NJDOT Route 72 Manahawkin Bay Bridge Project

Township of Stafford & Borough of Ship Bottom
Ocean County, New Jersey

Addendum
to the
Environmental Assessment

Thorofare Bridge Scour Countermeasures and Public Waterfront Access Improvements

U.S. Department of Transportation
Federal Highway Administration
New Jersey Department of Transportation

Submitted Pursuant To 42 U.S.C. 4332 (2) (c),
16 U.S.C. 470 (f), 49 U.S.C. 303 and 23 U.S.C. 138

February 16, 2016

FHWA-NJ-EA-10---01(Addendum)
Federal Project No. BR-0019(114) and BR-0019(116)/NHP-0019(116)

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U.S. Department of Transportation
Federal Highway Administration
& New Jersey Department of Transportation

2/16/16

For New Jersey Department of Transportation — **Date**

2/22/16

For Federal Highway Administration-NJ Division Administrator — **Date**

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1 Executive Summary

1.1 Where is the Project?

The Route 72 Manahawkin Bay Bridges Project (Project) is located in Ocean County, New Jersey. The Route 72 project corridor traverses Manahawkin Bay, connecting Long Beach Island in Ship Bottom Borough with the mainland in Stafford Township, carrying traffic over the Manahawkin Bay and the Intracoastal Waterway (see Figure 1-1).

The Route 72 Manahawkin Bay Bridges Project involves the construction of a new structure parallel to and south of the existing Manahawkin Bay Bridge, rehabilitation of the existing Manahawkin Bay Bridge, and the rehabilitation of three bridges over Hilliards Thorofare, East Thorofare, and West Thorofare.

The Project also includes the following planned improvements:

- Addition of sidewalks and bicycle accommodations on the westbound (north) side of Route 72, with connections to communities within the Project corridor;
- Improvements to the intersection of Route 72 and Marsha Drive in Stafford Township to alleviate seasonal traffic delays; and
- Intersection and drainage improvements along 8th and 9th Streets in Ship Bottom Borough, designed to improve traffic flow for both north/south traffic on Long Beach Island, and alleviate flooding.

The Project also allows for improved public access to the waterfront through a combination of improved bicycle and pedestrian facilities, the construction of five (5) new public parking lots along the Project corridor, rehabilitation of the bulkhead at the manmade island for recreational purposes, and restoration of a portion of the U.S. Fish and Wildlife Service (USFWS) Edwin B. Forsythe National Wildlife Refuge Cedar Bonnet Island Management Unit for passive recreational use.

1.2 Why is the Project needed?

Route 72 provides the only ingress and egress to Long Beach Island and as such serves as a vital link in the regional transportation system to maintain the safety and security of residents and visitors to Long Beach Island. The primary purpose of the Project is to address the poor condition of the four bridges that make up the Route 72 Project corridor.

1.3 When will the Project be built?

Construction of the Route 72 Manahawkin Bay Bridge Project was initiated in 2013 and is anticipated to be completed in 2020. No change in the project duration is anticipated.

1.4 What is new?

In July 2011, the New Jersey Department of Transportation (NJDOT), in conjunction with the Federal Highway Administration (FHWA), prepared an Environmental Assessment (EA) for the Route 72 Manahawkin Bay Bridges Project. On September 16, 2011, the FHWA issued a Finding of No Significant Impact (FONSI) (see Appendix A). Subsequently, permits were obtained from the New Jersey Department of Environmental Protection (NJDEP), US Army Corps of Engineers (USACE), and the US Coast Guard (USCG) authorizing the proposed activities.

The 2011 EA and associated permits are available for review at:
http://www.state.nj.us/transportation/commuter/roads/rte72manahawkinbaybridges/ea.shtm

This Addendum to the Environmental Assessment is intended to address changes to the project proposal. The new proposed action consists of the installation of scour protection at each of the three Thorofare Bridges to provide protection against scour events, such as hurricanes and large coastal storms that could result in the erosion of sediment in and around the bridge foundation which can compromise the structural reliability of the Thorofare Bridges. In addition, the new proposed action also revises the public waterfront access plan including changes to Parking Lot 5 to address comments received through ongoing public involvement and modifications to Parking Lot 3 to address stability issues of concern at the existing bulkhead at the northeasterly quadrant of the existing Bay Bridge.

1.5 Will there be a travel delay due to construction?

Existing traffic patterns will be maintained for the duration of construction, especially during peak summer months, in a manner that minimizes disruption to the traveling public. No alteration to proposed traffic patterns are anticipated as a result of the proposed action.

1.6 Will there be an impact to local residences or businesses?

Access will be maintained to all residences and businesses during construction. It is possible that some temporary and localized impacts to residential and business located immediately adjacent to the project will occur during construction due to construction noise, temporary construction access requirements, and change in traffic patterns.

1.7 Will it affect the environment?

The proposed action involves the installation of scour countermeasures within the coastal waterway, rehabilitation of an existing bulkhead, and construction of new parking and pedestrian facilities. Impacts are anticipated to coastal resources such as shellfish habitat, intertidal/subtidal shallows, open water, and submerged aquatic vegetation (SAV). The NJDOT will minimize these impacts to the extent practicable during project design. No endangered species or historic resources would be affected by the proposed action. As required by law, NJDOT will obtain permits from the New Jersey Department of Environmental Protection (NJDEP), the US Army Corps of Engineers (USACE), and from the United States Coast Guard (USCG) prior to the initiation of regulated activities to ensure the proposed action complies with all environmental regulations.

1.8 What is the mitigation for the new impacts?

Consistent with prior agency approval, and any required amendments to those approvals, the NJDOT will provide additional mitigation for project related impacts to SAV, riparian habitat, shellfish habitat, and intertidal/subtidal shallow habitat.

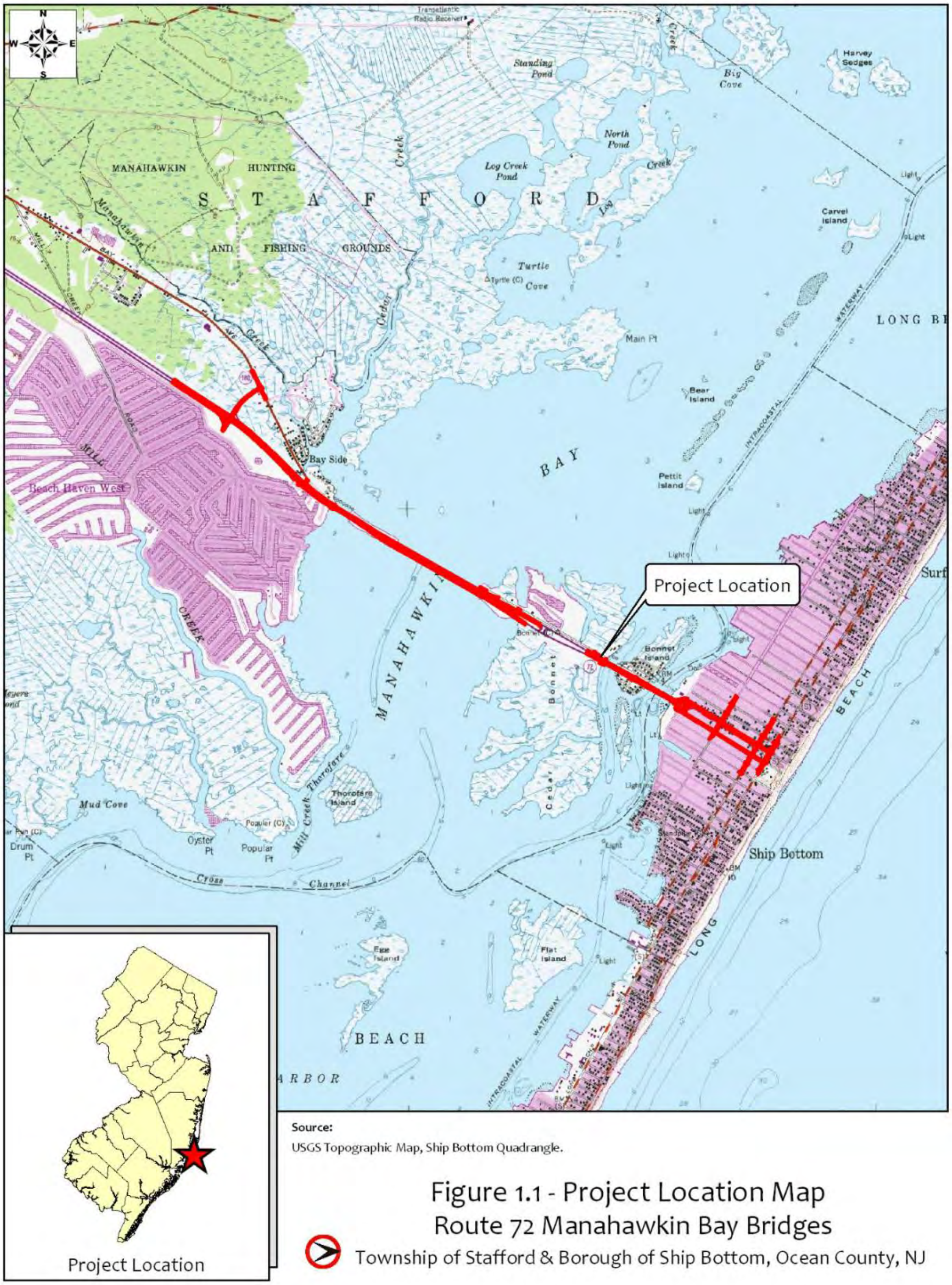

Figure 1-1: Project Location Map

2 Project Purpose and Need

2.1 Introduction

Route 72 is the only highway access to Long Beach Island connecting the mainland in Stafford Township, Ocean County, New Jersey to Long Beach Island in Ship Bottom, NJ. On peak summer weekends, as many as 150,000 people travel to the six municipalities of Long Beach Island—Barnegat Light, Beach Haven, Harvey Cedars, Long Beach Township, Ship Bottom, and Surf City – along the Route 72 corridor. Without an alternative route, it is imperative to maintain a safe, reliable highway connection to Long Beach Island for the safety of residents and visitors. The Route 72 corridor traverse Manahawkin Bay, a sensitive and valuable environmental resource that needs to be protected during and after construction.
The Route 72 Manahawkin Bay Bridges Project involves the construction of a new structure parallel to and south of the existing Manahawkin Bay Bridge, rehabilitation of the existing Manahawkin Bay Bridge, and the rehabilitation of three trestle bridges over Hilliards Thorofare, East Thorofare, and West Thorofare.

The Project also includes the following planned improvements:

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The Project also allows for improved public access to the waterfront through a combination of improved bicycle and pedestrian facilities, the construction of five (5) new public parking lots along the project corridor, rehabilitation of the bulkhead at the manmade island for recreational purposes, and restoration of a portion of the USFWS Edwin B. Forsythe National Wildlife Refuge Cedar Bonnet Island Management Unit as a passive recreational facility.

2.2 Environmental Assessment

The Route 72 Manahawkin Bay Bridge Environmental Assessment was approved in July 2011. Following a public comment period, FHWA issued the Finding of No Significant Impact (FONSI) in September 2011. Permits for construction activities were issued in 2012.

A copy of the FONSI is provided in Appendix A. The 2011 EA and previously issued permits are available for review at:

http://www.state.nj.us/transportation/commuter/roads/rte72manahawkinbaybridges/ea.shtm

2.3 Status of Preferred Alternative

The Preferred Alternative from the 2011 EA and FONSI is currently under construction (see Figure 2-1). The construction of the new Bay Bridge began on May 3, 2013 and is scheduled to open in the spring 2016. Construction on the remaining portion of the Project will continue through 2020.

NJDOT is proposing changes to the Preferred Alternative, hereafter the proposed action, specifically to address the need for scour countermeasures at each of the three Thorofare Bridges, and modification to public access facilities at Parking Lots 3 and 5.

2.4 Purpose of Proposed Action

2.4.1 Scour Protection

Subsequent to Hurricane Sandy, localized scour conditions were identified during regular inspections conducted by NJDOT. In response, FHWA requested that NJDOT conduct an updated scour analysis at the three Thorofare Bridges. Based upon the most recent analysis (see Appendix B) the bridges were determined to be scour critical. As such, a scour event such as a hurricane storm surge could lead to theoretical instabilities, including erosion of sediment in and around the bridge foundation, which can compromise the structural reliability of the Thorofare Bridges. NJDOT is therefore proposing scour protection at each of the three Thorofare Bridges to maintain safe roadway conditions.

2.4.2 Public Waterfront Access Improvements

The initial project proposal included five parking lots and the rehabilitation of the existing bulkhead on the man-made island to provide improved public access to the waterfront. Subsequently, the proposed location of Parking Lot 5 was modified to address public comments, and the existing bulkhead located adjacent to Parking Lot 3 (located immediately to the northeast of the existing Bay Bridge) was compromised due to storm damage. For these reasons, the NJDOT is proposing to include rehabilitation of the northeast bulkhead along with changes in the locations to these two parking lots. The layout of previously approved pedestrian and bicycle access improvements will also be adjusted to connect to the new parking lot locations.

2.5 Need for Proposed Action

2.5.1 Scour Protection

The proposed scour protection would provide stability to the bay bottom in the vicinity of the Thorofare bridges, which in turn maintains stability for the existing timber pile foundations. The proposed scour protection prevents scouring which could compromise the stability of the structures and create unsafe roadway conditions.

2.5.2 Public Waterfront Access Improvements

The NJDOT previously committed to providing improved public waterfront access as part of this project. The NJDOT is installing five parking lots and associated sidewalk improvements along Route 72 corridor for this purpose.

Figure 2-1
Project Components

3 Alternatives to the Proposed Action

3.1 No Action Alternative

The No Action Alternative consists of no additional work to the Project as detailed in the FONSI signed September 16, 2011.

3.1.1 Scour Protection

Under the No Action Alternative, the Project would consist of rehabilitation of the three structures carrying Route 72 over Hilliards Thorofare, West Thorofare, and East Thorofare without scour protection.

Work associated with the No Action alternative would still consist of pier cap rehabilitation, piling protection system, a new bearing support system, deck repairs including an overlay on the existing deck slab, and reconfiguring the deck and lane configuration to provide accommodations for pedestrian and bicycle use. The No Action would leave the Thorofare Bridges susceptible to scour.

3.1.2 Public Waterfront Access Improvements

Under the No Action Alternative, public waterfront access would be provided through a combination of new sidewalks and public parking facilities allowing pedestrian access to existing bulkheads and access to a portion of the Edwin B. Forsythe National Wildlife Refuge consistent with the previously approved plans.

3.2 Scour Countermeasure Design Alternatives

3.2.1 Scour Alternative 1: Bridge Rehabilitation with Scour Countermeasures

As part of this alternative analysis, several construction methods were considered for scour countermeasures for the Thorofare Bridges including Marine Mattress, Articulated Concrete Block Mattress, A-Jacks, and Riprap (eg. course stone).

Of the five (5) scour design alternatives considered all have the same footprint but vary according to the type and thickness of material used, and the extent to which bed preparation prior to installation is required.

3.2.1.1 Scour Alternative 1A and 1B - Marine Mattress

The Marine Mattress is a low profile armoring alternative with total depths ranging between six and twelve inches. The armoring system consists of stone filled geogrids made from high strength plastic materials that are UV protected. The typical size of each mattress is 20 feet by 5 feet and creates a large stable and protective mass during scour events.

Marine Mattresses are significantly more flexible than other similarly manufactured products. Due to the flexibility of the grid and the nature of the aggregate fill, the marine mattress is able to conform to small irregularities, which reduces the need for in-water preparation of the subgrade.

At the pile bents, special detailing would be required due to the limited space available. To provide protection in the space around individual piles, either Riprap (course stone) or grout bags would be used.

Alternative 1A consists of the use of Riprap to fill the void in and around each pile. Riprap placed between the piles would extend beyond the top of the marine mattress, and also extend above the bay bottom elevations from 2009 (see Figure 3-1).

Alternative 1B would utilize grout bags, as an alternative to Riprap, placed flush with the marine mattress to fill the void in and around the piles, helping to maintain the bay bottom elevation (see Figure 3-2).

3.2.1.2 Scour Alternative 1C - Articulated Concrete Block Mattress

Articulated Concrete Block Mattress (ACBM) is a low profile, hard armoring alternative with total depths of approximately 5-8 inches. In order to adequately anchor and stabilize these mats, the leading edges must be buried with 3.5 feet of Riprap. The material is composed of preformed concrete blocks that interconnect through a combination of forms and/or cables.

The blocks are able to bend to some degree along their adjoining faces allowing the system to conform to minor changes in the subgrade while maintaining a protective cover. However, for installation, the subgrade needs to be smooth with little to no abrupt changes in order for the ACBM to perform as designed.

At the pile bents, special detailing would be required due to the limited space available. This would likely require the use of Riprap or grout bags to protect these areas.

Since the undermining of ACBM will reduce its effectiveness, as noted above, the perimeter edges of the ACBM must be anchored by excavating a trench and burying the edges with Riprap (see Figure 3-3).

3.2.1.3 Scour Alternative 1D - A-Jacks

A-Jacks are tetrahedral shaped concrete armor units which interlock into a flexible, permeable matrix. The A-Jacks system dissipates energy and resists the erosive forces of flowing water allowing the system to protect against scour.

The total height of an A-Jack is 24 inches but typically rests on an angle on top of a coarse aggregate bedding layer with a minimum overall height of 16 inches above the bedding layer (see Figure 3-4). The subgrade preparation for A-Jacks is not as extensive as ACBM as the entire unit is not designed to be in contact with the substrate material, and is intended to be silted up over time.

Special detailing would be required in the limited available space around the piles to prevent damage which would likely require the use of Riprap to protect these congested areas. Due to concerns regarding stability of the existing bridge foundations, excavation prior to installing A-Jacks is not feasible. As such, A-Jacks would have to be installed above the existing bed elevation which may reduce water depths and impair navigation.

3.2.1.4 Scour Alternative 1E - Riprap

Riprap is the most traditional method to protect against scour and consists of large stones sized to prevent the loss of material. This project would require stones averaging 12 inches in size that rest upon a coarse aggregate bedding layer for a total of 4 feet 6 inches of protection (see Figure 3-5).

Riprap is the simplest method of construction for this site, but the depth required makes it very unfavorable due to the potential for environmental and navigational impacts in Manahawkin Bay. Loose Riprap is also considered a temporary scour countermeasure and would require continual monitoring after storm events.

3.2.1.5 Preferred Scour Countermeasure Design Alternative

Marine Mattress has the thinnest profile and requires minimal bed preparation prior to installation. Utilization of grout bags to provide scour protection in around the individual piles results in the least amount of placement of fill material within the waterway. As such Marine Mattress with Grout Bags (Alternative 1B) is recommended as the Preferred Scour Protection Design. A relative comparison of the various design alternatives in included in Table 3-1.

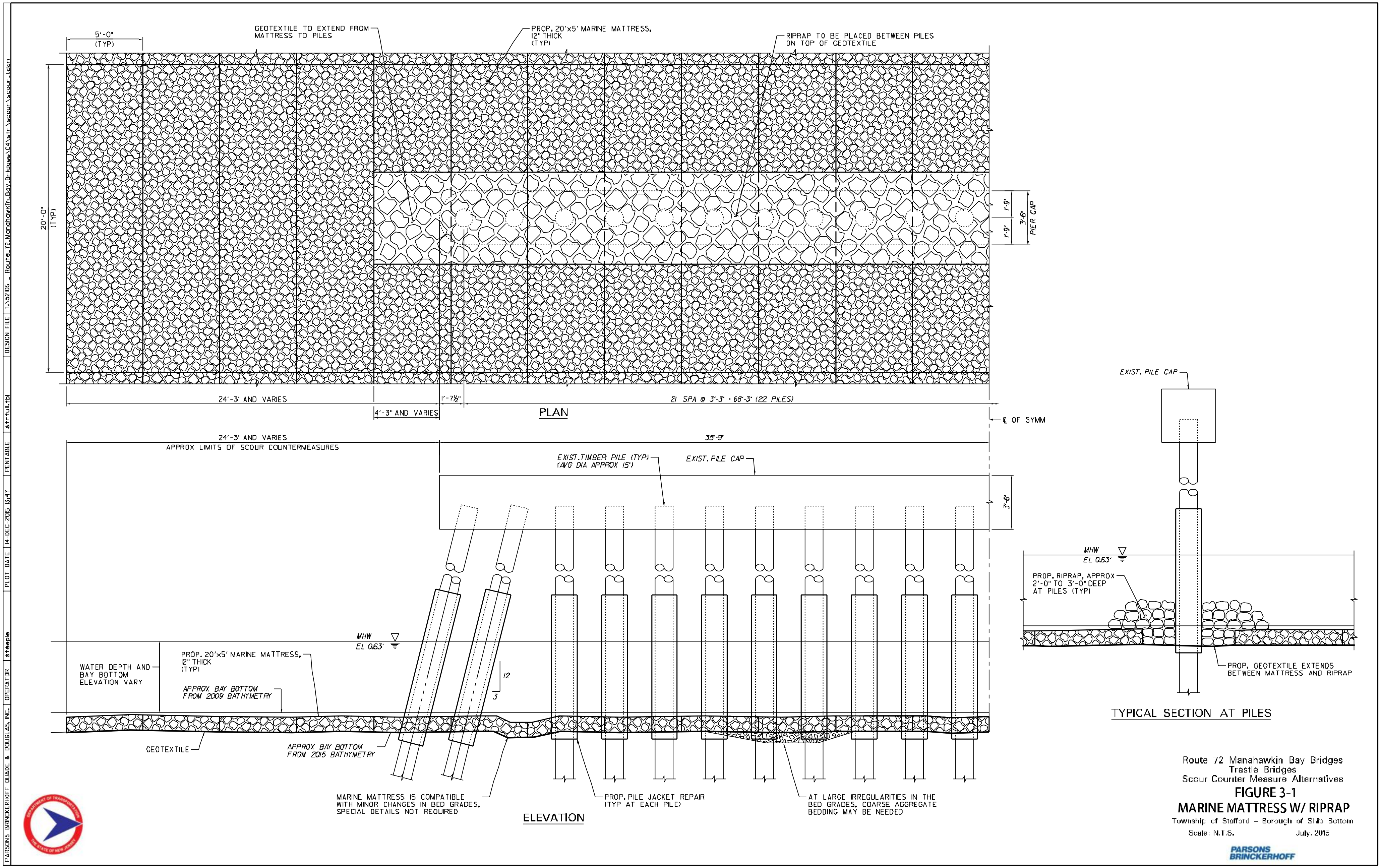
Table3-1:
Comparison of Scour Countermeasure Design Alternatives

Scour Countermeasures Comparison Matrix											
Scour Countermeasure Alternative	Subgrade Preparation	Depth[2] / Need for Excavation	Constructability	Durability	Future Maintenance	Environmental Impact	Adaptability	Approximate Limits (SY)	Unit Cost ($/SY)	Weighted Score	Rank
Weighted Score Multiplier	1.00	1.50	1.50	1.50	1.50	2.00	1.50	-	-	-	-
Articulated Concrete Block Mattress (ACBM)[1]	Extensive Preparation **{1}**	5 to 8 inches **{5}**	Difficult placement with low headroom and between piles **{2}**	Resilient concrete elements, toe-in points require monitoring **{4}**	Required at toe-in points **{2}**	Some excavation for toe-ins and largest limts **{2}**	Vulnerable to bed condition changes **{1}**	22,000	$150	26.00	**3**
A-Jacks	Moderate Preparation **{3}**	1.5 to 2 feet **{2}**	Difficult placement with low headroom **{2}**	Resilient concrete elements **{5}**	Moderate monitoring **{3}**	Some excavation over entire area, typical limits **{2}**	Susceptible to bed condition changes **{2}**	19,000	$350	28.00	**2**
Riprap	Minimal Preparation **{5}**	4.5 feet **{1}**	Easiest to install within project constraints **{4}**	Stones can become dislodged **{1}**	Requires Regular Maintenance **{1}**	Most excavation, typical limits **{1}**	Moderate performance with changed conditions **{4}**	19,000	$210	23.50	**4**
Marine Mattress	Reduced Preparation **{4}**	6 to 12 inches **{4}**	Difficult placement with low headroom and between piles **{2}**	Exposed geogrid at shallow locations may wear **{3}**	Minimal monitoring **{4}**	No excavation anticipated[3], typical **{5}**	Moderate performance with changed conditions **{4}**	19,000	$140	39.50	**1**

Note:
{1} - Indicates Rating for Parameter, a score of 5 indicates optimal performance, a score of 1 indicates poor performance

Footnotes

1 - Approximate quantity and unit costs are adjusted for ACBM to account for Riprap toe-in required at the edges of the countermeasure
2 - Depth includes coarse aggregate bedding layer for ACBM and Riprap, the range shown for A-jacks represents the likelihood of eliminating the bedding layer
3 - Based on manufacturer recommendations, no excavation for installation of Marine Mattress is proposed



Route 72 Manahawkin Bay Bridges
Trestle Bridges
Scour Counter Measure Alternatives

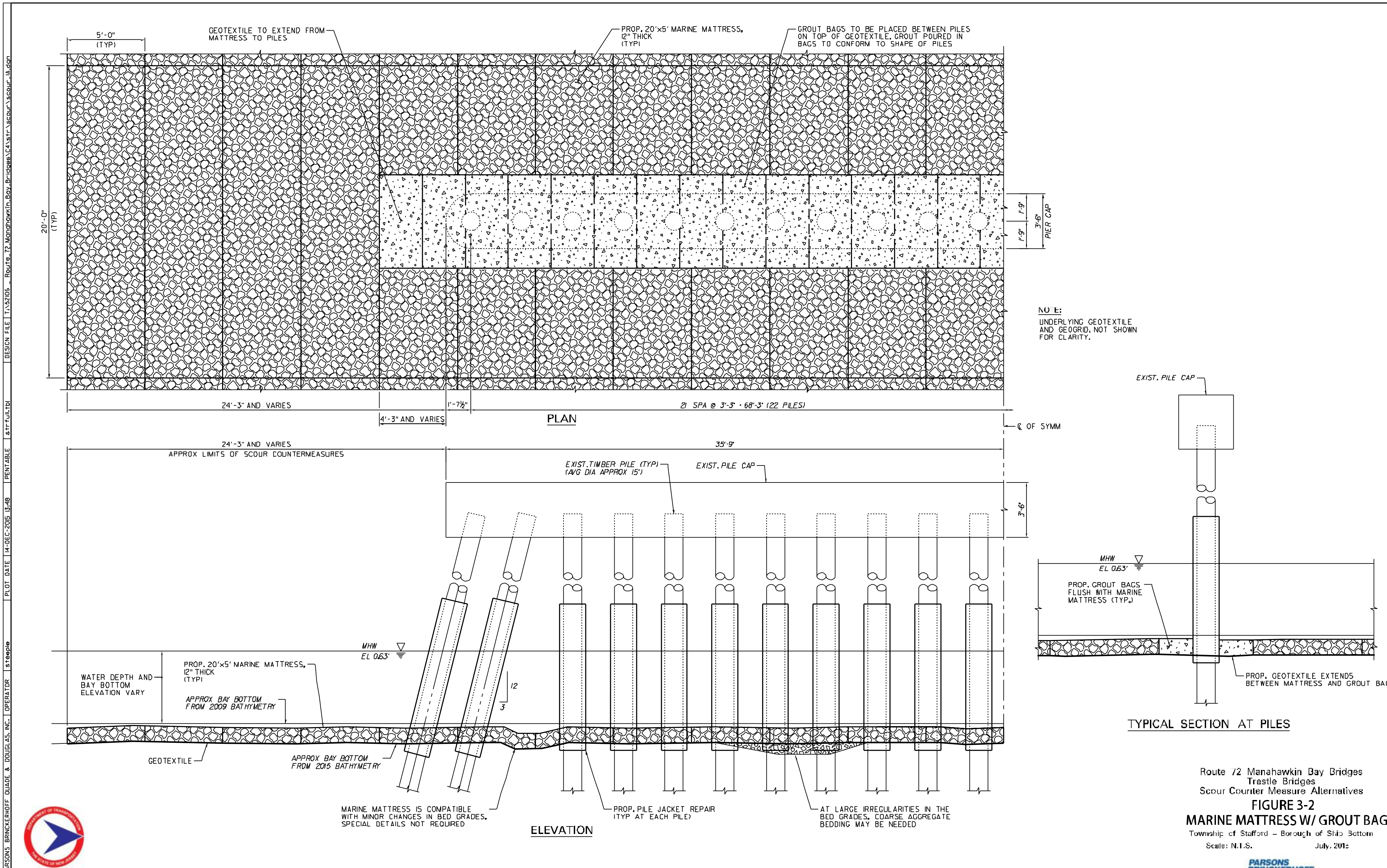
FIGURE 3-1

MARINE MATTRESS W/ RIPRAP

Township of Stafford – Borough of Ship Bottom

Scale: N.T.S. July, 2016

PARSONS BRINCKERHOFF

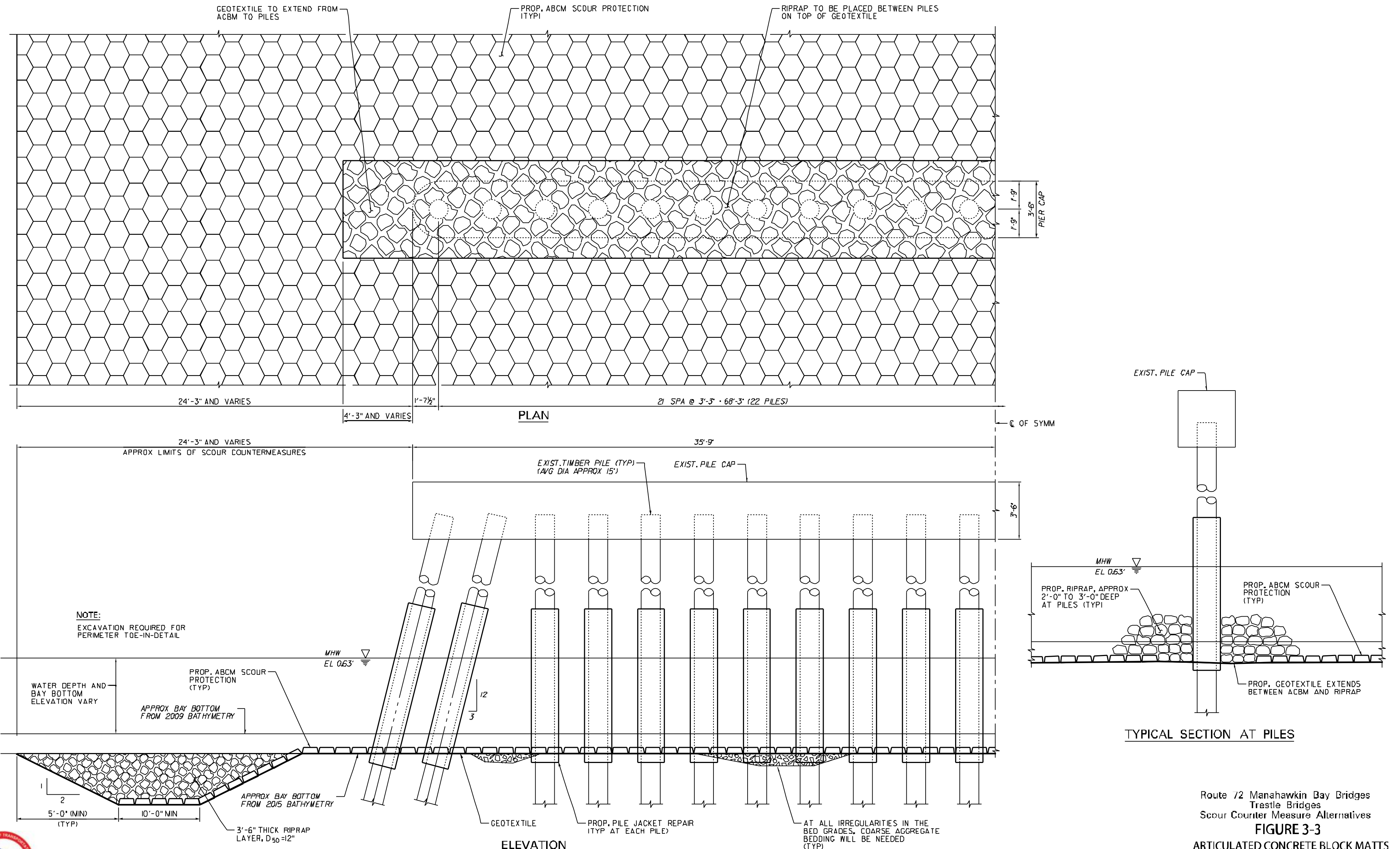


Route 72 Manahawkin Bay Bridges
Trestle Bridges
Scour Counter Measure Alternatives

FIGURE 3-2
MARINE MATTRESS W/ GROUT BAG

Township of Stafford – Borough of Ship Bottom
Scale: N.T.S. July, 2016

PARSONS BRINCKERHOFF



Route 72 Manahawkin Bay Bridges
Trestle Bridges
Scour Counter Measure Alternatives

FIGURE 3-3

ARTICULATED CONCRETE BLOCK MATTS

Township of Stafford – Borough of Ship Bottom

Scale: N.T.S. July, 2016

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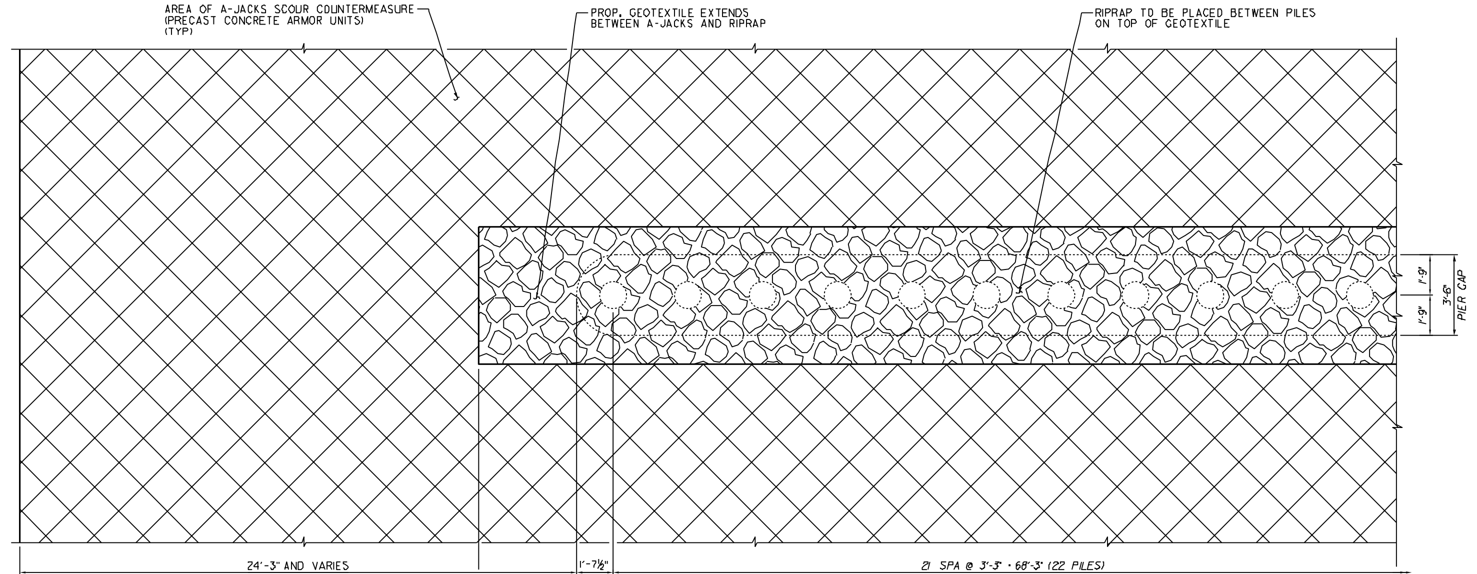
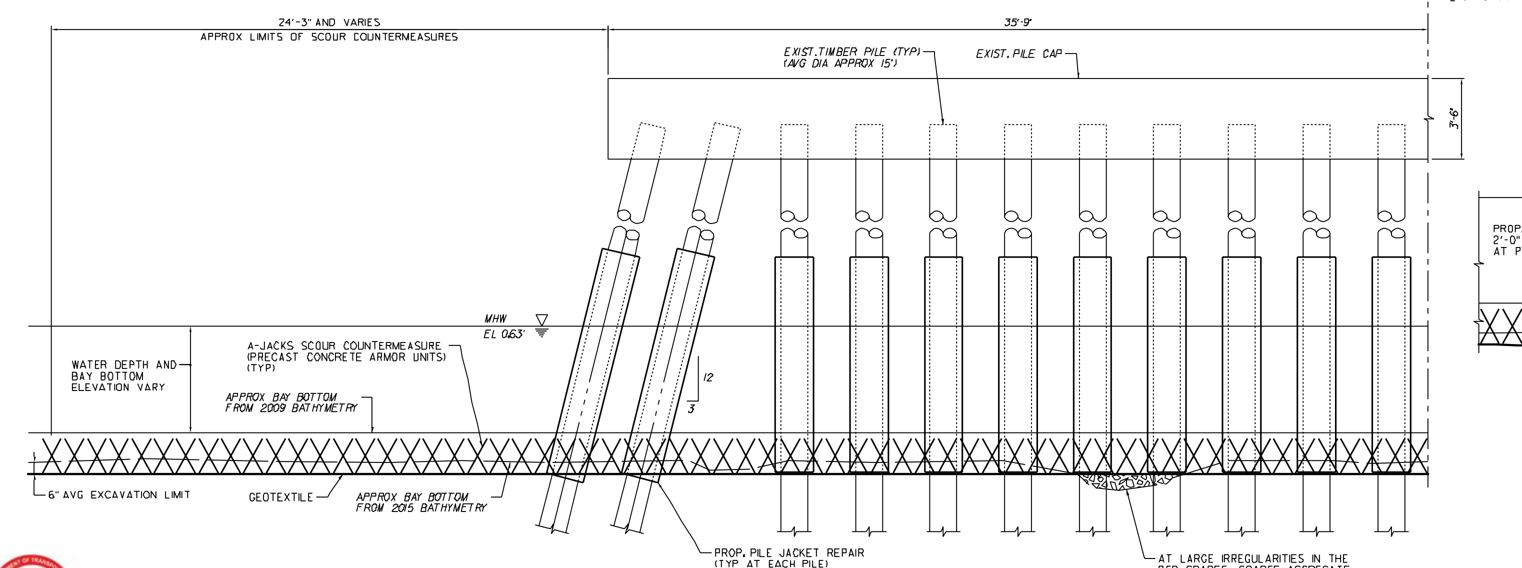
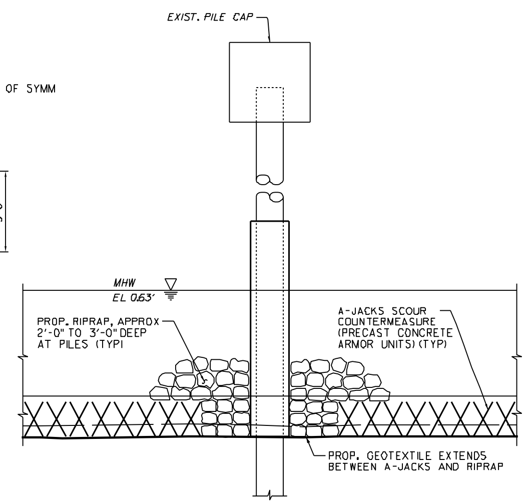


PLAN



ELEVATION



TYPICAL SECTION AT PILES

Route 72 Manahawkin Bay Bridges
Trestle Bridges
Scour Counter Measure Alternatives

FIGURE 3-4
A–JACKS

Township of Stafford – Borough of Ship Bottom
Scale: N.T.S. July, 2015

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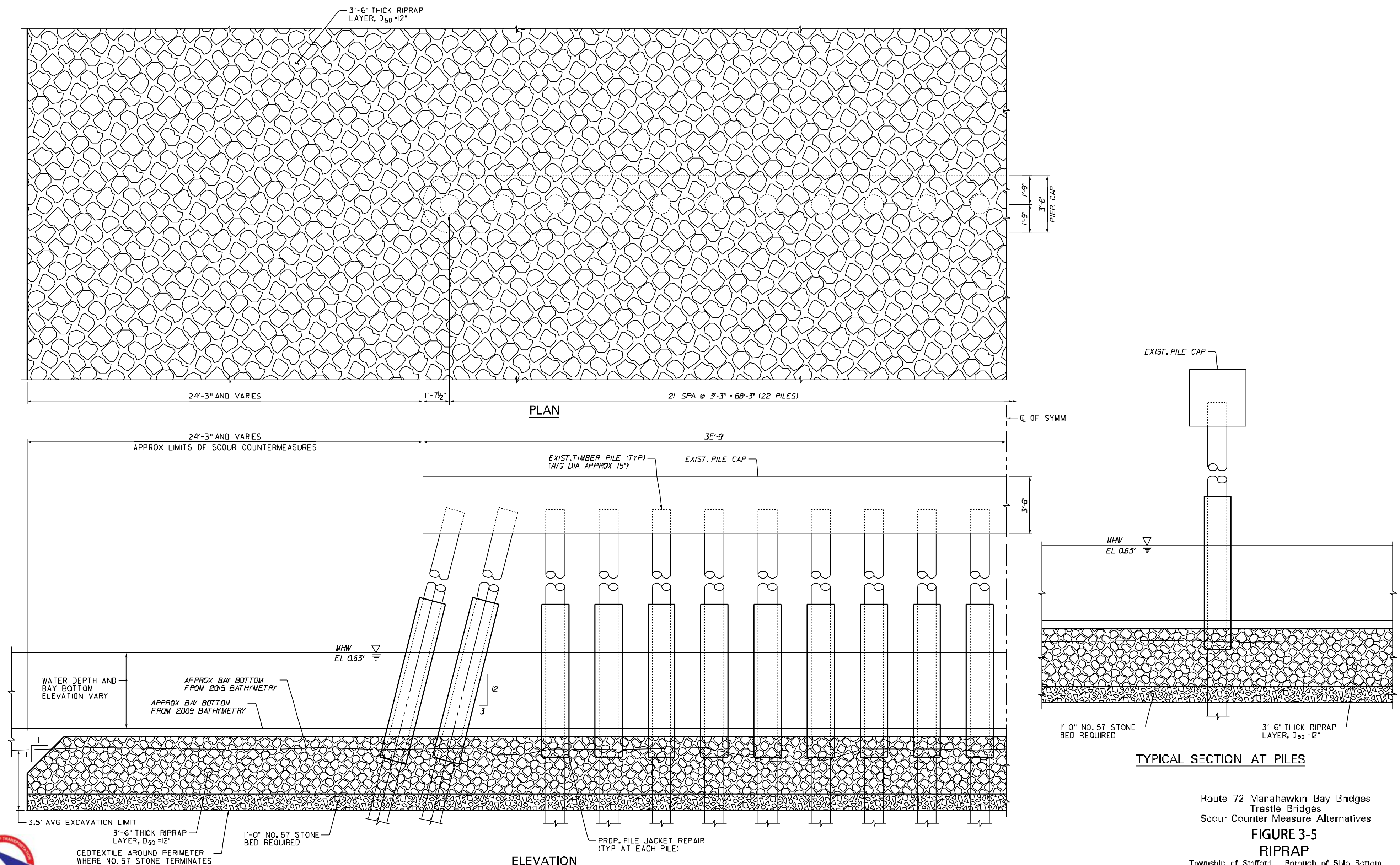

Route 72 Manahawkin Bay Bridges
Trestle Bridges
Scour Counter Measure Alternatives

FIGURE 3-5
RIPRAP

Township of Stafford – Borough of Ship Bottom
Scale: N.T.S. July, 2016

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3.2.2 Scour Alternative 2: Bridge Replacement

The Bridge Replacement Alternative would build new bridges on the same alignment as the existing Thorofare Bridges. Replacement of the existing Thorofare Bridges would need to be built in two stages in order to maintain traffic during construction (see Figure 3-6 and 3-7).

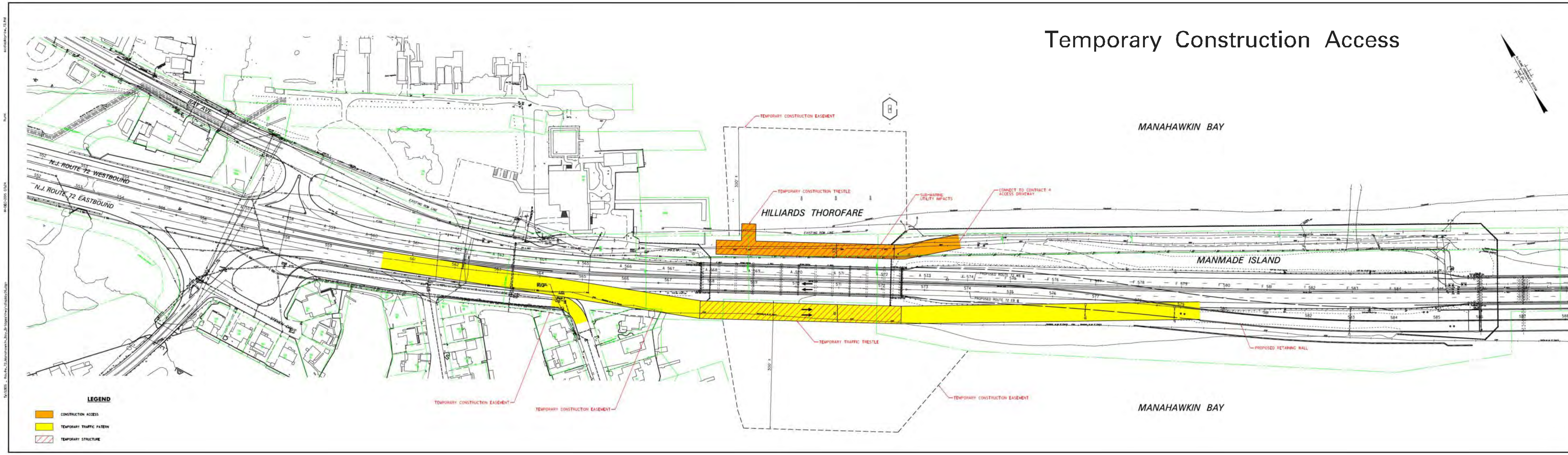
Stage I – Construct a temporary trestle bridge to the south to convey two lanes of traffic in eastbound direction. Due to the limited depth of the water within the project area the use of barges for construction access is not feasible. As such, two temporary trestle bridges are needed, one to accommodate maintenance of traffic and the other for construction access. Construct a temporary construction trestle to the north of the existing bridge to accommodate construction access while maintaining two lanes of traffic on the existing bridge in the westbound direction. Construct a temporary bridge for traffic. Demolish and construct the westbound (northerly) portion of the bridge to accommodate four lanes of traffic.

Stage II – Shift four lanes of traffic to the newly constructed portion of the new Thorofare Bridge. Remove the temporary construction trestle and utilize the temporary traffic trestle bridge to demolish and construct the southerly portion of the bridge. Establish two lanes of traffic in each direction on the new Thorofare Bridge. Remove the temporary traffic trestle bridge.

The new Thorofare Bridges would have new pile foundations designed to withstand a scour event. Significant electric and gas utilities adjoin the northern alignment of the existing Thorofare Bridges. Relocation of these utilities would be required prior to the start of construction. Approximately eight years would be required to design and obtain approvals for this alternative, allow for the relocation of utilities, and complete construction at the three trestle bridge locations. As such, this alternative would result in leaving the bridges scour critical, thus resulting in a prolonged public safety concern and is therefore not recommended.

3.2.3 Scour Alternative 3: Bridge Replacement with Interim Scour Countermeasures

The Bridge Replacement with Scour Countermeasures alternative would be the same as the Alternative 2 but would include interim scour countermeasures, similar to Alternative 1, to provide immediate scour protection of the existing Thorofare Bridges to maintain public safety. Under this alternative, the scour protection measures would be removed as part of the bridge replacement phase of the Project. However, once the interim scour countermeasures are installed, bridge replacement as scour protection is no longer warranted.



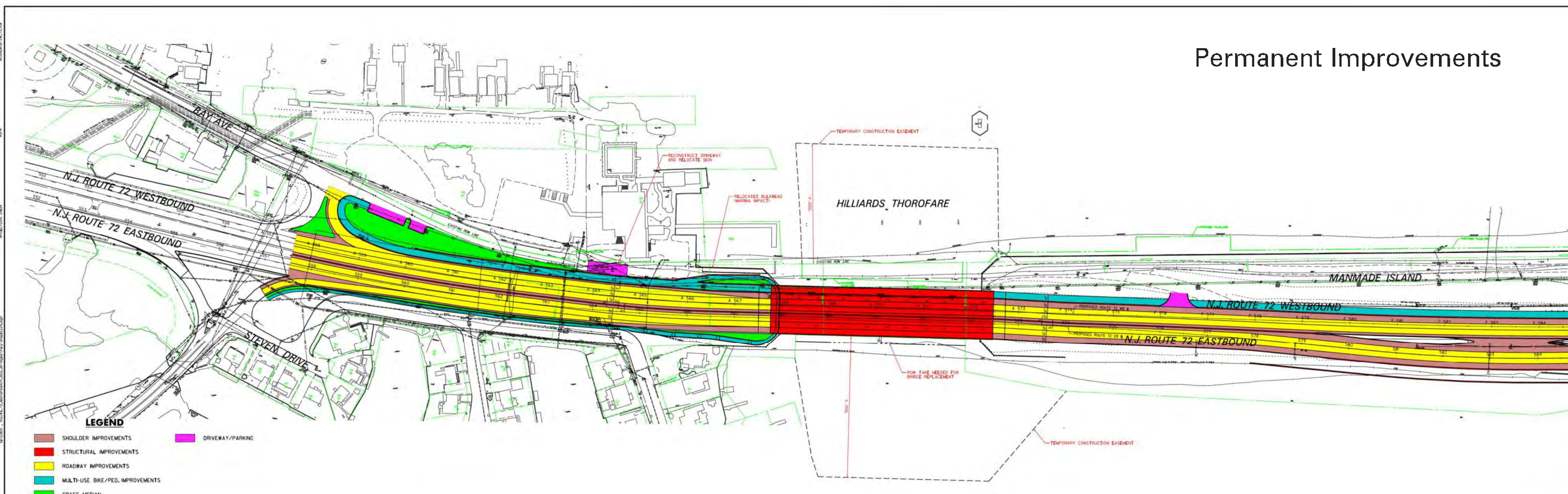
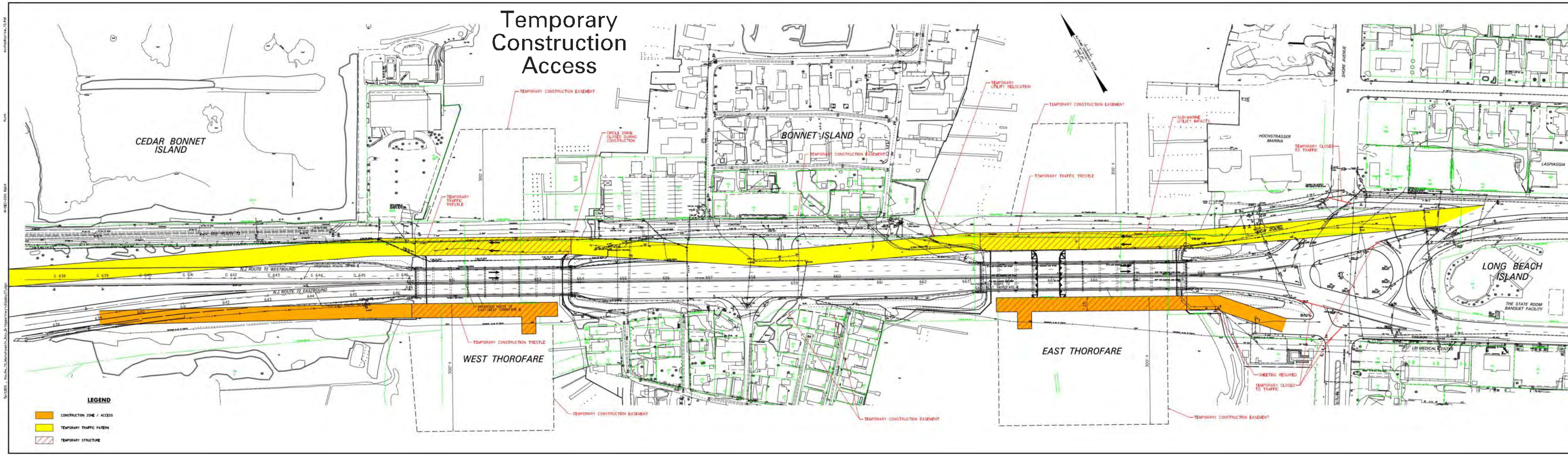


Figure 3-6
Alternative 2: Bridge Replacement Hilliards Thorofare

TOWNSHIP OF STAFFORD
BOROUGH OF SHIP BOTTOM
OCEAN COUNTY



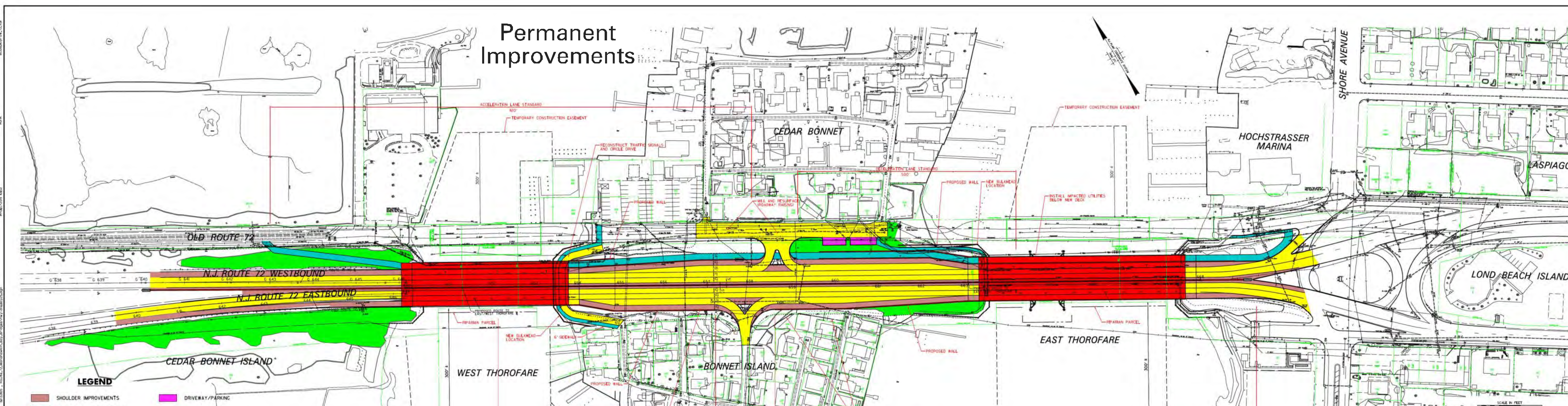


Figure 3-7
Alternative 2: Bridge Replacement West & East Thorofare

3.3 Public Waterfront Access Improvements

As part of the Project approvals, NJDOT has committed to improve public waterfront access. Of the five (5) public parking lots proposed as part of its public access plan, changes are being proposed to two (2) parking lots including Parking Lot 3 and Parking Lot 5.

3.3.1 No-Action Alternative – Approved Design

NJDOT previously included parking lots with pedestrian access to the waterfront as part of the original Project. Of those facilities, Parking Lot 3 included improved access accommodations to the existing bulkhead at the northeast abutment of the Bay Bridge but did not include the rehabilitation of the existing bulkhead which has deteriorated due to recent storm damage. Parking Lot 5 provided additional accommodations for access to the Cedar Bonnet Island Management Unit of the Edwin B. Forsythe National Wildlife Refuge from the Route 72 westbound travel lanes via a proposed pedestrian walkway (see Figure 3-8).

3.3.2 Parking Lot 3 Proposed Design Alternative

The approved design for Parking Lot 3 originally envisioned utilizing the existing wood bulkhead to provide access to the waterfront. However due to the advanced deterioration of the bulkhead, NJDOT is proposing to rehabilitate the existing bulkhead which was not previously included in the Project. The new bulkhead would consist of the replacement of a portion of the bulkhead with a new sheet pile bulkhead, railing, and sidewalk facilities as is being done on other areas of the Project (i.e. Man Made Island). The remaining portion of the bulkhead would be replaced with Riprap to avoid conflict with existing underground utilities, including three (3) sewer utility mains, which traverse the Project area. The proposed bulkhead would be landward of the existing bulkhead, and the proposed extent of Riprap would be designed such that placement of fill within the waterway is minimized. The design would include the relocation of the parking and pedestrian access pathway to accommodate the bulkhead rehabilitation and allow for better public access to and utilization of the waterfront. A portion of the existing roadway would be removed (see Figure 3-9).

3.3.3 Parking Lot 5 Proposed Design Alternative

Parking Lot 5 is located adjacent to the western abutment of the Western Thorofare Bridge. It includes pedestrian access to westbound Route 72 as well as an extended sidewalk that provides access to Eastbound Route 72, terminating at the entrance to Edwin B. Forsythe National Wildlife Refuge Cedar Bonnet Island Management Unit. In response to public comment received on the location of the parking lot from adjacent business owners, NJDOT has proposed a change in the location along with slight modifications to the sidewalk to improve public accessibility (see Figure 3-9).

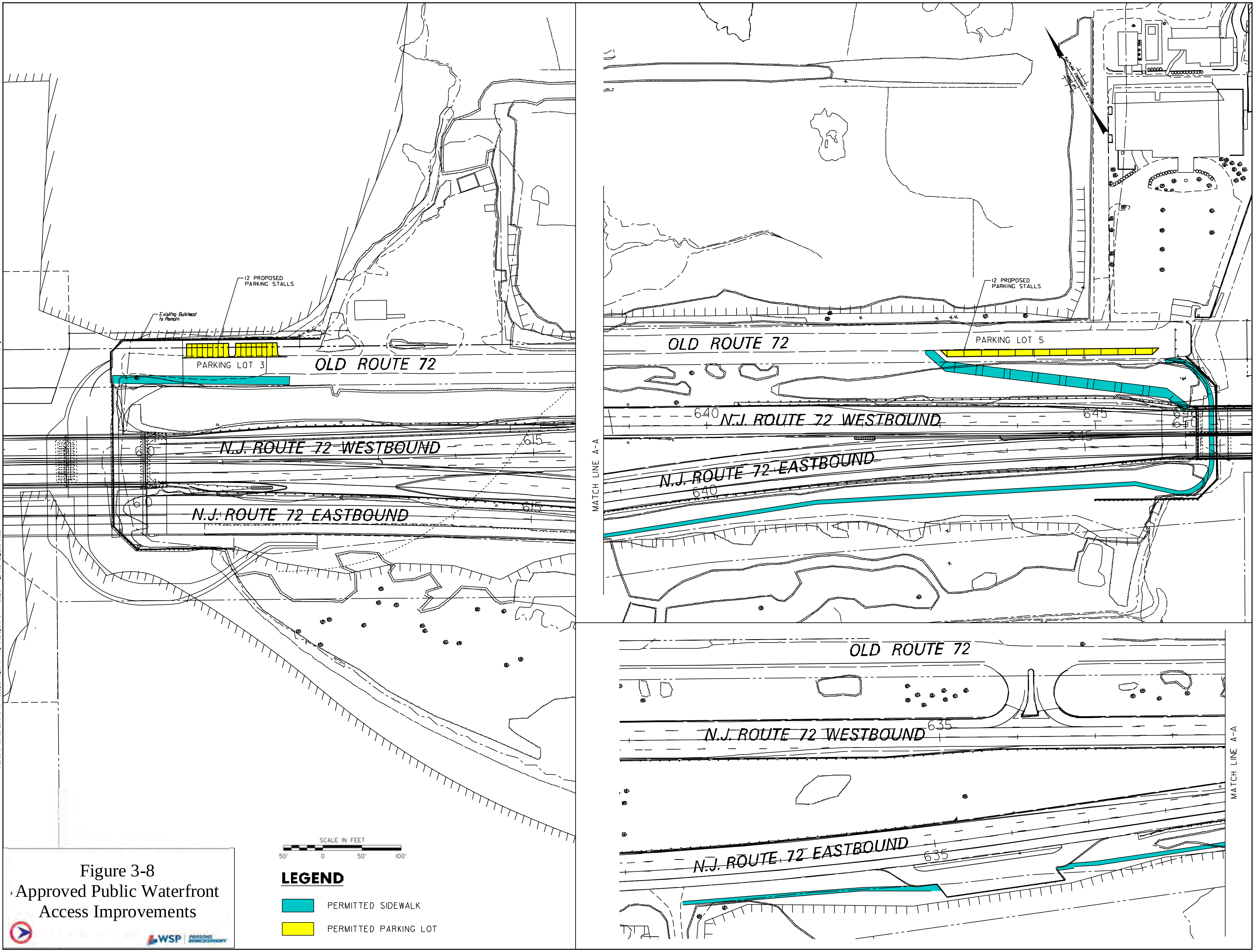


Figure 3-8
Approved Public Waterfront Access Improvements

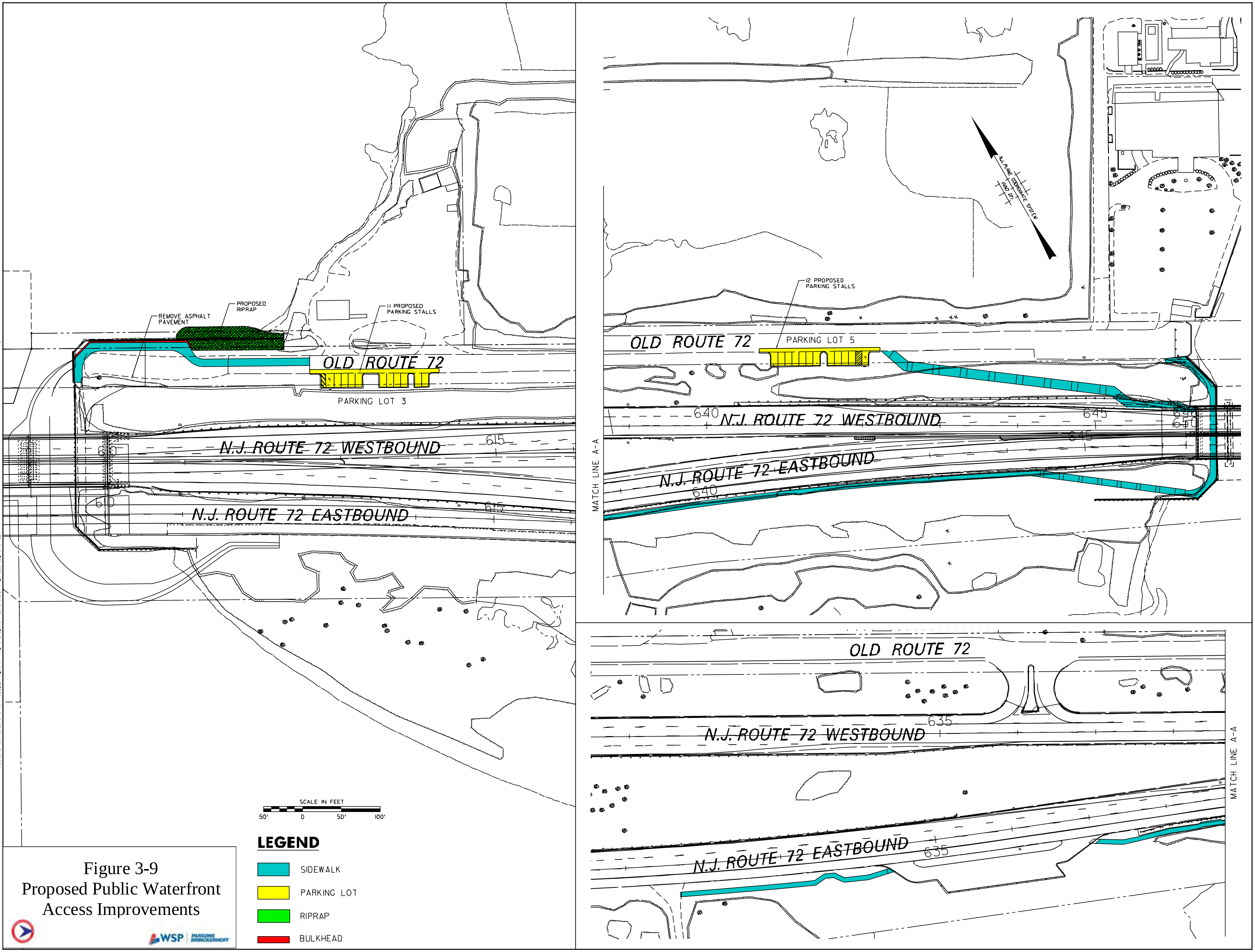


Figure 3-9
Proposed Public Waterfront Access Improvements

4 Affected Environment and Environmental Consequences

NJDOT considered the No Build Alternative and the Build Alternatives as defined in Chapter 3. The following sections analyze the impact of each alternative to resources in the Project area to make a recommendation for a Preferred Alternative for each project element – Scour Protection, Parking Lot 3, and Parking Lot 5. The location and extent of sensitive environmental features within the Project area are illustrated on Figures 4-1 and 4-2.

4.1 Traffic and Congestion

Under the No-Action Alternative for Scour Protection, the potential for instability to the existing Thorofare Bridges due to a scour event may result in the temporary closure of one or more Thorofare Bridges following a severe storm event.

4.2 Maintenance of Traffic during Construction

Under both the No-Action Alternative and the Build Alternatives, traffic would be maintained during construction.

4.3 Secondary, Indirect and Cumulative Impacts

The proposed action is intended to improve existing structural and operational conditions, and does not add additional roadway capacity or access to undeveloped areas that could potentially encourage additional development. As such, the proposed action will not result in any secondary, indirect, or cumulative impacts.

4.4 Right-of-Way and Access

The proposed action will maintain access to properties and existing developed areas. The project would not isolate neighborhoods or disrupt community services. The alternatives will not require additional Right-of-Way (ROW). However, additional tidelands grants from the NJ Department of Environmental Protection may be needed to accommodate scour protection measures and will be secured as part of project permit approvals.

4.5 Section 4(f) Compliance

Section 4(f) of the Department of Transportation Act of 1966 protects historic sites, parkland, conservation land, and refuges near federally funded highway and bridge projects. The proposed action would not result in the impairment of use to 4(f) resources. No further review under Section 4(f) is necessary.

4.6 Wetlands and Open Water

Manahawkin Bay is the primary water body in the project study area and is designated as Saline Estuarine 1 (SE1) waterway. Manahawkin Creek and Cedar Creek discharge to Manahawkin Bay. Both of these water bodies have been classified as Freshwater 2 Non-Trout/Saline Estuarine 1 (FW2-NT/SE1). Waterways within the boundary of the Edwin B. Forsythe National Refuge and the Manahawkin State Wildlife Management Area are defined as Category 1 (C1) waters.

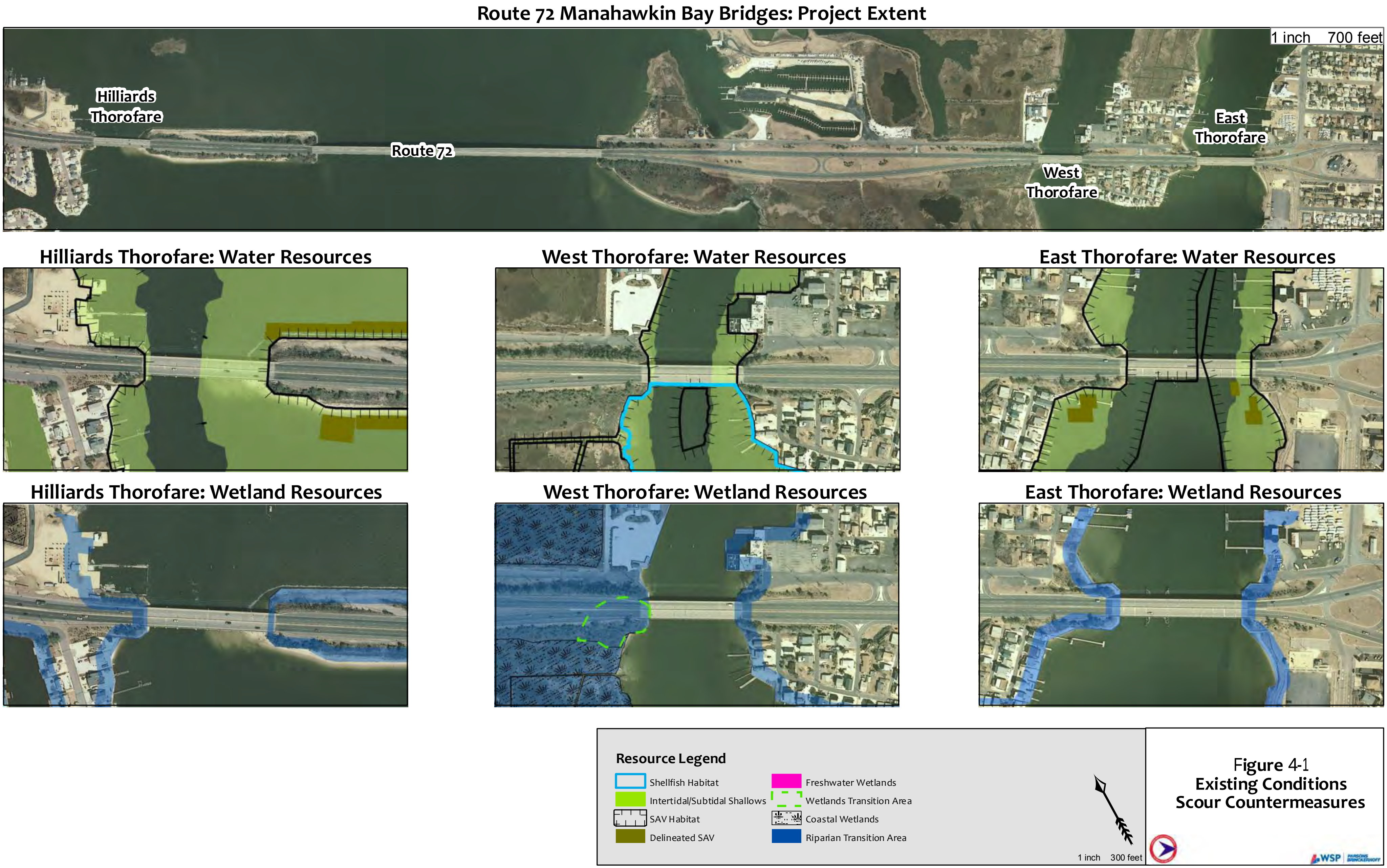


Figure 4-1
Existing Conditions
Scour Countermeasures

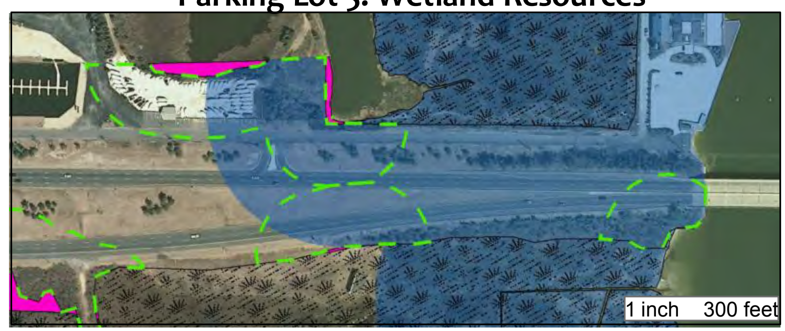
Route 72 Manahawkin Bay Bridges: Project Extent

Parking Lot 3: Water Resources

Parking Lot 5: Water Resources

Parking Lot 3: Wetland Resources

Parking Lot 5: Wetland Resources



Resource Legend

- Shellfish Habitat
- Intertidal/Subtidal Shallows
- SAV Habitat
- Delineated SAV
- Freshwater Wetlands
- Wetlands Transition Area
- Coastal Wetlands
- Riparian Transition Area

Figure 4-2
Existing Conditions
Public Waterfront
Access Improvements

WSP | PARSONS BRINCKERHOFF

There are both coastal and freshwater wetlands including adjacent freshwater wetland transition areas within the Project area. Wetlands are those areas between open water and firm, dry land. These special areas are a valuable resource to our environment because they help preserve water quality, protect groundwater by slowing down and retaining flood waters during periods of rain, and remove sediment and pollutants from the water. Wetlands provide habitat for a diversity of wildlife. Both the USACE and NJDEP have jurisdiction over the wetlands and open waters located in the project area. NJDEP regulates both coastal and freshwater wetlands including freshwater wetland transition areas. The extent of wetlands and associated transition areas are based on a wetland delineation completed in 2009.

The proposed action will have an impact to wetlands and open water areas.

4.7 Riparian Buffers

There are riparian buffers subject to NJDEP regulation located within the project limits associated with the Manahawkin Bay and its tributaries. Riparian buffers are the fringe of land lying immediately adjacent to a stream or bay, except for certain man-made waterways where specifically excluded in the regulations, which extend landward for up to 300 feet from the waterway. Maintaining existing vegetation near the shoreline helps to improve water quality and wildlife habitat.

The proposed action will have an impact to Riparian Buffers.

4.8 Intertidal/Subtidal Shallows (IT/STS) and Submerged Aquatic Vegetation (SAV)

Intertidal/subtidal shallows are defined as “all permanently or temporarily submerged areas from the spring high water line to a depth four feet below mean low water.” Some of these special habitats support SAV. These areas are favorite breeding habitats for marine fish and invertebrates. Because portions of Manahawkin Bay within the project limits are shallow, there is an abundance of IT/STS and SAV habitat within the project area. SAV habitat is determined based on NJDEP SAV maps (1979 and 1986). NJDOT also previously surveyed the Project area in 2012 and 2013 to delineate the actual extent of SAV beds within the project limits.

Both IT/STS and SAV will be impacted by the proposed action.

4.9 Shellfish Habitat

The Manahawkin Bay has extensive areas designated as Shellfish Harvesting areas by NJDEP which will be impacted by the project. Shellfish, including oysters and clams, are important commercial and recreational resources.

Shellfish habitat will be impacted by the proposed action.

4.10 Wildlife and Habitats

The 2011 Environmental Assessment documented more than 70 different species of birds using the bay and adjoining uplands as well as deer, otter, raccoons, numerous other mammals, snakes, turtles, and other non-game species. In addition, a few reptiles and dozens of game and non-game fish species can be found at different times in the Manahawkin Bay area. These habitats also support a wide range of migratory species.

4.10.1 Threatened and Endangered Species and Species of Concern

As a result of previous and on-going coordination with the US Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), and the NJDEP Endangered and Non-Game Species Program (ENSP), impacts to species of concern resulting from the proposed project are not anticipated.

Both the peregrine falcon (*Falco peregrinus*; State Endangered) and osprey (*Pandion haliaetus*; State Threatened) are known to nest in and adjacent to the project area. Additionally, marine species that may occasionally be present within Manahawkin Bay in the vicinity of the Project area include:

- Kemp's ridley sea turtle (*Lepidochelys kempi*) – federally endangered
- Atlantic leatherback sea turtle (*Dermochelys coriacea*) – federally endangered
- Loggerhead sea turtle (*Caretta caretta*) – federally threatened
- Atlantic green sea turtle (*Chelonia mydas)* – federally threatened
- Atlantic sturgeon (*Acipenser oxyrinchus)* - federally endangered

NJDOT has previously taken steps to avoid impacts to these species including:

- Prohibit in-water construction activities from January 1 to June 31;
- Restrict construction activities in proximity to a peregrine falcon nest in accordance with a plan developed in consultation with NJDEP;
- Restrict construction activities in proximity to an active osprey nest;
- Require use of aquatic noise abatement measures during the installation of piles within the waterway.

NJDOT will continue to implement these measures during construction to prevent any impact to these species.

4.10.2 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act requires that federal agencies perform an Essential Fish Habitat (EFH) assessment for projects that could have an impact to important fisheries. NJDOT previously completed an EFH assessment and has continued coordination with the National Marine Fisheries Service (NMFS).

The EFH assessment resulted in the requirement for seasonal restrictions on in-water construction activities for the protection of winter flounder, SAV, and anadromous fish such as blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*). NJDOT is also providing mitigation for impacts to SAV as part of the proposed action. NJDOT will continue to implement these measures to minimize impacts to Essential Fish Habitat.

4.11 Floodplain

The Federal Emergency Management Agency (FEMA) Study for Ship Bottom and Stafford Township, Ocean County, New Jersey shows the 100-year tidal floodplain for the Manahawkin Bay to be about elevation 8 feet NGVD (National Geodetic Vertical Datum, 1988). The Project is located entirely in the tidal zone and most of the Route 72 project corridor is above the 100-year flood event. Both the Marine Mattress and ACBM would not contribute to a significant change in the pre-existing bed elevation. The proposed public waterfront access improvements are largely contained to existing developed areas and within the project limits previously approved by the regulatory agencies and would not result in an impairment to the floodplain.

4.12 Air Quality

The Route 72 corridor is located in an ozone non-attainment zone. Ozone is a smog-inducing pollutant that is also an irritant. As this project is part of the project State Transportation Improvement Program (STIP), it therefore conforms to the air pollution reduction plan in New Jersey. This project would not cause or contribute to an exceedance of any air quality requirements.

4.13 Traffic Noise

Sensitive noise receptors with the project area include residential areas and the wildlife refuge. A noise analysis was previously completed and determined that the project would not have a significant noise impact on any of the sensitive receptors in the project area.

4.14 Cultural Resources

A previously completed cultural resource investigation determined that there are no eligible historic or prehistoric resources in the project area.

4.15 Community Facilities and Neighborhoods

NJDOT will maintain local access during and after construction. Pedestrian access and bicycle compatibility would be enhanced throughout the corridor. All of the pedestrian facilities will be Americans with Disabilities Act (ADA) compliant.

4.16 Utilities

Major utilities are located within the Route 72 corridor including:

- Electric – Atlantic City Electric Company
- Telecommunication – Verizon–New Jersey, Inc., Comcast Cable
- Gas – New Jersey Natural Gas Company
- Water and sanitary sewers – Stafford Township, Borough of Ship Bottom
- Treatment plant force main – Ocean County Utility Authority

The existing Bay Bridge was constructed in the 1950s to replace the then-aging bridge to Long Beach Island and was built parallel and to the south of the former bridge. NJDOT retained the ROW from the prior bridge that is now occupied by most of the utilities serving Long Beach Island. Accordingly, any construction activities located to the north of the existing bridges may require relocation of a number of major utilities.

4.17 Contaminated Materials

No known contaminated sites occur within the project area.

4.18 Environmental Consequences of the Proposed Project Alternatives

The environmental consequences of the proposed project alternatives are summarized below.

4.18.1 Scour Protection Alternatives

The introduction of scour countermeasures for the three Thorofare Bridges will result in additional environmental impacts attributed to the Route 72 Manahawkin Bay Bridge Project. Additional impacts attributed to scour protection for each alternative considered is summarized in Table 4-1 and illustrated on Figures 4-3 and 4-4.

Table 4-1: Environmental Impact Summary – Scour Protection Alternatives

Impact Type	Alternative		
	1B	2	3
	Bridge Rehabilitation with Scour Protection	Bridge Replacement	Bridge Replacement with Interim Scour Protection
Temporary Impact Area (ac)			
Open Waters			
Wetland Transition Area	0	0.08	0.08
Riparian Buffer	0	0.72	0.72
Shellfish Habitat	0	0.28	0.28
Intertidal/Subtidal Shallows	0	1	1
SAV Habitat	0	2.09	2.09
Delineated SAV	0	0.02	0.02
Permanent Impact Area (ac)			
Open Waters			
Riparian Buffer	0	0.02	0
Shellfish Habitat	0.19	0.1	0.19
Intertidal/Subtidal Shallows	1.15	0.3	1.15
SAV Habitat	3.27	0.83	3.27
Delineated SAV	0.01	0	0.01
Total Impact Area (ac)			
Open Waters			
Wetland Transition Area	0	0.08	0.08
Riparian Buffer	0	0.74	0.74
Shellfish Habitat	0.19	0.38	0.47
Intertidal/Subtidal Shallows	1.15	1.3	2.15
SAV Habitat	3.27	2.92	5.36
Delineated SAV	0.01	0.02	0.03

Note: Alternative with the least total impact area is highlighted in blue for each impact type.

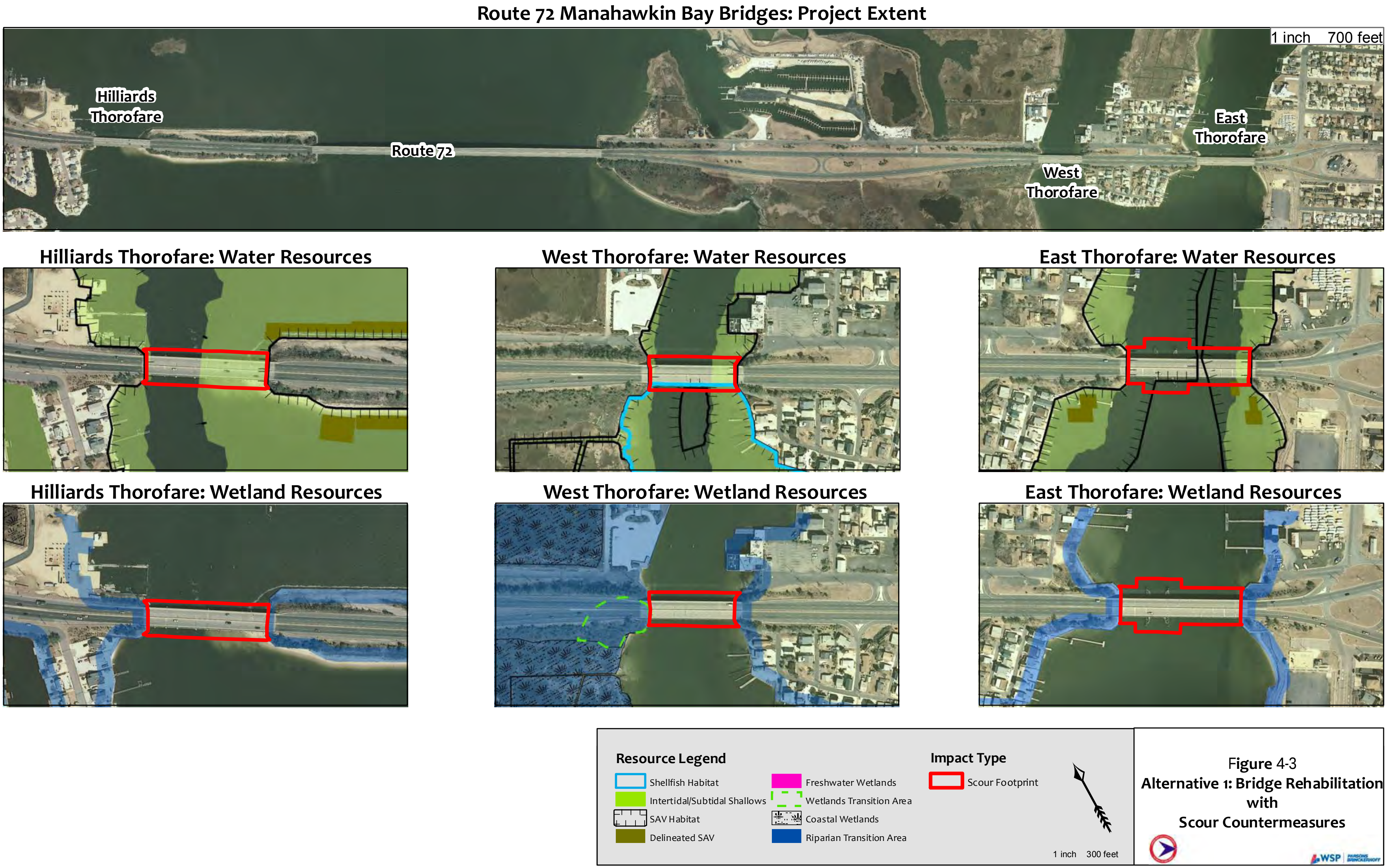
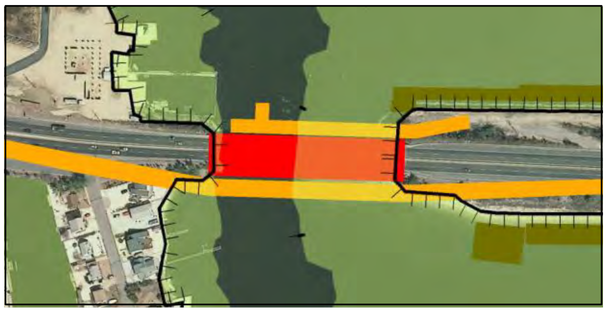


Figure 4-3
Alternative 1: Bridge Rehabilitation with Scour Countermeasures

Route 72 Manahawkin Bay Bridges: Project Extent

Hilliards Thorofare: Water Resources



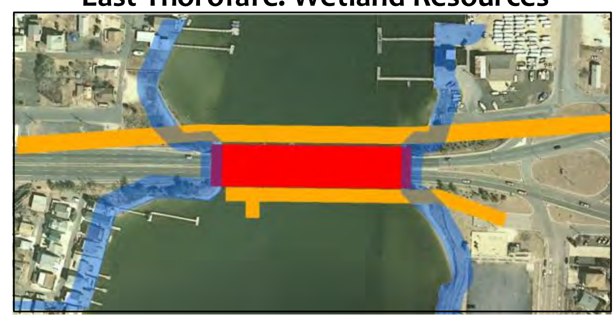
West Thorofare: Water Resources

East Thorofare: Water Resources

Hilliards Thorofare: Wetland Resources

West Thorofare: Wetland Resources

East Thorofare: Wetland Resources



Resource Legend

- Shellfish Habitat
- Intertidal/Subtidal Shallows
- SAV Habitat
- Delineated SAV
- Freshwater Wetlands
- Wetlands Transition Area
- Coastal Wetlands
- Riparian Transition Area

Impact Type

- Permanent Bridge Structure
- Temporary Access

1 inch 300 feet

Figure 4-4
Alternative 2:
Bridge Replacement

The majority of the impacts attributed to Alternatives 2 and 3 are due to the need for temporary bridges for construction, which would impact wetland transition areas, riparian buffers, shellfish habitat, intertidal/subtidal shallows, and SAV Habitat. Due to the duration needed to complete the replacement of the Thorofare Bridges, Alternative 2 is not recommended because it would not address the public safety concern within a reasonable time period. As such, of the two bridge replacement alternatives considered, only Alternative 3 would be consistent with the project purpose and need to address the public safety concern within a reasonable time period. Impacts attributed to Alternative 3 include those necessary for the installation of interim scour protection measures consistent with Alternative 1B as well as additional temporary and permanent impacts attributed to replacement of the Thorofare Bridges. As such, Alternative 1B results in the least impact to sensitive resources.

4.18.1.1 Scour Countermeasure Cost Comparison

There are two costs associated with any project: initial construction cost and the life cycle cost. The initial construction cost is the actual cost to construct the project. The life cycle cost is the cost to maintain the structure over the course of structure's lifetime (100 years). The costs for each alternative are shown in Table 4-2.

Table 4-2: Scour Countermeasure Cost Comparison

Alternative	Initial Construction Cost	Life Cycle Cost
Alternative 1B - Bridge Rehabilitation w/Scour Protection	$31,000,000.00	$122,753,000.00
Alternative 2 - Bridge Replacement	$102,485,000.00	$135,257,000.00
Alternative 3 - Bridge Replacement w/ Interim Scour Protection	$108,522,000.00	$141,294,000.00

The life cycle analysis for each alternative is based on the anticipated costs over a span of 100 years. For Alternate 1B, initial costs are for the originally scheduled rehabilitation and includes installation of scour countermeasures at all three bridges. For Alternate 2, the initial cost accounts for minor repair work to extend the life of the bridge until the bridge can be replaced (it is estimated that bridge replacement will be completed in eight years; for the purposes of the life cycle analysis the cost for the new bridge was programmed at the onset of construction estimated to be in year 5). For Alternate 3, the year zero cost accounts for minor repair work along with interim scour countermeasures installed to extend the life of the bridge and protect against a storm event until the bridge can be replaced (costs are also programmed in year 5). The following parameters are common to all three alternatives and are frequently attributed to the effect of the harsh marine environment:

- Costs for minor repairs to the deck are scheduled to occur every 10 years.
- Major repair costs are set to occur at 20 year intervals and include deck repairs, beam repairs, and substructure repairs.
- Deck replacement costs are scheduled every 40 years, the costs for beam and substructure repairs are also included for this item.
- Bridge replacement costs are assumed to be needed every 75 years, in accordance with AASHTO's standard design life.
- The inflation rate is set at 2%, the cost of capital is 4%, and all costs computed for future repairs are converted to a present value.
- Note that only a single repair type occurs at a given year, i.e., minor repairs are scheduled for year 10 and year 30, but not year 20 because major repairs occur at this time.

4.18.2 Public Waterfront Access Improvements

The public access improvements would be constructed along the waterfront near or in sensitive resources. Table 4-3 summarized the comparative impacts attributed to the approved alternative (No Action) with that of the proposed alternative. The extent of impacts attributed to the proposed alternative are illustrated in Figure 4-5.

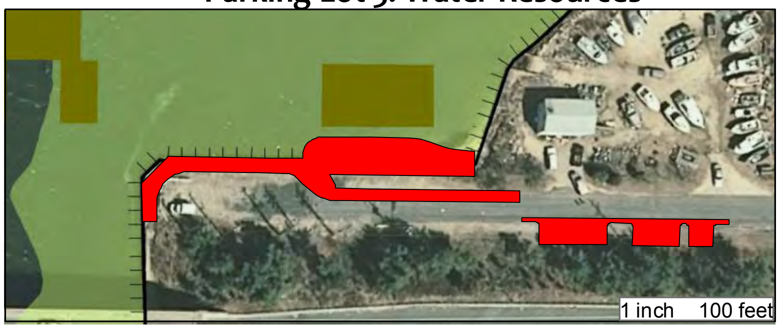
The proposed alternative for both Parking Lots 3 and 5 will result in a slight increase to impacts to intertidal/subtidal shallows and SAV Habitat primarily due to rehabilitation of the existing bulkhead, and additional impacts to riparian buffer due to change in location of the proposed sidewalk. Both improvements are necessary to provide safe access to the waterfront. As a result of the change in the location of the parking lot, a portion of the existing roadway can be removed, resulting in an overall reduction in impervious area. Parking Lot 5 will result in a slight increase to impacts to wetland transition area and riparian buffer due to the change in location of the parking lot necessary to address concerns expressed by the public.

Table 4-3: Change to Environmental Impacts Attributed to Public Waterfront Access Improvements

Impact Type	Alternative		Change in Impact Area (ac)
	Proposed Alternative	Approved Alternative	
Parking Lot 3 Impact Area (ac)			
Open Waters			
Wetland Transition Area	0.00	0.00	-
Riparian Buffer	0.09	0.05	0.04
Shellfish Habitat	0.00	0.00	-
Intertidal/Subtidal Shallows	0.05	0.00	0.05
SAV Habitat	0.05	0.00	0.05
Delineated SAV	0.00	0.00	-
Impervious Area (Net Increase)	-0.03	0.09	-0.11
Parking Lot 5 Impact Area (ac)			
Open Waters			
Wetland Transition Area	0.11	0.10	0.01
Riparian Buffer	0.31	0.26	0.05
Shellfish Habitat	0.00	0.00	-
Intertidal/Subtidal Shallows	0.00	0.00	-
SAV Habitat	0.00	0.00	-
Delineated SAV	0.00	0.00	-
Impervious Area (Net Increase)	0.35	0.31	0.04

Route 72 Manahawkin Bay Bridges: Project Extent

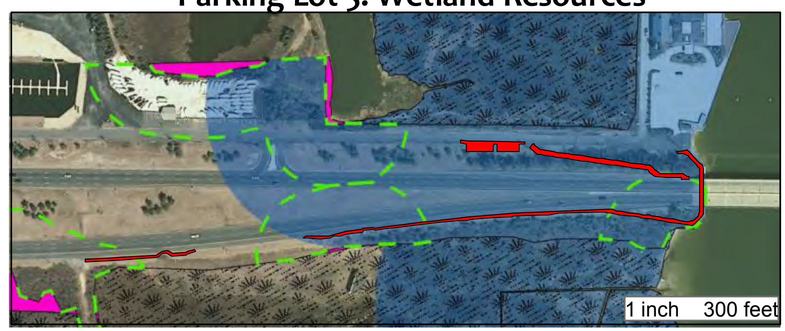
Parking Lot 3: Water Resources



Parking Lot 5: Water Resources

Parking Lot 3: Wetland Resources

Parking Lot 5: Wetland Resources



Resource Legend

- Shellfish Habitat
- Intertidal/Subtidal Shallows
- SAV Habitat
- Delineated SAV
- Freshwater Wetlands
- Wetlands Transition Area
- Coastal Wetlands
- Riparian Transition Area

Impact Type

- Proposed Public Access

Figure 4-5
Proposed Public Waterfront Access Improvements

4.19 Permits and Approvals

Implementation of the project would require NJDOT to amend previous permits and approvals. The proposed alternatives were developed in consideration of the existing environmental regulation and consultation with the agencies. Based upon prior inter-agency coordination, no objection to the proposed scour countermeasures were expressed by any of the permit agencies, and there was consensus on the Preferred Alternative. The proposed action is consistent with all applicable regulations and is justified, given public safety considerations. Mitigation for the proposed action will be addressed as part of the overall project mitigation at the time of permit authorization.

Table 4-4: Anticipated Permits and Approvals

Agency	Approval	Statutory Authority
NJDEP	General/Individual Freshwater Wetland and Open Water Fill Permit	N.J. Freshwater Wetlands Protection Act (NJFWPA) (N.J.A.C. 7:7A)
NJDEP	Water Quality Certification Federal CWA Section 401	Federal Clean Water Act
NJDEP	Waterfront Development Permit (WDP)	N.J. Coastal Permit Program Rules (N.J.A.C. 7:7)
NJDEP	Compliance with the Flood Hazard Area Control Act	N.J. Flood Hazard Area Control Act (N.J.A.C. 7:13)
NJDEP	Tidelands/Riparian Grants	New Jersey Statutes Annotated (N.J.S.A.) 13:1B-13
NJDEP	Coastal Zone Consistency Determination (part of WDP)	N.J. Coastal Permit Program Rules (N.J.A.C. 7:7)
NJDEP	Coastal Area Facility Review Act	N.J.S.A. 13:19
NJDEP	Wetlands Act of 1970	N.J.S.A. 13:9A
USACE	Individual Section 10/404 Permit	Rivers and Harbors Act of 1899, Section 10 & Federal Clean Water Act, Section 404
USCG	Permit to Construct or Modify a Bridge	Federal River and Harbors Act Section 9 & General Bridge Act of 1966

5 Conclusions

After analyzing the three alternatives, Alternative 1B (Bridge Rehabilitation with Marine Mattresses and Grout Bags) is selected as the Preferred Alternative. It is the only alternative that would meet the Purpose and Need to provide necessary scour protection to maintain public safety while minimizing impacts to sensitive environmental resources. Alternative 1B also minimizes impacts to residents and businesses and avoids the major utility relocations, and results in the least cost.

The proposed design for the public access for both Parking Lots 3 and 5 was selected over the previously approved design as the Preferred Alternative. It improves ADA compliant access to the waterfront and enhances public safety. This design results in only minimal increases in environmental impacts when compared to the previously approved alternative and rehabilitates the deteriorating bulkhead which is necessary to accommodate public waterfront access. This alternative would also address the public concern over the originally proposed location of Parking Lot 5.

The No Action Alternative was not selected as it would leave the Thorofare Bridges susceptible to scour damage, and would not provide for needed improvements to accommodate public waterfront access.

The Preferred Alternatives (Appendix C) will not result in a significant impact to environmental resources. In addition, while mitigation for the various resources will be addressed as part of subsequent permit review, and will implemented consistent with prior agency approvals.

Plan sheets illustrating the Preferred Alternatives are provided in Appendix C.

6 List of Technical Reports and References

FHWA, July 2011. *Environmental Assessment for Route 72 Manahawkin Bay Bridges, Township of Stafford & Borough of Ship Bottom Ocean County, New Jersey.*

FHWA, September 2011. *Finding of No Significant Impact for Route 72 Manahawkin Bay Bridges, Township of Stafford & Borough of Ship Bottom Ocean County, New Jersey.*

The following references are from the 2011 Environmental Assessment which provided much of the supporting documentation for the Addendum to the Environmental Assessment.

A.D. Marble & Company, March 2006. *Traffic Noise and Air Quality Technical Memorandum, New Jersey Route 72, Ship Bottom Operational and Drainage Improvements*.

A.D. Marble & Company, December 2005, *Cultural Resources Study, New Jersey Route 72, Ship Bottom Operational and Drainage Improvements.*

Amy S. Greene Environmental Consultants, Inc., July 2009. *Technical Environmental Study on Ecology, Route 72 Manahawkin Bay Bridges.*

LGA Engineering, Inc., June 2009, revised November 2009. *Submerged Aquatic Vegetation Delineation Survey, Route 72 Manahawkin Bay Bridges Improvement Project.*

New Jersey Department of Transportation, April 2010. *Essential Fish Habitat Assessment for Route 72 Manahawkin Bay Bridges Improvement Project.*

Malik and Scherer, PC, September 2006, *Roadway Drainage Report, Route 72 Ship Bottom Operations and Drainage Improvements*

Paul Carpenter Associates, Inc., February 2010. *Air Quality Assessment, Route 72 Manahawkin Bay Bridges.*

Paul Carpenter Associates, Inc., February 2010. *Noise Assessment, Route 72 Manahawkin Bay Bridges.*

PB Americas, Inc., January 2011, Drainage *Report for Route 72 Manahawkin Bay Bridges.*

PB Americas, Inc., January 2011. *Traffic Impact Report for Route 72 Manahawkin Bay Bridges.*

PB Americas, Inc., July 2009. *Wetland Delineation Report for Route 72 Manahawkin Bay Bridges, MP 25.5 to MP 28.2.*

PB Americas, Inc., December 2009. *Socioeconomic Impact Assessment for Route 72 Manahawkin Bay Bridges.*

PB Americas, Inc., January 2007. *Feasibility Assessment Report Addendum for Route 72 Manahawkin Bay Bridges.*

PB Americas, Inc., October 2005. *Feasibility Assessment Report for Route 72 Manahawkin Bay Bridges.*

Prestige Environmental, Inc., February 2010. *Hazardous Waste Screening, Route 72 Manahawkin Bay Bridges.*

Richard Grubb & Associates, July 2009, revised February 2010. *Cultural Resources Investigation, Improvements to Route 72 Manahawkin Bay Bridges and Marsha Drive Intersection.*

7 List of Preparers

The following individuals had primary responsibility for the preparation and review of the Environmental Assessment:

U.S. Department of Transportation, Federal Highway Administration

Tony Sabidussi

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New Jersey Department of Transportation

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Appendix A:

FONSI

State of New Jersey
DEPARTMENT OF TRANSPORTATION
P.O. BOX 600
TRENTON, NJ 08625-0600

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

JAMES S. SIMPSON
Commissioner

September 12, 2011

Mr. Ernie Blais
Division Administrator
Federal Highway Administration
840 Bear Tavern Road, Suite 310
West Trenton, New Jersey 08628

RE: Environmental Assessment, Finding of No Significant Impact Document
Route 72 Manahawkin Bay Bridges and Marsha Drive Intersection
Stafford Township and Ship Bottom Borough, Ocean County

Dear Mr. Blais:

Enclosed is a copy of the Finding of No Significant Impact (FONSI) Document for the Route 72 Manahawkin Bay Bridges project. The New Jersey Department of Transportation (NJDOT) is proposing to improve the Route 72 Manahawkin Bay Bridges and the intersection of Marsha Drive in Stafford Township Ship Bottom Borough, Ocean County, New Jersey.

The project consists of the rehabilitation of four Route 72 bridges: Route 72 Bridge over Hilliards Thorofare (Structure # 1513-151); Route 72 Bridge over Manahawkin Bay (a.k.a. Dorland J. Henderson Memorial Bridge (Structure #1513-152)); Route 72 over West Thorofare (Structure #1513-153); Route 72 over East Thorough Fare (Structure #1513-154). A new structure will be constructed parallel to the south of the Dorland Henderson Memorial Bridge. Also proposed are improvements to the Marsha Drive and Bay Avenue Intersection; Route 72 and Bay Avenue Intersection.

We are in receipt of a completed Environmental Assessment as of July 7, 2011, so the signature of this document would be the next step in the NEPA process. If you have any questions regarding the document, please contact me or Scott Ackerman at 609-530-5685.

Sincerely,

Bruce Hawkinson

Bruce Hawkinson, Section Chief
Bureau of Landscape and Environmental Solutions

FHWA-NJ-EA-10--01
Federal Highway Administration
Region I

Federal Project No. MG-0019 (III)

Route 72 Manahawkin Bay Bridges

Township of Stafford & Borough of Ship Bottom
Ocean County, New Jersey

Finding of No Significant Impact

U.S. Department of Transportation
Federal Highway Administration

September 2011

FHWA-NJ-EA-10--01
Federal Highway Administration
Region 1

Federal Project No. MG-0019 (III)

ROUTE 72 MANAHAWKIN BAY BRIDGES PROJECT

Stafford Township and Ship Bottom Borough, Ocean County, New Jersey

FINDING OF NO SIGNIFICANT IMPACT

By the
U.S. Department of Transportation
Federal Highway Administration

The Federal Highway Administration (FHWA) has determined, in accordance with 23 CFR 771.121, that the proposed project will have no significant impact on the environment.

This Finding of No Significant Impact (FONSI) is based on the Environmental Assessment (EA), and Technical Environmental Studies (TES) which are incorporated by reference. These documents have been independently evaluated by FHWA and have been determined to accurately discuss the project purpose, need, environmental issues, impacts of the proposed project, and appropriate mitigation measures. The review provided sufficient evidence and analysis for determining that an Environmental Impact Statement (EIS) is not required.

FHWA takes full responsibility for the accuracy, scope, and content of the EA, as modified by this FONSI and the referenced documents.

9-16-2011
Date of Approval

Ernest Blais
Ernie Blais, Division Administrator
Federal Highway Administration

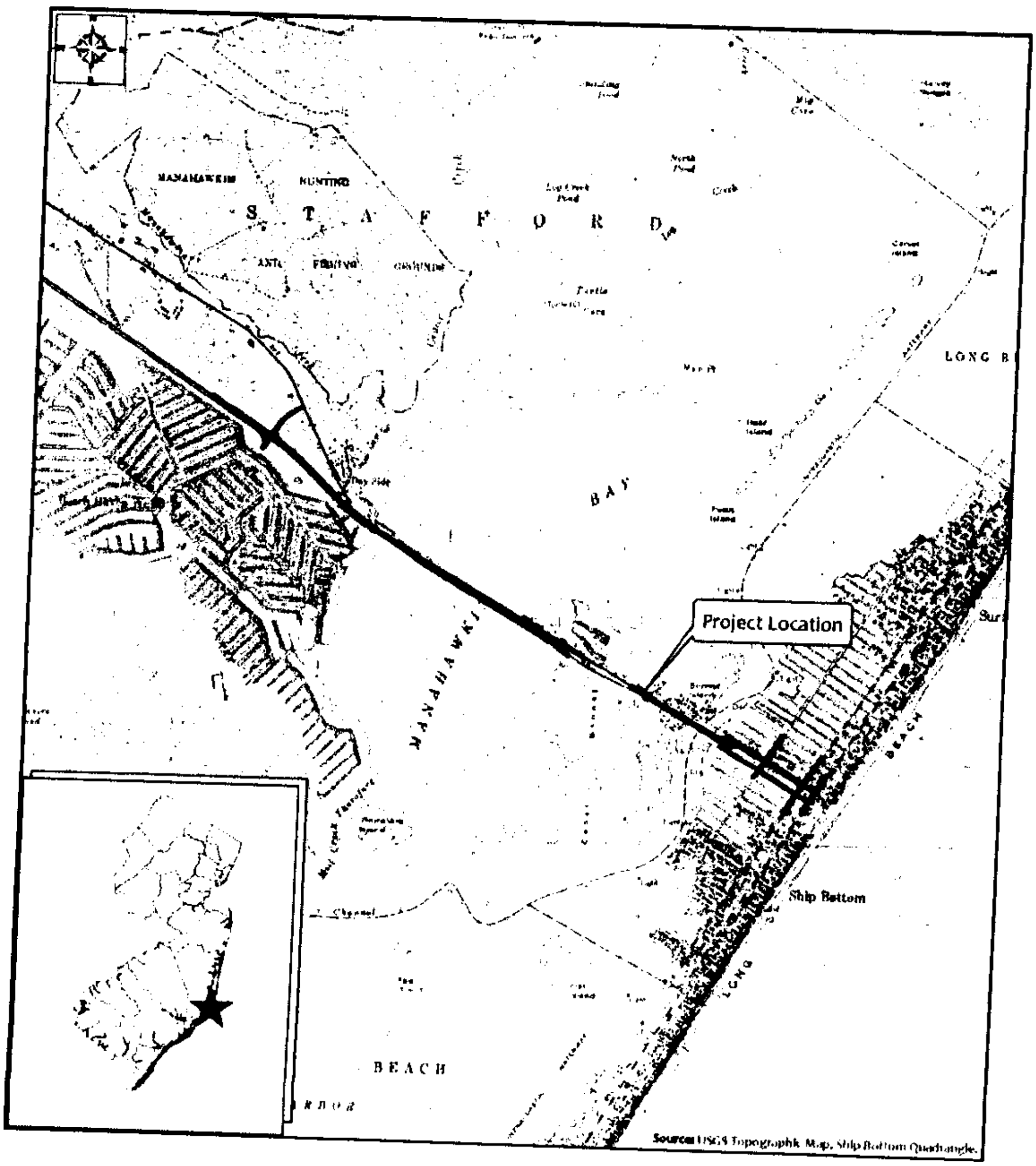
TABLE OF CONTENTS

LIST OF FIGURES

DESCRIPTION OF PROPOSED ACTION

The Route 72 Manahawkin Bay Bridges Project is a joint effort between the Federal Highway Administration (FHWA) and the New Jersey Department of Transportation (NJDOT). An Environmental Assessment (EA) was issued for the project on May 4, 2010 with revision issued on July 7, 2011. The Route 72 Manahawkin Bay Bridges Project is located in Stafford Township and Ship Bottom Borough, Ocean County, New Jersey (Figure 1). This FONSI considered both permanent and temporary impacts.

Figure 1 - Project Location Map



The project includes the following improvements (see Figure 2):

Route 72 Mainland/Marsha Drive Intersection Improvements

- Add one through lane in each direction on Route 72 near the intersection.
- Widen Marsha Drive by adding a shoulder so that in the future a double left-turn lane to eastbound Route 72 could be added.
- Maintain existing Route 72 jughandles.
- Provide Intelligent Transportation Systems (ITS) Facilities, including variable message signs (VMS), cameras, telecommunications cabinets, vehicle sensors and a weather station beginning west of the Garden State Parkway and ending in Ship Bottom.

Long Beach Island Improvements

- Reconstruct/reconfigure 8th and 9th Streets to provide three travel lanes and inside and outside shoulders on each roadway within the existing ROW;
- Reconstruct/reconfigure the 8th Street service road and median to provide an 8-foot-wide right shoulder on 8th Street;
- Reconstruct/reconfigure the through lanes and turning lanes on the cross street approaches (Long Beach Boulevard, Barnegat Avenue, Central Avenue) to 8th and 9th Streets for improved traffic operations;
- Restore two-way operation of Central Avenue and Long Beach Boulevard at 8th and 9th Streets;
- Reconfigure the Ship Bottom un-signalized intersection at 8th Street and Long Beach Boulevard and replace it with a signalized intersection
- Upgrade existing traffic signal equipment and install a controlled traffic signal system to maintain coordinated traffic signal operations at the five existing signals along 8th and 9th Streets with the new signal at 8th Street and Long Beach Boulevard;
- Provide communication of the Ship Bottom controlled traffic signal system to the NJDOT South Jersey Traffic Operations Center;
- Maintain the existing roadway profiles along 8th and 9th Streets to minimize grading impacts to adjacent properties;
- Replace the existing drainage system with a new system designed for higher intensity storm events and separate conveyance systems along 8th and 9th Streets between Long Beach Boulevard and Shore Avenue;
- Provide a pump station designed for a 5-year storm that would allow the roadway storm water runoff to be discharged into Manahawkin Bay, even during high tides;
- Provide a sand filter adjacent to the pump station to collect sand, grit, and debris from the combined roadway runoff before it enters the pump station; and
- Provide a check valve at the pump station outfall to protect the storm water system from backwater and debris during high tides.

New Bay Bridge on Parallel Alignment

Build a new parallel structure to the south of the existing structure to carry Route 72 Eastbound in the final configuration. This new bridge would be wide enough to temporarily carry two lanes of traffic in each direction during rehabilitation of the existing bridge and would be reconfigured to two eastbound lanes and shoulders at the conclusion of the project. Work includes scour counter measures, fenders, bulkheads, utility relocations and other work necessary to implement the project.

Rehabilitate the Three Trestle Bridges

- Rehabilitate the three structures carrying Route 72 over Hilliard's Thorofare, West Thorofare, and East Thorofare in stages.
- Work to include pier cap rehabilitation, piling protection system, a new bearing support system, deck repairs and providing an overlay on the existing deck slab, and reconfiguring the deck and lane configuration to provide two 11-ft. travel lanes, a 6-foot sidewalk along the westbound side and 6-foot shoulders that would be bicycle compatible on both sides of the structure without widening the bridge.

Rehabilitate Existing Bay Bridge

- Replace the entire superstructure on the rehabilitated existing substructure and replace the existing fender system. The rehabilitated bridge would carry Route 72 Westbound traffic in the final configuration. Scour protection would be provided for the existing abutments and the existing "string of pearls" rail-mounted lighting on the existing bridge would be replicated on both the rehabilitated bridge and the new parallel bridge.
- The overall width of the new superstructure would be 57'-9" and would allow two lanes in the westbound direction with a 12-ft. inside shoulder and 13-ft. bicycle compatible outside shoulder and a 6-foot-wide sidewalk along the north side of the bridge. It would be constructed wide enough to convert the outer shoulders into a temporary lane for coastal evacuation or to add a third lane in the westbound direction at some point in the future when traffic needs dictate. Sidewalks on the island would connect to the low-volume, low-speed local roadway system where possible.

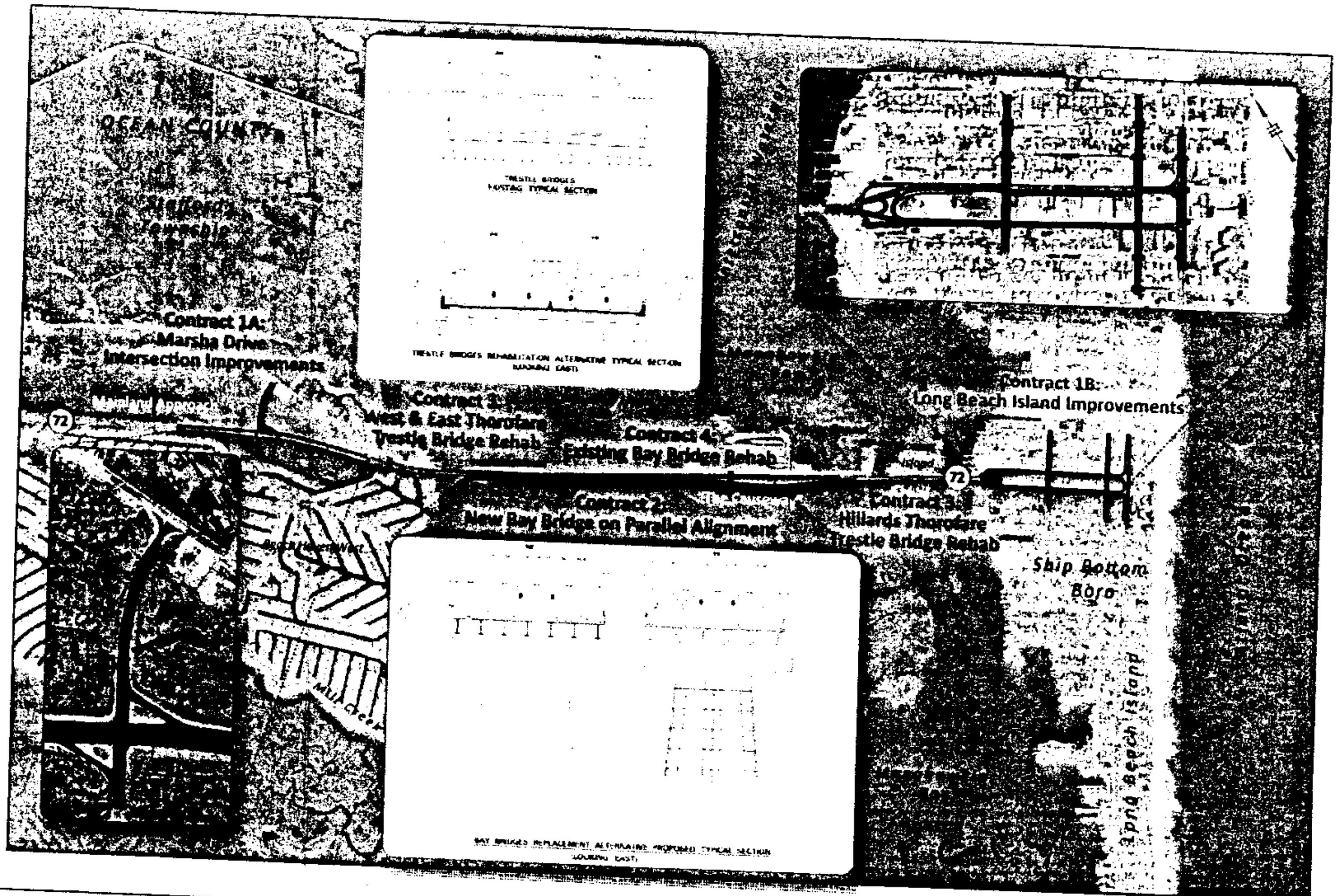
Mitigation Plan

The Route 72 Manahawkin Bay Bridges Project would include mitigation developed on a watershed approach taking advantage of the numerous federal, state and county management plans. The mitigation plan will compensate for loss of ecosystem functions stemming from unavoidable impacts to regulated resources approved under the FONSI. The determination of the details of the mitigation is not needed to issue a FONSI. The mitigation will be negotiated with the New Jersey Department of Environmental Protection (NJDEP), US Army Corps of Engineers (USACE), US Fish and Wildlife Service (USFWS), and National Oceanic and Atmospheric Administration (NOAA) and the National Marine Fisheries Service (NMFS) in accordance with their policies and procedures. The mitigation would address protected resources including coastal wetlands, fresh water wetlands, submerged aquatic vegetation (SAV), intertidal/subtidal shallows, shellfish, riparian zone, stormwater management and public access. Timing restrictions will be included to reduce impacts to species depending on Manahawkin Bay.

The NJDEP requires all permitted projects built in the tidal area to provide additional public access to the waterfront. The access for this project would be in accordance with the NJDEP rules and could include items such as sidewalks, public parking with pedestrian access, access to bulkheads and parking and access to a portion of the Edwin G. Forsythe National Wildlife Refuge, and will be determined as part of the negotiations during the permitting process.

Monitoring and maintenance would be performed on mitigation features determined as part of the negotiations during the permitting process with the permitting agencies.

Figure 2 – Improvements for the Route 72 Manahawkin Bay Bridges



EA COORDINATION AND COMMENTS

The Notice of Availability of the EA and the notice of the May 26, 2010 open house and public hearing were advertised in local newspapers on May 6 and 13, 2010. The advertised public open house and public hearing were held at the Stafford Township Municipal Building in Ocean County, New Jersey to allow the public to obtain information and provide comments on the EA. Attendees were invited to review information on display boards, talk to the project team, and submit formal comments, either through a written comment or orally with a stenographer. In addition, public notices invited written comment on the EA to be submitted to the NJDOT by July 1, 2010.

Approximately 40 people attended the open house and 7 individuals provided oral testimony. Additional written comments from agencies and the public were received. A transcript of the presentation at the public hearing is included in Appendix B to the EA.

The EA was revised in response to comments, and to update the project scope to reflect replacing the main girders on the rehabilitated Bay Bridge and installing Intelligent Transportation Systems between the Garden State Parkway and Ship Bottom. The revised and Final EA was posted on the NJDOT website on July 15, 2011 and copies were circulated to local governments, those who commented on the Draft EA and governmental resource agencies.

DETERMINATION OF FINDINGS

The following is a summary of the environmental issues and the impacts that are discussed in the EA and that are relevant to the finding of no significant impact for the project:

National Environmental Policy Act Finding

FHWA served as the lead agency under the National Environmental Policy Act (NEPA) for the project. NJDOT prepared the EA in compliance with NEPA, 42 United States Code (USC) Section 4321 et seq. and with FHWA's regulation, 23 Code of Federal Regulations (CFR) Part 771. The EA discusses the potential permanent and temporary impacts of the project on the environment so that FHWA can determine whether significant adverse impacts pursuant to Council on Environmental Quality (CEQ) 1508.27 are probable. If such a determination were made, an environmental impact statement (EIS) would need to be prepared.

After considering the EA, its supporting documents, and the public comments and responses, FHWA finds pursuant to 23 CFR 771.121 that the Route 72 Manahawkin Bay Bridges Project would not have significant adverse impacts on the environment. The record provides sufficient evidence and analysis for determining that an EIS is not required.

The FHWA considered the following in its determination of significance:

Impacts that may be both beneficial and adverse and a significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial

The selected alternative would not cause a significant adverse or beneficial effect since the purpose is to maintain the existing roadway system between Long Beach Island and the mainland, and to modernize existing infrastructure. All improvements would be installed essentially along the same alignment to minimize impacts to undeveloped areas. There would be no increase in capacity, but moderate improvement to traffic flow and driver safety would be achieved by the addition of shoulders, and necessary non-motorized circulation to increase public pedestrian and bicycle mobility would be achieved by providing a continuous sidewalk from the mainland to LBI.

The degree the proposed action affects public health or safety

The purpose of the project is to maintain the existing systems, to preserve public health and safety. Route 72 is the only way on or off Long Beach Island (LBI) and preserving this route is imperative for the safety of a 150,000 peak summer season residents of LBI and 50,000 year-round residents. Providing shoulders on the bridge over Manahawkin Bay will provide a necessary safety refuge for vehicles experiencing breakdowns. Providing for safe bicycle and pedestrian access will eliminate dangerous conflicts for vehicles with pedestrians and cyclists who utilize the existing 2 ft. wide safety-walks, despite the inherent danger. Traffic and access to driveways and all major social and medical services properties would be maintained at all times during construction. Emergency evacuation plans will be greatly enhanced by the addition of shoulders to the bridges, and will permit greater emergency services access. Maintaining two lanes for traffic in each direction during all tourist seasons would minimize traffic delays for the residents and visitors. Measures would be taken during construction to reduce risks to construction personnel and the traveling public. Additionally, having redundancy with the construction of new span to the south also improves safety. Since there would be no increase in through traffic, there would be little impact to air quality or effect on sensitive noise receptors. Spot capacity improvements would modestly improve local air quality.

Uniqueness of the environmental resources adjacent to the project
Manahawkin Bay is part of the Barnegat Bay Estuary and as such is an important national natural resource. The project crosses natural resources of significant state, regional, national and international importance. The project essentially maintains the current balance among resource protection, recreation and economic stability. No portion of the adjacent wildlife refuge would be taken or adversely affected by the project. The NJDOT would comply with minimization and mitigation requirements of various environmental regulations to further limit impacts from the project. The proposed project would only affect small portions of wetlands, aquatic resources and shorelines as compared to the large amounts of such resources located in the project area. The visual character of the project area would be maintained.

The degree that the proposed action will cause controversy
It is recognized that LBI is a key recreational and economic resource in the Ocean County region. Much of the value of LBI is the proximity of the unique natural character discussed above. Therefore, the NJDOT sought out substantial public participation and considered stakeholder interests. A public hearing was held in May 2010 and there was much public support for the project and minimal concerns were expressed to particular project elements. The design incorporates public input and balances the needs of these constituencies. The US Coast Guard recently completed additional public notice for lowering the existing clearances to 55 feet. There was no significant maritime opposition to the change. There is no project controversy.

The degree that the impacts are uncertain or involve unknown risks
There are no identified risks associated with the Build Alternative that are unique, and there are no effects that are highly uncertain that were identified during the analysis for the EA or during the public review of the EA.

The degree to which the action sets a precedent for future actions with significant effects
The project maintains the existing alignment and utility access to LBI. The proposed action would maintain the overall through traffic capacity of the system. Development of LBI started more than 120 years ago and the island is now fully developed. With no increase in capacity, and little room available on LBI for development, there is little likelihood that the proposed action would set a precedent for any future actions with significant effects.

The degree that there are significant cumulative or indirect impacts
This project maintains the primary traffic circulation, traffic capacity and utility service of the existing system. The traffic study concluded that the project area and LBI are essentially fully developed. Current building activity consists primarily of redevelopment of existing areas. There is no indication that the existing bridge traffic capacity limits would either encourage or discourage redevelopment of the project area. The impacts are limited to the project area. Therefore, this project would not trigger other projects that have a significant impact, either individually or cumulatively. Furthermore, there is no disproportionate impact to low income or minority populations, disruption of communities, isolation of neighborhoods, damage to economic viability of businesses or other significant indirect impacts.

Reasonable assurance the project will meet federal, state, or local law, rule or regulation
There are no significant impacts to the human environment as defined and considered under NEPA. NJDOT has demonstrated that it can and will continue to obtain NJDEP permits for bridge projects of the size and scale that cross over estuaries with fishery resources. NJDOT will address the regulations including impacts to state regulated subtidal and intertidal shallows that have the potential to support SAV. The NJDOT would prepare permit applications under relevant environmental regulations. The project has avoided and minimized impacts to the extent practicable, and would incorporate negotiated mitigation measures prepared on a watershed basis for unavoidable impacts needed to comply with applicable federal and state environmental

permitting regulations. In its comments on this EA, the NJDEP Division of Land Use Regulation concurred with the selected alternative subject to regulatory review. There is reasonable assurance that the project will comply with all regulations.

Air Quality Conformity Statement
The United States Environmental Protection Agency promulgated the Transportation Conformity Rules (TCR) under the Clean Air Act Amendments (CAAA), effective December 27, 1993. The TCR provides criteria and procedures for determining conformity to the Statewide Transportation Improvement Program (STIP) of transportation programs, plans, and projects funded or approved under Title 23 U.S.C. or the Federal Transit Act. This project is located in a carbon monoxide (CO) attainment area and ozone (O_3) non-attainment area; hence, conformity determination is required. The conformity requirements are as follows:

- The project must originate from a conforming transportation plan and program; and
- In non-attainment areas, the project must eliminate or reduce the severity and number of violations of the National Ambient Air Quality Standards (NAAQS).

The Route 72 Manahawkin Bay Bridges project has been included within the regional emission burden analyses performed by the North Jersey Transportation Planning Authority. The regional emission burden analyses performed for ozone and its precursors cover all analysis years including Build Year 2035. Transportation projects that originate from a conforming STIP are considered to conform to the rule. The Route 72 Manahawkin Bay Bridges Project (DB # 00357) is included within the FY 2009-2018 STIP. Therefore, due to the CO attainment status of Ocean County, predicted CO concentrations, as well as the inclusion of the project within the STIP, it can be stated that this project conforms to the goals and requirements as set forth within the CAAA and the Final Conformity Rule.

Noise Finding
Four noise monitoring stations were selected for site sensitivity and proximity to proposed improvements. Based on monitored results, roadway geometry, and existing seasonal peak traffic volumes, 39 residential structures currently approach or exceed the Category B criteria. Additionally, the portion of the project within Edwin B. Forsythe National Wildlife Refuge currently possesses noise levels that approach or exceed the Category B Noise Abatement Criteria (NAC). However, none of the increases on sensitive receptors exceeds the 3 decibels (dBA) level; therefore, the Route 72 Manahawkin Bay Bridges Project would not have a significant noise impact on any of the sensitive receptors in the project area. To minimize construction noise, all equipment would be powered by internal combustion engines with properly maintained mufflers. Noise from the proposed pump station would comply with the FHWA noise criteria.

Endangered Species Act Finding
The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) are responsible for administering the Endangered Species Act, and the NJDOT initiated formal Section 7 Endangered Species Act (ESA) consultation early in the project environmental review process. The USFWS concurred that the Route 72 Manahawkin Bay Bridges Project is not likely to adversely affect federally listed threatened or endangered (T&E) species under USFWS jurisdiction or their critical habitat. NMFS coordination will continue.

Magnuson-Stevens Act Finding
The project area has been designated by the NMFS as Essential Fish Habitat (EFH) for federally managed species including habitat for summer flounder (*Paralichthys dentatus*), and winter flounder (*Pseudopleuronetes americanus*). Winter flounder eggs and larvae settle to the bay bottom. Submerged Aquatic Vegetation (SAV) is EFH for summer flounder and also considered a habitat of particular concern (HAPC) for summer flounder. The impacts to SAV also can affect

prey species that are used by other federally managed species including Atlantic butterfish (*Peprilus triacanthus*), Atlantic sea herring (*Clupea harengus*), bluefish (*Pomatomus saltatrix*), black sea bass (*Centropristis striata*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), scup (*Stenotomus chrysops*), Spanish mackerel (*Scomberomorus maculates*), windowpane flounder (*Scomphthalmus aquosus*), winter skate (*Leucoraja ocellata*), little skate (*Leucoraja erinacea*) and clearnose skate (*Raja eglanteria*). The NMFS concluded that the project would have a substantial adverse effect to EFH, primarily caused by the temporary and permanent disturbance of SAV, and filling intertidal and subtidal shallows for construction of piers, filling of wetlands and reduction of shellfish and foraging habitat. NMFS conservation recommendations preferred that FHWA build in-kind replacement of aquatic habitats, the use of appropriate soil erosion and sediment control measures and timing restrictions for in-water work during construction. NMFS extended this recommendation to wetlands regulated by the USACE and for aquatic resources managed exclusively by the State of New Jersey.

FHWA modified the conservation recommendation to emphasize a watershed based mitigation program consistent with USACE mitigation policies. These policies formalize the finding that in-kind replacement over the decades has not been the most effective means to replace ecosystem function for impacts to aquatic resources. Accordingly, mitigation developed with a watershed approach focuses on the primary ecosystem function needs and may or may not result in in-kind replacement of aquatic resources. To streamline the process, the NJDOT will prepare the mitigation plan and submit it with permit applications sent to USACE and NJDEP who have joint regulatory jurisdiction in the project area. The alternative conservation recommendation is based upon best available information.

EFH as defined under the Magnuson Stevens Act is used to promote sustainable fishery stocks for commercially and recreationally important species. Winter flounder EFH as described by the NMFS consists of the entire Manahawkin Bay bottom because winter flounder eggs/ larvae sink to the bottom and winter flounder may spawn anywhere in the bay. Winter flounder is found in commercially and recreationally abundant amounts from North Carolina to Maine. The proposed project would disturb approximately 2 acres of bay bottom out of a total bay bottom in Manahawkin Bay of over 11,000 acres. Neither the habitat nor the fishery is considered rare. Limitations on the construction times and minimization of the project footprint reduce the relative impact. Therefore, this unavoidable project impact as compared to the overall winter flounder EFH is not considered significant.

The significance determination for effects to EFH for summer flounder is somewhat more involved. If the managed fish species uses that EFH in part due to the presence of the biological component, the NMFS has to include the SAV in the definition of the EFH. Therefore, the EFH for summer flounder varies with the presence of SAV based by mapping prepared by Rutgers University. SAV presence varies tremendously year to year in the bay.

Best available information indicates that the presence of SAV in the project areas comes and goes unpredictably. New Jersey has mapped SAV in the project areas five times since 1979 and not once did the surveys correspond. See Table A. An independent detailed 2003 SAV study performed by ENSR Corp. found little if any SAV present within the project limit. The least amount of SAV in Manahawkin Bay was in 2009 with roughly 2,790 acres out of the 11,094 acre estimated habitat area for Manahawkin Bay. This is about 25% of the bay bottom. In the 1985-1987 study, the total area of SAV in Manahawkin Bay was over 10,100 acres or about 90% of the bay bottom.

Estimated SAV coverage Manahawkin Bay 1979-2009*			
Year	Sq. Ft.	Acres	Percent
2009	121,520,695	2,790	25%
2003	173,294,922	3,978	36%
1996-99	127,684,157	2,931	26%
1985-87	440,463,638	10,112	91%
1979	338,347,077	7,767	70%

**Submerged Aquatic Vegetation Mapping*, Rutgers the State University, Grant F. Walton Center for Remote Sensing and Spatial Analysis. www.crssa.rutgers.edu/projects/coastal/sav/downloads.htm, downloaded August 31, 2011.

Research links increases in nutrient loads to a loss of SAV in Manahawkin Bay. Other studies link an increase of nutrients with an increase benthic macroalgae bed growth. Benthic macroalgae attaches itself to the bay bottom. Although there are no known studies that map the historical extent of macroalgae over the years, it is reasonable to assume that nutrient induced die-off of SAV beds can be offset by nutrient induced increases in macroalgae beds. In a recent study, *Characterization of the Jacques Cousteau National Estuarine Research Reserve: A Profile Report*, the *JCNERR* notes that SAV is primarily found in Little Egg Harbor and Barnegat Bays and little to no SAV in Great Bay. The report also shows an abundance of macroalgae in both Great Bay and Little Egg Harbor Bay. This report also notes substantial populations of summer flounder where there are only macroalgae beds. This demonstrates summer flounder make effective use of both SAV and macroalgae beds. These findings are consistent with other NMFS research that documents summer flounder using macroalgae beds as a surrogate for SAV.

Other researchers have documented an abundance presence of polychaetes (marine worms) in macroalgae beds. Polychaetes are preferred forage for small juvenile summer flounder. The link between macroalgae beds and fishery management is formalized in the Mid-Atlantic Fishery Management Council definition of habitat of particular concern for summer flounder as follows.

> Habitat Areas of Particular Concern (HAPC) for summer flounder is as follows: All native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH is HAPC. If native species of SAV are eliminated then exotic species should be protected because of functional value, however, all efforts should be made to restore native species.

Abundance of summer flounder is evident in the overall region. Mid-Atlantic Fishery Management Council increased 2011 catch quota by 33% from 22.13 million pounds to 29.48 million pounds. It is evident that minor loss of SAV will not result in a measureable impact to summer flounder production. The impact to SAV has to be considered in this context.

Regarding the finding of significance, had this project been constructed during period of low SAV in the project area, there would have been no significant impact to EFH. Had the project been constructed during periods of highest SAV presence, there could have been up to 3.2 acres of impact compared to base amount 10,111 acres of SAV in Manahawkin Bay. This 0.03% impact of total SAV would not be a significant impact. The proposed project has an estimated 2.59 acres of impact to SAV. Even if this impact was compared to the lowest base amount of SAV in the bay there would be 0.09% total SAV impacted. This is not a significant impact to EFH.

Overall there is no significant impact to EFH from this project.

Wetland Finding
The project would permanently impact less than ½ acres of wetlands. To compensate for this loss, the NJDOT would provide mitigation that would offset (no net loss) wetland losses through the banking, creation, enhancement and/ or preservation of wetlands outside of the project corridor. Detailed information on mitigation goals, site configuration, restoration, and monitoring would be provided in a wetland mitigation plan that would be submitted as part of the permit applications to the USACE and NJDEP. FHWA finds that there is no practicable alternative to the proposed new construction within wetlands. It is general practice that there be greater than five acres of impact to wetlands to worry whether there is a significant impact to wetlands for NEPA decisions. In this case, there is less than ½ acre of wetlands impact in an area where there are hundreds if not thousands of acres of wetlands. This project will not have a significant impact to wetlands.

Floodplain, Surface Water and Water Quality Finding
The project is constructed in the 100-year tidal flood plain. Fills from the project do not affect flood hazard elevations or increase flooding risks. The NJDOT would comply with NJDEP Flood Hazard Area Rules. The NJDOT expects to build approximately 9.70 acres of new impervious surface for this project and would comply with the Stormwater Rules and employ soil erosion and sediment control practices during construction. The stormwater rules require the NJDOT to control Total Suspended Solids (TSS) in runoff from improved areas; therefore, the NJDOT would install stormwater management facilities to treat the runoff including detention basins, sand filters, and infiltration basins. Protected resources and available land limit the ability of the NJDOT to install systems adjacent to the roadway; therefore, sand filters would have to be placed under the paved surface of the road or in close proximity to the road in DOT ROW. Sand filters are large concrete chambers, partially filled with sand that removes TSS. While it is preferred to build on-site systems, the NJDOT is working with the Barnegat National Estuary Program, the County, and local governments to identify whether it is feasible to build or rehabilitate offsite detention basins to supplement or supplant on-site systems.

A stormwater pump station would be constructed in Ship Bottom to reduce flooding along 8th and 9th Streets for the more frequent storm events. The pump station would incorporate a bar trash rack and sand filter. A comprehensive stormwater management plan would be submitted as part of the permit application to the NJDEP. The project would meet stormwater management requirements to the extent practicable.

Section 106 Finding
A cultural resource investigation was conducted within the Area of Potential Effect (APE) for both archaeology and historic architecture and it has been determined that there are no eligible historic or prehistoric resources in the project area. The State Historic Preservation Office (SHPO) was consulted and has concurred.

Section 4(f) Finding

As part of the EA, U.S. Department of Transportation (DOT) Act of 1966, Section 4(f), probable affect on historic resources, conservation land and wildlife refuge were evaluated. The State Historic Preservation Office (SHPO) concluded that there are no historic features in the project area. No property would be acquired from conservation space owned by Ocean County or from the Edwin B. Forsythe National Wildlife Refuge owned by the USFWS. Section 4(f) rules also require the NJDOT to consider whether any noise increase caused by the project could severely disrupt the refuge. Noise would not increase more than 3 dBA over the increase that is expected from the No Build Alternative. A noise increase that is less than 3 dBA is barely perceptible. Accordingly, noise increase would not severely disrupt the refuge and there is no constructive use of a Section 4(f) property. Therefore, FHWA finds that the project would have no impact on Section 4(f) properties.

Contaminated Materials Finding

Under the build alternative the project will not impact any properties that are known to have contaminated materials. However, if project encounters groundwater that is determined to be contaminated in this area, the NJDOT would follow established procedures for these activities. If any contaminated soils are encountered the NJDOT would handle and dispose of the material in accordance with the applicable state and federal regulations.

Appendix B:

Scour Analysis

ROUTE 72 TRESTLE BRIDGES

SCOUR ANALYSIS

Evaluations of the hydraulic environment and resulting scour potential have been conducted for three trestle bridges across the Manahawkin Bay, namely Rt. 72 over Hilliards Thorofare (Str. No. 1513-151), Rt. 72 over West Thorofare (Str. No. 1513-153), and Rt. 72 over East Thorofare (Str. No. 1513-154). A project location map is shown in Figure 1. The existing NBI item 113 scour rating in 2013, earliest known bathymetry data, and scour history is provided in Table 1 below along with a discussion of the scour and bathymetry history for the bridges.

Table 1. NBI Item 113 and Brief Commentary on Scour History

Trestle Bridges	Hilliards Thorofare	East Thorofare	West Thorofare
NBI Item 113 Rating (2013)	8: Bridge foundations determined to be stable for the assessed or calculated scour condition. Scour is determined to be above top of footing by assessment (i.e., bridge foundations are on rock formations that have been determined to resist scour within the service life of the bridge), by calculation or by installation of properly designed countermeasures.	5: Bridge foundations determined to be stable for assessed or calculated scour condition. Scour is determined to be within the limits of footing or piles by assessment (i.e., bridge foundations are on rock formations that have been determined to resist scour within the service life of the bridge), by calculations or by installation of properly designed countermeasures.	5: Bridge foundations determined to be stable for assessed or calculated scour condition. Scour is determined to be within the limits of footing or piles by assessment (i.e., bridge foundations are on rock formations that have been determined to resist scour within the service life of the bridge), by calculations or by installation of properly designed countermeasures.
Scour History of the Bridge	N/A	N/A	In late 2014, during inspection and testing of the trestle bridges, a scour hole was observed between the 3rd and 5th pile bents. The hole varied in depth but reached a maximum of 8' near the 4th pile bent. The scour hole was repaired by NJDOT using a coarse aggregate base layer of varying thickness, and an upper layer of riprap 3'-6" thick using 12" rocks.
Earliest Known Bathymetry	2004	2004	2004
How Much Scour Has Occurred over the Lives of the Structures?	The Underwater Bridge Evaluation Survey Report dated September, 2002, documents that the overall condition of the underwater components of the substructure are in good condition. They have minor to moderate scour potential. The Bridge Re-evaluation Survey Report dated December 2001, documents the bridge substructure in poor condition. The earliest bathymetry performed for the rehabilitation project was in 2004 and supplemented in 2009, a new survey was performed for the trestle bridges in 2015. The change in the bay bottom observed in these surveys generally ranges between a 1'-3" increase in elevation and a 3'-3" elevation drop. Taking an overall average between the older surveys and the newest data, the bay bottom has dropped approximately 1'-3".		

Superstorm Sandy in October 29-30, 2012 is the flood of record for these bridges based on USGS records (Attachment E). The maximum water surface elevation, maximum discharges and resulting damage from this event is listed in the Table 2.

Figure 1. Project Location Map: Route 72 Trestle Bridge Scour Study

Table 2. Record of Flooding for Three Trestle Bridges

Super Storm Sandy	USGS Gage ID	Time of Peak Record	Maximum Water Surface Elevation (NAVD 88, ft)	Maximum Discharge (cfs)	Resulting Damage
Hilliards Thorofare	01409145	10/30/2012	7.4	N/A	N/A
West Thorofare	01409146	10/29/2012	6.4	4,650	N/A
East Thorofare	01409146	10/29/2012	6.4	4,650	N/A

Scour analysis were performed based on the hydrodynamic model developed for the Stage II Scour Studies of the existing Rt. 72 Manahawkin Bay Bridges (Parsons Brinckerhoff, 2014). The latest version of Federal Highway Administration's (FHWA)'s two-dimensional (2D) hydrodynamic model Finite Element Surface Water Modeling System (FESWMS) was used for hydrodynamic simulation. Scour predictions were completed in accordance with FHWA's Hydraulic Engineering Circular (HEC) No.18 method. This memorandum describes the preliminary results of the scour analysis and layout of the proposed scour countermeasures. Hydraulic conditions along NJ Rt. 72 are tidally controlled. Rt. 72 divides the Manahawkin Bay that has a tidal inlet to the south, Little Egg Inlet, and Barnegat Inlet to the north. Water surface elevation constantly changes at coastal locations; these changes contribute to flow into (flood tide) and out of (ebb tide) Little Egg and Barnegat Inlets. Mean tides affecting these inlets have a period of approximately 12.5 hours and amplitude of about 1.1 feet. A hurricane storm surge, however, can significantly increase Atlantic Coast water surface elevations over relatively short periods of time. A storm surge is the relatively large local rise in water level that occurs during a significant storm event and tends to be the most damaging force along the coast. Surges are particularly damaging because water levels rise quickly over a short period of time and result in high, more erosive flow velocities.

The FESWMS 2D model of Manahawkin Bay was originally developed by Parsons Brinckerhoff in 2004, as part of the preliminary engineering studies for replacement of the main Rt. 72 Manahawkin Bay Bridge and scour studies for the three adjacent trestle bridges. During the initial 2004 study development, the design team researched calibration data for the study site, including NOAA tidal buoys, US Coast Guard data, and USACE data sets, however, no data sources were identified. In lieu of calibration data, the team performed a sensitivity test on the model domain to determine the most appropriate model conditions. The tests included modeling different model extents, different model boundaries locations, and different model timing conditions. Notable examples of the sensitivity tests included: model trials with coastal inputs only at Little Egg Inlet or only at Barnegat Inlet; model trials with and without Barnegat Bay (north of Barnegat Inlet); and model trials for storm surge lag time variations between Great Egg Harbor Inlet and Barnegat Inlet. The sensitivity tests ultimately determined that:

1. Little Egg Inlet and Barnegat Inlet are both substantial contributors to hydraulic conditions within the Bay and both must be incorporated in to the model.
2. Barnegat Bay north of Barnegat Inlet plays an important role in both the diffusion of the flood tide surge from Barnegat Inlet and supply of flow for the ebb tide surge through the bridge site.
3. Simultaneously timed surges from Little Egg Inlet and Barnegat Inlet produced a dampening effect, where opposing surge directions met at the project site, resulting in greatly dampened flood velocities.
4. Storm surges from Barnegat Inlet timed earlier than surges from Little Egg Inlet were also found to have a dampening effect at the project site. This occurred due to the diffusion of the surge between Barnegat Bay and Manahawkin Bay producing a smaller surge response at the project site, which counteracted a larger surge propagating from Great Egg Inlet towards the project site.
5. The conservative condition for surge timing was found to be cases where Little Egg Inlet surged more than 1-hour prior to surging at Barnegat Inlet. This condition is equivalent to a tropical cyclone with a path from south to north / southeast to northwest traveling with a forward speed of 20 miles per hour. This condition produces the highest velocity flood surge through the project site; caused by the surge conditions at Great Egg Inlet; and the highest velocity ebb surge; caused by amplification of the ebb surge as flows from Barnegat Inlet combine with the ebb of flows from Little Egg Inlet.

Additionally, the influence of energy loss coefficients in the FESWMS model were tested in the model sensitivity testing process. The two factors utilized are Manning’s ‘n’ and eddy viscosity. The Manning’s ‘n’ value was selected for the Bay areas following engineering judgement for other similar embayments. The selected ‘n’ value was 0.022 for the majority of the model domain. Eddy viscosity is a more difficult parameter to select, as references for common coefficients are not readily available, however, selection of lower values produces more conservative results; i.e. lower frictional dampening of storm surge velocities. The study team ultimately selected the lowest possible eddy viscosity that produced a stable running model. The selected viscosities ranged from 50 ft^2/sec for the majority of the model, up to 500 ft^2/sec at the model inlets.

Based on the results of the model sensitivity tests, the project team determined that the model as developed with inclusion of both the Barnegat Inlet and Little Egg Inlet, inclusion of Barnegat Bay, timing of the storm surge to propagate from south to north, and use of the selected ‘n’ values and eddy viscosities produces model results that are conservative, while not significantly overestimating the effects of a storm surge.

The hydrologic analysis was performed to obtain probable storm surge stage hydrographs for the 100-year and 500-year hurricanes. Hydrodynamic simulation of the bay involved a dynamic 2D model to simulate the complex exchange between the Atlantic Ocean and the isolated bays during tidal cycles and storm surge. The existing condition FESWMS hydraulic model was updated to include new detailed bathymetry survey conducted by Churchill Engineers in July 2015

(Attachment A). Scour analysis was performed for the 100- and 500-year hurricane events in accordance with HEC-18. The intent of HEC-18 is to establish methods for estimating various scour components for use in conjunction with engineering judgment to determine the total potential scour depth. The required hydraulic parameters for calculating scour depths were obtained from the results of FESWMS 2D model, such as peak water depth and peak flow velocity, as well as angle of attack (flow direction).

The contraction scour and local scour were computed for all the trestle bents and abutments. Contraction scour is caused by channel width constriction at a bridge crossing. Contraction scour occurs when the area of flow is decreased, resulting in increased velocities and bed shear stress in the contracted area. Laursen's equation was used to determine the mode of bed transport, and live-bed contraction scour was used to estimate the depth of contraction scour at the bridges. Local scour at the abutments and at the pile bents was also computed. Florida DOT method (Sheppard equation) was used for prediction of pier scour depths, and NCHRP method for abutment scour (Attachment B).

The predicted scour depths were instrumental in determining the extent of scour countermeasures required to protect these three structures. The computed scour depths were compared with the data previously developed and collected to assess the capacity and stability of the timber pile foundations. This previous analysis revealed that the piles are required to be embedded into the soil a minimum of 24 feet for standard conditions, 18 feet for a 100-year storm event, and 14 feet for a 500-year storm event in order for the structures to remain stable. Data was also collected to estimate the lengths of the piles installed because definitive documentation during construction is not available. The testing procedures provided results with a range of values. For the purposes of determining which pile bents require protection (i.e., scour countermeasures), the minimum length of piles estimated by the testing procedures were compared against the scour depths and associated embedment depth required for stability. If the piles were found to not meet the minimum embedment requirements during a storm event, it requires scour countermeasure protection. Once a pile bent was determined to require scour countermeasures, the limits of the protection were established based on the need to extend the protection two times the contraction scour depth of the 500-year storm surge beyond the piles (Attachment C). Anchors are also recommended to secure the outside edges (north and south of the bridges) of the marine mattress (Attachment D). Historical record of flooding at three trestle bridges, as well as the brief details of the derivation of the 100-year and 500-year hurricane are also discussed in Attachment E. Figures showing the scour profile and water surface elevations are included in Attachment F. Note that grout bags will be used to protect the bed material at and between the closely spaced piles at each pile bent, the bulkheads, and at the fenders for the East Thorofare Bridge. The grout bags provide the benefit of being able to better conform to the shape of the circular piles compared to other types of armoring.

The proposed scour countermeasures, including the marine mattresses, will be inspected as an added item to the federally participating biennial inspections. The general condition of the countermeasures will also be assessed after large floods.

Hilliards Thorofare Bridge

The N.J. Route 72 Bridge over Hilliards Thorofare (Structure ID 1513-151), is an eleven span viaduct constructed in 1957, located in Stafford Township, Ocean County, New Jersey. The eleven span superstructure is generally comprised of simple spanning prestressed concrete stringers; the longest span's superstructure utilized steel stringers. The existing bridge has a length of 467 feet and a deck width (out to out) of 69 feet and is founded on timber pile bents with piles spaced closely at 3'-3" on center. The hydrologic analysis was performed to obtain storm surge stages hydrographs for the 100- and 500-year hurricanes for Little Egg Inlet and Barnegat Inlet based on information including recent FEMA's Flood Insurance Study in March 2014. The peak tidal elevation of Hurricane Sandy (October 28, 2012) is around 5-6 feet at Little Egg Inlet and Barnegat Inlet, much lower than 10 feet of the 100-year hurricane PB used for analysis (Attachment E).

An in-depth scour analysis was performed for the 100-year and 500-year hurricane scenarios. The analysis included two scour components, contraction scour and local scour. The hydraulic parameters for calculating scour depths were obtained from the FESWMS model. The scour depths are summarized in Table 3 and 4 and detailed analysis are summarized in Attachment B. As it can be seen from Table 3 and 4, total scour depths for 100- and 500-year events are all less than the pile tip elevations. However, at 9 of the 10 pile bents, the minimum pile tip elevation required for stability exceeds the minimum estimated pile tip elevation as indicated by the highlighted cells.

Table 3. Scour Depth for 100-Year Storm Surge at Hilliards Thorofare Bridge

Crossing	Location	Scour Depths *(ft)*				Bed Elevation *(ft)*	Scour Elevation *(ft)*	Minimum Pile Tip Elevation Required for Stability (ft)	Minimum Estimated Pile Tip (ft)
		Piers	Contr. & Long Term	Abut *(Contr. & Long Term)*	Total *(ft)*				
Hilliards Thorofare	West Abut			14.0	14.0	-4.7	-18.7		
	H/1-2	5.1	6.2		11.3	-9.0	-20.3	-38.3	-33.1
	H/2-3	4.9	6.2		11.1	-12.0	-23.1	-41.1	-39.9
	H/3-4	2.6	6.2		8.8	-14.0	-22.8	-40.8	-39.9
	H/4-5	5.2	6.2		11.4	-11.0	-22.4	-40.4	-37.2
	H/5-6	5.7	6.2		11.9	-5.0	-16.9	-34.9	-38.5
	H/6-7	7.0	6.2		13.2	-2.0	-15.2	-33.2	-32.5
	H/7-8	7.1	6.2		13.3	-2.0	-15.3	-33.3	-31.8
	H/8-9	6.8	6.2		13.0	-1.0	-14.0	-32.0	-30.8
	H/9-10	6.5	6.2		12.7	-1.0	-13.7	-31.7	-29.9
	H/10-11	6.6	6.2		12.8	-1.0	-13.8	-31.8	-28.5
	East Abut			14.2	14.2	-1.0	-15.2		

Table 4. Scour Depth for 500-Year Storm Surge at Hilliards Thorofare Bridge

Crossing	Location	Scour Depths (ft)				Bed Elevation (ft)	Scour Elevation (ft)	Minimum Pile Tip Elevation Required for Stability (ft)	Minimum Estimated Pile Tip (ft)
		Piers	Contr. & Long Term	Abut (Contr. & Long Term)	Total (ft)				
Hilliards Thorofare	West Abut			15.5	15.5	-4.7	-20.2		
	H/1-2	4.9	8.3		13.2	-9.0	-22.2	-36.2	-33.1
	H/2-3	4.6	8.3		12.9	-12.0	-24.9	-38.9	-39.9
	H/3-4	5.1	8.3		13.4	-14.0	-27.4	-41.4	-39.9
	H/4-5	7.2	8.3		15.5	-11.0	-26.5	-40.5	-37.2
	H/5-6	8.1	8.3		16.4	-5.0	-21.4	-35.4	-38.5
	H/6-7	9.7	8.3		18.0	-2.0	-20.0	-34.0	-32.5
	H/7-8	9.7	8.3		18.0	-2.0	-20.0	-34.0	-31.8
	H/8-9	13.8	8.3		22.1	-1.0	-23.1	-37.1	-30.8
	H/9-10	10.3	8.3		18.6	-1.0	-19.6	-33.6	-29.9
	H/10-11	8.5	8.3		16.8	-1.0	-17.8	-31.8	-28.5
	East Abut			15.7	15.7	-1.0	-16.7		

The marine mattress is required to extend a minimum of two times the average 500-year contraction and long term scour depth beyond the pile bent obstructions based on HEC-18 method. The span lengths are generally 40 feet long and the protection for each individual pile bent coincides with the adjacent pile bent protection. For the one pile bent shown which does not require protection based on the available data (H/5-6), the maximum break in the scour countermeasures would be a 20 foot wide section due to the protection required at the adjacent bents (H/4-5 and H/6-7). Providing such a small break in the countermeasures could attract increased scour at this individual pile bent and can also reduce how effective the scour countermeasures behave when compared to a continuous installation across the entire structure's length. Therefore, the scour countermeasures are proposed to extend the entire length of the bridge and be offset approximately 27'4" feet from the north edge and 31' from the south edge of the deck to account for the battered geometry of the outermost piles.

West Thorofare Bridge

The N.J. Route 72 Bridge over West Thorofare (Structure ID 1513-153), is a nine span viaduct constructed in 1958, located in Stafford Township, Ocean County, New Jersey. The nine span superstructure is comprised of simple spanning prestressed concrete stringers. The approach sections for the bridge consist of Manahawkin Bay Bridge to the west and East Thorofare to the east. The existing bridge has a length of 360 feet and a deck width (out to out) of 69 feet and is founded on timber pile bents with piles spaced closely at 3'-3" on center. Based on FEMA's Flood Insurance Study in March 2014, the hydrologic analysis was performed to obtain storm surge stages hydrographs for the 100- and 500-year hurricanes at Little Egg Inlet and Barnegat Inlet.

An in-depth scour analysis was performed for the 100-year and 500-year hurricane scenarios. The scour analysis was performed in accordance with the FHWA's HEC-18 method. The analysis assumes that two scour components, contraction scour and local scour, develop independently. The required hydraulic parameters for calculating scour depths were taken from the FESWMS 2D models. The calculated scour depths are summarized in Table 5 and 6. Detailed analysis are summarized in Attachment B. As it can be seen from Table 5 and 6, the total scour depths for 100- and 500-year events are all less than the pile tip elevations. However, at 6 of the 8 pile bents, the minimum pile tip elevation required for stability exceeds the minimum estimated pile tip elevation as indicated by the highlighted cells.

Table 5. Scour Depth for 100-Year Storm Surge at West Thorofare Bridge

Crossing	Location	Scour Depths (ft)				Bed Elevation (ft)	Scour Elevation (ft)	Minimum Pile Tip Elevation Required for Stability (ft)	Minimum Estimated Pile Tip (ft)
		Piers	Contr. & Long Term	Abut (Contr. & Long Term)	Total (ft)				
West Thorofare	West Abut			15.4	15.4	-9.1	-24.5		
	W/12-13	5.5	4.0		9.5	-7.5	-17.0	-35.0	-34.6
	W/13-14	4.4	4.0		8.4	-14.5	-22.9	-40.9	-32.7
	W/14-15	2.5	4.0		6.5	-16.5	-23.0	-41.0	-35.6
	W/15-16	3.1	4.0		7.1	-18.0	-25.1	-43.1	-40.8
	W/16-17	5.1	4.0		9.1	-15.0	-24.1	-42.1	-41.1
	W/17-18	6.9	4.0		10.9	-9.0	-19.9	-37.9	-30.5
	W/18-19	4.7	4.0		8.7	-3.0	-11.7	-29.7	-37.3
	W/19-20	4.2	4.0		8.2	-1.0	-9.2	-27.2	-39.1
	East Abut			12.2	12.2	-2.5	-14.7		

Table 6. Scour Depth for 500-Year Storm Surge at West Thorofare Bridge

Crossing	Location	Scour Depths (ft)				Bed Elevation (ft)	Scour Elevation (ft)	Minimum Pile Tip Elevation Required for Stability (ft)	Minimum Estimated Pile Tip (ft)
		Piers	Contr. & Long Term	Abut (Contr. & Long Term)	Total (ft)				
West Thorofare	West Abut			17.9	17.9	-9.1	-27.0		
	W/12-13	7.6	7.0		14.6	-7.5	-22.1	-36.1	-34.6
	W/13-14	5.6	7.0		12.6	-14.5	-27.1	-41.1	-32.7
	W/14-15	2.7	7.0		9.7	-16.5	-26.2	-40.2	-35.6
	W/15-16	4.3	7.0		11.3	-18.0	-29.3	-43.3	-40.8
	W/16-17	7.7	7.0		14.7	-15.0	-29.7	-43.7	-41.1
	W/17-18	9.8	7.0		16.8	-9.0	-25.8	-39.8	-30.5
	W/18-19	8.9	7.0		15.9	-3.0	-18.9	-32.9	-37.3
	W/19-20	4.0	7.0		11.0	-1.0	-12.0	-26.0	-39.1
	East Abut			14.9	14.9	-2.5	-17.4		

The marine mattress is required to extend a minimum of two times the average 500-year contraction and long term scour depth beyond the pile bent obstructions based on HEC-18 method. The span lengths are generally 40 feet long and the protection for each individual pile bent coincides with the adjacent pile bent protection. For the two pile bents shown which do not require protection based on the available data (W/18-19 and W/19-20), the maximum break in the scour countermeasures would be a 65 foot wide section due to the protection required at the adjacent bent (W/17-18) and the location of the existing timber bulkhead. Providing such a small break between the countermeasures and the continuous obstruction of the timber bulkhead could attract increased scour at these pile bents and can also reduce how effective the scour countermeasures behave when compared to a continuous installation across the entire structure's length. Therefore, the scour countermeasures are proposed to extend the entire length of the bridge and be offset approximately 24' feet from the north edge and 26' from the south edge of the deck to account for the battered geometry of the outermost piles.

East Thorofare Bridge

The N.J. Route 72 Bridge over East Thorofare (Structure ID 1513-154), is an eleven span viaduct constructed in 1958. The eleven span superstructure is generally comprised of simple spanning prestressed concrete stringers; the longest span's superstructure utilized steel stringers. The existing bridge has a length of 477 feet and a deck width (out to out) of 69 feet and is founded on timber pile bents with piles spaced closely at 3'-3" on center. The bridge is a slight constriction to the normal tidal flow through the bridge opening. Hydraulic modeling of the tidal marshes and bay over which N.J. Route 72 East Thorofare Bridge simulates the complex exchange between the Atlantic Ocean and the isolated bays during tidal cycles and storm surge cycle. The hydrologic analysis was performed to obtain storm surge stages hydrographs for the 100- and 500-year hurricanes at Little Egg Inlet and Barnegat Inlet.

An in-depth scour analysis was performed for the 100-year and 500-year hurricane scenarios. The scour analysis estimates various scour components to determine the total potential depth of scour. This analysis assumes that the scour components develop independently. The calculated scour depths are summarized in Table 7 and 8. As it can be seen from Table 7 and 8, the total scour depths for 100- and 500-year events are all less than the pile tip elevations except for the bents E/23-24, E/24-25 adjacent to the fenders of the navigation channel. However, at 9 of the 10 pile bents, the minimum pile tip elevation required for stability exceeds the minimum estimated pile tip elevation as indicated by the highlighted cells.

Table 7. Scour Depth for 100-Year Storm Surge at East Thorofare Bridge

Crossing	Location	Scour Depths (ft)				Bed Elevation (ft)	Scour Elevation (ft)	Minimum Pile Tip Elevation Required for Stability (ft)	Minimum Estimated Pile Tip (ft)
		Piers	Contr. & Long Term	Abut (Contr. & Long Term)	Total (ft)				
East Thorofare	West Abut			16.9	16.9	-10.0	-26.9		
	E/21-22	0.0	7.5		7.5	-11.5	-19.0	-37.0	-39.9
	E/22-23	11.0	7.5		18.5	-14.5	-33.0	-51.0	-40.4
	E/23-24	24.4	7.5		31.9	-15.5	-47.4	-65.4	-42.7
	E/24-25	22.6	7.5		30.1	-15.0	-45.1	-63.1	-39.2
	E/25-26	6.4	7.5		13.9	-14.0	-27.9	-45.9	-38.5
	E/26-27	6.5	7.5		14.0	-14.0	-28.0	-46.0	-42.6
	E/27-28	5.7	7.5		13.2	-14.5	-27.7	-45.7	-28.4
	E/28-29	3.9	7.5		11.4	-15.0	-26.4	-44.4	-36.1
	E/29-30	2.6	7.5		10.1	-10.0	-20.1	-38.1	-36.4
	E/30-31	2.6	7.5		10.1	-3.5	-13.6	-31.6	-33.9
	East Abut			12.0	12.0	-3.5	-15.5		

Table 8. Scour Depth for 500-Year Storm Surge at East Thorofare Bridge

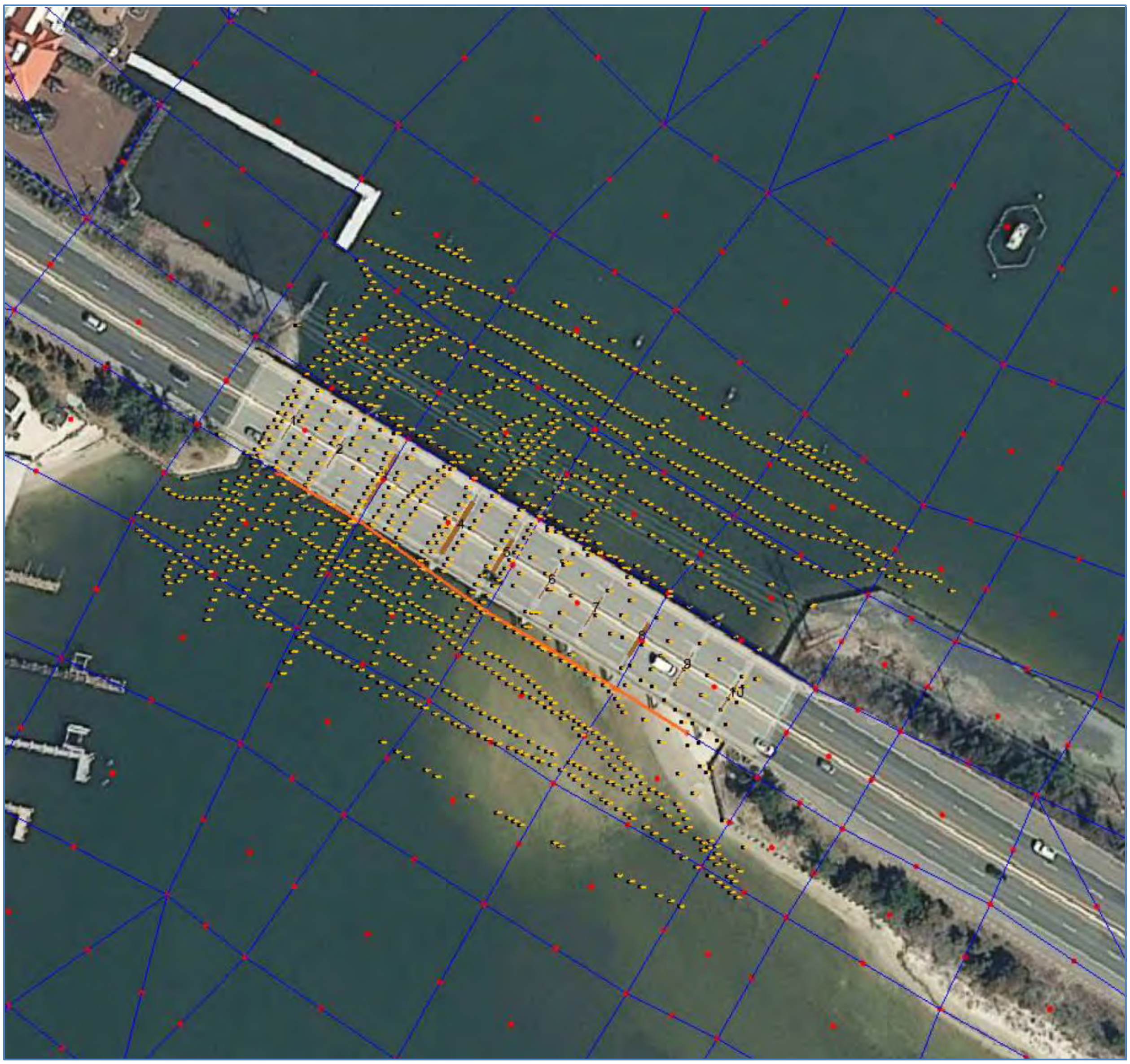
Crossing	Location	Scour Depths (ft)				Bed Elevation (ft)	Scour Elevation (ft)	Minimum Pile Tip Elevation Required for Stability (ft)	Minimum Estimated Pile Tip (ft)
		Piers	Contr. & Long Term	Abut (Contr. & Long Term)	Total (ft)				
East Thorofare	West Abut			20.4	20.4	-10.0	-30.4		
	E/21-22	18.8	9.5		28.3	-11.5	-39.8	-53.8	-39.9
	E/22-23	13.9	9.5		23.4	-14.5	-37.9	-51.9	-40.4
	E/23-24	24.4	9.5		33.9	-15.5	-49.4	-63.4	-42.7
	E/24-25	22.6	9.5		32.1	-15.0	-47.1	-61.1	-39.2
	E/25-26	7.9	9.5		17.4	-14.0	-31.4	-45.4	-38.5
	E/26-27	8.0	9.5		17.5	-14.0	-31.5	-45.5	-42.6
	E/27-28	6.7	9.5		16.2	-14.5	-30.7	-44.7	-28.4
	E/28-29	4.3	9.5		13.8	-15.0	-28.8	-42.8	-36.1
	E/29-30	3.2	9.5		12.7	-10.0	-22.7	-36.7	-36.4
	E/30-31	3.5	9.5		13.0	-3.5	-16.5	-30.5	-33.9
	East Abut			14.2	14.2	-3.5	-17.7		

The marine mattress is required to extend a minimum of two times the average 500-year contraction and long term scour depth beyond the pile bent obstructions based on HEC-18 method. The span lengths are generally 40 feet long and the protection for each individual pile bent coincides with the adjacent pile bent protection. For the pile bent shown which does not require protection based on the available data (E/30-31), the maximum break in the scour countermeasures would be a 25 foot wide section due to the protection required at the adjacent bent (E/29-30) and the location of the existing timber bulkhead. Providing such a small break between the countermeasures and the continuous obstruction of the timber bulkhead could attract increased scour at this pile bent and can also reduce how effective the scour countermeasures behave when compared to a continuous installation across the entire structure's length. Therefore, the scour countermeasures are proposed to extend the entire length of the bridge and be offset approximately 29' from the north edge and 31' from the south edge of the deck to account for the battered geometry of the outermost piles. These limits are increased to approximately 60 feet from the deck edges near the fender system obstruction to adequately protect the bridge.

A. UPDATE FESWMS 2D MODEL BASED ON BATHYMETRY SURVEY BY CHUCHILL ENGINEERS (JULY, 2015)

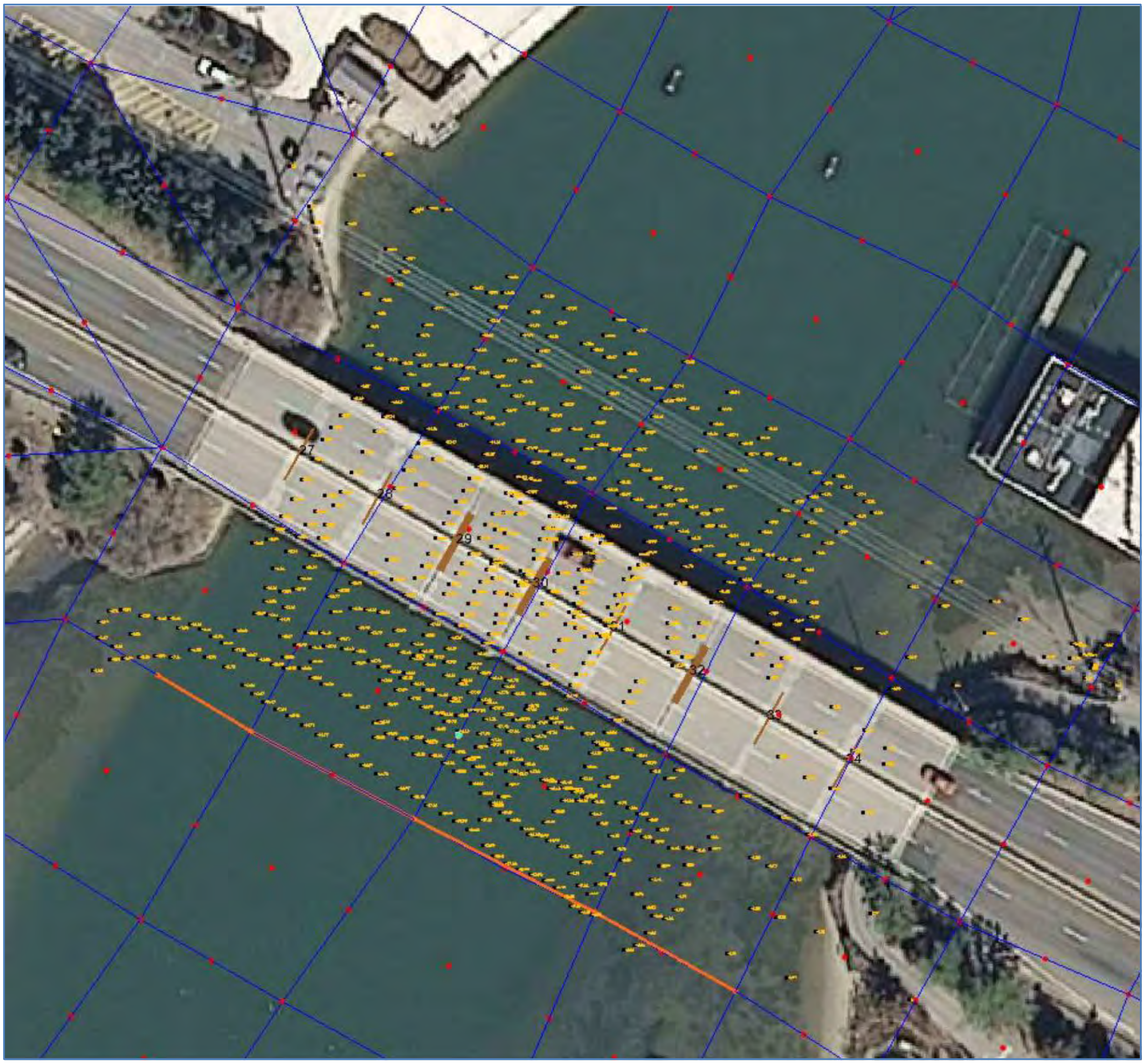
Parsons Brinckerhoff (PB) updated the bathymetry elevations in FESWMS 2D model using the latest survey data by Churchill Engineers in July 2015. Please see the maps (red points indicate nodes in model, yellow points are latest survey) and comparison tables are as attached. PB tracked all the nodes that need to be changed by the node ID at four bridge locations. As it can be seen, around 40%-60% of the changes are within 1 feet. PB also makes sure the bathymetry data in the mesh file "*.net" of 100-year event and 500-year event were updated to reflect the latest elevations in 2015. Data sets which are in the vicinity of pile bents have also been identified in the tables where applicable.

1. HILLIARDS THOROFARE BRIDGE



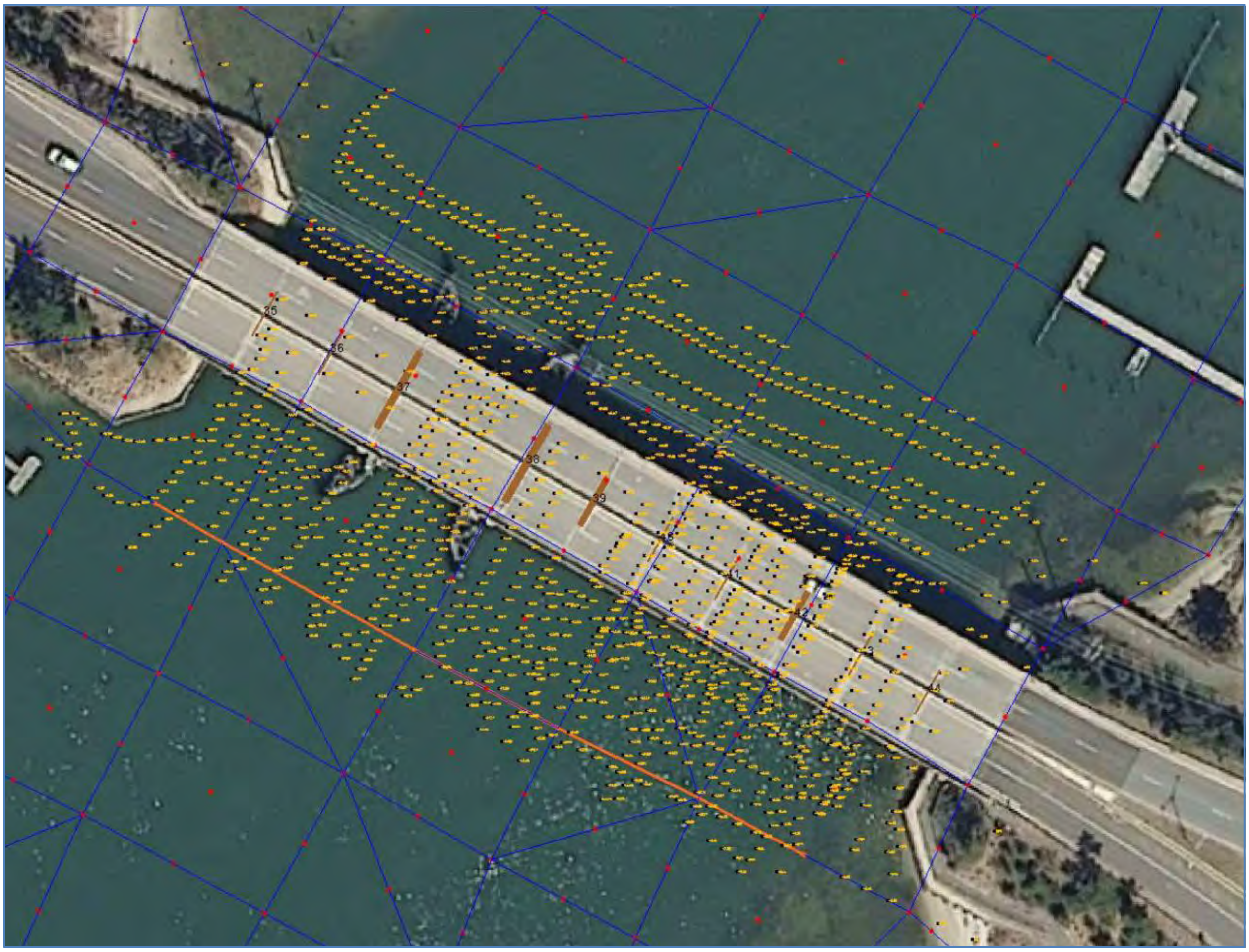
Bridge	ID	Original Z	New Z	Difference	Bents
Hilliards Thorofare	21389	-3.75	-3.375	0.375	
	21164	-8.4375	-5.935	2.5025	
	21167	0.55	-10.11	-10.66	H/1-2
	21193	-0.365	-9.775	-9.41	H/1-2
	21195	-7.741	-7.9	-0.159	
	20939	-13.5	-12.8	0.7	
	20940	-14.2	-12.5	1.7	
	20967	-14.9	-15.23	-0.33	H/3-4
	20968	-13.9	-14	-0.1	H/3-4
	20969	-12.9	-13.45	-0.55	H/3-4
	20970	-12.6	-10.58	2.02	
	20971	-12.3	-11.28	1.02	
	20972	-12.35	-11.24	1.11	
	20697	-8.35	-8.22	0.13	
	20727	-9.675	-9.57	0.105	H/4-5
	20729	-9.1	-9.8	-0.7	H/4-5
	20731	-7.8	-8.23	-0.43	
	20482	-3.2	-3.03	0.17	
	20483	-3.825	-2.9	0.925	
	20484	-4.45	-1.91	2.54	H/5-6
	20485	-3.15	-5.13	-1.98	H/5-6
	20486	-5.3	-3.18	2.12	H/5-6
	20487	-4.3	-3	1.3	
	20488	-3.3	-3.435	-0.135	
	20489	-3.95	-4.52	-0.57	
	20227	-2.8	-2.34	0.46	
	20229	-3.225	-2.465	0.76	H/7-8
	20231	-3.575	-2.2	1.375	H/7-8
	20233	-3.35	-2.965	0.385	
	19973	-2.4	-2.3	0.1	
	19974	-2.2	-2.43	-0.23	
	19975	-2	-0.7	1.3	H/8-9
	19976	-1.925	-1.41	0.515	H/8-9
	19977	-1.85	-2.21	-0.36	H/8-9
	19978	-2.625	-2.5	0.125	
	19979	-3.4	-3.05	0.35	
	19980	-3.725	-3.62	0.105	
	19698	-2.45	-2.53	-0.08	
	19700	7.64	1.14	-6.5	H/10-11
	19701	8.08	-0.87	-8.95	H/10-11
	19702	7.836	-2.01	-9.846	H/10-11
	19703	1.76	-2.53	-4.29	
	19704	-1.887	-3	-1.113	
	19419	-2.22	-2.47	-0.25	
	19420	7.394	0.03	-7.364	
	19426	-2.36	-3.15	-0.79	

2. WEST THOROFARE BRIDGE



Bridge	ID	Original Z	New Z	Difference	**Bents**
West Thorofare	10228	3.536	3.8	0.264	
	10227	-7.938	-6.13	1.808	
	9249	-16.635	-16.08	0.555	
	9560	-14.315	-14.64	-0.325	W/13-14
	9921	-14.449	-14.27	0.179	W/13-14
	9922	-14.536	-13.8	0.736	
	9241	-18.33	-17.185	1.145	W/14-15
	9562	-16.283	-19.2	-2.917	
	8869	-16.597	-18.69	-2.093	
	9239	-18.273	-17.275	0.998	W/15-16
	9240	-18.791	-19.32	-0.529	W/15-16
	9242	-16.949	-21.63	-4.681	W/15-16
	9243	-15.91	-19.84	-3.93	
	9244	-16.14	-15.19	0.95	
	8537	-18.09	-17.29	0.8	
	8868	-15.59	-15.3	0.29	W/16-17
	8871	-15.42	-14.645	0.775	W/16-17
	8535	-4.536	-2.7	1.836	
	8536	-4.64	-4.07	0.57	
	8540	-8.54	-10.03	-1.49	W/17-18
	8146	-5.861	-1.93	3.931	W/18-19
	8148	-4.125	-3.58	0.545	W/18-19
	7791	-1.468	-1.58	-0.112	
	7792	-2.3496	-1.73	0.6196	W/19-20
	7793	-2.406	-1.58	0.826	W/19-20
	7800	-1.776	-1.65	0.126	W/19-20
	7801	-3.066	-1.35	1.716	
	7018	1.75	2.8	1.05	

3. EAST THOROFARE BRIDGE



Bridge	ID	Original Z	New Z	Difference	**Bents**
East Thorofare	5562	-11.622	-9.2	2.422	
	5561	-13.161	-11.45	1.711	
	5919	-10.472	-13.45	-2.978	E/21-22
	5923	-8.386	-8.35	0.036	E/21-22
	6268	-12.051	-11.12	0.931	
	5559	-13.593	-13.72	-0.127	
	5560	-13.95	-13.49	0.46	
	5563	-15.481	-15.19	0.291	E/22-23
	5564	-14.62	-13.79	0.83	E/22-23
	5565	-15.02	-15.53	-0.51	E/22-23
	5889	-12.62	-12.095	0.525	
	5179	-16.46	-15.46	1	
	5184	-20.3	-13.5	6.8	E/23-24
	5533	-15.55	-14.39	1.16	E/23-24
	4820	-15.605	-13.72	1.885	
	4821	-19.177	-15.435	3.742	E/24-25
	5531	-16.476	-13.745	2.731	E/24-25
	5532	-11.1	-10.93	0.17	
	4436	-14.158	-12.8	1.358	
	4795	-15.329	-13.58	1.749	E/25-26
	5153	-13.997	-13.82	0.177	E/25-26
	4078	-14.796	-13.26	1.536	
	4406	-14.63	-14.46	0.17	
	4794	-15.103	-13.29	1.813	E/26-27
	4796	-14.63	-13.66	0.97	E/26-27
	4797	-14.573	-13.56	1.013	E/26-27
	4798	-13.077	-12.64	0.437	
	3710	-16.24	-14.61	1.63	
	4408	-15.068	-15.57	-0.502	
	4407	-16.27	-14.82	1.45	E/27-28
	4410	-15.03	-14.235	0.795	E/27-28
	4053	-15.034	-12.455	2.579	
	3687	-14.09	-13.67	0.42	
	4054	-13.608	-14.97	-1.362	E/28-29
	4055	-14.133	-15.22	-1.087	E/28-29
	4056	-13.296	-14.01	-0.714	E/28-29
	4057	-14.39	-13.34	1.05	
	4058	-13.69	-12.72	0.97	
	3683	-8.52	-3.79	4.73	
	3686	-8.007	-6.75	1.257	E/30-31
	3689	-6.799	-7.7	-0.901	E/30-31

B. SCOUR ANALYSIS CALCULATIONS

100-Year Calculations for Hilliards Thorofare Bridge

Route 72 Trestle Bridges Scour Analysis

MADE BY: Trevor H. Qi
DATE: August 5, 2015
CHECKED BY: Justin Lennon
DATE: August 5, 2015

100-Year Storm Contraction Scour Calculations for Hilliards Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
V_1	Average velocity in upstream reach	ft/s		1.25
y_1	Average depth in the upstream main channel	ft		7.61
D_{50}	Median Grain Diameter, D_{50}	mm		0.05
ω	Fall velocity (Figure 5.8 in HEC-18) ω	m/s		0.0300
D_{50}	D_{50}	ft		0.00016
ω	Fall velocity (Figure 5.8 in HEC-18) ω (fps) = ω (m/s) / 0.3048	ft/s		0.0984
	Computations			
V_c	Critical Velocity, $V_c = 11.17 {*} y^{(1/6)} D^{(1/3)}$	ft/s		0.86
	Scour Type			***Live-bed***

Live-bed Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
Q_1	Flow in the upstream channel transporting sediment	cfs	1	10,883
Q_2	Flow in the contracted channel	cfs	2	12,151
W_1	Bottom width of upstream main channel that is transporting bed material	ft	3	1000.0
W_2	Bottom width of the main channel in the contracted section less pier widths	ft	4	409.0
S_1	Slope of energy gradeline of main channel	ft/ft		0.00830
y_o	Existing depth in the contracted section before scour	ft	5	9.30
	Computations			
	V_* = Shear velocity in the upstream section $(gyS_1)^{0.5}$	ft/s		1.43
	V_* / ω			14.49
	k_1, Exponent determined by mode of bed material transport			0.69
	$y_2/y_1=(Q_2/Q_1)^{6/7}(W_1/W_2)^{k1}$			2.04
	y_2	ft		15.5
	y_s = scour depth, $y_s = y_2 - y_o$	***ft***	**6**	***6.2***

Notes:

1. Q_1 is the flow in the main channel upstream of the bridge not including overbank flows.
2. Q_2 may be the total flow going through the bridge opening as in cases 1a and 1b. It is not the total flow for Case 1c. For Case 1c, contraction scour must be computed separately for the main channel and the left and/or right overbank areas.
3. W_1 and W_2 are not easily defined. In some cases, it is acceptable to use the topwidth of the main channel to define these widths. Whether the topwidth or bottom width is used, it is important to be consistent so that W_1 and W_2 refer to either bottom widths or top widths.
4. The average width of the bridge opening (W_2) is normally taken as the bottom width, with the width of the piers subtracted.
5. In sand channels where the contraction scour hole is filled in on the falling stage, the y_o depth may be approximated by y_1. Sketches or surveys through the bridge can help in determining the existing bed elevation.

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

100-Year Abutment Scour Calculations for Hilliards Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

				Proposed Crossing	
	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
V_1	Average velocity in upstream reach	ft/s		0.939	1.116
y_1	Average depth in the upstream main channel	ft		7.777	8.451
D_{50}	Median Grain Diameter, D_{50}	mm	1	0.05	0.05
D_{50}	Median Grain Diameter, D_{50}	ft		0.00016	0.00016
	Computations				
V_c	Critical Velocity, $V_c = 11.17 * y^{(1/6)} D^{(1/3)}$	ft/s		0.86	0.87
	Scour Type				***Live-bed***

	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
y_o	Flow depth prior to scour	ft	2	3.49	3.55
q_1	Upstream unit discharge			7.30	9.43
q_2	Unit discharge at the constricted opening	ft^2/s		15.66	12.30
K_u	11.17 English units; 6.19 SI			11.17	11.17
L	Length of embankment obstructed by the embankment	ft		421	490.00
B_f	Width of the floodplian	ft		446	586.00
	Abutment Type			SpillThrough	SpillThrough

	Computations			**West Abut**	**East Abut**
q_2/q_1		ft/ft		2.14	1.30
α_A	Amplification factor for live-bed conditions; Figure 8.9 & 8.10			1.17	1.67
α_B	Amplification factor for clear-water conditions; Figure 8.11 & 8.12				
y_c	Flow depth including live-bed or clear-water contraction scour	ft	3	14.96	10.61
y_{max}	Maximum flow depth resulting from abutment scour	ft		17.50	17.72
$\mathbf{y_s}$	**Abutment scour depth; $y_s = y_{max} - y_0$**	**ft**		**14.01**	**14.17**

Notes:

1. D_{50}: Bed material size in the upper 1 ft of the stream bed, a lower limit D_{50} equal to 0.2 mm cab be applied to this equation.
2. Flow depth at the edge of bank (Floodplain)
3. Condition A / Live-Bed Equation: $y_c = y_1(q_{2c}/q_1)^{(6/7)}$;Condition B / Clear-Water Equation: $y_c = (q_{2f}/K_u D_{50}^{(1/3)})^{(6/7)}$
4. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.
5. Scour is computed using NCHRP method in HEC-18, Evaluating Scour at Bridges, 5th edition, FHWA publication No. FHWA NHI 01-001, April 2012

500-Year Calculations for Hilliards Thorofare Bridge

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

500-Year Storm Contraction Scour Calculations for Hilliards Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
V_1	Average velocity in upstream reach	ft/s		1.91
y_1	Average depth in the upstream main channel	ft		8.84
D_{50}	Median Grain Diameter, D_{50}	mm		0.05
ω	Fall velocity (Figure 5.8 in HEC-18) ω	m/s		0.0300
D_{50}	D_{50}	ft		0.00016
ω	Fall velocity (Figure 5.8 in HEC-18) ω (fps) = ω (m/s) / 0.3048	ft/s		0.0984
	Computations			
V_c	Critical Velocity, $V_c = 11.17*y^{(1/6)}D^{(1/3)}$	ft/s		0.88
	Scour Type			***Live-bed***

Live-bed Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
Q_1	Flow in the upstream channel transporting sediment	cfs	1	19,172
Q_2	Flow in the contracted channel	cfs	2	22,623
W_1	Bottom width of upstream main channel that is transporting bed material	ft	3	1000.0
W_2	Bottom width of the main channel in the contracted section less pier widths	ft	4	409.0
S_1	Slope of energy gradeline of main channel	ft/ft		0.00830
y_o	Existing depth in the contracted section before scour	ft	5	10.53
	Computations			
	V_* = Shear velocity in the upstream section $(gyS_1)^{0.5}$	ft/s		1.54
	V_* / ω			15.62
	k_1, Exponent determined by mode of bed material transport			0.69
	$y_2/y_1=(Q_2/Q_1)^{6/7}(W_1/W_2)^{k1}$			2.14
	y_2	ft		18.9
	y_s = scour depth, $y_s = y_2 - y_o$	***ft***	**6**	***8.3***

Notes:

1. Q_1 is the flow in the main channel upstream of the bridge not including overbank flows.
2. Q_2 may be the total flow going through the bridge opening as in cases 1a and 1b. It is not the total flow for Case 1c. For Case 1c, contraction scour must be computed separately for the main channel and the left and/or right overbank areas.
3. W_1 and W_2 are not easily defined. In some cases, it is acceptable to use the topwidth of the main channel to define these widths. Whether the topwidth or bottom width is used, it is important to be consistent so that W_1 and W_2 refer to either bottom widths or top widths.
4. The average width of the bridge opening (W_2) is normally taken as the bottom width, with the width of the piers subtracted.
5. In sand channels where the contraction scour hole is filled in on the falling stage, the y_o depth may be approximated by y_1. Sketches or surveys through the bridge can help in determining the existing bed elevation.

Route 72 Trestle Bridges Scour Analysis

MADE BY: Trevor H. Qi
DATE: August 5, 2015
CHECKED BY: Justin Lennon
DATE: August 5, 2015

500-Year Abutment Scour Calculations for Hilliards Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

				Proposed Crossing	
	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
V_1	Average velocity in upstream reach	ft/s		0.932	2.166
y_1	Average depth in the upstream main channel	ft		8.996	10.002
D_{50}	Median Grain Diameter, D_{50}	mm	1	0.05	0.05
D_{50}	Median Grain Diameter, D_{50}	ft		0.00016	0.00016
	Computations				
V_c	Critical Velocity, $V_c = 11.17 * y^{(1/6)} D^{(1/3)}$	ft/s		0.88	0.90
	Scour Type				***Live-bed***

	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
y_o	Flow depth prior to scour	ft	2	4.39	4.56
q_1	Upstream unit discharge			8.38	21.66
q_2	Unit discharge at the constricted opening	ft^2/s		17.64	27.09
K_u	11.17 English units; 6.19 SI			11.17	11.17
L	Length of embankment obstructed by the embankment	ft		421	490.00
B_f	Width of the floodplian	ft		446	586.00
	Abutment Type			SpillThrough	SpillThrough

	Computations			**West Abut**	**East Abut**
q_2/q_1		ft/ft		2.10	1.25
α_A	Amplification factor for live-bed conditions; Figure 8.9 & 8.10			1.17	1.67
α_B	Amplification factor for clear-water conditions; Figure 8.11 & 8.12				
y_c	Flow depth including live-bed or clear-water contraction scour	ft	3	17.02	12.11
y_{max}	Maximum flow depth resulting from abutment scour	ft		19.92	20.23
y_s	**Abutment scour depth; $y_s = y_{max} - y_0$**	**ft**		**15.53**	**15.67**

Notes:

1. D_{50}: Bed material size in the upper 1 ft of the stream bed, a lower limit D_{50} equal to 0.2 mm cab be applied to this equation.
2. Flow depth at the edge of bank (Floodplain)
3. Condition A / Live-Bed Equation: $y_c = y_1(q_{2c}/q_1)^{(6/7)}$; Condition B / Clear-Water Equation: $y_c = (q_{2f}/K_u D_{50}^{(1/3)})^{(6/7)}$
4. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.
5. Scour is computed using NCHRP method in HEC-18, Evaluating Scour at Bridges, 5th edition, FHWA publication No. FHWA NHI 01-001, April 2012

100-Year Calculations for West Thorofare Bridge

Route 72 Trestle Bridges Scour Analysis

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DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

100-Year Storm Contraction Scour Calculations for West Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
V_1	Average velocity in upstream reach	ft/s		2.08
y_1	Average depth in the upstream main channel	ft		9.55
D_{50}	Median Grain Diameter, D_{50}	mm		0.20
ω	Fall velocity (Figure 5.8 in HEC-18) ω	m/s		0.0270
D_{50}	D_{50}	ft		0.00066
ω	Fall velocity (Figure 5.8 in HEC-18) ω (fps) = ω (m/s) / 0.3048	ft/s		0.0886
	Computations			
V_c	Critical Velocity, $V_c = 11.17 * y^{(1/6)} D^{(1/3)}$	ft/s		1.41
	Scour Type			***Live-bed***

Live-bed Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
Q_1	Flow in the upstream channel transporting sediment	cfs	1	16,064
Q_2	Flow in the contracted channel	cfs	2	19,323
W_1	Bottom width of upstream main channel that is transporting bed material	ft	3	679.0
W_2	Bottom width of the main channel in the contracted section less pier widths	ft	4	306.0
S_1	Slope of energy gradeline of main channel	ft/ft		0.00039
y_o	Existing depth in the contracted section before scour	ft	5	15.37
	Computations			
	V_* = Shear velocity in the upstream section $(gyS_1)^{0.5}$	ft/s		0.35
	V_* / ω			3.91
	k_1, Exponent determined by mode of bed material transport			0.69
	$y_2/y_1=(Q_2/Q_1)^{6/7}(W_1/W_2)^{k1}$			2.03
	y_2	ft		19.4
	y_s = scour depth, $y_s = y_2 - y_o$	***ft***	**6**	***4.0***

Notes:

1. Q_1 is the flow in the main channel upstream of the bridge not including overbank flows.
2. Q_2 may be the total flow going through the bridge opening as in cases 1a and 1b. It is not the total flow for Case 1c. For Case 1c, contraction scour must be computed separately for the main channel and the left and/or right overbank areas.
3. W_1 and W_2 are not easily defined. In some cases, it is acceptable to use the topwidth of the main channel to define these widths. Whether the topwidth or bottom width is used, it is important to be consistent so that W_1 and W_2 refer to either bottom widths or top widths.
4. The average width of the bridge opening (W_2) is normally taken as the bottom width, with the width of the piers subtracted.
5. In sand channels where the contraction scour hole is filled in on the falling stage, the y_o depth may be approximated by y_1. Sketches or surveys through the bridge can help in determining the existing bed elevation.

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
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DATE:	August 5, 2015

100-Year Abutment Scour Calculations for West Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

				Proposed Crossing	
	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
V_1	Average velocity in upstream reach	ft/s		1.442	2.37
y_1	Average depth in the upstream main channel	ft		10.396	10.442
D_{50}	Median Grain Diameter, D_{50}	mm	1	0.2	0.20
D_{50}	Median Grain Diameter, D_{50}	ft		0.00066	0.00066
	Computations				
V_c	Critical Velocity, $V_c = 11.17 * y^{(1/6)} D^{(1/3)}$	ft/s		1.43	1.44
	Scour Type				***Live-bed***

	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
y_o	Flow depth prior to scour	ft	2	8.87	9.66
q_1	Upstream unit discharge			14.99	24.75
q_2	Unit discharge at the constricted opening	ft^2/s		34.30	32.45
K_u	11.17 English units; 6.19 SI			11.17	11.17
L	Length of embankment obstructed by the embankment	ft		1786	472.00
B_f	Width of the floodplian	ft		1829	525.00
	Abutment Type			SpillThrough	SpillThrough

	Computations			**West Abut**	**East Abut**
q_2/q_1		ft/ft		2.29	1.31
α_A	Amplification factor for live-bed conditions; Figure 8.9 & 8.10			1.15	1.66
α_B	Amplification factor for clear-water conditions; Figure 8.11 & 8.12				
y_c	Flow depth including live-bed or clear-water contraction scour	ft	3	21.13	13.17
y_{max}	Maximum flow depth resulting from abutment scour	ft		24.30	21.87
$\mathbf{y_s}$	**Abutment scour depth; $y_s = y_{max} - y_0$**	**ft**		**15.44**	**12.21**

Notes:

1. D_{50}: Bed material size in the upper 1 ft of the stream bed, a lower limit D_{50} equal to 0.2 mm cab be applied to this equation.
2. Flow depth at the edge of bank (Floodplain)
3. Condition A / Live-Bed Equation: $y_c = y_1(q_{2c}/q_1)^{(6/7)}$;Condition B / Clear-Water Equation: $y_c = (q_{2f}/K_u D_{50}^{(1/3)})^{(6/7)}$
4. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.
5. Scour is computed using NCHRP method in HEC-18, Evaluating Scour at Bridges, 5th edition, FHWA publication No. FHWA NHI 01-001, April 2012

500-Year Calculations for West Thorofare Bridge

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

500-Year Storm Contraction Scour Calculations for West Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
V_1	Average velocity in upstream reach	ft/s		3.14
y_1	Average depth in the upstream main channel	ft		11.22
D_{50}	Median Grain Diameter, D_{50}	mm		0.20
ω	Fall velocity (Figure 5.8 in HEC-18) ω	m/s		0.0270
D_{50}	D_{50}	ft		0.00066
ω	Fall velocity (Figure 5.8 in HEC-18) ω(fps) = ω(m/s) / 0.3048	ft/s		0.0886
	Computations			
V_c	Critical Velocity, $V_c = 11.17 \cdot y^{(1/6)} D^{(1/3)}$	ft/s		1.45
	Scour Type			***Live-bed***

Live-bed Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
Q_1	Flow in the upstream channel transporting sediment	cfs	1	26,890
Q_2	Flow in the contracted channel	cfs	2	33,446
W_1	Bottom width of upstream main channel that is transporting bed material	ft	3	679.0
W_2	Bottom width of the main channel in the contracted section less pier widths	ft	4	306.0
S_1	Slope of energy gradeline of main channel	ft/ft		0.00039
y_o	Existing depth in the contracted section before scour	ft	5	16.48
	Computations			
	V_* = Shear velocity in the upstream section $(gyS_1)^{0.5}$	ft/s		0.38
	V_* / ω			4.24
	k_1, Exponent determined by mode of bed material transport			0.69
	$y_2/y_1=(Q_2/Q_1)^{6/7}(W_1/W_2)^{k1}$			2.09
	y_2	ft		23.4
	y_s = scour depth, $y_s = y_2 - y_o$	***ft***	**6**	***7.0***

Notes:

1. Q_1 is the flow in the main channel upstream of the bridge not including overbank flows.
2. Q_2 may be the total flow going through the bridge opening as in cases 1a and 1b. It is not the total flow for Case 1c. For Case 1c, contraction scour must be computed separately for the main channel and the left and/or right overbank areas.
3. W_1 and W_2 are not easily defined. In some cases, it is acceptable to use the topwidth of the main channel to define these widths. Whether the topwidth or bottom width is used, it is important to be consistent so that W_1 and W_2 refer to either bottom widths or top widths.
4. The average width of the bridge opening (W_2) is normally taken as the bottom width, with the width of the piers subtracted.
5. In sand channels where the contraction scour hole is filled in on the falling stage, the y_o depth may be approximated by y_1. Sketches or surveys through the bridge can help in determining the existing bed elevation.
6. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

500-Year Abutment Scour Calculations for West Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

				Proposed Crossing	
	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
V_1	Average velocity in upstream reach	ft/s		2.244	3.719
y_1	Average depth in the upstream main channel	ft		12.026	12.263
D_{50}	Median Grain Diameter, D_{50}	mm	1	0.2	0.20
D_{50}	Median Grain Diameter, D_{50}	ft		0.00066	0.00066
	Computations				
V_c	Critical Velocity, $V_c = 11.17 * y^{(1/6)} D^{(1/3)}$	ft/s		1.47	1.47
	Scour Type				***Live-bed***

	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
y_o	Flow depth prior to scour	ft	2	10.17	10.55
q_1	Upstream unit discharge			26.99	45.61
q_2	Unit discharge at the constricted opening	ft^2/s		61.64	59.28
K_u	11.17 English units; 6.19 SI			11.17	11.17
L	Length of embankment obstructed by the embankment	ft		1786	472.00
B_f	Width of the floodplian	ft		1829	525.00
	Abutment Type			SpillThrough	SpillThrough

	Computations			**West Abut**	**East Abut**
q_2/q_1		ft/ft		2.28	1.30
α_A	Amplification factor for live-bed conditions; Figure 8.9 & 8.10			1.15	1.66
α_B	Amplification factor for clear-water conditions; Figure 8.11 & 8.12				
y_c	Flow depth including live-bed or clear-water contraction scour	ft	3	24.41	15.35
y_{max}	Maximum flow depth resulting from abutment scour	ft		28.07	25.49
$\mathbf{y_s}$	**Abutment scour depth; $y_s = y_{max} - y_0$**	**ft**		**17.90**	**14.94**

Notes:

1. D_{50}: Bed material size in the upper 1 ft of the stream bed, a lower limit D_{50} equal to 0.2 mm cab be applied to this equation.
2. Flow depth at the edge of bank (Floodplain)
3. Condition A / Live-Bed Equation: $y_c = y_1(q_{2c}/q_1)^{(6/7)}$;Condition B / Clear-Water Equation: $y_c = (q_{2f}/K_u D_{50}^{(1/3)})^{(6/7)}$
4. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.
5. Scour is computed using NCHRP method in HEC-18, Evaluating Scour at Bridges, 5th edition, FHWA publication No. FHWA NHI 01-001, April 2012

100-Year Calculations for East Thorofare Bridge

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

100-Year Storm Contraction Scour Calculations for East Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
V_1	Average velocity in upstream reach	ft/s		3.27
y_1	Average depth in the upstream main channel	ft		15.43
D_{50}	Median Grain Diameter, D_{50}	mm		0.20
ω	Fall velocity (Figure 5.8 in HEC-18) ω	m/s		0.0270
D_{50}	D_{50}	ft		0.00066
ω	Fall velocity (Figure 5.8 in HEC-18) ω (fps) = ω (m/s) / 0.3048	ft/s		0.0886
	Computations			
V_c	Critical Velocity, $V_c = 11.17 \cdot y^{(1/6)} D^{(1/3)}$	ft/s		1.53
	Scour Type			***Live-bed***

Live-bed Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
Q_1	Flow in the upstream channel transporting sediment	cfs	1	43,423
Q_2	Flow in the contracted channel	cfs	2	40,726
W_1	Bottom width of upstream main channel that is transporting bed material	ft	3	825.0
W_2	Bottom width of the main channel in the contracted section less pier widths	ft	4	418.0
S_1	Slope of energy gradeline of main channel	ft/ft		0.00071
y_o	Existing depth in the contracted section before scour	ft	5	15.86
	Computations			
	V_* = Shear velocity in the upstream section $(gyS_1)^{0.5}$	ft/s		0.59
	V_* / ω			6.70
	k_1, Exponent determined by mode of bed material transport			0.69
	$y_2/y_1=(Q_2/Q_1)^{6/7}(W_1/W_2)^{k1}$			1.51
	y_2	ft		23.3
	y_s = scour depth, $y_s = y_2 - y_o$	***ft***	**6**	***7.5***

Notes:

1. Q_1 is the flow in the main channel upstream of the bridge not including overbank flows.
2. Q_2 may be the total flow going through the bridge opening as in cases 1a and 1b. It is not the total flow for Case 1c. For Case 1c, contraction scour must be computed separately for the main channel and the left and/or right overbank areas.
3. W_1 and W_2 are not easily defined. In some cases, it is acceptable to use the topwidth of the main channel to define these widths. Whether the topwidth or bottom width is used, it is important to be consistent so that W_1 and W_2 refer to either bottom widths or top widths.
4. The average width of the bridge opening (W_2) is normally taken as the bottom width, with the width of the piers subtracted.
5. In sand channels where the contraction scour hole is filled in on the falling stage, the y_o depth may be approximated by y_1. Sketches or surveys through the bridge can help in determining the existing bed elevation.
6. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

100-Year Abutment Scour Calculations for East Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

				Proposed Crossing	
	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
V_1	Average velocity in upstream reach	ft/s		2.644	2.832
y_1	Average depth in the upstream main channel	ft		14.137	7.464
D_{50}	Median Grain Diameter, D_{50}	mm	1	0.2	0.20
D_{50}	Median Grain Diameter, D_{50}	ft		0.00066	0.00066
	Computations				
V_c	Critical Velocity, $V_c = 11.17 * y^{(1/6)} D^{(1/3)}$	ft/s		1.51	1.36
	Scour Type				***Live-bed***

	Parameters	**Unit**	**Note**	**West Abut**	**East Abut**
y_o	Flow depth prior to scour	ft	2	14.43	12.04
q_1	Upstream unit discharge			37.38	21.14
q_2	Unit discharge at the constricted opening	ft^2/s		84.75	60.89
K_u	11.17 English units; 6.19 SI			11.17	11.17
L	Length of embankment obstructed by the embankment	ft		445	293.00
B_f	Width of the floodplian	ft		488	336.00
	Abutment Type			SpillThrough	SpillThrough

	Computations			**West Abut**	**East Abut**
q_2/q_1		ft/ft		2.27	2.88
α_A	Amplification factor for live-bed conditions; Figure 8.9 & 8.10			1.1	1.30
α_B	Amplification factor for clear-water conditions; Figure 8.11 & 8.12				
y_c	Flow depth including live-bed or clear-water contraction scour	ft	3	28.52	18.49
y_{max}	Maximum flow depth resulting from abutment scour	ft		31.37	24.03
$\mathbf{y_s}$	**Abutment scour depth; $y_s = y_{max} - y_0$**	**ft**		**16.94**	**11.99**

Notes:

1. D_{50}: Bed material size in the upper 1 ft of the stream bed, a lower limit D_{50} equal to 0.2 mm cab be applied to this equation.
2. Flow depth at the edge of bank (Floodplain)
3. Condition A / Live-Bed Equation: $y_c = y_1(q_{2c}/q_1)^{(6/7)}$;Condition B / Clear-Water Equation: $y_c = (q_{2f}/K_u D_{50}^{(1/3)})^{(6/7)}$
4. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.
5. Scour is computed using NCHRP method in HEC-18, Evaluating Scour at Bridges, 5th edition, FHWA publication No. FHWA NHI 01-001, April 2012

500-Year Calculations for East Thorofare Bridge

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

500-Year Storm Contraction Scour Calculations for East Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
V_1	Average velocity in upstream reach	ft/s		5.10
y_1	Average depth in the upstream main channel	ft		17.13
D_{50}	Median Grain Diameter, D_{50}	mm		0.20
ω	Fall velocity (Figure 5.8 in HEC-18) ω	m/s		0.0270
D_{50}	D_{50}	ft		0.00066
ω	Fall velocity (Figure 5.8 in HEC-18) ω(fps) = ω(m/s) / 0.3048	ft/s		0.0886
	Computations			
V_c	Critical Velocity, $V_c = 11.17 \cdot y^{(1/6)} D^{(1/3)}$	ft/s		1.56
	Scour Type			***Live-bed***

Live-bed Contraction Scour

	Parameters	Unit	Note	Proposed Crossing
Q_1	Flow in the upstream channel transporting sediment	cfs	1	73,765
Q_2	Flow in the contracted channel	cfs	2	70,736
W_1	Bottom width of upstream main channel that is transporting bed material	ft	3	825.0
W_2	Bottom width of the main channel in the contracted section less pier widths	ft	4	418.0
S_1	Slope of energy gradeline of main channel	ft/ft		0.00071
y_o	Existing depth in the contracted section before scour	ft	5	16.96
	Computations			
	V_* = Shear velocity in the upstream section $(gyS_1)^{0.5}$	ft/s		0.63
	V_* / ω			7.06
	k_1, Exponent determined by mode of bed material transport			0.69
	$y_2/y_1=(Q_2/Q_1)^{6/7}(W_1/W_2)^{k1}$			1.54
	y_2	ft		26.4
	y_s = scour depth, $y_s = y_2 - y_o$	***ft***	**6**	***9.5***

Notes:

1. Q_1 is the flow in the main channel upstream of the bridge not including overbank flows.
2. Q_2 may be the total flow going through the bridge opening as in cases 1a and 1b. It is not the total flow for Case 1c. For Case 1c, contraction scour must be computed separately for the main channel and the left and/or right overbank areas.
3. W_1 and W_2 are not easily defined. In some cases, it is acceptable to use the topwidth of the main channel to define these widths. Whether the topwidth or bottom width is used, it is important to be consistent so that W_1 and W_2 refer to either bottom widths or top widths.
4. The average width of the bridge opening (W_2) is normally taken as the bottom width, with the width of the piers subtracted.
5. In sand channels where the contraction scour hole is filled in on the falling stage, the y_o depth may be approximated by y_1. Sketches or surveys through the bridge can help in determining the existing bed elevation.
6. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.

Route 72 Trestle Bridges Scour Analysis

MADE BY:	Trevor H. Qi
DATE:	August 5, 2015
CHECKED BY:	Justin Lennon
DATE:	August 5, 2015

500-Year Abutment Scour Calculations for East Thorofare

Prepared by Parsons Brinckerhoff, Inc.

Determine Live-bed or Clear-water Contraction Scour

	Parameters	Unit	Note	Proposed Crossing West Abut	Proposed Crossing East Abut
V_1	Average velocity in upstream reach	ft/s		4.158	4.644
y_1	Average depth in the upstream main channel	ft		15.971	9.091
D_{50}	Median Grain Diameter, D_{50}	mm	1	0.2	0.20
D_{50}	Median Grain Diameter, D_{50}	ft		0.00066	0.00066
	Computations				
V_c	Critical Velocity, $V_c = 11.17 * y^{(1/6)} D^{(1/3)}$	ft/s		1.54	1.40
	Scour Type				***Live-bed***

	Parameters	Unit	Note	West Abut	East Abut
y_o	Flow depth prior to scour	ft	2	15.40	12.99
q_1	Upstream unit discharge			66.41	42.22
q_2	Unit discharge at the constricted opening	ft^2/s		152.23	111.81
K_u	11.17 English units; 6.19 SI			11.17	11.17
L	Length of embankment obstructed by the embankment	ft		445	293.00
B_f	Width of the floodplian	ft		488	336.00
	Abutment Type			SpillThrough	SpillThrough

	Computations	Unit	Note	West Abut	East Abut
q_2/q_1		ft/ft		2.29	2.65
α_A	Amplification factor for live-bed conditions; Figure 8.9 & 8.10			1.1	1.30
α_B	Amplification factor for clear-water conditions; Figure 8.11 & 8.12				
y_c	Flow depth including live-bed or clear-water contraction scour	ft	3	32.52	20.95
y_{max}	Maximum flow depth resulting from abutment scour	ft		35.77	27.23
y_s	**Abutment scour depth; $y_s = y_{max} - y_0$**	**ft**		**20.37**	**14.24**

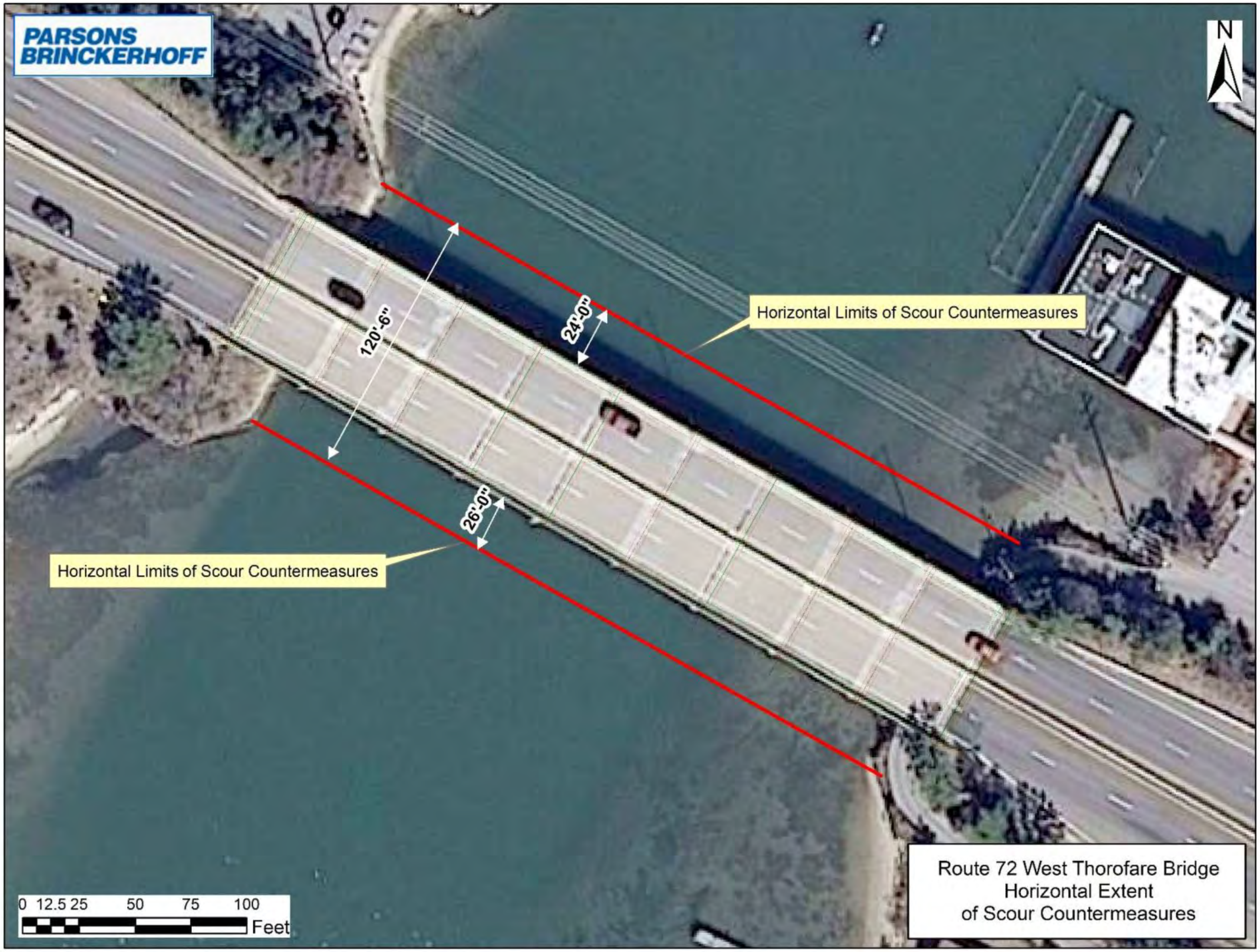
Notes:

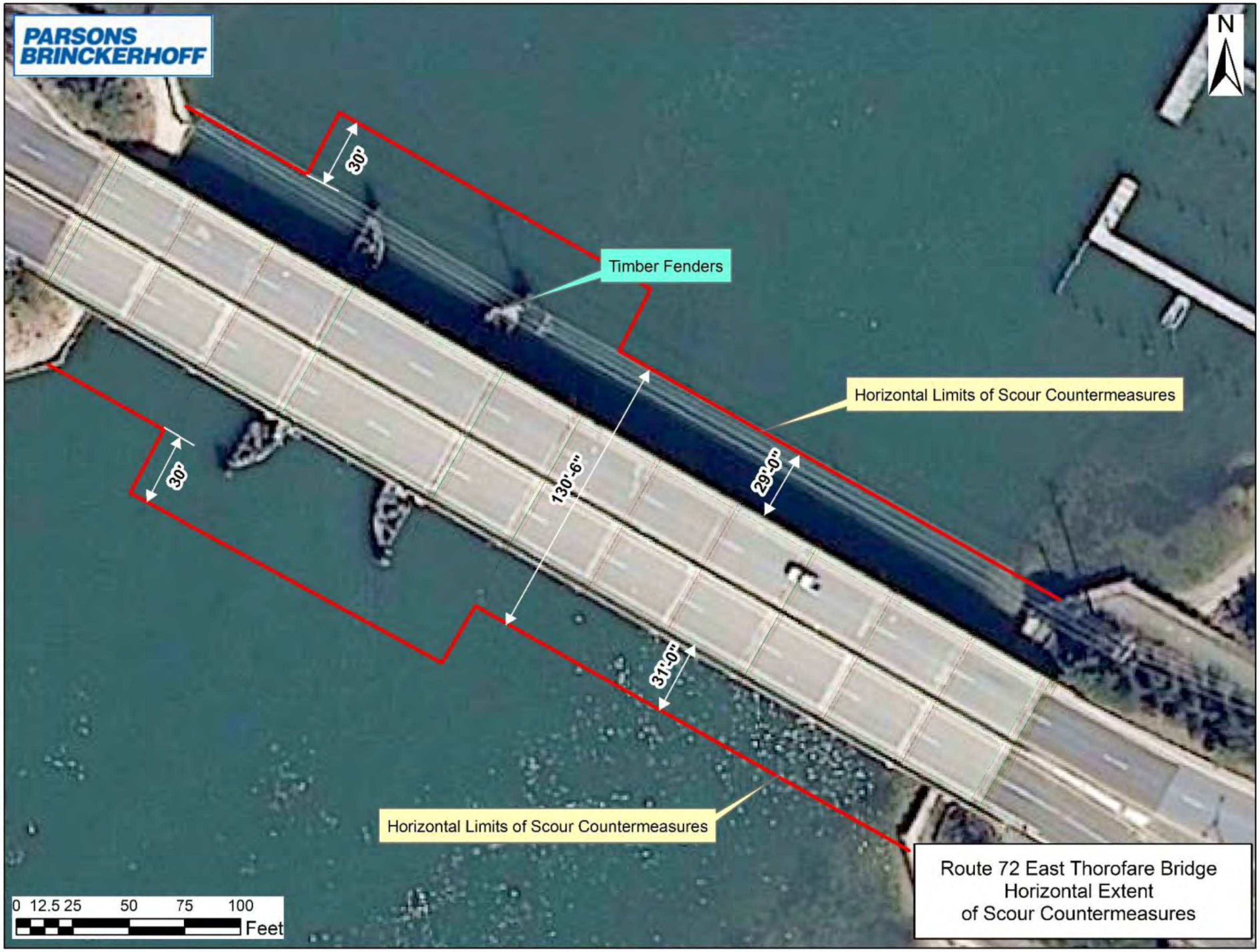
1. D_{50}: Bed material size in the upper 1 ft of the stream bed, a lower limit D_{50} equal to 0.2 mm cab be applied to this equation.
2. Flow depth at the edge of bank (Floodplain)
3. Condition A / Live-Bed Equation: $y_c = y_1 (q_{2c}/q_1)^{(6/7)}$;Condition B / Clear-Water Equation: $y_c = (q_{2f}/K_u D_{50}^{(1/3)})^{(6/7)}$
4. Scour depths with live-bed contraction scour may be limited by coarse sediments in the bed material armoring the bed. Where coarse sediments are present, it is recommended that scour depths be calculated for live-bed scour conditions using the clear water scour equation in addition to the live-bed equation, and that the smaller calculated scour depth be used.
5. Scour is computed using NCHRP method in HEC-18, Evaluating Scour at Bridges, 5th edition, FHWA publication No. FHWA NHI 01-001, April 2012

C. HORIZONTAL LAYOUT OF SCOUR COUNTERMEASURE

(BASED ON 2 TIMES 500-YEAR CONTRACTION AND LONG TERM SCOUR DEPTH)


PARSONS BRINCKERHOFF
N
Horizontal Limits of Scour Countermeasures
128'-9"
27'-4"
31'
Horizontal Limits of Scour Countermeasures
0 12.5 25 50 75 100
Feet
Route 72 Hilliards Thorofare Bridge
Horizontal Extent
of Scour Countermeasures


PARSONS BRINCKERHOFF
N
Horizontal Limits of Scour Countermeasures
24'-0"
120'-6"
26'-0"
Horizontal Limits of Scour Countermeasures
Route 72 West Thorofare Bridge
Horizontal Extent
of Scour Countermeasures
0 12.5 25 50 75 100
Feet


PARSONS BRINCKERHOFF
N
30'
Timber Fenders
Horizontal Limits of Scour Countermeasures
130'-6"
29'-0"
30'
31'-0"
Horizontal Limits of Scour Countermeasures
0 12.5 25 50 75 100
Feet
Route 72 East Thorofare Bridge
Horizontal Extent
of Scour Countermeasures

D. MARINE MATTRESS ANCHORING DISCUSSION

According to Publication 593 of National Cooperative Highway Research Program (NCHRP), *Countermeasures to Protect Bridge Piers from Scour*, anchors may be used with marine mattresses; however, the layout guidance presented in Section 1.3 in Publication 593 indicates that the system should be toed down to a termination depth at least as deep as any expected contraction scour and long-term degradation. Where such toe down depth cannot be achieved, for example where bedrock is encountered at shallow depth, anchoring the marine mattress along the front (upstream) and sides of the installation is recommended. The spacing of the anchors should be determined based on a factor of safety of at least 5.0 for pullout resistance based on calculated drag on the exposed outside edges (north and south of the bridges). Spacing between anchors of no more than 4 ft (1.3 m) is recommended. The following computation is provided:

The mattress is not proposed to be toed down. The limits of the scour countermeasures have been set to extend far beyond 2 times the pier width as suggested in NCHRP Publication 593 (dimension 'a' from Figure F1.3 of the referenced document). This in combination with the anchors provided at the edges of the mattress and the mattress' flexibility is considered to provide the protection needed for the piers. Furthermore, the manufacturer has suggested that based on the relatively flat application proposed, a subgrade toe-in is not required. This recommendation is further substantiated in a technical paper issued by the Army Corps of Engineers titled *Uses for Marine Mattresses in Coastal Engineering*, where it is stated that marine mattresses provide adequate toe protection as long as they are not directly exposed to breaking wave heights of 5 feet or more. The mattress' flexibility allow the ends to conform to the changes in the bed profile so that if some scour is experienced at the outside limits of the protection, the mattress will naturally deflect and toe itself in as sediment returns to the area and the mattresses would remain stable for the desired protection.

A general assessment was performed to confirm that the minimal load capacity requirements of the anchor (approximately 500 pounds every 2.5 feet) can be met with the substrate material. It is estimated that an anchor depth of approximately 5 feet will be adequate to mobilize the resistance needed from the anchors.

Hilliards Thorofare

ρ	1.989	$slugs/ft^2$	(Mass Density of Sea Water)
V =	6	ft/s	(Max 500-year velocity)
Δz =	1	ft	(Marine Mattress Height)
b =	448	ft	

Step 1: Calculate the total force, Fd, on the outside edges of the marine mattress (north and south of the bridges)

$Fd = 0.5\rho V^2(\Delta z)b$ 16,039 lb

Step 2: Calculate required uplift restraint using 5.0 safety factor:

$F_{resistant}$ = 80,196 lb

Step 3: Counting anchors at the corners of the system, calculate required pullout resistance per anchor (round to nearest 10 lb):

a) Assuming 112 anchors at 4-ft spacing: 720 lb/anchor

b) Assuming 224 anchors at 2-ft spacing: 360 lb/anchor

West Thorofare

ρ	1.989	$slugs/ft^2$	(Mass Density of Sea Water)
V =	5.7	ft/s	(Max 500-year velocity)
Δz =	1	ft	(Marine Mattress Height)
b =	322	ft	

Step 1: Calculate the total force, Fd, on the outside edges of the marine mattress (north and south of the bridges)

$Fd = 0.5\rho V^2(\Delta z)b$ 10,404 lb

Step 2: Calculate required uplift restraint using 5.0 safety factor:

$F_{resistant}$ = 52,021 lb

Step 3: Counting anchors at the corners of the system, calculate required pullout resistance per anchor (round to nearest 10 lb):

a) Assuming 80 anchors at 4-ft spacing: 650 lb/anchor

b) Assuming 160 anchors at 2-ft spacing: 330 lb/anchor

East Thorofare

ρ	1.989	$slugs/ft^2$	(Mass Density of Sea Water)
V =	6.5	ft/s	(Max 500-year velocity)
Δz =	1	ft	(Marine Mattress Height)
b =	440	ft	

Step 1: Calculate the total force, Fd, on the outside edges of the marine mattress (north and south of the bridges)

$Fd = 0.5\rho V^2(\Delta z)b$ 18,488 lb

Step 2: Calculate required uplift restraint using 5.0 safety factor:

$F_{resistant}$ = 92,439 lb

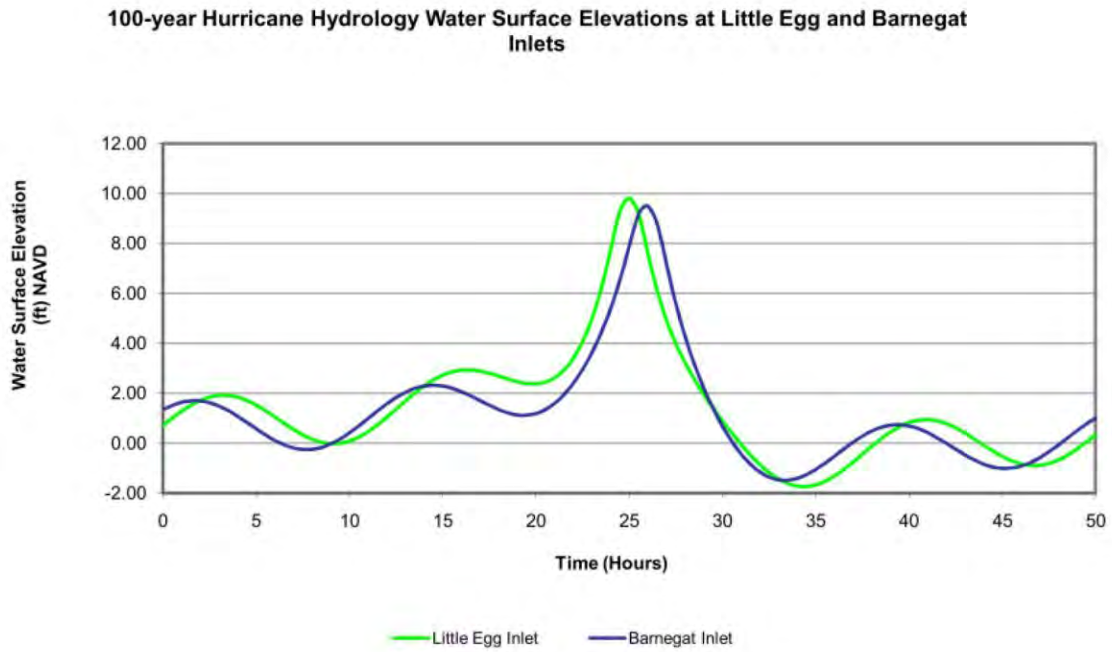
Step 3: Counting anchors at the corners of the system, calculate required pullout resistance per anchor (round to nearest 10 lb):

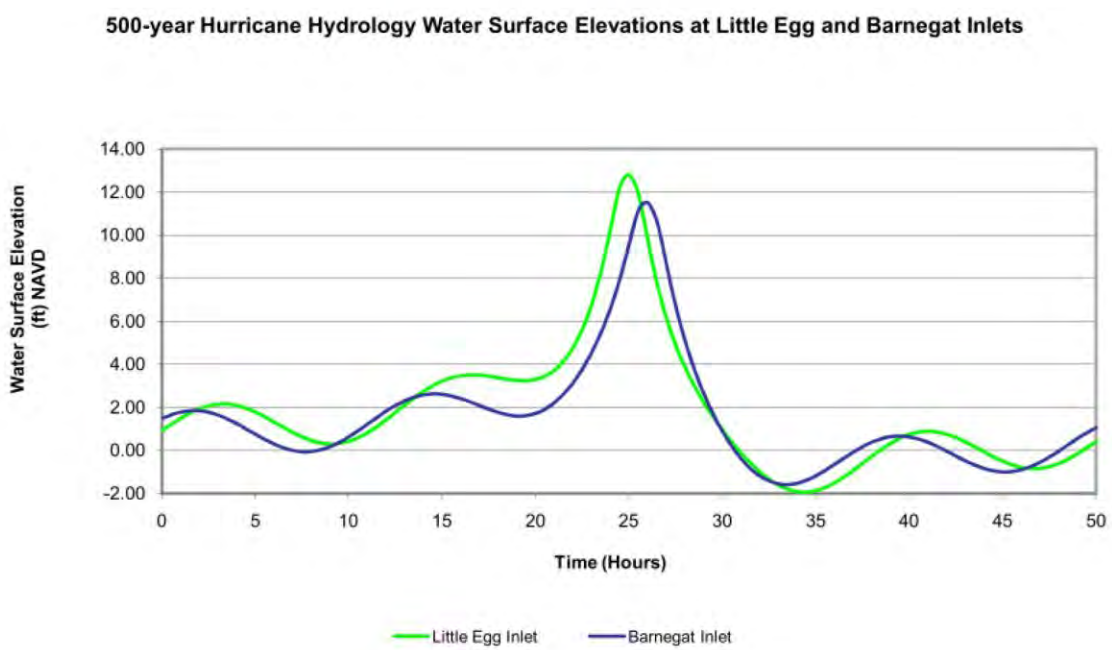
a) Assuming 110 anchors at 4-ft spacing: 840 lb/anchor

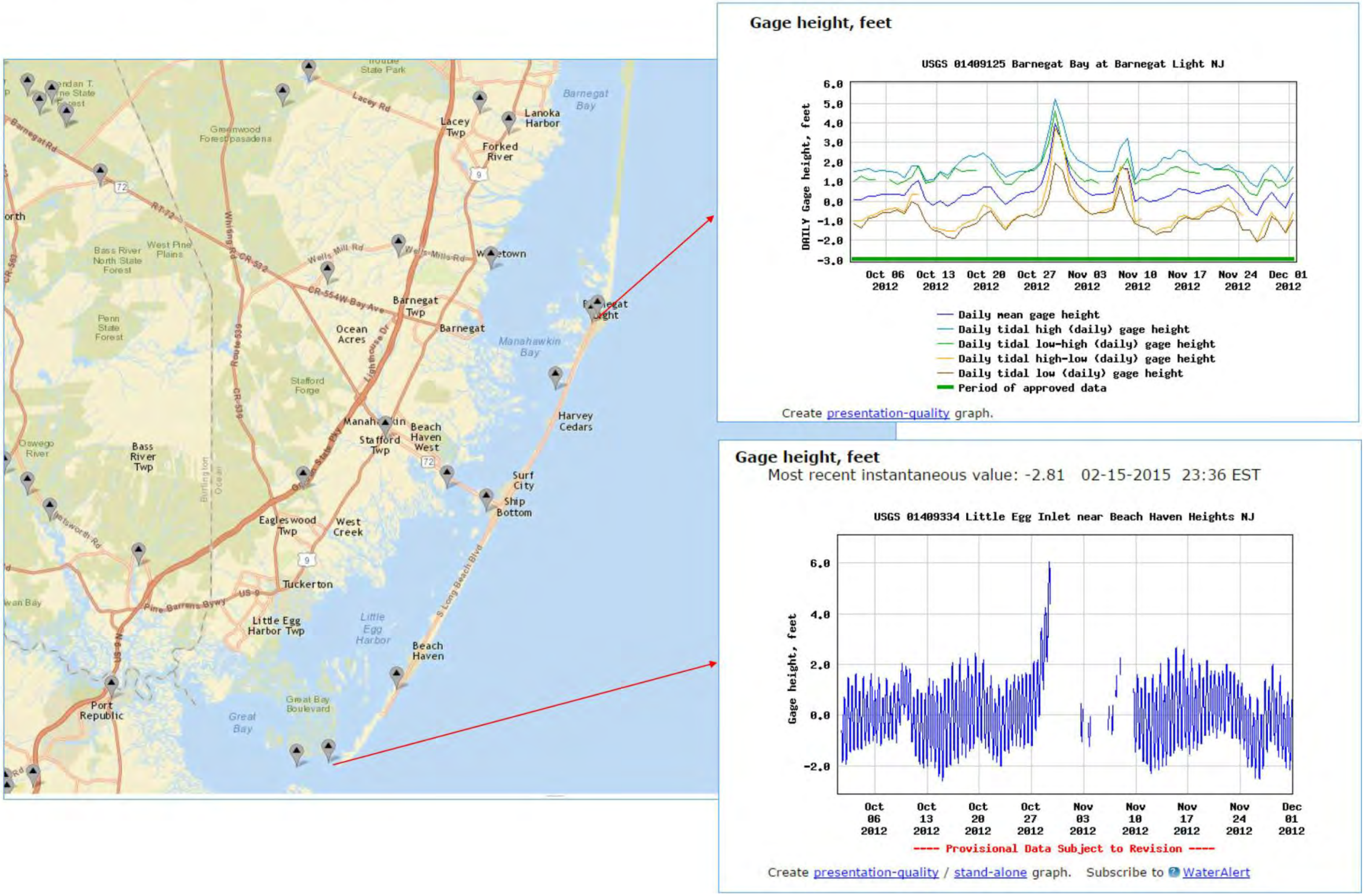
b) Assuming 220 anchors at 2-ft spacing: 420 lb/anchor

E. TIDAL ELEVATION DATA OF SUPERSTORM SANDY AND DERIVATION OF 100-YEAR AND 500-YEAR HURRICANES

PB downloaded the tidal elevation data of Hurricane Sandy (October 28, 2012) from USGS National Water Information Website (http://maps.waterdata.usgs.gov/mapper), at two locations (Barnegat and Little Egg Harbor) shown in the figure on next page. The peak water surface elevation is between 5~6 feet. When compared with peak tidal water surface elevations PB used for 100-year storm and 500-year storm as the two boundary conditions, which are around 10 feet and 12 feet respectively, Super Storm Sandy is much less, which means the real event shouldn't be a concern.






Lanoka Harbor
Barnegat Bay
Lacey Twp
Forked River
Greenwood Forest/pasadena
West Pine Plains
Bass River North State Forest
Penn State Forest
Bass River Twp
Oswego River
Waretown
Barnegat Twp
Barnegat
Ocean Acres
Stafford Forge
Manahawkin Bay
Barnegat Light
Harvey Cedars
Manahawkin
Stafford Twp
Beach Haven West
Surf City
Ship Bottom
Eagleswood Twp
West Creek
Tuckerton
Little Egg Harbor Twp
Little Egg Harbor
Beach Haven
Great Bay Boulevard
Great Bay
Port Republic
Gage height, feet
USGS 01409125 Barnegat Bay at Barnegat Light NJ
DAILY Gage height, feet
Oct 06 2012
Oct 13 2012
Oct 20 2012
Oct 27 2012
Nov 03 2012
Nov 10 2012
Nov 17 2012
Nov 24 2012
Dec 01 2012
Daily mean gage height
Daily tidal high (daily) gage height
Daily tidal low-high (daily) gage height
Daily tidal high-low (daily) gage height
Daily tidal low (daily) gage height
Period of approved data
Create presentation-quality graph.
Gage height, feet
Most recent instantaneous value: -2.81 02-15-2015 23:36 EST
USGS 01409334 Little Egg Inlet near Beach Haven Heights NJ
Gage height, feet
---- Provisional Data Subject to Revision ----
Create presentation-quality / stand-alone graph. Subscribe to WaterAlert

Brief details of derivations of the 100-year and 500-year hurricanes are provided below for information. Hydraulic conditions along Route 72 are tidally controlled. N.J. Route 72 divides Manahawkin Bay that has a tidal inlet to the south, Little Egg Inlet, and to the north, Barnegat Inlet.

The water surface elevation is constantly changing at coastal locations, and these changes contribute to flow into (flood tide) and out of (ebb tide) Little Egg and Barnegat Inlets. The more rapid the rise and fall in water level, the greater the velocities through the inlets. Mean tides affecting these inlets have a period of approximately 12.5 hours and an amplitude of about 1.1 feet. However, a hurricane storm surge can significantly increase Atlantic Coast water surface elevations over relatively short periods of time. A storm surge is the relatively large local rise in water level that occurs during a significant storm event and it tends to be the most damaging force along the coast. Storm surges are caused by a combination of the extremely low pressure associated with a severe storm and high winds that literally "pile" water onto the coast. Surges are particularly damaging because water levels rise quickly over a relatively short period of time and therefore result in higher, and more erosive, flow velocities.

The hydrologic investigation produced the data required for a hydraulic analysis of the bays, marshes and channels over which N.J. Route 72 crosses. The goal of the hydrologic analysis was to obtain probable storm surge stage hydrographs for the 100-year and 500-year hurricanes and stage graphs for normal tidal conditions. The stage hydrographs for Little Egg Inlet and Barnegat Inlet were developed for this study based on several information sources. The information from NOAA tidal benchmark 8533615, the FEMA flood insurance study (FIS) for Ocean County, N.J. and the United States Army Corp of Engineers (USACE) ADCIRC storm surge prediction stations were all consulted for the hydraulic modeling. Once the tidal datum and appropriate storm surge heights were determined, the hydrologic modeling was conducted using methods outlined in the Pooled Fund Study report entitled Tidal Hydraulic Modeling for Bridges (Source: Ayres Associates and Edge & Associates (2002), Pooled Fund Study: *Tidal Hydraulic Modeling for Coastal Bridges*).

The behavior of the astronomical tides at Barnegat and Little Egg Inlets were simulated based upon NOAA tidal predictions for Barnegat Inlet and the Beach Haven Coast Guard Station, located near Little Egg Inlet. The tidal predictions for Barnegat Light and the Beach Haven Coast Guard Station were developed by NOAA based upon a calibrated harmonic tidal analysis at Sandy Hook, N.J., located 47.2 and 64.9 miles from each inlet, respectively. A travel time of 59 minutes from Barnegat Inlet to Little Egg Inlet for the tidal cycle was determined from this analysis. The lag time was approximated to 1 hour to meet the timing criteria for input into the hydraulic model.

The FEMA Stillwater elevations used for the hydrologic model at Ocean County are presented in Table E-1. The Stillwater elevations in Table E-1 are from FEMA Flood Insurance Study for Long Beach Island, Ocean County, New Jersey. Both locations are shown in Figure E-1.

Table E-1. FEMA FIS Stillwater Elevations for Long Beach Island, New Jersey.

	100-year (ft, NAVD 88)	500-year (ft, NAVD 88)
Barnegat Inlet	9.5	11.5
Little Egg Harbor	9.8	12.8

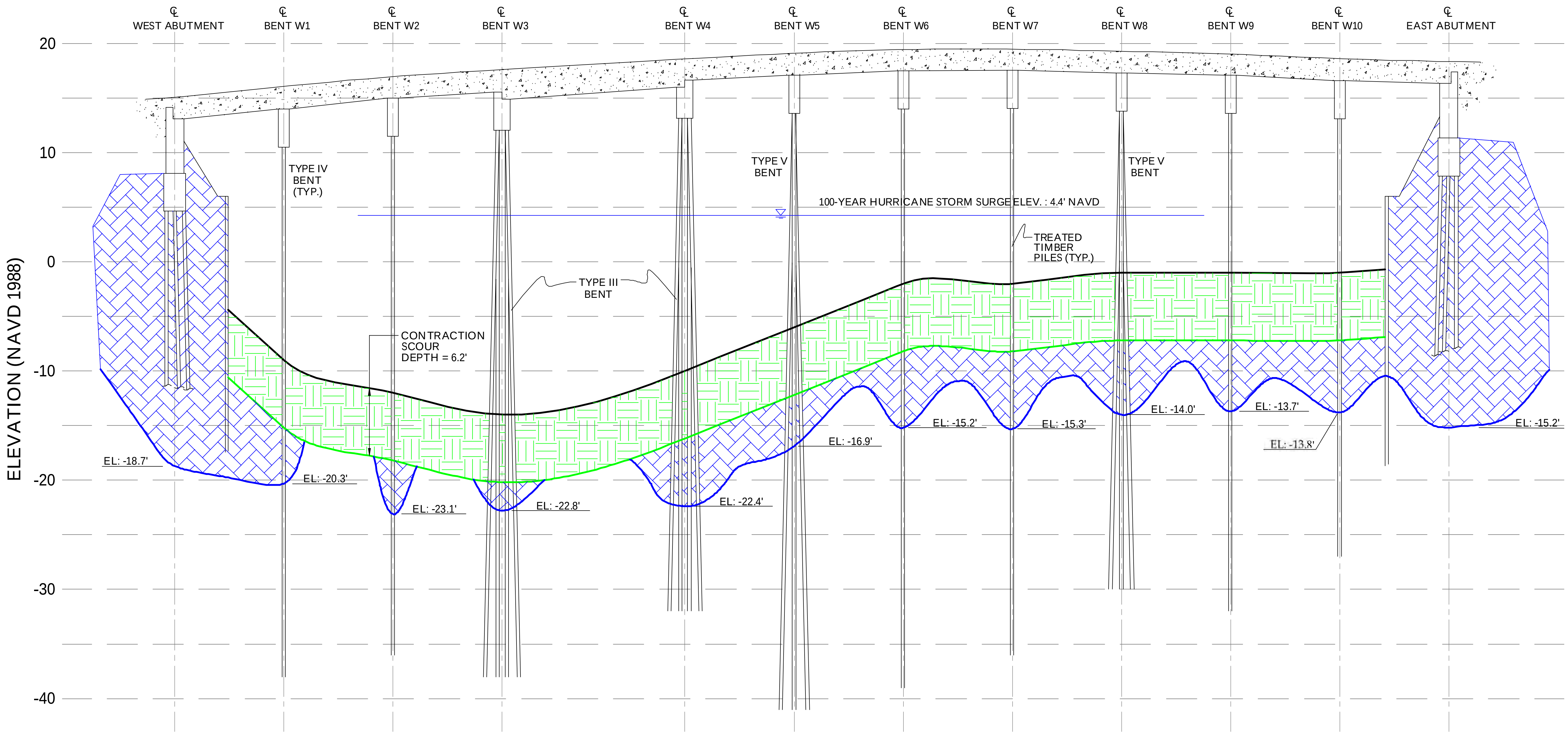
Figure E-1. Location of the FIS Stillwater Elevations for Long Beach Island

The storm surge hydrograph is constructed using the selected surge height, estimated storm duration and a synthetic hydrograph representative of coastal hurricane storm surges. The storm duration is estimated from the data provided in NOAA technical report NWS-38 (Source: National Weather Service (1987), "Hurricane Climatology for the Atlantic and Gulf Coasts of the United States," NOAA Technical Report NWS-38).

Storm duration (D) is calculated from the radius of maximum winds (R) and the forward speed of the storm (f) such that D = R/f. Based on NWS-38 the 50% probability hurricane for the New Jersey coastline near Long Beach Island would have a radius of maximum winds of 35 nautical miles and a forward speed of 19 knots and thus a duration of 1.84 hr. The storm surge hydrograph was modeled using the Alternative Surge Hydrograph method presented in the Pooled Fund Study.

F. SCOUR PROFILES WITH SUPER STORM SANDY ELEVATIONS

(Includes 100-yr, 500-yr, and Sandy water surface elevations along with 100-yr and 500-yr scour profiles)



CROSS-SECTION (LOOKING NORTH)

HORIZONTAL SCALE : 1" = 40'
VERTICAL SCALE : 1" = 10'

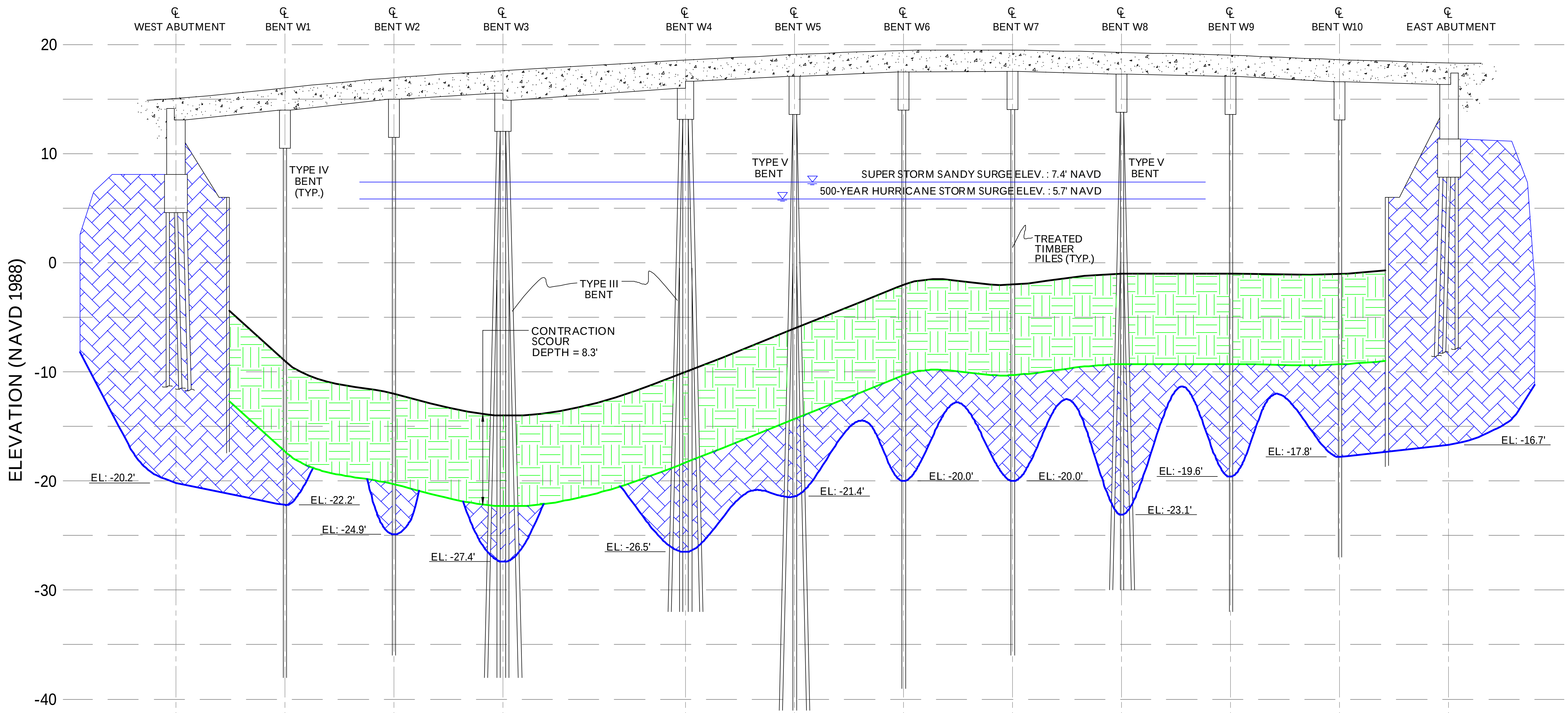
SURVEYED BED ELEVATION*
PCA ENGINEERS, JUNE 2015

CONTRACTION SCOUR

LOCAL SCOUR

NOTES: PILE TIP ELEVATIONS FOR BULKHEAD, FENDERS AND ABUTMENTS ARE UNKNOWN AND ASSUMED TO BE SHALLOW.
PILE TIP ELEVATIONS FOR PIERS ARE BASED ON PILE LENGTHS ESTIMATED BY NDT CORPORATION USING SONIC/ULTRASONIC PULSE-ECHO REFLECTION MEASUREMENTS ON REPRESENTATIVE PILES IN JUNE 2014.
PILE DIAMETER ESTIMATED AT 14".
ELEVATIONS OF SCOUR HOLES ARE THE ONLY CALCULATED QUANTITIES
OTHER GEOMETRIC PROPERTIES ARE ESTIMATES (E.G. SIDE SLOPE AND WIDTH).
*SURVEYED CROSS-SECTION IS APPROX. 100' SOUTH OF BRIDGE FASCIA.

New Jersey Department of Transportation	Figure F.1 - 100-year Storm Surge Estimated Scour Elevation and Pile Elevation
CALCULATED SCOUR DEPTHS Structure No.: 1513-151 N.J. Route 72 over Hillards Thorofare Ocean County, New Jersey	Prepared By: Parsons Brinckerhoff January 2016 Sheet 1 of 6



CROSS-SECTION (LOOKING NORTH)
HORIZONTAL SCALE : 1" = 40'
VERTICAL SCALE : 1" = 10'

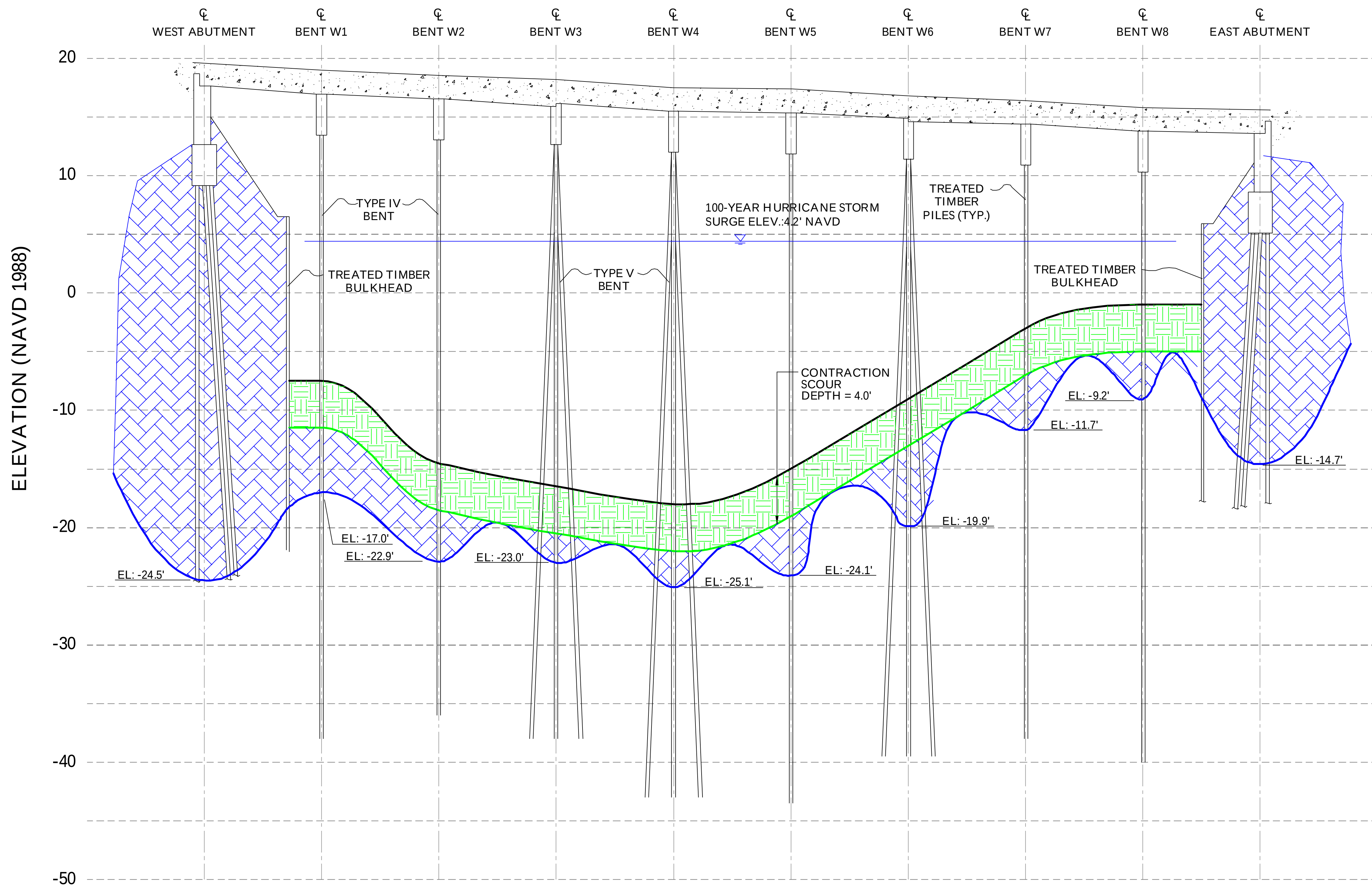
SURVEYED BED ELEVATION*
PCA ENGINEERS, JUNE 2015

CONTRACTION SCOUR

LOCAL SCOUR

NOTES: PILE TIP ELEVATIONS FOR BULKHEAD, FENDERS, AND ABUTMENTS ARE UNKNOWN AND ASSUMED TO BE SHALLOW.
PILE TIP ELEVATIONS FOR PIERS ARE BASED ON PILE LENGTHS ESTIMATED BY NDT CORPORATION USING SONIC/ULTRASONIC PULSE-ECHO REFLECTION MEASUREMENTS ON REPRESENTATIVE PILES IN JUNE 2014.
PILE DIAMETER ESTIMATED AT 14".
ELEVATIONS OF SCOUR HOLES ARE THE ONLY CALCULATED QUANTITIES
OTHER GEOMETRIC PROPERTIES ARE ESTIMATES (E.G. SIDE SLOPE AND WIDTH).
*SURVEYED CROSS-SECTION IS APPROX. 100' SOUTH OF BRIDGE FASCIA.

New Jersey Department of Transportation	Figure F.2 - 500-year Storm Surge Estimated Scour Elevation and Pile Elevation
CALCULATED SCOUR DEPTHS Structure No.: 1513-151 N.J. Route 72 over Hillards Thorofare Ocean County, New Jersey	Prepared By: Parsons Brinckerhoff January 2016 Sheet 2 of 6



CROSS-SECTION (LOOKING NORTH)

HORIZONTAL SCALE : 1" = 40'

VERTICAL SCALE : 1" = 10'

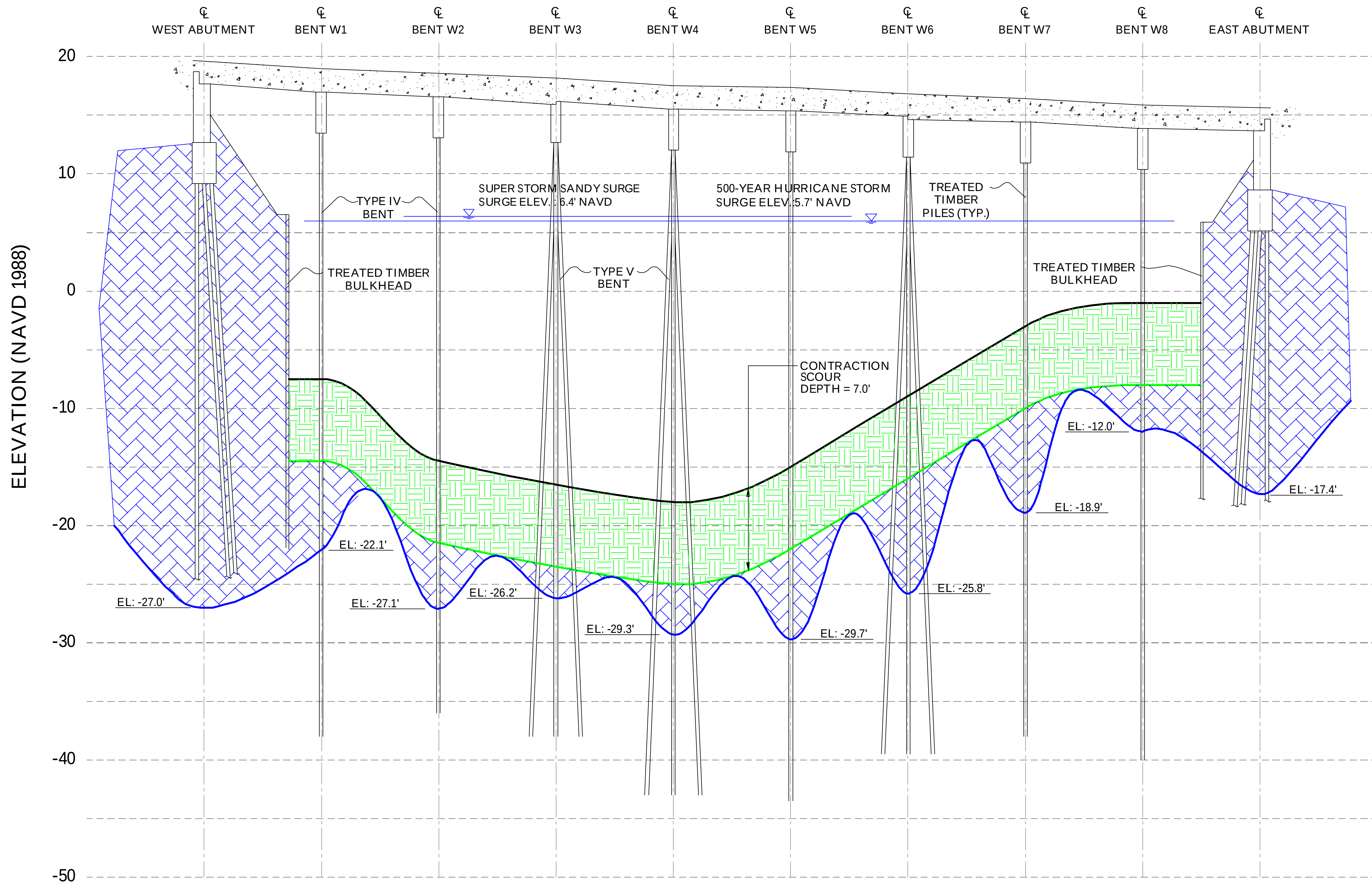
SURVEYED BED ELEVATION PCA ENGINEERS, JUNE 2015

CONTRACTION SCOUR

LOCAL SCOUR

NOTES: PILE TIP ELEVATIONS FOR BULKHEAD, FENDERS AND ABUTMENTS ARE UNKNOWN AND ASSUMED TO BE SHALLOW.
PILE TIP ELEVATIONS FOR PIERS ARE BASED ON PILE LENGTHS ESTIMATED BY NDT CORPORATION USING SONIC/ULTRASONIC PULSE-ECHO REFLECTION MEASUREMENTS ON REPRESENTATIVE PILES IN JUNE 2014.
PILE DIAMETER ESTIMATED AT 14".
ELEVATIONS OF SCOUR HOLES ARE THE ONLY CALCULATED QUANTITIES
OTHER GEOMETRIC PROPERTIES ARE ESTIMATES (E.G. SIDE SLOPE AND WIDTH).
*SURVEYED CROSS-SECTION IS APPROX. 100' SOUTH OF BRIDGE FASCIA.

New Jersey Department of Transportation	Figure F.3 - 100-year Storm Surge Estimated Scour Elevation and Pile Elevation
CALCULATED SCOUR DEPTHS Structure No.: 1513-153 N.J. Route 72 over West Thorofare and "U" Turn Ocean County, New Jersey	Prepared By: Parsons Brinckerhoff January 2016 Sheet 3 of 6



CROSS-SECTION (LOOKING NORTH)

HORIZONTAL SCALE : 1" = 40'

VERTICAL SCALE : 1" = 10'

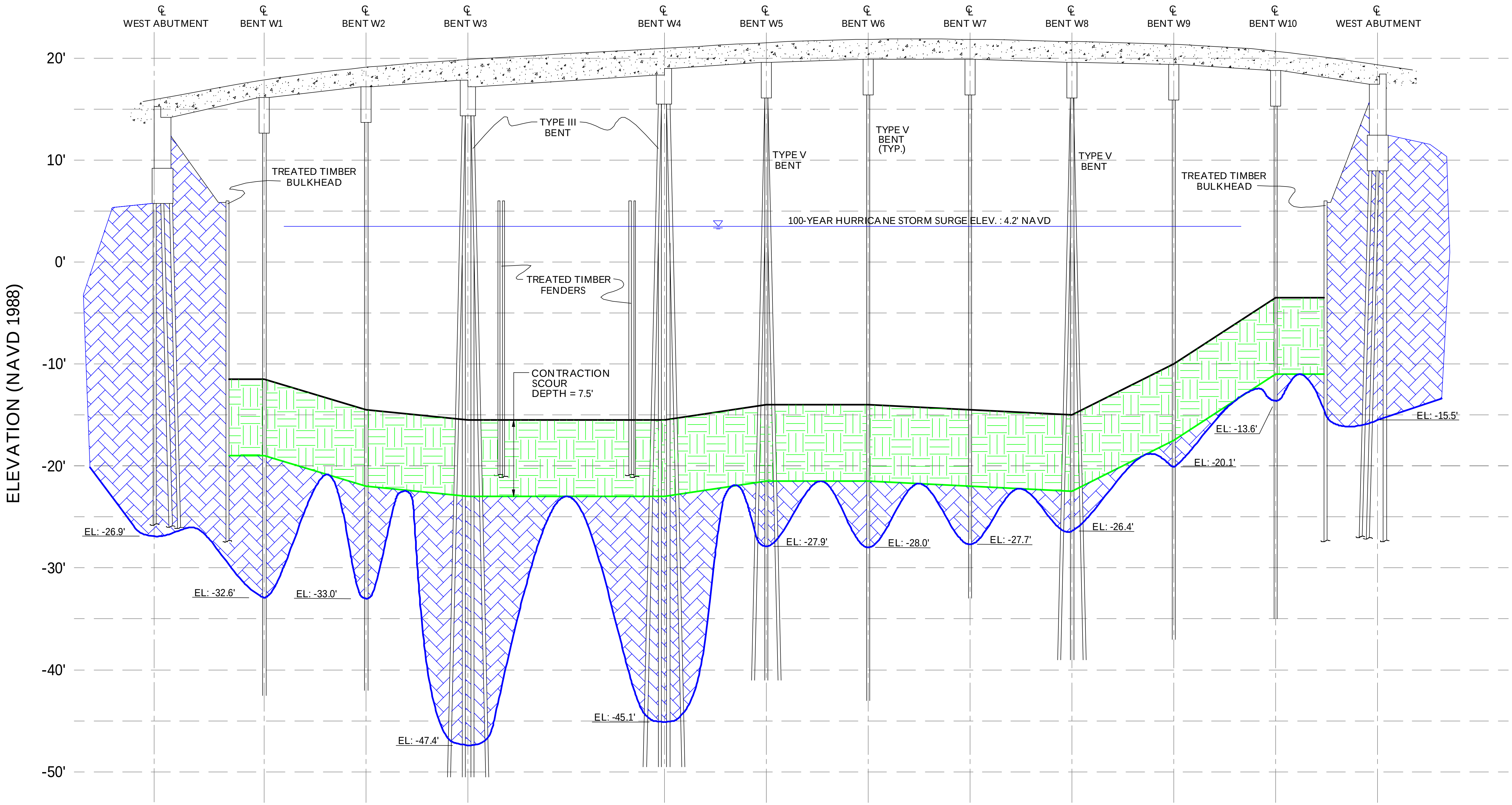
SURVEYED BED ELEVATION
PCA ENGINEERS, JUNE 2015

CONTRACTION SCOUR

LOCAL SCOUR

NOTES: PILE TIP ELEVATIONS FOR BULKHEAD, FENDERS AND ABUTMENTS ARE UNKNOWN AND ASSUMED TO BE SHALLOW.
PILE TIP ELEVATIONS FOR PIERS ARE BASED ON PILE LENGTHS ESTIMATED BY NDT CORPORATION USING SONIC/ULTRASONIC PULSE-ECHO REFLECTION MEASUREMENTS ON REPRESENTATIVE PILES IN JUNE 2014.
PILE DIAMETER ESTIMATED AT 14".
ELEVATIONS OF SCOUR HOLES ARE THE ONLY CALCULATED QUANTITIES
OTHER GEOMETRIC PROPERTIES ARE ESTIMATES (E.G. SIDE SLOPE AND WIDTH).
*SURVEYED CROSS-SECTION IS APPROX. 100' SOUTH OF BRIDGE FASCIA.

New Jersey Department of Transportation	Figure F.4 - 500-year Storm Surge Estimated Scour Elevation and Pile Elevation
CALCULATED SCOUR DEPTHS Structure No.: 1513-153 N.J. Route 72 over West Thorofare and "U" Turn Ocean County, New Jersey	Prepared By: Parsons Brinckerhoff January 2016 Sheet 4 of 6



CROSS-SECTION (LOOKING NORTH)

HORIZONTAL SCALE : 1" = 40'
VERTICAL SCALE : 1" = 10'

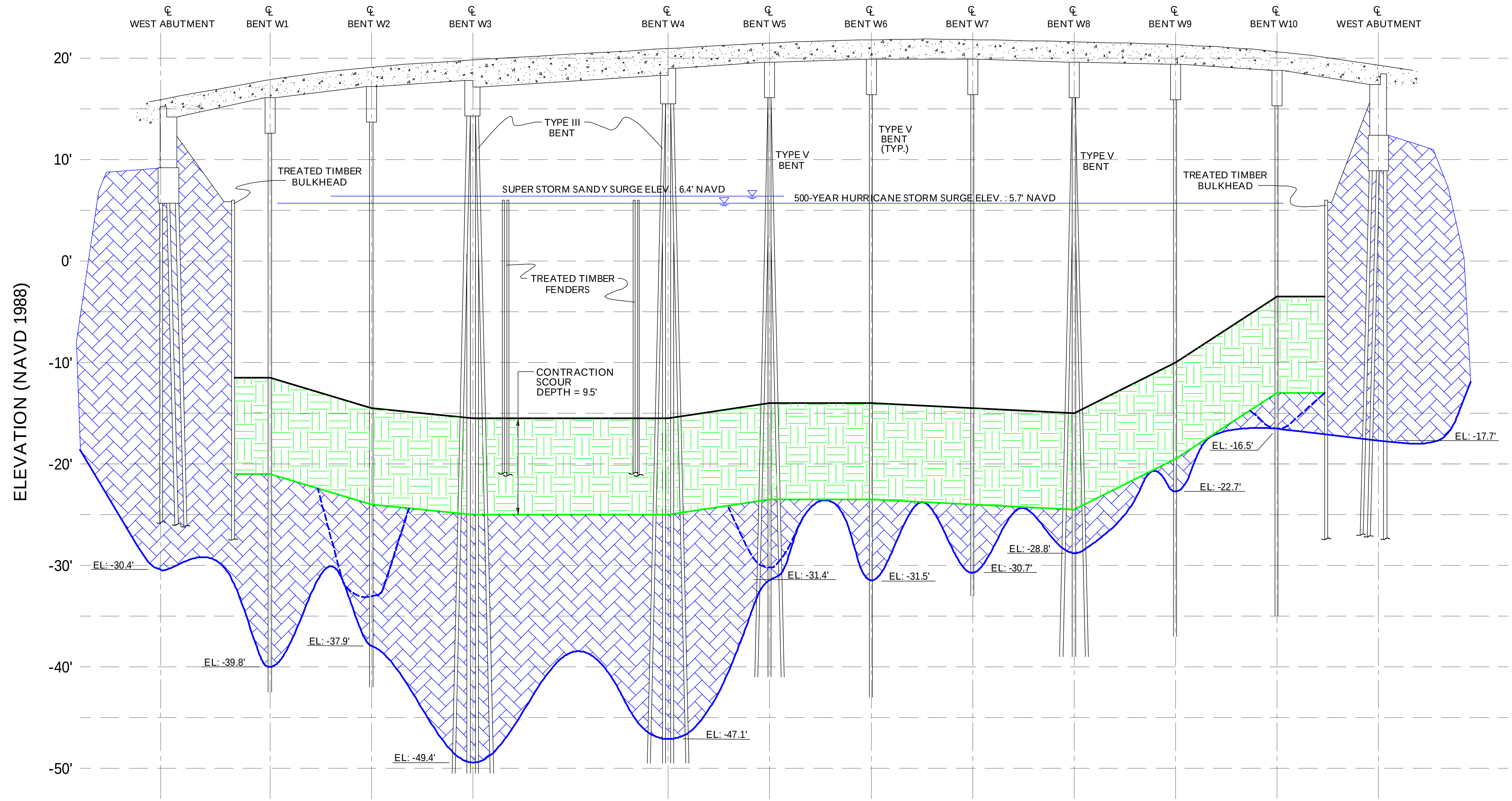
SURVEYED BED ELEVATION*
PCA ENGINEERS, JUNE 2015

CONTRACTION SCOUR

LOCAL SCOUR

NOTES: PILE TIP ELEVATIONS FOR BULKHEAD, FENDERS AND ABUTMENTS ARE UNKNOWN AND ASSUMED TO BE SHALLOW.
PILE TIP ELEVATIONS FOR PIERS ARE BASED ON PILE LENGTHS ESTIMATED BY NDT CORPORATION USING SONIC/ULTRASONIC PULSE-ECHO REFLECTION MEASUREMENTS ON REPRESENTATIVE PILES IN JUNE 2014.
PILE DIAMETER ESTIMATED AT 14".
ELEVATIONS OF SCOUR HOLES ARE THE ONLY CALCULATED QUANTITIES
OTHER GEOMETRIC PROPERTIES ARE ESTIMATES (E.G. SIDE SLOPE AND WIDTH).
*SURVEYED CROSS-SECTION IS APPROX. 100' SOUTH OF BRIDGE FASCIA.

New Jersey Department of Transportation	Figure F.5 - 100-year Storm Surge Estimated Scour Elevation and Pile Elevation
CALCULATED SCOUR DEPTHS Structure No.: 1513-154 N.J. Route 72 over East Thorofare Ocean County, New Jersey	Prepared By: Parsons Brinckerhoff January 2016 Sheet 5 of 6



CROSS-SECTION (LOOKING NORTH)

HORIZONTAL SCALE : 1" = 40'

VERTICAL SCALE : 1" = 10'

SURVEYED BED ELEVATION*
PCA ENGINEERS, JUNE 2015

CONTRACTION SCOUR

LOCAL SCOUR

NOTES: PILE TIP ELEVATIONS FOR BULKHEAD, FENDERS AND ABUTMENTS ARE UNKNOWN AND ASSUMED TO BE SHALLOW.
PILE TIP ELEVATIONS FOR PIERS ARE BASED ON PILE LENGTHS ESTIMATED BY NDT CORPORATION USING SONIC/ULTRASONIC PULSE-ECHO REFLECTION MEASUREMENTS ON REPRESENTATIVE PILES IN JUNE 2014.
PILE DIAMETER ESTIMATED AT 14".
ELEVATIONS OF SCOUR HOLES ARE THE ONLY CALCULATED QUANTITIES
OTHER GEOMETRIC PROPERTIES ARE ESTIMATES (E.G. SIDE SLOPE AND WIDTH).
*SURVEYED CROSS-SECTION IS APPROX. 100' SOUTH OF BRIDGE FASCIA.

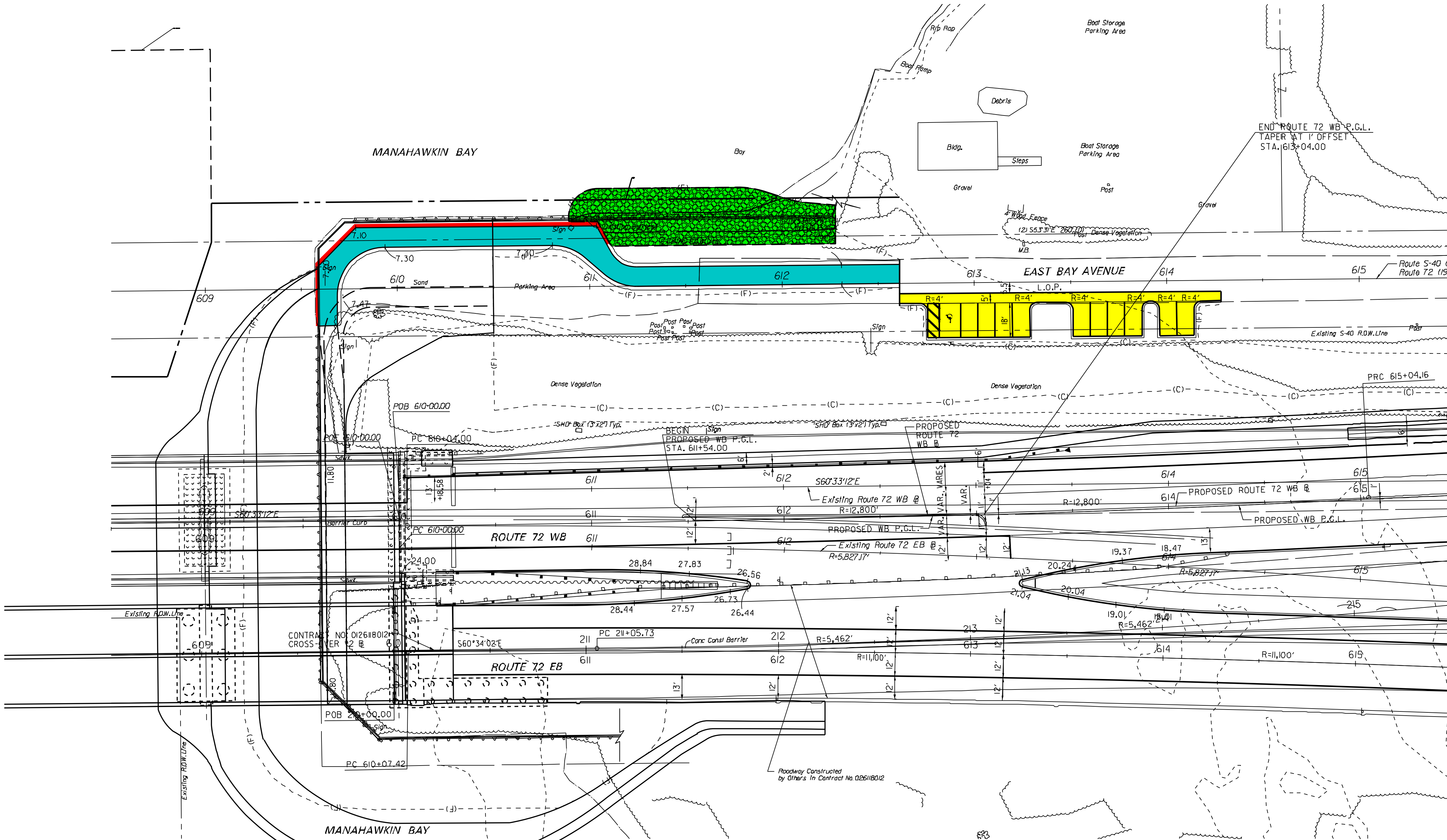
New Jersey Department of Transportation	Figure F.6 - 500-year Storm Surge Estimated Scour Elevation and Pile Elevation
CALCULATED SCOUR DEPTHS Structure No.: 1513-154 N.J. Route 72 over East Thorofare Ocean County, New Jersey	Prepared By: Parsons Brinckerhoff January 2016 Sheet 6 of 6

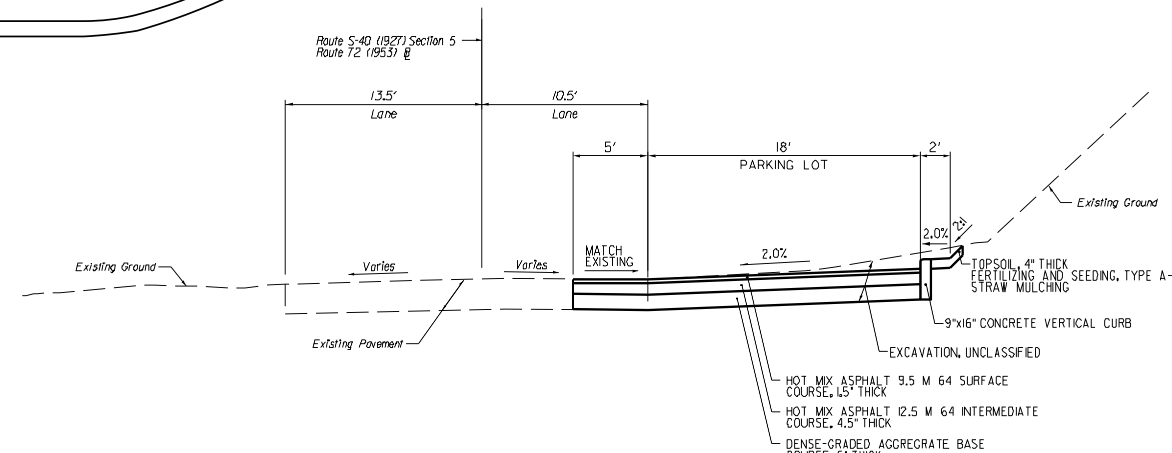
Appendix C:

Preferred Alternatives

STATE	FEDERAL PROJECT NO.
N.J.	NHP-0019(122)

TOWNSHIP OF STAFFORD COUNTY OF OCEAN





PARKING LOT - 3

Route S-40 (1927) Section 5 Route 72 (1953) Sta. 612+61 TO Sta. 614+28

LEGEND:

- PARKING LOT IMPROVEMENTS
- SIDEWALK IMPROVEMENTS
- RIPRAP
- BULKHEAD

SCALE IN FEET
30' 20' 10' 0 30' 60'

EA-1 / EA-3

NEW JERSEY DEPARTMENT OF TRANSPORTATION

PREFERRED ALTERNATIVE
PARKING LOT 3, BULKHEAD AND SIDEWALK

ROUTE 72 MANAHAWKIN BAY BRIDGES

AHORA and ASSOCIATES, P.C.

DAVID HUTCHINSON, P.E.
NEW JERSEY PROFESSIONAL ENGINEER NO. 24GE04001800

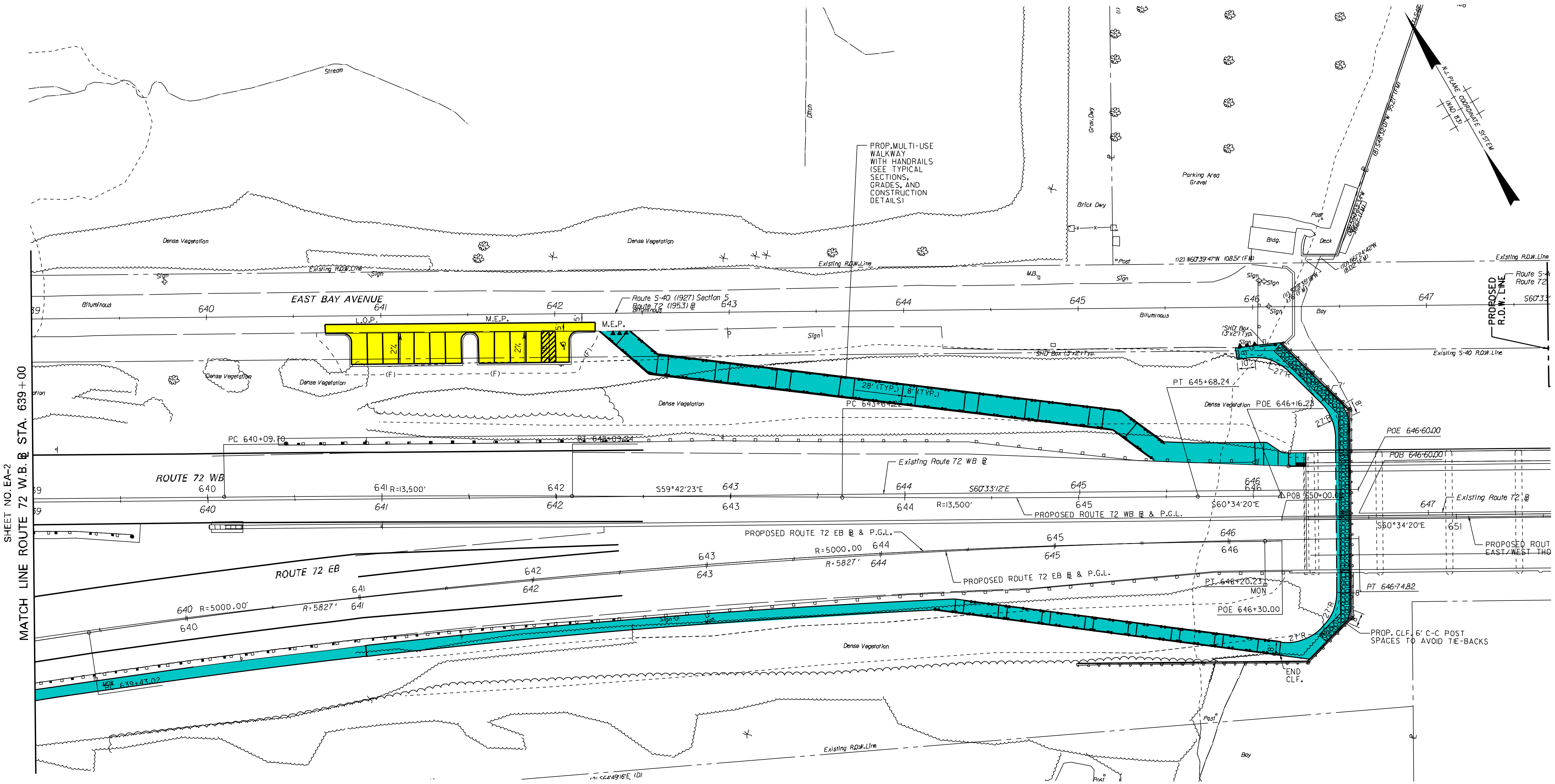
PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029600

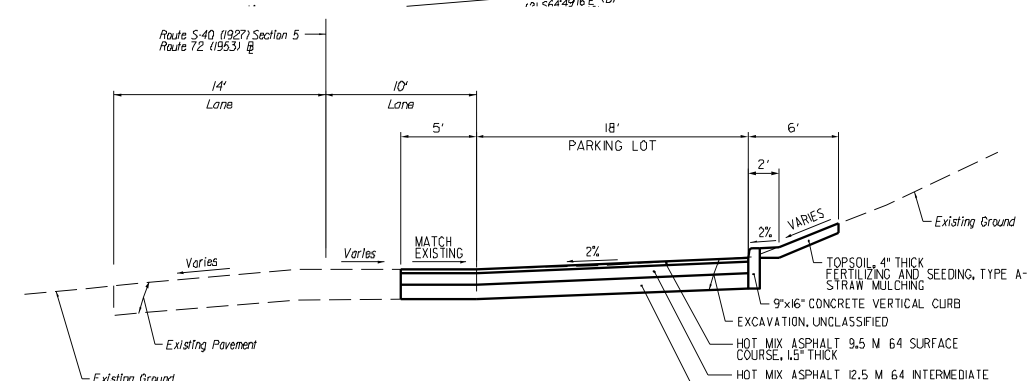
KULDIP SINGH
NEW JERSEY PROFESSIONAL ENGINEER NO. 24GE03877000

PARSONS BRINCKERHOFF, INC. T:\52105 - Route_72_Manahawkin_Bay_Bridges\C4\hwy\received\Arora\2015-11-17\PB_Color_Versions\EA02 ... 2015 ... Runk ecdisplay_V8i.tbl

TOWNSHIP OF STAFFORD COUNTY OF OCEAN

STATE	FEDERAL PROJECT NO.
N.J.	NHP-0019(122)





PARKING LOT - 5

Route S-40 (1927) Section 5 Route 72 (1953) ℄ Sta. 640+68 TO Sta. 642+23

LEGEND:

- PARKING LOT IMPROVEMENTS (yellow)
- SIDEWALK IMPROVEMENTS (teal)

SCALE IN FEET: 30' 20' 10' 0 30' 60'

EA-3

NEW JERSEY DEPARTMENT OF TRANSPORTATION

PREFERRED ALTERNATIVE
PARKING LOT 5 AND SIDEWALK

ROUTE 72 MANAHAWKIN BAY BRIDGES

ARORA and ASSOCIATES, P.C.
DAVID HUTCHINSON, P.E.
NEW JERSEY PROFESSIONAL ENGINEER NO. 24GE04001800

IH ENGINEERS, P.C.
MATTHEW A. BENSCOTER, P.E.
NEW JERSEY PROFESSIONAL ENGINEER NO. 24GE04708600

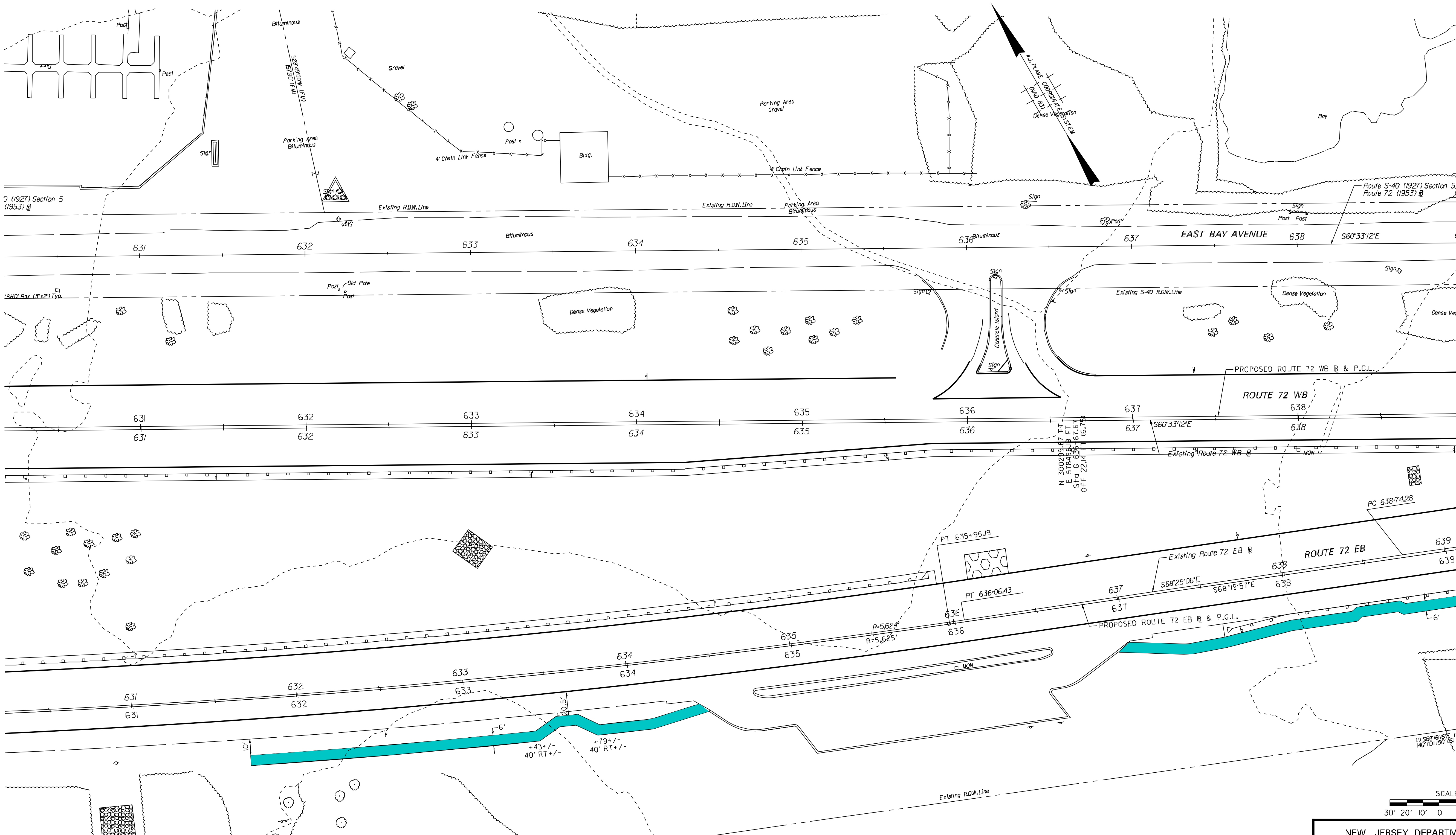
PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029800
KULDIP SINGH
NEW JERSEY PROFESSIONAL ENGINEER NO. 24GE03877000

PARSONS BRINCKERHOFF, INC. T:\52105 - Route_72_Manahawkin_Bay_Bridges\C4\hwy\received\Arora\2015-11-17\PB_Color_Versions\EA03.dgn 2015 13:42 Runk ecdisplay_V8i.tbl

STATE	FEDERAL PROJECT NO.
N.J.	NHP-0019(122)

TOWNSHIP OF STAFFORD

COUNTY OF OCEAN



EA-2
EA-3

LEGEND:

(yellow)	PARKING LOT IMPROVEMENTS
(cyan)	SIDEWALK IMPROVEMENTS

NEW JERSEY DEPARTMENT OF TRANSPORTATION

PREFERRED ALTERNATIVE
PARKING LOT 5 AND SIDEWALK

ROUTE 72 MANAHAWKIN BAY BRIDGES

ARORA and ASSOCIATES, P.C.

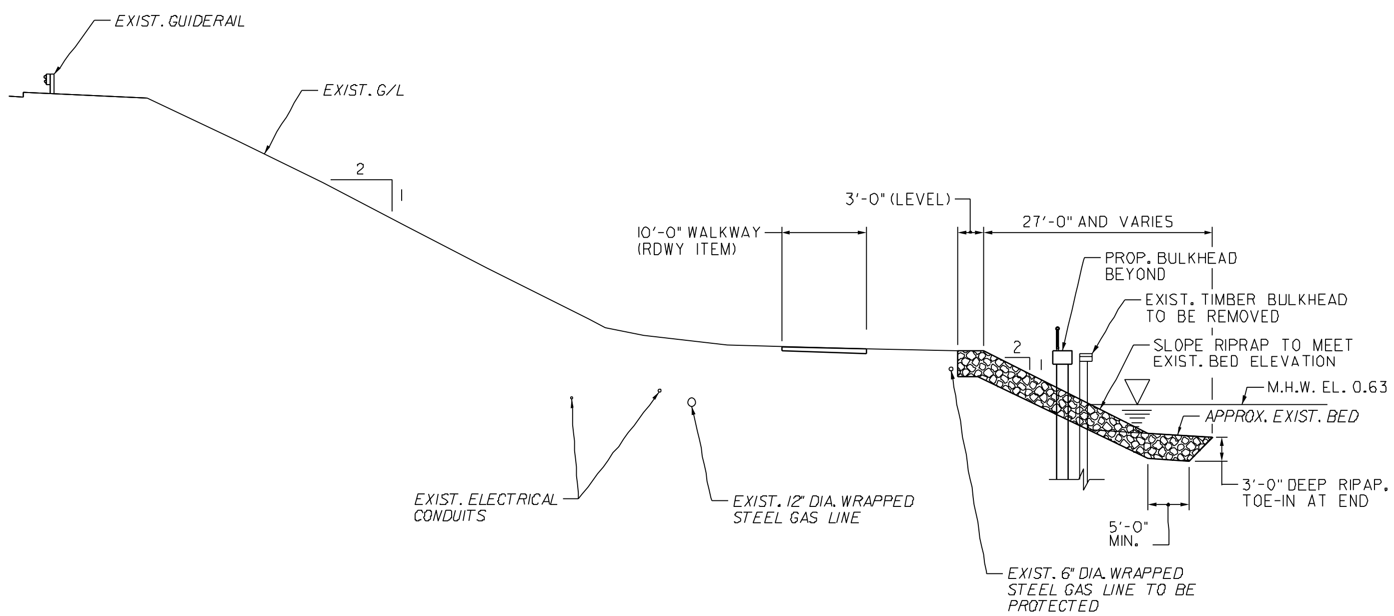
DAVID HUTCHINSON, P.E.
NEW JERSEY PROFESSIONAL ENGINEER NO. 24GE04001800

IH ENGINEERS, P.C.

MATTHEW A. BENSCOTER, P.E.
NEW JERSEY PROFESSIONAL ENGINEER NO. 24GE04708600

PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029600

KULDIP SINGH
NEW JERSEY PROFESSIONAL ENGINEER NO. 24GE03872000



TYPICAL SECTION AT
RIPRAP SLOPE PROTECTION
3/32" = 1'-0"

NEW JERSEY DEPARTMENT OF TRANSPORTATION
BUREAU OF STRUCTURAL ENGINEERING

PREFERRED ALTERNATIVE
PARKING LOT 3, BULKHEAD, & SIDEWALK

ROUTE 72 MANAHAWKIN BAY BRIDGES

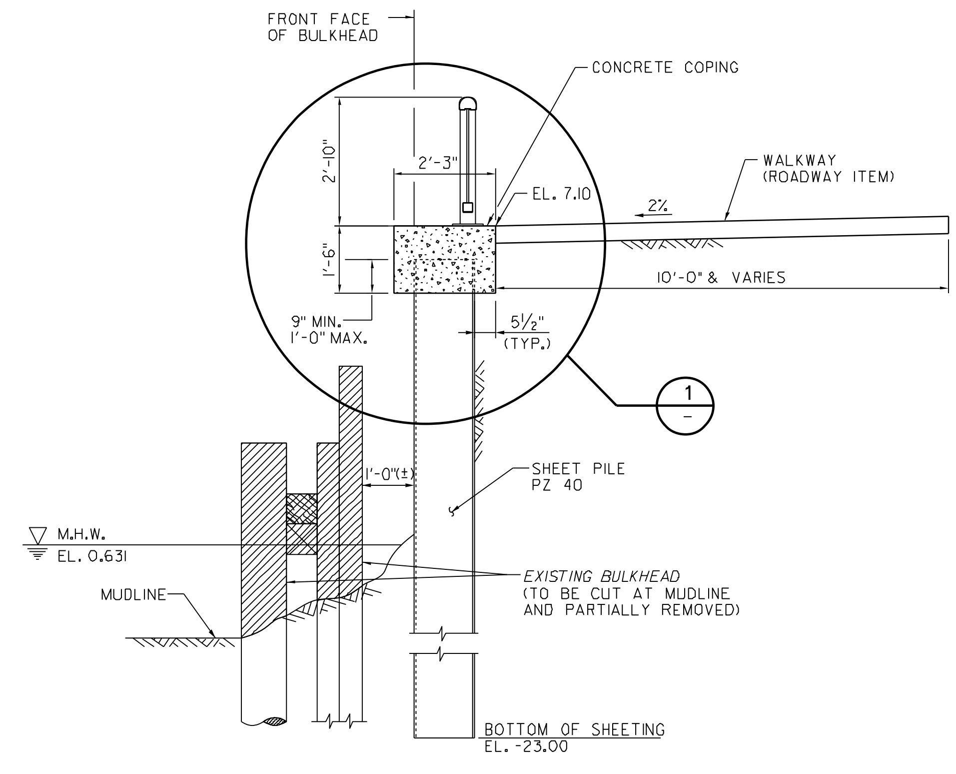
PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029800
JOSEPH VUMBER
NEW JERSEY PROFESSIONAL ENGINEER LICENSE NO. 24GE02593700

SCALE: AS SHOWN
BRIDGE
SHEET NO. ____ OF ____

STATE	FEDERAL PROJECT NO.	SHEET	TOTAL SHEETS
N.J.	NHP-0019(122)		

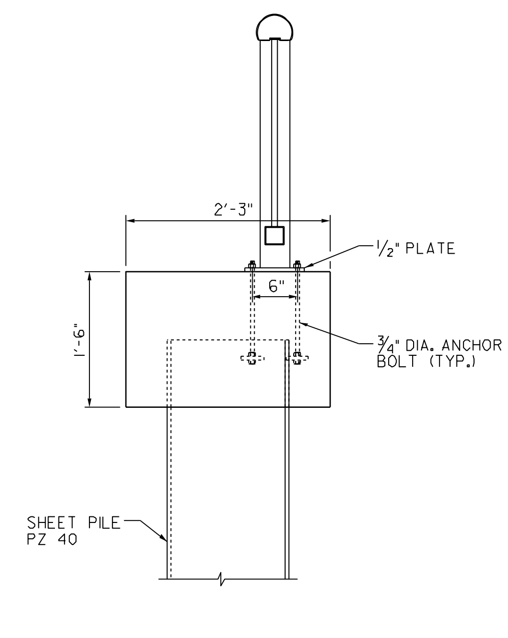
STRUCTURE NO.

NORTHEAST BULKHEAD



CROSS SECTION AT SHEET PILE BULKHEAD

½" = 1'-0"



DETAIL 1
N.T.S.

NOTES:

1. CONTRACTOR TO LEAVE EXISTING BULKHEAD IN PLACE. AFTER NEW BULKHEAD HAS BEEN INSTALLED, CUT EXISTING BULKHEAD OFF AT THE MUDLINE AND ABANDON THE REMAINING PORTION. ALL COSTS TO BE INCLUDED IN "CLEARING SITE, STRUCTURE (BULKHEAD NO 2)".
2. CONTRACTOR IS ALERTED TO THE FACT THAT FALSEWORK FROM ORIGINAL BULKHEAD CONSTRUCTION MAY BE PRESENT. ALL COSTS ASSOCIATED WITH DEMOLISHING OR WORKING AROUND THE FALSEWORK SHALL BE INCLUDED IN THE BID PRICE FOR "CLEARING SITE, STRUCTURE (BULKHEAD NO 2)".
3. CONTRACTOR SHALL EXCAVATE MATERIAL AS NECESSARY TO CUT TIE RODS, IF ANY, ANCHORING THE EXISTING BULKHEAD.
4. STEEL SHEET PILING SHALL RECEIVE COAL TAR EPOXY PAINT IN ACCORDANCE WITH SUBSECTION 511.03.01C.
5. CONTRACTOR SHALL TAKE PRECAUTIONS TO AVOID DAMAGING NEW BULKHEAD DURING CUTTING AND REMOVAL OF OLD BULKHEAD. ANY DAMAGE TO THE NEW BULKHEAD SHALL BE REPAIRED AT NO ADDITIONAL COST TO THE STATE.
6. COORDINATE WITH ATLANTIC CITY ELECTRIC WHEN CONSTRUCTING BULKHEAD IN VICINITY OF ELECTRIC LINES. COST OF CUTTING LINES TO BE INCLUDED UNDER "CLEARING SITE, STRUCTURE (BULKHEAD NO 2)".
7. COORDINATE WITH NEW JERSEY NATURAL GAS WHEN CONSTRUCTING BULKHEAD IN VICINITY OF GAS LINE. EXISTING LINE TO BE REMOVED AND RELOCATED. NEW GAS LINE TO PENETRATE BULKHEAD THROUGH SLEEVE IN SHEETING. CONTRACTOR TO SUBMIT SHOP DRAWINGS FOR PIPE PENETRATION DETAILS AND SLEEVE FOR CERTIFICATION PRIOR TO INSTALLATION. SEE UTILITY PLANS FOR ADDITIONAL GAS RELOCATION DETAILS AND NOTES.

LEGEND:

TO BE REMOVED

1/2" = 1'-0"   1' 0 1' 2' 4'

CONTROL SECTION		JOB NO.
DES. BY		CHK. BY
DWN. BY		
EST. BY		CHK. BY
SPECS. BY		CHK. BY
IN CHARGE OF		

BRIDGE
ARORA AND ASSOCIATES, P.C.
ERIC YERMACK
NEW JERSEY PROFESSIONAL ENGINEER LICENSE NO. 38046

REVISION	BY	CHK.	DATE

NEW JERSEY DEPARTMENT OF TRANSPORTATION
BUREAU OF STRUCTURAL ENGINEERING

PREFERRED ALTERNATIVE NORTHEAST BULKHEAD

ROUTE 72 MANAHAWKIN BAY BRIDGES

PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029800
JOSEPH MUMBER
NEW JERSEY PROFESSIONAL ENGINEER LICENSE NO. 24GE02583700

SCALE: AS SHOWN
BRIDGE SHEET NO. B OF

PARSONS BRINCKERHOFF, INC. \\ararapc.com\shares\Corporate_General\1506\CADD\Str\Br\Change of Plan\BHD15_A4_C4_COPI.dgn 18-NOV-2015 16:24 mmyers 1506_struc_bw.tbl

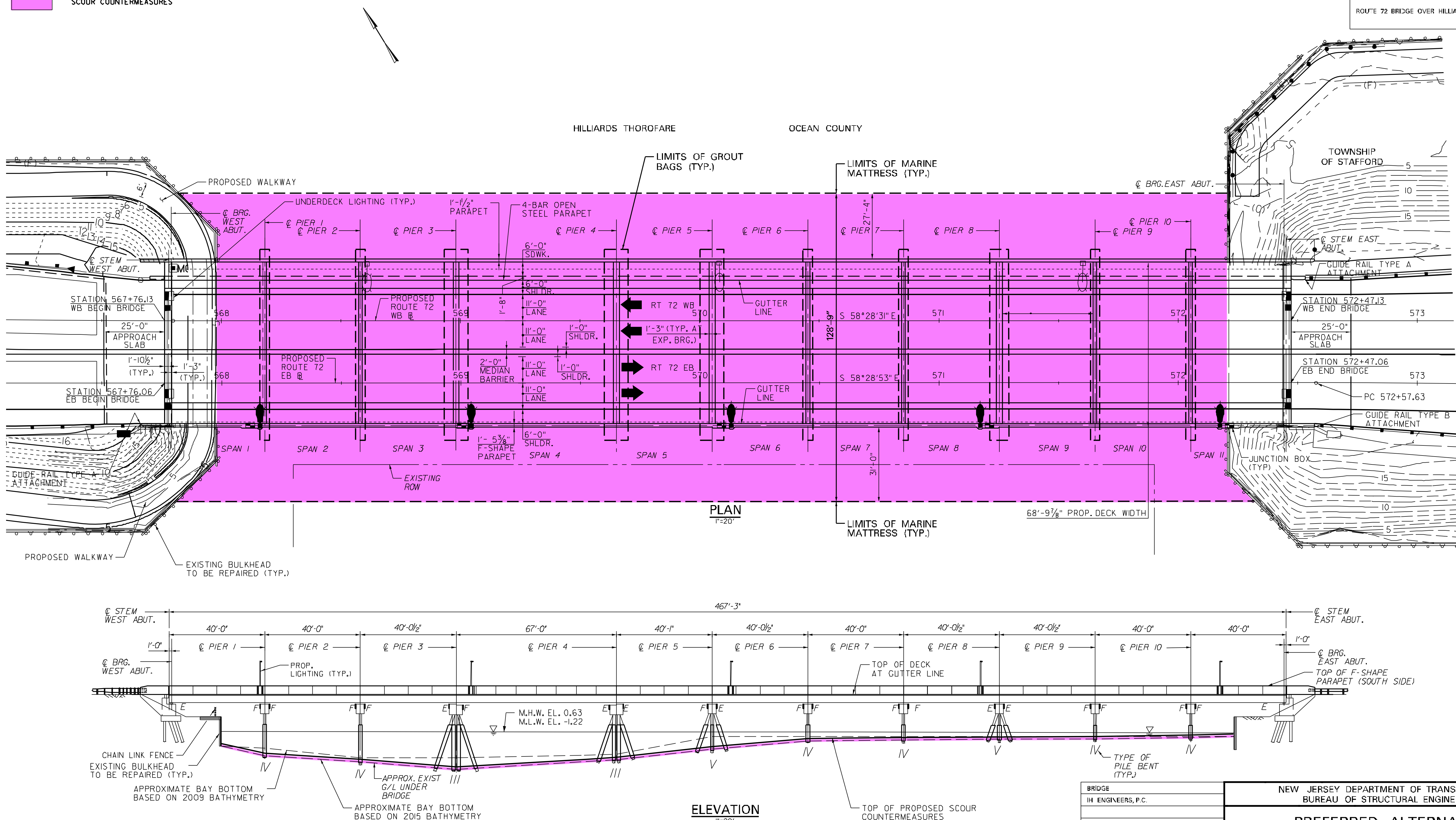
STATE	FEDERAL PROJECT NO.	SHEET	TOTAL SHEETS
N.J.	NHP-0019(122)	268	414

STRUCTURE NO. 1513-151

ROUTE 72 BRIDGE OVER HILLIARDS THOROFARE

LEGEND:

SCOUR COUNTERMEASURES



1" = 20'

BRIDGE
IH ENGINEERS, P.C.
HAMUDUR V. RAHMAN
N.J. PROFESSIONAL ENGINEER LICENSE NO. 24GE04333600

NEW JERSEY DEPARTMENT OF TRANSPORTATION
BUREAU OF STRUCTURAL ENGINEERING

PREFERRED ALTERNATIVE HILLIARDS THOROFARE SCOUR COUNTERMEASURES

ROUTE 72 MANAHAWKIN BAY BRIDGES

PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029600
JOSEPH MUMBER
NEW JERSEY PROFESSIONAL ENGINEER LICENSE NO. 24GE2763700

SCALE: AS SHOWN
BRIDGE SHEET NO. ____ OF ____

REVISION	BY	CHK.	DATE

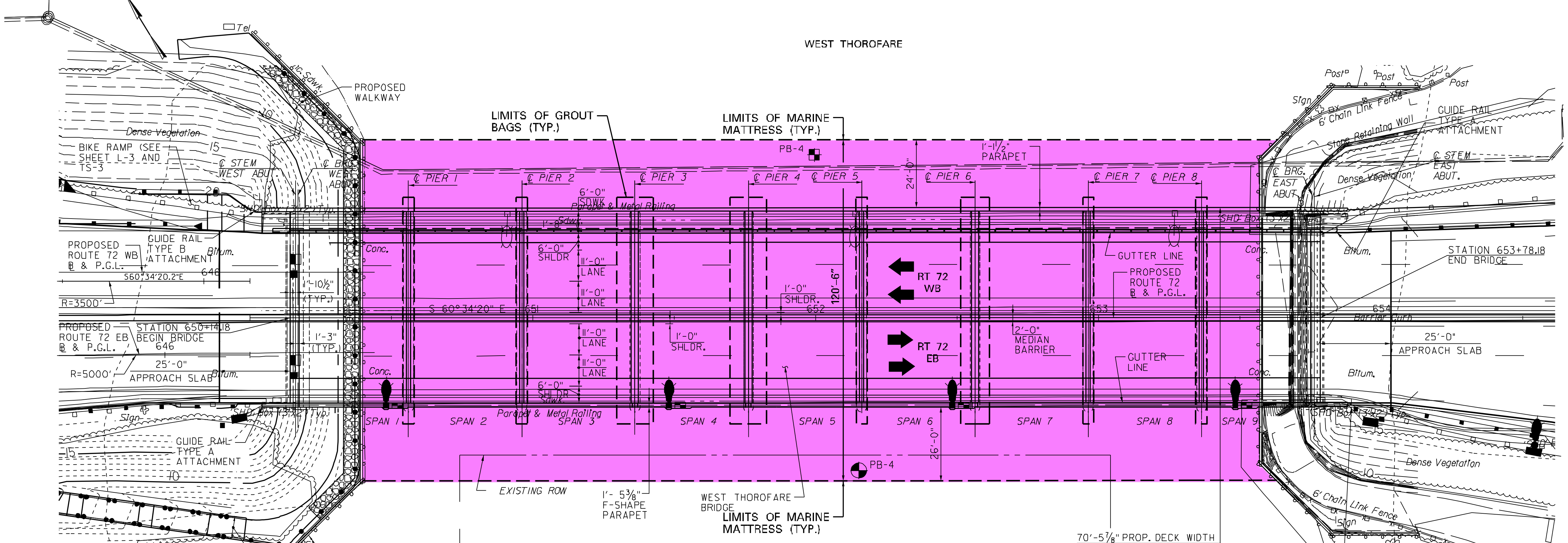
CONTROL SECTION		JOB NO.	
DES. BY	H. RAHMAN	CHK. BY	W.J. CHIOU
DWN. BY	M. PATULOT		
EST. BY	B. KORDZIAN	CHK. BY	Y. WANG
SPECS. BY	H. RAHMAN	CHK. BY	W.J. CHIOU
IN CHARGE OF	WEN-JINN CHIOU		

IH Engineers, P.C.

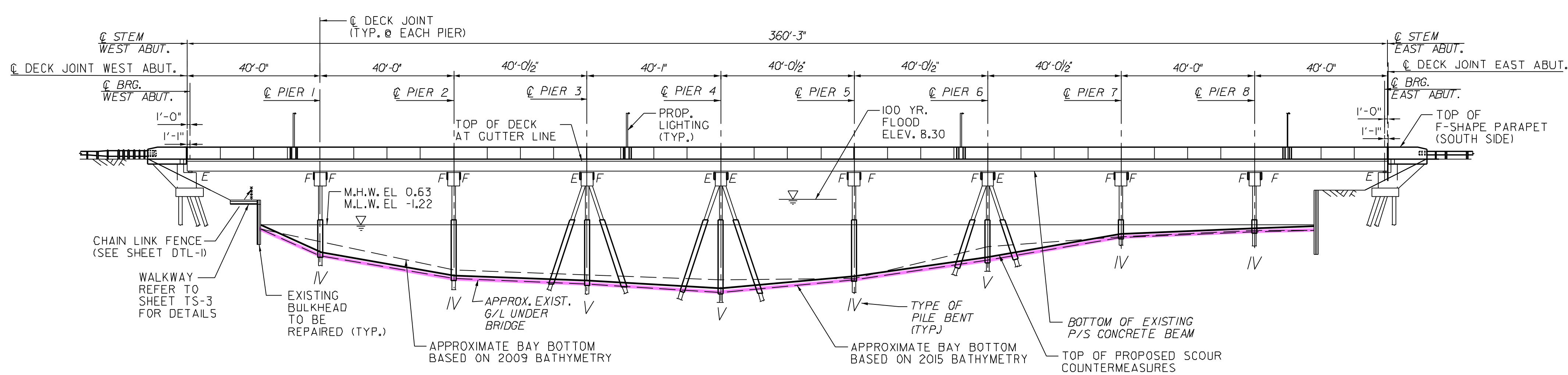
STATE	FEDERAL PROJECT NO.	SHEET	TOTAL SHEETS
N.J.	BR-0019 (114)	106	

STRUCTURE NO. 1513-153

ROUTE 72 BRIDGE OVER WEST THOROFARE



PLAN
1" = 20'



ELEVATION
1" = 20'

LEGEND:

SCOUR COUNTERMEASURES

1" = 20'
20' 10' 0 20' 40'

CONTROL SECTION		JOB NO.	
DES. BY	H. RAHMAN	CHK. BY	W.J. CHIOU
DWN. BY	R. GRILLO		
EST. BY	B. KORDZIAN	CHK. BY	Y. WANG
SPECS. BY	H. RAHMAN	CHK. BY	W.J. CHIOU
IN CHARGE OF	W.J. CHIOU		

BRIDGE
IH ENGINEERS, P.C.
WEN-JINN CHIOU
N.J. PROFESSIONAL ENGINEER LICENSE NO. 24GE04707500

REVISION	BY	CHK.	DATE

NEW JERSEY DEPARTMENT OF TRANSPORTATION
BUREAU OF STRUCTURAL ENGINEERING

PREFERRED ALTERNATIVE WEST THOROFARE SCOUR COUNTERMEASURES

ROUTE 72 MANAHAWKIN BAY BRIDGES

PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029800
JOSEPH MUMBER
NEW JERSEY PROFESSIONAL ENGINEER LICENSE NO. 24GE02593700

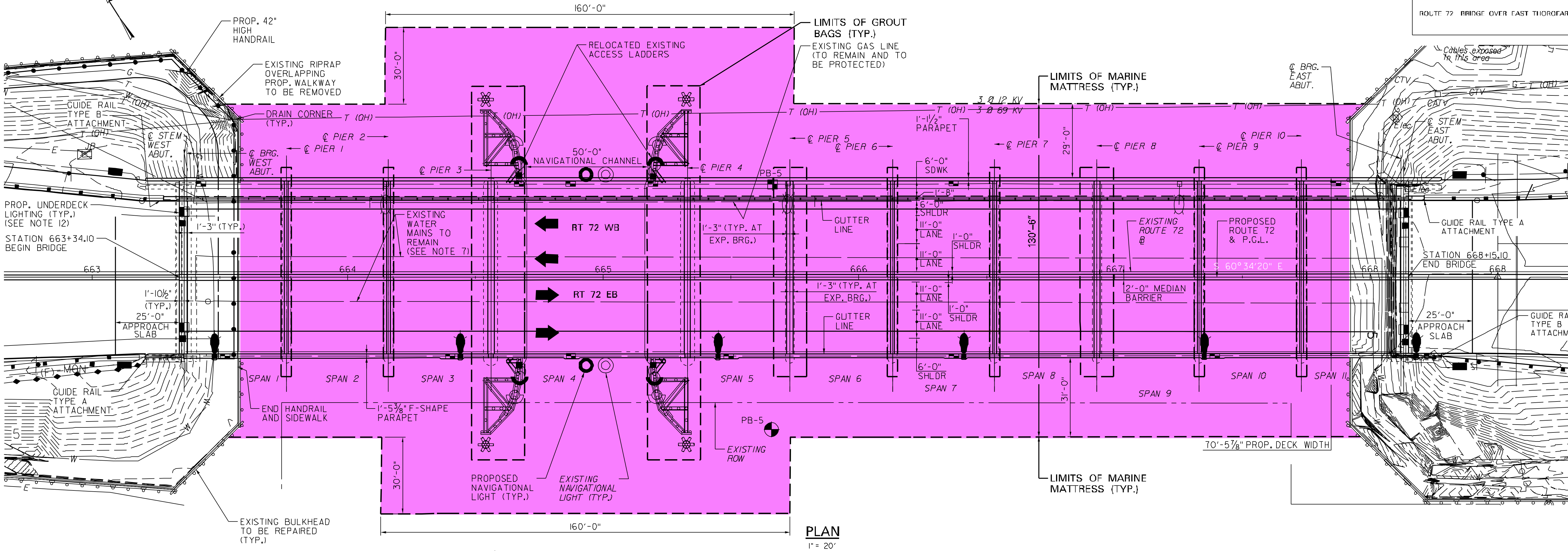
SCALE: AS SHOWN
BRIDGE SHEET NO. ____ OF ____

T:\52105 - Route_72_Manahawkin_Bay_Bridges\ DGN

STATE	FEDERAL PROJECT NO.	SHEET	TOTAL SHEETS
N.J.	BR-0012 (114)	138	

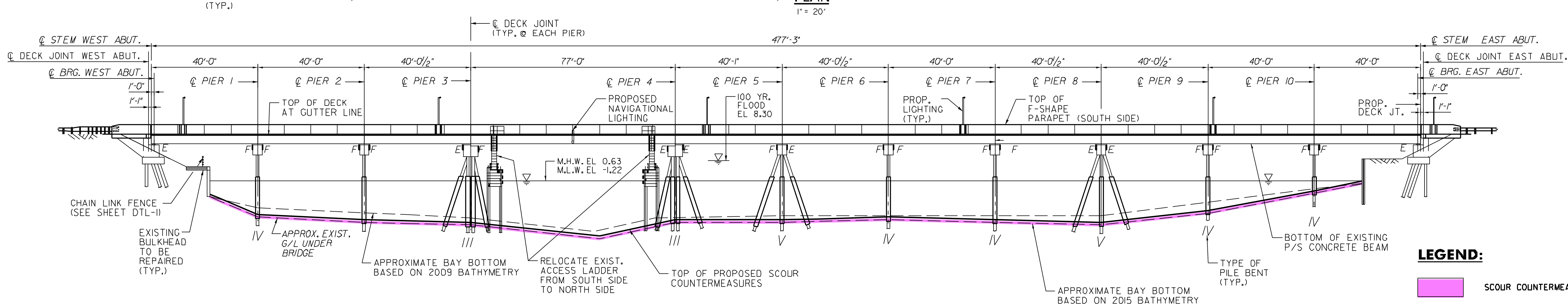
STRUCTURE NO. 1513-154

ROUTE 72 BRIDGE OVER EAST THOROFARE



PLAN

1" = 20'



ELEVATION

1" = 20'

LEGEND:

SCOUR COUNTERMEASURES

1" = 20'

20' 10' 0 20' 40'

CONTROL SECTION		JOB NO.	
DES. BY	H. RAHMAN	CHK. BY	W.J. CHIOU
DWN. BY	R. GRILLO		
EST. BY	B. KORDZIAN	CHK. BY	Y. WANG
SPECS. BY	H. RAHMAN	CHK. BY	W.J. CHIOU
IN CHARGE OF	W.J. CHIOU		

BRIDGE
IH ENGINEERS, P.C.
WEN-JINN CHIOU
N.J. PROFESSIONAL ENGINEER LICENSE NO. 24GE04347500

NEW JERSEY DEPARTMENT OF TRANSPORTATION
BUREAU OF STRUCTURAL ENGINEERING

PREFERRED ALTERNATIVE EAST THOROFARE SCOUR COUNTERMEASURES

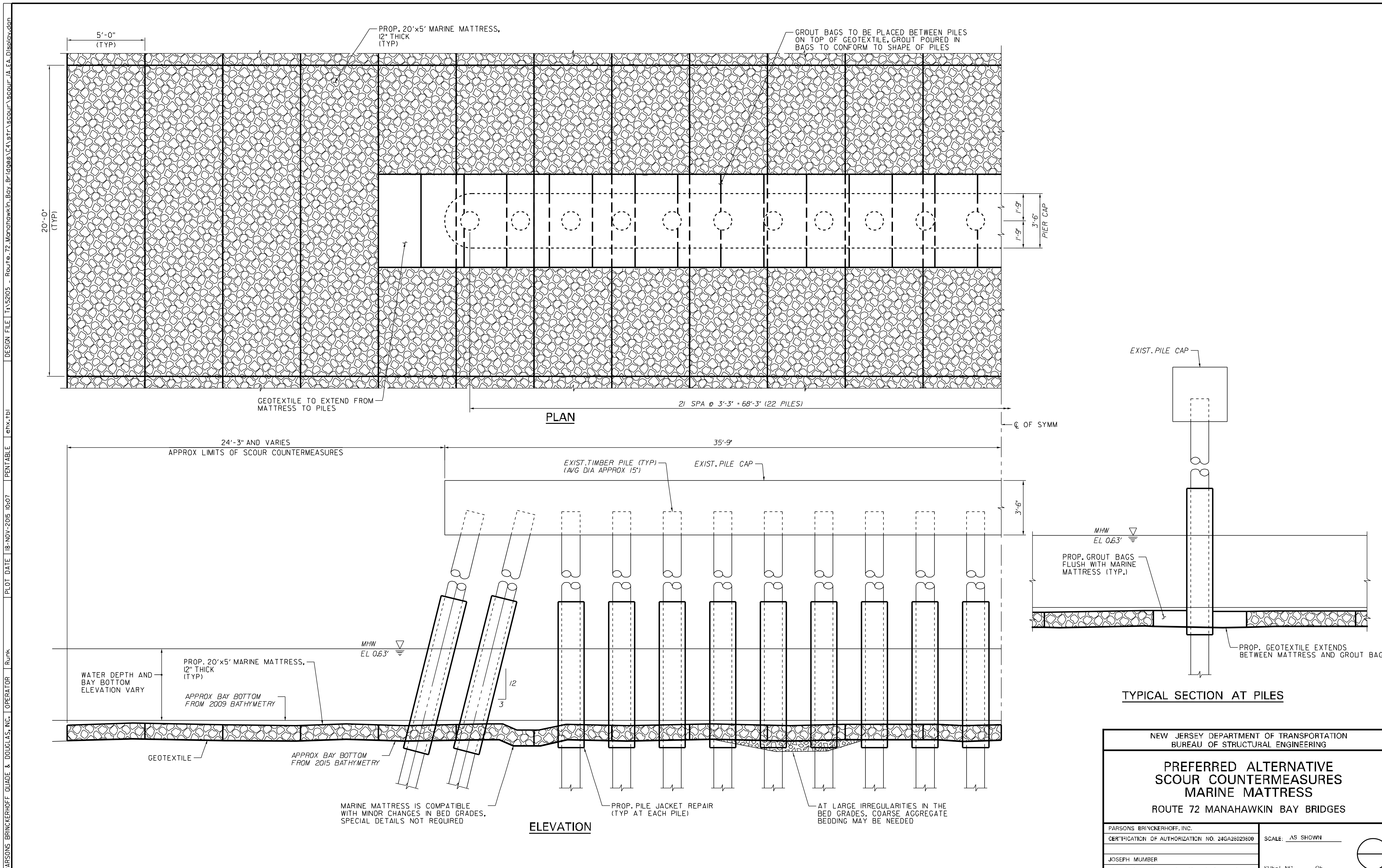
ROUTE 72 MANAHAWKIN BAY BRIDGES

PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029800
JOSEPH VUMBER
N.J. PROFESSIONAL ENGINEER LICENSE NO. 24GE03763700

REVISION	BY	CHK.	DATE

SCALE: AS SHOWN

BRIDGE SHEET NO. ____ OF ____


PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.
OPERATOR Runk
PLOT DATE 18-NOV-2015 10:07
PENTABLE ehx.tbl
DESIGN FILE T:\52105 _ Route_72_Manahawkin_Bay_Bridges\C4\str\scour\scour_IA_EA_Display.dgn
5'-0" (TYP)
PROP. 20'x5' MARINE MATTRESS, 12" THICK (TYP)
GROUT BAGS TO BE PLACED BETWEEN PILES ON TOP OF GEOTEXTILE, GROUT POURED IN BAGS TO CONFORM TO SHAPE OF PILES
20'-0" (TYP)
1'-9"
1'-9"
3'-6" PIER CAP
GEOTEXTILE TO EXTEND FROM MATTRESS TO PILES
21 SPA @ 3'-3" = 68'-3" (22 PILES)
PLAN
℄ OF SYMM
24'-3" AND VARIES
APPROX LIMITS OF SCOUR COUNTERMEASURES
35'-9"
EXIST. TIMBER PILE (TYP) (AVG DIA APPROX 15")
EXIST. PILE CAP
3'-6"
MHW EL 0.63'
WATER DEPTH AND BAY BOTTOM ELEVATION VARY
PROP. 20'x5' MARINE MATTRESS, 12" THICK (TYP)
APPROX BAY BOTTOM FROM 2009 BATHYMETRY
12
3
GEOTEXTILE
APPROX BAY BOTTOM FROM 2015 BATHYMETRY
MARINE MATTRESS IS COMPATIBLE WITH MINOR CHANGES IN BED GRADES, SPECIAL DETAILS NOT REQUIRED
PROP. PILE JACKET REPAIR (TYP AT EACH PILE)
AT LARGE IRREGULARITIES IN THE BED GRADES, COARSE AGGREGATE BEDDING MAY BE NEEDED
ELEVATION
EXIST. PILE CAP
MHW EL 0.63'
PROP. GROUT BAGS FLUSH WITH MARINE MATTRESS (TYP.)
PROP. GEOTEXTILE EXTENDS BETWEEN MATTRESS AND GROUT BAGS
TYPICAL SECTION AT PILES
NEW JERSEY DEPARTMENT OF TRANSPORTATION
BUREAU OF STRUCTURAL ENGINEERING
PREFERRED ALTERNATIVE
SCOUR COUNTERMEASURES
MARINE MATTRESS
ROUTE 72 MANAHAWKIN BAY BRIDGES
PARSONS BRINCKERHOFF, INC.
CERTIFICATION OF AUTHORIZATION NO. 24GA28029800
JOSEPH MUMBER
NEW JERSEY PROFESSIONAL ENGINEER LICENSE NO.
SCALE: AS SHOWN
SHEET NO. ___ OF ___

Appendix D:

Agency Correspondence

Agency	Date
Inter-Agency Meeting Minutes	October 22, 2015
Inter-Agency Meeting Minutes	July 23, 2015
U.S. Department of Commerce, National Oceanic and Atmospheric Administration	December 18, 2015
U.S. Department of Commerce, National Oceanic and Atmospheric Administration	September 29, 2010
NJDEP Natural & Historic Resources, Historic Preservation Office	December 29, 2009
U.S. Department of the Interior, Fish and Wildlife Service, Ecological Service	September 21, 2009

Memorandum of Meeting

Prepared By: Tara Bencivenga, WSP | PB
Date: October 22, 2015, 9:30AM
Project: Route 72 Manahawkin Bay Bridges
Location: NJDOT E&O Conf. Room 3B
Subject: Scour Countermeasures Supplemental Environmental Review

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A meeting was held for the above referenced project on Tuesday, October 20, 2015 at NJDOT. Those in attendance were as follows:

Attendees:

Bruce Hawkinson	NJDOT Environmental
Tina Shutz	NJDOT Environmental
Joseph Sweger	NJDOT Environmental
Aasti Gupta	NJDOT Environmental
Brendan Brock	NJDOT Office of Maritime Resources
Shaun O'Hanlan	FHWA
Tony Sabidussi	FHWA
Mike Hayduk	USACE
Karen Greene	NOAA Fisheries
Steve Mars	USFWS
Steven Balzano	WSP | Parsons Brinckerhoff
Steve Esposito	WSP | Parsons Brinckerhoff
Anthony Suleski	WSP | Parsons Brinckerhoff
Tara Bencivenga	WSP | Parsons Brinckerhoff

Purpose:

The purpose of this meeting was to review the Proposed Alternatives for the Route 72 Scour Countermeasures and Public Access/Waterfront Improvements to be included in an Addendum to the 2011 Environmental Assessment.

I. Withdrawal of Pump Station

Design would lag progression on EA Approvals for scour countermeasures and has been withdrawn from further consideration at this time until design revisions can be further developed and vetted through municipal officials/regulatory agencies.

II. Scour Protection

1. Purpose and Need
   - Provide Protection to existing Thorofare Bridges to protect against future scour events
   - Provide Scour Protection by December 31st, 2016 to address FHWA conditions
   - Current Design Code Requirements designate bridges as scour critical
   - FHWA asked for clarification on what had changed since the last EA to make the bridges now scour critical
     - **i.** Localized scour conditions
     - **ii.** Damage from Hurricane Sandy
     - **iii.** As a result of items i and ii above, a more refined analysis was performed in accordance with the revised and updated Design Code Requirements
2. Scour Protection Alternatives: Alternative 1- Bridge Rehabilitation with Scour Countermeasures
   - Design Alternatives

- Riprap- 12” stones that rest upon a coarse aggregate bedding layer, for 4’-6” of protection
  - **i.** Pros: simplest, most traditional method
  - **ii.** Cons: substantial fill within waterway attributing to environmental impacts; excavation required, which would jeopardize stability of trestle piles; considered “temporary” and requires continual monitoring
- A-Jacks- Tetrahedral shaped concrete armor units that interlock into a flexible, permeable matrix, providing 16 inches of protection above the bedding layer.
  - **i.** Pros: Moderate subgrade preparation, reduces environmental impacts, utilizes resilient concrete elements
  - **ii.** Cons: change in bay bottom elevation may result in navigational impacts; still requires some riprap installation at piles
- Articulated Concrete Block Mattress- low profile, hard armoring composed of preformed concrete blocks that interconnect through a combination of forms and/or cables to act as a method of ground stabilization.
  - **i.** Pros: lowest profile protection, minor flexibility as system can conform to minor changes in subgrade
  - **ii.** Cons: a smooth subgrade is required to perform as designed, so extensive subgrade preparation is required; perimeter edges must be anchored by excavating a trench and burying with riprap; riprap still required at pile bents
- Marine Mattress with Riprap- low profile armoring alternative with total depths ranging between 6-12”, consists of stone filled geogrids made from high strength plastic materials
  - **i.** Pros: creates a large stable and protective mass during scour events; very flexible, reducing the in-water preparation of the subgrade; additional bedding layers are not required, thus reducing in-water preparation
  - **ii.** Cons: Riprap required between piles
- Marine Mattress with Grout Bags - low profile armoring with total depths ranging between 6-12 inches; consists of stone filled geogrids made from high strength plastic materials
  - **i.** Pros: Avoids the need for placement of riprap and generally maintains the 2009 bay bottom elevation

3. Preferred Alternative for Scour Countermeasure Design
   - Marine Mattress with Grout Bag
     - **i.** Achieves desired scour protection
     - **ii.** Reduces discharge of fill to waters (less than riprap alternative)
     - **iii.** Generally maintains 2009 bottom contour elevation
     - **iv.** Avoids in-water excavation
4. Alternative 2: Bridge Replacement
   - Key Issues
     - **i.** Adds cost
     - **ii.** May result in residential and business displacement to address temporary construction access requirements
     - **iii.** Temporary construction access requires relocation of major electric and gas transmission lines
   - Design Alternatives
     - **i.** Staged construction would require temporary trestle bridge installation
   - Duration
     - **i.** 8 years to accommodate design, approvals and construction of bridge
     - **ii.** Bridges would remain scour critical throughout duration of 8 years and as such does not meet purpose and need
5. Alternative 3: Bridge Replacement with Interim Scour Countermeasures

- Same issues as Alternative 2, but includes interim scour protection prior to bridge replacement to satisfy FHWA conditions

6. Environmental Impact Comparison
    - Alternative 1: Bridge Rehabilitation with Scour Countermeasures
        - **i.** No impacts to freshwater wetlands, wetland transition area, coastal wetlands, or riparian buffers
        - **ii.** Shellfish Habitat Impacts= 0.19ac
        - **iii.** Intertidal/Subtidal Shallows Impacts= 1.15ac
        - **iv.** SAV Habitat Impacts= 3.24ac
        - **v.** Delineated SAV Impacts= 0.01ac
    - Alternative 2: Bridge Replacement
        - **i.** Wetland Transition Area Impacts= 0.08ac
        - **ii.** Riparian Buffer Impacts= 0.74ac
        - **iii.** Shellfish Habitat Impacts= 0.38ac
        - **iv.** Intertidal/Subtidal Shallows Impacts= 1.3ac
        - **v.** SAV Habitat Impacts= 2.92ac
        - **vi.** Delineated SAV Impacts= 0.02ac
    - Alternative 3: Bridge Replacement with Interim Scour Countermeasures
        - **i.** Sum of impacts from both alternatives
7. Other Environmental Considerations
    - Protected Species- Marine Turtles and Atlantic Sturgeon
        - **i.** Alternative 1 reduces duration of in-water construction and avoids pile installation
    - Essential Fish Habitat
        - **i.** No in-water work from January through July
        - **ii.** Alternative 2 minimizes impacts to SAV Habitat but does not satisfy Purpose and Need
    - Socio-Economic Considerations
        - **i.** Alternative 1 avoids residential displacement and disruption to traffic/business
    - Utilities
        - **i.** Alternative 1 avoids conflicts with major utilities
8. Cost Considerations
    - Alternative 1 provides the most cost effective solution
        - **i.** $31,000,000 initial construction cost
        - **ii.** $122,753,000 life cycle cost

III. <u>Public Waterfront Access Improvements</u>

1. Alternatives
    - Alternative 1: Modify Parking Lot 3 and 5 to include Bulkhead Rehabilitation (Parking Lot 3 only) and address community concerns
    - No Action Alternative: Maintain approved design
2. Purpose and Need
    - Provide ADA compliant public access to the waterfront
    - Address public comments opposing location of Parking Lot 5
    - Rehabilitate deteriorated Bulkhead on North East quadrant of Parking Lot 3
    - Comply with permit conditions to provide waterfront access improvements as part of the project
3. Alternative 1: Parking Lot 3
    - Introduces riprap due to conflicts with sewer utilities that precludes extension of the sheet piling for the full extent of the existing bulkhead

- Proposed bulkhead is landward of the existing bulkhead, with the existing bulkhead to be cut at the mudline

4. Alternative 1: Parking Lot 5
    - Relocation of Parking Lot 5 due to public opposition
5. Environmental Consequences
    - Alternative 1 Impacts
        - **i.** No impacts to Shellfish Habitat, Delineated SAV, Freshwater Wetland, or Coastal Wetland
        - **ii.** Intertidal/Subtidal Shallows Impacts= 0.04ac
        - **iii.** SAV Habitat Impacts= 0.04ac
        - **iv.** Wetland Transition Area Impacts= 0.11ac
        - **v.** Riparian Buffer Impacts= 0.41ac
    - No Action Alternative
        - **i.** No impacts to Shellfish Habitat, Intertidal/Subtidal Shallows, SAV Habitat, Delineated SAV, Freshwater Wetland, or Coastal Wetland
        - **ii.** Wetland Transition Area Impacts= 0.10ac
        - **iii.** Riparian Buffer Impacts= 0.31ac
6. Preferred Alternative: Alternative 1
    - Improves ADA compliant access to waterfront and public safety
    - Minimizes environmental impacts
    - Provides rehabilitation of existing bulkhead
    - Addresses public comment

IV. <u>Comments</u>

a. Karen Greene, NOAA, suggested that she may not consider area under trestle bridges as EFH due to scouring
- **i.** Turbidity measures may be needed, but there may not be a need for timing restrictions for winter flounder
- **ii.** Removal of Timing Restrictions would allow work to continue into January/February
- **iii.** Suggested utilizing the EFH Worksheet to facilitate review of EA document

b. <u>No exceptions were taken to the installation of the recommended scour countermeasures consisting of marine mattresses and grout bags.</u>

c. Steve Mars, USFWS, posed concern over extent of riprap proposed at Parking Lot 3 and requested that PB look into other options

Additional Mitigation consistent with prior permit authorization will be required for Shellfish, Wetlands/Riparian Buffers and Intertidal/Subtidal Shallows and can be addressed during permit review

V. <u>Next Steps</u>

a. EA Addendum will advance review of the preferred alternatives presented
- **i.** Document review and agency consultation will be done concurrently
- **ii.** Anticipate distribution of EA mid-December with close of comments by end of January
- **iii.** Agencies were agreeable to schedule

Memorandum of Meeting

Prepared By:	Tara Bencivenga, WSP | PB
Date:	July 23, 2015 9:30 AM
Project:	Route 72 Manahawkin Bay Bridges
Location:	NJDOT E&O Conf. Room 3B
Subject:	Contract 4 Status and Scour Protection Supplemental Environmental Review

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A meeting was held for the above referenced project on Thursday, July 23, 2014 at NJDOT. Those in attendance were as follows:

Attendees:

Bruce Hawkinson	NJDOT Environmental
Tina Shutz	NJDOT Environmental
Joseph Sweger	NJDOT Environmental
Brenna Fairfax	NJDOT Environmental
Paula Scelsi	NJDOT Environmental
Zack Asadpour	NJDOT Environmental
Charlie Welch	NJDEP Landuse
Shaun O'Hanlan	FHWA
Tony Sabidussi	FHWA
Sam Reynolds	USACE
Mike Hayduk	USACE
Karen Greene	NOAA Fisheries
Jennifer Goebel	NOAA Fisheries
Meghan Myers	Arora and Associates, PC
Steve Balzano	WSP | Parsons Brinckerhoff
Mike Folli	WSP | Parsons Brinckerhoff
Steve Esposito	WSP | Parsons Brinckerhoff
Darren Delenick	WSP | Parsons Brinckerhoff
Tara Bencivenga	WSP | Parsons Brinckerhoff

Purpose:

The purpose of this meeting was to review the status of regulated activities to be included in Contract 4 that were not previously approved; as well as to discuss the scope of upcoming design changes to accommodate scour protection at the three Thorofare Bridges requiring Supplemental Environmental Review (EA) and subsequent permit authorization.

I. Contract 4: Items of Discussion

1. **Items not included in current approved plans but suggested to include for Contract 4 Bid Documents**:
   - Temporary Construction Access on each side of temporary trestle
     - Temporary sheeting piles for West Trestle
     - Riparian Zone Impact: loss of trees will be re-planted; however will be considered "permanent impact"
       - Charlie Welch concluded this may be covered in a Field Change
   - Utility Relocation
     - There is a gas utility line that runs along the Manmade Island north of Route 72 and crosses through the Manmade Island north bulkhead, which is being replaced. As part of

the bulkhead replacement, the gas line will need to be disconnected, realigned at the bulkhead, and then reconnected. This activity will require the installation of a cofferdam, which will result in about 100sqft of temporary impact to IT/STS, Mapped SAV, and Tidal State Open Waters.
    - Utility company requested a 10'x10' working area, so the cofferdam limits would need to be outside of that
    - Charlie Welch concluded this may be covered in a Field Change as it poses no real issues

- Turtle Fencing
  - Turtle fence installation will be installed at the existing wetland line, to be retained within DOT ROW. The type of turtle fence is to be determined.
    - Charlie Welch concluded this may be covered in a Notification of Change of Plans

2. **Pier (Spall) Repair Requirements**
   - Installation of a Temporary Cofferdam
     - The cofferdam limits will not modify the existing LOD line. The contractor will determine the method of installation and we will need to accommodate. Repairs will vary from pier to pier.
   - USACOE considers this a new regulated element that will need to be covered under a Change of Plan requiring a Permit Modification
   - Charlie Welch (NJDEP) stated that we may attach this to Contract 4 as a Permit Mod

3. **Peregrine Falcon Protection Measures**
   - Peregrine Falcon pair nested on Pier 7 of the existing bridge during 2015 nesting season. Proposing temporary nest box to be located on Pier 7 of the new structure for the 2016-2018 nesting season. Temporary nest box will require a 300ft work restriction zone active from February 15 to July 31st of each nesting season. The restriction zone and time frame will not conflict with overall project completion date.
   - Beginning the 2019 nesting season a permanent nest box will be installed on Pier 8 of the existing structure. The ladder system on Pier 8 is suggested to be maintained as so to provide suitable access to the nest for banding purposes.

II. Supplemental Environmental Assessment: Items of Discussion

1. **Scour Protection Measures**
   - The three trestle bridges; Hilliards Thorofare, West Throrfare, and East Thorofare., are scour-critical based on recent analyses performed. The need for protection has also been validated by the recent scour hole at West Thorofare which was fixed as part of a priority repair at the end of last year/start of this year.
   - Several design alternatives were presented, including the replacement of the three bridges, rip-rap installed above and below grade elevation, a-jacks installed above and below grade elevation, articulated concrete block mattress, and marine mattress installed at grade elevation.
   - The recommended alternative for scour protection is a low level (12" thick) mattress filled with stones. This product is preferred to reduce or eliminate excavation to the extent possible and for its benefits for constructability concerns within the project constraints. The use of this product needs to be approved by NJDOT and FHWA SME's (subsequent to the meeting, NJDOT's approval has been obtained and FHWA's resolution is still pending).

- Due to the tight spacing of the piles at the piers, riprap will need to be placed at locations where other countermeasures will not fit or could result in damage to the piles. It is likely that the riprap will need to be built thicker than the general countermeasure product.
- It was noted that on average, the bay bottom elevations at these structures are approximately 1.75' lower now (based on a survey performed earlier this year) than they were at the onset of design (based on a survey performed in 2009). There are, however, locations where the current bed elevations are above the previously reported elevations.
- Due to the short spans, the spacing of the piers, and the magnitude of contraction scour, it is expected that the entire length of each bridge will need to receive scour countermeasure protection.
- Existing Environmental Conditions within Project Limits:
    - IT/STS: additional impacts are anticipated to address scour protection. There is sufficient surplus mitigation on CBI to address the additional impact
    - SAV Habitat: additional impacts to SAV mapped habitat are anticipated resulting from scour protection but minimal impacts to actual delineated SAV beds are anticipated; any additional mitigation requirements would be addressed in SAV mitigation plan
    - Shellfish: only mapped within West Thorofare. Additional impacts would require monetary contribution
    - Karen Greene (NOAA) stated that she does not consider the three thorofares as essential fish habitat due to localized scouring. Construction activity may require turbidity barriers.
- Charlie Welch indicated this activity may not need a new permit from NJDEP
    - He will refer to NOAA to approve Scour Countermeasure Alternative

2. Public Access

- Revisions to Parking Lots #3 and #5 will deviate from the approved plans.
- Parking Lot #3
    - Originally designed against the bulkhead at the northeast corner of the existing Bay Bridge, the parking lot is proposed to be relocated due to the condition of the existing bulkhead.
    - The bulkhead would be reconstructed under this proposal to provide improved public access to the waterfront at this location
- Parking Lot #5
    - This parking lot is being moved following dispute from local business owners. The new plans will also include minor modification to the proposed sidewalk to provide better pedestrian access
- NE Bulkhead Reconstruction
    - The bulkhead at the NE corner of the existing Bay Bridge is severely deteriorated and is now proposed to be replaced. It is expected that much of the replacement will match what was previously approved for the north bulkhead on the Manmade Island to the west of the Bay Bridges.
    - A parapet and rail system is proposed to be installed along the shoreline above the bulkhead in order to create a public access space for fishing.
    - The bulkhead replacement will include some utility relocation, similar to the Manmade Island bulkhead replacement,.
    - Karen Greene asked if we looked into a soft-shoreline approach for the bulkhead repair. This is not possible due to the limited space available, existing utility lines and the need to maintain public access.

3. Drainage

- There is currently an on-going discussion with Ship Bottom officials whether to eliminate the pump station on Long Beach Island. An alternative to the pump station is utilizing a gravity based drainage system, with either 1 or 2 outfall locations. The 1-outfall system is currently in the approved design. The 2-outfall system would be located north of the bridge where the existing outfall is located. Both alternatives are still undergoing analysis.
- Karen Greene expressed concern whether the location of the outfall would permanently impact SAV habitat.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

DEC 18 [illegible]

Bruce Hawkinson
State of New Jersey
Department of Transportation
P.O. Box 600
Trenton, New Jersey 08625-0600

Re: Rt 72 Manahawkin Bay Bridge

Dear Mr. Hawkinson,

In correspondence dated April 1, 2011, we were informed that the New Jersey Department of Transportation (NJDOT) was designated by the Federal Highway Administration as the non-federal representative for the proposed replacement of the Route 72 Manahawkin Bay Bridge, Ocean County, New Jersey. On October 21, 2011 we received your initial request for consultation in accordance with section 7 of the Endangered Species Act (ESA). Coordination between both our agencies has been ongoing since this time in order to address our requests for additional information. In addition, during this time, however, five distinct population segments (DPSs) of Atlantic sturgeon were listed as threatened or endangered (see below; 77 FR 5880; 77 FR 5914; February 6, 2012). On February 22, 2012, you notified us of your intent to send a revised request for consultation that also considered Atlantic sturgeon. On November 7, 2012, you provided us, via email, a draft of the revised request for ESA section 7 consultation, with clarification of your effects determination provided, via email, on November 9, 2012. On November 13, 2012, we received your official revised request for ESA section 7 consultation and our concurrence with your determination that the proposed replacement of the Route 72 Manahawkin Bay Bridge, Ocean County, New Jersey, is not likely to adversely affect any species listed as threatened or endangered under the ESA of 1973, as amended. Based on information provided to us on October 21, 2011, and additional information we have received through December 12, 2012, we have conducted a consultation in accordance with Section 7 of the ESA. We concur with your determination and our supporting analysis is provided below.

Proposed Project

The Route 72 Manahawkin Bridge is located in Ocean County, New Jersey, and traverses Manahawkin Bay, which is part of the larger Barnegat Bay. The bridge consists of three trestle bridges (i.e., one over Hilliard's Thorofare, West Thorofare, and East Thorofare) and a large bridge (Bay Bridge) that carries traffic over the Intracoastal Waterway. Currently, the trestle bridge and Bay Bridge are structurally deficient and are in need of repair. The following is the work to be undertaken to repair these structures:

Trestle Bridges
Rehabilitation of the three structures over Hillard's Thorofare, West Thorofare, and East Thorofare will involve pier cap rehabilitation, piling protection systems (i.e., pile jackets placed over one timber at pier numbers 1 &5 for the Hillard's Thorofare Bridge), a new bearing support system, and reconfiguration of the deck and lanes to include a 6-foot wide sidewalk along the westbound side and a 6-foot wide shoulder compatible for a bike on both sides of the structures. The trestle bridges will be rehabilitated in two stages, with the first stage involving traffic being reduced to one lane in the eastbound side of the bridge while the westbound side is reconstructed, and the second stage involving shifting traffic to the rebuilt westbound side while the eastbound side is rebuilt. In addition, bulkhead located in front of each bridges abutments will be repaired. This will require new bulkhead to be installed behind the existing bulkhead, and once installed, the removal of existing bulkhead, via cutting.

Bay Bridge
Rehabilitation of the Bay Bridge will involve the reconstruction of the existing Bay Bridge, as well as the construction of a new four lane bridge (Southern Bay Bridge) running parallel to the existing bridge. The reconstruction/construction of these two bridges will occur in two stages, with the new bridge being constructed first, while the existing bridge maintains the flow of traffic.

Before construction of the new bridge begins, temporary construction bridges, approximately 60-feet wide by 172-feet long, will be installed on the future southeast- and southwest-bound side of the new bridge. The construction bridges will serve as staging areas and construction platforms that will assist in the construction of the sub-and superstructure of the new bridge. The southwestern construction bridge will be supported by 126 three-foot diameter (36-inch diameter) steel pipe piles (trestle piles) and the southeastern construction bridge will be supported by 134 three-foot diameter steel pipe piles. The three-foot diameter steel pipe piles will initially be installed with a vibratory hammer and then driven to capacity with an impact hammer. Approximately three to four piles will be installed per day until the entire span of each temporary bridge is complete.

Once the temporary construction bridges are in place, construction of the new bridge will begin. The new bridge to be constructed will be supported by sixteen 30-feet wide by 48-feet long pier foundations. Before construction of the new bridge is initiated, the contractor will install 16 sheet pile cofferdams around the perimeter of the area where pier foundations will be placed. In order to provide a template and establish a limit to where the cofferdams will be installed, eight steel piles will be installed, via a vibratory or impact hammer, to "mark" each area where a cofferdam is to be placed.[1] Following the installation of the steel piles, the sheet pile cofferdams will be installed via a vibratory or impact. Once the cofferdams are in place, the area inside the cofferdam will be dewatered, and construction of the pier foundation will begin.

Each pier will be supported by six 6-foot (72- inch) diameter caissons (*i.e., steel hollow pile drill shafts/casings; also known as cast in drilled holes (CIDH) steel pipe piles*). The 6-foot diameter

[1] The diameter of the steel piles used to mark the boundaries of the cofferdam are unknown at this time.

caissons will be installed, via a vibratory or impact hammer, in two rows (3 caissons per row), with each caisson spaced 18-feet from one another. After the caissons are installed, a drilling rig will excavate the soil inside the casing holes, with soil deposited in bins on the temporary construction bridges. Once the soil has been removed from the caissons, steel reinforced cages will be inserted within the caissons, followed by placement of cast-in-place concrete, which will be poured inside the caisson until it reaches the top of the pile. Once installation of the caissons is complete, a cast-in-place reinforced concrete pile cap will be placed on top of the caissons. From there, cast-in-place or pre-cast components of the piers will be installed to form each piers substructure. All equipment necessary for the installation of the caissons, pier cap, and other substructure components will be located on the temporary construction bridges and/or barges. Approximately two caissons per day will be installed.

Once construction of the new bridge is completed, the cofferdams and the temporary bridges will be removed. The cofferdams will be removed by cutting the steel sheet piles just above the mud-line, while the temporary construction bridges will be deconstructed by removing the decking and vibrating the piles out of place. In addition, following construction of the new bridge, traffic will be shifted over to the new bridge, which can handle four lanes of traffic, while the second stage of construction, the rehabilitation of the existing Bay Bridge, begins.

Similar to the construction of the new bridge, rehabilitation of the existing Bay Bridge will initially begin by the construction of two temporary construction bridges on the northwest and northeast side of the existing bridge. The temporary construction bridges will be approximately 30-feet wide by 30-feet long and will serve as staging areas and construction platforms that will assist in the construction of the superstructure of the rehabilitated bridge. The northwestern and northeastern construction bridge will be supported each by 78 three-foot diameter steel pipe piles. The 3-foot diameter steel pipe piles will initially be installed with a vibratory hammer and then driven to capacity with an impact hammer. Approximately 4 to 6 piles will be driven per day.

Once the temporary construction bridges are installed, the contactor will begin rehabilitation of the existing Bay Bridge. The existing Bay Bridge substructure, including piers, abutments, and foundations will be reused/kept in place; only the superstructure (e.g., decking) of the existing bridge will be rehabilitated. Cranes and other equipment located on the construction bridges will remove and replace the existing bridge's superstructure. Following the rehabilitation of the existing bridge, the temporary bridges will be deconstructed by removing the decking and vibrating the piles out of place. In addition, bulkhead located in the northeast corner of the existing Bay Bridge will be repaired via the installation of new bulkhead behind the existing bulkhead, and once installed, removing the existing bulkhead, via cutting.

In total, the proposed action is expected to take approximately 6 years to complete. Construction and completion of the new bridge is expected to begin in July 2013 and take approximately 2 years to complete, while rehabilitation to the existing Bay Bridge is expected to begin in July 2017 and take approximately 2 years to complete (see Figure 1). Additionally, based on information provided to us on December 11, 2012 (pers. comm. Scott Ackerman, NJDOT, email dated December 11, 2012), throughout all phases of construction:

- A semi-enclosed turbidity curtain will be placed around all in-water construction areas. The turbidity curtain will be placed approximately 200 feet from the piles/cofferdam area(s); however, to allow for barges to enter/exist the construction site throughout construction operations, a section of the curtain (approximately 100 feet wide) will remain open;

- A bubble curtain will be placed around all piles to be installed (i.e., around piles and cofferdams) to assist in underwater noise attenuation (*i.e., approximately a 20 dB reduction in underwater noise*) during pile driving activities (Illingworth and Rodkin, Inc. and Jones and Stoke 2009; Illingworth and Rodkin, Inc. 2010); and,

- A cushion block/pad will be placed on all piles to be installed. This will also assist in underwater noise attenuation during pile driving activities (*i.e., approx. 4 to26 dB reduction in underwater noise, depending on material of block; Illingworth and Rodkin, Inc. and Jones and Stoke 2009*).

Figure 1.

Preliminary Construction Schedule In-Water Activities by Month and Year

Description	In-Water Construction Activity	Early Start	Early End	Year	Critical Y/N	Total Duration In-Water Construction (Months)
New Bay Bridge Construction	Install Bulkhead Sheeting - Abutment	July	Sept	2013	Y	July-Dec
	Construct Temporary Trestle	Aug	Dec	2013	Y	
	Install Demonstration Shaft	Sept	Oct	2013	Y	
	Install Cofferdams	Sept	Dec	2013	Y	
	Install Cofferdams	July	Sept	2014	Y	July-Dec
	Install Fender System	Oct	Dec	2014	N	
	Remove Temporary Trestle/Cofferdams	July	Dec	2015	Y	Jul-Dec
Rehabilitation of Existing Bridges	Construct Temporary Trestle	July	Dec	2017	Y	Jul-Dec
	Construct Fender System	Sept	Oct	2017	Y	
	Bulkhead Repairs	Sept	Nov	2017	N	
	Bulkhead Construction	Aug	Nov	2018	N	Aug-Dec
	Pier Repairs	Sept	Dec	2018	N	
	Remove Temporary Trestle	Sept	Dec	2018	N	
	Install Scour Protection	Nov	Dec	2018	N	
	Bulkhead Repairs	Sept	Nov	2019	N	Sept-Dec
	Construct Storm Drainage Outfalls	Nov	Dec	2019	N	

NMFS listed species in Project Area

The proposed project is located within Manahawkin Bay, which is part of the larger Barnegat Bay, Ocean County, New Jersey. The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR § 402.02). For this project, the action area includes the project footprint as well as the underwater area where effects of pile driving (e.g., increase in underwater noise levels) will be experienced. Analysis of pile driving activities (*i.e., the type and size of the piles to be driven*) indicates that effects of increased under water noise are likely to be experienced from a zero, to up to 3,281 foot radius of the pile to be driven (Illingworth and Rodkin, Inc. and Jones and Stoke 2009). Based on this information, the action area is considered to be that area within Manahawkin and Barnegat Bays located within a zero to 3,281 foot radius of the piles being driven. This area is expected to encompass all of the effects of the proposed project.

Sea Turtles

Four species of federally threatened or endangered sea turtles under our jurisdiction may be found seasonally in the coastal waters of New Jersey: federally threatened Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead (*Caretta caretta*), and the federally endangered Kemp's ridley (*Lepidochelys kempi*), green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*) sea turtles, although the latter species is found in deeper, more offshore waters and as such, is unlikely to occur in the action area (i.e., depths up to 16 feet). Sea turtles are expected to be in these waters in warmer months, generally when water temperatures are greater than 15°C. This typically coincides with the months of May through mid-November, with the highest concentration of sea turtles present from June – October. Although sea turtles are known to occur along the coastal waters of New Jersey, sea turtles have only been occasionally documented in Manahawkin and Barnegat Bays. As these waters of New Jersey are not known to be a high use area for sea turtles, we believe only rare transient sea turtles may be present in the action area.

Atlantic sturgeon

There are five DPSs of Atlantic sturgeon listed as threatened or endangered. Atlantic sturgeon originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina DPSs are listed as endangered, while the Gulf of Maine DPS are listed as threatened (77 FR 5880; 77 FR 5914; February 6, 2012). The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida.

Atlantic sturgeon spawn in their natal river, with spawning migrations generally occur during February-March in southern systems, April-May in Mid-Atlantic systems, and May-July in Canadian systems (Murawski and Pacheco 1977; Smith 1985; Bain 1997; Smith and Clugston 1997; Caron *et al.* 2002). Young remain in the river/estuary until approximately age 2 and at lengths of 30-36 inches before emigrating to open ocean as subadults (Holland and Yelverton 1973; Dovel and Berggen 1983; Dadswell 2006; ASSRT 2007). After emigration from the natal river/estuary, subadults and adult Atlantic sturgeon travel within the marine environment, typically in waters between 5 to 50 meters in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley 1963; Murawski and Pacheco 1977; Dovel and Berggren 1983; Smith 1985; Collins and Smith 1997; Welsh *et al.* 2002; Savoy and Pacileo 2003; Stein *et al.* 2004;

Laney *et al.* 2007; Dunton *et al.* 2010; Erickson *et al.* 2011); however, as the distribution of Atlantic sturgeon is strongly associated with prey availability, Atlantic sturgeon may occur in shallower nearshore waters, such Barnegat Bay, if suitable forage (e.g., benthic invertebrates such as mollusks and crustaceans) and appropriate habitat conditions are present (e.g., in areas of SAV). Although Atlantic sturgeon have never been documented within Barnegat or Manahawkin Bays, based on information provided by the NJDOT, SAV and shellfish beds do exist within portions of the action area, and thus, Atlantic sturgeon may be found foraging within the action area.

Based on the best available information, Atlantic sturgeon originating from any of five DPSs could occur in the action area. In addition, because of their life history, only sub-adult or adult Atlantic sturgeon may be present in Manahawkin and Barnegat Bays and are likely to be migrating and possibly foraging opportunistically.

Effects of the Action

Pile Driving

The installation of piles via pile driving can produce underwater sound pressure waves that can affect aquatic species. The proposed project will involve the installation of steel sheet piles (for cofferdam installation), caissons, and steel pipe piles via a vibratory and/or impact hammer. As described above, bubble curtains and cushion blocks/pads (noise attenuation devices) will be used in combination with one another throughout the installation of steel sheet piles, caissons, and steel pipe piles to aid in the attenuation of underwater noise levels produced during pile installation. Bubble curtains reduce the sound energy emanating from the pile by creating a column of air bubbles that rise around the pile from the substrate to the water surface. The air bubbles act as a medium that absorbs and scatters sound waves propagating from the pile, thus reducing the sound energy being emitted during pile driving. Based on the best available information, the use of bubble curtains will result in an approximately 20 dB reduction in sound energy/pressure emitted from the pile during installation (Illingworth and Rodkin, Inc. and Jones and Stoke 2009; Illingworth and Rodkin, Inc. 2010).

Cushion blocks/pads, will also be used in conjunction with bubble curtains. The cushion block/pad will be placed atop of piles during pile driving activities to act as an "absorbent" of sound energy. Based on the best available information, cushion blocks/pads can reduce source level pressures by 4 to 26 dB, depending on the material of the cushion block/pad. As the material of the cushion block/pad to be used under the proposed action is unknown, a worst case scenario of only a 4 dB reduction in source level pressures will be assumed (Illingworth and Rodkin, Inc. and Jones and Stoke 2009).

When multiple attenuation devices are used, the attenuation rates are additive in nature; thus, the proposed action's use of a bubble curtain and cushion block, in conjunction with one another, will result in an approximately 24 dB reduction in underwater noise levels produced during pile driving operations (Illingworth and Rodkin, Inc. and Jones and Stoke 2009; Bastach *et al.* 2008). Based on this information, and the best available information on underwater noise levels produced during the installation of steel sheet piles, caisson, and steel pipe piles (*i.e., Illingworth* *and Rodkin, Inc. and Jones and Stoke 2009*), the table below (Table 1) describes the estimated average attenuated underwater noise levels produced by the driving of these types of piles. The estimated underwater noise levels are taken from a distance of 33 feet from the pile being driven.

Table 1. Estimated average attenuated* underwater noise levels produced by the driving of steel sheet and steel pipe piles, and caissons (*Attenuation achieved via a bubble curtain and a cushion block, together).

Type Pile	Hammer Type	Estimated Peak Noise Level (dB_{Peak}[2])	Estimated Pressure Level (dB_{RMS}[3])	Estimated cumulative sound exposure level (cSEL)[4]
Steel Sheet Pile	Impact	181	165	155
Steel Sheet Pile	Vibratory	153	139	138
72" Caisson/CIDH Steel Pile	Impact	186	171	161
72" Caisson/CIDH Steel Pile	Vibratory	176	161	151
36" diameter Steel Pipe Piles[5]	Impact	184	166	153
36" diameter Steel Pipe Piles	Vibratory	161	151	156

[2] Peak sound pressure level is the largest absolute value of the instantaneous sound pressure and is expressed as dB re: 1 μPa.

[3] Root Mean Square (RMS) pressure is the square root of the time average of the squared pressure and is expressed as dB re: 1 μPa. Current thresholds for determining impacts to sea turtles typically center around RMS.

[4] Sound Exposure Level (SEL) is defined as that level which, lasting for one second, has the same acoustic energy as the transient and is expressed as dB re: $1 \mu Pa^2 \cdot sec$. Accumulative or cumulative SEL (cSEL) is calculated as SELcumulative = SELsingle strike + 10 log (# of pile strikes).

[5] As the diameter of the steel pipe piles to be used to mark the boundaries of the cofferdam are unknown at this time, we will use this estimate of underwater noise produced by the driving of 36"diameter steel pipe piles as a conservative estimate of the noise underwater noise levels also produced during the installation of these steel "marker" piles, even though these steel "marker" piles are likely to be smaller than 36" in diameter, and thus, lower in underwater noise intensity.

These levels are dependent not only on the pile and hammer characteristics, but also on the geometry and boundaries of the surrounding underwater and benthic environment. As the distance from the source increases, underwater sound levels produced by pile driving are known to attenuate rapidly. Using data from Illingworth and Rodkin, Inc. and Jones and Stoke (2009), underwater noise levels produced from the driving of steel sheet piles will attenuate approximately 5 dB per doubling of distance, up to 66 feet, and from 66 feet on, attenuate approximately 10 dB per doubling of distance, while the driving of steel piles and caissons will attenuate approximately 5 dB every 33 feet (Illingworth and Rodkin, Inc. and Jones and Stoke 2009).

Sea Turtles

There is little available information on the effects of noise on sea turtles, and hearing capabilities of these turtles are poorly known. A relatively limited number of studies have demonstrated that sea turtles have fairly limited capacity to detect sound (Ketten and Bartol 2007; Ridgway et al. 1969; Lenhardt 1994; Lenhardt et al. 1996; Bartol et al. 1999). However, results within these studies are based on responses from a low number of individuals and must be interpreted cautiously. Most recently, it has been found that decibel levels of 166 dB re $1\mu Pa_{RMS}$ were required before any behavioral reaction (e.g., increased swimming speed) was observed, and decibel levels above 175 dB re $1\mu Pa_{RMS}$ elicited avoidance behavior from sea turtles (McCauley et al. 2000; Lenhardt 2002; Martin 2011; DeRuiter and Doukara 2012). As no additional studies have been done to assess the effects of noise sources on sea turtles, the studies mentioned above serve as the best available information on the levels of underwater noise that may produce a startle, avoidance, and/or other behavioral or physiological response in sea turtles. Based on this information, we believe that underwater noise levels at or above 166 dB re $1\mu Pa_{RMS}$ have the potential to affect sea turtles (e.g., behavioral changes).

The following analysis assesses the underwater noise effects on sea turtles of installing steel sheet piles, steel pipe piles and caissons:

Steel Sheet Piles

As described in Table 1, at a distance within 33 feet of the sheet pile being driven with an impact hammer (*i.e., within 0 to 33 feet of the pile*), underwater sound levels may be as high as 165 dB re$1\mu Pa_{RMS}$, while underwater noise levels will only reach 139 dB re$1\mu Pa_{RMS}$ at a distance of 33 feet from the sheet piles being driven with a vibratory hammer. Should sheet piles be installed with a vibratory hammer, potential modification to sea turtle behavior and/or physiology is not expected as underwater noise levels will be below 166 dB re $1\mu Pa_{RMS}$ within 33 feet or more of the pile being driven[6].

In regards to the installation of steel sheet piles via an impact hammer, underwater noise levels will be below 166 dB re $1\mu Pa_{RMS}$ at a distance of 33 feet or more from the pile being driven;

[6] Maximum underwater noise levels are experienced at the source (i.e., within 3 feet or less of the pile) of the pile. A source level of approximately 144 dB re$1\mu Pa_{RMS}$ was estimated (Received Level= Source Level-15 Log R; NMFS 2012) for steel sheet piles driven with a vibratory hammer and therefore, at any distance from the pile being driven, underwater noise levels will be below 166 dB re$1\mu Pa_{RMS}$.

however, exposure to levels of underwater noise at or above 166 dB re 1μPa$_{RMS}$ will be experienced within zero to 33 feet of the pile being driven. As described above, a semi enclosed turbidity curtain will be installed (at a distance of 200 feet from the pile) around the majority of the area where sheet piles will be installed, with an approximate 100 foot wide opening in the curtain to allow barges to enter/exit the construction site. Aside from the opening, a significant portion of the curtain will remain closed and therefore, prevent sea turtle's immediate access to the majority of the project area and therefore, the ensonified area within 33 feet of the pile being driven. Although the opening to the turbidity curtain provides a potential access point to the work area, due to significant disturbances occurring at the entrance of, and within the curtain (*i.e., continuous construction activities, barges exiting and entering the work site*), there is extremely low likelihood that a sea turtle will enter the curtain and continue normal behaviors (e.g., feeding and resting) within the construction site and thus, come within the ensonified area of the pile (*i.e., within 0 to 33 feet of the pile*). Based on this and the best available information, and the fact that only rare transient sea turtles are expected to occur within Barnegat/Manahawkin Bay, the noise effects on sea turtles of driving steel sheet piles are discountable.

Steel Pipe Piles

As described in the description of the action, steel pipe piles will initially be installed with a vibratory hammer, and then driven the last few feet to capacity with an impact hammer. During the initial installation of the steel pipe piles, via a vibratory hammer, underwater noise levels of approximately 151 dB re1μPa$_{RMS}$ will be produced at a distance of 33 feet from the pile being driven; however, when the final stages of pile installation are reached, underwater noise levels of approximately 166 dB re1μPa$_{RMS}$ will be produced at distance of 33 feet of the pile being driven with an impact hammer (see Table 1). As exposure to underwater noise levels at or above 166 dB re 1μPa$_{RMS}$ will be experienced within zero to 33 feet of the steel pipe pile being driven with either a vibratory or impact hammer, only at distances beyond 33 feet from the piles being driven with a vibratory or impact hammer will underwater noise levels be below 166 dB re 1μPa$_{RMS}$.[7]

As noted above, a semi enclosed turbidity curtain will be installed (at a distance of 200 feet from the pile) around the majority of the area where sheet piles will be installed, with an approximate 100 foot wide opening in the curtain to allow barges to enter/exit the construction site. Aside from the opening, a significant portion of the curtain will remain closed and thus, will prevent sea turtle's immediate access to the majority of the project area and therefore, the ensonified area within 33 feet of the pile being driven. Although the opening to the turbidity curtain provides a potential access point to the work area, due to significant disturbances occurring at the entrance of, and within the curtain (*i.e., continuous construction activities, barges exiting and entering the work site*), there is extremely low likelihood that a sea turtle will enter the curtain opening and continue normal behaviors (e.g., feeding and resting) within the construction site and thus, come within the ensonified area of the pile (*i.e., within 0 to 33 feet of the pile*). Based on this and the

[7] Maximum underwater noise levels are experienced at the source (i.e., within 3 feet or less of the pile) of the pile. A source level of approximately 166 dB re1μPa$_{RMS}$ was estimated (Received Level= Source Level-15 Log R; NMFS 2012) for steel pipe piles driven with a vibratory hammer and 181 dB re1μPa$_{RMS}$ for steel pipe piles driven with an impact hammer.

best available information, and the fact that only rare transient sea turtles are expected to occur within Barnegat/Manahawkin Bay, the noise effects on sea turtles from driving steel pipe piles are discountable.

Caissons

The caissons to be installed serve as support "piles" for each pier of the new Bay Bridge. As described in Table 1, each caisson will be installed via a vibratory hammer or impact hammer. Unlike the other piles installed under the proposed action, caissons will be installed within a dewatered cofferdam. Dewatered cofferdams act as an effective means to reduce underwater noise levels as there is a layer of air between the vibrating pile and the seawater, and thus, a complete decoupling of the pile from the water column (Illingworth and Rodkin, Inc. and Jones and Stoke 2009; Cockrell *et al.* 2011); however, although the cofferdam prevents direct radiation of sound from the pile to the water, underwater noise, albeit attenuated, will be experienced within the area surrounding the cofferdam due to low frequency ground radiated noise propagating through the ground and into the water (Illingworth and Rodkin, Inc. and Jones and Stoke 2009; Reinhall and Dahl 2011). It is estimated that the resultant far field underwater noise levels produced by the pile installed within the cofferdam will be attenuated by approximately 10-20 dB (as measured within 33 feet of the cofferdam; Illingworth and Rodkin, Inc. and Jones and Stoke 2009; Cockrell *et al.* 2011; Reinhall and Dahl 2011); however, noise reductions greater than 10 dB cannot be reliably predicted and thus, a worst case scenario of a 10 dB reduction will be assumed.

Based on this information, and the information presented in Table 1, the installation of the caissons will result in an additional 10 dB reduction in underwater noise levels presented in Table 1 and therefore, at a distance of 33 feet of the cofferdam, underwater noise levels will be 161 dB re $1\mu Pa_{RMS}$ for caissons installed with an impact hammer or 151 dB re $1\mu Pa_{RMS}$ within 33 feet of the cofferdam for caissons installed with a vibratory hammer. As underwater noise levels will be below 166 dB re $1\mu Pa_{RMS}$ within 33 feet or more of the cofferdam, whether an impact or vibratory hammer is used to install the caisson within the cofferdam, potential modification to sea turtle behavior and/or physiology is not expected.[8] Based on this information, the noise effects on sea turtles from driving caissons, under attenuated conditions, are discountable.

Atlantic Sturgeon

Pile driving affects fish through underwater noise and pressure which can cause effects to hearing and air containing organs, such as the swim bladder. Effects to fish can range from temporary avoidance of an area to death due to injury of internal organs. The type and size of pile, type of installation method (i.e., vibratory vs. hammer), type and size of fish (smaller fish are more often impacted), and distance from the sound source (i.e., sound attenuates over distance so noise levels are greater closer to the source) all contribute to the likelihood of effects to an individual fish. The available literature on effects of pile driving on aquatic species is difficult to summarize due to inconsistent methods of measuring underwater sound, the diversity

[8] Sea turtle exposure to source levels will never be experienced as the pile is surrounded by a dewatered cofferdam and therefore, prevents sea turtle access to the area within 3 feet of the pile where sound pressure levels are the highest. Therefore, at any distance from the cofferdam underwater noise levels will be below 166 dB re $1\mu Pa_{RMS}$.

of pile driving methods and receiving substrates, and the differing tolerances of aquatic species to underwater noise. Generally, however, the larger the pile and the closer a fish is to the pile, the greater the likelihood of effects.

An interagency work group, including the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), has reviewed the best available scientific information and developed criteria for assessing the potential of pile driving activities to cause injury to fish (Fisheries Hydroacoustic Working Group (FHWG) 2008). The workgroup established dual sound criteria for injury, measured 33 feet away from the pile, of 206 dB re 1 μPa_{Peak} and 187 dB accumulated sound exposure level (dBcSEL; re: $1\mu Pa^2 \cdot sec$) (183 dB accumulated SEL for fish less than 2 grams). While this work group is based on the US West coast, species similar to Atlantic sturgeon were considered in developing this guidance (green sturgeon). As these species are biologically similar to the species being considered herein, it is reasonable to use the criteria developed by the FHWG.

Based on the information presented in Table 1, peak pressure levels and cSEL levels produced by the driving of steel sheet piles, caissons, and steel pipe piles, via a vibratory or impact hammer, will produce underwater noise levels below 206 dB re 1 μPa_{Peak} and 187cSEL (see Table 1). Based on this information, at any distance from the pile being driven, underwater noise levels will be below levels thought to cause injury to sturgeon.[9] Based on this and the best available information, the installation of steel sheet piles, steel pipe piles, and caissons is extremely unlikely to cause injury to Atlantic sturgeon, and thus, we have concluded that injury to Atlantic sturgeon resulting from the noise effects of pile driving is discountable .

For purposes of assessing behavioral effects of pile driving at several West Coast projects, NMFS has employed a 150 dB re 1 μPa_{RMS} sound pressure level criterion at several sites, including the San Francisco-Oakland Bay Bridge and the Columbia River Crossings. As we are not aware of any studies that have considered the behavior of Atlantic sturgeon in response to pile driving noise, given the available information from studies on other fish species (i.e., Anderson *et al.* 2007; Purser and Radford 2011; Wysocki *et al.* 2007), we consider 150 dB re 1 μPa_{RMS} to be a reasonable estimate of the noise level at which exposure may result in behavioral modifications. As such, for the purposes of this consultation, we will use 150 dB re 1 μPa_{RMS} as a conservative indicator of the noise level at which there is the potential for behavioral effects. That is not to say that exposure to noise levels of 150 dB re 1 μPa_{RMS} will always result in behavioral modifications, but that there is the potential, upon exposure to noise at this level, to experience some behavioral response (e.g., temporary startle to avoidance of an ensonified area).

Based on estimated attenuation rates for all piles in Table 1, underwater noise levels are expected to be below 150 dB re 1 μPa_{RMS} at a distance beyond approximately 132 feet from any of the

[9] Maximum underwater noise levels are experienced at the source (i.e., within 3 feet or less of the pile) of the pile. Overall source levels of no more than 199 dB re1μPa_{Peak} and 171 dB_{CSEL} were estimated (Received Level= Source Level-15 Log R; NMFS 2012) for steel pipe and steel sheet piles driven with an impact or vibratory hammer and therefore, at any distance from the piles, underwater noise levels will be below 206 dB re 1 μPa_{Peak} and 187cSEL Source levels of the caissons were not estimated as the area within 3 feet of the pile is found within the dewatered cofferdam, and thus, outside of the in-water medium where ESA listed species occur.

piles being driven with an impact hammer, and beyond 33 feet from any of the piles being driven with a vibratory hammer. As described above, a semi enclosed turbidity curtain will be installed (at a distance of 200 feet from the pile) around the majority of the area where piles will be installed, with an approximate 100 foot wide opening in the curtain to allow barges to enter/exit the construction site. Aside from the opening, a significant portion of the curtain will remain closed and therefore, prevent the immediate access of Atlantic sturgeon to the majority of the project area and thus, the ensonified area within 33 feet or 132 feet of the pile being driven with a vibratory or impact hammer, respectively. Although the opening to the turbidity curtain provides a potential access point to the work area, due significant disturbances occurring at the entrance of, and within the curtain (*i.e., continuous construction activities, barges exiting and entering the work site*), there is extremely low likelihood that an Atlantic sturgeon will enter the curtain opening and continue normal behaviors (e.g., feeding and resting) within the construction site and thus, come within the ensonified area of the pile (*i.e., within 0 to 132 feet of the pile*). Instead, as Atlantic sturgeon have other sensory organs, aside from "hearing", that enable them to detect particle disturbance in the water, if present, it is reasonable to assume that sturgeon, on hearing the pile driving sound, would either not approach the source or move around it. If any movements away from the area where piles are being installed do occur, it is extremely unlikely that these movements will amount to substantial changes to essential Atlantic sturgeon behaviors (e.g., reproduction, foraging, resting, and migration). Additionally, the extent of underwater noise is not likely to present a barrier to Atlantic sturgeon movements and as such, if individuals are present within the vicinity of the action area, they are likely to veer/swim away from the pile driving sites and continue normal behaviors (e.g., feeding, resting, and migrating) in other portions of the action area and/or in other locations within New Jersey coastal waters. Based on this and the best available information, and the fact that to date, no Atlantic sturgeon have been documented within Barnegat/Manahawkin Bay, we conclude that pile driving noise is not likely to cause significant behavior modification to Atlantic sturgeon. Based on this and the best available information, we believe the noise effects on Atlantic sturgeon behavior is insignificant.

Water Quality Effects of Pile Driving

The installation of piles will disturb bottom sediments and may cause a temporary increase in suspended sediment in the nearshore area. However, little increase in sedimentation or turbidity is expected to result from this construction activity due to the use of a turbidity curtain. If any sediment plume does occur, it is expected to be small and suspended sediment is expected to settle out of the water column within a few hours and any increase in turbidity will be short term. Turbidity levels associated with pile driving activities are expected to be only slightly elevated above background levels (average range of 10.0 – 120.0 mg/L) (ACOE 2007, Anchor Environmental 2003).

No information is available on the effects of total suspended solids (TSS) on juvenile and adult sea turtles. Studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). TSS is most likely to affect sturgeon and sea turtles if a plume causes a barrier to normal behaviors or if sediment settles on the bottom affecting sea turtle prey. As Atlantic sturgeon and sea turtles are highly mobile, they are likely to be able to avoid any sediment plume and any effect on sea turtle or Atlantic sturgeon movements is likely to be insignificant. Additionally, the TSS levels expected for pile driving and placement of fill (10.0 to 120.0 mg/L) are below those shown to have an adverse effect on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical; see summary of scientific literature in Burton 1993) and benthic communities (590.0 mg/L (EPA 1986)); therefore, effects to benthic resources that sturgeon or sea turtles may eat are unlikely. Additionally, while the increase in suspended sediments may cause Atlantic sturgeon or sea turtles to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve movements to alter course out of the sediment plume and is not likely to affect the overall movement or migration ability of sturgeon and sea turtles. Based on this information, the effect of suspended sediment resulting from pile driving activities on Atlantic sturgeon or sea turtles will be insignificant.

Habitat Alteration

The proposed action will alter the surrounding benthos, both temporarily (e.g., via pile driving) and permanently (i.e., via the installation of pier foundations for the new Bay Bridge, shading from new bridge). Although some mobile benthic species (e.g., crabs, gastropods) may be able to move out of the construction area during construction operations, those organisms that are sessile and immobile (e.g., submerged aquatic vegetation (SAV), shellfish) will be unable to avoid the impacts of the proposed action, resulting in the removal of these organisms from the impacted areas of the action area. According to information provided to us by the New Jersey Department of Transportation (pers. Comm., Scott Ackerman, NJDOT, March 2, 2012), sea grass and shellfish beds are located throughout Barnegat and Manahawkin Bays, including portions of the action area where construction activities will be undertaken. As a result of the proposed action, approximately 0.662 acres of submerged aquatic vegetation (SAV) and 2.028 acres of shellfish beds will be permanently removed from this ecosystem (pers. Comm., Scott Ackerman, NJDOT, March 2, 2012). As Green sea turtles forage on sea grasses; Kemp's ridley and loggerhead sea turtles typically feed on crustaceans and mollusks; and Atlantic sturgeon, feed on benthic invertebrates (e.g., mollusks, gastropods, annelids, amphipods), often foraging at, or near, mudflats with areas of SAV or shellfish resources, the short and long term removal of these benthic resources from the Bay system will result in the removal of food resources for these ESA listed species.[10] However, while there will be a reduction in the amount of prey resources in the action area, on a short term and long term basis, the area affected is small in relation to the entire Barnegat Bay ecosystem (i.e., total area affected is approximately 2.69 acres; total number of acres of Barnegat Bay is approximately 80,309 acres) and thus, the proposed action will result in the loss of only a very small amount of the available forage in the action area and an even smaller percentage of available foraging habitat in the Barnegat Bay ecosystem.[11] The proposed action, therefore, is not likely to remove critical amounts of prey resources from the action area and will not alter the habitat in a way that prevents sea turtles or Atlantic sturgeon from using the action area as a migratory pathway to other areas within Bay system that are suitable for foraging and thus, normal feeding behaviors for sea turtles and

[10] Leatherback sea turtles feed on jellyfish. As jellyfish are not benthic species, there is not likely to be a reduction in the forage base for leatherbacks as a result of the work to be undertaken to construct and install the new Bay Bridge system.

[11] Barnegat Bay is approximately 50 kilometers (164,042 feet) long and up to 6.5 kilometers (21,326 fee) wide (Lordi 1997).

Atlantic sturgeon are not expected to be disrupted as a result of the proposed action. Based on this and the best available information, and the fact that sea turtles and Atlantic sturgeon are thought to be rare within Barnegat Bay, we have concluded that the proposed actions effects on foraging sea turtles or Atlantic sturgeon will be insignificant.

Vessel Traffic

Construction of the new bridge and rehabilitation to the existing bridges will require the presence of construction vessels, such as barges, to transport material to and from the construction sites, as well as provide a structure from which work will be performed from. The presence of these barges will result in additional vessel traffic within the action area; however, the increase will be temporary and is not expected to be significant relative to the existing vessel traffic in the heavily traveled waters of Barnegat bay. However, as listed species of sea turtles and/or sturgeon may occur within action area, there is a potential for vessels to interact with these listed species.

Atlantic Sturgeon
Although there have been no documented reports of barges colliding with Atlantic sturgeon, vessel strikes have been identified as a threat to Atlantic sturgeon. The exact number of Atlantic sturgeon killed as a result of being struck by boat hulls or propellers is unknown, it is an area of concern. Brown and Murphy (2010) examined twenty-eight dead Atlantic sturgeon observed in the Delaware River from 2005-2008. Fifty-percent of the mortalities resulted from apparent vessel strikes and 71% of these (10 of 14) had injuries consistent with being struck by a large vessel (Brown and Murphy 2010). Eight of the fourteen vessel struck sturgeon were adult-sized fish (Brown and Murphy 2010). Given the time of year in which the fish were observed (predominantly May through July; Brown and Murphy 2010), it is likely that many of the adults were migrating through the river to the spawning grounds. Similarly, five sturgeon were reported to have been struck by commercial vessels within the James River, Virginia in 2005, and one strike per five years is reported for the Cape Fear River. Locations that support large ports and have relatively narrow waterways seem to be more prone to ship strikes (e.g., Delaware, James, and Cape Fear rivers) (ASSRT 2007).

The factors relevant to determining the risk to Atlantic sturgeon from vessel strikes are currently unknown, but they may be related to size and speed of the vessels, navigational clearance (i.e., depth of water and draft of the vessel) in the area where the vessel is operating, and the behavior of Atlantic sturgeon in the area (e.g., foraging, migrating, etc.). It is important to note that vessel strikes have only been identified as a significant concern in the Delaware and James Rivers and current thinking suggests that there may be unique geographic features in these areas (e.g., potentially narrow migration corridors combined with shallow/narrow river channels) that increase the risk of interactions between vessels and Atlantic sturgeon. These geographic features are not present in the waters of the action area where Atlantic sturgeon may be found (*i.e., Barnegat and Manahawkin Bays*). Therefore, vessel strike is not considered to be a significant threat in the action area. Additionally, in contrast to the Delaware and James Rivers where several vessel-struck individuals are identified each year, very few Atlantic sturgeon with injuries consistent with vessel strike have been observed in harbor, bay, or ocean environments.

Although the likelihood of a vessel collision with Atlantic sturgeon in these environments is expected to be low, we cannot discount the possibility of such an interaction and as such, will discuss below the risk of such an interaction.

As described above, Atlantic sturgeon are likely to be primarily using the action area as a migration corridor to and from spawning, overwintering, and/or foraging sites along the U.S. eastern coastline. Based on available information, it is believed that when migrating, Atlantic sturgeon are found primarily at mid-water depths (Cameron 2010) and while foraging, within the bottom meter of the water column. As depths within the portion of the action area that barges will be operating will be 16 feet or more (pers. Comm. Scott Ackerman, NJDOT, March 2, 2012), there should be sufficient clearance between the underkeel of the barge and the bottom that Atlantic sturgeon should be able to continue essential behaviors (e.g., migration, foraging) without an interaction with a barge to occur. However, Atlantic sturgeon are not restricted to these depths, and on occasion, have been known to occur in the upper water column. Similar to sea turtles, it may be assumed that Atlantic sturgeon are more likely to avoid injury from slower-moving vessels since the sturgeon has more time to maneuver and avoid the vessel. Barges operating in the action area are expected to be slow moving and will not be operating at excessive speeds (e.g., speeds greater than 4-5 knots), thereby reducing the chances of collision with an Atlantic sturgeon. Based on this and the best available information, and the fact that Atlantic sturgeon are expected to be rare in the action area, the potential interaction of a barge/vessel and an Atlantic sturgeon is likely to be discountable.

Sea Turtles
Interactions between vessels and sea turtles occur and can result in injury or death. Most forms of vessel interactions result from contact between sea turtles and boat propellers. While sea turtles may be vulnerable to being struck by fast moving vessels, strikes are thought to occur most often between fast recreational vessels. As barges/vessels operating in the action area will be moving at slow speeds (e.g., 4 knots), it is extremely unlikely for sea turtles to be struck by a barge. In addition, due to the rare occurrence of sea turtles in the action area, there is low likelihood that interaction between a barge and a sea turtle will occur. Based on this information, effects of vessel operations on sea turtles is discountable.

Other Construction Activities

Rehabilitation of the trestle bridges (e.g., reconfiguration of decking; installation of a new bearing support system; bulkhead replacement) and the existing Bay bridge (i.e., superstructure replacement), as well as the construction of the superstructure of the new Bay Bridge will occur above the water line or behind existing bulkhead where sea turtles and Atlantic sturgeon do not occur and thus, no direct or indirect effects to these species will result from these proposed construction activities.

Removal of the cofferdam (*i.e., steel sheet piles*) will involve cutting, likely with a hydraulic chainsaw, just above the mudline of the Bay bottom. As the engine used to drive the hydraulics is located above the surface of the water, the actual pile cutter is silent as it is completely hydraulic. As such, the effects of cutting piles on sea turtles and Atlantic sturgeon will be discountable.

Temporary steel pipe piles installed for the purposes of supporting the temporary trestle bridges, will also be removed by vibrating the piles out of place. The vibrations produced in order to loosen the embedded piling may produce low levels of noise, with vibratory frequencies expected to be between 5 and 40 Hertz (Hz) (ACOE 1998). This is below the hearing range of sea turtles (*i.e., 20 to 1,000 Hz ; Ketten and Bartol 2007; Ridgway et al. 1969; Lenhardt 1994; Lenhardt et al. 1996; Bartol et al. 1999*), and Atlantic sturgeon (*i.e., estimated to range from 100 Hz to 1000 Hz; Meyer and Popper 2002; Popper 2005; Lovell et al. 2005*) and thus, will not be detected by either species. As a result, the removal of piles via vibratory means will not result in any adverse effects to ESA listed species of sea turtles and Atlantic sturgeon. Based on this and the best available information, we conclude that the effects of noise/vibrations produced by the removal of pilings on sea turtles and Atlantic sturgeon will be discountable.

Conclusions

Based on the analysis that any effects to listed sea turtles and Atlantic sturgeon will be insignificant or discountable, we are able to concur with your determination that the proposed project is not likely to adversely affect any listed species under NMFS jurisdiction. Therefore, no further consultation pursuant to section 7 of the ESA is required.

Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (a) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered in the consultation; (b) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the consultation; or (c) If a new species is listed or critical habitat designated that may be affected by the identified action. No take is anticipated or exempted. If there is any incidental take of a listed species, reinitiation is required. Should you have any questions about this correspondence please contact Danielle Palmer at (978) 282-8468 or by e-mail (Danielle.Palmer@noaa.gov).

Coordination between NMFS' Habitat Conservation Division and your office regarding effects of the action on Essential Fish Habitat (EFH) and NOAA Trust Resources considered under the Fish and Wildlife Coordination Act is still ongoing. By completing this ESA consultation, you are not relieved of your obligations to complete consultation and coordination under these other authorities. I look forward to continuing to work with you and your staff as this action moves forward.

Sincerely,

For John K. Bullard
Regional Administrator

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Ec: Greene, NMFS/HCD
Palmer, NMFS/NER
Ackerman, ACOE/NY

File Code: Sec 7 FHWA Rt 72 Manahawkin Bay Bridge
PCTS:NER-2012-9240

UNITED STATES DEPARTMENT OF COMMERCE
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SEP 29 2010

Dear Mr. Sweger:

NOAA's National Marine Fisheries Service (NMFS), Northeast Region, Habitat Conservation Division has reviewed the essential fish habitat assessment (EFH) for the Route 72 Manahawkin Bridges Project prepared by the New Jersey Department of Transportation (NJDOT), the designated non-federal representative of the Federal Highway Administration (FHA), the lead federal agency.

Based upon the information contained in the environmental assessment (EA) prepared for the project, the preferred alternative selected by the NJDOT involves the rehabilitation of the existing Route 72 Bridge over Manahawkin Bay, also known as the Bay Bridge as well as three smaller trestle bridges, collectively known as the Route 72 Causeway. Also included is the construction of a new Bay Bridge south of the existing bridge along with roadway improvements in Stafford Township and Ship Bottom, Ocean County, New Jersey. We provided comments on the EA in our letter dated July 6, 2010. We look forward to receiving a revised EA that addresses the issues raised in that letter. Our comments below focus on the EFH assessment provided to us with your August 20, 2010 letter.

The project area has been designated as EFH for a number of federally managed species including Atlantic butterfish (*Peprilus triacanthus*), Atlantic sea herring (*Clupea harengus*), bluefish (*Pomatomus saltatrix*), black sea bass (*Centropristis striata*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), scup (*Stenotomus chrysops*), Spanish mackerel (*Scomberomorus maculatus*), summer flounder (*Paralichthys dentatus*), windowpane flounder (*Scophthalmus aquosus*), winter flounder (*Pseudopleuronectes americanus*), winter skate (*Leucoraja ocellata*), little skate (*Leucoraja erinacea*) and clearnose skate (*Raja eglanteria*).

The Magnuson Stevens Fishery Conservation and Management Act (MSA) requires federal agencies such as FHA to consult with the Secretary of Commerce, through NMFS, regarding any action or proposed action authorized, funded, or undertaken by the agency that may adversely affect EFH identified under the MSA. The EFH regulations, 50 CFR Section 600.920, outline that consultation procedure. A Federal agency may designate a non- Federal representative to conduct an EFH consultation by giving written notice of such designation to NMFS. If a non-Federal representative is used, the Federal action agency remains ultimately responsible for compliance with sections 305(b) (2) and 305(b) (4) (B) of the MSA.

The EFH final rule published in the Federal Register on January 17, 2002 defines an adverse effect as; "any impact which reduce the quality and/or quantity of EFH." The rule further states that:

> An adverse affect may include direct or indirect physical, chemical or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

The rule also states:

> Loss of prey may be an adverse effect on EFH and managed species because the presence of prey makes waters and substrate function as feeding habitat and the definition of EFH includes waters and substrate necessary to fish for feeding. Therefore, actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat that are known to cause a reduction in the population of the prey species, may be considered adverse effects on EFH if such actions reduce the quality of EFH.

The required contents of an EFH assessment include: 1) a description of the action; 2) an analysis of the potential adverse effects of the action on EFH and the managed species; 3) the Corps's conclusions regarding the effects of the action on EFH; 4) proposed mitigation, if applicable. Other information that should be contained in the EFH assessment, if appropriate, includes: 1) the results of on-site inspections to evaluate the habitat and site-specific effects; 2) the views of recognized experts on the habitat or the species that may be affected; 3) a review of pertinent literature and related information; and 5) an analysis of alternatives to the action that could avoid or minimize the adverse effects on EFH.

The EFH assessment worksheet and species list submitted by NJDOT includes the required elements of an EFH assessment and, within the limits of the information available on the construction methods to be used and the specifics of the bridge design, evaluates the impacts adequately. Sufficient information is presented to allow us to provide EFH conservation recommendations. However, additional coordination will be necessary once the construction plans and construction methods are developed more fully. Further coordination is also necessary to develop the needed monitoring and mitigation plans.

Impact Assessment
In the EFH worksheet, the NJDOT has concluded that the proposed project will have substantial adverse effects on EFH. We agree. Impacts to EFH will result from the permanent filling of aquatic habitat for the construction of the piers for the new bridge, shading impacts from the new bridge deck and the widened trestle bridge decks and potential changes in sedimentation and scour patterns that will result from the installation of the new structures in the waterway. Temporary impacts to EFH will result from the installation and removal of the two trestle bridges to be used for construction access for the rehabilitation of the existing bridge and the

construction of the new bridge. Cofferdams to be installed to allow for the construction of the new bridge piers will also impact EFH. Because the exact sizes and locations of the access structures and cofferdams are not available, NJDOT has estimated the area of impact using a worst-case scenario. Further, since the temporary structures will be in place for more than six months, compensatory mitigation for these areas to address the temporal loss of the use of the habitat by NOAA trust resources is necessary.

According to the EFH assessment, the proposed project will impact permanently intertidal and subtidal shallows, shellfish habitat and submerged aquatic vegetation (SAV or seagrass). These habitats are important for a wide variety of federally managed species and their prey. Permanent impacts include 0.52 acres of intertidal and subtidal shallows (water depths less than 4 feet at mlw), 0.63 acres of mapped shellfish habitat and 0.41 acres of SAV. Temporary impacts include 0.30 acres of intertidal and subtidal shallows, 0.36 acres of mapped shellfish habitat and 0.25acres of SAV. Since some areas are mapped as more than one type of habitat, the acreage cannot be added together to get a total area of aquatic habitat affected. Also not included in the impacts assessment are the 1.46 acres of temporary and 1.42 acres of permanent shading of SAV. Since SAV is present under the existing bridge, it is not known if the additional shading from the new, adjacent bridge and the widened causeway bridges will result in the loss or degradation of SAV. Nor is it known if the temporary shading from the trestle bridges will affect SAV.

Much of the project area has been identified as SAV habitat under New Jersey Coastal Zone Management Rules (7:7E- 3.6). Submerged vegetation habitat consists of water areas supporting or documented as previously supporting rooted, submerged vascular plants such as widgeon grass (*Ruppia maritima*) and eelgrass (*Zostera marina*) as well as several others. Both eelgrass and widgeon grass have been found in the area. If SAV is found in the area, or the area has been identified as supporting SAV in the past on historic maps such as the New Jersey Submerged Aquatic Vegetation Distribution Atlas (Final Report) (1980), conducted by Earth Satellite Corporation and also on "Eelgrass Inventory" maps prepared by the Division of Fish and Wildlife, Bureau of Shellfisheries in the 1980's (McCloy and Joseph 1985), the area is considered SAV habitat regardless if SAV is currently present. According to Fonseca et al. (1998), SAV beds move; and depending upon the species and physical setting, the rate at which portions of the seafloor switch from vegetated to unvegetated may vary on the scale of days or decades, meaning that the amount of seafloor required to maintain patchy seagrass beds is greater than the coverage of seagrass itself at any one point in time, sometimes by a factor of two. From the information in the EA and the EFH assessment it is not clear if the SAV areas of impact are only those that currently support SAV. NJDOT should ensure that the impact information includes all areas of SAV habitat, not just areas where SAV exists currently. The New Jersey Submerged Aquatic Vegetation Atlas (1980) shows SAV present in all areas along the bridge except for the navigation channels.

SAV and their associated epiphytes are highly productive, produce a structural matrix on which many other species depend, improve water quality and stabilize sediments (Fonseca et al 1998). Seagrasses are among the most productive ecosystems in the world and perform a number of irreplaceable ecological functions which range from chemical cycling and physical modification of the water column and sediments to providing food and shelter for commercial, recreation as well as economically important organisms (Stephan and Bigford 1997). Larvae and juveniles of many important commercial and sport fish such as bluefish, summer flounder, spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), herrings (*Clupeidae*) and many others appear in eelgrass beds in the spring an early summer (Fonseca et al 1992). Studies from the lower Chesapeake Bay found that SAV beds are important for the brooding of eggs for fishes with demersal eggs and as habitat for the larvae of spring-summer spawners such as anchovies (*Anchoa* spp.), gobies, (*Gobiosoma* spp.), weakfish (*Cynoscion regalis*), and silver perch (*Bairdiella chrysoura*) (Stephan and Bigford 1997). Heckman and Thoman (1984) concluded that SAV beds are also important nursery habitats for blue crabs (*Callinectes sapidus*). According to Peterson (1982) in Kenworthy (1988) shallow dwelling hard clams (*Mercenaria mercenaria*) may be protected from predation by the rhizome layer of seagrass beds.

SAV has been designated as a habitat area of particular concern (HAPC) for summer flounder. HAPCs are subsets of EFH based on one or more of the following considerations: 1) the importance of the ecological function, 2) extent to which the habitat is sensitive to human-induced degradation, 3) whether and to what extent, development activities are stressing the habitat type, or 4) rarity of habitat type (50 CFR 600.815(a)(8)). Studies by Weinstein and Brooks (1983), Adams (1976) and Lascara (1981) in Packer et al. (1999) indicate that SAV is important habitat for juvenile summer flounder. Rodgers and Van Den Avyle (1983) suggest that SAV beds are important to summer flounder, and that any loss of these areas along the Atlantic seaboard may affect summer flounder stocks.

The proposed project many affect SAV beds and EFH for summer flounder in several ways; the direct loss from the construction of the bridge pier, trestle bridges and cofferdams; the loss or degradation due to shading from the structures, increases in suspended sediments during construction, and changes in sedimentation and scour pattern while construction is ongoing and after the new structures are in place.
At this point only the direct impacts can be calculated.

Water quality and, in particular, water clarity are considered among the most critical, if not the most critical, factors in the maintenance of healthy SAV habitats (Stephan and Bigford 1997). Seagrasses require at least 15% to 25% of the incident solar radiation (at the water surface) just for maintenance (Kenworthy et al. 1991). Increases in suspended sediments and the subsequent reductions in water transparency caused by dredging or other in-water construction activities such as the installation of piles and cofferdams, or from nutrient loading stormwater runoff, and boating activities limits photosynthesis. Experiments by Short et al. (1991) with eelgrass have shown that reduction in light decreases growth, promotes a reduction in plant density and can ultimately eliminate an eelgrass population altogether. As a result, NMFS has recommended that activities that generate suspended sediments be avoided in and near SAV beds when eelgrass and widgeon grass are actively growing, generally from April 15 to September 30 to avoid affecting the plant's ability to photosynthesize, grow and survive.

Because of the ecological importance of SAV habitat, we also recommend compensatory mitigation for all areas of SAV that will be affected by this project. However, because the compensatory process for seagrass is of questionable merit (Race and Fonseca 1996 in Fonseca et al. 1998), we generally recommend a ratio of at least 3:1 for mitigation to account for the difficulties in establishing successful seagrass beds and the uncertainty associated with its long-term success. Fonseca et al. (1998) notes that the existence of techniques to transplant seagrass has often been used to justify the destruction of existing, productive habitat, and that this approach has consistently resulted in a net loss of habitat. This net loss occurs for a number of reasons including insufficient area for on-site planting to offset the habitat loss, and the selection of an inappropriate planting location off-site.

In considering off-site locations, particularly in areas where seagrass once existed but does not currently exist, it must first be determined why seagrass no longer exists in that location. If the seagrass loss was caused by water quality issues, then those issues must be corrected before seagrass planting in the site can be successful. Post construction monitoring of the mitigation site and a nearby reference for a minimum of five years is also necessary to evaluate the success of the mitigation. Monitoring of a reference site is recommended to ensure that any system-wide seagrass declines due to climatic conditions, disease or other causes are considered in evaluating the success of the mitigation. Further, since it is not known if shading or changes in the scour pattern from the new bridge will affect adversely the existing seagrass around the bridge, these areas should also be monitored. If a decline in the seagrass is seen in these locations that is disproportionate to any regional changes in seagrass, additional compensatory mitigation should be provided.

The project area has also been designated as EFH for winter flounder. The New England Fisheries Management Council (NEFMC) has defined the EFH for winter flounder early life stages as having depths of less than 5 meters for eggs and less than 6 meters for larvae with salinities between 10 and 30 ppt for eggs and 4 to 30 ppt for larvae on bottoms with substrates of sand, muddy sand, mud and gravel. Winter flounder have demersal eggs that sink and remain on the bottom until they hatch. After hatching, flounder larvae are initially planktonic, but following metamorphosis they assume an epibenthic existence. Winter flounder larvae are negatively buoyant (Pereira et al. 1999), and are typically more abundant near the bottom (Able and Fahay 1998). These young-of-the-year flounder tend to burrow in the sand rather than swim away from threats. Because eggs or newly metamorphosed larvae are located on the bottom and are not mobile, they can be harmed by the deposition of suspended sediments and the installation of the cofferdams. To minimize impacts to winter flounder early life stages and their EFH, we recommend that in-water work be avoided from January 1 to May 31 or each year.

The *Inventory of New Jersey's Estuarine Shellfish Resources* (McCloy and Joseph 1985) and the Department of Interior shellfish maps (1963) identify the project area as hard clam habitat. In addition to their commercial value, shellfish have an important ecological role in the Barnegat and Manahawkin Bay complex. As filter feeders, they improve water quality in the bays. They also serve as a food source for a variety of fish that feed the siphons of shellfish. Steimle et al. (2000) studied the diets of demersal fish in the lower Hudson-Raritan Estuary. They reported the siphons of hard clams were an important part of the diet of winter flounder in the estuary. Any reduction or degradation to the habitat for hard clam is considered to be an adverse effect on EFH for winter flounder.

While NJDOT's proposal to notify the shellfisherman prior to the start of construction to allow them to harvest any shellfish in the area may be beneficial, this action does not address the loss of shellfish habitat that will result from the project. As stated in our comments on the EA, we expect the NJDOT to develop and to implement a compensatory mitigation plan that will restore, create or enhance shellfish habitat in the vicinity of the project area in order to offset the impacts to shellfish beds and to EFH. NJ Department of Environmental Protection's Bureau of Shellfisheries should be consulted to determine the most appropriate form of compensatory mitigation. In addition, portions of the project area are open seasonally from November 1 to April for the direct harvest of shellfish. Activities that generate turbidity should be avoided during this time in any area open for direct harvest.

Lastly, from the EA it appears that a small amount of tidal wetlands will be affected by the proposed project. We expect that the revised EA for the project will clearly define the extent of the wetlands impacts and include a compensatory mitigation plan to offset those impacts. Estuarine wetlands provide nursery and forage habitat for a variety of species of concern to NMFS including alewife (*Alosa pseudoharengus*), Atlantic croaker (*Micropogonias undulatus*), Atlantic menhaden (*Brevoortia tyrannus*), spot, striped bass (*Morone saxatilis*) as well as federally managed bluefish, winter flounder and summer flounder (Graff and Middleton undated). Important forage species such as mummichog (*Fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), inland silverside (*Menidia beryllina*), striped killifish (*Fundulus majalis*) and bay anchovy (*Anchoa mitchilli*) also use these areas. Mummichog, killifish, anchovies and other small fish and benthic organisms found in estuarine wetlands provide a valuable food source for many of the commercially and recreationally valuable species mentioned above including striped bass, summer flounder, weakfish, red hake, scup and windowpane (Steimle et al. 2000).

Wetlands also provide many other important ecological functions including water storage, nutrient cycling and primary production, sediment retention, water filtration or purification, and groundwater recharge. The loss of wetlands as a result of this project can adversely affect EFH for a number of federally managed species through the loss of nursery, forage and refuge habitat, the reduction in prey species and primary production and water quality degradation from the reduction in sediment retention and pollution filtration. As a result, we recommend that a compensatory mitigation plan be developed to offset all of the project impacts to aquatic resources, including wetlands, SAV, shellfish and EFH, in accordance with the federal standards and criteria for compensatory mitigation for losses of aquatic resources as published in the Federal Register on April 10, 2008 (Vol. 73 No. 70) prior to the issuance of a Finding of No Significant Impact (FONSI) and as part of any federal permit application.

EFH Conservation Recommendations

As discussed above, we concur with the NJDOT's determination that the proposed project will have substantial impacts to EFH. To minimize the impacts, NMFS recommends the following EFH conservation recommendations pursuant to Section 305(b) (4) (A) of the MSA:

1. The development, review, approval and implementation of a compensatory mitigation plan for all unavoidable impacts to aquatic habitats including SAV, intertidal and subtidal shallows, wetlands and shellfish habitats in accordance with the 2008 federal mitigation regulations. We note that the submittal of this plan is required as part of any Department of the Army permit application. The plan must include baseline information on the mitigation site or sites, the goals and objectives of the plan, performance measures and

2. success criteria, monitoring and maintenance plans and provisions for the long-term stewardship of the site. The mitigation plan must also demonstrate how it will replace the functions and values of the habitats to be impacted.

   We expect in-kind mitigation for these important habitats. For SAV, we recommend a minimum ratio of 3:1. For wetlands and other aquatic habitats, the ratio recommended will depend upon the location and nature of the compensatory mitigation proposed. Typically, 3:1 is recommended for in-kind enhancement of wetlands and 2:1 is recommended for in-kind creation or restoration. We will not support the creation, restoration or enhancement of wetlands to offset the loss SAV, shellfish or unvegetated intertidal and subtidal shallows.

   The NJDEP Bureau of Shellfisheries should be consulted as soon as possible to discuss options for addressing the mitigation of impacts to shellfish habitat as well as SAV habitat. NMFS should be included in these discussions.

3. The development, review, approval and implementation of a monitoring plan for SAV in and around the project site to determine if shading or scour effects from the new bridge and rehabilitated bridges affects adversely existing SAV beds. The plan should include monitoring of reference locations as well as the area in and around the bridges. The monitoring should be undertaken for a minimum of five years in conjunction with the monitoring period for the compensatory mitigation.

4. No dredging or other in-water work that would result in increases in suspended sediments from:

   - January 1 to May 31 to minimize adverse effects on winter flounder EFH and early life stages. Work within the cofferdams may occur during this time frame provided the cofferdams are installed and removed outside of this time.

   - April 15 to September 30 to minimize impacts to SAV. SAV beds have been identified as an HAPC for summer flounder. As discussed above, SAV is also valuable habitat for wide variety of NOAA trust resources including bluefish, spot, blue crabs and many others. Work within the cofferdams may occur during this time frame provided the cofferdams are installed and removed outside of this time.

5. In areas identified as seasonally open for shellfish harvesting, any work that would result in the closure of the shellfish beds should be avoided from November 1 to April 15. The NJDEP Bureau of Shellfisheries should be consulted to determine the areas of concern and the activities that should be avoided as well as any potential mitigation that may be necessary should any of the work proposed result in the closure of commercially harvested shellfish beds.

Please note that Section 305 (b)(4)(B) of the MSA requires the NJDOT, acting as FHA's designated non-federal representative, to provide NMFS with a detailed written response to these

EFH conservation recommendations, including the measures adopted by the NJDOT for avoiding, mitigating, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with NMFS' recommendations, Section 305 (b) (4) (B) of the MSA also indicates that the NJDOT must explain its reasons for not following the recommendations. Included in such reasoning would be the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate or offset such effect pursuant to 50 CFR 600.920 (k).

Please also note that further EFH consultation must be reinitiated pursuant to 50 CRF 600.920 (j) if new information becomes available, or if the project is revised in such a manner that affects the basis for the above EFH conservation recommendations.

We recognize that EFH conservation recommendations, particularly the seasonal work restrictions that we have provided may present logistical difficulties for the construction and rehabilitation of the Route 72 bridges. As project plans are developed more fully and the details of the construction methods are known, these recommendations may be modified. We look forward to additional coordination on this project as those details become available and as the mitigation and monitoring plans are developed. If you have any questions regarding our comments or need additional information, please contact Karen Greene at 732 872-3023.

Sincerely,

Peter Colosi

Peter D. Colosi
Assistant Regional Administrator
Habitat Conservation Division

cc: EPA Region II - L. Knudson, R. Montgomerie
FWS Pleasantville – C. Popolizio
ACOE Phila. – M. Hayduk
PRD – J. Crocker
NJDEP Bureau of Shellfisheries- M. Cellestino
NJDEP – Div. Fish and Wildlife – K. Davis

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State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION

JON S. CORZINE
Governor

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MARK N. MAURIELLO
Acting Commissioner

December 29, 2009

Pamela Garrett
Supervising Environmental Specialist
Bureau of Environmental Program Resources
New Jersey Department of Transportation
1035 Parkway Avenue
P.O. Box 600
Trenton, NJ 08625

Dear Ms. Garrett,

As Deputy State Historic Preservation Officer for New Jersey, in accordance with 36 CFR Part 800: Protection of Historic Properties, as published in the Federal Register on December 12, 2000 (65 FR 77725-77739) and amended on July 6, 2004 (69 FR 40553-40555), I am providing consultation comments on the following proposed undertaking:

Ocean County, Township of Stafford and Borough of Ship Bottom
Route 72 Manahawkin Bay Bridge

This letter was prepared in response to your submission of a cover letter and a copy of the following report, received by the Historic Preservation Office (HPO) on December 1, 2009:

Leynes, Jennifer B. and Robert J. Lore. July 27, 2009. *Cultural Resources Investigation, Improvements to Route 72 Manahawkin Bay Bridges and Marsha Drive Intersection, Township of Stafford and Borough of Ship Bottom, Ocean County, New Jersey.* Cranbury, NJ: Richard Grubb & Associates, Inc. Prepared for PB Americas, Inc. and New Jersey Department of Transportation.

<u>800.4 Identifying Historic Properties</u>

The submitted report states that based upon the results of background research, previous archaeological investigations, environmental setting, and existing conditions, the APE-Archaeology has a low potential for significant prehistoric and historic period resources. The HPO concurs with this assessment.

The submitted report identified one new architectural resource, the Dorland J. Henderson Memorial Bridge (Route 72 over the Manahawkin Bay, Structure No. 1513-152) as eligible for listing in the New Jersey and National Registers of Historic Places for state level significance under Criterion C in the area of engineering for its low-level lighting system.

The HPO respectfully disagrees with this determination of eligibility. In addition to the information provided in the submitted report, HPO staff conducted additional research in an attempt to gain a better contextual understanding of post-war highway bridge construction with a focus on lighting systems and the extent to which this technology was utilized in other locations on future bridge projects. While the Dorland J. Henderson Memorial Bridge and particularly its low-level lighting system do retain integrity from the time of construction, HPO staff does not feel that the information available at this time sufficiently supports a level of significance that justifies register eligibility under Criterion C.

The HPO concludes that there are **no historic properties affected** by the proposed undertaking. Consequently, pursuant to 36 CFR 800.4(d)(1), no further consultation is required unless additional resources are discovered or there is a change in the scope of work during the project implementation pursuant to 36 CFR 800.13.

It should be noted that the history of Dorland Henderson and his low-level lighting system is intriguing and the well-known "string of pearls" effect produced by the lighting system has certainly made the bridge a familiar landmark for anyone traveling to or from Long Beach Island. The HPO commends the New Jersey Department of Transportation's commitment to replicate the low-level lighting system using modern technology on both the rehabilitated Dorland J. Henderson Memorial Bridge and the new bridge to be constructed parallel to the existing structure.

Thank you for providing the opportunity to review and comment on the potential for the above-referenced project to affect historic properties. Please do not hesitate to contact Jonathan Kinney of my staff at (609) 984-0141 with any questions.

Sincerely,

Daniel D. Saunders/km

Daniel D. Saunders
Deputy State Historic
Preservation Officer

Cc:

Timothy Hart, Ocean County Cultural and Heritage Commission
Robert Garthwaite, Ocean County Historical Society
Craig Brearly, Stafford Township Historic Preservation Commission
Timothy Hart, Stafford Township Historical Society
Jaime Ciardelli, Long Beach Island Historical Association
Mayor William Huelsenbeck, Borough of Ship Bottom
Mayor John McMenimon, Township of Stafford

United States Department of the Interior
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In Reply Refer To:
09-FA-0259

SEP 16 2009

John Pabish, GIS Specialist
Amy S. Greene Environmental Consultants, Incorporated
4 Walter E. Foran Boulevard, Suite 209
Flemington, New Jersey 08822

Subject: Route 72 – Manahawkin Bay Bridge Project, Ocean County New Jersey (AEGECI project # 3109)

Dear Mr. Pabishi:

The U.S. Fish and Wildlife Service (Service) has reviewed your requests dated May 7 and September 3, 2009 for information on federally listed species, significant habitats, and critical environmental areas for the new structures proposed for addition to the existing Manahawkin Bay Bridge.

AUTHORITY

This response is pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of federally listed endangered and threatened species and the Migratory Bird Treaty Act of 1918 (MBTA) (40 Stat. 755; 16 U.S.C. 703-712), as amended. These comments do not preclude separate review and comments by the Service as afforded by the Fish and Wildlife Coordination Act (48 Stat. 401; 16 U.S.C. 661 *et seq.*), if any permits are required from the U.S. Army Corps of Engineers pursuant to the Clean Water Act of 1977 (33 U.S.C. 1344 *et seq.*), or comments pursuant to the December 22, 1993 Memorandum of Agreement among the U.S. Environmental Protection Agency, New Jersey Department of Environmental Protection (NJDEP), and the Service, if project implementation requires a permit from the NJDEP pursuant to the New Jersey Freshwater Wetlands Protection Act (N.J.S.A. 13:9B *et seq.*), nor do they preclude comments on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

The Service concurs with your determination that the proposed project is not likely to adversely affect federally listed threatened or endangered species under Service jurisdiction or their critical habitats. No federally listed or proposed threatened or endangered species under Service jurisdiction are currently known to occur within the project area. No further consultation pursuant to Section 7(a)(2) of the ESA is required by the Service. If project plans change or new information on federally listed threatened or endangered species becomes available, this determination may be reconsidered.

OTHER SERVICE COMMENTS

Nesting habitat for terns (*Sterna* spp.) and colonial waterbirds occurs in the vicinity of the proposed project area. Loud construction noises can be expected during bridge construction and there is a high likelihood of nest interruption and/or abandonment. A seasonal restriction on project activities producing loud noises may be necessary between March 15 and August 15 during the breeding season. Migratory birds are a federal trust resource responsibility of the Service pursuant to the MBTA.

The commercially harvested hard clam (*Mercenaria mercenaria*) is the most valuable of the food species harvested in the bays. The densities of hard clams are highest in the open water and sandflats areas at the southern end of Barnegat Bay and in Little Egg Harbor. Estuarine, shallow waters and associated shellfish beds provide food for federal trust species such as migratory birds and fish, support commercial fisheries, and serve as important nurseries to the young of many marine and estuarine species (Day *et al.* 1989). In accordance with NJAC 7:7E-3.2(e), "New dredging within shellfish habitat is prohibited . . . ." The Service recommends that the applicant coordinate with the NJDEP and National Marine Fisheries Service to determine if project activities will be in compliance with applicable State statutes and consistent with federal concerns regarding fisheries.

The bay is an important spawning and nursery area for blue crab (*Callinectes sapidus*). Adult crabs can be found from late May, when crabs come out of their wintering habitat in the bottom sediments, until October when they return.

The northern diamondback terrapin (*Malaclemys terrapin*) lives and feeds in the bays, especially among the salt marsh islands, and nests above the high tide line on the back sides of barrier islands, sandy beaches, dredged material islands, dirt roads, causeways, and other suitable locations with sandy soil. Hibernating diamondback terrapins are susceptible to harm between November 1 and March 15.

The proposed project site is within Priority Wetlands designated by the Service pursuant to the Emergency Wetlands Resources Act of 1986 (100 Stat. 3582) because of National Significance. Consistent with the intent of the Service's Mitigation Policy (Federal Register, Vol. 46, No. 15, Jan. 23, 1981). The Service will likely recommend that losses be compensated by replacement of the same kind of habitat value so that populations of species may remain stable in the area over time (in-kind replacement). As noted in National studies performed by the National Research Council (2001) and the U.S. General Accounting Office (2001), the success rate for mitigation required by Clean Water Act Section 404 permits was not met in the last 20 years. In response to this finding, the U.S. Army Corps of Engineers and the Departments of Transportation and Interior, among other federal agencies, released a National Wetlands Mitigation Action Plan (U.S. Army Corps of Engineers *et al.* 2002) (Action Plan). The Action Plan identified 16 action items, which are under development by the federal inter-agency team. The applicant's mitigation plan should be developed with sufficient flexibility to ensure success while capturing the intent of the Action Plan. The Service is available to assist in the development of this mitigation and compensation plan. The mitigation plan should include the following provisions:

- All mitigation should be constructed prior to or concurrent with project implementation, when possible.
- The traditional authorizing method for monitoring should be increased from the traditional 5-year requirement to the life of the project (although the likelihood of success for tidal wetland mitigation is typically high). As a cost-saving measure, these additional monitoring efforts could be incorporated into the applicant's project maintenance schedule.
- All vegetation planting should be accomplished with native species.
- All mitigation shall meet a set of performance standards designed for success over the life of the project, including a detailed monitoring plan and reporting requirement.
- All temporary construction areas shall be restored to pre-construction grade.
- Upon completion of the proposed mitigation, a conservation easement, or similar real estate protective instrument, should be developed and filed with the appropriate federal, State or local agency, or non-governmental organization. A goal of the instrument should be to maintain the functions and values of all wetlands created for the life of the project.

The Service also recommends that, in association with the implementation of best management practices (BMPs), the applicant include provisions to control the spread of invasive species, such as *Phragmites australis*.

A draft Management Plan by the Chesapeake Bay Program's *Phragmites australis* Working Group (2003) includes recommendations to curb the spread of *Phragmites* through federal and State permit conditions, in order to help achieve a long-term goal of no net gain in *Phragmites* acreage. In the interim, the Service recommends that any Federal authorization resulting in wetland disturbance include conditions requiring: (1) BMPs to prevent the introduction or spread of *Phragmites*, such as avoiding creation of elevated berms and the spread or burial of *Phragmites* rhizomes; (2) 2 to 5 years of post-construction monitoring; and (3) control efforts if *Phragmites* is detected, including re-grading or performing hydrologic alterations.

If you have any question regarding the above, please contact Carlo Popolizio at 609-383-3938, extension 32.

Sincerely,

Ron Popowski
Assistant Supervisor

REFERENCES

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