge at MP 1.30, and Middle Thoroughfare Bridge at MP 1.70. A project location map is shown in **Figure 1**.

Figure 1: Project location map

Based on the 17th Cycle Bridge Re-evaluation Survey Report (bridge inspection report), dated August 2016, the overall condition of the Mill Creek Bridge is Fair (National Bridge Inspection Standards rating of 5). The structure is functionally obsolete due to the narrow deck roadway width. The superstructure (including deck slab and beams) is in fair condition. The deck is in fair condition due to the light to moderate scaling throughout all spans with several spans also exhibiting shallow spalling on both the top and underside, and cracking with asphalt patches on the top of the deck. The substructure is in fair condition. There is undermining along both abutments, and severe scaling and deteriorated repair jackets at piers 5, 8 and 9 from the south. The Load Factor Inventory Rating is 24 tons and the Operating Rating is 40 tons for the HS-20 Truck and is therefore deficient.

Based on the 17th Cycle bridge inspection report, dated August 2016, the overall condition of the Upper Thorofare Bridge is Poor. The structure is deemed to be functionally obsolete due to the narrow deck width. The superstructure (deck slab and beams) is in fair condition. The concrete T-beams typically have wide cracks and efflorescence at the bearing locations. The deck has both armored and non-armored joints over the piers. The substructure is in poor condition due to undermining of the north abutment including deteriorated and missing grout bags at both abutments and medium to wide cracks and spalls on several concrete piles. The Load Factor Inventory Rating is 27 tons and the Operating Rating is 45 tons for the HS-20 Truck and is therefore deficient.

The Middle Thorofare Bridge consists of 21 fixed spans and one movable span that permits passage of vessels with unlimited height and a maximum width of 50'. Based on the 14th Cycle Bridge Re-evaluation Survey Report, dated October 2015, the overall condition of the Middle Thorofare Bridge is critical due to low ratings. The bridge is deemed functionally obsolete due to its narrow width, and structurally deficient due to its inability to carry loads greater than 15 tons. The superstructure is in poor condition due to holes, vessel collision damages on bascule spans girders and arrested section loss on steel girders and all steel elements throughout the structure. Bearings exhibit severe-pack rust. Severe collision damage/torn flange angle was noted. The concrete deck on the approach spans are in satisfactory condition due to the wide cracks (feet long) and spalls on the top and bottom surfaces of the slab. The deck of the movable span was replaced along with the supporting stringers in 1992 and is in good condition. The substructure's overall condition is poor due to large spalls and wide cracking on the pier columns and severely deteriorated fender system.

Currently Ocean Drive is below the 100-year flood elevation and is an important evacuation route for the southern end of the Wildwoods. It is the last of the three access points to the Wildwoods to become impassible during a storm, and thus is critically important for evacuation.

This report documents the results of the CD Study for the assessment of existing conditions and recommended improvements within the study limits. Data collection and analysis were performed within the project limits to develop alternatives for the replacement or rehabilitation of the bridges, including the analysis of substandard roadway elements. The study developed bridge rehabilitation and replacement alternatives and considered various structural options as well as geometric configurations to address bridge and roadway deficiencies.

The Preliminary Preferred Alternative (PPA) was selected based on the established purpose and need, feedback from the local municipalities and public, overall cost, and the construction schedule.

B. Original and Successor Projects

Ocean Drive and the Mill Creek, Upper Thorofare, and Middle Thorofare bridges were constructed in 1939 and have been repaired and/or rehabilitated at various times since the original construction. As-built plans for structural repairs of the Middle Thorofare Bridge from October 2008 were obtained and survey-based mapping was performed during CD.

In 1999, Cape May County and the South Jersey Transportation Planning Organization (SJTPO) started a study of Ocean Drive from Route 109 to west of the Middle Thorofare Bridge. The study was extended in 2002 at the request of the local community to include the Middle Thorofare Bridge and extended to Madison Avenue in Lower Township. The PPA proposed for the Middle Thorofare Bridge was deemed not viable, as the U.S. Fish and Wildlife Service (USFWS) now owns most of the land where the alignment was proposed. In 2009, Cape May County sought funding through a TIGER grant, but was unsuccessful. The project was also subject of an earlier comprehensive scoping endeavor. In September 2012, this was terminated by agreement between the New Jersey Department of Transportation (NJDOT) and Cape May County.

C. Data Reviewed

As part of the data collection phase of the study, available data was requested and reviewed to assess the existing conditions of the corridor. This information was evaluated for nonconformance with current design standards. The following information was obtained and reviewed:

Bridge inspection reports (**Appendix A**):

- Bridge Re-Evaluation Survey Report 17th Cycle, Structure No. 0500-030, County Route 621 (Ocean Drive) Over Mill Creek, prepared by Michael Baker International, August 9, 2016
- Bridge Re-Evaluation Survey Report 17th Cycle, Structure No. 0500-029, County Route 621 (Ocean Drive) Over Upper Thorofare, prepared by Michael Baker International, August 9, 2016
- Bridge Re-Evaluation Survey Report 14th Cycle, Structure No. 3100-006, County Route 621 (Ocean Drive) Over Middle Thorofare, prepared by Gibson Associates P.A., October 20, 2015
- NJDOT Bridge Scour Evaluation Report, Structure No. 0500030, Ocean Highway Over Mill Creek, prepared by Gannett Fleming, Inc., August 1992
- NJDOT Bridge Scour Evaluation Report, Structure No. 0500029, Ocean Highway Over Upper Thorofare, prepared by Gannett Fleming, Inc., August 1992
- NJDOT Bridge Scour Evaluation Report, Structure No. 3100006, Ocean Highway Over Middle Thorofare, prepared by Gannett Fleming, Inc., August 1992
- Type II Mechanical Inspection Report, Structure No. 3100-006, County Route 621 (Ocean Drive) over Middle Thorofare, prepared by Stafford Bandlow Engineering, Inc. December 9, 2013

As-built plans (**Appendix B**):

- Route 109 & CR621 (Ocean Drive) Traffic Signal Installation Plan, June 28, 2017
- Bridge Construction for Ocean Highway Bridges P.W.A. Project N.J. 1038-F As Builts, 1938
- Ocean Drive Bridges Miscellaneous Structural Repairs Design Drawings, 2008

Topographical mapping and ROW surveying were performed by Churchill Consulting Engineers.

In addition to existing data collection, field investigations were performed to verify the existing conditions in December 2017.

D. Design Standards

The following design standards and guidelines were used during this study:

New Jersey Department of Transportation (NJDOT):

- NJDOT Design Manual – Roadway, 2015
- NJDOT Design Manual – Bridges and Structures, 6th Edition, 2016
- NJDOT Bicycle Compatible Roadway and Bikeways Guidelines, 1996
- NJDOT Pedestrian Compatible Planning and Design Guidelines, 1996
- NJDOT Guidance for ADA Project Evaluation & Inventory, 2013
- NJDOT Design Exception Manual, 2012
- NJDOT Access Design Guidelines, 2012
- NJDOT State Highway Access Management Code, November 2014
- NJDOT Complete Streets Policy No. 703, December 3, 2009
- NJDOT Soil Erosion and Sediment Control Standards, 2017
- NJDOT Standard Roadway Construction – Traffic Control – Bridge Construction Details 2016
- NJDOT AASHTOWare Project Cost Estimation (CES) Manual, October 2017
- NJDOT Traffic Mitigation Guidelines, 2014

American Association of State Highway and Transportation Officials (AASHTO)

- LRFD Bridge Design Specifications, Customary U.S. Units, 8th Edition, September 2017
- A Policy of Geometric Design of Highways and Streets, AASHTO, 2018

- Roadside Design Guide. AASHTO, 2012

Federal Highway Administration (FHWA)

- Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), FHWA, 2009 Edition, Rev. 2

Other Reference Material

- Highway Capacity Manual (HCM) 2010
- NJDEP Storm Water Management Guidelines
- NOAA Atlas 14, Volume 2
- New Jersey Administrative Code (NJAC 7:8) Storm Water Management
- 2010 ADA Standards for Accessible Design

E. Characteristics of the Roadways and Surrounding Area

As published in the NJDOT Straight Line Diagram (SLD), Ocean Drive (CR 621) from MP 0.00 to approximately CMP 2.38 is classified as a Rural Minor Arterial and is under Cape May County jurisdiction. Between Fish Dock Road (CR 630) and the eastern study limit at Madison Ave, Ocean Drive is classified as an Urban Minor Arterial under Cape May County jurisdiction. This change in classification coincides with the approach to Diamond Beach. Ocean Drive between milepost (MP) 0.0 to MP 2.75 is an undivided two-lane urban/rural arterial that runs in the north-south direction with various posted speed limits ranging from 25 to 50 mph.

The surrounding area is predominantly undeveloped wetlands with much of it designated as open space or protected land. Ocean Drive also provides an emergency evacuation route for the Wildwoods.

Within the vicinity of the study limits, there are no bus stops or bus shelters present along either direction of Ocean Drive. Pedestrian sidewalks are also not present along Ocean Drive and at any of the three bridges. Although sidewalks are currently not provided, there is relatively heavy bicycle and pedestrian usage, particularly in the summer months. Cape May County is currently planning for interim bicycle and pedestrian access along the corridor until this project is completed.

As part of the data collection process, Automated Traffic Recorders (ATRs) were installed at various locations to count vehicle volumes in the vicinity of the three bridges. Two locations were counted in August 2017 during the summer peak and three locations were counted in December 2017. The bi-directional Average Daily Traffic (ADT) volumes collected during the seven-day period shown in **Table 1**.

Table 1: ATR ADT Volumes

	PEAK SEASON (SUMMER)	OFF-PEAK SEASON (WINTER)
Mill Creek Bridge	N/A	2,207 vehicles/day
Upper Thorofare	9,898 vehicles/day	1,990 vehicles/day
Middle Thorofare	9,901 vehicles/day	1,720 vehicles/day

The peak hours volumes collected during the off-peak and peak seasons along Ocean Drive are summarized in **Table 2**.

Table 2: ATR Peak-Hour Traffic Volumes

	Peak Season (Summer)		Off-Peak Season (Winter)	
	Hour	Volume	Hour	Volume
AM Peak Hour	8:00 AM - 9:00 AM	618	7:45 AM - 8:45 AM	554
PM Peak Hour	4:45 PM - 5:45 PM	1,376	3:45 PM - 4:45 PM	623
Saturday Peak Hour	12:00 PM - 1:00 PM	1,488	12:15 PM - 1:15 PM	526

Additionally, peak hour turning movement counts (TMCs) were performed in December 2017 at the intersection of NJ 109 and Ocean Drive (CR 621). The turning movement counts for the AM and PM peak hours at the intersection of NJ 109 and Ocean Drive are shown in **Figure 2**. These were conducted during the off-peak season. Toll collection volumes at Middle Thorofare Bridge during the off-peak and peak seasons, from 2014 to 2016, are shown in **Figure 3**.

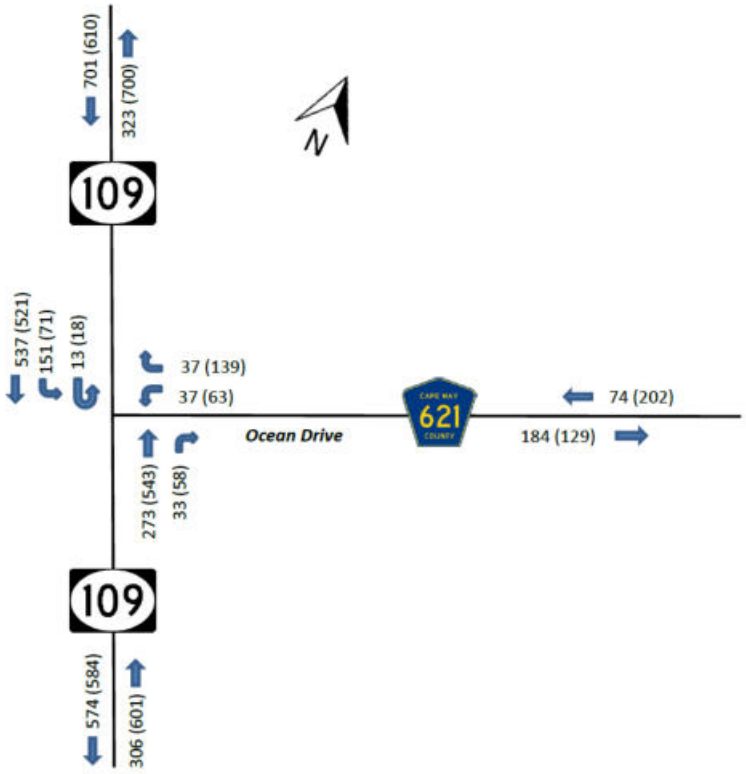

Figure 2: TMC Counts: Turning Movement Peak Hours (Off-Season)

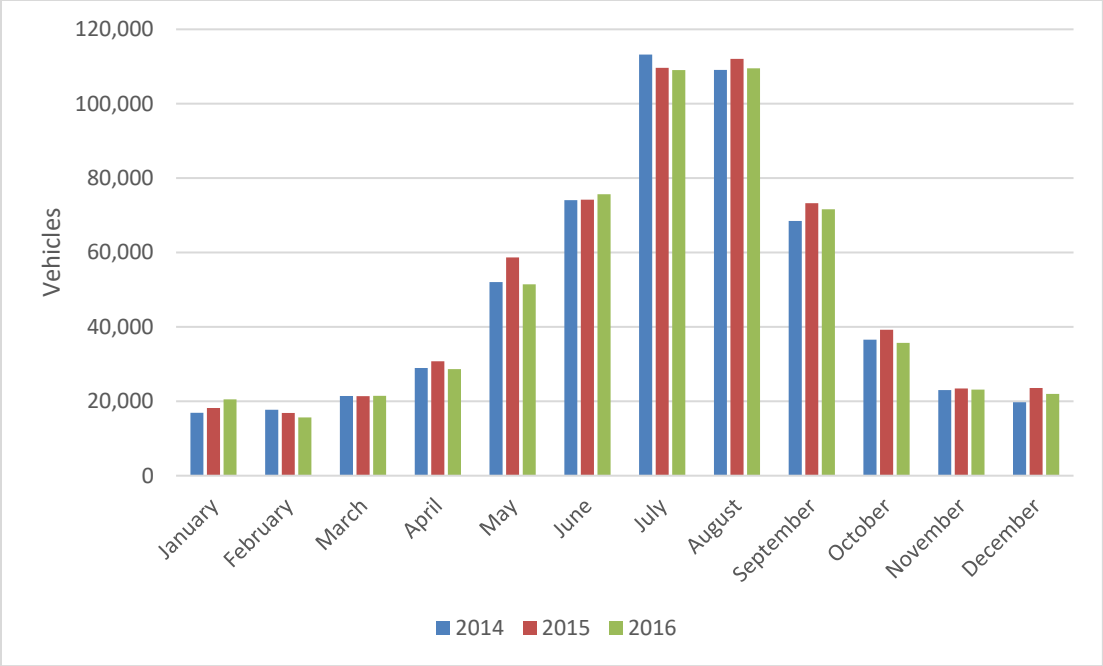

Figure 3: Toll collection volumes at Middle Thorofare Bridge

Traffic volume data collected as part of this study are included in **Appendix C**.

F. Concept Development Scope Statement

The Ocean Drive (CR 621) Upgrades & Bridge Improvements CD phase was completed in accordance with the NJDOT CD Project Delivery Process. The scope of work for this study was developed using the NJDOT CD Guideline. This included activities associated with the Data Collection and Analysis, Alternative Development and Analysis, selection of a Preliminary Preferred Alternative (PPA), and preparation of the CD Report.

G. Public Involvement Action Plan

A Public Involvement Action Plan (PIAP) was developed and submitted to the Project Team. The PIAP was finalized and approved by SJTPO, Cape May County, Michael Baker and NJDOT in May 2018. A copy of the PIAP is included in **Appendix D**.

Public Involvement during the Local CD process included the development and maintenance of a public website to promote the study and keep the public informed of the study and overall process.

Stakeholder List

The study team identified key stakeholders which included county and local representatives. Municipalities within the study area include:

- Lower Township
- City of Cape May
- City of Wildwood
- Borough of Wildwood Crest
- Borough of West Cape May

Community Stakeholders Survey

A Community Stakeholders Survey form was sent out in April 2018 to the local and regional stakeholders to solicit their input on the perceived transportation needs and concerns within the study area. The survey was also made available on-line with a link from the project website. A total of 24 survey responses were received. The results of the questionnaire survey included the following feedback:

- EZ-Pass alone would ease traffic toward Cape May
- Driving speed needs to be reduced to 25mph in both directions
- Minimal detours during June, July, and August should be obtained at all costs. That information should be posted well in advance.
- If closed, there will be significant impact to Wildwood Crest businesses and local marinas as there are no convenient solutions
- Keeping the current businesses along Ocean Drive easily accessible for customers, tractor trailers and boat trailers. All the businesses along Ocean Drive cater to the tourist industry and are going to be more impacted by traffic changes and detours than the fisheries marine traffic.

The PIAP, stakeholders list and survey summary are included in **Appendix D**.

II. PURPOSE AND NEED

The overall purpose of this project is to address structural, geometric, carrying capacity, and operational deficiencies of the two Cape May County-owned bridges and one Commission-owned bridge located on the Ocean Drive Causeway, and to provide safe, efficient, and reliable passage for all modes of transportation.

The following sections summarize the existing needs identified within the study limits.

A. Bridge Needs

The three main bridges on the causeway, Mill Creek, Upper Thorofare, and Middle Thorofare, were all constructed in 1939. All three bridges are currently deemed functionally obsolete due to their narrow widths. The Mill Creek and Upper Thorofare bridges have low sufficiency ratings, while the Middle Thorofare Bridge is structurally deficient due to its inability to carry loads greater than 15 tons.

Mill Creek Bridge

The Mill Creek Bridge has been deemed functionally obsolete due to the narrow deck width. The superstructure (including deck slab and beams) of the Mill Creek Bridge is in fair condition. The deck is in fair condition due to the light to moderate scaling throughout all spans with several spans also exhibiting shallow spalling on both the top and underside and/or cracking with asphalt patches on the top of the deck. There is exposed reinforcement in all spans at the underside top flanges of the T-beams. The bridge railing is severely deteriorated and substandard since it does not meet current strength or geometric requirements. A recent design upgrade analysis suggested that the railing will not support a TL-1 load condition, and modifications to the rail system will not provide for required load resistance capabilities. The substructure is in fair condition. There is undermining along both abutments, and severe scaling and deteriorated repair jackets at piers 5, 8 and 9 from the south. There is extensive cracking and spalling on the west end of the north abutment breastwall. The south abutment apron is undermined throughout. The curb-to-curb

width of 20' is substandard, leading to the bridge being classified as functionally obsolete. Based on the 17th Cycle bridge inspection report, the Load Factor Inventory Rating is 24 tons and the Operating Rating is 40 tons for the HS-20 Truck, the bridge is therefore deficient. The bridge deck width of 20' is substandard to accommodate two 12-foot travel lanes. There are no shoulders.

Upper Thorofare Bridge

The Upper Thorofare Bridge is deemed to be functionally obsolete due to the narrow deck width. The superstructure (deck slab and beams) is in fair condition. The concrete T-beams have wide cracks and efflorescence at the bearing locations. The deck has both armored and non-armored joints over the piers. The joint material in most of these joints is deteriorated. The bridge railing is substandard for current strength and geometry and in poor condition with severe deterioration. Vehicular impact damage is visible at several locations. The bridge is currently listed structurally deficient due to the substructure being listed in poor condition. The substructure is in poor condition due to undermining of the North Abutment including deteriorated and missing grout bags at both abutments and medium to wide cracks and spalls on several concrete piles. The curb-to-curb width of 20' is substandard, leading to the bridge being classified as functionally obsolete. The bridge is on a horizontal curve and has no superelevation on the deck which is substandard. The current curved alignment and adjacent drive elevations at the westerly end of the bridge limit site distance and the ability for trucks to quickly enter the roadway, compounding the necessity for additional sight distance. Based on the 17th Cycle inspection report, the Load Factor Inventory Rating is 27 tons and the Operating Rating is 45 tons for the HS-20 Truck, the bridge is therefore deficient. The bridge deck width of 20' is substandard to accommodate two 12-foot travel lanes. There are no shoulders.

Middle Thorofare Bridge

The Middle Thorofare Bridge consists of 21 fixed spans and one movable span that permits passage of vessels with an unlimited height and a maximum width of 50'. The structure is deemed functionally obsolete due to its narrow width, and structurally deficient due to its inability to carry loads greater than 15 tons. The overall condition of the structure is critical due to its low inventory live load ratings. The superstructure is in poor condition due to several holes, several vessel collision damages on bascule spans girders and arrested section loss on steel girders and all steel elements throughout the structure. The bridge railing is substandard for strength and geometry and is severely deteriorated. The substructure's overall condition is poor due to large spalls and wide cracking on the pier columns and severely deteriorated fender system. The curb-to-curb width of 20' is substandard, requiring the bridge to be classified as functionally obsolete. This configuration changes at the centrally located toll house where two 10' lanes traverse around the toll house. Based on the 14th Cycle bridge inspection report, the Load Factor Inventory Rating is 13 tons and the Operating Rating is 21.1 tons for the HS-20 Truck, the bridge is therefore deficient. The bridge deck width of 20' is substandard to accommodate two 12-foot travel lanes. There are no shoulders.

A copy of the Purposed and Need Statement is included in **Appendix E**.

B. Scour Needs

As per the 14th Cycle bridge inspection report, Ocean Drive lists an FHWA Scour category of 7: Scour Critical for the Middle Thorofare Bridge. Foundations are unstable for scour.

C. Maintenance Needs

The Mill Creek, Upper Thorofare, and Middle Thorofare bridges require routine maintenance. Based on the most recently available bridge reports, the following Priority II repairs were recommended:

Mill Creek Bridge (Cycle 17)

1. Fill in the gaps with concrete along the curbs at the south approach, and in the safety walk at the north approach.
2. Replace the bridge railing in-kind throughout the structure.
3. Backfill the undermined area along the north abutment, place riprap along both abutments and repair/replace the severely scaled/spalled concrete jackets with epoxy concrete along pier bents 5, 8 and 9.

Upper Thorofare (Cycle 17)

1. Fill in the gaps with concrete along both approach roadways.
2. Backfill the undermined area along the north abutment, place riprap along both abutments.
3. Patch large spalls in bridge curbs in Spans 2, 8 and 11.
4. Replace severely corroded east railing in Spans 5, 9 and 11.

Middle Thorofare (Cycle 15)

1. Remove the existing fender system and install a new timber fender system or equivalent.
2. Install a new span lock system.
3. Straighten and install bolted steel plates on the top and bottom of the bottom flange angles.
4. Install bolted steel plates on both sides of the bascule girder webs where there is severe section loss adjacent to the counterweights.
5. Modify the PLC programming to ensure the interlock between the traffic gates, traffic signals, span locks, span drive and motor brakes functions as designed and as per code.

D. Roadway Needs

In addition to addressing the structural deficiencies of the bridges along Ocean Drive, additional roadway needs were identified within the study limits. The roadway needs were determined by identifying substandard roadway design elements and high crash locations. The substandard roadway design elements were assessed using available as-built plans, base mapping and a Digital Terrain Model (DTM), and evaluated in accordance with the current NJDOT Roadway Design Manual and NJDOT Design Exception Manual. Controlling Substandard Design Elements (CSDE) were identified in the following categories:

- Stopping Sight Distance (Horizontal Curve)
- Minimum Radius of Curve
- Minimum Grade
- Lane Width
- Shoulder Width
- Bridge Width
- Design Loading

Due to the narrow roadway width and lack of shoulders at all three bridges along the Ocean Drive causeway, facilities for bicyclists and pedestrians are not provided. Despite these conditions, bicyclists continue to use the Ocean Drive causeway.

Reportable crash data for the years 2014 to 2016 were obtained from the NJDOT – Bureau of Transportation Data and Safety to ascertain high crash locations.

E. Goals and Objectives

To provide a safe and efficient network for all users within the study area, the following is a list of goals and objectives that should be considered during alternatives development and incorporated into the Preliminary Preferred Alternative:

- Avoid delays or disruptions caused by aging infrastructure.
- Avoid or minimize impacts to social, economic and environmental resources.
- Accommodate recreation on the bridge where safe and appropriate.
- Accommodate ADA compliant bicycle and pedestrian access.
- Accommodate public access where feasible.
- Avoid or minimize complete or long-term bridge openings or roadway closures.
- Minimize traffic impacts related to bridge openings.
- Implement context sensitive design solutions.
- Accommodate reasonable needs of navigation.
- Improve navigational clearances and access.

III. EXISTING INVENTORY AND CONDITION

Information on the existing inventory and condition of the bridges can be found in the bridge inspection reports provided in **Appendix A**. This information includes the existing deck, superstructure, and substructure condition ratings, the LFD and LRFR superstructure load ratings, and the sufficiency rating for the structure. Existing inventory conditions were determined by reviewing collected data received from NJDOT, field inventory, and evaluation. The full Field Condition and Appraisal Survey Report can be found in **Appendix A**.

A. Existing Bridge Inventory and Condition

Mill Creek Bridge

This bridge (**Figure 4**) was constructed in 1939 to connect Cape May to the Wildwoods and consists of twelve 25'-0" spans with a total length of 300'-0". The bridge provides two 10'-0" wide lanes and 1'-6" safety walks on both sides and is on a tangent section of roadway. The superstructure is composed of four reinforced concrete T-beams with a monolithic 7½" thick reinforced concrete deck.

Figure 4: Mill Creek Bridge

The beams are spaced at approximately 6'-0" on center support with a total deck width of 23'-0". The substructure consists of reinforced concrete pile bents and stub abutments on timber piles. The substructure is comprised of two bin-type abutments on timber piles and piers consisting of reinforced concrete pier caps with three precast concrete piles at each pile bent pier. Rip Rap and bagged concrete slope protection were visible at the abutments, apparently placed to counter prior scour and erosion.

The curb-to-curb width of 20'-0" is inadequate, leading to the bridge being classified as functionally obsolete. Based on the 17th Cycle Bridge Re-evaluation Survey Report dated August 2016, the Load Factor Inventory Rating is 24 tons and the Operating Rating is 40 tons for the HS-20 Truck and is therefore deficient.

Based on the 17th Cycle Bridge Re-evaluation Survey Report, dated August 2016, the overall condition of the bridge is Fair (National Bridge Inspection Standards rating of 5). The structure is functionally obsolete due to the narrow deck roadway width. The National Bridge Inspection Standards can be found in **Table 3**.

Table 3: National Bridge Structural Rating System

N	Not applicable	--
9	Excellent condition	--
8	Very good condition	"No problems noted."
7	Good condition	"Some minor problems."
6	Satisfactory condition	"Some minor deterioration of structural elements."
5	Fair condition	"Minor section loss to primary structural elements."
4	Poor condition	"Advanced section loss to primary structural elements."
3	Serious condition	"Seriously deteriorated primary structural elements."
2	Critical condition	"Facility should be closed until repairs are made."
1	Imminent failure condition	"Facility closed. Study of repairs is feasible."
0	Failed condition	"Facility is closed and beyond repair."

Field Assessment

A limited field assessment of the Mill Creek Bridge was conducted on November 15, 2017, to verify the current condition of the bridge. The observations made during this field assessment support the 17th Cycle Bridge Re-evaluation Survey Report and are presented below.

The superstructure (including deck slab and beams) is in fair condition. The deck is in fair condition due to the light to moderate scaling throughout all spans with several spans also exhibiting shallow spalling on both the top and underside (**Figure 5**), and cracking with asphalt patches on the top of the deck. There is exposed reinforcement in all spans at the underside top flanges of the T-beams. The T-beams exhibit cracking and spalling along the web in several spans. The bottoms of the beams are spalled at several locations, including the previously repaired sections. The reinforcement is exposed and rusted throughout.

Figure 5: Mill Creek Bridge - Underside of Deck

The bridge railing is severely deteriorated and is also substandard since it does not meet strength or geometric requirements. The majority of the rails are rusted through (see **Figure 6**). The railing exhibits several locations of previous vehicular impact. NJDOT Item 36 for Bridge railings, approach railings, transitions and end terminals are all deficient, as per the 17th Cycle Bridge Re-evaluation Survey Report.

Figure 6: Mill Creek Bridge Railing

The substructure is in fair condition. There is undermining along both abutments, and severe scaling and deteriorated repair jackets at piers 5, 8 and 9 from the south.

The pile caps have several areas of map cracks and efflorescence. The end of the caps have medium to wide cracks. Several of the piles have been previously repaired with steel or fiberglass jackets filled with grout. The steel jackets are moderately rusted.

As noted, the above conditions were documented during a field assessment conducted on November 15, 2017. In the spring of 2019, the County completed a contract that included the following repairs and improvements:

- The surface deck spalls were repaired. Deteriorated deck joints were reconstructed and replaced.
- All approach guiderail was replaced and upgraded with new guiderail and end treatments conforming to current NJDOT standards
- The roadway approaches were resurfaced
- The undermining of the abutments of both bridges was addressed by coring thru the approach slabs and filling the voids completely with flowable grout.
- New bridge pylons were constructed to attach the new guiderail to the bridge structure
- All deck joints were resealed with compression joint material.

A bridge rail replacement project, which includes the addition of a cantilevered pedestrian walkway is currently planned for 2021 and 2022.

Upper Thorofare Bridge

This bridge was constructed in 1939 to connect Cape May to the Wildwoods and consists of fourteen 25'-0" spans in length with a total length of 350'-0". The bridge provides two 10'-0" wide lanes and 1'-6" safety walks on both sides and is on a horizontal curved section of roadway that does not have proper superelevation. The superstructure is composed of four reinforced concrete T-beams with a monolithic 7-1/2" thick deck. The beams are spaced at approximately 6'-0" on center and provide a total deck width of 23'-0". The substructure consists of reinforced concrete pile bents and stub abutments on timber piles. Based on the 17th Cycle Bridge Re-evaluation Survey Report, dated August 2016, the overall condition of the bridge is poor.

The curb-to-curb width of 20'-0" is inadequate, leading to the bridge being classified as functionally obsolete. The bridge is on a horizontal curve and has no superelevation on the deck, which is substandard. Based on the 17th Cycle Bridge Re-evaluation Survey Report, dated August 2016, the Load Factor Inventory Rating is 27 tons and the Operating Rating is 45 tons for the HS-20 Truck, and is therefore deficient. NJDOT Item 36 for bridge railings, approach railings, transitions and end terminals are all deficient, as per the 17th Cycle Bridge Re-evaluation Survey Report.

Field Assessment

A limited field review of the Upper Thorofare Bridge was conducted on November 15, 2017, to verify the current condition of the bridge. The observations made during this review support the 17th Cycle Bridge Re-evaluation Survey Report and are presented below.

Figure 7: Upper Thorofare Bridge

The superstructure (deck slab and beams) is in fair condition. The concrete T-beams typically have wide cracks and efflorescence at the bearing locations (**Figure 7**). The deck has both armored and non-armored joints over the piers. The joint material in most of these joints is deteriorated.

There is exposed reinforcement in all spans at the underside top flanges of the T-beams. The bottoms of the beams are spalled in several locations, and the diaphragms have efflorescence and various cracks throughout. The bridge railing is substandard for strength and geometry and is in poor condition with severe deterioration and vehicular impact damage visible at several locations.

The substructure is in poor condition due to undermining of the north abutment including deteriorated and missing grout bags at both abutments and medium to wide cracks and spalls on several concrete piles.

As noted, the above conditions were documented during a field assessment conducted on November 15, 2017. In the spring of 2019, the County completed a contract that included the following repairs and improvements:

- The surface deck spalls were repaired. Deteriorated deck joints were reconstructed and replaced.
- All approach guiderail was replaced and upgraded with new guiderail and end treatments conforming to current NJDOT standards
- The roadway approaches were resurfaced
- The undermining of the abutments of both bridges was addressed by coring thru the approach slabs and filling the voids completely with flowable grout.
- New bridge pylons were constructed to attach the new guiderail to the bridge structure
- All deck joints were resealed with compression joint material.

A bridge rail replacement project, which includes the addition of a cantilevered pedestrian walkway is currently planned for 2021 and 2022.

Middle Thorofare Bridge

This bridge was constructed in 1939 to connect Cape May with the Wildwoods and consists of 21 fixed spans and one movable span that permits passage of vessels with unlimited height and a maximum width of 50’-0” (**Figure 8**). The fixed spans vary in length from 35’-0” to 110’-9 1/8” and

the movable span is a single leaf bascule bridge with a span of 64'-5" between the centerline of the trunnion and centerline of bearing at the toe. The existing bridge consists of a single leaf non-redundant steel bascule span, four non-redundant steel girder-floorbeam-stringer spans and seventeen continuous steel stringer approach spans. The total length of the bridge is approximately 1044' and it provides two 10'-0" lanes and 1'-6" safety walks on both sides of the bridge. The curb-to-curb width of 20'-0" is inadequate, deeming the bridge to be classified as functionally obsolete.

There are seventeen 35'-0" long spans that consist of three continuous steel stringers with pin and hanger assemblies supporting an 8" reinforced concrete deck slab. The other four approach spans are two girder, floorbeam/sub-stringer structures with an 8" reinforced concrete deck slab that is supported on the two girders and central sub-stringer. This structure is on a tangent section of roadway. The overall condition of the structure is critical due to its low ratings. The bridge is deemed functionally obsolete due to its narrow width, and structurally deficient due to its inability to carry loads greater than 15 tons. These findings are based upon the 14th Cycle Bridge Re-evaluation Survey Report, dated October 2015 and a cursory assessment performed on November 15, 2017. Additionally, the major fishing industry in the vicinity of the bridge also has a significant demand on the bridge openings.

Figure 8: Middle Thorofare Bridge

The bascule leaf is comprised of two steel girders, to which trunnion assemblies are mounted. The bascule girders are approximately at the same elevation and have an approximate center-to-center spacing of 22'-3". A trunnion shaft is attached to each girder and it's simply supported by bronzed bushed sleeve bearings at the ends (total of four bearings, two per girder). The two simply supported trunnions support the weight of the bascule leaf. At the rear of the trunnions, the girders support the counterweight located below the east flanking approach span. Each approach to the bascule span is equipped with traffic signals and warning gates. The west warning gates; one at each corner spans the west approach span when lowered. The northeast warning

gate housing is not equipped with arm. The southeast warning gate spans the east approach span when lowered. There are no barrier gates.

The bridge mechanical systems consist of span drive machinery, span support machinery (trunnion bearing assemblies, live load bearings, span lock machinery) and overtravel bumper blocks. In the event of loss of normal electrical power, the bridge is equipped with a standby 60 kW diesel powered generator (**Figure 9**) to provide emergency electrical power. The existing auxiliary drive system is original to the bridge and comprises of a gasoline engine, a coupling, reversing unit and clutch assembly located in the machinery room. The auxiliary drive system is not in use and showed signs of age. The components appeared to not have been serviced in a long time and appeared abandoned in place.

Figure 9: Generator

Based on the 14th Cycle Bridge Re-evaluation Survey Report, dated October 2015, the Load Factor Inventory Rating is 13 tons and the Operating Rating is 21.1 tons for the HS-20 Truck, and is therefore deficient. NJDOT Item 36 for Bridge railings, approach railings, transitions and end terminals are all deficient, as per the 14th Cycle Bridge Re-evaluation Survey Report. The bridge deck width is substandard for a two-lane roadway and there are no existing shoulders.

Field Assessment

A limited field assessment of the Middle Thorofare Bridge was conducted on November 15, 2017 to verify the current condition of the bridge. Prior to this visit, the 14th Cycle Bridge Re-evaluation Survey Report, dated October 2015 was reviewed. The observations made during this review support the 14th Cycle Bridge Re-evaluation Survey Report. The bridge is currently appraised "Critical" in the 14th Cycle Bridge Re-evaluation Survey Report, dated October 2015, due to low inventory live load ratings. Investigation of the mechanical systems included visual and aural review of the components. Bridge test openings were performed, and the components were aurally inspected to verify their operational condition. Assessment of machinery did not include removal of trunnion bearing caps to determine and document the condition of trunnion shaft journals. As part of the review, previous available inspection reports were obtained and reviewed. Per available plans some mechanical and electrical systems repair work was performed in 1984.

Since the previous inspection, new utility lines running along the structure have been installed. The infrastructure for EZ-Pass has been installed at the toll booth location with new overhead utilities as shown in **Figure 10**.

Figure 10: New Utilities and EZ-Pass

The superstructure is in poor condition due to holes, vessel collision damages on bascule spans' girders (**Figure 11**) and arrested section loss on steel girders and all steel elements throughout the structure. Bearings exhibit severe-pack rust. Severe collision damage/torn flange angle was noted, and the County was informed of this condition for further coordination with the NBIS inspection team.

Figure 11: Bascule span damage

The bridge railing is substandard for strength and geometry and is severely deteriorated. There are numerous rails that are rusted through. The railing exhibits locations of previous vehicular impact.

The substructure's overall condition is poor due to large spalls and wide cracking on the pier columns and severely deteriorated fender system.

The precast concrete piles were repaired at several locations with concrete jackets. The sleeves are heavily deteriorated at several locations with the reinforcing cage exposed. Pier S7 consists of three concrete piles. The east pile has heavy collision damage and has been supplemented with two steel H-piles for additional support.

Figure 12: Timber Fender

The main piers and timber fender system are generally in poor condition (**Figure 12**). The fender timber piles have up to 90% section loss. Many piles including dolphins were swaying from small wake. The timber fender is severely deteriorated.

The bridge span operated satisfactorily during our operational tests with no significant issues or operational deficiencies noted. The existing span position indication meter on the control desk and machinery room was not properly calibrated.

The motor (**Figure 13**) is original and showed signs of age but operated satisfactorily. The housing exterior exhibited paint failure and corrosion.

Figure 13: Motor

The open gearing was in fair condition. Lubrication generally appeared inadequate and the rack and pinion lubricant was discolored and appeared contaminated. The tooth surfaces generally exhibited light surface corrosion and plastic flow typically at the pitch lines. Tooth contact was typically good for all gear sets.

There are two brakes (one motor, one machinery) to provide braking and holding torques for the span. The brakes are the spring-set thrustor release type and show signs of aging. There was dirt accumulation on the brake components, linkages and support. During operation, not all pads were observed to fully release from the wheel. The motor brake manual hand release lever was not functional, and the torque scale was damaged. Additionally, the power conduit to the thrustor was loose and not properly secured.

The south span lock machinery components have been removed (**Figure 14**). The north span lock is abandoned in-place and not in use. Locking devices at the toe ends for single leaf bascule spans are a mandatory requirement per the AASHTO to secure the bascule leaf in the closed position.

Figure 14: South Span Lock Removed

A loss of utility power was simulated by disconnecting the primary switch outside the transformer room. Once power was disconnected, the generator on roadway level started immediately, confirming that the ATS is functional. The control desk is functional, however it is antiquated, and obsolete, and spare parts are very hard to find, if at all, and found to be in poor condition. The analog span position meter needs to be recalibrated – at the fully seated position it still indicated that the span was open 15 degrees. Several indication lights were non-functional. There is no emergency stop button on the control desk. Labels for the buttons and indicators were handwritten.

The channel navigation light consisted of one green-over-red channel navigation light on the north side of the span that was found to be in fair condition (**Figure 15**). The marine horn was functional but showed signs of moderate corrosion. The CCTV cameras were in fair condition; however, the bridge operator does not have access to the camera feed.

Figure 15: Green-Over-Red Channel Navigation Light

As noted, the above conditions were documented during a field assessment conducted on November 15, 2017. The County is currently planning to execute a contract in 2021 and 2022 to replace the existing bridge rails, approach railings, and fender system and conduct various other bridge repairs.

Old Lower Thorofare Culvert

This culvert (**Figure 16**) is considered a minor bridge and is not inspected on a regular basis since it is presently a 5-foot diameter pipe; however, this culvert is being inspected in 2021 as part of the NJDOT's minor bridge inspection program. The flow of water through this pipe is typically very swift during tide changes. The pipe appears to be undersized for the flow.

Figure 16: Old Lower Thorofare Culvert

The full Bridge Re-evaluation Survey Report can be found in **Appendix A**.

B. Scour

As per the 14th Cycle Bridge Re-evaluation Survey Report (attached as **Appendix A**), Ocean Drive lists an FHWA Scour category of 7: Scour Critical for the Middle Thorofare Bridge. Foundations at the Middle Thorofare Bridge are unstable for scour. An FHWA Scour category of 02: Screened (Low Risk) is listed for the Mill Creek Bridge and FHWA Scour category of 04: Screened (Scour Susceptible) for the Upper Thorofare Bridge.

C. Maintenance Issues

There are no identified maintenance issues within the study limits other than the existing condition of the bridge.

D. Existing Roadway Inventory and Condition

Ocean Drive (CR 621) from MP 0.00 to approximately MP 2.38 is classified as a Rural Minor Arterial and is under Cape May County jurisdiction. Between Fish Dock Road (CR 630) and the eastern study limit at Madison Ave, Ocean Drive is classified as an Urban Minor Arterial under Cape May County jurisdiction. This change in classification coincides with the approach to Diamond Beach. The posted speed limits vary throughout the corridor from MP 0.0 to MP 0.1 (25 MPH), MP 0.1 to MP 1.30 (45 MPH), MP 1.30 to MP 1.58 (40 MPH), MP 1.58 to MP 1.90 (25 MPH), and from MP 1.90 to MP 2.75 (50 MPH).

The travel way within the study limits is 24’ on pavement and 20’ when crossing the three bridges. Shoulders vary throughout the corridor from 0’ on the bridges to up to 16’ on the roadway. The lack of shoulders on the bridges also restricts sight distance when the roadway is on a curve. The existing roadway was constructed within a 120-foot right-of-way by placing fill in the higher areas of an existing floodplain. The two-lane road consists of a 40-foot wide paved surface with 10-foot travel lanes and 10-foot shoulders on either side, with 8:1 slopes down to existing grade adjacent to the shoulders. In the spring of 2019, all approach guiderail was replaced and upgraded with new guiderail and end treatments conforming to current NJDOT standards.

The roadway profile of Ocean Drive is relatively flat, except for the approach to the Middle Thorofare Bridge. A major deficiency of the existing roadway is that it is susceptible to flooding due its existing low elevation of about 6.0’ North American Vertical Datum (NAVD88). Recent Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM), from the adjacent area, place the highest 100-year Base Flood Elevation at 11.0’ NAVD88 in the coastal flood zone areas with wave action. This would render Ocean Drive unusable as an evacuation route during a flood event.

Several horizontal curves exist along the alignment of Ocean Drive. Notably, substandard horizontal curvature exists at both the southern and northern study limits. At the southern study limit, there is a substandard 1,000’ radius horizontal curve on the approach to the signalized intersection with NJ 109. At the northern study limit, there is a substandard 900’ radius horizontal curve at Madison Ave, as Ocean Drive enters Diamond Beach. Due to local complaints regarding sight distance for pedestrian traffic at this location, Ocean Drive may be a candidate for traffic calming to slow traffic before entering Diamond Beach.

A toll booth exists on the Middle Thorofare Bridge. The toll booth is located between the travel lanes and previously served both directions of traffic, but currently only tolls southbound drivers. Drivers must slow down when approaching the toll booth to safely navigate the shift in alignment at the toll booth. The toll booth creates delay and long queues for southbound drivers during peak travel times and acts as an obstruction in the roadway for northbound drivers.

1. **Controlling Substandard Design Elements**

Several sources of existing information were identified and reviewed to verify the existence of CSDEs. The sources of information include:

- Alternatives Analysis Report, Dated January 2004
- Base Mapping, Dated 2003
- Supplemental topographic mapping, Dated 2018
- USGS Lidar Point Cloud, Dated 2014
- Site Visit, Conducted December 2017
- Virtual Inspection, via Google Earth
- Ocean Drive (CR621) Straight Line Diagram (SLD), Prepared by NJDOT, Dated July 2011
- Structural Inventory and Appraisals (SI&As)

The assessment identified existing substandard design elements based on NJDOT Design Exception Manual's list of Controlling Design Elements, and in accordance with the latest NJDOT Roadway Design Manual, NJDOT Bridges and Structures Design Manual and AASHTO's A Policy on Geometric Design of Highways and Streets design standards. The Controlling Design Elements as indicated in the NJDOT Design Exception Manual include the following elements:

Roadway Elements

- Stopping Sight Distance (vertical curves, horizontal curves and non-signalized intersections)
- Superelevation
- Minimum radius of curve
- Minimum and Maximum Grades
- Cross Slope
- Lane Width
- Shoulder Width
- Through Lane Drop Transition Length
- Acceleration and Deceleration Lane Length (for ramps)
- Design Speed (a design exception for a reduction in the design speed will not be approved)

Bridge Elements

- Bridge Width
- Vertical Clearance
- Design Loading

Table 4 lists the minimum required values for the CSDE.

Table 4: Minimum required values for CSDE

CSDE	MINIMUM REQUIRED
Design Speed	55 mph
Stopping Sight Distance	495’
Non-signalized Intersection Sight Distance (right turn/left turn)	530’/610’
Minimum Curve Radius	1060’
Minimum and Maximum Grades	0.3% / 4%
Cross Slope	1.5%
Lane Width	12’
Shoulder Width	8’
Bridge Width	Approach Width
Design Loading	See below

Design Loading

The NBIS Reports for each structure were investigated and demonstrate that all three structures are deficient. The following is a summary of the NBIS Report load ratings for each structure:

- Mill Creek Bridge - Based on the 17th Cycle NBIS Report Dated August 2016, the Load Factor Inventory Rating is 24 tons and the Operating Rating is 40 tons for the HS-20 Truck.
- Upper Thorofare Bridge - Based on the 17th Cycle NBIS Report Dated August 2016, the Load Factor Inventory Rating is 27 tons and the Operating Rating is 45 tons for the HS-20 Truck.
- Middle Thorofare Bridge - Based on the 14th Cycle NBIS Report Dated October 2015, the Load Factor Inventory Rating is 13 tons and the Operating Rating is 21.1 tons for the HS-20 Truck.

Within the study limits, CSDEs were identified in the following seven element categories:

- Sight Distance (Horizontal Curve)
- Minimum Curve Radius
- Minimum Grade
- Lane Width
- Shoulder Width
- Bridge Width
- Design Loading

As part of the alternatives analysis, the study investigated improving the CSDEs in coordination with drainage and traffic requirements. Proposed improvements will be accomplished within the limited scope of construction, including minimal ROW and utility impacts.

2. Right of Way Widths

Existing tax maps show a Right of Way (ROW) width of 120’. Further investigation is required to survey the current ROW line during the design phase. Available tax maps are included in **Appendix F**.

3. Existing Pavement

Within project limits, the existing roadway consists of bituminous pavement. The approach roadways at the bridges are paved with bituminous concrete. The existing roadway was constructed within a 120' ROW by placing fill in the higher areas of the existing floodplain. The two-lane roadway typically consists of a 40' wide paved surface with 10' travel lanes and 10' shoulders on either side.

4. Geotechnical Information

Soil and Geology

Physiographic Settings

The project site is located within the outer Coastal Plain of NJ near the northeastern margin of the Atlantic Coastal Plain. The Coastal Plain Province consists of unconsolidated fine to coarse sediments that are continental and marine-type deposits developed during the Cretaceous to Holocene ages. It thickens seaward until it reaches a depth of 6,500' at the southern tip of Cape May County.

Surficial Geology

The surficial soil information was obtained from the Surficial Geologic Map of Central and Southern NJ (NJ Geological Survey, 2002). The soil units within the project limits consist mainly of Estuarine & Salt-marsh Deposits (Qm), and to a lesser extent Dredge Spoil (DS). The Qm unit is a marine tidal marsh deposit that is predominantly dark colored organic silt, clay, and peat, with some sand and fine gravel. The underlying soils are alluvium and deltaic deposits consisting of stratified sand, silt, clay and gravel in varying proportions. The thickness of the Qm is about 6', and it thickens to 20' along shorelines. The DS consists of widely variable unconsolidated aggregates of sediments dredged, pumped, and discharged into settling ponds behind manmade levees. The thickness of the DS soil unit is commonly 10' to 20'.

Bedrock Geology

Based on the USGS Bedrock Geologic Map, Cape May County falls within the Unnamed Geological Formation (Tc) developed in the Upper Pliocene Age. The Tc Formation is characterized by interbedded layers of sands, clays and gravels. The unit is up to approximately 197' in thickness. The upper 40' consists of a thick-bedded, medium-gray clays and silts that are overlain by fine-to medium-grained quartz sands, with little feldspar contents (~10%). The lower 60' contains interbedded gravels, poorly sorted sands (medium to very coarse grained), and thin to thick, dark gray clays. The Tc Formation rests on Belleplain Member of the Kirkwood Formation that are predominant with silty clays and sands.

Soil Investigation

Subsurface Conditions from the Existing Borings

The subsurface soil properties along the existing roadway and bridge alignment were evaluated based on standard penetration test (SPT) results from eighteen (18) soil borings drilled between 2000 and 2003 (namely, PB-1 through PB-9, B-1 through B-8, and one water boring, WB-1, near Middle Thorofare Bridge location). The borings were drilled as part of a subsurface exploration program for the Ocean Drive Upgrade and Bridge Replacement Project performed by Parsons Brinckerhoff (now known as WSP). The boring program included SPT sampling and conducting laboratory tests on selected disturbed and undisturbed soil samples. SPT sampling records blows per six-inch increment following industry standards for obtaining SPT N-values. N-values are the sum of hammer blows to advance the second and third 6 inch

increments driving a standardized split barrel sampler. **Table 5** summarizes boring depth and location information.

Table 5: Ocean Drive Existing Borings Information

STRUCTURE	BORING ID	BORING DEPTH (FT)	BORING ELEVATION (FT)
Mill Creek Bridge	B-1	72	7.85
	B-2	72	7.56
Upper Thorofare Bridge	B-3	72	8.71
	B-4	77	8.26
Middle Thorofare Bridge	B-5	52	5.17
	WB-1	121	2.19
	B-6	52	4.55
Roadway Borings	B-7	52	3.48
	B-8	52	4.59
	PB-1	37	6.38
	PB-2	37	5.82
	PB-3	32	6.14
	PB-4	27	7.2
	PB-5	27	5.14
	PB-6	37	5.6
	PB-7	37	5.87
	PB-8	42	5.82
	PB-9	32	5.71

Geotechnical laboratory index testing was performed by French and Parrello Associates of Holdmel, NJ and Princeton Geotechnical and Material Services, LLC of Trenton, NJ. Index testing consisted of natural water content, particle size distribution analysis, hydrometer test, Atterberg determination of fine soil samples, organic content, and dry unit weight. Four one-dimensional consolidation tests were also performed on undisturbed (obtained by Shelby tubes) cohesive soil samples. The undrained shear strength of the cohesive soil was determined using pocket penetrometer and torvane test. Laboratory test results are shown in **Appendix G**.

Based on test borings results, subsurface conditions within the project limit can be generalized into four layers described in order of increasing depth.

- Layer I: Granular Fill Material (2’ to 6’ thick):
  The top layer below grade consists mainly of granular fill material that is comprised of brown and gray coarse to fine sand with varying amounts of gravel (mostly fine) and silt. Shells and roots were occasionally encountered in the fill layer. The SPT N-Value for the fill material ranged from 10 to 48, with the majority of N-values ranging from 10 to 30 indicating medium dense soil state.
- Layer II: Fine to Coarse Sand with Silt (2’ to 16’ thick):
  The second soil stratum consists mainly of fine to coarse cohesionless sand with varying amounts of silt and fine gravel. Shell fragments were also observed in some soil samples. SPT N-values for this soil layer varied between weight of hammer (WOH)

and 34 indicating loose to medium dense soil condition. The particle size distribution analysis for five samples obtained from this stratum indicated that the about 78% of the soil particles are coarse fraction (larger than #200 sieve or 0.075 mm). Layer II can be classified as SM and SW-SM per unified soil classification system (USCS).

- Layer III: Organic Silt and Clay/Tidal Marsh, (7' to 24' thick):
  A layer of fine cohesive soil underlies the Sandy layer. This tidal marsh layer is comprised of dark gray organic silt, organic clay, and peat. Varying amounts of fine sand, shell fragments, and roots were occasionally encountered. The cohesive soil in this layer is very soft. Sampler advance typically recorded WOH and Weight-of-Rod (WOR). Higher N-values (1 to 36) were encountered at the interfaces with the granular materials above and below this layer. Laboratory test results indicated that the natural water content ranges from 31% to 133%, the liquid limit ranges from 28% to 166%, and the plastic limit ranges from 16% to 66%. Layer III was laboratory classified as high plasticity organic soil (OH) per USCS. The undrained shear strength of the organic silt and clay was determined using pocket penetrometer and torvane test. The undrained shear strength was estimated to be as low as 250 psf. Limited one dimensional consolidation tests on undisturbed soil samples from this layer indicated very high compressibility. The secondary consolidation coefficient is high. (A high secondary consolidation coefficient implies post construction settlement of embankments over this soil layer over a prolonged period of time if this soil layer is not properly improved. Recommendations to mitigate potential consolidation are discussed later in this report.

- Layer IV: Alternating Layers of Cohesionless and Cohesive Materials
  The organic cohesive soils are underlain by alternating layers of cohesionless and cohesive soils. The cohesionless soils are comprised of fine to coarse sand with varying amounts of silt fine gravel. SPT N-values for the sandy layers varied between 5 and 130 with a majority of N-values between 20 and 60 indicating medium dense to very dense soil condition. The thickness of the sandy sublayers varies between 1 and 19'. Medium stiff to very hard cohesive soil layers were also encountered within layer IV. The cohesive soils are comprised of silts and clays with varying amounts of fine sand. Organic silt and clays were also occasionally encountered within this sublayer. SPT N-values of the cohesive sublayers varied between WOH and 84, most frequently between 5 and 35. The thickness of the cohesive sublayers varied between 1' and more than 30'.

  Particle size analysis on two soil samples from the granular material within layer IV indicated that soil contains about 81% fine to coarse sand with about 19% fine soil fraction. The natural water content for the cohesive soil samples ranged from 27% to 52%. Liquid limit varied between 26% and 66% and plastic limit ranged from 17% to 27%. The cohesive soils in this layer were classified as low plasticity clay (CL) per USCS. The undrained shear strength was measured using pocket penetrometer and was estimated to be 1000 psf. Based on the regional geology and Michael Baker's experience on Route 52 Causeway project in Cape May County, NJ, the cohesive soil is over-consolidated.

5. **Curbs**
   Curb is not provided along the majority of the study limits. Sections of curb are present at some intersections and driveways along Ocean Drive.

6. **Guide Rail**
   Guide rail is provided in the vicinity of the three bridges, as well as on the northerly side of Ocean Drive in the vicinity of NJ 109.

7. **Highway Lighting**
   Limited roadway lighting exists along both sides of the roadway for the entire length of the study limits. Lighting is primarily concentrated at the bridge locations. Analysis to determine if the existing lighting meets NJDOT Standards was not included as part of this study. A lighting warrant analysis and conceptual level plans for the layout of lighting design will be completed during future design phases.

8. **Railroad Crossing**
   Within the study limits there are no railroad crossings.

9. **Land Use**
   The surrounding area is generally comprised of preserved land, commercial and light residential.

10. **Bicycle and Pedestrian Compatibility**
    Ocean Drive, within the study limits, is considered an urban/rural minor arterial section. Sidewalk and other pedestrian and bicycle facilities are currently provided along Ocean Drive in the vicinity of NJ 109. Overall, the corridor is not considered bicycle and pedestrian compatible.

11. **Complete Street Compatibility**
    According to the NJDOT Complete Streets Policy dated December 2009, a complete street facility provides safe access for all users by providing a comprehensive, integrated, multi-modal network of transportation options. Complete street design includes investigation of bicycle, pedestrian, and transit facilities to ensure mobility for all users, including those with disabilities.

    As part of the field inventory, the Complete Streets checklist was utilized and is included in **Appendix H**. Documented assessments of existing curb ramps and pedestrian control features at the intersections within the study limits were also performed and included in the ADA Checklists in **Appendix I**.

12. **Storm Drainage System**
    The project area is located within the Cape May HUC-14 Watershed (02040302080090). The project consists of seventeen (17) overall surface drainage areas within the project limits that contribute to the watershed. The ultimate point of discharge for the drainage areas is the Cape May Inlet.

13. **Concurrent Projects**
    There are no concurrent projects within the study area.

14. **Landscaping**
    There is no formal landscaping within the study limits.

15. **Jurisdiction**
    Ocean Drive, within the study limits, is under the jurisdiction of Cape May County.

16. **ITS Facilities**
    There are no ITS facilities present within the study limits.

17. **Transit**
    Transit is not present within the study limits.

E. Existing Drainage and Storm Water Inventory and Condition

The project area is located within the Cape May HUC-14 Watershed (02040302080090). The project consists of 17 overall surface drainage areas within the project limits that contribute to the watershed. The ultimate point of discharge for the drainage areas is the Cape May Inlet. The majority of Ocean Drive is umbrella section and drains by sheet flow to the marshes and waterways along Ocean Drive. The existing bridges along Ocean Drive are curbed and drained by curb openings that free drop into their respective waterways. The Ocean Drive approach to the intersection with NJ-109 is curbed and runoff is collected via a series of inlets and pipes that discharges within the area. The runoff of NJ-109 is collected via a series of inlets and pipes that discharges to a newly constructed basin west of NJ-109 before ultimately discharging to the Cape May Canal. There are 17 points of interest (POI) within the project area and each is as follows:

- POI # 1 drains Drainage Area 1 and is located northwest of the existing Mill Creek Bridge;
- POI # 2 drains Drainage Area 2 and is located southwest of the existing Mill Creek Bridge;
- POI # 3 drains the existing Mill Creek Bridge;
- POI # 4 drains Drainage Area 4 and is located northeast of the existing Mill Creek Bridge;
- POI # 5 drains Drainage Area 5 and is located southeast of the existing Mill Creek Bridge;
- POI # 6 drains Drainage Area 6 and is located northwest of the existing Upper Thorofare Bridge;
- POI # 7 drains Drainage Area 7 and is located southwest of the existing Upper Thorofare Bridge;
- POI # 8 drains the existing Upper Thorofare Bridge;
- POI # 9 drains Drainage Area 9 and is located northeast of the existing Upper Thorofare Bridge;
- POI # 10 drains Drainage Area 10 and is located southeast of the existing Upper Thorofare Bridge;
- POI # 11 drains Drainage Area 11 and is located northwest of the existing Middle Thorofare Bridge;
- POI # 12 drains Drainage Area 12 and is located southwest of the existing Middle Thorofare Bridge;
- POI # 13 drains the existing Middle Thorofare Bridge;
- POI # 14 drains Drainage Area 14 and is located northeast of the existing Middle Thorofare Bridge;
- POI # 15 drains Drainage Area 15 and is located southeast of the existing Middle Thorofare Bridge;

- POI # 16 drains Drainage Area 16 and consists of the westbound side of Ocean Drive between approximately M.P. 1.9 and Madison Avenue;
- POI # 17 drains Drainage Area 17 and consists of the eastbound side of Ocean Drive between approximately M.P. 1.9 and Madison Avenue.

The locations of the 17 POIs are identified in the Drainage and Stormwater Management Existing Conditions Memorandum located in **Appendix J**.

In general, the drainage areas consist primarily of the existing roadway and are essentially developed with large amounts of impervious surfaces. The existing topography has little to flat slopes, with the Middle Thorofare Bridge approaches being more steeply sloped. Since the area is mostly drained by umbrella section sheet flow and the roadway is at a higher elevation than the surrounding area, there is a low time of concentration. The Soil Survey of Cape May County, NJ was examined to identify soils within the project area. According to the soil survey, three soil series types underlie the study area and are identified as Urban land-Psamments, sulfidic substratum complex, 0 to 2 percent slopes, occasionally flooded; Appoquinimink-Transquaking-Mispillion complex, 0 to 1 percent slopes, very frequently flooded; and Pawcatuck-Transquaking complex, 0 to 1 percent slopes, very frequently flooded.

Existing drainage areas include areas parallel to the roadway to account for anticipated limits of disturbance and roadway widening. A detailed hydraulic analysis, including scour calculations and design of scour countermeasures, will be provided during Local Preliminary Engineering to demonstrate compliance with both the NJDEP FHACA and stormwater management regulations. A criterion of the project is to elevate the roadway in the project area above the 100-year floodplain. Coastal elevations for the 10, 50, 100 and 500-year FEMA effective flood insurance study are shown in the table below. The 100-year flood elevation along Ocean Drive was determined from the 1983 Flood Insurance Rate Maps (FIRM) for Cape May, NJ (FEMA, 1983). The project is mapped on Panels 340153007B and 340153008B, effective date February 2, 1983 and are the most recent maps provided for the area. The FEMA FIRMs are shown in **Appendix J** and report the 100-year flood elevation near Ocean Drive as 10' NGVD 1929, Zone A7 (EL 10). This corresponds to an elevation of 8.7' NAVD 1988.

The FEMA Flood Insurance Study (FIS) of Lower Township, Cape May County, NJ, dated August 2, 1982, provides a summary of elevations for the Atlantic Ocean in this location. **Table 6** below lists these elevations.

Table 6: Coastal Flood Elevations towards Atlantic Ocean

FLOOD EVENT	ELEVATION (NGVD 29)	ELEVATION (NAVD 88)
10-Year[1]	6.3	5.0
50-Year[1]	8.5	7.2
100-Year	9.8/15.0[2]	8.5/13.7[2]
500-Year[1]	13.1	11.8

[1]Surge Stillwater Elevation
[2]Surge Stillwater Elevation / Maximum Wave Crest Elevation

Cape May County has recently adopted new FEMA floodplains for all of the communities in the county except for Lower Township. It is understood that Lower Township is appealing the FEMA study due to velocity (VE) zones depicted in back bay areas of Lower Township. Their appeal is expected to not change the elevations at this project location. The preliminary maps depict a

range of elevations over the project area. See **Appendix J** for the preliminary FEMA FIRMS. At this time, it is recommended to design the roadway to the unapproved elevations in anticipation that by the time the project is constructed, higher base flood elevations will be adopted.

F. Hydrodynamics Study

A detailed hydrodynamic study for Ocean Drive Causeway (CR621) Local Concept Development Study was performed using the state-of-art ADCIRC hydrodynamic model. A short summary of the results is provided below:

- A high-resolution ADCIRC hydrodynamic model with the best available digital elevation models (DEMs) was developed for modeling hydrodynamics along the Ocean Drive project site for existing conditions and the preferred alternative design. A model resolution of 10 ft was used, to appropriately resolve existing and proposed bridge, roadway and culvert structures in the project area.
- Results from model calibration and validation indicate that the high-resolution model is capable of simulating both water levels and velocity attributed to the combined forcing of tides and storm effects.
- Results comparing the maximum water elevation from 100-year storm simulations reveal that the hydrodynamic impacts due to the proposed bridge, roadway, and culvert designs are negligible when compared to the existing conditions. The change of water level is within ±0.5 ft in most places within the project area. The preferred alternative design would not be inundated during a 100-year storm due to elevations of proposed bridges and roads that are above the effective 100-year base flood elevation. Additionally, results of modeled maximum velocity suggest that the proposed culvert design would significantly reduce the magnitude of velocity at the site of Old Lower Thorofare Culvert.

In summary, the modeled results show that changes in water elevation and flow patterns due to the proposed bridge, roadway, and culvert designs do not present significant negative impacts to the project area in terms of increased area of inundation or increased velocities during 100-year storm events. However, given the dynamic and complicated nature during the extreme events at the project site, it is recommended that further refined hydrodynamic modeling be performed once the project moves to Local Preliminary Engineering to account for any adjustments to the preferred alternative. The Hydrodynamic Study Report is included in **Appendix K**.

G. Existing Utilities

There are existing utilities and highway lighting within the study limits that include utility poles (electric, cable and telephone) with aerial crossings over Mill Creek and Upper Thorofare.

In February 2018, copies of Utility Letter No. 1 were sent to utility companies to verify existing facilities located within study limits. A copy of the Utility Letter No. 1 is included in **Appendix L**. Based on the responses to Utility Letters, as-built information and field observations, the existing utilities in the vicinity of the study are listed in **Table 7**.

Table 7: Existing Utility Owners

UTILITY	OWNER	CONTACT
Electric	Atlantic City Electric	Jeffrey Mercanti
Gas	South Jersey Gas	Kenny Chen
Telephone	Verizon	Thomas Reber
Cable	Comcast	Tim Mills
Sanitary Sewer (Force Main)	Lower Township	Mike Chapman

H. As-Built Plans and Right of Way Maps

As-Built Plans can be found in **Appendix B**. The plans reviewed include:

- Route 109 & CR621 (Ocean Drive) Traffic Signal Installation Plan, June 28, 2017
- Bridge Construction for Ocean Highway Bridges P.W.A. Project N.J. 1038-F As Builts, 1938
- Ocean Drive Bridges Miscellaneous Structural Repairs Design Drawings, 2008

IV. TRAFFIC AND CRASH SUMMARY

A. Traffic Operations

A traffic operations analysis was performed to detail the predicted traffic conditions for the current, construction, and design year traffic volumes within the study limits. This analysis was performed in accordance with FHWA Highway Capacity Manual (HCM, 2010) procedures. Socio-economic and census data for Cape May County and Lower Township were utilized to develop the design year growth rate and project traffic volumes for the construction and design years. Methodologies and findings of the traffic data collection and traffic analysis are presented in **Appendix C**.

B. Vehicle Traffic Volume

As part of the data collection process, Automated Traffic Recorders (ATRs) were installed at various locations to count vehicle volumes in the vicinity of the three bridges. Two locations were counted in August 2017 during the summer peak and three locations were counted in December 2017. The bi-directional Average Daily Traffic (ADT) volumes collected during the seven-day period shown in **Table 8**.

Table 8: ATR ADT Volumes

	PEAK SEASON (SUMMER)	OFF-PEAK SEASON (WINTER)
Mill Creek Bridge	N/A	2,207 vehicles/day
Upper Thorofare	9,898 vehicles/day	1,990 vehicles/day
Middle Thorofare	9,901 vehicles/day	1,720 vehicles/day

The peak hours volumes collected during the off-peak and peak seasons along Ocean Drive are summarized in **Table 9**.

Table 9: ATR Peak Hour Traffic Volumes

	PEAK SEASON (SUMMER)		OFF-PEAK SEASON (WINTER)	
	HOUR	VOLUME	HOUR	VOLUME
AM Peak Hour	8:00 AM - 9:00 AM	618	7:45 AM - 8:45 AM	554
PM Peak Hour	4:45 PM - 5:45 PM	1,376	3:45 PM - 4:45 PM	623
Saturday Peak Hour	12:00 PM - 1:00 PM	1,488	12:15 PM - 1:15 PM	526

Additionally, peak hour turning movement counts (TMCs) were performed in December 2017 at the intersection of NJ 109 and Ocean Drive (CR 621). The turning movement counts for the AM and PM peak hours at the intersection of NJ 109 and Ocean Drive are shown in **Figure 17**. These were conducted during the off-peak season. The overall toll collection volumes at the Middle Thorofare Bridge during the off-peak and peak seasons, from years 2014 to 2016, are shown in **Figure 18**.

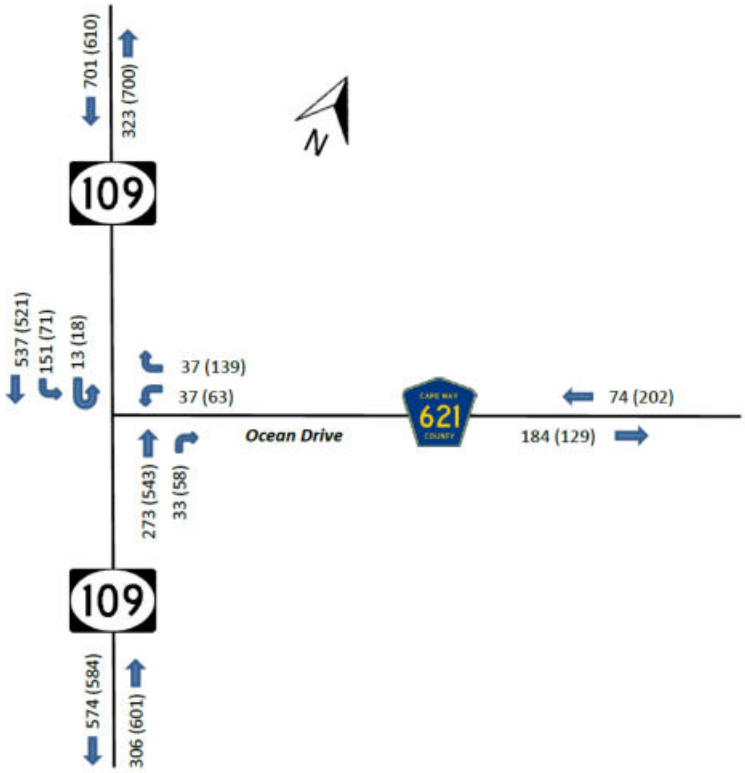

Figure 17: TMC Counts: Turning Movement Peak Hours (Off-Season)

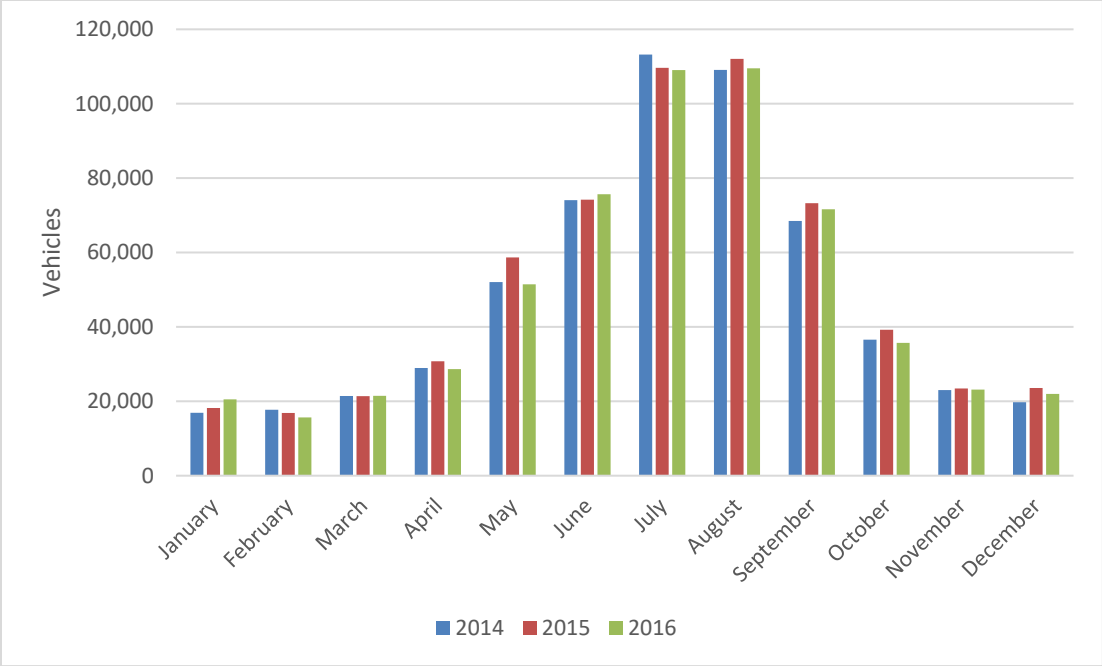

Figure 18: Toll collection volumes at Middle Thorofare Bridge

Traffic volume data collected as part of this study are included in **Appendix C**.

C. Traffic Volume Forecasts

The turning movement volumes will be grown using an annual background growth rate of 1% to project traffic volumes from the base year (2017) to the anticipated construction year (2026). This assumes a conservative growth rate and takes into consideration possible increases in commercial and truck traffic on the new bridge. For traffic volume projections from the anticipated construction year (2026) to the anticipated design year (2046), a 0.33% growth rate will be applied to conservatively project volumes.

The Background Growth Rate Memorandum, and the existing, construction and design year traffic volume diagrams are included in **Appendix M**.

D. Traffic Operations Analysis

Level of Service (LOS) analyses were conducted for the intersection of NJ 109 and Ocean Drive using Synchro software to determine if the intersection currently operates acceptably. Under existing off-peak conditions (Winter), the intersection operates at LOS B during both the AM and PM peak hours. During both the AM and PM peak hours, the westbound left turn and southbound left turn movements operate at LOS D, the northbound through movement and westbound right turn movement operate at LOS B, while the remaining movements all operate at LOS A.

Detailed analysis including traffic volume diagrams are included in the HCS Analysis and Summary in **Appendix C**.

E. Non-Motorized Traffic Activity

Pedestrians and bicyclists were not observed while the TMCs were being conducted. However, it should be noted that these observations occurred during the off-peak season in December and

non-motorized traffic activity may be observed more during the summer peak season. It is known that bicyclists, particularly fishing industry workers, use Ocean Drive to commute to work.

F. Marine Traffic

Bridge opening data was obtained from Cape May County for the most recent three years (2015-2017) for the Middle Thorofare Bridge. The openings during the peak season (Memorial Day to Labor Day) accounts for 60% of openings, while the off-peak season accounts for 40% of openings. **Table 10**, **Table 11**, and **Table 12** summarize the yearly bridge openings by peak, by month, and by height, respectively.

Table 10: Peak Bridge Openings (Per Year)

	2015	2016	2017	Average
Total	5,223	5,642	5,203	5,356
Off-Peak	1,898	2,446	2,050	2,131
Peak	3,325	3,196	3,153	3,225
Peak %	64%	57%	61%	60%

Table 11: Bridge Openings by Month

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
2015	178	89	172	182	602	823	1,316	790	424	301	224	122	5,223
2016	170	96	143	271	485	884	1,080	1,104	479	435	311	184	5,642
2017	183	260	216	415	575	879	1,079	983	459	145	8	1	5,203
Average	177	148	177	289	554	862	1,158	959	454	294	181	102	5,356

Table 12: Bridge Openings by Height

	2015	2016	2017	Average
25'	236	196	258	230
30'	23	45	41	36
35'	0	0	0	0
40'	1,320	1,583	1,507	1,470
45'	21	26	23	23
50'	111	112	122	115
55'	164	173	204	180
60'	703	554	613	623
65'	526	450	644	540
70'	45	125	125	98
75'	57	82	167	102

The existing vertical under clearance is 23' and the existing horizontal clearance is 50' fender to fender. A survey of all the local recreational and commercial vessels showed that the maximum known commercial vessel utilizing the channel requires a vertical clearance of 75' and the maximum known recreational vessels require a vertical clearance of 80'. To the north of Two Mile Bridge (Middle Thorofare), the next crossing is the George Redding Bridge (Rio Grande/NJ 47).

The George Redding Bridge has a bascule span with a closed position vertical under clearance of 25' and horizontal clearance of 57'. In North Wildwood, the only other crossing is at North Wildwood Boulevard (NJ 147). North Wildwood Boulevard Bridge is a fixed structure with the channel span having a vertical under clearance of 55' and horizontal clearance of 100'.

The existing structure opens on command an average of 32 times per day in the peak season. The complete collection of data and analysis can be found in the Navigation Impact Report in **Appendix N**.

G. Crash Data Analysis and Crash Diagram

Crash data was obtained from NJDOT for the most recent three years (2014-2016). During that time period, 31 crashes occurred within the study area. In terms of crash severity, three crashes (9.7%) resulted in moderate injury, four crashes (12.9%) resulted in complaints of pain, and 24 crashes (77.4%) did not result in complaints of pain. The four most common crash types were Fixed Object with 11 crashes (35.5%), Same Direction – Rear End with eight crashes (25.8%), Opposite Direction – Sideswipe with three crashes (9.7%), and Right Angle with three crashes (9.7%). Of the 31 crashes, seven crashes (22.6%) occurred in darkness, 20 crashes (64.5%) occurred in daylight, and four crashes (12.9%) occurred at dusk. **Table 13** shows a summary of crash types and percentages.

Table 13: Crash Table

CRASH TYPE	# OF CRASHES	PERCENTAGE
Same Direction – Rear End	8	25.8%
Fixed Object	11	35.5%
Right Angle	3	9.7%
Opposite Direction - Sideswipe	3	9.7%
Other	2	6.5%
Non-Fixed Object	1	3.2%
Left Turn/U-Turn	1	3.2%
Same Direction - Sideswipe	1	3.2%
Struck Parked Vehicle	1	3.2%
TOTAL	**31**	**100.0%**

The highest crash concentrations occurred near the Middle Thoroughfare Bridge. Seven crashes (22.6%) occurred on the Middle Thoroughfare Bridge and four crashes (12.9%) occurred at the base of the bridge. Of the six crashes that occurred on the Middle Thoroughfare Bridge, five were Fixed Object and one was Opposite Direction – Sideswipe. The tollbooth is a contributing factor to the Fixed Object crashes on the bridge. **Table 14** summarizes the crash rates calculated along Ocean Drive.

Table 14: Crash Rates Table

PROJECT SEGMENT	MILEPOST	SHOULDER PRESENT?	CRASH RATE	STATE-WIDE CRASH RATE (2016)*
NJ 109 to Mill Creek Bridge	0.00 - 0.80	Yes	1.41	3.90
Mill Creek Bridge	0.80 - 0.85	No	9.03	2.64
Mill Creek Bridge to Upper Thorofare Bridge	0.85 - 1.30	Yes	1.50	3.90
Upper Thorofare Bridge	1.30 - 1.36	No	11.29	2.64
Upper Thorofare Bridge to Middle Thorofare Bridge	1.36 - 1.70	Yes	2.66	3.90
Middle Thorofare Bridge	1.70 - 1.88	No	8.78	2.64
Middle Thorofare Bridge to Madison Avenue	1.88 - 2.75	Yes	1.82	3.90

** Source: NJDOT Crash Rates by Cross Section Geometry for State and Interstate Routes (2006-2016). County Route Crash rates by Cross Section Geometry are not available.*

The findings of the Historical Crash Review will be used in the development and evaluation of bridge alternatives. Roadway features that contribute to the observed crash patterns, such as substandard roadway design elements, will be addressed when possible. Additionally, safety measures can be incorporated into future roadway design based on observed crash types. For example, a high frequency of Same Direction – Rear End crashes may indicate a need for advanced warning signs, right or left-turn lanes, or increased skid resistance. Frequent Fixed Object crashes may indicate the need for guiderails, shoulders, improved roadway lighting, or a reduced speed limit. A high concentration of Sideswipe crashes may indicate the need for wider vehicle travel lanes or increased shoulder widths. The Historical Crash Review, Crash Diagrams, and Crash Table are included in **Appendix O**.

V. SOCIAL, ECONOMIC AND ENVIRONMENTAL SCREENING

The Environmental Screening Report was prepared in January 2018, and a copy of the completed screening report and supplemental constraints map are provided in **Appendix P**.

A. Community Outreach

Stakeholders were identified and a letter of notification regarding the Ocean Drive Upgrades and Bridge Improvements CD Study was sent by Cape May County to the municipalities within the study limits. The letter included a brief description of the study and provided a point of contact to address any concerns from the local officials.

Public Involvement during the study included the creation of a public website to promote the study and keep the public informed of the study and overall process. Legal Advertisements for each of the Public Information Meetings were published in the Cape May Herald, Atlantic City Press, and Cape May Star and Wave. Public Information Meeting notices were posted on the project website and the Cape May County Library – Wildwood Crest and Cape May City branches, as well as Lower Township, Wildwood City and Cape May City were all asked to post the meeting notices at their locations. Additionally, Public Information Meeting notices were mailed to residents within 500' of the project area.

A Community Stakeholders Survey form was sent out in April 2018 to the local and regional stakeholders to solicit their input on the perceived transportation needs and concerns within the study area. The survey was also made available on-line with a link from the project website. A

total of 24 survey responses were received. The results of the questionnaire survey included the following feedback:

- EZ-Pass alone would ease traffic toward Cape May
- Driving speed needs to be reduced to 25mph in both directions
- Minimal detours during June, July, and August should be obtained at all costs. That information should be posted well in advance.
- If closed, there will be significant impact to Wildwood Crest businesses and local marinas as there are no convenient solutions
- Keeping the current businesses along Ocean Drive easily accessible for customers, tractor trailers and boat trailers. All the businesses along Ocean Drive cater to the tourist industry and are going to be more impacted by traffic changes and detours than the fisheries marine traffic.

This project was presented to local officials and the public through the following community outreach activities:

- The first Local Officials Meeting was conducted on November 1, 2017 in the Cape May County Administrative Offices, Cape May Court House, NJ
- The second Local Officials Meeting was conducted on March 28, 2018 in the Cape May County Administrative Offices, Cape May Court House, NJ
- The first Community Stakeholders Meeting was conducted on April 16, 2018 in the Millman Community Center, Villas, NJ
- The first Public Information Center Meetings were conducted on May 3, 2018 in the Crest Pier Recreational Center, Wildwood Crest, NJ, in the afternoon, and Cape May City Hall Auditorium, Cape May, NJ, in the evening
- The third Local Officials Meeting was conducted on August 14, 2018 in the Cape May County Administrative Offices, Cape May Court House, NJ
- The second Community Stakeholders Meeting was conducted on August 22, 2018 in the Meeting Room of Township Hall, Lower Township, Villas, NJ
- The second Public Information Center Meetings were conducted on August 23, 2018 in the Meeting Room of Township Hall, Lower Township, Villas, NJ in the afternoon and evening
- The fourth Local Officials Meting was conducted on March 12, 2019 in the Cape May County Administrative Offices, Cape May Court House, NJ
- The third Community Stakeholders Meeting was conducted on March 14, 2019 in the Meeting Room of Township Hall, Lower Township, Villas, NJ
- The third Public Information Center Meetings were conducted on April 11, 2019 in the Crest Pier Recreational Center, Wildwood Crest, NJ, in the afternoon, and Cape May City Hall Auditorium, Cape May, NJ, in the evening

  Feedback and input collected during the public meetings include the following:

  - Agreement that current bridges need replacement/rehabilitation
  - Concern about disruptions to business along Ocean Drive during construction
  - Support for a fixed span Middle Thorofare
  - Concern about drainage and ROW implications for affected businesses along Ocean Drive
  - Desire for minimal disruption
  - Support for resiliency improvement of an evacuation zone

- Concern for project funding and future tolling

Based on the input received, there is general public support to the presented PPA. A Resolution of Support was received from Cape May County. Resolution of Support is expected from Lower Township.

The PIAP, stakeholders list, survey summary can be found in **Appendix D**. The minutes of the above listed meetings can be found in **Appendix Q**. A copy of the Resolution of Support from Cape May County can be found in **Appendix R**.

B. Noise and Air Quality

Cape May County is in attainment for all applicable NAAQS except for Ozone. Sensitive receptors such as, hospitals, schools, daycare facilities, elderly housing and convalescent facilities, do not occur within the study area. The project is not anticipated to result in changes to vehicular traffic volumes, vehicle speeds, travel patterns or types of vehicles that would affect localized or regional pollutant levels. As a result, no further air quality assessment is required.

Based on the Federal Highway Administration (FHWA) 23CFR772 guidance for noise, Category B, C, and E noise sensitive receptors are located within the project area. Due to the proposed improvements, the project would be classified as a Type I project requiring a quantitative noise assessment.

C. Socioeconomics

A Community Profile was developed for populations within the study limits of the Township of Lower to determine existing community information and identify potential concerns and considerations. The Community Profile provides comprehensive information about the communities within which the study is located. Findings from the Community Profile was used to develop the PIAP and stakeholder list. An EJSCREEN analysis, an Environmental Justice (EJ) mapping tool provided by the Environmental Protection Agency (EPA), was also used to analyze the population living within 500' of the bridges and causeway.

Within the study, median incomes are high, and the population consists mostly of families in single-family, owner occupied housing units. The majority of these units are second homes. No residents within 500' of the bridge reported a limited knowledge of English, and a large majority of residents were identified as Non-Hispanic White. Most residents drive alone to work or work from home. During the planning process, special considerations may be needed for older residents (47.8% of the population) to fully participate. However, due to the absence of vulnerable minority or low-income groups, this project is unlikely to require enhanced public outreach efforts. A copy of the Community Profile is included in **Appendix S**.

D. Cultural Resources

There is one known historic resource within the study area, the Ocean Drive over Middle Thorofare Bridge (Structure No. 3100-006). The bridge is eligible for listing on the State and National Registers of Historic Places under Criterion A and Criterion C.

There are six additional historic resources identified during background research that occurred adjacent to but outside of the Study limits, including:

- Garden State Parkway Historic District (SHPO Opinion 10/12/2001);
- Cape May Historic District (State: 12/10/1970; National: 12/29/1970);

- Hornbeam (SHPO Opinion 3/17/1999);
- Wildwoods Shore Historic District (SHPO Opinion 7/23/2003);
- The Atlantic City Railroad Cape May Division Historic District (SHPO Opinion 7/2/2004); and
- The USCG Loran-C Support Unit Wildwood (SHPO Opinion 12/2/2011).

Additionally, an underwater survey conducted in 2013 identified six potential targets in proximity to Upper Thorofare and south of Ocean Drive. However, a review of National Oceanic and Atmosphere Administration (NOAA) online mapping showed no shipwrecks in the study area.

As the project will require federal approvals from the US Army Corps of Engineers (USACE) and the US Coast Guard (USCG), consultation with the NJ SHPO under Section 106 of the National Historic Preservation Act will be required. During this study, Section 106 consultation was initiated with the preparation of the Area of Potential Effect (APE) letter. The APE letter is included in **Appendix Z**.

E. Section 4(f) Properties

The Cape May Coastal Wetlands Wildlife Management Area (WMA), managed by the New Jersey Department of Environmental Protection (NJDEP) Division of Fish and Wildlife (DFW), is located north of Ocean Drive extending from Route 109 to Middle Thorofare. Green Acres funding was used to purchase a portion of this WMA; therefore, any encroachment must be coordinated through the NJDEP Green Acres Program.

The southeastern side of Ocean Drive extending from Middle Thorofare to the border of Wildwood is the Two Mile Beach Unit of the Cape May National Wildlife Refuge managed by the USFWS. Any proposed disturbance or encroachment within this area would require additional coordination with the USFWS.

A meeting was held on March 27, 2018 with USFWS to introduce and discuss the project. The USFWS was invited to provide input for the project due to the location of and possible impacts to the Cape May National Wildlife Refuge. The USFWS acquired most of the land where the previous PPA was proposed, therefore deeming the previous PPA no longer viable. During this meeting, it was stated that a Determination of Compatibility will be performed to determine if proposed activities meet the needs of the Cape May National Wildlife Refuge. Notes from this meeting are included in **Appendix Q**.

A second meeting was held on December 3, 2018 with USFWS to discuss the Determination of Compatibility and approval for use of the USFWS property. USFWS indicated that there are no real estate restrictions on the use of the property, but that roadways and bridges would be considered an incompatible use. Although the new bridge is not compatible with the wildlife refuge, the Department of Interior regulations has allowances for transportation facilities on federal lands; however, the process is lengthy and would require mitigation generally in the form of a land swap. Notes from this meeting are included in **Appendix Q**.

No schools, athletic fields, or other community parks are located within the study area.

F. Highlands/Pinelands

The project area is not located within the Highlands or Pinelands regions of NJ.

G. Wetlands

Wetlands within the study area were initially delineated in December 1999 and March 2002, and verified in 2010 and 2018. Coastal wetlands regulated under the Coastal Zone Management Rules (N.J.A.C. 7:7) border most of the Ocean Drive roadway corridor. Freshwater wetlands regulated under the Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A) exist within the study area where the delineated wetland extends above the upper coastal wetland boundary line. It is anticipated that the freshwater wetlands will receive a transition area of 150' due to the presence of threatened or endangered species or their habitat; however, the final determination of transition area width will be determined by the NJDEP.

H. Reforestation

The project will not result in the clearing of more than one half acre of contiguous forested land. The NJ No Net Loss Reforestation Act only applies to State owned or maintained projects.

I. Floodplain

The base flood elevation (BFE) of the 100-year floodplain along Ocean Drive is 10' (NAVD 29) within flood zone A7 according to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Numbers 3401530007B and No. 3401530008B from 1983. Preliminary updates to FEMA Flood Mapping, proposed in 2015 but not yet adopted by FEMA, within Lower Township shows the BFE at 11' (NAVD 88) within flood zone VE.

J. Sole Source Aquifer

The study area is located within the Coastal Plain Sole Source Aquifer which is the largest in NJ encompassing more than 50% of the state over nine counties. Depth to groundwater is highly variable throughout this region.

K. Threatened / Endangered Species

Data on the potential presence of state and federal listed species was obtained through review of the USFWS Service Information for Planning and Consultation tool (IPaC), NJDEP Natural Heritage Program (NMP), NJDEP Landscape data (Version 3.3), and National Marine Fisheries Service Online Mapper.

Due to the project's location near the Cape May Coastal Wetlands Wildlife Management Area and the Cape May National Wildlife Refuge, the land surrounding the project area contains suitable habitat for a variety of threatened and endangered species.

The following species were identified within the project area:

<u>USFWS IPaC report dated December 13, 2017</u>

- piping plover (*Charadrius melodus*, federal threatened/state endangered)
- red knot (*Calidris canutus rufa,* federal threatened/state endangered)
- American chaffseed (*Schwalbea americana,* federal endangered)
- seabeach amaranth (*Amaranthus pumilus,* federal threatened)
- swamp pink (*Helonias bullata,* federal threatened)
- 29 Migratory Bird Species protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act

NJDEP NHP data request dated December 20, 2017

- bald eagle (*Haliaeetus leucocephalus*, state endangered, foraging)
- black skimmer (*Rynchops niger*, state endangered, foraging)
- black-crowned night-heron (*Nycticorax nycticorax*, state threatened, foraging and nesting)
- yellow-crowned night-heron (*Nyctanassa violacea*, state threatened, foraging and nesting)
- cattle egret (*Bubulcus ibis*, state threatened, foraging)
- least tern (*Sternula antillarum*, state endangered, foraging)
- osprey (*Pandion haliaetus*, state threatened, foraging and nesting)
- Migratory Raptor Winter Concentration Site
- Natural Heritage Priority Site – Two Mile Beach Unit (located on the Cape May National Wildlife Refuge)

A historic heron rookery was formerly located on the Coast Guard Reservation, however, correspondence with the NJDEP Nongame and Endangered Species Program determined that the heron rookery was no longer active within the study area and that the nearest heron rookery was located over two miles outside of the study area limits.

The project area also supports transient fish species including the shortnose sturgeon (*Acipenser brevirostrum*, *federal/state endangered*), Atlantic sturgeon (*Acipenser oxyrinchus, federal/state endangered)* and transient turtle species Green Turtle (*Chelonia mydas*, *federal/state threatened*), Loggerhead (*Caretta caretta, federal/state endangered**)***, Kemp Ridleys (*Lepidochelys kempii*, *federal/state endangered*), and Leatherback (*Dermochelys coriacea*, *federal/state endangered*).

A small beach area south of the project area along the eastern shore of Middle Thorofare and within the Cape May National Wildlife Refuge may provide habitat for the federally-listed species piping plover, red knot and sea beach amaranth. Habitat for the remaining federally-listed species identified by IPaC above has been determined to not exist within the project area.

Essential fish habitat (EFH) has been identified throughout the project area for the following species:

- winter flounder (*Pseudopleuronectes americanus*)
- red hake (*Urophycis chuss*)
- monkfish (*Lophius spp*.)
- summer flounder (*Paralichthys dentatus*)
- black sea bass (*Centropristis striata*)
- scup (*Stenotomus chrysops*)
- Atlantic cod (*Gadus morhua*)
- longfin inshore squid (*Doryteuthis pealeii*)
- Atlantic herring (*Clupea harengus*)
- tiger shark (*Galeocerdo cuvier*)
- smoothhound shark (*Mustelus spp.)*

Intertidal/subtidal shallows and high commercial value shellfish habitat are also located within the study area which may serve as suitable habitat for the listed fish species. Submerged aquatic vegetation (SAV) mapping from the NJDEP does not show SAV within the study area.

L. Category 1 Waters

Per the NJDEP Surface Water Quality Standards GIS data, Mill Creek, Upper Thorofare, and Middle Thorofare are classified as FW2-NT/SE1 (freshwater, non-trout/saline estuarine). Dickenson Creek and Mud Hen Gut and their upstream tributaries, located within the Cape May Coastal Wetlands WMA immediately upstream of the study area, are designated as Category 1 waters and will receive a 300-foot riparian zone under the NJDEP Surface Water Quality Standards (N.J.A.C. 7:9B).

Remaining non-Category 1 waters throughout the project area will receive a 50' riparian zone due to the presence of state endangered species documented within one mile of the study area that are critically dependent on the regulated waterway for survival. Riparian zones do not extend within coastal wetland areas regulated under the Wetlands Act of 1970 and are not assigned to waters located on the oceanfront barrier island of Wildwood. Final riparian zone widths will be determined by the NJDEP.

M. Vernal Pools

There are no vernal pools or vernal habitat within the project area.

N. Stormwater

The proposed project qualifies as a "major development" under the Stormwater Management (SWM) Rules (N.J.A.C. 7:8) for expected disturbance of greater than 1 acre and/or an increase of more than 0.25 acre of impervious surface. Stormwater management for the project must be designed to meet water quality standards including a reduction in total suspended solids (TSS) from stormwater runoff by 95% within areas or new or reconstructed pavement discharging to a Category 1 waterway. Water quantity and groundwater recharge standards are not required within tidal areas.

O. Hazardous Material

A review of existing NJDEP GIS data shows Borden Foods (now the location of Bumble Bee Seafoods), Inc. located at 994 Ocean Drive (PI #G000001870) as the only site within the study area identified as a known contaminated sites and groundwater classified exception area (CEA). Additionally, a review of data requested through EDR dated December 13, 2017 shows an additional number of sites within the study area that currently or were historically linked with contaminated materials.

During project design, further investigation of all sites with potential areas of concern will be required to determine what, if any, hazardous waste remediation will be required. At that time a sampling plan will be developed and a Licensed Site Remediation Professional (LSRP) will oversee the management of the contamination if needed. Any work on existing bridge structures will also need to be evaluated for the potential presence of asbestos containing materials and lead-based paint.

P. Environmental Summary with Probable NEPA Document Required

Given the amount of possible impacts to environmental resources and potential encroachments within existing commercial businesses, an Environmental Assessment is anticipated to comply with the National Environment Policy Act of 1969.

Assuming the project is federally funded through the Federal Highway Administration, the anticipated permits and approvals are as follows:

Federal Permits/Approvals/Coordination

- US Army Corps of Engineers Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act Permit
- US Army Corps of Engineers Section 408
- US Coast Guard Section 9 of the Rivers and Harbors Act Bridge Permit
- USFWS and NMFS Section 7 Endangered Species Act Consultation
- NMFS Essential Fish Habitat Assessment
- FHWA Section 4(f) of the USDOT Act Evaluation
- NJ State Historic Preservation Office Section 106 Consultation per the National Historic Preservation Act
- FHWA NEPA Review

State Permits/Approvals/Coordination

- NJDEP Freshwater Wetlands Protection Act Permit
- NJDEP Coastal Area Facilities Review Act (CAFRA) Permit
- NJDEP Coastal Wetlands Act Permit
- NJDEP Waterfront Development Permit
- NJDEP Stormwater Management Plan Review and Approval
- NJDEP Flood Hazard Area Control Act compliance through the NJDEP Coastal Zone Management Rules
- NJDEP Water Quality Certificate
- NJ Pollutant Discharge Elimination System (NJPDES) Construction Stormwater Permit
- NJDEP Tidelands Conveyance
- NJDEP Green Acres Program Authorization and State House Commission Approval
- NJDEP Technical Guidelines for Site Remediation

Regional Permits/Approvals/Coordination

- Cape-Atlantic Soil Conservation District Soil Erosion and Sediment Control Plan Certification

Q. Navigation Impact

All alternatives were designed to accommodate current and expected future needs of the local recreational and commercial vessels. The movable alternatives were optimized for the current needs and has no vertical clearance limit. The fixed alternatives were set based on the maximum current and reasonably assumed future needs for the vessels. Full analysis of the navigational impact was performed and can be found in the Navigation Impact Report of **Appendix N**. The USCG Preliminary Navigation Clearance Determination Letter indicating that at least 80' of vertical clearance above mean high water and 80' of horizontal clearance through the main navigation span of the bridge is also included in **Appendix N**.

VI. EVALUATION OF CONCEPTUAL ALTERNATIVES

The primary purpose of this project is to address the structurally deficient and functionally obsolete conditions of the bridges and address other bridge and roadway deficiencies. An investigation of the existing conditions, including substandard bridge features, geometric conditions, and high vehicle crash locations was performed. This resulted in the identification of several roadway improvements and bridge improvement alternatives.

A. Roadway Improvements

Roadway conceptual alternatives were developed to complement the bridge conceptual alternatives based on the proposed cross sections as well as by comparing the existing CSDEs with high crash locations. Within the study limits, CSDEs were identified, for roadway elements in the following five element categories:

- Sight Distance (Horizontal Curve)
- Minimum Curve Radius
- Minimum Grade
- Lane Width
- Shoulder Width

As part of the alternatives analysis, the study investigated improving the CSDEs in coordination with drainage, traffic requirements and high crash accidents locations. Proposed improvements will be accomplished with minimal ROW and utility impacts.

With the No-Build bridge conceptual alternative, the roadway will remain below the 100-year flood elevation.

With the bridge conceptual Alternatives 2 through 8 (plus X), Ocean Drive will be widened to include 12’ lanes with 8’ shoulders in each direction. The entire study area will be elevated to meet 100-year flood elevation requirements.

1. Culvert Replacement

The existing pipe culvert just west of Fish Dock Road is a gathering place for recreational fishing and crabbing. This culvert is the only waterway that permits water to flow from the east side of Ocean Drive to the west side during tidal changes. The pipe is undersized and typically has water flowing through it at a high velocity as shown in **Figure 19**.

Figure 19: Existing Culvert

The new three cell box culvert (See **Figure 20**) will replace the undersized pipe culvert and will be properly sized to reduce the velocity of flow to acceptable levels that are not viewed as safety concerns. The box culvert will most likely consist of three 30-foot precast concrete units that can be installed in stages while traffic and flow through the existing pipe is maintained. The total length of the box culvert will be approximately 100'.

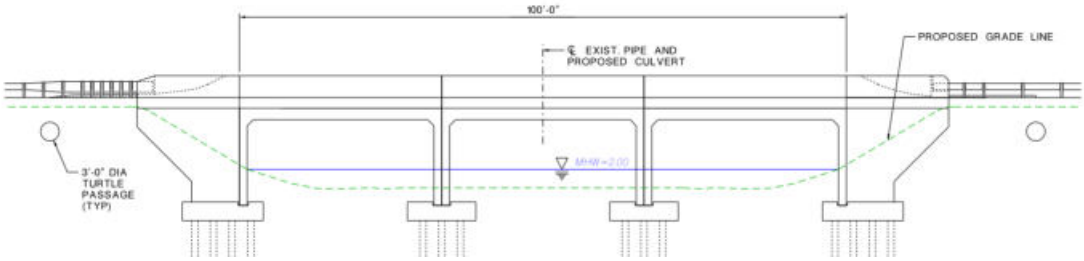

Figure 20: Proposed Three Cell Culvert

The proposed grade line for Ocean Drive in this section of the project will be increased above the 100-year flood elevation. At the location of the culvert, the approach grade is 0.3% on both sides of the structure.

Currently, this location is frequented by recreational fishing and crabbing. For this reason, there will be a 5-foot sidewalk provided on each side of the structure that is protected by the TL-4 approved barrier. The roadway cross section will maintain the normal roadway cross section with a 12-foot lane and 8-foot shoulder in each direction as shown in **Figure 21**.

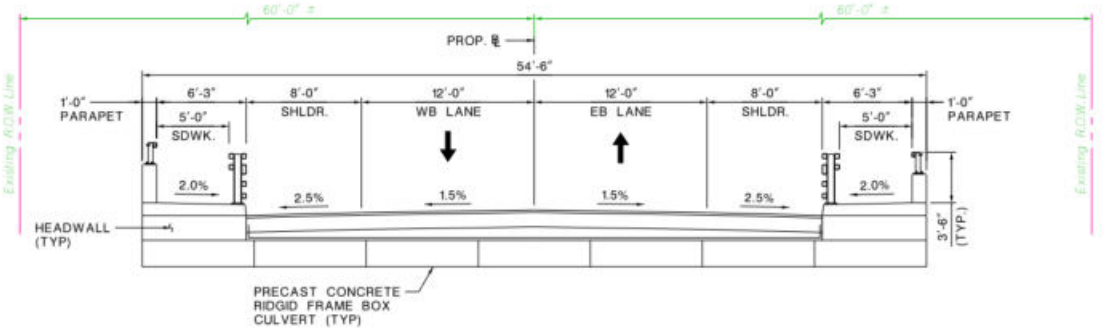

Figure 21: Proposed Culvert Cross Section

The three-sided box precast sections will be approximately 7'-9" wide to facilitate ease of shipment and placement. The headwall can be precast or cast in place as coordinated with the staging.

The proposed three cell precast box culvert meets the project needs and is viable for all Middle Thorofare alternatives.

B. 2004 Study Alternative Evaluation of Applicability (Previous Alternatives)

In 2004, Parsons Brinckerhoff-FG (now WSP), Inc prepared the Ocean Drive Upgrade and Bridge Replacement Alternative Analysis Report for the Cape May County Office of the County Engineers and SJTPO. As part of this CD Report, each of the previous alternatives were evaluated for applicability as part of this report.

1. Replace in Kind Alternative

The Replace In-Kind Alternative would retain the historic character of the existing Middle Thorofare Bridge by constructing a replacement bridge "in-kind", keeping the character, type, and style of the existing bridge intact while increasing its load carrying capacity to current standards, providing a scour resistant subsurface and improving operating and safety conditions where possible. In order to maintain the appearance of the existing bridge to the largest extent possible, it is estimated that the replacement bridge in this alternative would be reconstructed with the same span lengths while the bridge width would be increased to accommodate two 12-foot travel lanes and 8-foot shoulders, consistent with the approach roadways. The main span would not be capable of spanning the 80-foot fender to fender necessary based on the Navigational Report and still match the existing single leaf bascule span shown in **Figure 22**.

Figure 22: Existing Bascule Span

To replace the bridge in its present location, the existing structure would have to be closed in its entirety for at least 24 months and all traffic detoured. Maintenance of traffic would not be feasible on the bridge due to the narrow width of the existing structure, which would not accommodate even one lane of traffic during construction. The fact that the bridge is supported by only three longitudinal beams and three piles at each pier also complicated the staged construction operation.

Replicating the existing bridge would not be a cost-effective design. The steel superstructure of such a low-level bridge would be a constant source of maintenance problems, even with current state-of-the-art steel coating systems.

The redesigned trestle spans would be supported on 14-inch square prestressed concrete piles driven to a sufficient depth to ensure that they would not be subject to scour, erosion or shifting of the ocean floor. Protective measures would have to be used with these slim piles, to minimize problems associated with wave action. Precast pile caps grouted in place would be used to minimize construction in the water. The structural members would be similar to the existing plans but would be designed to carry an HS20 + 25% (45 tons) vehicle. The additional roadway width would increase the number of girders and make the two girder spans non-redundant.

While the in-kind replacement mitigates the loss of the original historic bridge by providing a "look alike" replacement designed to current load standards and future anticipated scour conditions, the result of this alternative would be a costly bridge, both in terms of construction and user and life cycle costs. Additionally, the bascule span would be constructed to match the existing navigational channel and therefore would still be substandard from a

vessel safety, maintenance, and socio-economic standpoint while the community would still be faced with the inconvenience of the movable span, single lane toll booths, and related traffic delays. This alternative will not meet the future requirements of the Commercial Fishing Industry.

2. **2004 Alternative 3A**
   This alternative shifted alignment south of the existing centerline to a new Middle Thorofare Bridge, constructed approximately 30' south of and parallel to the existing bridge. This alternative is no longer viable due to the USFWS Wildlife Management Area at the Southeast of the existing structure. The previous location of the East Abutment for 2004 Alternative 3A is no longer viable and therefore did not get advanced in this project. Additionally, this alternative required a major relocation of the existing underground sanitary sewer force main.

   Previously, the 2004 proposed Alternative 3A provided a movable structure consisting of a double-leaf bascule bridge with an increased vertical clearance of 45' in the closed position and a 130-feet wide horizontal opening between fenders at the navigation channel. The proposed approach spans would consist of AASHTO Type VI Prestressed Concrete Girders with a conventional concrete deck with span lengths of 124.5'. Foundations would consist of large cylinder piles or drilled shafts with a pier table at the waterline and piers with single shaft hammerheads or multi-column configuration. The provided a 45-foot minimum vertical clearance at the navigation channel and maintaining the 100-year flood elevation, would cause a significant increase to the roadway profile. The resulting profile increase was projected to cause 9 driveway adjustments and 2 driveway closures near the west abutment. Maintaining access to the numerous, remaining driveways in this area during construction would be extremely difficult due to their close proximity and the amount of embankment required in this area. Maintenance of access is a critical issue for this area of the project, as many of these driveways service fishing-related businesses with time-sensitive products. To maintain access to Lund's Fisheries, a new, realigned driveway supported on both sides by retaining walls would need to be constructed.

3. **2004 Alternative 3A**
   This alternative is the proposed Alternative 6A/6B alignment of a movable structure to the north of the existing alignment. This alternative was advanced and is evaluated in the Bridge Conceptual Alternatives section of this report.

4. **2004 Alternative 3C**
   This alternative was a high-level fixed bridge alternative on a new alignment. The proposed alignment was to the north of the existing alignment through the lands of the Marmora Wildlife Center crossing Upper Thorofare to the north of the Atlantic Cape Fisheries. The Middle Thorofare and Intracoastal Waterway crossing proposed a 75-foot vertical clearance and continuing across Thorofare Island on structure, crossing Lower Thorofare with a vertical clearance of 116'. The structure continued back towards the existing Ocean Drive alignment. This alternative also required a two lane service road connecting realigned Ocean Drive with the existing section of Ocean Drive between Upper and Middle Thorofare with a vehicular turnaround and related retaining wall. An additional service road would be required on the east due to substantial differences in grade in order to provide access to Fish Dock Road. The proposed superstructure was 4,640' with spans up to 350' using 54'-0" wide precast

segmental single cell box girders with superstructure depth between 10'-0" and 20'-0". This alternative is no longer viable due to the Marmora Wildlife Center and extensive access and service roads and therefore did not get advanced in this project.

5. 2004 Alternative 3D

This alternative was originally conceived in June 2000 by members of the local business community attending a public information center where other alternatives were presented. This alternative was identical to 2004 Alternative 3C from Route 109 up to and including the proposed service road just east of Upper Thorofare. The alternative's alignment then continued across Middle Thorofare, over Thorofare Island, across Lower Thorofare, around Two Mile Associates and tied into the existing Ocean Drive alignment about 500' south of Madison Avenue.

Because of the proximity of the tie-in location to Madison Avenue and Diamond Beach, the toll facilities for this alternative were located adjacent to the western abutment of the Middle Thorofare Bridge between the service road intersection. The service building and parking spaces were located adjacent to the service road.

As with 2004 Alternative 3C, the bridge featured a northbound approach grade of 5% and a vertical clearance of 75' over Middle Thorofare. A horizontal clearance of 155' was provided over the Intracoastal Waterway (Navigation channel). However, because the structure passes north of Two Mile Associates and its marina and fishing facilities, no particular vertical clearance is required over Lower Thorofare. Approximately 50' of vertical clearance was provided over this section of Lower Thorofare. The structure continues across tidal wetlands with an approximate 2% downgrade. Existing Ocean Drive was realigned to form a T-intersection with the new alignment. This realignment would preserve access to Dolphin Cove Marina located just east of the existing Middle Thorofare Bridge and Two Mile Landing. Similar to 2004 Alternative 3C, vehicular turnarounds would be constructed on either side of the existing Middle Thorofare Bridge, which would be demolished and the culvert near Fish Dock Road would be reconstructed. Approximately 500' of existing Ocean Drive pavement would be removed in the vicinity of the tie-in.

Utility relocations would be nearly identical to 2004 Alternative 3C, except there would be fewer pole relocations between Fish Dock Road and the easterly project limits since the roadway rejoins the existing alignment closer to the limit.

The Middle Thorofare Bridge and its approaches would be a single cell precast concrete segmental box girder that would also be used for the Upper Thorofare Bridge. This type of structure was recommended because of the uniformity of the cross section along the entire 5,220' of structure. Span lengths for the Middle Thorofare Bridge would be 175' and are constructed by the span-by-span method. The foundations, piers and deck construction for this alternative are the same as defined in 2004 Alternative 3C. This alternative had 535' of retaining walls with a majority of the length along the new western access road and the turnaround on the west side of Middle Thorofare.

This alternative is no longer viable due to the Marmora Wildlife Center and extensive access and service roads and therefore did not get advanced in this project.

6. **2004 Alternative 3E**
   This alternative presents an option featuring a fixed, high-level bridge over Middle Thorofare on an alignment shifted south of the existing bridge. Alternative 7 uses a similar alignment, was advanced in this project and will be evaluated in the Bridge Conceptual Alternatives.

7. **2004 Alternative 3F**
   This alternative also features a fixed, high-level bridge over Middle Thorofare, though on a new alignment. East of the Mill Creek Bridge, the proposed alignment curves to the right into lands of the Bree-z-lee Marina (Block 822.02, Lots 2 and 3). Alternative 5 uses a similar alignment, was advanced in this project and will be evaluated in the Bridge Conceptual Alternatives.

8. **2004 Alternative 3G**
   This alternative featured the exact same alignments, features and utility impacts as 2004 Alternative 3F, with the exception of the channel crossing for the Middle Thorofare Bridge. Instead of a Concrete Segmental Bridge for the entire length, 2004 Alternative 3G featured a Cable-Stayed Bridge as the main crossing of the Intracoastal Waterway within the 2,600' tangent section. The approach spans at each end of the bridge would consist of precast concrete segmental box girders utilizing a span-by-span construction method with a maximum span length of 180'-0". The approach foundations would be comprised of prestressed concrete hollow cylinder piles up to the water level, where a pile cap would be built. The pier shaft would be built on this water line pile cap. The shaft could either be cast-in-place or precast box pier cap segments. After the navigational impact report, the proposed vertical under clearance for fixed alternatives is 80' and a horizontal clearance of 80' fender to fender. A Cable-Stayed structure is not economical for these clearance requirements and will have a significant impact to the view shed. Additionally, this alternative is no longer viable due to the USFWS Wildlife Management Area at the Southeast of the existing structure and therefore did not get advanced in this project.

C. Bridge Conceptual Alternatives (Current Alternatives)

The bridge conceptual alternatives were developed to mitigate existing deficiencies. The following conceptual alternatives were identified:

- Alternative 1: No Build
- Alternative 2A: Replacement of Mill Creek and Upper Thorofare, Rehabilitation of Middle Thorofare
- Alternative 2B: Rehabilitation of Middle Thorofare (SOI) + Alternative 3
- Alternative 3: Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south
- Alternative 4: Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south
- Alternative 5: Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south
- Alternative 6A/6B: Replacement of all three bridges, realignment of Mill Creek, Upper Thorofare and Middle Thorofare to the north (Movable)
- Alternative 7: Replacement of all three bridges, realignment of Mill Creek and Middle Thorofare to the north, Upper Thorofare to the South

- Alternative 8: Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south
- Alternative X (Modified Alternative 3): Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south

With the No Build alternative, the roadway will not be reconstructed to meet the 100-year flood elevation requirements. With Alternatives 2 through 8, the roadway will be reconstructed to meet the 100-year flood elevation requirements.

The eleven bridge alternatives were developed to include the No Build, partial rehabilitation/replacement and full replacement options. Of the eleven alternatives, the "No Build" alternative does not address the Purpose and Need to advance the bridge rehabilitation or replacement project and therefore will not be discussed in detail throughout the remainder of this report.

For Alternatives 3 to 8 (plus X), the main difference is the location of the new alignments. The Mill Creek, Upper Thorofare and Middle Thorofare bridges will be replaced and will be widened to meet geometric requirements. The new bridges will utilize a precast concrete girder structural option.

The bridge rehabilitation and replacement alternatives were developed and were evaluated based on numerous parameters. Concept design sketches of the alternatives are presented in **Appendix T**.

A description of each alternative and the advantages and disadvantages of each alternative are summarized as follows:

Alternative 1 – No Build

This alternative would keep the bridges in the current state of repair. This No Build alternative will not address structural, geometric, carrying capacity, and operational deficiencies of the bridges. The roadway will remain below the 100-year flood elevation. The bridges would continue to be maintained as needed.

This alternative would not reduce the traffic delays and vessel restrictions resulting from the conditions at the existing Middle Thorofare Bridge. The roadway would continue to flood, and other elements requiring upgrades, such as the culvert near Fish Dock Road, will remain substandard.

Figure 23: Existing Middle Thorofare

Leaving the bridges unaltered, particularly the Middle Thorofare Bridge (**Figure 223**), will allow their deterioration to continue and will assuredly result in future repairs or replacements. The condition of the Middle Thorofare Bridge is such that a major storm could cause enough damage to require an immediate closure of the bridge and substantial disruption to the surrounding community and businesses. Routine maintenance and operation of the roadway would continue.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - No road closures due to construction
  - No near-term construction cost
  - No environmental impacts
- Disadvantages:
  - Does not meet the study's Purpose and Need
  - Does not improve CSDEs
  - Does not improve bicycle and pedestrian compatibility
  - High maintenance cost
  - Does not provide a 100-year life
  - No improvement to the number of bridge openings
  - Bridges will require replacement in the future

Alternative 2A – Replacement of Mill Creek and Upper Thorofare, Rehabilitation of Middle Thorofare

For Alternative 2A, the Mill Creek and Upper Thorofare bridges will be replaced due to the raising of the roadway profile to meet the 100' year flood elevation. The Middle Thorofare Bridge will be rehabilitated and still meet the 100' year flood elevation. This alternative maintains the existing condition and would involve the rehabilitation of the existing structures, reconstructing the roadway and raising it to meet the 100-year flood

elevation requirements. In a major rehabilitation contract, the NJ Department of Transportation requires that the resulting rehabilitated structure be designed such that no reduced load posting would be necessary. In other words, the bridge would have to be made capable of carrying the current national minimum standard design load specified by AASHTO (HS20), which is a 36-ton vehicle. Criteria for minimum clear roadway widths for new and reconstructed bridges require the width of the bridge to be the width of the traveled way plus 3' on each side.

Figure 24: Existing Bascule Span

The existing structural steel for the Middle Thorofare Bridge (even before it was severely corroded) was not capable of supporting a 36-ton vehicle, and it is not possible to increase the strength on the majority of the structure without replacing or supplementing that steel. Therefore, the main longitudinal beams, which run the length of the structure, must be replaced or supplemented with additional beams. The remainder of the bridge, which is comprised of the girder spans approaching the bascule span and the bascule span itself (**Figure 24**), is supported on only two longitudinal girders.

To satisfy the HS-20 (36 tons) load criteria, all the stringers, floorbeams, and roadway gratings of the bascule span will need to be replaced. In order to increase the capacity of the main bascule girders, all of the flange cover plates would have to be removed, and new larger flange plates constructed of higher strength steel would need to be added. In addition, the existing web plate of the existing girder is not thick enough to satisfy current design standards for local buckling, and therefore it will also be necessary to add a longitudinal stiffener to the web. All this work will be extremely difficult and costly because it would involve the removal of many rivets connecting the existing girder web to the existing cover plates.

In summary, to upgrade the bascule span to HS-20 loading, the entire bascule span, except for the web plate of the bascule girder itself, would need to be replaced. It would be much more cost effective to replace the entire bascule girder with a new girder.

However, for the comparative cost included in this study we have considered the alternative where the existing web of the bascule girder is left in place. Because the existing bascule girder and other steel members will be heavier, the counterweight that balances the bascule span will also need considerable retrofitting to maintain the span in balance.

The final result is a system which would require constant maintenance and repairs in addition to operation costs and inconveniences to both vehicular and navigational traffic at the Middle Thorofare Bridge. The roadway will perhaps be completely unavailable for the entire construction duration while the Middle Thorofare Bridge is closed for rehabilitation.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Least environmental impacts (of the build alternatives)
  - No property acquisitions required
  - Least amount of impacts to access
  - Shorter construction duration
  - Lower construction cost
- Disadvantages:
  - Does not meet the study's Purpose and Need
  - Does not improve all CSDEs
  - No improvement to the number of bridge openings
  - Does not improve bicycle and pedestrian compatibility over Middle Thorofare
  - Highest maintenance cost
  - Will not provide a 100-year service life for Middle Thorofare Bridge
  - Middle Thorofare Bridge remains functionally obsolete
  - Middle Thorofare Bridge will require replacement in the future

Alternative 2B – Replacement of Middle Thorofare (SOI) + Alternative 3

For Alternative 2B, the Mill Creek and Upper Thorofare bridges will be replaced due to the raising of the roadway profile to meet the 100' year flood elevation. The new Middle Thorofare Bridge will be the same as described in Alternative 3 – a new fixed bridge to the south of the existing alignment with an 80' vertical clearance along the navigation channel; however, the existing Middle Thorofare bridge will be rehabilitated per Secretary of the Interior (SOI) standards and remain in place to allow access for pedestrian and bicycle traffic only. The character-defining historic features will be preserved, and the bascule span will still be maintained and operated for navigational traffic. Additional information regarding Alternative 2B is included in **Appendix AA**.

This alternative will rehabilitate and preserve the following character-defining features of the Middle Thorofare Bridge over the period of 60 years:

- The Ash, Howard, Needles & Tammen-designed 57'-long single-leaf trunnion bascule span featuring a built-up, riveted steel, haunched-deck girder with floor beams with a steel grid deck;
- The operating mechanisms and machinery consisting of a pinion that engages a rack fixed to the outside of the girder near the trunnion, the enclosed primary and open

secondary reducers and open-gear drive sets, trunnions, supporting columns, control panel, the bridge's original electrical motor;
- The cantilevered flat-roofed Moderne-style operator's house on the inland side of the movable leaf;
- The lookout opposite the operator's house containing a bridge plaque on its south (ocean) side;
- The flat-roofed, concrete and metal toll booth located in the center of the bridge adjacent to the movable leaf; and
- The 21 approach spans consisting of four built-up deck girder spans and 17 steel, three-beam, partially continuous stringer spans.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Preserves the character-defining historic features
  - Provide a wide shared-use path on the rehabilitated Middle Thorofare bridge
  - Restricts vehicular traffic and extends the service life of the existing bridge
  - Allows unrestricted vehicular traffic flow on the new bridge

- Disadvantages:
  - Does not meet the study's Purpose and Need
  - No improvement to marine traffic delay due to need for bridge openings
  - No improvement to existing 50' fender width
  - Any future maintenance, repair or emergency repair to the bascule span may require complete closure of the existing bridge, and navigational access may be restricted.
  - Environmental impacts expected
  - Three commercial partial property acquisitions expected
  - 18 potential access impacts
  - Highest maintenance cost
  - Highest initial construction cost
  - Highest life cycle cost
  - Detour is required for construction
  - Substantial rehabilitation of Middle Thorofare Bridge will be required to maintain the structure in a good state of repair

Alternative 3 - Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south

The horizontal alignment of the Middle Thorofare Bridge will be shifted to the south, while the Mill Creek and Upper Thorofare bridges will be realigned to the north. The new Middle Thorofare Bridge will be a fixed span structure with an 80' vertical clearance along the navigation channel.

The Mill Creek Bridge will be 312' long with two 12' lanes, two 8' shoulders and two 5' sidewalks. Sidewalks will be separated from traffic by steel railing. Parapets will satisfy Test Level 5 requirements. The bottom of the girders will be one foot above the 100-year flood elevation. Bulkheads will be proposed around the abutments to accommodate

scour. The footprint of the proposed bridge will be shifted north from the existing location to accommodate staging.

The Upper Thorofare Bridge will be 362'-6" long with two 12' lanes, two 8' shoulders and two 5' sidewalks. Sidewalks will be separated from traffic by steel railing. Parapets will satisfy Test Level 5 requirements. The bottom of the girders will be one foot above the 100-year flood elevation. Bulkheads will be proposed around the abutments to accommodate scour. The footprint of the proposed bridge will be shifted north from the existing location to accommodate staging.

The Middle Thorofare Bridge will be approximately 2,830' long with span lengths ranging from 150' to 250'. The bridge cross section will accommodate two 12' lanes, two 8'-6" shoulders and a 5' sidewalk. The sidewalk will be separated from traffic by steel railing. Parapets will satisfy Test Level 5 requirements. The bottom of the girders will be at least one foot above the 100-year flood elevation. Bulkheads will be proposed around the abutments to accommodate scour.

Since Alternative 3 alignment crosses over the existing bridge, up to a 4-week detour is required to build the span over the existing bridge.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Improves all CSDEs
  - Decrease number of bridge openings by 100%
  - Improves bicycle and pedestrian compatibility
  - No/Low maintenance and operations costs
  - Lower life cycle costs than all other alternatives
- Disadvantages:
  - Environmental impacts expected
  - Three commercial partial property acquisitions expected
  - 18 potential access impacts
  - Detour is required for construction

Alternative 4 - Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south

The horizontal alignment of the Middle Thorofare Bridge will be shifted to the south, while the Mill Creek and Upper Thorofare bridges will be realigned to the north. The new Middle Thorofare Bridge will be a fixed span structure with an 80' vertical clearance along the navigation channel.

The Mill Creek and Upper Thorofare bridges will be similar to Alternative 3.

The Middle Thorofare Bridge will be approximately 3,130' long with span lengths ranging from 90' to 200'. The bridge cross section will accommodate two 12' lanes, two 8'-6" shoulders and a 5' sidewalk. The sidewalk will be separated from traffic by steel railing. Parapets will satisfy Test Level 5 requirements. The bottom of the girders will be at least one foot above the 100-year flood elevation. Bulkheads will be proposed around the abutments to accommodate scour.

Since Alternative 4 alignment also crosses over the existing bridge, up to a 4-week detour is required to build the span over the existing bridge.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Improves all CSDEs
  - Decrease number of bridge openings by 100%
  - Improves bicycle and pedestrian compatibility
  - No/Low maintenance and operations costs
- Disadvantages:
  - High environmental impacts expected
  - Four commercial partial property acquisitions expected
  - 18 potential access impacts
  - Detour is required for construction
  - Higher construction and life cycle costs than all other alternatives, except Alternatives 7 and 8

Alternative 5 – Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south

The horizontal alignment of the Middle Thorofare Bridge will be shifted to the south, while the Mill Creek and Upper Thorofare bridges will be realigned to the north. The new Middle Thorofare Bridge will be a fixed span structure with an 80' vertical clearance along the navigation channel.

The Mill Creek and Upper Thorofare bridges will be similar to Alternative 3.

The Middle Thorofare Bridge will be approximately 3,000' long with span length of 150'. The bridge cross section is similar to Alternative 3. The bottom of the girders will be at least one foot above the 100-year flood elevation. Bulkheads will be proposed around the abutments to accommodate scour.

Alternative 5 alignment is shifted to the south of the existing bridge; therefore, it can be constructed offline and no detour is required.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Improves all CSDEs
  - Decrease number of bridge openings by 100%
  - Improves bicycle and pedestrian compatibility
  - Detour is not required for construction
  - No/Low maintenance and operations costs
  - Lower life cycle costs than all other alternatives, except Alternatives 2 and 3
- Disadvantages:
  - High Environmental impacts expected
  - Two commercial partial property acquisitions expected
  - 18 potential access impacts
  - USFWS Impacts

- May not receive federal approval due to presence of other feasible and prudent alternatives

Alternative 6A/6B - Replacement of all three bridges, realignment of Mill Creek, Upper Thorofare and Middle Thorofare to the north

For Alternatives 6A and 6B, the horizontal alignment of all three bridges will be shifted to the north. The Middle Thorofare Bridge will be replaced with a double leaf movable bridge with a 45' vertical clearance along the navigation channel. The vertical clearance determination can be found in the Navigation Impact Report. The main difference between alternatives 6A and 6B are the proposed pier types.

Figure 25: Alternative 6 Alignment

Alternative 6 is an alignment that is parallel to the existing structure to the North shown in **Figure 25**. This alignment facilitates the minimum impact at the abutments and does not impact the force main to the south of the existing structure. The Middle Thorofare Bridge includes a double leaf bascule main span. As per the Navigational Report, the main span will have a 45-foot vertical underclearance and an 80-foot horizontal clearance. In order to meet the vertical clearance and approach grades of 5%, an access road is required to maintain existing access to the local businesses seen in **Figure 26**.

Figure 26: Alternative 6 Access Road

The access road from Ocean Drive at the West abutment first span will have a minimum of 17'6" underclearance which meets all current and expected future needs for the local businesses. The local businesses access will be graded to meet existing access. Detailed coordination with property owners will be required in order to maintain access to all the businesses during construction. There will be some partial property impacts associated with this alternative and the access road.

Based on the horizontal clearance requirements of an 80' fender to fender clear distance, a bascule span of 150' will be required. A single leaf bascule span is not efficient at this distance so a double leaf structure was evaluated. The main girders of the bascule span will vary between 54" deep to 96" deep shown in **Figure 27**. Floorbeams (48" deep) will

be spaced at 12’-6”. In order to reduce load and increase structural steel design efficiency, an exodermic deck is recommended.

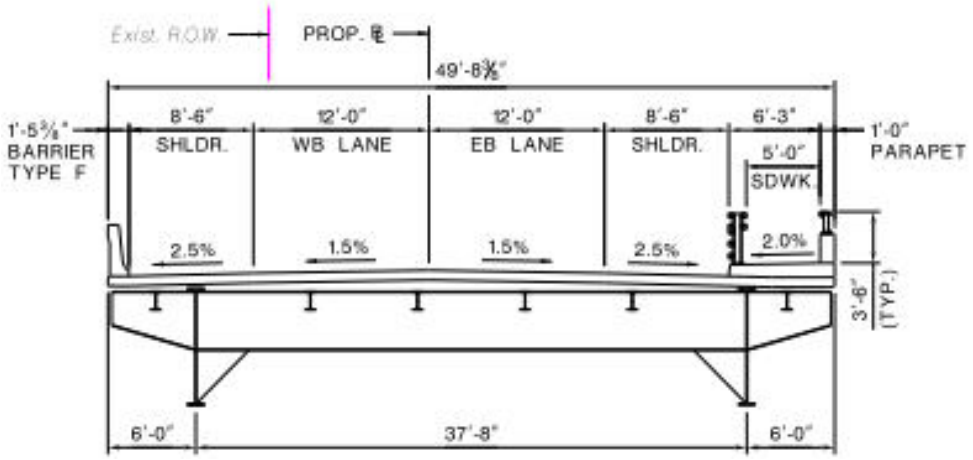

Figure 27: Bascule Span Cross Section

The bascule approach spans will be a similar steel cross section and span 140’ on either side of the main span. Structural and mechanical redundancy was considered for the bascule span by utilizing double girders or duel redundant motors, but these alternatives were not determined to be efficient or necessary.

The four west approach spans will vary between 124’-6” and 133’-11” with optimized dimensions for fabrication of the five 6’-0” deep AASHTO Type VI prestressed girders utilized for the cross section shown in **Figure 28**. The three approach spans to the east will be two 124’-6” and one 114’11” span utilizing the same cross section and proposed prestressed girders used for the west approach spans.

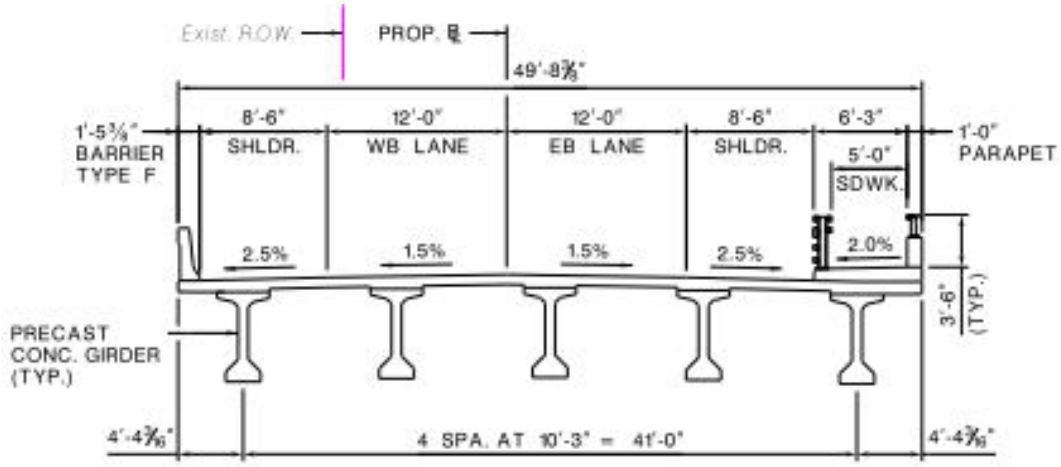

Figure 28: Approach Spans

In order to accommodate a one-person staff to operate both the toll booth and on command bascule span opening, a 15’ x 20’ operators house (seen in **Figure 29)** will be cantilevered off the north of the east approach main span. A 7’ wide toll booth will be provided in the same span at the middle of the alignment.

Figure 29: Sample Operators House

The alignment is identical for alternative 6A and 6B. The only difference in the structures is the main pier concept. Alternative 6A utilizes an open concept pier (**Figure 30**), whereas Alternative 6B utilizes traditional pier design mimicking the existing main span piers (**Figure 31**).

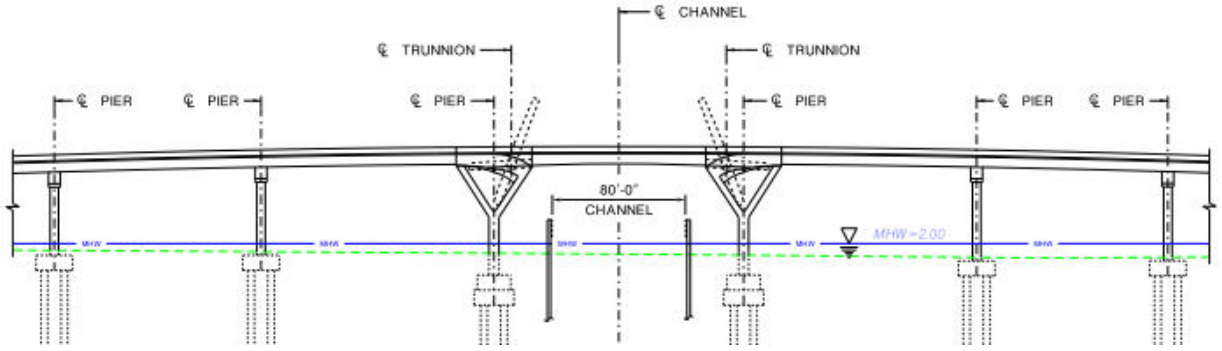

Figure 30: Alternative 6A Open Concept Pier Schematic

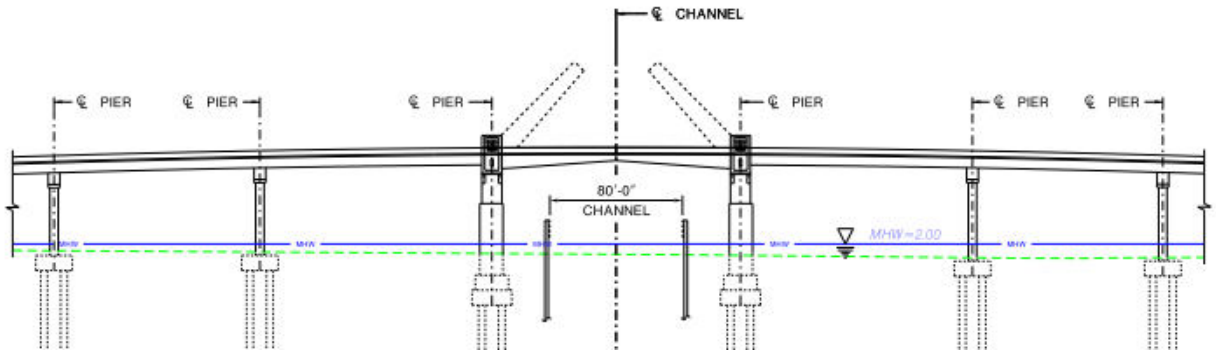

Figure 31: Alternative 6B Traditional Pier Concept Schematic

An example of an open concept pier with the bascule span open can be seen in **Figure 32**.

Figure 32: Example Open Pier Concept

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Improves all CSDEs
  - Decrease number of bridge openings by 68%
  - Improves bicycle and pedestrian compatibility
  - Detour is not required for construction
  - Lower initial construction cost than all alternatives, except Alternative 2A
- Disadvantages:
  - Environmental impacts expected
  - 4 commercial partial property acquisitions expected
  - 18 potential access impacts
  - Highest yearly maintenance and operations costs are expected
  - Highest impact to commercial frontages near fisheries
  - Delays motorists and emergency responders during openings and storm events
  - Requires a skilled maintenance crew for emergency repairs

Alternative 7: Replacement of all three bridges, realignment of Mill Creek and Middle Thorofare to the north, Upper Thorofare to the South

For Alternative 7, the horizontal alignment of the Upper Thorofare Bridge will be shifted to the south, while the Mill Creek and Middle Thorofare bridges will be realigned to the north. The new Middle Thorofare Bridge will be a fixed span structure with an 80' vertical clearance along the navigation channel. A new access road will be constructed to provide access to the businesses currently along Ocean Drive.

The Mill Creek and Upper Thorofare bridges will be similar to Alternative 3.

The Middle Thorofare Bridge will be approximately 3,550' long with span lengths ranging from 92' to 150'. Spans on Bumble Bee Island are arranged such that the piers will clear access for local businesses. The bridge cross section is similar to Alternative 3. The bottom of the girders will be at least one foot above the 100-year flood elevation. Bulkheads will be proposed around the abutments to accommodate scour.

Alternative 7 alignment is shifted to the north of the existing bridge; therefore, it can be constructed offline and no detour is needed.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Improves all CSDEs
  - Decrease number of bridge openings by 100%
  - Improves bicycle and pedestrian compatibility
  - Detour is not required for construction
  - No/Low maintenance and operations costs
- Disadvantages:
  - High environmental impacts expected
  - 6 commercial partial property acquisitions expected
  - 18 potential access impacts
  - High initial construction cost and life cycle cost

Alternative 8 - Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south

For Alternative 8, the horizontal alignment of the Middle Thorofare Bridge will be shifted to the south, while the Mill Creek and Upper Thorofare bridges will be realigned to the north. The new Middle Thorofare Bridge will be a fixed span structure with an 80' vertical clearance along the navigation channel.

The Mill Creek and Upper Thorofare bridges will be similar to Alternative 3.

The Middle Thorofare Bridge will be approximately 3,560' long with span lengths ranging from 79' to 230'. The 79' spans at the south end of the bridge can utilize the same design as the Mill Creek and Upper Thorofare Bridge to reduce girder depth. The 230' spans are over the Bumble Bee Seafoods processing plant to minimize right of way impact. The remaining are 150' spans that can accommodate navigation both at Middle Thorofare and Upper Thorofare. The bridge cross section is similar to Alternative 3. The bottom of the girders will be at least one foot above the 100-year flood elevation. Bulkheads will be proposed around the abutments to accommodate scour.

Alternative 8 alignment is shifted to the south of the existing bridge; therefore, it can be constructed offline and no detour is required.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Improves all CSDEs
  - Decrease number of bridge openings by 100%
  - Improves bicycle and pedestrian compatibility
  - Detour is not required for construction
  - No/Low maintenance and operations costs
- Disadvantages:
  - Environmental impacts expected
  - 3 commercial partial property acquisitions expected

- 18 potential access impacts
- Impact to known NJDEP contaminated site
- Higher construction and life cycle costs than all other alternatives, except Alternative 7

Alternative X (Modified Alternative 3) – Replacement of all three bridges, realignment of Mill Creek and Upper Thorofare to the north, Middle Thorofare to the south
Alternative X was developed to minimize the impacts to the USFWS property. The alignment is similar to Alternative 3, except for that Ocean Drive will be realigned to the south without crossing over the existing Middle Thorofare Bridge. The Mill Creek and Upper Thorofare bridges will be realigned to the north. The new Middle Thorofare Bridge will be a fixed span structure with an 80' vertical clearance along the navigation channel.

The Mill Creek and Upper Thorofare bridges will be similar to Alternative 3.

Ultimately, it was decided that the possibility of gaining federal approval was the same as Alternative 5; therefore, Alternative X was not further advanced.

The advantages and disadvantages of this alternative are as follows:

- Advantages:
  - Improves all CSDEs
  - Decrease number of bridge openings by 100%
  - Improves bicycle and pedestrian compatibility
  - Detour is not required for construction
  - No/Low maintenance and operations costs
- Disadvantages:
  - High Environmental impacts expected
  - Two commercial partial property acquisitions expected
  - 18 potential access impacts
  - USFWS Impacts
  - May not receive federal approval due to presence of other feasible and prudent alternatives

D. Maintenance and Protection of Traffic

Due to the structure type, the rehabilitation or replacement options cannot be performed without some temporary closure to Ocean Drive. A key element of design would be to consider solutions that limit the duration of a complete closure to Ocean Drive as well as to marine operations below. Structural solutions that can minimize a total closure to Ocean Drive include:

- Middle Thorofare Alternative 6A and 6B: where the proposed bridge tie in with the existing alignment, the footprint of the proposed bridge will overlap with the existing. To maintain traffic during construction, a temporary access bridge is required for the first four spans at the south end of the bridge (approximately 175 ft).
- Middle Thorofare Alternatives 3 and 4: while the majority of the bridge can be built offline, the new span crossing the existing alignment will require a temporary closure of the existing bridge. During the closure, work will be limited to constructing the new span over the existing bridge. Demolition of the existing bridge will not occur during this

closure. After the closure, traffic will re-open to the existing bridge while the new span is completed above. The estimated time for this work is approximately 4 weeks.

- All other alternatives are independent of the existing Middle Thorofare Bridge and can be constructed with the existing bridge in service.
- Bridges over Mill Creek and Upper Thorofare: For all alternatives other than No Build, the low level bridges will be replaced. To accommodate traffic, the proposed alignments are offset from the existing. In Stage 1, traffic will be maintained on the existing bridge and the western half of the new bridge will be constructed. In Stage 2, traffic will be shifted onto the newly built western half of the bridge. The existing bridge will be demolished, and the eastern half of the bridge will be constructed. See **Appendix T** for details.
- For all bridges, girder spacing is arranged to accommodate future deck replacement.

E. Bridge Type Comparison

Concrete versus Steel Superstructure: Although steel girder superstructures cost slightly more than concrete girder superstructures, they are lighter in weight which results in lighter substructures and less installation costs. A recent study (2016) of the Scudder Falls Bridge shows that the costs of steel bridges and concrete bridges over water are comparable; however, because of the highly corrosive marine environment, steel bridges will have much higher maintenance and corresponding life cycle costs. It is for this reason that a concrete superstructure is recommended for all bridges in this study.

Middle Thorofare:

Among concrete options, there are three possible solutions: segmental bridge, spliced bulb-tee girders and spliced U-girders.

The overall deck width of the proposed bridge would be approximately 50’ in order to accommodate two 12’ lanes, two 8’ shoulders and a 5’ sidewalk. This deck width can be accommodated by a single cell segmental box girder. For the majority of the approach spans, the span length is within 150’. These spans can be constructed using the span-by-span method. For the channel span and the side spans, which vary from 190’ to 250’, these can be erected using the cantilever method.

So far, there are two segmental bridges that have been built in NJ. The Route 35 Victory Bridge was completed in 2005 with a unit price of $247 per square foot. Considering inflation and profile difference, the equivalent unit cost will be $348 per square foot for Middle Thorofare. The other segmental bridge in NJ, Route 36 Highlands Bridge, was completed in 2010. The equivalent unit cost (considering inflation and profile difference), however, would be $832 per square foot. This could be because of Hurricane Katrina, which damaged many of the segmental precast plants. In summary, NJ has limited experience with segmental bridges and there is a higher risk in accurately determining the construction cost of this type of bridge.

Other concrete alternatives include spliced bulb-tee or spliced U-girders. According to the Bridge Design Manual published by Precast/Prestressed Concrete Institute, “straight beams are by far the simplest and most cost-effective way to use precast, prestressed beams in a curved bridge; they should be used whenever appropriate.” The Middle Thorofare Bridge can be arranged into 4 to 5 span continuous units. Each span is comprised of three straight segments – two pier segments and a drop-in segment. On curved alignments, small angles can be formed between adjacent segments to account for curvature. Angular changes between straight chords are rarely noticed,

especially with large radii. The individual segments may be pretensioned for shipping, handling, and erection and the complete unit post-tensioned. Diaphragms are required at the splice locations to counteract the lateral forces from the post-tensioning. Thicker webs may be needed to accommodate the post-tensioning ducts.

The span arrangement for all alternatives range from 150' to 250' in length. Each girder segment may be limited up to 127'. These segments can be shipped to the job site either by barge or on land, depending on the pier location. The pier segments will be erected first after the substructure is constructed. Temporary supports are usually required from the pier to stabilize the pier segments. Then, the drop-in piece will be erected and supported by strong-backs from the pier segments instead of temporary shoring to save construction cost and time. After the concrete diaphragms (closure pours) are cast and gain their strength, the whole unit will be post-tensioned. The first stage post-tensioning is just for the girder dead weight. After the deck slab is poured and gains its strength, the girders will be post-tensioned again for the deck dead load and the live load.

With properly designed High Performance Concrete, the deck will last longer than conventional cast-in-place concrete decks. To further mitigate deck deterioration, a polyester polymer concrete (PPC) overlay with 30 to 40 years of service life may be considered on top of the proposed deck.

A preliminary cost analysis shows that the unit price for the spliced concrete girder option is around $340 per square foot (more economical than the segmental option); therefore, spliced concrete girder superstructure is recommended for all Middle Thorofare Bridge alternatives except movable spans.

Mill Creek and Upper Thorofare:
The Mill Creek Bridge is 312'-0" long and the Upper Thorofare Bridge is 362'-6" long. Considering the proposed roadway profile while maintaining/improving the hydraulic opening, either AASHTO Type III concrete beams or 36" deep NEXT beams may be used. A proposed span length of 78'-0" for Mill Creek and 72'-6" for Upper Thorofare is recommended. The spans will be made continuous for super-imposed dead loads and live loads. This not only increases the load carrying capacity of the bridges, but also eliminates deck joints, resulting in improved rideability and minimal maintenance. The number and spacing of girders was arranged to accommodate future deck replacements.

F. Traffic Analysis

To assess the existing and future operating conditions of the roadway, a Level of Service analysis was performed in accordance with the 2010 Highway Capacity Manual; however, as the intersections geometries and the number of lanes along Ocean Drive will not be altered, changes in traffic operations are not expected.

Bridge openings during the peak season (Memorial Day to Labor Day) account for 60% of openings, while the off-peak season accounts for 40% of openings; therefore, a majority of the bridge opening coincide with the peak travel months for vehicles along Ocean Drive. With the proposed replacement of the Middle Thorofare Bridge, the number of bridge openings will be reduced and will therefore improve traffic operations within the vicinity. **Table 15** shows the required bridge openings by height of the proposed alternatives.

Table 15: Required Bridge Openings by Height

	AVERAGE[1]	45' CLEARANCE (ALTERNATIVE 6A/6B)	80' CLEARANCE (ALTERNATIVES 3, 4, 5, 7, 8, X)
25'	230	No Openings	No Openings
30'	36	No Openings	No Openings
35'	0	No Openings	No Openings
40'	1,470	No Openings	No Openings
45'	23	No Openings	No Openings
50'	115	111	No Openings
55'	180	164	No Openings
60'	623	703	No Openings
65'	540	526	No Openings
70'	98	45	No Openings
75'	102	57	No Openings
Total Openings	**3,417**	**1,606**	**0 Openings**

[1]Based on average heights from 2015-2017

Due to the larger percentage of openings in the peak season, the highest reduction in openings occurs during the peak season, coinciding with the peak travel months along Ocean Drive. It is anticipated that the number of openings daily during the peak season will be reduced from an average of 32 openings per day for the existing structure to approximately 10 openings per day with a 45' underclearance structure. Full navigational traffic analysis can be found in the Navigation Impact Report in **Appendix N**.

G. Hydrology & Hydraulics Analysis

The project area is located within the Cape May Harbor & Bays (below Rt 47) HUC-14 Watershed (02040302080090). The project consists of seventeen (17) overall surface drainage areas within the study limits that contribute to the watershed. The locations of seventeen POI are identified in the Drainage and Stormwater Management Existing Conditions Memorandum located in **Appendix J**. The same POIs will be evaluated under the proposed condition.

In general, the drainage areas consist primarily of the existing roadway and are essentially developed with large amounts of impervious surfaces. The existing topography has little to flat slopes, with the Middle Thorofare Bridge approaches being more steeply sloped. The Soil Survey of Cape May County, NJ was examined to identify soils within the project area. According to the soil survey, three (3) soil series types underlie the study area and are identified in the Drainage and Stormwater Management Existing Conditions Memo in **Appendix J**.

The project proposes to elevate the roadway above the 100-year floodplain. The FEMA Flood Insurance Study (FIS) of Lower Township, Cape May County, NJ, dated August 2, 1982, provides a summary of the coastal elevations of the 10, 50, 100 and 500-year event. **Table 16** lists these elevations.

Table 16: Coastal Flood Elevations towards Atlantic Ocean

FLOOD EVENT	ELEVATION (NAVD 29)	ELEVATION (NAVD 88)
10-Year[1]	6.3	5.0
50-Year[1]	8.5	7.2
100-Year[1]	9.8/15.0[2]	8.5/13.7[2]
500-Year[1]	13.1	11.8

[1]Surge Stillwater Elevation
[2]Surge Stillwater Elevation / Maximum Wave Crest Elevation

A copy of the FEMA FIRMs and full Flood Insurance Study are included in the Drainage and Stormwater Management Existing Conditions Memo in **Appendix J.**

H. Right of Way Impacts and Review

According to the information provided by NJDEP there are existing riparian grants on record for the entire project area. It is anticipated that no additional riparian rights (license or grant) acquisition for the project are required.

The bridge and roadway realignment for each proposed alternative on the project requires permanent partial right of way acquisitions and temporary easements for construction.

The anticipated Right of Way impacts vary for each alternative. In general, each alternative's impacts consist of a combination of fee takes with associated temporary easements and temporary easements for driveways and grading. Impacts occur on commercial properties and there are no total property takes currently anticipated. Efforts during future design phases will be made to minimize the partial property acquisitions and construction easements impact. A brief description of impacts for each alternative is described below:

Alternative 2B and Alternative 3 – Alternative 2B and 3 anticipated two minor fee take parcels and one major take (3 Acres +\-, Block 823.01 Lot 2, undeveloped portion of Bree-z-lee). An additional four temporary easements for grading and driveway work are anticipated.

The largest impact will occur for the property of Lot 2 in Block 822.02 (Bree-z-lee), which is anticipated to be approximately 3 acres of land. The land to be acquired would be located along north-easterly side of the property along the waterline. It should be noted that property is a business in operation (marina); however, all land anticipated for acquisition is located in an undeveloped part of the property. The anticipated acquisition is not anticipated to reduce the property value at large. The construction of the project should not impact operation of the business on property or will be very minor if occurs. The remaining anticipated acquisitions for this alternative are located in easterly part of the project and on undeveloped parts of the Lots.

Alternative 4 – This is the most intrusive alternative with relatively large fee takes from three properties will be required. In addition to the major take similar to the one described for Alternative 3 (Block 823.01 Lot 2), the new bridge alignment (fee take) on Cape May Marina property (Block 820, Lot 8.02) is crossing through their access drive to the docks. The access from the facility to the docks will need to be maintained under the proposed bridge in the future. If needed, an alternative access during the construction of the project will be provided. Also, the location of the roadway alignment may result in an unusable (landlocked) portion of land (Block 820, Lot 8.01) located in the south west corner of the property which may need to be purchased.

An additional two temporary easements for grading at vicinity of Fish Dock Road (public ROW will be needed).

Alternative 5 – Impacts for Alternative 5 are similar to those described for Alternatives 3, except Alternative 5 would include impacts to the USFWS property. Note that since the USFWS is public land, it is not listed in **Table 17** as a fee take. Impacts to this property would however likely result in significant mitigation costs.

Alternative 6 – Alternative 6 will require four minor fee/strip takes for the new roadway and bridge alignment and temporary easements for driveways and grading. Due to the proposed Middle Thorofare Bridge shift to the north, 3 properties will incur minor impacts (0.7 acres), of which approximately 60% is within the waterway. This is due to the existing tidelands rights in the project area. An additional fee take is anticipated at the southern end of the Block 822.01, Lot 1.01 (Bumble Bee Seafoods) to accommodate the access road surrounding the fisheries.

Alternative 7 – Alternative 7 will require seven minor fee/strip takes for the new roadway and bridge alignment and temporary easements for driveways and grading. Due to the proposed Middle Thorofare Bridge shift to the north, 3 properties will incur minor impacts (0.7 acres), of which approximately 60% is within the waterway.

To accommodate the access road back to the fisheries, acquisition of a strip take at Block 822.02, Lot 3 (Bree-z-lee) may require realignment or loss of some of parking spots abutting the roadway. The new entrance to the access road in the westerly part of the project will require a partial fee take of undeveloped land (total area of 0.75 acres) at the corner of two adjacent properties (Block 822.02, Lots 4 & 5).

Alternative 8 – Impacts for Alternative 8 are similar to those described for Alternative 5, except Alternative 8 includes a large partial fee take at Block 822.01, Lot 1.01 (Bumble Bee Seafoods) and there are no impacts to the USFWS property.

It should be noted that it is anticipated the project will require the acquisition of additional permanent easements, such as slope, drainage, utility, etc. Once the design of those disciplines is progressed further, determination of the easements required to be acquired will be performed.

For each proposed alternative the currently anticipated fee parcels and easements to be acquired are outlined in **Table 17** below:

Table 17: Anticipated acquisitions of fee parcels and easements

BLOCK/LOT	ALT. 2B & ALT. 3	ALT. 4	ALT. 5	ALT. 6	ALT. 7	ALT. 8
822.02/2	FEE	FEE	FEE	-	-	FEE
822.02/4	-	-	-	-	FEE, TE	-
822.02/5	-	-	-	-	FEE, TE	-
822.02/6	-	-	-	-	TE	-
822.03/7.01	-	-	-	-	TE	-
822.01/1.01	FEE	FEE		FEE		FEE
823.01/1	-	-	-	-	TE	-
823.01/3.01	-	-	-	-	TE	-
820/8.01	-	FEE	-	-	-	-
820/8.02	FEE, TE	FEE	FEE, TE	FEE, TE	FEE (2), TE	FEE, TE
820/4.02	TE	TE	TE	TE	TE	TE
820/3.02	TE	TE	TE	TE	TE	TE
793/15.05	-	-	-	TE	-	-
793/15.07	-	-	-	TE	-	-
793/15.01	-	-	-	FEE, TE	FEE	-
820/4,6	-	-	-	FEE	FEE	-

FEE – Fee take parcel (with assoc. easements if needed).
TE – Temporary Easement for grading and driveways.

I. Utility and Highway Lighting Impacts

In the final condition, utilities are proposed to be installed under the bridge deck or attached to the parapet on both sides. Existing highway lighting and utility poles along Ocean Drive will be relocated within proposed widening limits. Pedestrian scale lighting is proposed along the sidewalk within the study limits.

J. ITS Facilities

Intelligent Transportation System (ITS) devices and infrastructure currently do not exist within the study limits. It is recommended that empty ITS conduit be installed on the bridge structures for future use in accordance with the NJDOT Transportation Systems Management (TSM) Procedures and Standards Manual.

K. Complete Streets Policy

According to the NJDOT Complete Streets Policy dated December 2009, a complete street facility provides safe access for all users by providing a comprehensive, integrated, multi-modal network of transportation options. Complete street design includes investigation of bicycle, pedestrian, and transit facilities to ensure mobility for all users, including those with disabilities. The Ocean Drive proposed improvements that will complete the street include:

- Americans With Disabilities Act (ADA) compatible sidewalks, 6’ wide, will be provided along the northbound side of Ocean Drive. Additionally, 5’ wide sidewalk will be provided along the

northbound side of the Middle Thorofare Bridge and both sides of the Mill Creek and Upper Thorofare bridges.

- Pedestrian scale lighting on the bridge and within the vicinity of the study limits is proposed.
- Bicycle compatible 8' shoulders will be provided on both sides of Ocean Drive. Shoulders may be striped to provide buffered bicycle lanes (3' buffer with 5' bicycle lane).

The Complete Streets Checklist is included in **Appendix H**.

L. Access Impacts and Review

Based on the preliminary proposed improvements, this project will require access modifications to 12 properties – 18 access points with 14 adjustments and 4 modifications. NJDOT defines an access adjustment as changing the width of a driveway by five feet or less, changing the location of a driveway by 10 feet or less, moving a driveway away from the centerline of the State highway (such as when the State highway is widened), or changing the elevation or profile of a driveway, in conjunction with a State highway project advanced by the Department or others. An access modification is defined as changes to driveways in conjunction with the implementation of a State highway improvement advanced by the Department or others, with Department approval, which changes the number of driveways, the width of a driveway by more than five feet, or the location of a driveway by more than 10 feet. It includes replacing all ingress or all egress between a State highway and a lot or site with ingress or egress via a private easement on a different lot or site; or elimination of ingress, egress, or both between one State highway and a lot or site, while still providing ingress, egress, or both between a different State highway and the lot or site. Modification of driveway does not refer to changes made by a lot or site owner to his or her own driveway. **Table 18** provides a summary of the affected properties.

Table 18: Access Impacts

No	Block	Lot	Owner	Lot Address	Type of Access Modification
1	793	15.07	983 Ocean Drive, LLC	985 Ocean Drive	Adjustment
2	793	15.04 & 15.05	Hinch Marina	989 Ocean Drive	Adjustment (2)
3	793	15.02	991 Ocean Drive, LLC	991 Ocean Drive	Adjustment (2)
4	793	15.02	993 Ocean Drive, LLC	993 Ocean Drive	Adjustment (3)
5	793	15.01	Lund's Fisheries Inc.	997 Ocean Drive	Adjustment
6	822.01	1.01	Snows/Doxsee Inc.	994 Ocean Drive	Adjustment (2)
7	820	8.02	Cape May Inlet Marina, Inc	1001 Ocean Drive	Modification
8	823.01	3.01	Harbortown Resort Marina, Inc	900 Ocean Drive	Adjustment (2)
9	823.01	1	Snug Harbor Marina, LLC	926 Ocean Drive	Adjustment
10	822.03	7.01	JD Wagner, LLC	954 Ocean Drive	Modification
11	822.02	6	Harlo Inc.	960 Ocean Drive	Modification
12	822.02	3	Jenlo Corporation	978 Ocean Drive	Modification

M. Constructability and Staging Plans and Detour Plans

Based on the preliminary assessment of the construction methods for the various alternatives that were developed, the proposed raised roadway can be constructed conventionally with a two-stage traffic shift, maintaining one (1) lane each in the northbound and southbound direction. A Pre-Stage will widen the northbound shoulder to accept both lanes of traffic on the existing northbound roadway and shoulder as well as any work for proposed sections of the roadway which do not fall on the current existing footprint of the roadway. Construction of the proposed

roadway would take place on the southbound side to the proposed elevations. Once construction of the southbound sections are completed, traffic will use the southbound roadway and shoulder for northbound and southbound traffic. The new bridges for Mill Creek and Upper Thorofare can be constructed conventionally with a two-stage traffic shift along each existing bridge and will maintain one (1) lane each in the northbound and southbound direction. The Middle Thorofare Bridge will be constructed offline from the existing bridge. The total construction duration is estimated to be 36 months.

During construction, traffic will be maintained at Fish Dock Road except during short term construction/demo operations. Access to all driveways and ramps will also be maintained at all times.

N. Controlling Substandard Design Elements and Reasonable Assurance

Within the study limits, CSDEs were identified in the following seven element categories:

- Sight Distance (Horizontal Curve)
- Minimum Curve Radius
- Minimum Grade
- Lane Width
- Shoulder Width
- Bridge Width
- Design Loading

Design Loading

The NBIS Reports for each structure were investigated and demonstrate that all three structures are deficient. The following is a summary of the NBIS Report load ratings for each structure:

- Mill Creek Bridge - Based on the 17th Cycle NBIS Report Dated August 2016, the Load Factor Inventory Rating is 24 tons and the Operating Rating is 40 tons for the HS-20 Truck.
- Upper Thorofare Bridge - Based on the 17th Cycle NBIS Report Dated August 2016, the Load Factor Inventory Rating is 27 tons and the Operating Rating is 45 tons for the HS-20 Truck.
- Middle Thorofare Bridge - Based on the 14th Cycle NBIS Report Dated October 2015, the Load Factor Inventory Rating is 13 tons and the Operating Rating is 21.1 tons for the HS-20 Truck.

As part of the alternatives analysis, the study investigated improving the CSDEs in coordination with drainage, traffic requirements and high crash locations. Proposed improvements will be accomplished within the limited scope of construction, including minimal ROW and utility impacts.

O. Construction Cost Estimate

The total construction cost for each alternative was estimated based on Classification No. 2 – Reconstruction, Widening and Dualization of the current NJDOT Transport Construction Cost Estimating Guide, dated November 2014.

The conceptual cost estimates and cost comparison for the key alternatives are included in **Appendix U**.

P. Life Cycle Cost Analysis

A 100-Year Life Cycle Cost Analysis (LCCA) was developed for key alternatives and is included in **Appendix U**.

Q. Value Engineering Study and Report

A Value Engineering (VE) review workshop was conducted by NJDOT's VE Unit on January 6-8, 2020, and a Draft VE Report was completed in April 2020 that presented initial recommendations. The Project Team evaluated the initial recommendations and provided comments that are documented in the Final VE Report, dated November 2020. During the Project Team's evaluation of the Draft VE Report, an additional alternative (Alternative 9) was developed to determine if overall construction costs could be reduced. It was eventually determined that Alternative 9 was more expensive than the PPA. Alternative 9 is documented in the Final VE Report, which is included in **Appendix BB**.

Included in the Final VE Report is a recommendation by the NJDOT VE Unit to evaluate "Environmental Resilience" and conduct a site-specific risk assessment during Local Preliminary Engineering to determine the long term effects of climate change within the area. During the CD study, Michael Baker conducted a separate study to model the hydrodynamics of the area along the Ocean Drive project site for existing conditions and the PPA. In summary, the modeled results show that changes in water elevation and flow patterns due to the proposed bridge, roadway, and culvert designs do not present significant negative impacts to the project area in terms of increased area of inundation or increased velocities during 100-year storm events. The Hydrodynamic Study Report is included in **Appendix K**.

With regard to the long-term viability of the project area, the local municipalities and Cape May County are committed to a proactive approach for addressing site-specific climate changes. Capital investments to protect residents and businesses will be undertaken in the future to maintain the project area for these regionally important shore communities.

Although the NJDOT VE Unit recommended that the PPA be advanced to Local Preliminary Engineering, the NJDOT VE Unit developed an additional alternative for further consideration. This additional alternative is included in Section 7 of the Final VE Report as "VE Alternative 2 - Hybrid of Designer Alternative #7 and VE Alternative #2." The Project Team has evaluated this alternative and has determined that due to the higher overall construction costs and impacts to local businesses, does not recommend that this alternative be further evaluated in Local Preliminary Engineering. The following advantages and disadvantages as compared to the PPA are provided:

<u>Advantages:</u>

- More construction over land (which facilitates a reduced construction duration)
- Less substructure construction in open waterway

<u>Disadvantages:</u>

- More overall structure to construct
- Higher initial construction cost due to overall more structure
- Higher life-cycle cost due to overall more structure
- Staging will be more difficult due to proposed tie-ins with Ocean Drive
- Elevated Intersection at a sag curve coming from a 5% downgrade
- Full acquisition of Bumble Bee Seafoods site due to the elimination of their main parking area. This will result in the loss of existing jobs and the underutilization of a land parcel

that is uniquely situated for marine use, in conflict with the intent of the purpose of local zoning.
- Significant access changes to the local businesses due to the new local roadway
- Relocated access points under the new structure
- Lack of support from local businesses due to access and property impacts

The Project Team supports the following three recommendations documented in the Final VE Report:

1. Consider multiple contracts.
    - *Construction of the project under separate contracts is feasible and is already being considered. This will be further investigated in Local Preliminary Engineering. Potential project funding sources and the effects on the overall construction schedule will also require further investigation.*
    - Environmental impacts, including timing restrictions and required permits, would require further review.
2. Consider advanced foundation contract.
    - *An advanced foundation contract has been considered and is feasible; however, this work is tied to the environmental approval process. Based on our assessment of when the environmental permits will be secured, the bridge contracts (Mill Creek, Upper and Middle Thorofare bridges) will be ready to be let. The details of the nature of the contracts and contract limits still need to be finalized. This will require further investigation in Local Preliminary Engineering.*
3. Consider advanced utility and ground improvements contracts.
    - *This has been considered and will require further investigation in Local Preliminary Engineering. Advanced utility and ground improvements contracts are considered a necessity in order to comply with seasonal shutdowns and schedule limitations resulting from anticipated environmental restrictions.*

R. Alternatives Matrix

An Alternatives Matrix was prepared comparing the various alternatives that were developed and the proposed improvements for this project. The Alternatives Matrix is included in **Appendix V**.

S. Risk Analysis Summary

Risk Analysis is one out of five key components of the Risk Management Process. It prioritizes risks for further analysis or action by assessing and combining their probability of occurrence and magnitude of impact. The project Risk Register was completed during CD and will require updates during future design phases.

The Risk Register for the project is provided in **Appendix W**.

T. Preliminary Preferred Alternative (PPA)

The selected PPA for the Ocean Drive Local CD Study is Alternative 3. Alternative 3 includes the replacement of the Middle Thorofare Bridge with an 80' high-level fixed bridge that utilizes spliced concrete girders. The PPA was recommended based on inputs received from Cape May County, the Cape May County Bridge Commission, SJTPO, NJDOT, SJTPO and further investigations conducted as part of this CD study. The following summarizes the proposed features and improvements of the PPA.

1. **Structural Design / Geotechnical Engineering**

Mill Creek: The PPA replaces the Mill Creek Bridge with a 4-span bridge with each span at 78'-0". Either AASHTO Type III or 36" deep NEXT beams may be used. Proposed girder types/depths will be further investigated during the Local Preliminary Engineering phase. The beams will be erected simply supported and made continuous for live load by casting a concrete diaphragm at the piers. The bridge is on a tangent alignment. The proposed abutments will be constructed behind the existing abutments, saving time and budget for excavation and backfill. The abutments will be integral with the superstructure, making the bridge jointless. The piers and abutments will be supported on prestressed concrete piles, and the abutments will be wrapped around with a bulkhead. Both the piles and the bulkheads will be designed to account for scour.

The low chord of the superstructure will be set one foot above the 100-year flood elevation.

The new cross section maximizes the use of the existing right of way and will improve the geometry for both northbound and southbound directions.

Table 19 summarizes the proposed improvements to the bridge cross section.

Table 19: Mill Creek Bridge cross-section

CROSS-SECTION	EXISTING	PROPOSED
Travel lanes – thru	Two 10' lanes	Two 12' lanes
Shoulder – left	0'	8'
Shoulder – right	0'	8'
Sidewalk	Two 1'-6" walkways with curbs	Two 5' sidewalks with separation barriers

Upper Thorofare: The PPA replaces the Upper Thorofare Bridge with a 5-span bridge with each span at 72'-6". Either AASHTO Type III or 36" deep NEXT beams may be used. Proposed girder types/depths will be further investigated during the Local Preliminary Engineering phase. The bridge is on a horizontal curve with a radius of 2,309'. The superstructure and substructure will be similar to Mill Creek except that integral abutments are not recommended for curved bridges; however, the bridge can be made continuous for live load, thus eliminating deck joint on the bridge. Expansion joints will be provided at the abutments only.

The proposed improvements for the Upper Thorofare Bridge are the same as listed above in **Table 19** for the Mill Creek Bridge.

Middle Thorofare: The PPA replaces the Middle Thorofare Bridge with a high-level fixed bridge that will provide 80' x 80' clearance at the navigation channel. The alignment is on curves with radii ranging from 900' to 1,850'. The proposed superstructure will be spliced precast concrete girders composite with a cast-in-place concrete deck. The girders could be of constant depth or approximately 10' deep at the mid-span and haunched down at the piers to create an aesthetically pleasing appearance. Proposed girder types/depths will be further investigated during the Local Preliminary Design phase.

Piers are proposed to be hammerhead type supported on drilled shafts or prestressed concrete hollow cylinder piles. A concrete pile cap will be constructed at the waterline using floating concrete cofferdams. Abutments will also be supported by drilled shafts or concrete piles to account for scour.

Table 20 summarizes the proposed improvements to the bridge cross section.

Table 20: Middle Thorofare Bridge cross-section

CROSS-SECTION	EXISTING	PROPOSED
Travel lanes – thru	Two 10' lanes	Two 12' lanes
Shoulder – left	0'	8'
Shoulder – right	0'	8'
Sidewalk	Two 1'-6" walkways with curbs	One 5' sidewalk with separation barrier

2. **Roadway Geometrics**

For the roadway section of Ocean Drive, the PPA will improve the existing geometry and will raise the profile to above the 100-year flood elevation requirements. Additionally, the horizontal alignment will be improved where possible.

Table 21 summarizes the proposed improvements to the roadway cross section.

Table 21: Roadway cross-section

CROSS-SECTION	EXISTING	PROPOSED
Travel lanes – thru	One 12' Lane	One 12' Lane
Shoulder – right	Varies (0' to 16')	8'
Sidewalk	Varies (0' to 6')	6'

The proposed PPA is anticipated to eliminate all of the CSDE locations.

3. **Safety**

An estimated decrease of 7% in crashes on the bridges is expected, based on a Crash Modification Factor (CMF) of 0.93 associated with the increase of lane width from 11' to 12'. Additionally, with the addition of an 8' shoulder there is an estimated decrease of 8% in crashes, based on a CMF of 0.92. Further quantitative safety analysis can be performed during the next design phase in utilizing methodologies presented in the Highway Safety Manual to estimate the benefits to safety as a result of the proposed geometric improvements.

4. **Guide Rail**

Existing substandard guide rail will be replaced, and non-vegetative surfacing will be installed in accordance with current NJDOT standards within the limits of widening and reconstruction.

5. **Bicycle and Pedestrian Compatibility**

ADA compatible 6' wide sidewalks will be provided along the southerly side of the roadway and the Middle Thorofare Bridge, and along both sides of the Mill Creek and Upper Thorofare bridges. Shoulders that are a minimum of 8' wide will be provided along both sides of the roadway and on all bridges. These shoulders are bicycle compatible and may be striped to provide buffered bicycle lanes (3' buffer with 5' bicycle lane).

6. **Drainage / Environmental**

Three interagency meetings were held with various environmental agencies including NJDEP Division of Land Use Regulation, Historic Preservation Office, NJDEP Division of Fish and Wildlife, USFWS, National Marine Fisheries Service, and the U.S. Army Corp of Engineers Regulatory Program. The intent of the meetings was to gain input and guidance throughout the development of the alternatives. Based on input received at the first two interagency meetings, specifically regarding encroachments within USFWS owned property, Alternative 3

was selected because it avoids encroachment within the Cape May National Wildlife Refuge and the Cape May Coastal Wetlands Wildlife Management Area. The PPA also avoids impacts to the only known contaminated site in the project area located at 994 Ocean Drive.

The PPA was presented at the third and final interagency meeting and no objections to the PPA were presented.

The following meetings were held:

- NJ Joint Permit Processing Meeting #1, February 14, 2018
- NJ Joint Permit Processing Meeting #2, October 10, 2018
- NJ Joint Permit Processing Meeting #3, April 10, 2019

Minutes of each interagency meeting can be found in **Appendix Q**.

Like all developed alternatives, the PPA has unavoidable impacts to a variety of environmental resources including coastal wetlands, freshwater wetlands, state open waters, riparian zone, and marine resources. Refer to the Alternatives Matrix in **Appendix V** for a comparison of impacts between alternatives.

7. **ITS Facilities**
   As part of the PPA, empty ITS conduit will be installed on the bridge structures for future use in accordance with the NJDOT TSM Procedures and Standards Manual.

8. **Utility and Highway Lighting Impacts**
   Utilities along Ocean Drive will be either temporarily or permanently relocated during construction. A major relocation of the existing underground sanitary sewer force main may be necessary due to the proposed location of the piers. In the final condition, utilities are proposed to be relocated under the bridge deck on both sides. Existing highway lighting and utility poles along the Ocean Drive will be relocated within proposed widening limits. Pedestrian scale lighting is proposed along the sidewalk within study limits.

   Final utility and highway lighting impacts will be further investigated during Local Preliminary Engineering when subsurface utility engineering is conducted.

9. **Right of Way and Access Impacts**
   The recommended PPA requires minor permanent right of way acquisitions from three properties and temporary construction easement (TE) from three properties.

   Based on the preliminary proposed improvements, this project will require access modifications to 12 properties with 14 adjustments and four modifications (18 access points).

10. **Construction Staging**
    The proposed construction staging consists of two main stages and an offline pre-stage. Due to the feasibility of staged construction, traffic will be maintained with one lane in each direction. A short period (4 weeks) detour is required to construct the main span crossing the existing Middle Thorofare Bridge.

    The proposed construction staging consists of two main stages and a pre-stage.

Pre-Stage 1 (duration included in Stage 1):

- Construct Middle Thorofare structure offline on the south side and north side of the existing bridge. This work can extend into stage 1 and stage 2;
- Construct Mill Creek and Upper Thorofare structures offline on the north side of the existing bridge;
- Construct temporary pavement along Ocean Drive eastbound (EB) at both approaches of the bridge;
- Conceptual Traffic Operation: maintain one 10' lane in each direction on all existing bridges.

Stage 1:

- Shift the EB traffic to new EB shoulder and the westbound (WB) traffic to the EB lane of the existing roadway, Mill Creek and Upper Thorofare Bridge;
- Provide one 10' lane in each direction;
- Demolish north portion of the existing Mill Creek and Upper Thorofare Bridge;
- Construct WB portion of Mill Creek and Upper Thorofare bridges;
- Conceptual Traffic Operation: maintain one 10' lane in each direction on existing bridges.

Stage 2:

- Shift traffic to new WB pavement and shoulder and new Mill Creek and Upper Thorofare bridges;
- Provide one 10' lane in each direction;
- Demolish remaining (south) portion of the existing Mill Creek and Upper Thorofare Bridge;
- Construct EB sections of Mill Creek and Upper Thorofare bridges;
- Detour traffic crossing the Middle Thorofare Bridge. Construct the new span over the existing Middle Thorofare Bridge. Demolition of the existing bridge will not occur during this closure. After the closure, traffic will re-open to the existing bridge while the new span is completed above. A four-week detour is required.
- Stripe and reopen traffic to one lane of traffic in each direction on the existing Middle Thorofare Bridge;
- Once the last span over Middle Thorofare is complete, move the traffic onto the new structure. Demolish the existing Middle Thorofare Bridge, temporary pavement and temporary retaining wall (off-line).

Total construction duration = 36 months.

11. Preliminary Cost Estimates

The estimated total construction cost of the PPA is approximately **$217,000,000** based on Classification No. 1 – New Construction of the *NJDOT Cost Estimating Guide*, dated February 2017. Below is the list of the proposed project estimates for each category from CD:

Project Item	CD Phase Cost Estimate
Right-Of-Way	$ 3,080,000
Utility Relocation	$ 4,000,000
Construction	$ 182,500,000
Construction Engineering	$ 17,320,000
Contingencies	$ 500,000
Escalation (Year 2026)	$ 9,600,000
Total:	**$ 217,000,000**

12. Project Schedule

The following are the anticipated start dates and funding needs for the subsequent stages of this project.

Project Delivery Phase	Anticipated Start Date
Local Preliminary Engineering	Federal FY 2022
Final Design	Federal FY 2024
Right-Of-Way	Federal FY 2026
Construction	Federal FY 2026

U. Preliminary Engineering Scope Statement

The Preliminary Engineering Scope Statement documents key elements of the project scope including information gathered during CD. Activities that will be required in the Local Preliminary Engineering phase are identified in Preliminary Engineering Scope Statement included in **Appendix X**.

VII. CONCEPT DEVELOPMENT RECOMMENDATION

The recommended PPA, **Alternative 3**, addresses the established purpose and need, was viewed favorably by Local Officials and Stakeholders and received general support from the public. No fatal flaws have been identified with the PPA.

Documentation of important decisions that were made during the CD phase is recorded in the Design Communication Report (DCR) that can be found in **Appendix Y**.

A. Federal Highway Administration (FHWA) Approval of Report

A letter of approval from the Interagency Review Committee (IRC) was received on February 22, 2021 to advance the project to Local Preliminary Engineering. This letter is included in **Appendix CC**.