Chapter 13: Energy and Climate Change

13-1 INTRODUCTION

The effect of the Tappan Zee Hudson River Crossing Project's operation on greenhouse gas emissions and energy use is assessed in this chapter. The project's operation would not substantially affect energy use and greenhouse gas emissions, and no quantified analysis is required. Energy use and greenhouse gas emissions associated with construction are analyzed in Chapter 18, "Construction Impacts," which also includes a description of the regulatory context and analysis methodology.

13-2 ENVIRONMENTAL EFFECTS

13-2-1 NO BUILD ALTERNATIVE

The No Build Alternative would not change energy use or greenhouse gas emissions. Vehicles using the facility would continue to do so, with emissions per vehicle declining in future years (due to federal regulation of emissions and fuel economy for new vehicles) and total vehicle miles increasing (due to growth), potentially outpacing the emission reductions. Bridge maintenance would continue to require materials and energy use resulting in greenhouse gas emissions. The New York State Thruway Authority (NYSTA) estimates that it would spend $1.3 billion to maintain and repair over the next decade. Major work activities would include seismic upgrades to portions of the bridge, navigational safety improvements, steel and concrete repairs, and other miscellaneous work to continue to keep the bridge safe for the traveling public. Furthermore, heavy congestion occurring due to vehicle accidents and breakdowns on the bridge, where no shoulder is available to clear the roadway, would persist, resulting in avoidable fuel consumption and greenhouse gas emissions.

13-2-2 REPLACEMENT BRIDGE ALTERNATIVE

As compared to the No Build Alternative, the Replacement Bridge Alternative would not increase traffic volumes or reduce vehicle speeds (see Chapter 4, "Transportation"). Therefore, fuel consumption and greenhouse gas emissions would be largely unaffected by the Replacement Bridge Alternative. However, a few features of the Replacement Bridge Alternative would result in some energy and greenhouse gas benefit as compared to the No Build Alternative:

- There are frequent accidents on the existing bridge, which can result in substantial vehicle delays, as described in Chapter 1, "Purpose and Need." The existing bridge has lanes that range in width from 11 feet, 2 inches to 12 feet. All of the traffic lanes on the bridge would be 12 feet wide, improving safety on the bridge. The bridge would also include wide shoulders for vehicles involved in accidents and breakdown incidents and for emergency vehicle access, improving the traffic flow and reducing the substantial delays that these incidents cause. Overall, the improvement in lane

widths and the addition of shoulders would substantially improve incident management and reduce the propensity for substantial vehicle delays.

- The introduction of three highway-speed E-ZPass lanes allowing vehicles to proceed at 65 mph through the lanes (replacing the two existing 35 mph lanes) would reduce fuel consumption associated with congestion and idling vehicles at the toll plaza.
- The bridge would have four lanes in each direction, eliminating the need to move the median barriers twice daily (currently accomplished using a specialized diesel engine, which takes approximately half an hour for each switch) and improving traffic flow during those times.

13-3 MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS

The operation of the Replacement Bridge Alternative would result in some local reduction in traffic congestion on the bridge. The net GHG emissions associated with the Replacement Bridge Alternative would include construction emissions presented in Chapter 18, “Construction”, which would not be offset by these operational benefits. However, consistent with New York State policies aimed at increasing energy efficiency and the use of renewable energy, designed to reduce statewide GHG emissions to 80 percent lower than 1990 levels by 2050, the following energy efficiency and renewable energy components would be included in the project design where practicable:

- ***Heat Exchange Pumps*:** Concrete can be an efficient platform for heat exchange. Systems embedded in concrete in the bridge and landing area on the Westchester County side could supply renewable heating and cooling for facilities in the toll plaza area. The construction contract bid documents will require proposals to include options for efficient and renewable energy design for the toll plaza facilities, and will include them where found to be practicable.
- ***Efficient Lighting:*** As with most new facilities, the bridge will incorporate efficient lights. To increase lighting efficiency, daylight sensor switching systems could be incorporated throughout the bridge. Using independent switching throughout the bridge would not only reduce energy consumption by operating lights only at times when they are needed, but would also reduce the need for considerable wiring to connect lights throughout the bridge with centralized switching and timer systems. This would further reduce both direct energy consumption and indirect emissions associated with production of electrical wiring and systems.

In addition, NYSTA and the New York State Department of Transportation (NYSDOT) will consider options to incorporate renewable energy production to support operations associated with the replacement bridge. As design progresses, the feasibility of these measures would be explored and incorporated where practicable.

Overall, given the efforts to reduce GHG emissions throughout the lifetime of the replacement bridge (during both construction and operation of the project), the project would be consistent with all state policies aimed at reducing GHG emissions.

13-4 MITIGATION

Since the operation of the Replacement Bridge Alternative would have no adverse impact on energy use and greenhouse gas emissions, mitigation would not be required.

Chapter 14: Topography, Geology, and Soils

14-1 INTRODUCTION

This chapter describes existing topography, geology, and soils in the study area; potential environmental effects of the project alternatives on these resources.

Topography addresses issues related to slopes. Geology considers both bedrock (e.g., sandstone, shale, gneiss, etc.) and unconsolidated surficial deposits (e.g., sand, gravel, clay, etc.). The section on soils considers the uppermost layer of the ground, which has been exposed to climatic and erosive forces. Impacts to topography, geology, and soils are primarily associated with construction activities, which are discussed in more detail in Chapter 18, "Construction Impacts." As detailed in the analyses below, operation of the project would not result in any adverse impacts to these resources.

14-2 REGULATORY CONTEXT

The regulatory implications of geology are generally established through building codes or other engineering criteria that dictate design requirements for project elements. Examples include design codes for earthquake resistance and bearing capacity of foundations. Seismic design requirements for roadway and bridge structures, for example, are prescribed by the American Association of State Highway and Transportation Officials (AASHTO) and the New York State Department of Transportation (NYSDOT) in its *Bridge Safety Assurance* and *Blue Pages* manuals. Such codes and criteria are typically accounted for during detailed design of project-related structures.

The New York State Department of Environmental Conservation (NYSDEC) administers the State Pollutant Discharge and Elimination System (SPDES) program that protects waterways from soil erosion and pollutant impacts during construction and operation of projects under the authority of the federal Clean Water Act of 1972 (CWA). While this chapter addresses impacts related to ground disturbance, surface water runoff and the SPDES program are discussed further in Chapter 15, "Water Resources," and Chapter 18, "Construction Impacts." Prime farmland soils are protected and regulated by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA) under the *Farmland Protection Policy Act (FPPA)*. However, this is not applicable to the study area for this project.

14-3 METHODOLOGY

The potential for impacts to topography, geology, and soils is related to direct ground disturbance (also referred to as the "limit of disturbance"). The study area evaluated for this chapter is coterminous with the proposed limit of disturbance boundary, and is shown on the figures that accompany this chapter.

Topographic and slopes data for the study area are based on Geographic Information Systems (GIS) resources for Rockland and Westchester Counties. Other sources include the NRCS, the U.S. Geological Survey (USGS), and the New York State Geological Survey (NYSGS). Bedrock and surficial geologic conditions are based on published maps for the southern New York region. Soils data are provided by soil surveys from the NRCS (formerly the Soil Conservation Service).

14-4 AFFECTED ENVIRONMENT

This section characterizes existing topographic, geologic, and soils conditions in the study area. As discussed above, existing conditions are largely based on available mapping and surveys of the study area, as well as preliminary geotechnical investigations conducted by Mueser Rutlege Consulting Engineers (MRCE). More extensive geotechnical investigations would occur during final design of the project.

14-4-1 TOPOGRAPHY

The study area is located within the Hudson River Valley and is primarily characterized by rolling topography with steeper embankments along the Hudson River shoreline. As shown on **Figure 14-1**, the study area ascends from the shoreline to approximately 200 feet above sea level at South Broadway. Just west of the study area in Rockland County, a prominent ridge results in an abrupt change in elevation. This ridge is commonly referred to as “the Palisades.”

As shown on **Figure 14-2**, the majority of the study area comprises minimal slopes (i.e., 0-15 percent). The area along the Hudson River in Westchester County exhibits steeper slopes ranging between 25 and 35 percent. The Hudson River shoreline in Rockland County also exhibits some slopes, but they are primarily less than 15 percent. The existing Interstate 87/287 is elevated over the areas of steeper slopes and touches ground in more level areas of the study area.

14-4-2 GEOLOGY

14-4-2-1 BEDROCK GEOLOGY

The Rockland County portion of the study area is underlain by sedimentary rock of the Newark Group. Published geologic maps indicate that this bedrock is of the Brunswick formation (Trba), comprising mudstone, sandstone, and arkose (see **Figure 14-3**). Just west of the study area is a notable north-south trending geologic feature classified as Palisade Diabase (Trp), forming the Palisades ridge discussed above.

The Brunswick formation extends under the western portion of the Hudson River. Near the western shoreline, bedrock is located at approximately 60 feet below mean sea level (MSL) but drops abruptly to more than 700 feet below MSL (Worzel and Drake, 1959) due to a pre-glacial river channel. Near the middle of the Hudson River, bedrock is located between 220 and 270 feet below MSL. **Figure 14-4** provides a cross-section of the Hudson River’s geological characteristics.

The eastern section of the Hudson River is underlain by metamorphic rock identified as Fordham gneiss, which extends into the Westchester County portion of the study area. Two subcategories of Fordham gneiss are located in this area: 1) fe: garnet-biotite-quartz-

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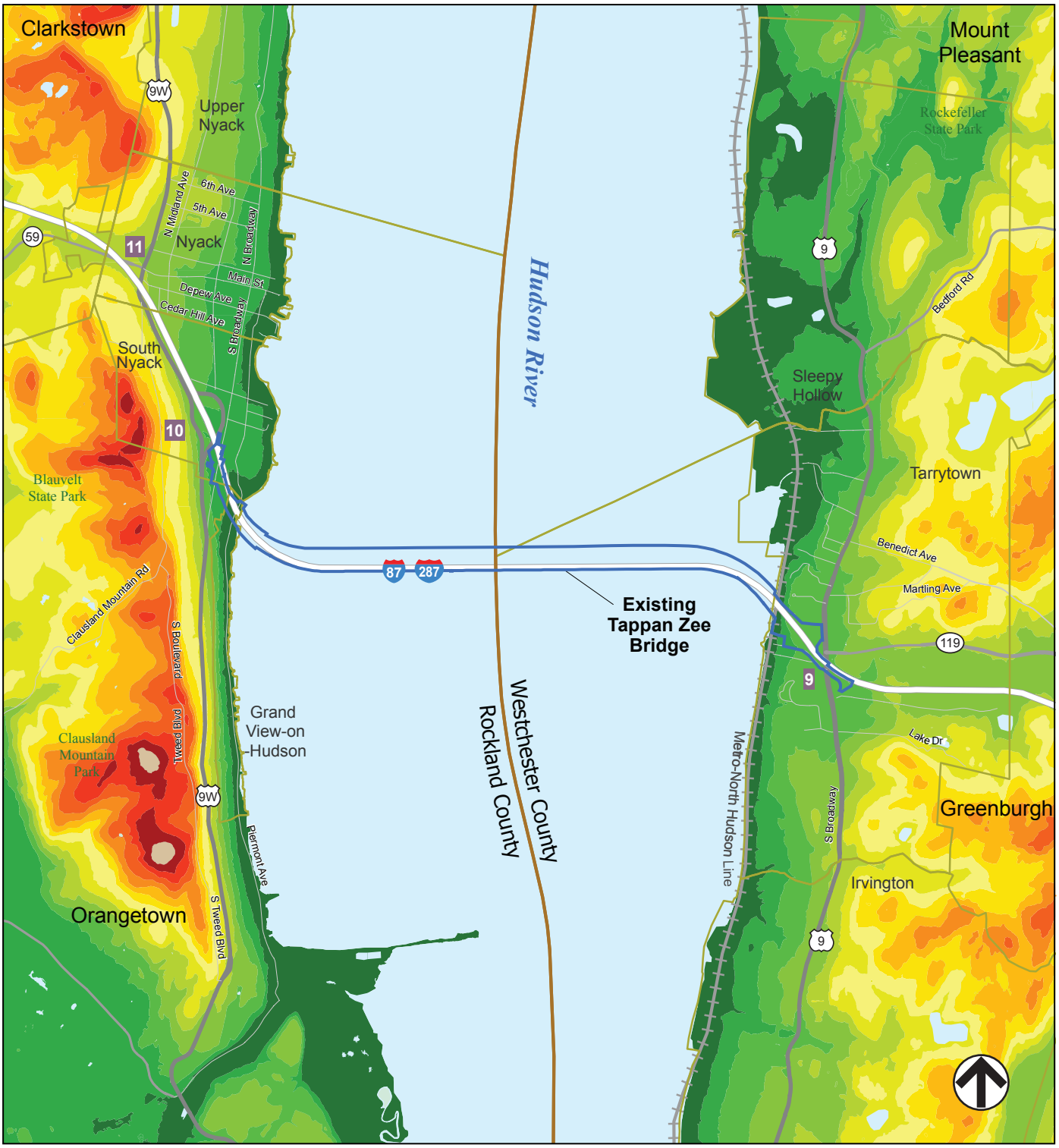

Study Area	200-249	450-499
0-49	250-299	500-549
50-99	300-349	550-599
100-149	350-399	600-649
150-199	400-449	650-699

Elevations in Feet

0 1/2 1 MILE
SCALE

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Figure 14-1
Existing Topography

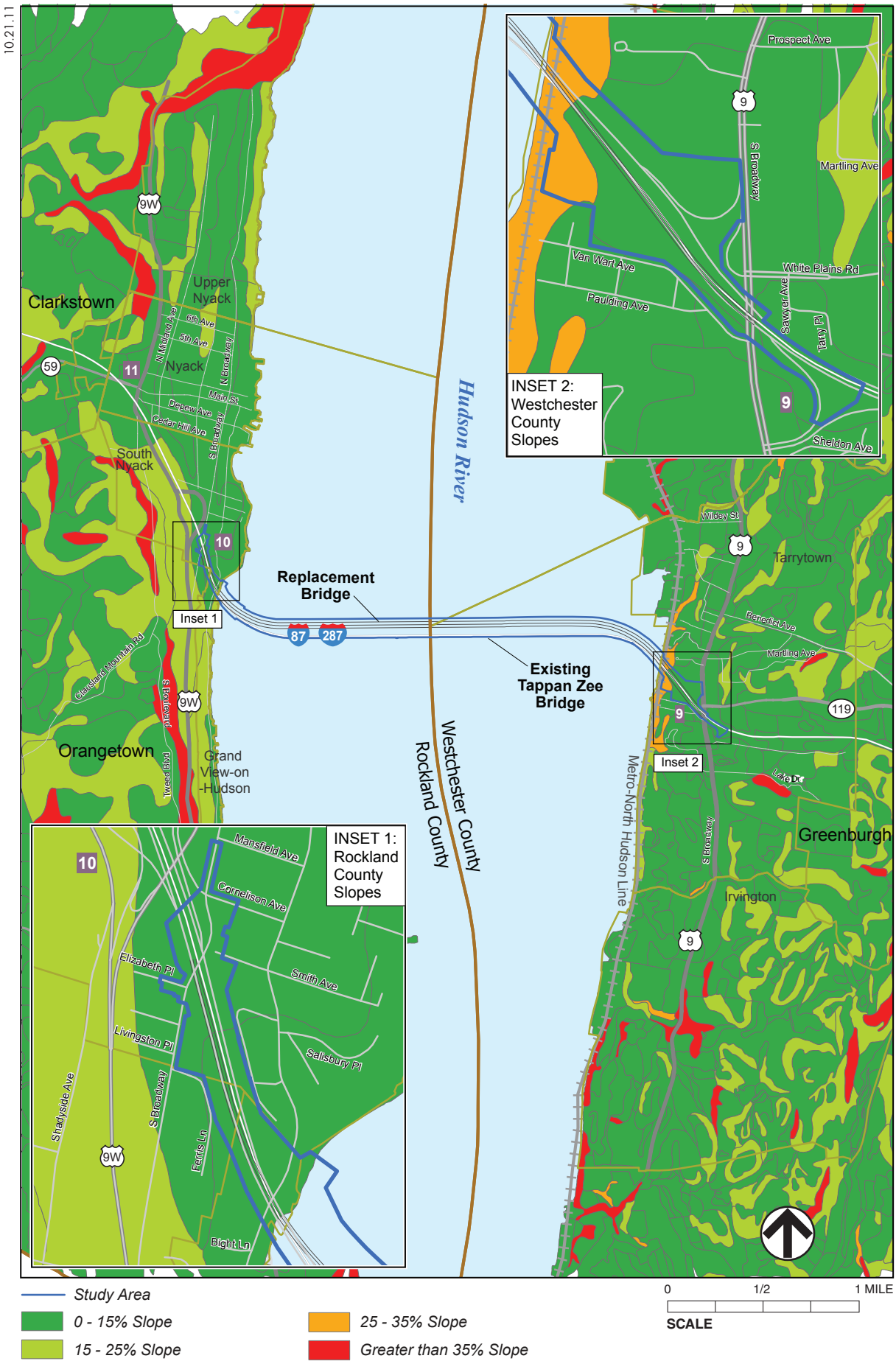

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Figure 14-2
Existing Slopes

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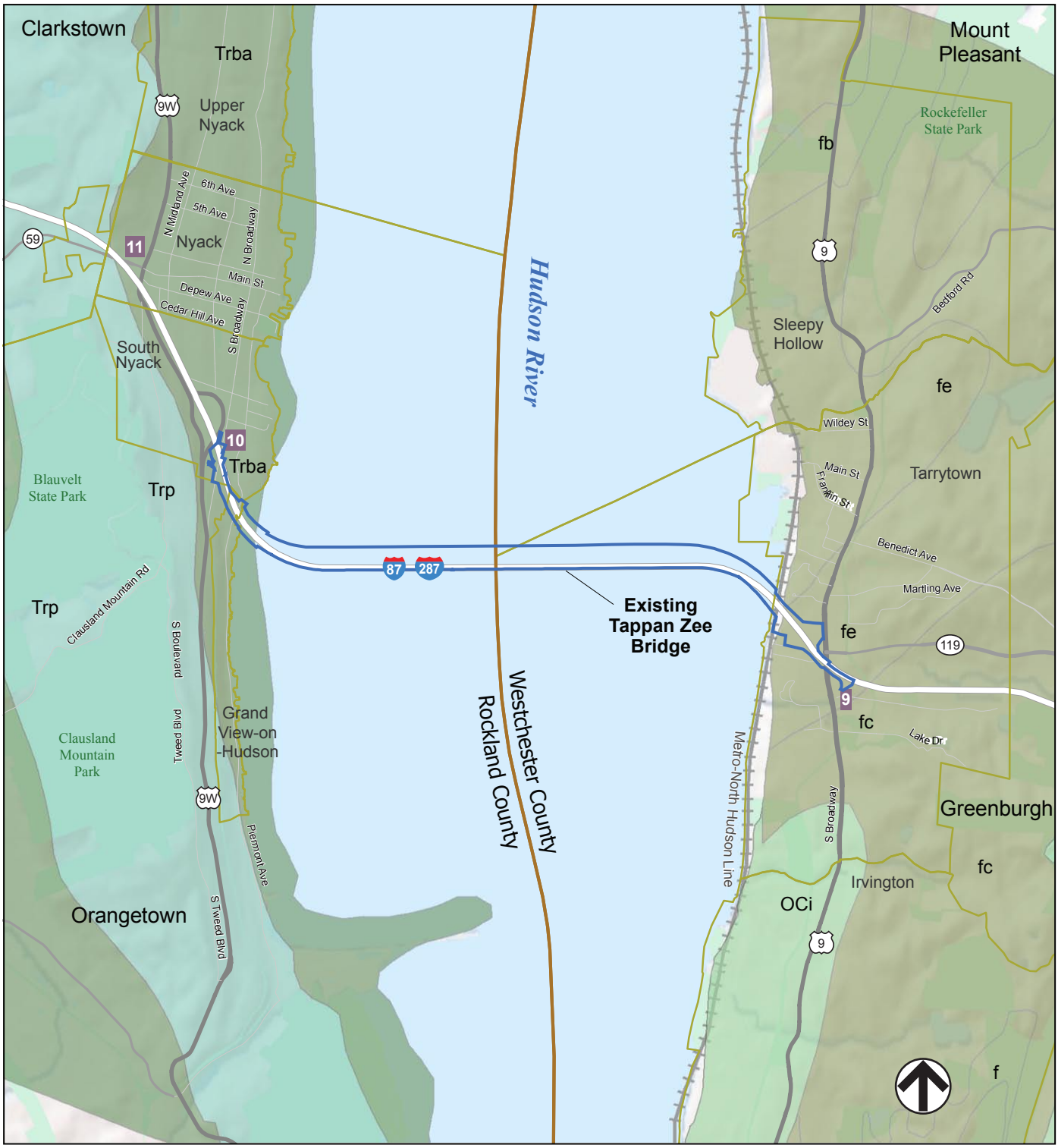

Study Area

Trp - Palisade Diabase Sill

Trba - Brunswick Formation

fc/fe - Fordham Gneiss

0 1/2 1 MILE

SCALE

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Environmental Impact Statement

Figure 14-3
Bedrock Geology

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Environmental Impact Statement

Figure 14-4
Geologic Cross Section

plagioclase gneiss and amphibolite; and 2) fc: biotite-hornblende-quartz-plagioclase gneiss, quartz-feldspar lenses, amphibolite, biotite, and/or hornblende-quartz-feldspar gneiss.[1]

The results of the geotechnical investigation and boring logs prepared by MRCE are consistent with the geology mapping of this area.

14-4-2-2 SURFICIAL GEOLOGY

The surficial geology of the study area is shown on **Figure 14-5**. Maps of unconsolidated deposits indicate that the surficial geology of the Rockland County portion of the study area comprises till with the following characteristics: "variable texture (e.g., clay, silt-clay, boulder clay), usually poorly sorted diamict, deposition beneath glacial ice, relatively impermeable (loamy matrix), variable clast content."[2]

The surficial geology of the Westchester County portion of the study area is primarily characterized as bedrock. However, just north of Interstate 87/287, bedrock is overlaid by artificial fill, deposited for development purposes. The surficial geology of the far eastern portion of the study area is characterized by till.

The surficial geology of the Hudson River bottom primarily comprises organic silt and clay with traces of shells, decayed roots, and peat (Mueser Rutledge, 2008). The upper portion of this deposit is approximately 10 to 150 feet thick.

14-4-2-3 SEISMIC CONDITIONS

According to the Seismic Zoning Map for the New York State Seismic Building Code (Multidisciplinary Center for Earthquake Engineering Research, 2002), the study area is in a region with the potential for an earthquake. The USGS "Earthquake Probability Map" estimates that there is a 15 to 18 percent probability of an earthquake of magnitude 4.75 or higher occurring in the study area within the next 100 years. General earthquake probability in Rockland and Westchester Counties is similar. The Ramapo (or Ramapo-Canopus) Fault is the largest structure and only known active fault in proximity to the study area. This fault extends northeastward from New Jersey, through Suffern, and along the eastern edge of the Hudson Highlands, approximately 12 miles west of the study area.

14-4-3 SOILS

The NRCS (formerly Soil Conservation Service) identifies major classifications of soils that have similar characteristics (such as texture and drainage) into a series. Within each series, soils differ in slope and other characteristics that affect their use. On the basis of these differences, soil series are further divided into phases (soil map units). Different soil phases exhibit variable water storage, erosion potential, and other characteristics that are important from a development perspective.

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[1] Fisher et. al. 1970. Geologic Map of New York, Lower Hudson Sheet. New York State Museum.

[2] Cadwell et al. 1986. Surficial Geologic Map of New York, Lower Hudson Sheet. New York State Geologic Survey.

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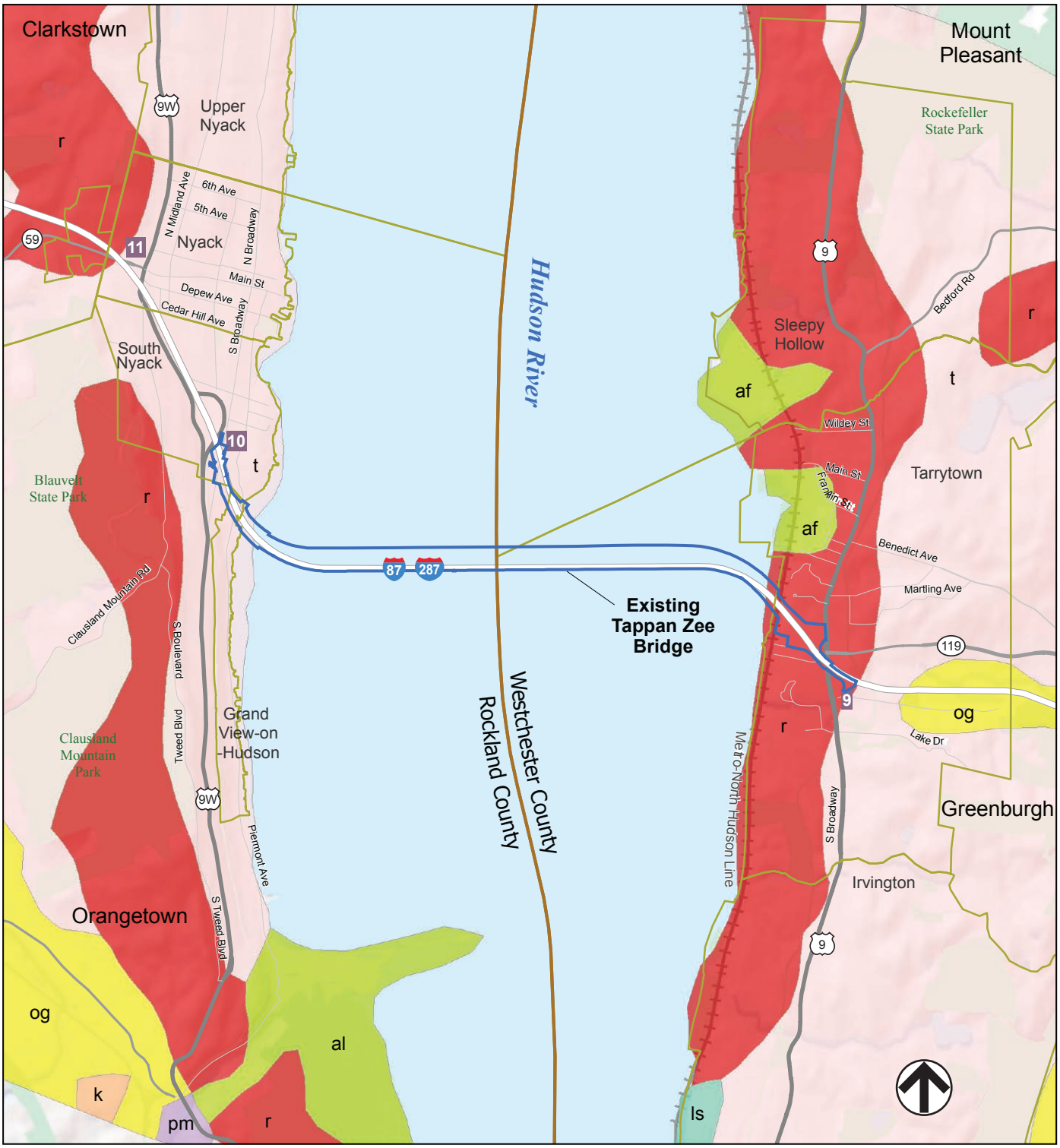

Study Area

af - Artificial Fill

og - Outwash Sand and Gravel

r - Bedrock

t - Till

0 1/2 1 MILE

SCALE

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Environmental Impact Statement

Figure 14-5
Surficial Geology

Table 14-1 contains a complete list of the soil mapping units located within the study area and lists their primary characteristics. The spatial arrangement of these soil types, as mapped by the NRCS Soils Survey of Rockland County (1990) and the Soil Survey of Putnam and Westchester Counties (1994), is shown on **Figure 14-6**.

Table 14-1
Soils in the Study Area

Symbol	Soil Series Name	Depth to Bedrock	Depth to Water Table	Characteristics
Rockland County				
WuB	Wethersfield-Urban land complex, 2 to 8 percent slopes	More than 60 inches	1.5 to 2.5 feet below the surface from February to April	Well drained. Permeability is moderate in the surface layer and subsoil and slow or very slow in the substratum. Main limitation for development of local roads and streets is seasonal wetness and frost action. Erosion hazard is moderate, surface runoff medium, and water capacity moderate. “K” Factor: 0.24 to 0.32. Hydrologic Group is C.
WuC	Wethersfield-Urban land complex, 8 to 15 percent slopes	More than 60 inches	1.5 to 2.5 feet below the surface from February to April	Well drained. Permeability is moderate in the surface layer and subsoil and slow or very slow in the substratum. Main limitation for development of local roads and streets is seasonal wetness, frost action, and slope. Erosion hazard is severe, surface runoff rapid, and water capacity moderate. “K” Factor: 0.24 to 0.32. Hydrologic Group is C.
Westchester County				
ChB	Charlton loam, 2 to 8 percent slopes	More than 60 inches	At a depth of more than 6 feet throughout the year	Well drained. Permeability is moderate or moderately rapid throughout the profile. No major limitations for local roads and streets. Erosion hazard is slight, surface runoff is medium, and water capacity is moderate. “K” Factor: 0.24. Hydrologic Group is B. Capability subclass is IIe.
ChC	Charlton loam, 8 to 15 percent slopes	More than 60 inches	At a depth of more than 6 feet throughout the year	Well drained. Permeability is moderate or moderately rapid throughout the profile. Main limitation for local roads and streets is slope. Erosion hazard is moderate, surface runoff is medium, and water capacity is moderate. “K” Factor: 0.24. Hydrologic Group is B. Capability subclass is IIIe.
ChE	Charlton loam, 25 to 35 percent slopes	More than 60 inches	At a depth of more than 6 feet throughout the year	Well drained. Permeability is moderate or moderately rapid throughout the profile. Main limitation for local roads and streets is slope. Erosion hazard is very severe, surface runoff is very rapid, and water capacity is moderate. “K” Factor: 0.24. Hydrologic Group is B. Capability subclass is VIe.
Uf	Urban land	---	---	Developed land.
UlC	Urban land-Charlton-Chatfield complex, rolling, very rocky	24 inches, fractured granitic bedrock	More than 60 inches	Well drained. Permeability is moderate or moderately rapid throughout the profile. Main limitation for local roads and streets is variable depth to bedrock and frost action. Erosion hazard is severe during construction, surface runoff is rapid, and water capacity is moderate.

Note: “K” Factor given indicates the erosion potential of each soil type. This indicates the susceptibility of a soil to sheet and rill erosion by water. Values of “K” range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to erosion.

Sources: Soil Survey of Rockland County, New York, USDA Soil Conservation Service (now NRCS)
Soil Survey of Putnam and Westchester Counties, New York, USDA Soil Conservation Service (now NRCS)

The primary concerns related to soils are erosion and suitability for construction. Erosion characteristics for the soils in the study area range from moderate to very severe. The main limitations for construction of roadways are slopes, variable depth to

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0 1000 FEET

SCALE

Rockland County

0 1000 FEET

SCALE

Westchester County

Study Area	
WuB	*Wethersfield-Urban Land Complex, 2-8% Slopes*
WuC	*Wethersfield-Urban Land Complex, 8-15% Slopes*
ChB	*Charlton Loam, 2-8% Slopes*
ChC	*Charlton Loam, 8-15% Slopes*
ChE	*Charlton Loam, 25-35% Slopes*
Uf	*Urban Land*
UlC	*Urban Land-Charlton-Chatfiled Complex, Rolling, Very Rocky*

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 14-6
Soils Map

bedrock, and frost action, all of which are common for this region. Grading, erosion and sediment control plans, and other engineering measures can and will be put in place to overcome these limitations.

14-5 ENVIRONMENTAL EFFECTS

14-5-1 NO BUILD ALTERNATIVE

Under the No Build Alternative, the existing Tappan Zee Bridge and its approaches would continue to function and operate under existing conditions. There are no planned roadway or bridge improvements in this area, other than maintenance and upkeep of the Tappan Zee Bridge. As such, there would be no impacts to topography, geology, or soils under the No Build Alternative. Although some seismic retrofits would be undertaken, the bridge would be more susceptible to earthquakes than a new bridge would be.

14-5-2 REPLACEMENT BRIDGE ALTERNATIVE

Potential impacts related to topography, geology, and soils would be primarily associated with construction, which are described in Chapter 18, “Construction Impacts.” Any potential impacts relevant to operation of the project are discussed below. The limit of disturbance area for each bridge option would be essentially the same. Therefore, both options are analyzed together below, with differences in the evaluation noted where applicable.

14-5-2-1 TOPOGRAPHY

The Replacement Bridge Alternative would not result in any substantial changes to topography or steep slopes. In Westchester County, the roadway would be elevated over the area of steep slopes (25-35 percent) along the Hudson River shoreline. In Rockland County, substantial regrading (using approximately 147,400 cubic yards of fill) would be required for the Long Span Option to elevate the ground for the bridge approach. As discussed further in Chapter 18, “Construction Impacts,” engineering methods, including retaining walls, would be used to ensure that the ground is stabilized and could adequately support the bridge structure. Further, the project would comply with any applicable post-construction stormwater pollution prevention plans (SWPPP) and erosion and sediment control (ESC) plans to avoid long-term erosion and landslide hazards. Therefore, no adverse impacts related to topography and steep slopes from the Replacement Bridge Alternative would be expected.

14-5-2-2 GEOLOGY

Construction of the Replacement Bridge Alternative would require excavation of earth material, which is detailed further in Chapter 18, “Construction Impacts.” The Replacement Bridge Alternative would be designed in accordance with the existing geologic conditions of the study area, as determined through geotechnical investigations. Bridge piers and piles would be secured into bedrock to the extent possible. Because bedrock drops to more than 700 feet below MSL under western sections of the Hudson River, some piers and piles would be secured into a layer of glacial varved silt and clay or till. Piles would be of sufficient diameter and be driven to sufficient depths in the ground to ensure that the bridge structure is adequately

supported. Therefore, no adverse impacts to geologic resources would result from the Replacement Bridge Alternative.

Seismic Conditions

Given its location, the Replacement Bridge Alternative would be susceptible to earthquakes. The Replacement Bridge Alternative would be designed in accordance with seismic structural criteria for the downstate New York region established by AASHTO and NYSDOT. These design standards have been developed to ensure the structural integrity of bridges remains intact during seismic events of magnitudes that can be reasonably expected in this region. The Replacement Bridge Alternative would be a substantial improvement over the existing Tappan Zee Bridge, which pre-dates current seismic design standards and is considerably more vulnerable to earthquakes.

14-5-2-3 SOILS

The primary concerns with respect to soils are erosion and suitability for construction. Erosion would primarily be a potential impact during construction, as soils would be exposed to wind, rain, and other erosive forces (see Chapter 18, “Construction Impacts,” for further discussion.) Any areas of soil exposed during construction would be developed with highway improvements or maintenance facilities, or would be revegetated. As such, erosion would not be a substantial concern during operation of the project. Further, the project would operate in accordance with any NYSDEC-approved SWPPP and ESC plan to minimize long-term erosion hazards. Further, existing soils in the study area do not exhibit any severe limitations to roadway development, as described above. Therefore, no adverse impacts to soils would result from the Replacement Bridge Alternative.

14-6 MITIGATION

As the Replacement Bridge Alternative would not result in any adverse effects on topography, geology, and soils, no mitigation measures would be required.

15-1 INTRODUCTION

This chapter describes existing groundwater, floodplain, and surface water resources in the study area and presents potential impacts of the operation of the No Build and Replacement Bridge Alternatives. The chapter concludes that the project would not result in adverse impacts on water resources. Freshwater wetlands, tidal wetlands, and ecological resources within the Hudson River and the potential impacts to these resources from the operation of the No Build and Replacement Bridge Alternatives are discussed in Chapter 16, "Ecology." Chapter 18, "Construction Impacts," assesses the potential environmental impacts from the construction of the Replacement Bridge Alternative.

15-2 REGULATORY CONTEXT

The Replacement Bridge Alternative has the potential to affect groundwater and surface water resources from the discharge of stormwater runoff, floodplains due to alignment modification, and river bottom sediments (i.e. scour and deposition) due to changes in river flow around the new bridge piers. Activities within the floodplain, and discharges to surface water and groundwater must comply with the federal and state legislation and regulatory programs as described below.

- ***Clean Water Act (33 USC §§ 1251 - 1387).*** The objective of the Clean Water Act, also known as the Federal Water Pollution Control Act, is to restore and maintain the chemical, physical, and biological integrity of the waters of the United States. It regulates point sources of water pollution, such as discharges of municipal sewage, industrial wastewater, and stormwater runoff; the discharge of dredged or fill material into navigable waters and other waters; and non-point source pollution (e.g. runoff from streets, construction sites, etc.) that enter water bodies from sources other than the end of a pipe. Applicants for discharges to navigable waters in New York must obtain a Water Quality Certificate from NYSDEC.
- ***National Wild and Scenic Rivers Act of 1968 (16 USC §§ 1271-1287).*** Under Section 7 of the National Wild and Scenic Rivers Act, federal agencies with "water resources" projects (defined as those that would affect the free-flowing nature of the river)—including projects that require permits from the USACE—must consult with the river-administering agency regarding effects to rivers that are part of the National Wild and Scenic Rivers System, designated as Study Rivers under Section 5(a) of the National Wild and Scenic Rivers Act, or listed on the Nationwide Rivers Inventory. However, no portion of the Hudson River is classified as a National Wild and Scenic River.
- ***Hudson River Valley National Heritage Area.*** Congress designated the Hudson River Valley National Heritage Area under Title IX of Public Law 104-333 (1996), as

amended by Section 324 of Public Law 105-83 (1997). The National Heritage Area extends from Yonkers, New York to Troy, New York, comprising the 10 counties of Albany, Rensselaer, Columbia, Greene, Ulster, Dutchess, Orange, Putnam, Westchester, and Rockland, and the Village of Waterford in Saratoga County. The Hudson River Valley National Heritage Area Act of 1996 has the following purposes:

> (1) To recognize the importance of the history and the resources of the Hudson River Valley to the Nation.
>
> (2) To assist the State of New York and the communities of the Hudson River Valley in preserving, protecting, and interpreting these resources for the benefit of the Nation.
>
> (3) To authorize Federal financial and technical assistance to serve these purposes. (Public Law 104-333 Title IX Sec. 903)

The Hudson River Valley Greenway Communities Council and the Greenway Conservancy serve as the management entities, and must develop a management plan for the National Heritage Area. The Hudson River Valley National Heritage Area Management Plan was approved by the Secretary of the Interior in 2002. The Management Plan's goals include, among others, to safeguard and enhance the area's natural heritage through conservation of its resources.

- ***National Flood Insurance Act of 1968 (44 CFR § 59) and Floodplain Management Executive Order 11988 (42 FR 26951).*** Development in floodplains defined by Federal Emergency Management Agency (FEMA) mapping is regulated at the federal level by the Floodplain Management Executive Order 11988 and National Flood Insurance Act of 1968 (44 CFR § 59). Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.
- ***Section 1424(e) of the Safe Drinking Water Act.*** Section 1424(e) of the Safe Drinking Water Act of 1974 [P.L. 93-523] authorizes the Administrator of the US Environmental Protection Agency (USEPA) to designate an aquifer for special protection if it is the sole or principal drinking water resource for an area (i.e., supplies 50 percent or more of the drinking water in a particular area), and if its contamination would create a significant hazard to public health. No commitment for federal financial assistance may be entered into for any project that the Administrator determines may contaminate such a designated aquifer so as to create a significant hazard to public health.
- ***Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.*** To the greatest extent practicable and permitted by law, and consistent with the principles set forth In the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-

income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Marian islands.

- ***Floodplain Management Criteria for State Projects (6 NYCRR § 502).*** The implementation of Part 502 by all State agencies will insure that the use of State lands and the siting, construction, administration and disposition of State-owned and State-financed facilities are conducted in ways that will minimize flood hazards and losses.
- ***State Pollutant Discharge Elimination System (SPDES) (ECL Article 17; 6 NYCRR Part 750).*** Title 8 of ECL Article 17 authorized the creation of SPDES to regulate discharges to New York State's waters. Activities requiring a SPDES permit include point source discharges of wastewater into surface or groundwater of the state, including the intake and discharge of water for cooling purposes, constructing or operating a disposal system (sewage treatment plant), discharge of stormwater runoff, and construction activities that disturb one or more acres.

15-3 METHODOLOGY

The study area for the evaluation of impacts to groundwater, floodplains, and water quality comprises the area extending ½ mile north and south of the Interstate 87/287 right-of-way generally between Interchange 10 (US Route 9W) in Rockland County and Interchange 9 (US Route 9) in Westchester County (see **Figure 15-1**). This study area incorporates the portions of the roadway and bridge landings included within which stormwater management measures would be implemented as part of the project.

Primary data sources used to identify and characterize surface and groundwater resources, and floodplains include the United States Geological Survey (USGS) National Hydrographic Dataset (NHD), New York State Department of Environmental Conservation (NYSDEC) surface water classification system, National Oceanic and Atmospheric Administration (NOAA) navigation charts, FEMA Flood Insurance Rate Maps (FIRM), water quality data from the USGS gauge station south of Poughkeepsie (#01372058), water and sediment quality data from the NYSDEC's Hudson River Benthic Mapping Project, and results of surface water and sediment quality sampling, high-resolution acoustic survey to estimate the depth, volume and distribution of (post-1930) industrial era (i.e., 20th Century) sediments, bathymetric, tidal, suspended solid concentration (SSC), and current studies conducted for this project.

In 2006 and 2008, water quality data were collected for the project to better characterize water quality conditions within the study area in the vicinity of the Tappan Zee Bridge (see **Figure 15-2**) and to provide data required as inputs for hydrodynamic and sediment transport modeling.

Two sediment-sampling programs were also implemented in 2006 and 2008 to gather data about the physical and chemical characteristics of Hudson River sediments within the study area. Both programs used vibracore samplers to obtain 4-inch-diameter sediment cores from 38 locations, as shown on **Figure 15-3**. Except where the vibracore device encountered refusal at shallower depths, each vibracore was driven to a depth of at least 6 feet.

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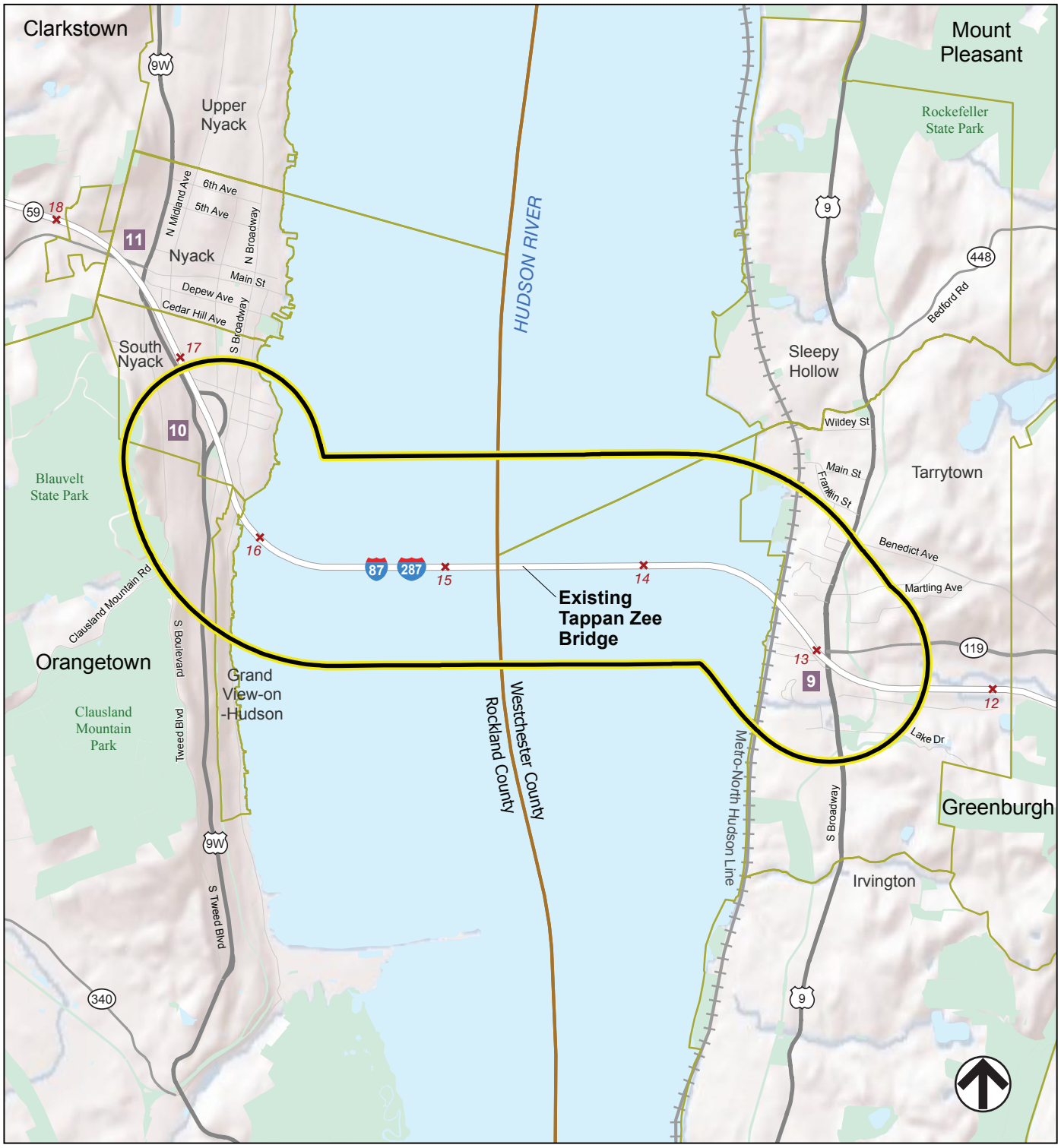

Study Area
15 Mile Post
Municipal Boundary
County Boundary
Railroad
14 Interchange Number
87 Interstate Highway
9W U.S. Highway
59 State Highway
Other Major Road

0 1/2 1 MILE
SCALE

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 15-1
Study Area

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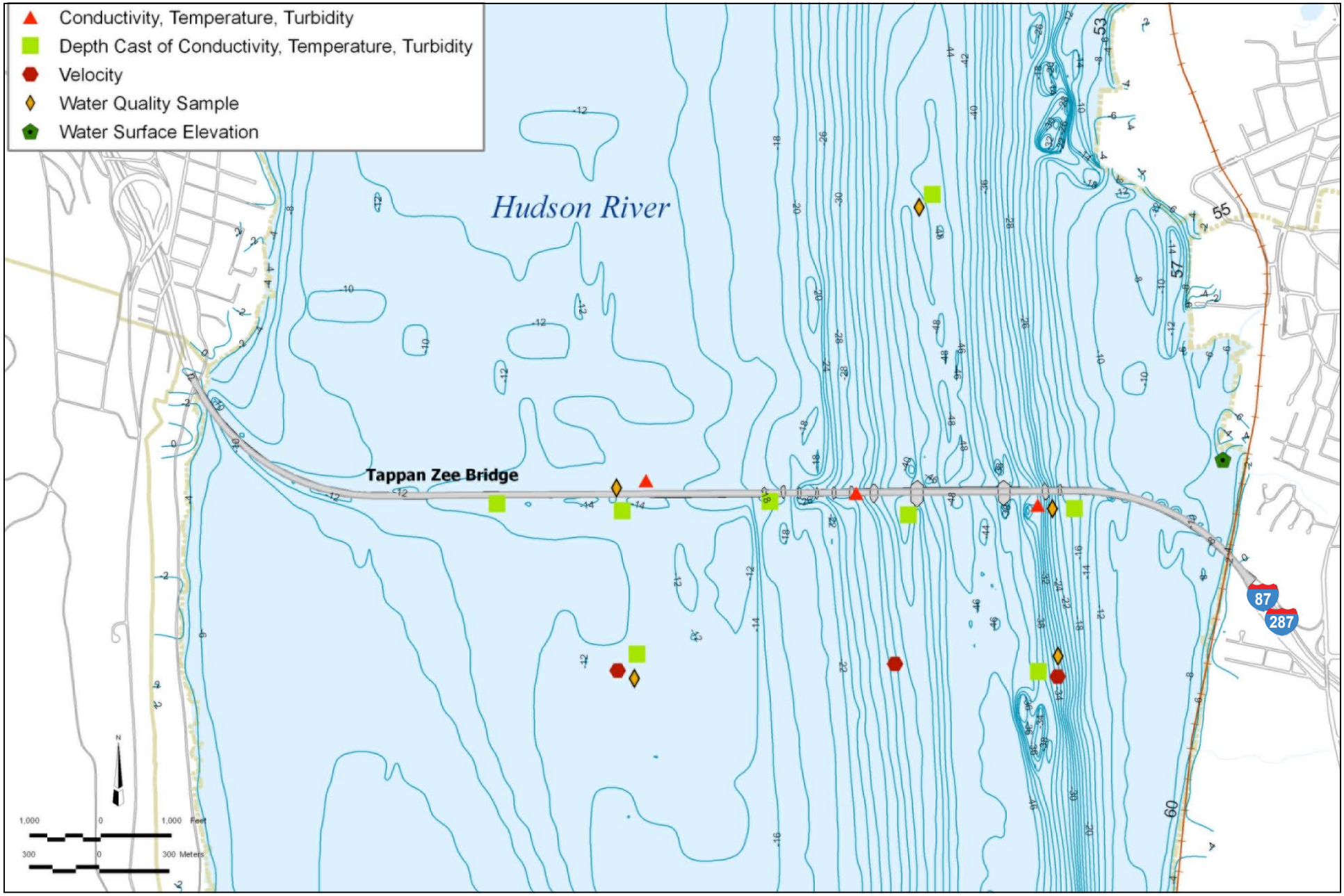
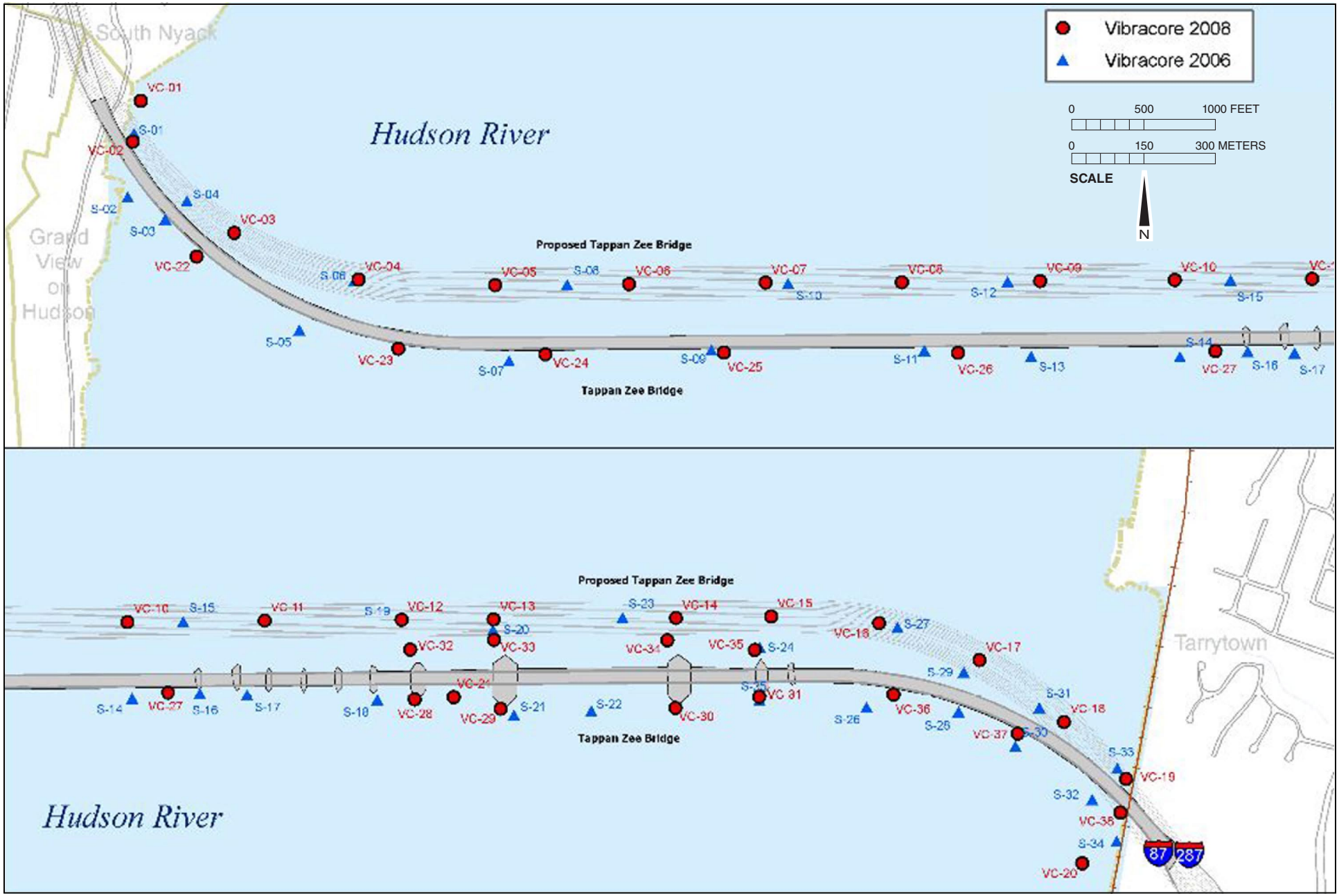


TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 15-2
Bathymetry



TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 15-3
Sediment Sample Locations

A total of 156 samples from 38 cores were submitted for sediment chemistry analyses, including Semivolatile Organic Compounds (SVOCs)-base/neutral fraction, pesticides, Polycyclic Aromatic Hydrocarbons (PAHs) and metals. A subset of 17 samples from 10 cores was submitted for dioxins analysis. Eighty samples form 36 cores were submitted for geotechnical analyses that included grain-size analysis, Atterberg[1] limits, water content, visual classification[2], and unit weight analysis.

With the project, stormwater runoff discharged to the Hudson River from the replacement bridge could affect the Hudson River's water quality and aquatic habitats. Additionally, the new bridge piers have the potential to result in scouring of the river bottom, and deposition of resuspended bottom material. Potential impacts on groundwater, floodplain, and water quality of the Hudson River were assessed by considering the following:

- The existing groundwater and floodplain resources and Hudson River water quality within the study areas;
- The potential for the Replacement Bridge Alternative to adversely affect groundwater resources; and
- Results of the stormwater runoff pollutant loading analysis and the scour and depositional analysis are described in greater detail below.

15-3-1 STORMWATER ANALYSIS METHODOLOGY

Potential effects to Hudson River water quality due to the discharge of stormwater runoff from the project were assessed by considering the change in impervious surfaces and changes in pollutant loadings discharged to the Hudson River.

A pollutant loading analysis was performed to evaluate the quality of the stormwater runoff in existing and proposed conditions using the pollutant coefficient method, as outlined in *Reducing the Impacts of Stormwater Runoff from New Development* published by the New York State Department of Environmental Conservation (NYSDEC) in April 1992. Pollutant coefficient values were used to best evaluate the pre- and post-development conditions based on the land use type, which was predominantly impervious surfaces. Following the pollutant coefficient method, the upland portion of the study area was broken up into three major drainage areas on the basis of topography: Rockland landing, bridge, and Westchester landing. The predominant land use within these three drainages is roadways or impervious surface. Therefore, a pollutant loading coefficient of 0.6 pounds per year (lbs/acre/year) was used for phosphorus and 833 lbs/acre/year was used for total suspended solids (TSS). The contributing drainage areas are multiplied by the pollutant loading coefficient for the associate land use resulting in the total annual pollutant load to the Hudson River.

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[1] These test methods are used as an integral part of several engineering classification systems to characterize the fine-grained fractions of soils and to specify the fine-grained fraction of construction materials. The liquid limit, plastic limit, and plasticity index of soils are also used extensively, either individually or together, with other soil properties to correlate with engineering behavior such as compressibility, hydraulic conductivity (permeability), compactibility, shrink-swell, and shear strength. The liquid and plastic limits of a soil and its water content can be used to express its relative consistency or liquidity index (http://www.astm.org/Standards/D4318.htm).

[2] Unified Soil Classification System (USCS).

Appendix E provides the detailed pollutant loading calculations: On the basis of the New York State Stormwater Management Design Manual (SWMDM), the stormwater management practices that would be implemented to treat the stormwater runoff are capable of reducing Total Suspended Solids (TSS) by 80 percent and total phosphorus (TP) by 40 percent. These pollutant removal rates are then applied to the calculated total pollutant load to determine the final pollutant load to the Hudson River.

15-3-2 SCOUR AND DEPOSITION ANALYSIS METHODOLOGY

Bridge piers can have morphological effects on a body of water by altering local hydrodynamic conditions, resulting in areas of scour (depressions) and deposition/accretion (mounding). While the exact effects depend on pier configuration, piers typically both increase and decrease localized water velocities, resulting in scour or accretion of bed material at different locations. Scoured bottom material is resuspended and deposited elsewhere in the estuary. In assessing the effects of pier scour, the main question is whether or not a depression is likely to develop at a particular pier and if so, to what extent and depth. Detailed bathymetry data were used to delineate the extent of scour at the existing Tappan Zee Bridge. The analysis to delineate existing scour patterns assumed the conditions present during the bathymetric survey are typical. This is reasonable as tidal forces dominate currents near the Tappan Zee Bridge. Existing scour was delineated as those areas that were depressed more than 1 foot below the unaffected area north of the bridge. The results of the analysis of the existing pier scour were used to calibrate the model used to project areas of scour and erosion from the Replacement Bridge Alternative and to assess potential changes within the footprint of the existing bridge.

Pier scour and depositional zones resulting from the Replacement Bridge Alternative were predicted using relationships established in the FHWA Hydraulic Engineering Circular No. 18 (HEC-18) (FHWA, 2001) with some parameters calibrated based on observations of existing conditions observed during hydrographic surveys conducted for the project. The Replacement Bridge Alternative options will have span lengths of a similar magnitude to the eastern approach spans which only experience local scour. Subsequently, the predictive analyses are focused on the existing condition at eastern piers and the expected condition of the proposed structure. Velocities used for the environmental pier scour analyses were taken from the calibrated RMA-2 model[1] run of the April 2007 Nor'easter, which was approximately a 10- to 50-year storm which coincided with a spring tide, which is likely to moderately over-represent the magnitude of scour which will have ecological impacts.

The basic scour equation presented in HEC-18 is modified for a variety of foundation configurations. Two modifications were used in the predictive analyses. The first is where the pile caps occupy the entire water column depth and are significantly wider than the water depth. In this circumstance, the basic pier scour equation was used with the addition of a correction factor to account for the wide pier width. The second modification to the basic scour equation was required for complex foundations in which piles are exposed below the pile caps. This modification involves calculating the scour component of individual foundation components and then using superposition to sum

[1] The RMA-2 model is a widely tested model that is used extensively for bridge scour evaluations in estuaries.

the results. For pier scour analyses, the majority of piers are considered complex foundations. Other correction factors were determined based on the pier characteristics and the sediment grain size distribution.

15-4 AFFECTED ENVIRONMENT

The following sections describe the existing groundwater resources, floodplains and water resources within the study area for the project.

15-4-1 GROUNDWATER RESOURCES

Groundwater is present in almost all geologic media below the ground surface, as a result of infiltrating precipitation. When precipitation falls to the ground, a portion of the precipitation is returned to the atmosphere through evapotranspiration. Another portion of the precipitation runs off through drainage courses or overland flow (sheet flow) to streams and rivers where it may infiltrate the groundwater regime or continue downstream as surface flow.

Rockland and Westchester Counties have an array of groundwater resources, some of which are near the study area. Geologic materials that can yield appreciable quantities of groundwater are referred to as aquifers. In 1987, NYSDEC identified the region's Primary and Principal Aquifers, which were used to determine presence of aquifers within the study area. Primary Aquifers are highly productive and heavily used for water supplies. Principal Aquifers are known to be highly productive, but are not used as a public water supply. The USEPA also identifies and maps Sole Source Aquifers (SSAs) throughout the country. An SSA is an aquifer that supplies 50 percent or more of the drinking water in a particular area. The USEPA reviews all projects with federal financial assistance in order to ensure that such projects do not have the potential to contaminate designated SSAs and create a significant hazard to public health. There are no Principal or Primary Aquifers designated by the NYSDEC or SSAs designated by the USEPA within the study area for the project.

The primary source of groundwater resources within the study area is contributed by the river itself, with minor contributions from recharge areas. The area recharging to the Hudson River within the study area extends approximately 1 mile and 3 miles from the river's west and east banks at the Tappan Zee Bridge, respectively.

15-4-2 SURFACE WATER RESOURCES

15-4-2-1 WATERSHEDS AND WATERBODIES

The surface water resources within the study area include the Hudson River and Sheldon Brook. **Figure 15-4** shows the watersheds, or drainage basins, in the vicinity of the study area. While generically the term watershed can be applied to the drainage area tributary to any point, as defined in the National Hydrographic Database (NHD) the term watershed refers to the delineation of entire tributary areas to major rivers, such as the Hudson River. Activities affecting the volume and quality of runoff in the study area have the potential to affect the character, health, and potential human uses of the Hudson River and Sheldon Brook.

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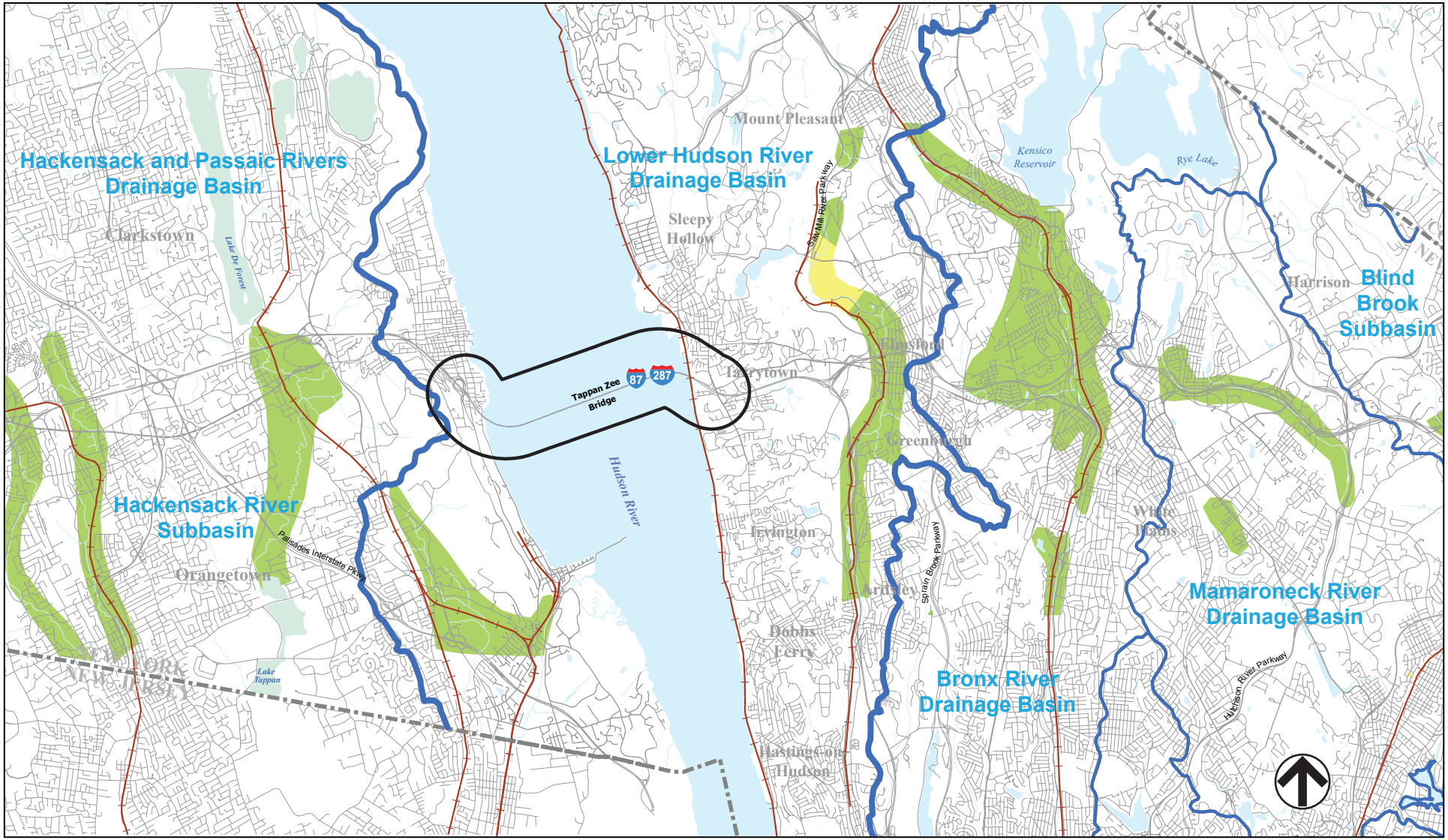

Project Site Boundary
Drainage Basins
Subbasins
Principal Aquifers 10-100 gpm
Principal Aquifers >100 gpm
Primary Aquifers

0 1 2 MILES
SCALE

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 15-4
Aquifer and Drainage Basins

15-4-2-2 FLOODPLAINS

A 100-year floodplain is a geographic area that is flooded by a storm that has a 1 percent chance of being equaled or exceeded in any given year. **Figure 15-5** presents the 100-year and 500-year floodplains (i.e., the areas with a 1 percent chance and 0.2 percent chance, respectively, of flooding in a given year) within the study area. The Hudson River is tidally influenced and commonly referred to as the Hudson River estuary. Tides in the Hudson River estuary are semidiurnal, having two high and low waters each day. In the study area, the average tidal range is 3.2 feet (NOAA 2009). The Hudson River near the eastern shoreline (Westchester County) is classified as FEMA Zone AE (100-year floodplain) with a base flood elevation of 7 feet (North American Vertical Datum of 1988 (NAVD 88)), whereas portions of the shoreline along the Hudson within Tarrytown are classified as FEMA Zone X (500-year floodplain). Sheldon Brook in Tarrytown is located within the 100-year floodplain. The Hudson River near the western shoreline (Rockland County) is classified as FEMA Zone A3 (100-year floodplain) with a base flood elevation of 8 feet (National Geodetic Vertical Datum of 1929 (NGVD 29), whereas the shoreline along the Hudson within Grand View-on-Hudson is classified as FEMA Zone B (500-year floodplain) (see **Figure 15-5**).

15-4-2-3 WATER QUALITY

Article 17, Title 3 the ECL (Water Pollution Control) authorizes the NYSDEC to develop a surface water classification system and promulgate regulations to administer the surface water quality program. NYSDEC classifies waterbodies based on their best uses (as determined by physical characteristics). The Federal Clean Water Act requires states to periodically assess (every two years) and report on the quality of waters in their state. Section 303(d) of the Act also requires states to identify *Impaired Waters*—waters whose water quality does not fully support their designated use. For these *Impaired Waters,* states must consider the development of a Total Maximum Daily Load (TMDL) or other strategy to reduce the input of the specific pollutant(s) that restrict waterbody uses, in order to restore and protect such uses. New York State's 2010 303(d) list of impaired waters was approved by the USEPA, and published in June 2010 (http://www.dec.ny.gov/docs/water_pdf/303dlistfinal10.pdf).

Non-point source pollution from urban and suburban development is a major contributor to pollutant loadings in watercourses. Contaminants typically associated with urban stormwater run-off are sediments, nutrients, organic compounds, pathogens, and heavy metals. Pollutants originating from vehicles can make up a substantial portion of those pollutant loads.

Sheldon Brook

Sheldon Brook is a second-order stream that discharges into the Hudson River on the east side of the study area. Sheldon Brook crosses Interstate 87/287 twice in the village of Tarrytown while en route to the Hudson River. The western crossing flows from northeast to southwest, and is part of a long series of culverts near Interchange 9. The drainage area for Sheldon Brook is about 2.5 square miles, of which approximately 2 square miles is upstream of the most downstream crossing of Interstate 87/287.

In this area, Sheldon Brook is shallow and has low, gradually-sloping banks. This portion of Sheldon Brook has been designated as Class SC/C waters by NYSDEC.

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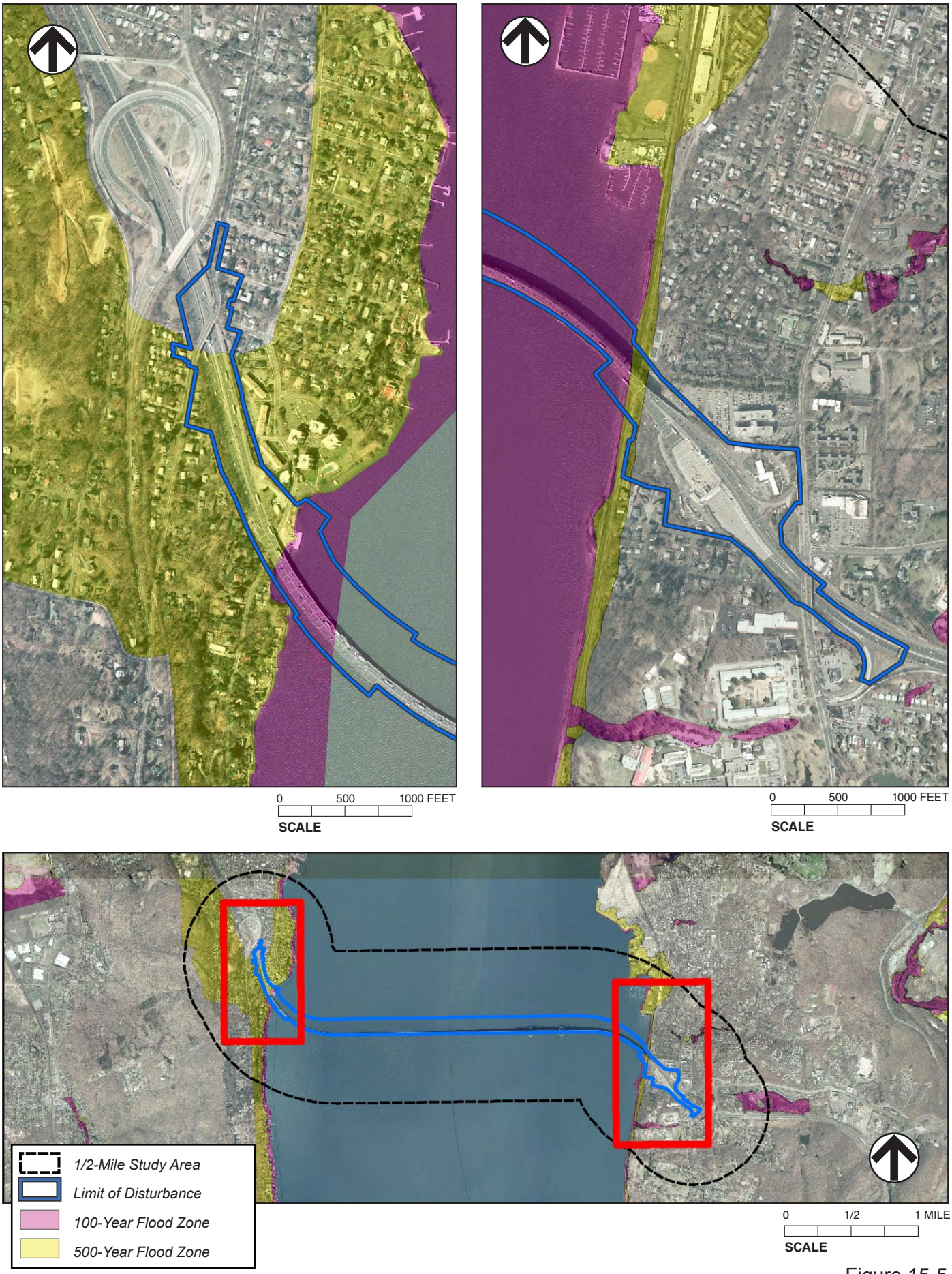

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 15-5
Floodplain

Class SC/C waters are suitable for fishing, fish propagation and survival, and primary and secondary recreation. Sheldon Brook is not on the 2010 NYSDEC Section 303(d) list of impaired waterbodies.

Hudson River

The approximately 3-mile-wide portion of the Hudson River within the study area is designated by NYSDEC as a Class SB waterbody. Best usages of Class SB saline surface waters are primary and secondary contact recreation and fishing; these waters shall be suitable for fish propagation and survival. Within the study area, the Hudson River is included on the 2010 New York State 303(d) list due to the presence of contaminated sediment containing Polychlorinated Biphenyls (PCBs) (NYSDEC 2010).

In the vicinity of the Tappan Zee Bridge, the river ranges in depth from less than 12 feet at mean lower low water (MLLW) along the western causeway to greater than 47 feet at MLLW in the shipping channel under the main span (see **Figure 15-2**). The Hudson River is tidally influenced from the Battery to the Federal Dam at Troy, New York. Tidal currents are generally greatest in the navigational channel. Results of field surveys conducted for the project in April 2007 and November 2008 indicate that peak vertically averaged tidal currents in the navigational channel are about 2.5 feet per second (ft/sec). Peak velocities during the spring freshet— a time of high freshwater inflows resulting from snow and ice melt in rivers—may be greater than 3 ft/sec. Velocities are generally lower in the western mud flats in the vicinity of the bridge, with peak velocities generally on the order of 1 to 2 ft/sec. The tidal excursion at the Tappan Zee Bridge is approximately 4.0 and 6.2 miles for the flood and ebb tide, respectively (DiLorenzo et al. 1999).

Salinity

The salt front, as defined by the USGS for the Hudson River estuary, is where chloride concentration begins to exceed 100 milligrams per liter (mg/L) (Devries and Weiss, 2001). Seawater has a chloride concentration of about 19,400 mg/L. With the exception of very large freshwater discharge events, there is always a salt front present in the Hudson River estuary, the location of which varies at a given time with tidal forcing and the magnitude of freshwater discharge. In general, the salt front is located between 15 and 75 miles upstream of the Battery. It is located farther upriver during the summer when there are low freshwater inflows, and farther downriver during the spring when freshwater flows are greatest.

The term salt wedge is a more generic term that describes the tendency for saltwater to intrude beneath freshwater without substantial mixing. A salt wedge is marked by a steep salinity gradient, or halocline, in the vertical direction. The presence of a salt wedge does not indicate an immediate horizontal transition from fresh to salt water. In the Hudson River estuary, the transition is often 50 miles long.

Figure 15-6 shows average salinities in Practical Salinity Units (PSU) over a 16-year period at the USGS gauge at Hastings-on-Hudson (#1376304), which is about 6 miles downstream of the Tappan Zee Bridge. Although salinity concentrations are somewhat lower at the Tappan Zee Bridge, the salinity at Hastings-on-Hudson is indicative of the magnitude and yearly variation of salinity at the bridge. At the Hastings-on-Hudson station, salinity ranged from about 2 to 6 PSU during high freshwater flow periods in the

Figure 15-6
Average Salinity Concentration at Hastings-on-Hudson

spring to a high of about 8 to 10 PSU during low freshwater flow periods in the summer. Salinities in the winter varied between 4 and 6 PSU. Salinities recorded during the 2006 and 2008 sampling program conducted for the project were similar to those recorded at Hastings-on-Hudson.

Temperature

Water temperatures are relatively uniform throughout the freshwater reach of the Hudson River estuary, and follow a similar cycle each year. At the mouth of the Hudson River estuary, near the Battery, temperatures are substantially affected by the inflow of water from the New York Bight and tend to exhibit a milder degree of variation throughout the year. **Figure 15-7** demonstrates the average yearly cycle in water temperature in the upper reach of the Hudson River estuary near Albany, and near its mouth, near the Battery over a period of 2002-2009. The NOAA Gauge at the Battery (#8518750) is 26.5 miles downstream of the bridge. The USGS gauge at Albany (#1359139) is 118 miles upstream of the bridge.

In the lower reaches of the Hudson River estuary and near the Tappan Zee Bridge, ocean water intrudes beneath fresh water to form a salt wedge, often resulting in a large degree of stratification in the water column. In these areas large vertical variations in temperature may be present. Average water temperatures at the Tappan Zee Bridge are generally close to the average of temperatures at the Battery and Albany, NY, ranging from below close to 0º Celsius (C) (32º Fahrenheit (F)) in the winter to about 25º C (77º F) in the summer, with temperatures in the spring ranging between 2º C and 10º C (36º F to 50º F).

Suspended Solids

Generally, suspended solids concentrations (SSC) show a strong correlation with water-column depth, with higher concentrations near the bottom of the river. Significant variation based on a variety of river conditions can also be expected, with the tidal cycle and magnitude of freshwater discharge being the most dominant factors. During the spring freshet sediment concentrations much higher than normal can be expected.

The USGS operates an Acoustic Doppler Current Profiler (ADCP) at the Hudson River estuary gauge station south of Poughkeepsie, approximately 27 miles north of the bridge. The station uses backscatter information from the ADCP to estimate suspended solids concentration (Wall et al. 2006). Using the SSC data combined with the current data measured by the device, an estimate of total sediment discharge is also calculated. This gauge has been monitoring SSC almost continuously since 2002, and represents the most complete data set of sediment concentration and sediment loading in the Hudson River estuary.

For the purposes of impact evaluation, an understanding of the typical sediment concentrations at the study area, and their variability, is useful. To aid in this understanding, the yearly variation of the depth-averaged SSC concentration at the USGS gauge south of Poughkeepsie is presented in **Figure 15-8** for the period 2002 through 2009. It is expected that the suspended sediment concentration at the Tappan Zee Bridge will be similarly inherently variable and seasonally dependent, as indicated by the USGS gauge upstream. Depth averaged SSC measurements made during field

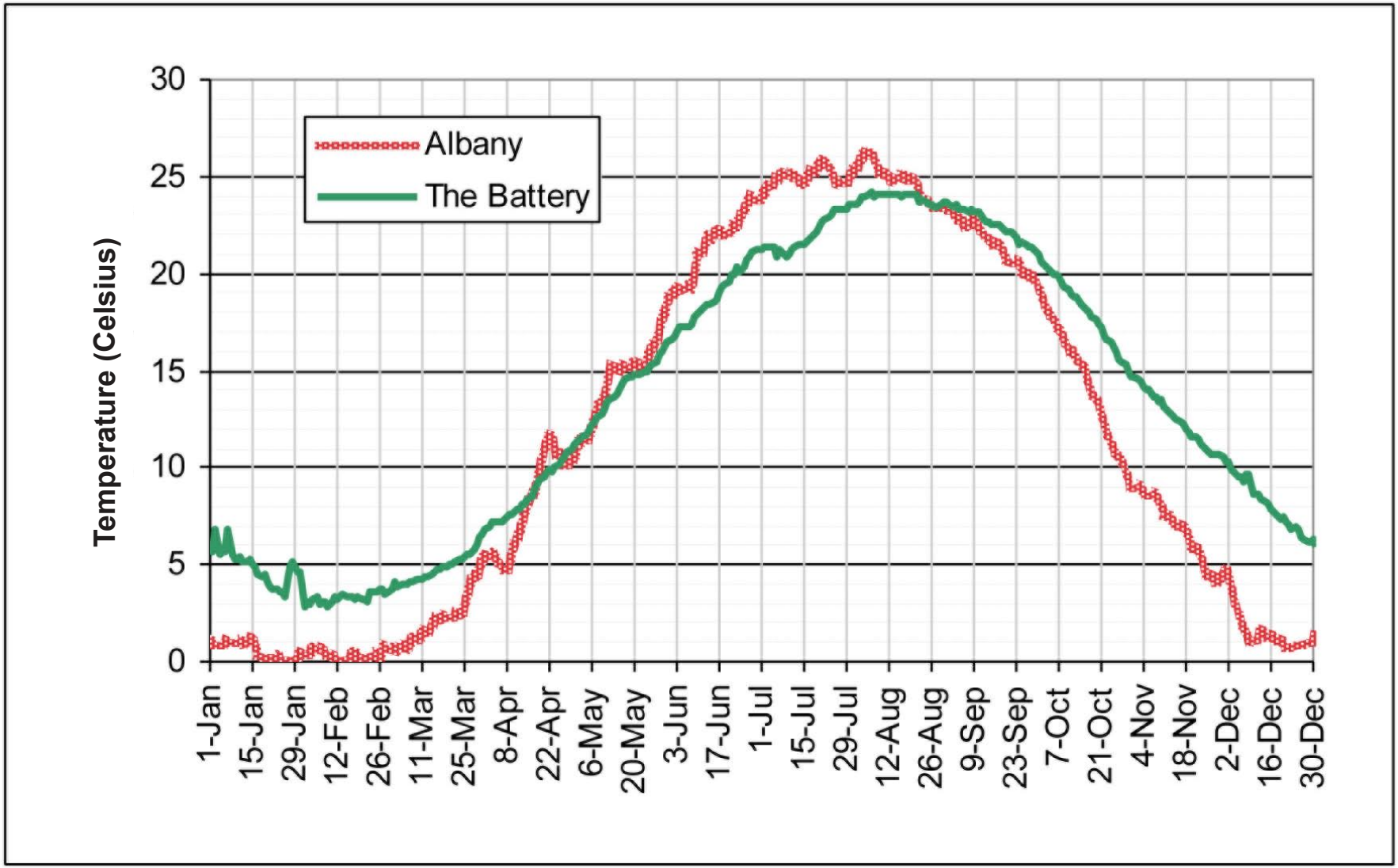

Figure 15-7
Average Water Temperature at Albany and the Battery

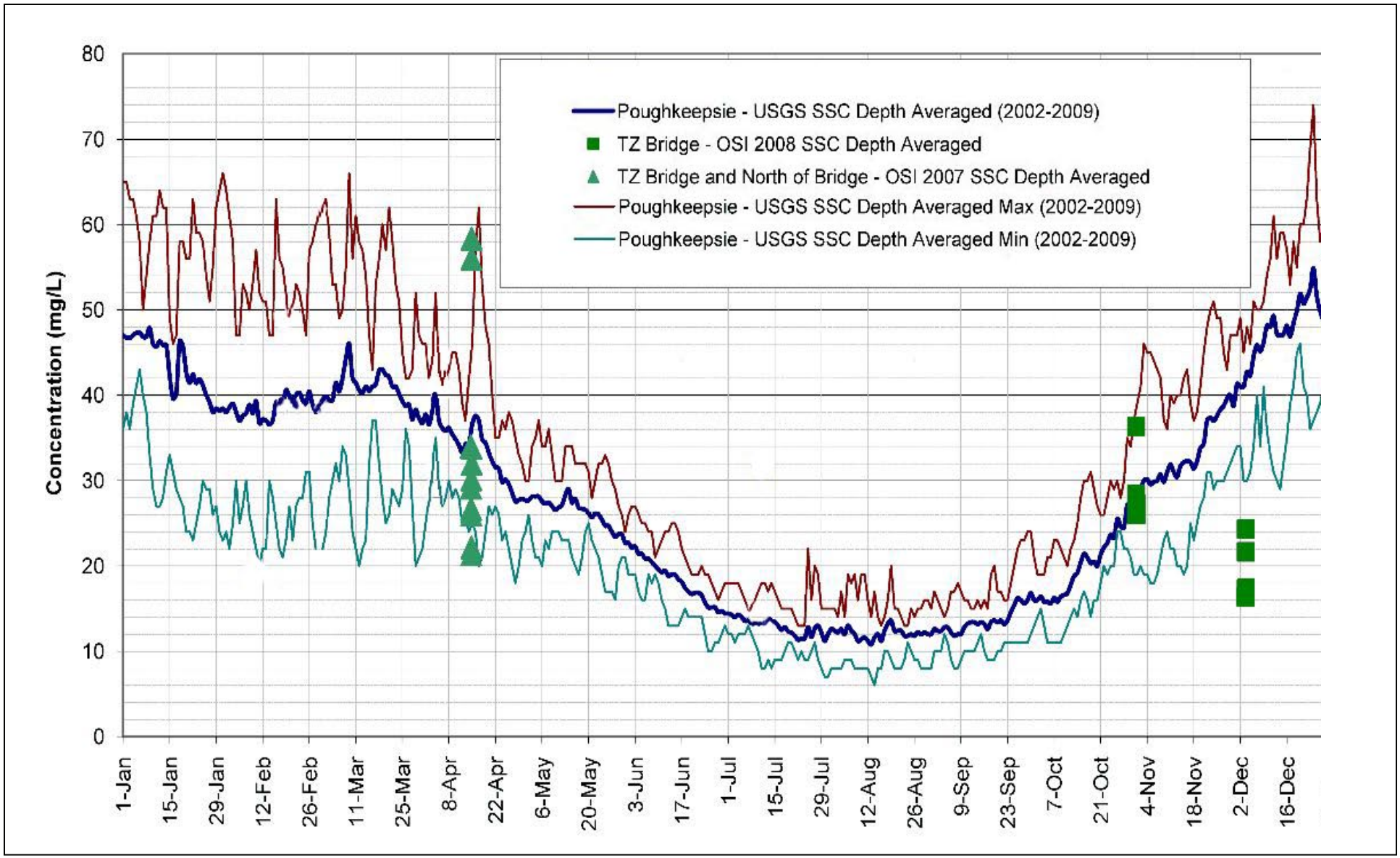

Figure 15-8
SSC Data

surveys of the Tappan Zee were similar in magnitude to those recorded at the Poughkeepsie station (see **Figure 15-8**).

SSC was recorded during water quality sampling conducted from late October through early December 2008 within the study area. Results showed that increases in SSC with depth were more dramatic at deep locations than at shallow water locations. Fluctuations in SSC occurred over each tidal cycle, with the highest SSC observed at max flood and max ebb tides. SSC recorded during this time frame generally ranged from about 10 to 75 mg/L, with maximum concentrations recorded of about 140 mg/L. Depth averaged water-column sediment samples in the vicinity of the Tappan Zee Bridge appear to range from 15 to 50 (mg/L) under normal conditions, and may exceed 100 mg/L during large freshwater events.

15-4-3 SEDIMENT QUALITY

15-4-3-1 SEDIMENT CHARACTERISTICS

Hudson River bottom sediments in the vicinity of the bridge comprise primarily clayey silt (see **Figure 15-9**). Accumulations of sand, silt and clay material are observed along the causeway section of the existing bridge. Gravelly sediments are also found extensively near the eastern shore of the Hudson River and across a large swath of the mud flats north of the existing causeway section.

Due to releases from industrial activity, sediments deposited on the river bottom during the twentieth century are more likely to exhibit signs of contamination. Examples of industrial contamination include heavy metals, volatile or semivolatile organic compounds (VOCs or SVOCs), pesticides, and PCBs. Industrial-era sediments were identified through a combination of seismic-profiling data and the concentration of lead in sediment samples. The thickness of industrial era sediment deposits in the vicinity of the Tappan Zee Bridge is shown on **Figure 15-10**. While recently deposited sediments (i.e., from the 20th and 21st centuries) can be found throughout much of the study area, deposition of recent sediments north of the existing bridge is limited, ranging from no deposition to a depth of about 2 feet, with most of the recent deposits occurring between 0 and about 8 inches. South of the bridge deposition of recent sediments is limited on the western margin (ranging from 0 to 8 inches) with some areas of deeper deposition further east along the causeway (2 to 4 feet), deposition along the eastern margin appears to be greater (ranging from 0 to at least 6 feet). On the basis of the evaluation of recent sediment deposits, the net rate of deposition within the vicinity of the existing bridge is estimated to range from 0 inches per year to as high as 1 inch per year in the eastern margin south of the existing bridge.

15-4-3-2 SEDIMENT SCOUR AND DEPOSITION

Permanent structures such as bridge piers can have morphological effects by altering local hydrodynamic conditions. While the exact effects depend on pier configuration, piers typically both increase and decrease localized water velocities, resulting in scour or accretion of bed material at different locations. Once initial deposition occurs, the sediment may be subsequently resuspended as part of the natural sediment transport processes within the Hudson River Estuary. These cycles of resuspension and deposition may occur over larger time periods than those considered by the hydraulic analysis, on the order of weeks and months. Published information suggests that large

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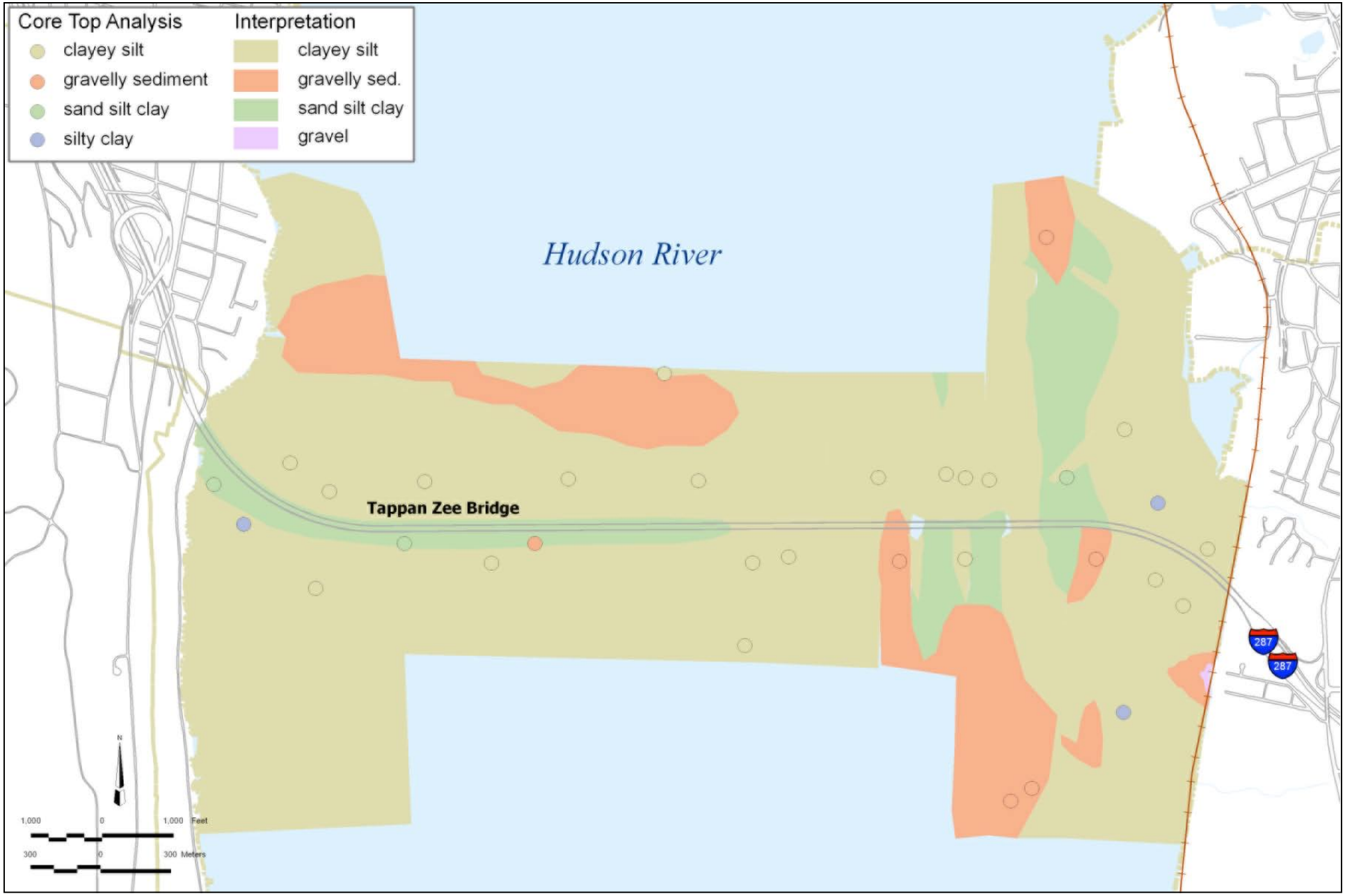

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 15-9
Sediment Texture

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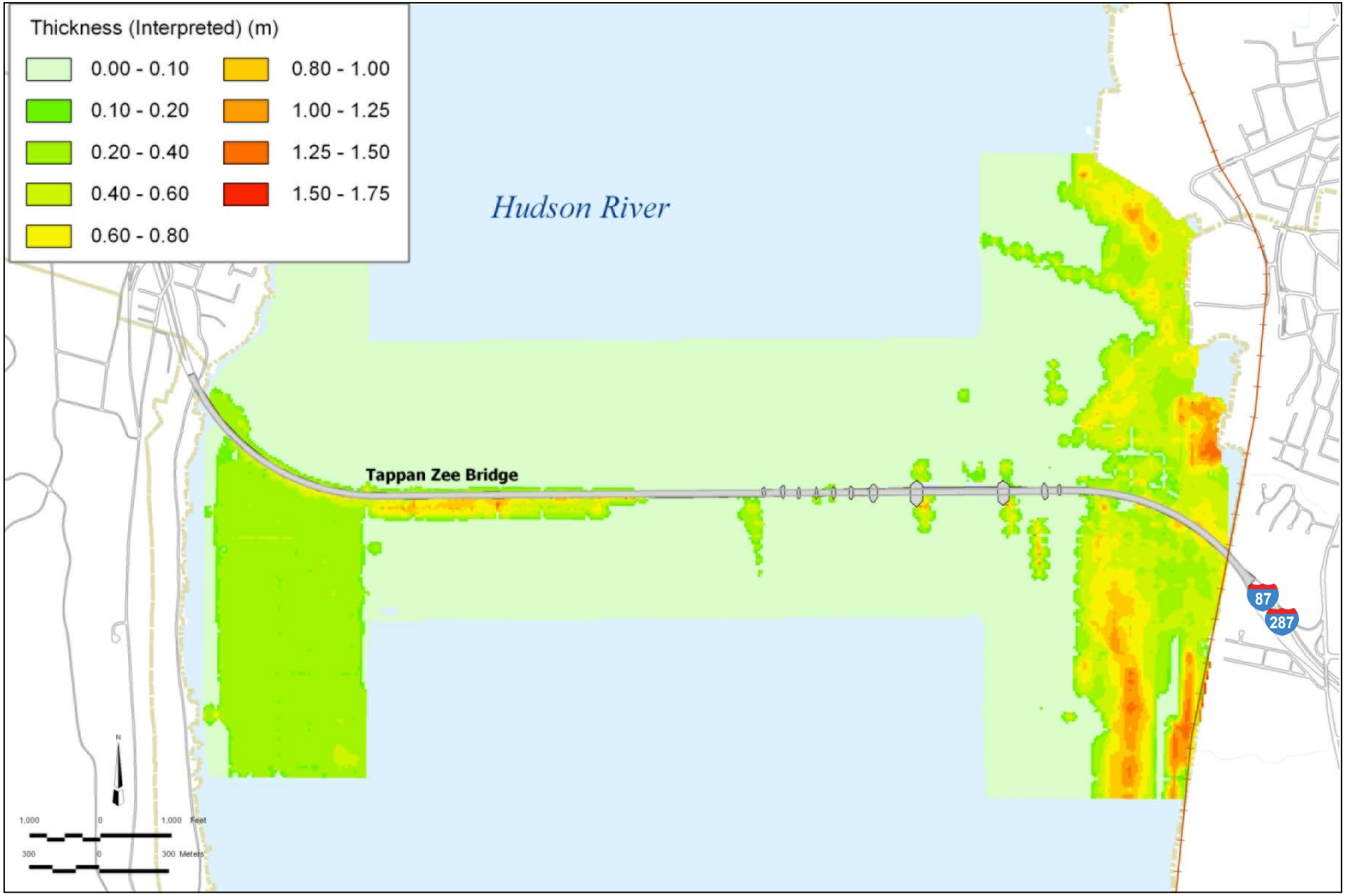


TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 15-10
Recent Sediment Deposit Thickness

discharge events can flush long term sediment deposits within the estuary into New York Harbor and Bay on a decadal time scale.

The existing causeway and bridge piers cause river currents to locally scour the bottom sediments, resulting in depressions in the bottom of the river alongside the bridge (see **Figures 15-11 and 15-12**). A large area near the existing bridge is subject to scour due to the small column spacing. The western causeway is dominated by contraction scour (i.e., bottom erosion due to increased water velocity and shear stress resulting from the narrow spacing between piers) with a moderate amount of local scour (i.e., bottom erosion around bridge piers and abutments due to the acceleration of water flow around these structures and vortices that occur when this flow is obstructed) occurring at the tips of the piers. The western shoals of the Tappan Zee Reach are relatively flat and featureless, and the effect of the western causeway on bathymetry is clear. The existing scour at the piers of the existing eastern causeway are dominated by local scour. The existing total scour area associated with pier scour is about 62 acres.

15-4-3-3 SEDIMENT QUALITY

River bottom sediment quality is important to understand for purposes of dredging or other river bottom disturbance. Hudson River sediment samples collected for the project were compared to existing sediment chemistry data for the Hudson River based on NYSDEC's Hudson River Benthic Mapping Project. Sediment quality was evaluated based on various NYSDEC screening criteria and guidance. Appendix 4 of NYSDEC's Technical Guidance for Screening Contaminated Sediments (NYSDEC 1999) establishes the Effects Range-Low (ERL) and the Effects Range-Median (ERM) sediment criteria. ERL and ERM criteria for specific contaminants are used to determine levels of contamination, as described in **Table 15-1**. Where ERL and ERM values are not listed, benthic aquatic (BA) chronic and acute criteria and wildlife bio-accumulation (WA) criteria can be used.

Table 15-1
ERL and ERM Screening Criteria

Screening Criteria	Potential Effect
< ERL value	Minimal-Effects Range - Effects would be rarely observed
≥ ERL value, < ERM value	Possible-Effects Range - Effects could occasionally occur
≥ ERM value	Probable-Effects Range - Effects could frequently occur
Sources: Long et al. 1995	

Sediment quality thresholds for in-water/riparian placement are based on NYSDEC's In-Water and Riparian Management of Sediment and Dredged Material (Technical and Operational Guidance Series (TOGS) 5.1.9, NYSDEC 2004). TOGS 5.1.9 establishes three classes of sediment quality thresholds for areas proposed for dredging and for dredged material proposed for in-water/riparian placement based on concentration of contaminants identified (see **Table 15-2**).

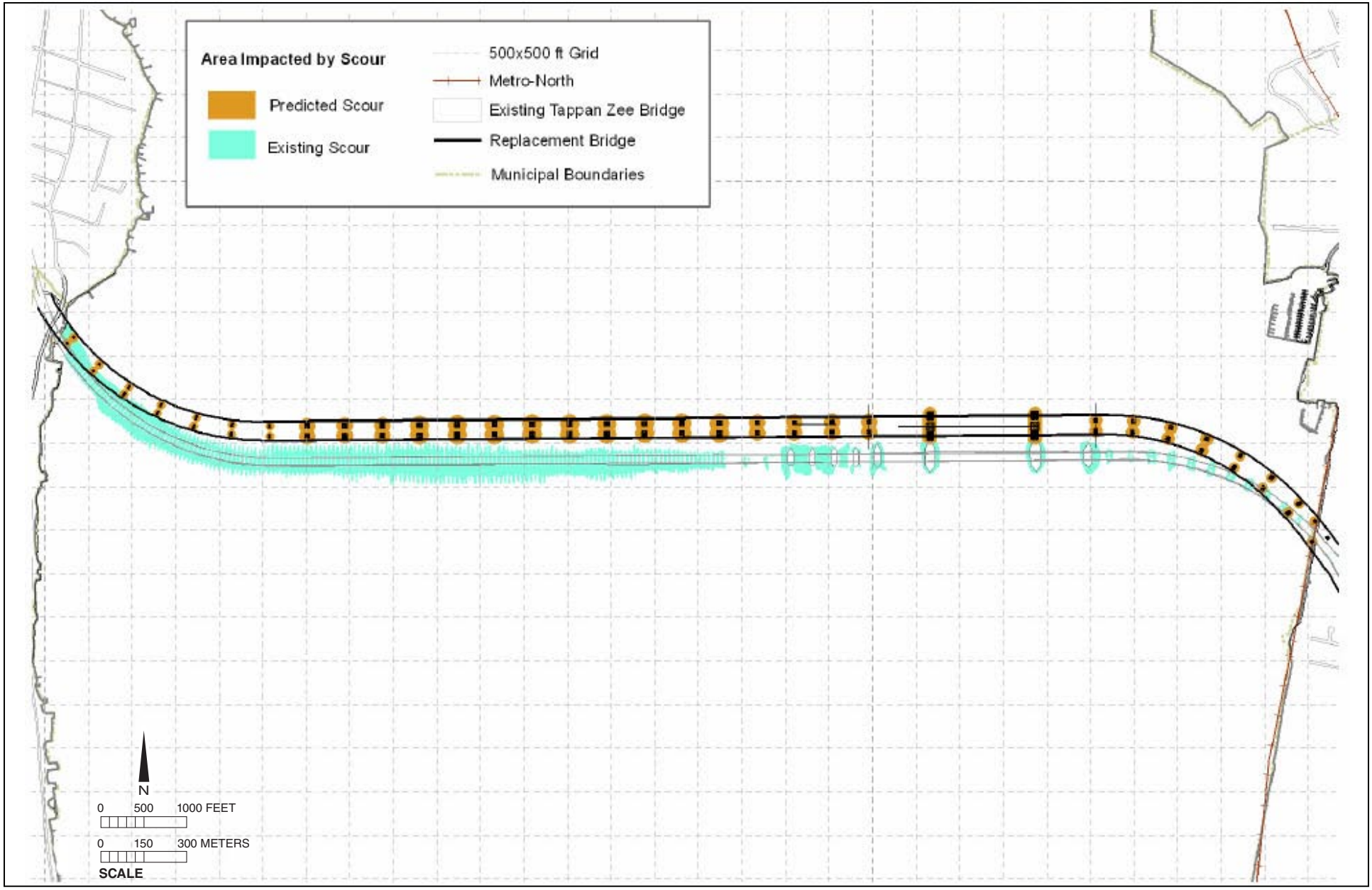


Figure 15-11
Long Span Option Scour

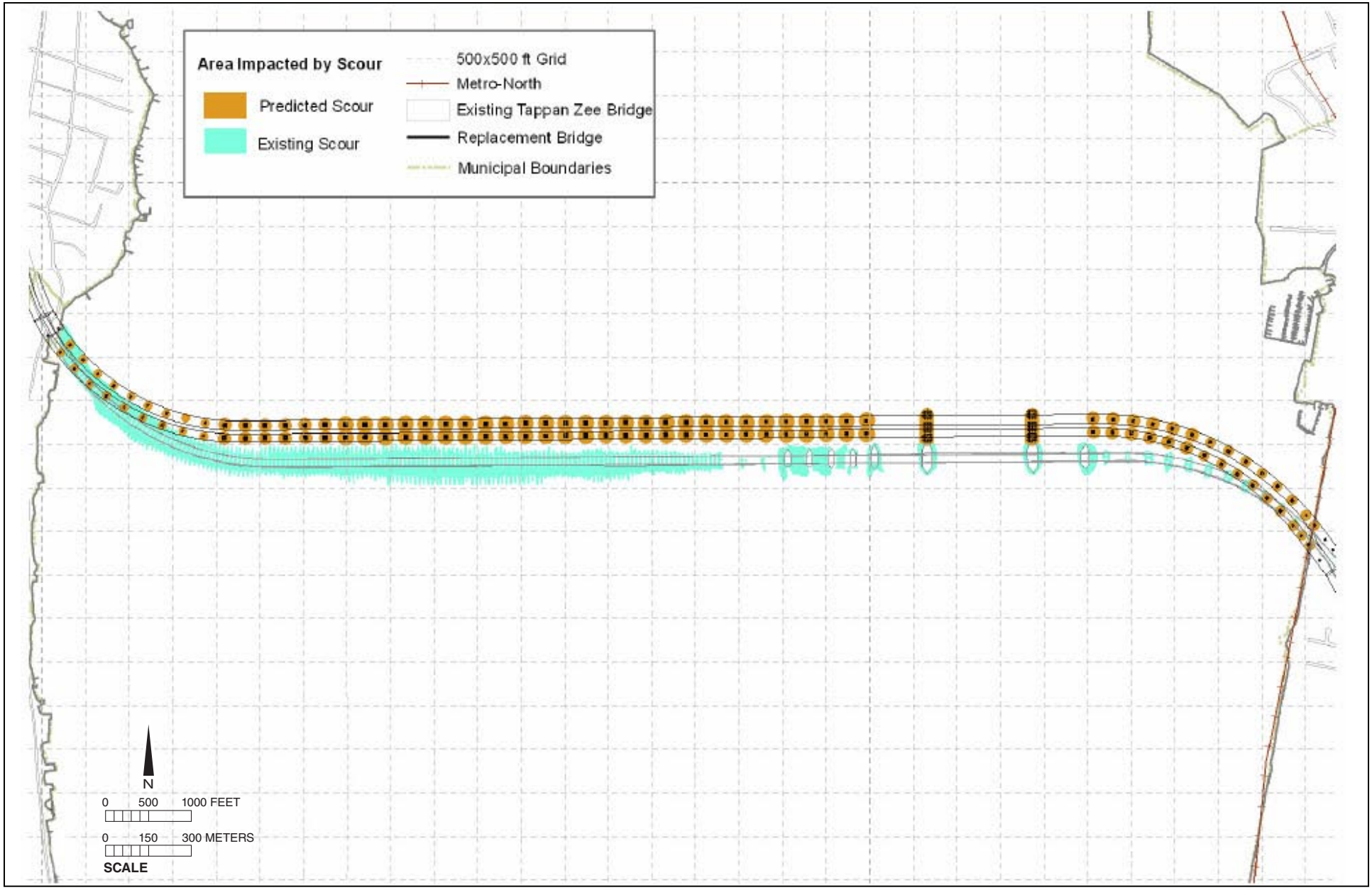


Figure 15-12
Short Span Option Scour

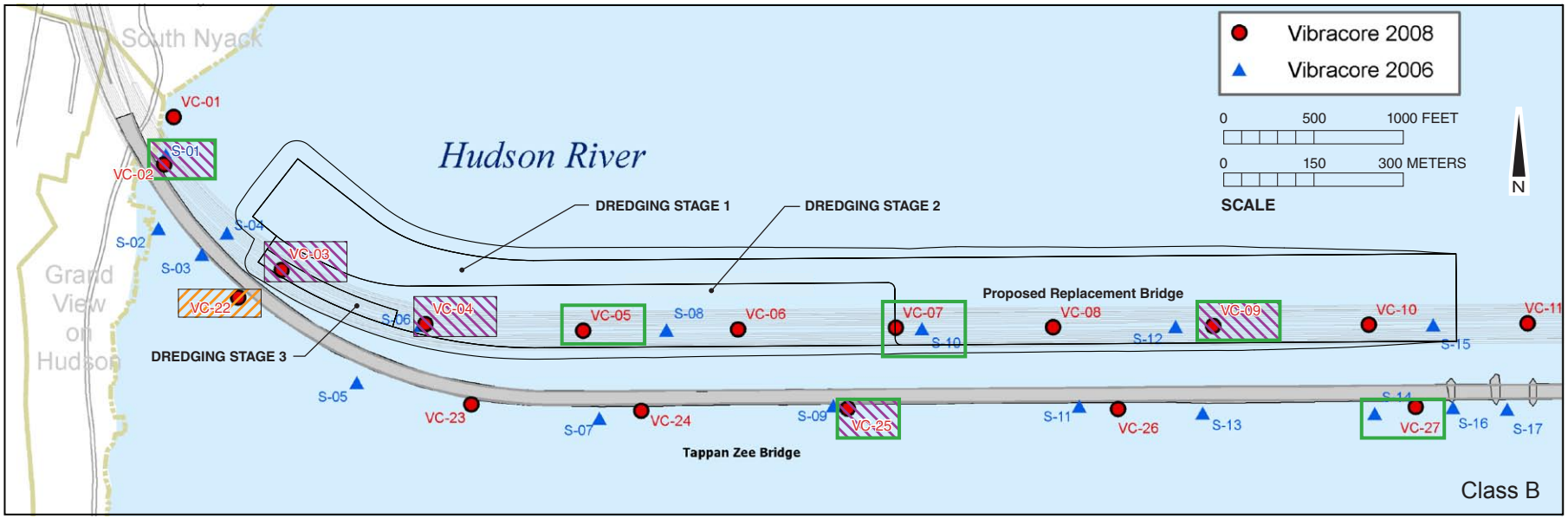
Table 15-2
TOGS 5.1.9 Sediment Quality Thresholds

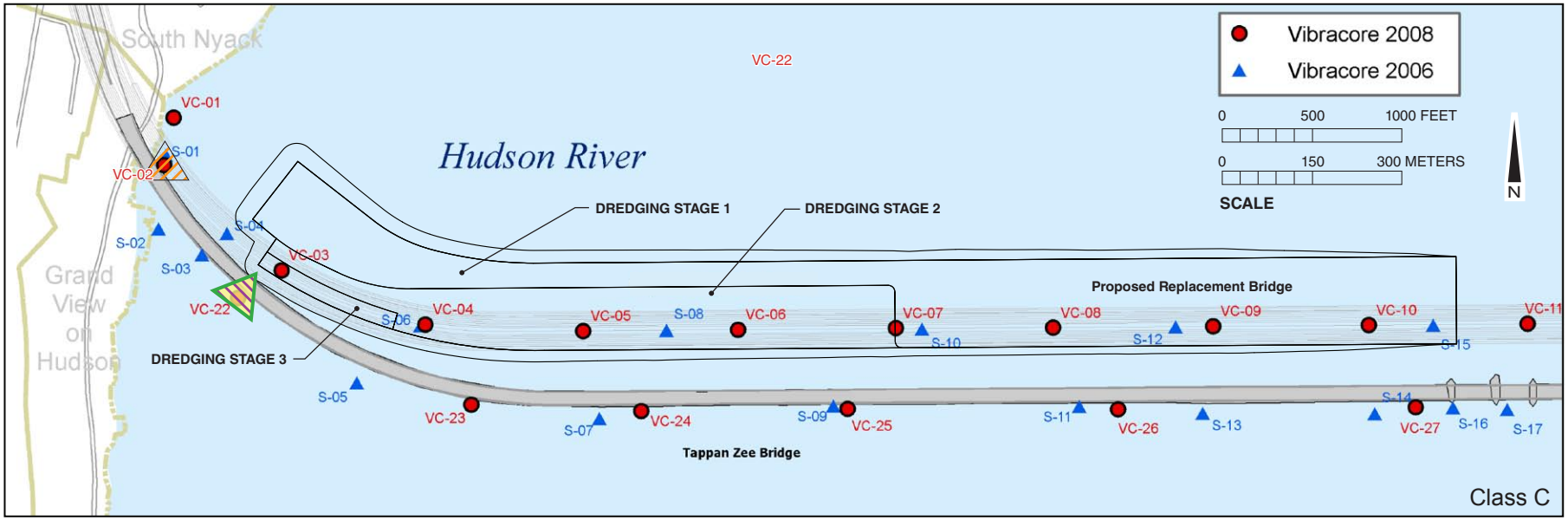
Threshold	Potential Effect
Class A	No appreciable contamination (no toxicity to aquatic life) and dredging and in-water or riparian placement, at approved locations, can generally proceed
Class B	Moderate contamination (chronic toxicity to aquatic life) and dredging and riparian placement may be conducted with several restrictions.
Class C	High contamination (acute toxicity to aquatic life) and dredging and disposal requirements may be stringent (NYSDEC 2004).
Sources: NYSDEC 2004	

Summaries of the sediment-chemistry analyses for metals; SVOCs; and pesticides, PCBs, and dioxins are presented in **Tables 15-3 through 15-5**. Only data for compounds that were detected in at least one sample are included in these tables. **Figures 15-13 through 15-16** illustrate the sediment sampling locations for which concentrations of contaminants are classified as Class B or C according to TOGS 5.1.9. The salinity of the Hudson River in the vicinity of the project area ranges from 2 to 10 PSU. The marine values for TOGS thresholds were used wherever they differed sufficiently from freshwater values. Contaminants not indicated in **Figures 15-13 through 15-16** as Class B and C at the sediment sampling locations were classified as Class A. Dieldren concentrations in all of the samples were classified as Class A. Contaminants for which concentrations were classified as Class B or C include Total PCBs, Total PAH, mercury, dioxin/furan TEQ, Total DDT, DDD and DDE, arsenic, copper, and cadmium. As indicated in **Figures 15-13 through 15-16**, Class C concentrations (Total PAH, dioxin/furan TEQ, mercury, Total PCBs, and cadmium) and the Class B concentrations for dioxin/furan TEQ, occurred in only a few locations, which coincided with areas identified as having thicker deposits of industrial age sediments (ranging from about 8 inches to 6 feet)—north and south of the existing bridge on the western and eastern margins, and north and south of the piers for the main span. The locations of Class B contaminant concentrations are more widely distributed north and south of the bridge but are also associated with portions of the river bottom identified as having accumulation of industrial age sediment deposits. Class B and C contaminant concentrations typically decrease to concentrations classified as Class A within 2 to 4 feet of the surface with the exception of sampling locations south of the bridge along the eastern shoreline of the Hudson River identified as having the deepest accumulation of recent deposits.

Results from the 2006/2008 sediment sampling were compared to results found for historic Hudson River sampling conducted by Llanso et al (2003). In general, levels of contaminants such as metals, pesticides, and PCBs in the sediment samples collected within the study area are similar to average levels found elsewhere in the Hudson River as indicated by the Hudson River Benthic Mapping Project. On the basis of the 20th century deposits mapping and the results of the laboratory analysis of 2006 and 2008 sediment cores, the upper few feet of river sediment would be characterized as moderately contaminated following TOGS 5.1.9 with the exception of a few locations near the western and eastern Hudson River shorelines and south of the main span bridge piers where higher concentrations appear to have accumulated.

1.3.12





Class B | Mercury | Total PAH

Class C | PCBs | Dioxin/Furan TEQ

Figure 15-13

Sediment Sample Locations and TOGS 5.1.9 Sediment Quality Classifications

1.3.12

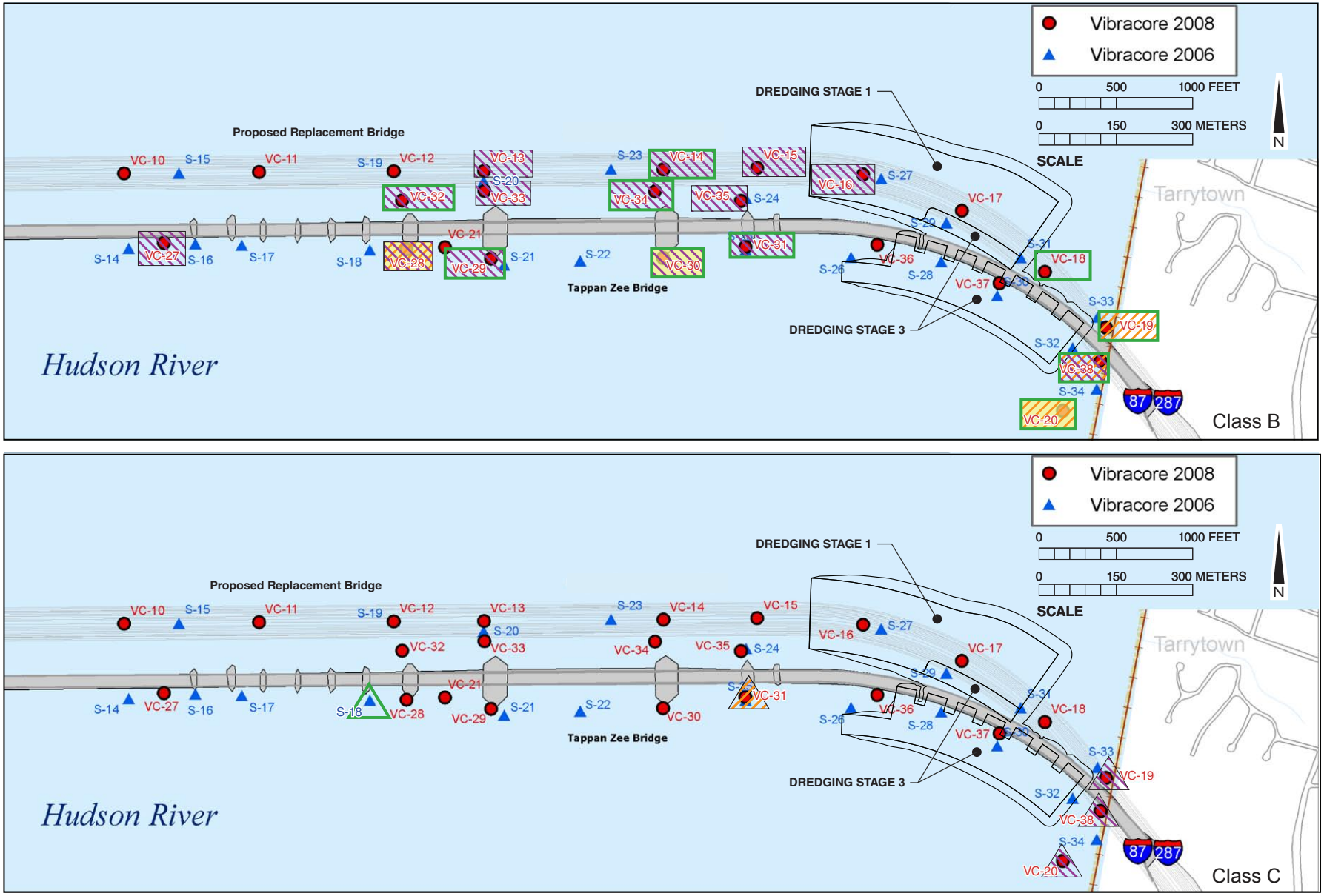
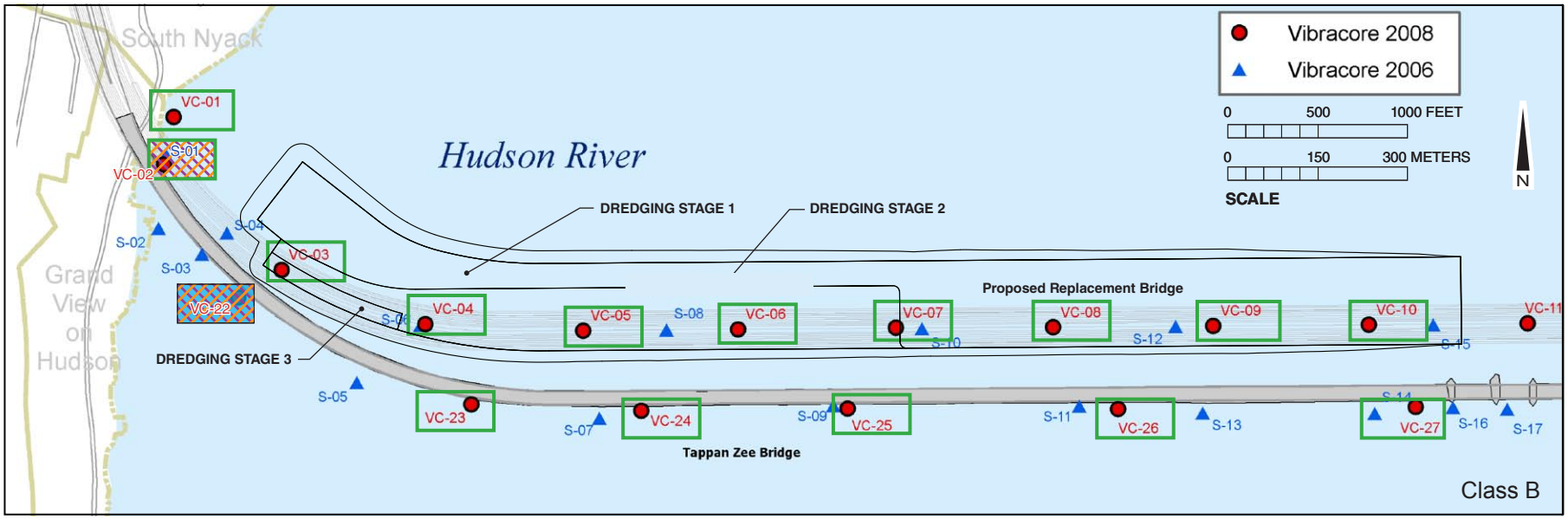
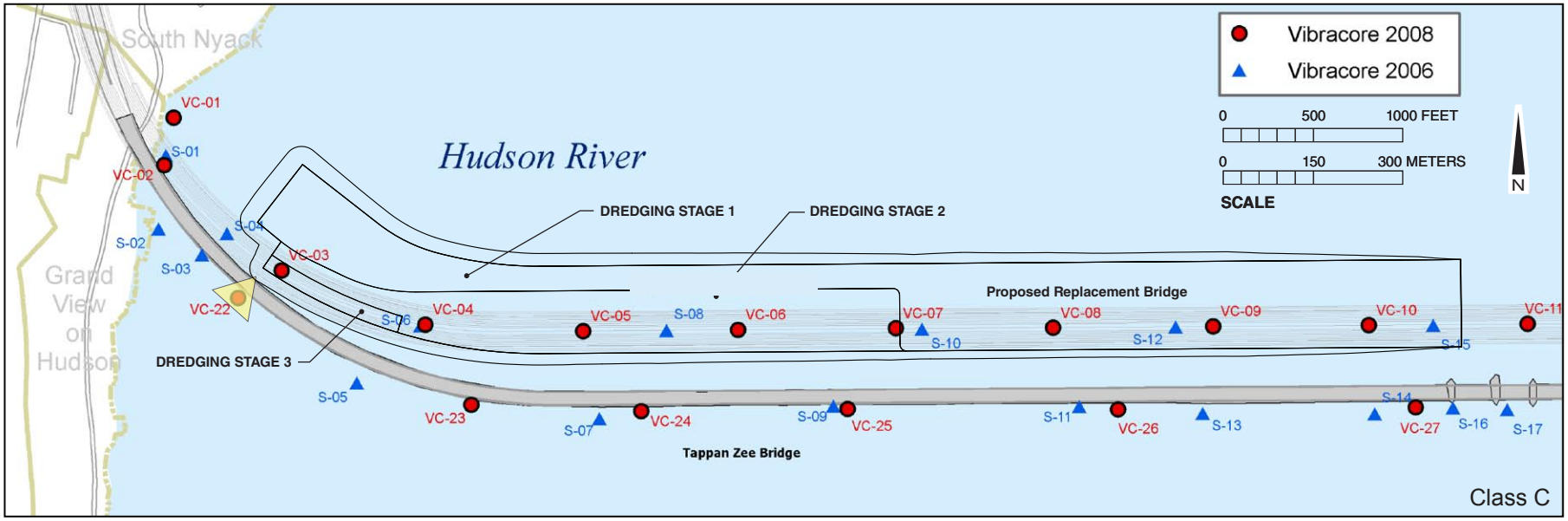


Figure 15-14

Sediment Sample Locations and TOGS 5.1.9 Sediment Quality Classifications

1.3.12





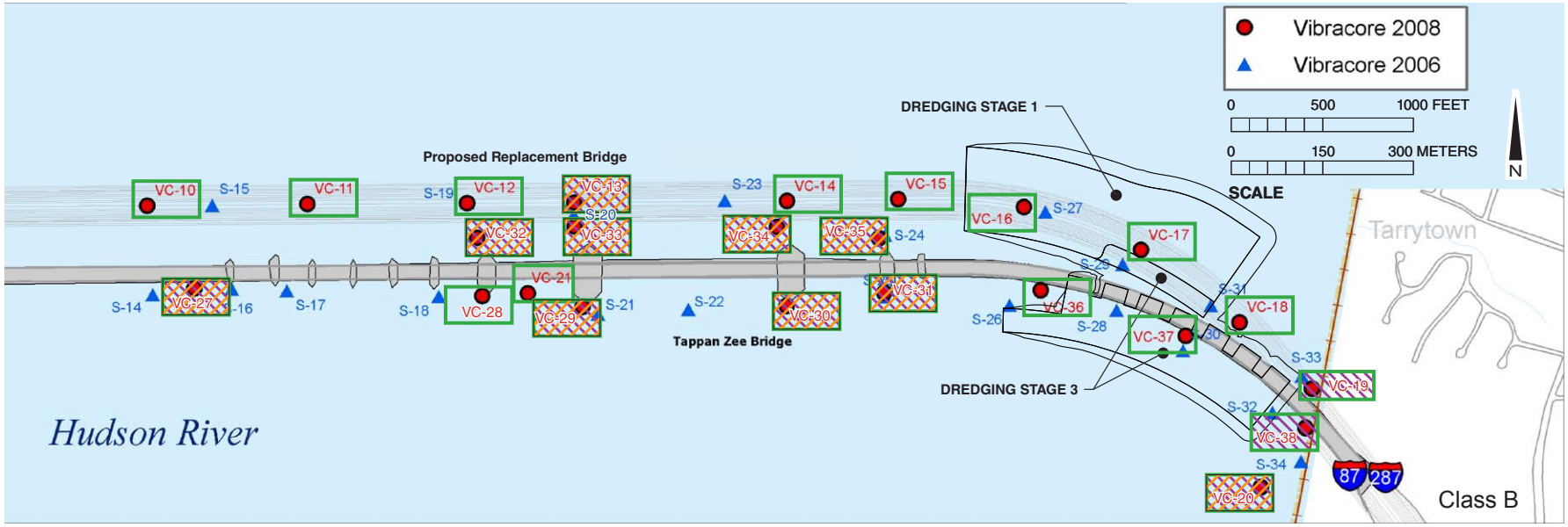
Class B — DDT,DDD, & DDE — Lead — Arsenic

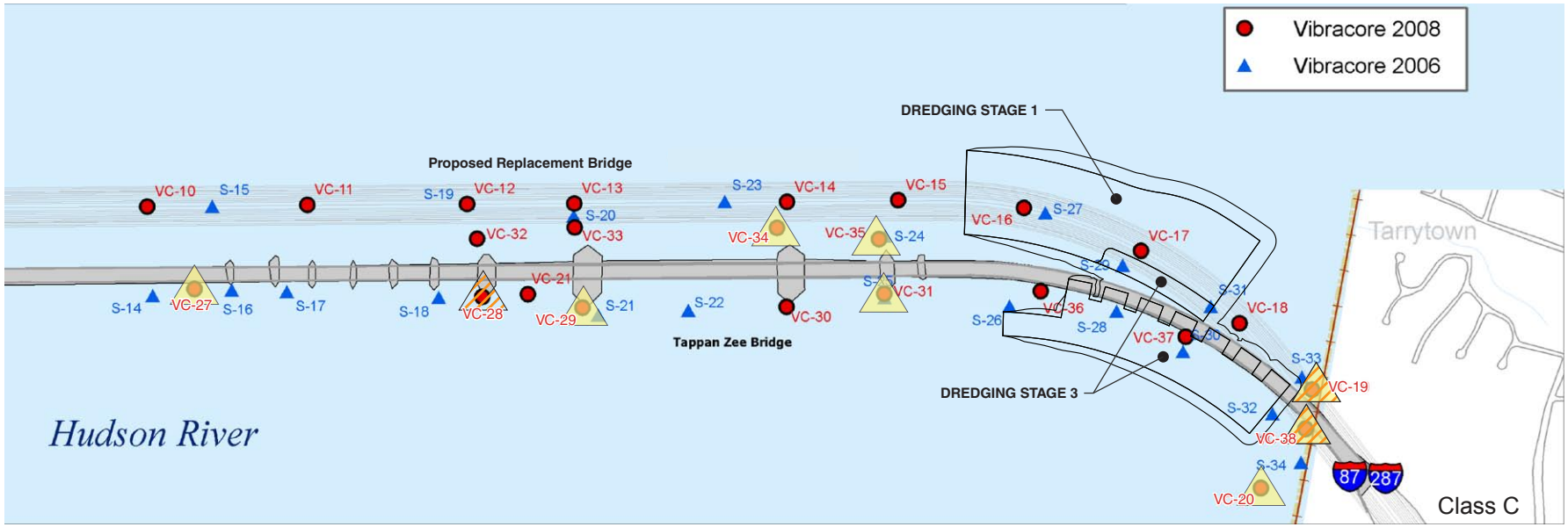
Class C — Copper — Cadmium

Figure 15-15

Sediment Sample Locations and TOGS 5.1.9 Sediment Quality Classifications

1.3.12





Class B — DDT,DDD, & DDE — Lead

Class C — Copper — Cadmium

Figure 15-16

Sediment Sample Locations and TOGS 5.1.9 Sediment Quality Classifications

Table 15-3
Metals

Parameter	Sediment Criteria		Hudson River Average[2]	Number of Samples Analyzed	Detection Rate	Minimum (mg/kg)	Average (mg/kg)	Median (mg/kg)	95th Percentile (mg/kg)	Maximum (mg/kg)
	ERL[1] (mg/kg)	ERM[1] (mg/kg)								
Aluminum	NC	NC	10256.9	313	100%	483	11,714	11,700	17,300	21,700
Antimony	NC	NC	--	156	0%	ND	ND	ND	ND	ND
Arsenic	8.2	70	7.2	313	97%	ND	8.06[A]	7.4[A]	14[B]	26.4[B]
Barium	NC	NC	--	313	92%	ND	43	32.9	91.04	190
Beryllium	NC	NC	--	313	47%	ND	0.79	0.76	1.1	2.61
Cadmium	1.2	9.6	1.0	313	46%	ND	1.9[B]	1.92[B]	3.2[B]	6[B]
Calcium	NC	NC	--	313	98%	ND	4,919	2,620	16,550	64,600
Chromium	81	370	38.1	313	100%	1.17	31	21.9	85.86	116
Cobalt	NC	NC	--	313	96%	ND	10	9.8	13.7	17.3
Copper	34	270	42.4	313	99%	ND	32[A]	12.4[A]	102.55[B]	1,550[C]
Iron	NC	NC	--	313	100%	1380	24,227	24,200	32,600	40,900
Lead	46.7	218	44.6	313	100%	1.42[A]	36[A]	10.9[A]	137.4[B]	604[C]
Magnesium	NC	NC	--	313	100%	252	5,765	5,760	7,476	39,600
Manganese	NC	NC	--	313	100%	21.8	626	587	1,170	1,600
Mercury	0.15	0.71	0.38	313	37%	ND	0.89[B]	0.53[B]	2.46[C]	6.33[C]
Nickel	20.9	51.9	21.5	313	99%	ND	21	20.6	32.6	38.3
Potassium	NC	NC	--	313	97%	ND	2181	2,130	3,257	4,460
Selenium	NC	NC	--	313	43%	ND	4.01	3.945	6.2775	12.6
Silver	1	3.7	1.5	156	17%	ND	2.02	1.9	3.04	3.3
Sodium	NC	NC	--	313	94%	ND	2,229	2,035	3,761.50	5,730
Thallium	NC	NC	--	156	1%	ND	12.4	12.4	12.4	12.4
Vanadium	NC	NC	--	313	99%	ND	24.7	23.7	36.3	54.1
Zinc	150	410	129.2	313	100%	8.74	90	65	221	399

Notes: mg/kg = milligrams per kilogram; NC = no criteria; ND = not detected, -- = not available.

Sources:

[1] NYSDEC 1999

[2] Llanso et al. 2003

[A] Concentration falls within Class A - no appreciable contamination/no toxicity to aquatic life (NYSDEC 2004).

[B] Concentration falls within Class B - moderate contamination/chronic toxicity to aquatic life (NYSDEC 2004).

[C] Concentration falls within Class C - high contamination/acute toxicity to aquatic life (NYSDEC 2004).

Table 15-4
SVOCs

Parameter	Sediment Criteria		Hudson River Average[3]	Number of Samples Analyzed	Detection Rate	Minimum (µg/kg)	Average (µg/kg)	Median (µg/kg)	95th Percentile (µg/kg)	Maximum (µg/kg)
	ERL[1] (µg/kg)	ERM[1] (µg/kg)								
Acenaphthene	16	500	289.4	156	8%	ND	36	ND	89	3,270
Acenaphthylene	44	640	139.2	156	16%	ND	13	ND	111	206
Anthracene	85.3	1,100	283.2	156	27%	ND	47	ND	155	2,030
Benzo(a)anthracene	261	1,600	176.4	156	43%	ND	130	ND	418	3,760
Benzo(a)pyrene	430	1,600	174.1	156	51%	ND	133	37	496	3,020
Benzo(b)fluoranthene	NC	NC	184.7	156	42%	ND	110	ND	445	2,460
Benzo(g,h,i)perylene	NC	NC	123.5	156	42%	ND	64	ND	260	1,530
Benzo(k)fluoranthene	NC	NC	163.4	156	42%	ND	91	ND	328	2,370
Chrysene	384	2,800	178.7	156	44%	ND	134	ND	487	3,490
Dibenzo(a,h)anthracene	63.4	260	--	156	15%	ND	14	ND	78	456
Fluoranthene	600	5,100	218.9	156	49%	ND	333	ND	994	13,300
Fluorene	19	540	291.2	156	10%	ND	28	ND	81	2,210
Indeno(1,2,3-c,d)pyrene	NC	NC	104.8	156	33%	ND	53	ND	220	1,510
2-Methylnaphthalene	70	670	--	156	1%	ND	0.96	ND	ND	113
Naphthalene	160	2,100	111.0	156	9%	ND	11	ND	49	504
Phenanthrene	240	1,500	299.1	156	40%	ND	163	ND	539	7,030
Pyrene	665	2,600	265.7	156	48%	ND	288	ND	999	9,570
Total PAHs (sum of above)	4,020	44,792	3,003	156	--	22.8[A]	1,673[A]	113[A]	6,079[B]	48,211[C]
bis(2-Ethylhexyl)phthalate	NC	NC	--	156	33%	ND	82	ND	259	4,240
Butyl benzyl phthalate	NC	NC	--	156	12%	ND	101	ND	289	5,140
Carbazole	NC	NC	--	156	3%	ND	5.25	ND	ND	349
Dibenzofuran	NC	NC	--	156	5%	ND	20	ND	6.6	2,660
Di-n-butyl phthalate	NC	NC	--	156	3%	ND	30	ND	ND	4,360

Notes: µg/kg = micrograms per kilogram; NC = no criteria; ND = not detected; -- = not available.

Sources:

[1] NYSDEC 1999; [2] NYSDEC 1999; [3] Llanso et al. 2003

[A] Concentration falls within Class A - no appreciable contamination/no toxicity to aquatic life (NYSDEC 2004).

[B] Concentration falls within Class B - moderate contamination/chronic toxicity to aquatic life (NYSDEC 2004).

[C] Concentration falls within Class C - high contamination/acute toxicity to aquatic life (NYSDEC 2004).

Table 15-5
Pesticides, PCBs, and Dioxins

Parameter	Sediment Criteria					Hudson River Average[2]	Number of Samples Analyzed	Detection Rate	Minimum (µg/kg)	Average (µg/kg)	Median (µg/kg)	95th Percentile (µg/kg)	Maximum (µg/kg)
	ERL[1] (µg/kg)	ERM[1] (µg/kg)	BA- Chronic[1] (µg/gOC)	BA- Acute[1] (µg/gOC)	WA[1] (µg/gOC)								
alpha-Chlordane	NC	NC	NC	NC	0.006	--	156	1%	ND	0.1	ND	ND	16
gamma-Chlordane	NC	NC	NC	NC	0.006	--	156	1%	ND	0.09	ND	ND	15
Chlordane (sum of above)	NC	NC	0.002	0.05		--	156	--	--	0.19[A]	--	--	31[B]
Dieldrin	NC	NC	17.0	NC	NC	--	156	1%	ND	0.03[A]	ND	ND	4.8[A]
4,4'-DDD	NC	NC	-	-	NC	5.7	156	14%	ND	2.07	ND	12	54
4,4'-DDE	2.2	27	-	-	NC	--	156	7%	ND	0.47	ND	3.85	17
4,4'-DDT	1	7	1	130	NC	19.7	156	5%	ND	2.47	ND	0.73	352
Sum of DDT, DDD, and DDE	1.58	46.1	-	-		25.4	156	--	--	5.01[B]	--	16.58[B]	423[C]
Aroclor 1242	NC	NC	NC	NC	NC	--	156	13%	ND	51	ND	280	1,520
Aroclor 1248	NC	NC	NC	NC	NC	--	156	8%	ND	35	ND	239	1,200
Aroclor 1254	NC	NC	NC	NC	NC	--	156	4%	ND	6.13	ND	ND	221
Total PCBs	22.7	180	-	-	NC	726.8	156	--	40[A]	169.95*[B]	64[A]	682.25[B]	1,520*[C]
TCDD TEQ (pptr)	NC	NC	NC	NC	0.0002	--	17	100%	0.069[A]	11.84[C]	0.89[A]	54.2[C]	94.67[C]

Notes: µg/gOC = micrograms per gram of organic carbon; µg/kg = micrograms per kilogram; NC = no criteria; ND = not detected; BA = Benthic Aquatic; WA = Wildlife Accumulation; -- = not available; - ERM/ ERL applies.

Sources:

[1] NYSDEC1999

[2] Llanso et al. 2003

* The sum of PCBs is multiplied by two to determine the total PCB concentration (NYSDEC 2004).

[A] Concentration falls within Class A - no appreciable contamination/no toxicity to aquatic life (NYSDEC 2004).

[B] Concentration falls within Class B - moderate contamination/chronic toxicity to aquatic life (NYSDEC 2004).

[C] Concentration falls within Class C - high contamination/acute toxicity to aquatic life (NYSDEC 2004).

15-5 ENVIRONMENTAL EFFECTS

This section assesses potential impacts of the No Build Alternative and Replacement Bridge Alternative to groundwater, floodplains, and surface water resources within the study area.

15-5-1 NO BUILD ALTERNATIVE

15-5-1-1 GROUNDWATER RESOURCES

Under the No Build Alternative, the primary source of groundwater resources within the study area would continue to be contributed by the Hudson River with minor contributions from recharge areas. Land use changes within the small portion of the recharge area located within the study area (about 1 mile from the west bank and 3 miles from the east bank (see **Figure 15-4**) would not have the potential to adversely affect groundwater resources within the study area.

15-5-1-2 SURFACE WATER RESOURCES

The No Build Alternative would not result in changes to land uses within the study area that would have the potential to affect surface water resources and floodplains of Sheldon Brook and the Hudson River. This alternative would involve the continued operation of the existing bridge with ongoing maintenance to keep the bridge in a state of good repair. There would be no construction that would result in development of additional water quality management facilities for stormwater runoff from the existing highway or portions of the existing Tappan Zee Bridge in Rockland or Westchester counties. As with existing conditions, no treatment of stormwater would take place on the bridge. Maintenance of existing drainage systems along Interstate 87/287 would continue according to current practices for the foreseeable future.

15-5-1-3 SEDIMENTS

Under the No Build Alternative, the patterns of pier scour and deposition would remain largely the same as existing conditions, although they may vary somewhat with changing water column conditions. Under this condition, which is described under Affected Environment above, a large area near the existing bridge is subject to scour due to the narrow column spacing.

15-5-2 REPLACEMENT BRIDGE ALTERNATIVE

The Replacement Bridge Alternative would replace the existing Tappan Zee Bridge with two new parallel structures to the north of its existing location. As described in Chapter 2, “Alternatives,” there are two options for the Replacement Bridge Alternative’s approach spans (Short Span and Long Span Options) and two for the main span (Cable-stayed and Arch Option). The evaluation of potential impacts from these options considers the potential impacts from the Replacement Bridge Alternative in general, noting differences in the potential for adverse impacts for the two approach span options as appropriate. There would be no difference in the potential for affects to groundwater or surface water resources between the two main span options.

15-5-2-1 GROUNDWATER RESOURCES

Potential impacts to groundwater would occur primarily from the infiltration of chlorides (a residue of roadway deicing) or roadway pollutants (e.g., petroleum products, heavy metals, etc.) into the groundwater. Because there are no SSAs or NYSDEC-designated Primary or Principal Aquifers located within the study area, the Replacement Bridge Alternative would not have the potential to affect groundwater supplies. As was discussed for the No Build Alternative, the primary source of groundwater resources within the study area for the Replacement Bridge Alternative would continue to be contributed by the Hudson River with minor contributions from recharge areas. For the Long and Short Span Options, the approximately 27-acre and 17-acre upland landings of the Replacement Bridge Alternative on the Rockland and Westchester County sides of the Hudson River, respectively, comprise a small portion of the recharge area located within the study area. Therefore, operation of the landing areas for both approach options would not have a potential to result in adverse environmental impacts to groundwater resources within the study area. Additionally, the proposed collection and treatment of stormwater runoff from both landing areas prior to discharge to the Hudson River (discussed in section 15-5-2-2 below under Water Quality and Stormwater Management) would further minimize the potential for operation of the landings to result in adverse environmental impacts to groundwater resources. Therefore, the Replacement Bridge Alternative would be consistent with the goals of the Hudson River Valley National Heritage Area's Management Plan to preserve and protect the area's resources.

15-5-2-2 SURFACE WATER RESOURCES

Floodplains

Impacts to floodplains are estimated based on the encroachment into the 100-year floodplain (also known as the base flood). The water surface elevations of the 100 year flood elevation, or base flood elevation, were used in conjunction with cross-sections of the build alternatives to determine the area and volume of impacts of the Replacement Bridge Alternative to the 100-year floodplain.

No floodways have been designated within the study area for Sheldon Brook or the Hudson River.

For the Short and Long Span Options, approximately 0.3 acres of the replacement bridge landing in Rockland County would be located within 100-year floodplain and about 10 acres of the replacement bridge landing would be located within the 500-year floodplain (see **Figure 15-5**). The use of a portion of the 100-year and 500-year floodplain within the Rockland County portion of the study area for the replacement bridge landing would not result in adverse impacts to floodplain resources or result in increased flooding of adjacent areas. Piers for the replacement bridge would be located within the Hudson River in the 100-year floodplain. The Hudson River within the study area is tidally influenced and as such is affected by coastal flooding, which is influenced by astronomic tide and meteorological forces and, therefore, would not be affected by the Replacement Bridge Alternative. Minimal portions of the piers for the replacement bridge alternative would be located within the 500-year floodplain for the Hudson River within Westchester County on the east side of the Hudson River. No portion of the Replacement Bridge Alternative would be located within the 100-year floodplain for

Sheldon Brook within Westchester County. The Replacement Bridge Alternative would not affect floodplain elevations, and therefore, it would be in compliance with Executive Order 11988.

Water Quality and Stormwater Management

For the Hudson River, the principal potential impact to water quality of the Hudson River from the operation of the Replacement Bridge Alternative is the discharge of stormwater runoff from the decks of the replacement bridge. NYSDEC General Permit GP-0-10-001 regulates the discharge of stormwater runoff from construction activities associated with soil disturbance, including both water quality and quantity controls. NYSDEC requires treatment of stormwater runoff from areas of soil disturbance to improve water quality, as well as a reduction of peak flows of stormwater runoff providing channel protection, overbank flood protection and flood control. The technical standards and design criteria for stormwater management facilities are presented in NYSDEC's New York State SWMDM (NYSDEC 2010).

The stormwater quality management goals stated in the SWMDM are to achieve an 80 percent reduction in TSS and a 40 percent reduction in TP. Most water quality treatment practices accomplish this goal by collecting the stormwater runoff and detaining it for some length of time, infiltrating it into the ground or filtering it. These practices, commonly referred to as "standard practices," are assumed to meet the required removal efficiencies if designed according to the requirements presented in the SWMDM. Other treatment systems, or proprietary practices, such as hydrodynamic separators and grit chambers, can also be employed for water quality treatment. Typically proprietary practices are used when there are certain site specific conditions that prohibit the implementation of "standard practices."

The sizing of any stormwater quality treatment practices as outlined in the SWMDM is based on the Water Quality volume (WQv). The WQv is based on the volume of runoff as a result of the 90 percent rainfall event (i.e., 1.3 inches of rainfall). The intent is to maximize the volume of stormwater runoff treated for quality since much of the pollution in stormwater runoff comes during the early stages of a rainfall event. As a result, the smaller, but more frequent, rainfall events that constitute 90 percent of the precipitation events are expected to account for a considerable fraction of the pollution in stormwater runoff.

Stormwater Management Practices (SMPs) are intended to improve the water quality from redeveloped or new impervious surfaces. However, NYSDEC recognizes the difficulties encountered by linear transportation projects, as well as the opportunity to substantially improve water quality through the installation of stormwater treatment practices at sites that currently have no runoff controls, but for which the installation of SMPs is impractical. The SWMDM offers alternative methods of calculating the treatment volume for redevelopment projects to demonstrate compliance with the construction general permit. The following three methods discuss means of calculating treatment volumes for redeveloped portions of the project depending on whether standard or alternative practices (or a combination of the two) are employed:

- Treatment with standard practices—A minimum of 25 percent of the WQv of the total disturbed area would be captured and treated within the standard stormwater management treatment practices. For portions of redevelopment, 25% of the

existing impervious area and 100 percent of the additional impervious area would be captured and treated within a standard treatment practice.

- Treatment with alternative practices—If the site plan includes alternative water quality practices (or proprietary practices) that treat 75 percent of the WQv from the redeveloped site, plus any additional runoff from any undisturbed areas that are tributary to the practice, no additional treatment of stormwater runoff is required.
- Weighted average approach—If a site plan includes a combination of impervious cover reduction, standard practices and alternative practices that meets the weighted average criteria of the SWMDM, no additional treatment of stormwater runoff is required.

The redevelopment criteria described above apply only to existing areas of impervious cover that are disturbed during construction. If a site redevelopment results in the addition of impervious cover to an area that is currently pervious, then the water quality management criteria for new site development (i.e., 100 percent treatment using standard methods) applies.

Stormwater runoff discharges from the Replacement Bridge Alternative would be ultimately discharged into the Hudson River, a tidal water body. The Hudson River is not on the State's Section 303(d) list of waterbodies impaired by stormwater runoff or within a watershed improvement strategy area. Therefore, stormwater quantity or the channel protection volume, overbank flood protection or flood control sizing criteria would not be required. However, post-construction stormwater quality treatment practices would be required for runoff discharging to the Hudson River from the bridge landing portions of Interstate 87/287 in both Rockland and Westchester Counties. Stormwater runoff from the approaches and main span of the Replacement Bridge Alternative would be discharged directly to the Hudson River without treatment, as occurs for the existing bridge. However, the presence of full shoulders and emergency access lanes on the replacement bridge would permit faster emergency response to on-bridge incidents that could result in spills of hazardous materials or other contaminants than would be possible on the existing Tappan Zee Bridge.

With the implementation of post-construction or long-term quality treatment controls at the bridge landings, the net concentration of pollutants to the Hudson River from the Replacement Bridge Alternative (landings, approach spans, and main spans) would be expected to decrease for TSS and increase by only 4.6 pounds per year for TP (see **Table 15-7** below). Based on the treatment capabilities of the stormwater management practices the pollutant loading would result in a greater reduction of TSS than TP; thus, TP would increase whereas TSS would decrease in comparison to existing conditions. This increase in TP loadings from the Replacement Bridge Alternative would not result in adverse impacts to water quality of the Hudson River, or result in a failure to meet the Class SB water quality standards. Therefore, the Replacement Bridge Alternative would be consistent with the goals of the Hudson River Valley National Heritage Area's Management Plan to preserve and protect the area's resources. Additionally, when comparing just pollutant loadings within the landings under the existing and Replacement Bridge Alternative, pollutant loadings would decrease for TP and TSS (see **Table 15-8** below).

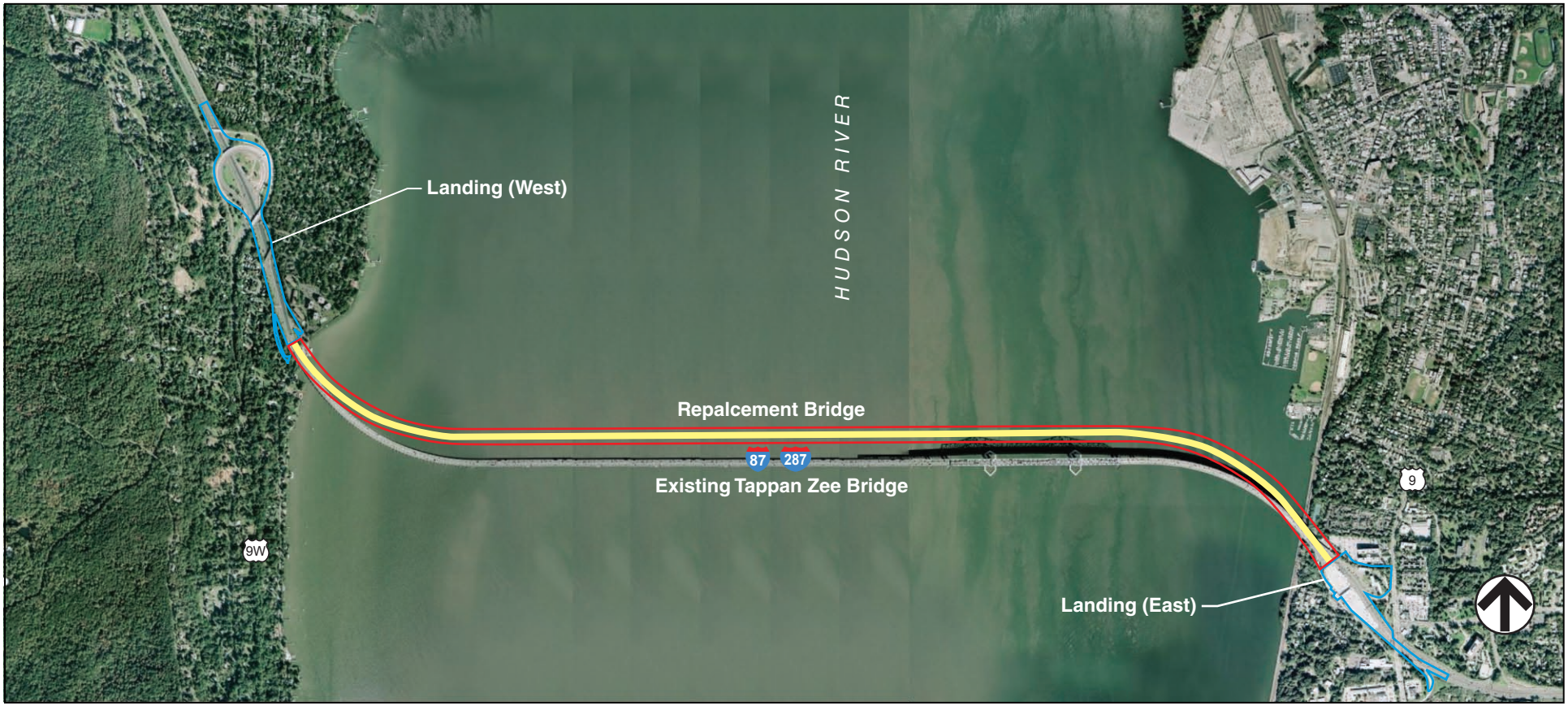
Table 15-6 provides a comparison of impervious surfaces based on the contributing drainage areas from Interstate 87/287 and bridge improvements (see **Figure 15-17**). Under current conditions, the 79-acre drainage area consists of approximately 27 acres of contributing drainage area from the Rockland County portion, approximately 17 acres from the Westchester County portion, and 35 acres is from the bridge span. The Replacement Bridge Alternative would increase the drainage area by 24 acres, primarily due to the proposed bridge span and other roadway improvements. Differences in impervious surface coverage between the Long Span Option and the Short Span Option would be negligible.

Table 15-6
Impervious Surface Comparison

	Existing		Replacement Bridge Alternative	
Location	Impervious Surface (sf)	Pervious Surface (sf)	Impervious Surface (sf)	Pervious Surface (sf)
Rockland County Approach	858,239	324,879	917,844	265,274
Bridge	1,511,630	NA	2,618,327	NA
Westchester County Approach	673,314	77,855	751,169	0
TOTAL	**3,043,183**	**402,734**	**4,287,340**	**265,274**

Under both the Short Span and Long Span Options, the ability to provide stormwater quality treatment for the proposed modification to the landings would be constrained by a number of factors that would preclude the development of large water quality management facilities. While treatment of the stormwater runoff from the bridge deck is not required by NYSDEC regulations, the Replacement Bridge Alternative would be required to collect the water quality volume or ”first flush” stormwater runoff from the bridge landings in Rockland and Westchester Counties and convey it to proposed water quality treatment facilities located in these two areas. Stormwater runoff from the two bridge landings is currently collected and conveyed to the Hudson River without treatment. With the treatment of the runoff from the bridge landing areas, the Replacement Bridge Alternative would result in a net decrease in pollutant loading to the Hudson River for TSS and an increase of 4.6 pounds per year or a 10% increase for TP (see **Table 15-7**). **Table 15-7** includes the calculations for the entire project (landings, approaches, and bridge). **Table 15-8** shows only the landings. This was done to show the compliance with the General Permit, which typically addresses stormwater runoff from land disturbance.

11.29.11



0 2000 4000 FEET

SCALE

Figure 15-17

Drainage Areas

Table 15-7
Pollutant Loading Comparison

Existing		Replacement Bridge Alternative (with treatment[1])	
TP (lbs/year)	TSS (lbs/year)	TP (lbs/year)	TSS (lbs/year)
47.5	69,851	52.1	60,917

Note: The pollutant loading rates of 0.6 pounds per acre per year (lbs/acre/year) TP and 883 lbs/acre/year for TSS [source: Wanielista, MP and Yousef, YA, 1992] were used to estimate the annual pollutant load as a result of the increase in impervious surfaces. A reduction of 80 percent for TSS and 40 percent for TP was assumed for the total drainage area in the proposed condition.

1. Treatment proposed is for the landing only. No treatment proposed for the bridge.

Table 15-8
Pollutant Loading Comparison for Landings Only

Existing		Westchester and Rockland County Landings (with treatment[1])	
TP (lbs/year)	TSS (lbs/year)	TP (lbs/year)	TSS (lbs/year)
26.6	39,210	16	7,842

Note: The pollutant loading rates of 0.6 pounds per acre per year (lbs/acre/year) for TP and 883 lbs/acre/year for TSS [source: Wanielista, MP and Yousef, YA, 1992] were used to estimate the annual pollutant load as a result of the increase in impervious surfaces. A reduction of 80 percent for TSS and 40 percent for TP was assumed for the total drainage area in the proposed condition.

1. Treatment proposed is for the landing only (Westchester/Rockland Side). These calculations represent only the bridge landings and do not incorporate the bridge span. It assumed that stormwater runoff from the bridge span will be discharged directly to the Hudson River.

There are certain project site constraints, such as a limited right-of-way, proximity to the shoreline, and depth to water and bedrock, that make the location, sizing and design of post construction stormwater practices, such as created wetlands, extended detention ponds, wet ponds or surface filtering practices unachievable. Similarly, green infrastructure practices, such as stormwater planters, rain gardens or rainwater collection and reuse could not feasibly be implemented. Therefore, water quality treatment measures would be proposed to capture and treat the stormwater runoff from the roadway. The treatment measure implemented would include those demonstrated to be equal to the performance criteria required by the State of New York (i.e. 80 percent TSS removal and 40 percent TP removal) and have met the USEPA Environmental Technology Verification Program, the state of Washington Technology Assessment Protocol, or the Technology Acceptance Reciprocity Partnership Protocol Permanent stormwater controls would be designed and constructed in accordance with the NYSDEC's SWMDM, NYSDOT Highway Design Manual, NYSDOT TEM Manual, and NYSTA engineering guidance. The permanent controls would be developed as part of the Stormwater Pollution Prevention Plan (SWPPP) for the Replacement Bridge Alternative. Locations for the facilities would be determined as the final design for the Replacement Bridge Alternative is developed.

15-5-2-3 SEDIMENTS

Figures 15-11 and 15-12 illustrate the results of the pier scour resulting from the existing bridge and Replacement Bridge Alternative, estimated using relationships established in the FHWA Hydraulic Engineering Circular No. 18 (HEC-18) (FHWA 2001). The existing Tappan Zee Bridge has 188 piers in the Hudson River. The estimated area of river bottom affected by scour is about 62 acres. The Replacement Bridge Alternative Short Span Option would have only 58 piers in the river and is projected to result in approximately 41 acres of scour and the Long Span Option would have only 32 piers in the river and result in about 26 acres of scour. Along the eastern approaches and in the main span there are a similar number of piers between both bridges; however, in the western causeway, the existing Tappan Zee Bridge contains 165 piers, where the Short Span Option would have 42 and the Long Span Option would have 22. For the existing Tappan Zee Bridge's western causeway, the piers are spaced approximately 50 feet apart. For the Replacement Bridge Alternative, the distance between piers would be approximately 230 to 430 feet. This increase in interpier area would attenuate the interpier water velocities from the existing condition and result in less scour. Reduced pier sediment scour rates would benefit the stability of the bridge structure and reduce sediment resuspension and movement and habitat disturbance.

Upon completion of the replacement bridge, the existing Tappan Zee Bridge would be demolished, and the bridge pier foundations would be removed. For the causeway spans, the timber piles for the foundations would be cut to just below the mudline. For the deck truss spans, the base slab of the caisson would be demolished and removed and the concrete demolished to the mudline. The steel H-piles below the caisson would not extend above the mudline and would remain in place. For the main span, the caissons would be demolished and the steel H-piles foundation piles would be cut to just below the mudline. With the removal of the piers, the hydraulic forces which cause pier scour at the existing bridge would also be removed, and the sediment bed in the vicinity of the existing bridge would gradually return to a natural condition. The rate of this transformation would begin at approximately 1 foot per year, likely decreasing as the bed nears it natural elevation. The time scale for the bed at the existing Tappan Zee Bridge to return to a quasi-natural condition is on the order of a decade.

15-6 MITIGATION

As noted above, with the implementation of stormwater management plans to treat stormwater quality for the landing areas for the Replacement Bridge Alternative designed and constructed in accordance with the NYSDEC's SWMDM, NYSDOT Highway Design Manual, NYSDOT TEM, and NYSTA engineering guidance, the discharge of stormwater runoff from the Replacement Bridge Alternative would not result in a net increase in pollutant loading to the Hudson River for TSS and would result in an increase in pollutant loading for TP which would not be substantial, minimizing the potential for substantial or long-term adverse changes to Hudson River water quality from the discharge of stormwater from the Replacement Bridge Alternative. Therefore, no additional mitigation would be required for the Replacement Bridge Alternative.

Chapter 16: Ecology

16-1 INTRODUCTION

This chapter describes existing terrestrial resources including vegetation and wildlife, aquatic resources including wetlands and aquatic biota, and threatened and endangered species in the study area; presents potential adverse impacts of the No Build and Replacement Bridge Alternatives on those resources during operation of the project; and proposes measures to minimize and mitigate potential impacts. Temporary impacts associated with construction activities, and measures for mitigating adverse construction impacts are discussed in Chapter 18, "Construction Impacts."

16-2 REGULATORY CONTEXT

Operation of the project has the potential to affect the ecological resources described above from the loss of habitat, including wetlands, terrestrial, and aquatic habitats; noise; changes in the height of the bridge structure; and discharge of stormwater runoff. Activities within wetlands, special habitats, or activities with the potential to affect threatened and endangered species must comply with the federal and state legislation and regulatory programs as described below.

16-2-1 FEDERAL

Endangered Species Act of 1973. The Endangered Species Act (ESA) of 1973 prohibits the importation, exportation, taking, possession, and other activities involving illegally taken species covered under the Act, and interstate or foreign commercial activities. The Act also provides for the protection of designated critical habitats on which endangered or threatened species depend for survival.

Bald and Golden Eagle Protection Act. The Bald and Golden Eagle Protection Act prohibits anyone without a permit issued by the Secretary of the Interior from taking bald or golden eagles, including their parts, nests, or eggs. The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb."

Clean Water Act. The objective of the Clean Water Act, also known as the Federal Water Pollution Control Act, is to restore and maintain the chemical, physical, and biological integrity of waters of the United States. Waters of the United States include streams, rivers, wetlands, mudflats, and sandflats that meet the specified requirements defined in 33 CFR 328.3. The Clean Water Act regulates point sources of water pollution (such as discharges of municipal sewage and industrial wastewater and discharges of dredged or fill material into navigable waters and other waters of the United States) and non-point source pollution (such as runoff from streets, agricultural fields, construction sites, and mining).

- Under Section 401 of the Act, any applicant for a federal permit or license for an activity that may result in a discharge to navigable waters must provide to the

federal agency issuing a permit a certificate (either from the state where the discharge would occur or from an interstate water pollution control agency) that the discharge would comply with Sections 301, 302, 303, 306, 307, and 316 (b) of the Clean Water Act.

- Section 404 of the Act requires authorization from the Secretary of the Army, acting through the U.S. Army Corps of Engineers (USACE), for the discharge of dredged or fill material into waters of the United States. Activities authorized under Section 404 must comply with Section 401 of the Act.

Rivers and Harbors Act of 1899. Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the Secretary of the Army acting through USACE for the construction of any structure in or over any navigable waters of the United States; the excavation from or deposition of material in these waters; or any obstruction or alteration in these waters. The purpose of this Act is to protect navigation and navigable channels. Any structures placed in navigable waters—such as pilings, piers, or bridge abutments up to the mean-high-water line—are regulated pursuant to this Act. USACE must evaluate, in the public interest, the benefits of the proposed activity versus potential detriments. In addition, authorization required under the Rivers and Harbors Act of 1899 is for Section 9 for issuance of a Bridge Permit by the US Coast Guard (USCG), as discussed in Chapter 3, "Process and Public Participation."

Executive Order 11990, "Protection of Wetlands." In accordance with Executive Order 11990, "Protection of Wetlands," and U.S. Department of Transportation (USDOT) Order 5660.1a, "Preservation of the Nation's Wetlands," federal agencies must avoid undertaking or providing assistance for new construction in wetlands unless there is no practical alternative to such construction and the proposed action includes all practicable measures to minimize harm to the wetland.

Executive Order 13112, "Invasive Species." In accordance with Executive Order 13112, "Invasive Species," federal agencies must prevent, to the extent practicable and permitted by law, the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause.

Fish and Wildlife Coordination Act. The Fish and Wildlife Coordination Act entrusts the Secretary of the Interior with providing assistance to, and cooperation with, federal, state, and public or private agencies and organizations to ensure that wildlife conservation receives equal consideration and coordination with other water-resource development programs. These programs can include the control (such as a diversion), modification (such as channel deepening), or impoundment (dam) of a body of water.

Migratory Bird Treaty Act. The Migratory Bird Treaty Act (MBTA) of 1918 was implemented following the 1916 convention between the U.S. and Great Britain (on behalf of Canada) for the protection of birds migrating between the U.S. and Canada. Subsequent amendments implemented treaties between the U.S. and Mexico, the U.S. and Japan, and the U.S. and the former Soviet Union. The MBTA makes it unlawful to pursue, hunt, take, capture, kill or sell birds listed therein. Over 800 species are currently protected under the Act. The statute applies equally to both live and dead birds, and grants full protection to any bird parts, including feathers, eggs and nests.

Magnuson-Stevens Fishery Conservation and Management Act. Section 305(b)(2)-(4) of the Magnuson-Stevens Act outlines the process for the National Marine Fisheries Service (NMFS) and the Regional Fishery Management Councils (in this case, the Mid-Atlantic Fishery Management Council) to comment on activities proposed by federal agencies (issuing permits or funding projects) that may adversely impact areas designated as Essential Fish Habitat (EFH). EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Adverse impacts to EFH, as defined in 50 CFR 600.910(A), include any impact that reduces the quality and/or quantity of EFH. Adverse impacts may include:

- Direct impacts such as physical disruption or the release of contaminants;
- Indirect impacts such as the loss of prey or reduction in the fecundity (number of offspring produced) of a managed species; and
- Site-specific or habitat-wide impacts that may include individual, cumulative, or synergetic consequences of a Federal action.

Marine Protection, Research and Sanctuaries Act (MPRSA), Section 103. The Marine Protection, Research, and Sanctuaries Act prohibits the dumping of material into the ocean that would unreasonably degrade or endanger human health, the marine environment, or economic potential. Section 103 regulates the transportation and disposal of dredged materials in the ocean. Permits for ocean dumping of dredged materials are issued by the US Army Corps of Engineers (USACE) and are subject to approval by the US Environmental Protection Agency (EPA). Ocean dumping is only permitted if there are no other reasonable alternative sites.

National Wild and Scenic Rivers Act of 1968 (16 USC §§ 1271-1287). Under Section 7 of the National Wild and Scenic Rivers Act, federal agencies with “water resources” projects (defined as those that would affect the free-flowing nature of the river)—including projects that require permits from the USACE—must consult with the river-administering agency regarding effects to rivers that are part of the National Wild and Scenic Rivers System, designated as Study Rivers under Section 5(a) of the National Wild and Scenic Rivers Act, or listed on the Nationwide Rivers Inventory. However, no portion of the Hudson River is classified as a National Wild and Scenic River.

Hudson River Valley National Heritage Area. Congress designated the Hudson River Valley National Heritage Area under Title IX of Public Law 104-333 (1996), as amended by Section 324 of Public Law 105-83 (1997). The National Heritage Area extends from Yonkers, New York to Troy, New York, comprising the 10 counties of Albany, Rensselaer, Columbia, Greene, Ulster, Dutchess, Orange, Putnam, Westchester, and Rockland, and the Village of Waterford in Saratoga County. The Hudson River Valley National Heritage Area Act of 1996 has the following purposes:

- To recognize the importance of the history and the resources of the Hudson River Valley to the Nation;
- To assist the State of New York and the communities of the Hudson River Valley in preserving, protecting, and interpreting these resources for the benefit of the Nation; and

- To authorize Federal financial and technical assistance to serve these purposes. (Public Law 104-333 Title IX Sec. 903)

The Hudson River Valley Greenway Communities Council and the Greenway Conservancy serve as the management entities, and must develop a management plan for the National Heritage Area. The Hudson River Valley National Heritage Area Management Plan was approved by the Secretary of the Interior in 2002. The Management Plan's goals include, among others, to safequard and enhance the area's natural heritage through conservation of its resources.

16-2-2 NEW YORK STATE

Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern. The Endangered and Threatened Species of Fish and Wildlife, Species of Special Concern Regulations prohibit the taking, import, transport, possession, or selling of any endangered or threatened species of fish or wildlife, or any hide, or other part of these species as listed in 6 NYCRR §182.6.

Protection of Waters, ECL Article 15. The New York State Department of Environmental Conservation (NYSDEC) is responsible for administering Protection of Waters regulations to prevent undesirable activities on surface waters (streams, lakes, and ponds). The New York State Thruway Authority (NYSTA) is exempt from the permit requirements of Article 15. In addition, NYSDEC and the New York State Department of Transportation (NYSDOT) signed a Memorandum of Understanding (MOU) regarding Environmental Conservation Law (ECL) Articles 15 and 24. Pursuant to the MOU, NYSDOT does not need to obtain individual permits for projects regulated by ECL Article 15, but must comply with the provisions set forth in the MOU and the intent of the law. The project will be progressed in accordance with NYSDOT/NYSDEC's MOU.

Removal of Trees and Protect Plants. NYSDEC, through the New York Natural Heritage Program, maintains a list of plant species that are listed as endangered, threatened, rare, or exploitably vulnerable. Section 9-1503 of the ECL states that: "[n]o person shall, in any area designated by such list or lists, knowingly pick, pluck, sever, remove, damage by the application of herbicides or defoliants, or carry away without the consent of the owner thereof, any protected plant."

Freshwater Wetlands Act, (ECL Article 24). NYSDEC is responsible for implementing New York State's Freshwater Wetland Regulatory program, which is intended to prevent despoliation and destruction of freshwater wetlands in accordance with the environmental protection regulations of the state. These regulations were designed to preserve, protect, and enhance the present and potential values of wetlands, protect the public health and welfare, and be consistent with the reasonable economic and social development of the state. As discussed above, NYSDEC and NYSDOT have an MOU regarding ECL Articles 15 and 24. The February 12, 1997 MOU streamlines the use of five Freshwater Programmatic Permits. However, NYSDOT must continue to submit Individual Article 24 permit applications to the NYSDEC Regional Permit Administrator.

Tidal Wetlands Act, (ECL Article 25). Tidal wetlands regulations apply anywhere tidal inundation occurs on a daily, monthly, or intermittent basis. In New York, tidal wetlands occur along the salt-water shore, bays, inlets, canals, and estuaries of Long Island,

New York City and Westchester County, and the tidal waters of the Hudson River up to the salt line. NYSDEC administers the tidal wetlands regulatory program and the mapping of the state's tidal wetlands. A permit is required for almost any activity that would alter wetlands or the adjacent areas (up to 300 feet inland from wetland boundary). The northern limit of NYSDEC's tidal wetlands jurisdiction is to the south of the existing bridge.

16-3 METHODOLOGY

16-3-1 STUDY AREA

Potential adverse effects to ecological resources can include both direct, physical effects—such as loss of habitat due to excavation, filling, dredging, and new structures—and indirect effects, such as stormwater runoff, resuspension of sediments, and acoustic disturbance during pile driving (hydroacoustic effects). Three study areas are considered in this chapter to account for the greatest distance of potential effects, particularly sedimentation and hydroacoustic effects (see **Figure 16-1**). The three study areas are as follows:

- The study area for evaluation of impacts to terrestrial resources and wetlands generally comprises the area of disturbance, or project area.
- The study area for evaluation of impacts to aquatic resources, terrestrial and aquatic threatened and endangered species, and special habitats comprises the area extending ½ mile north and south of the Interstate 87/287 right-of-way generally between Interchange 10 (US Route 9W) in Rockland County and Interchange 9 (US Route 9) in Westchester County, including the Hudson River.
- The study area for evaluation of hydroacoustic effects extend across the entire width of the Tappan Zee Reach of the Hudson River, and based on modeled sound isopleths with a 10 dB reduction associated with proposed BMPs, extend approximately 1.5 miles in both up and downriver directions.

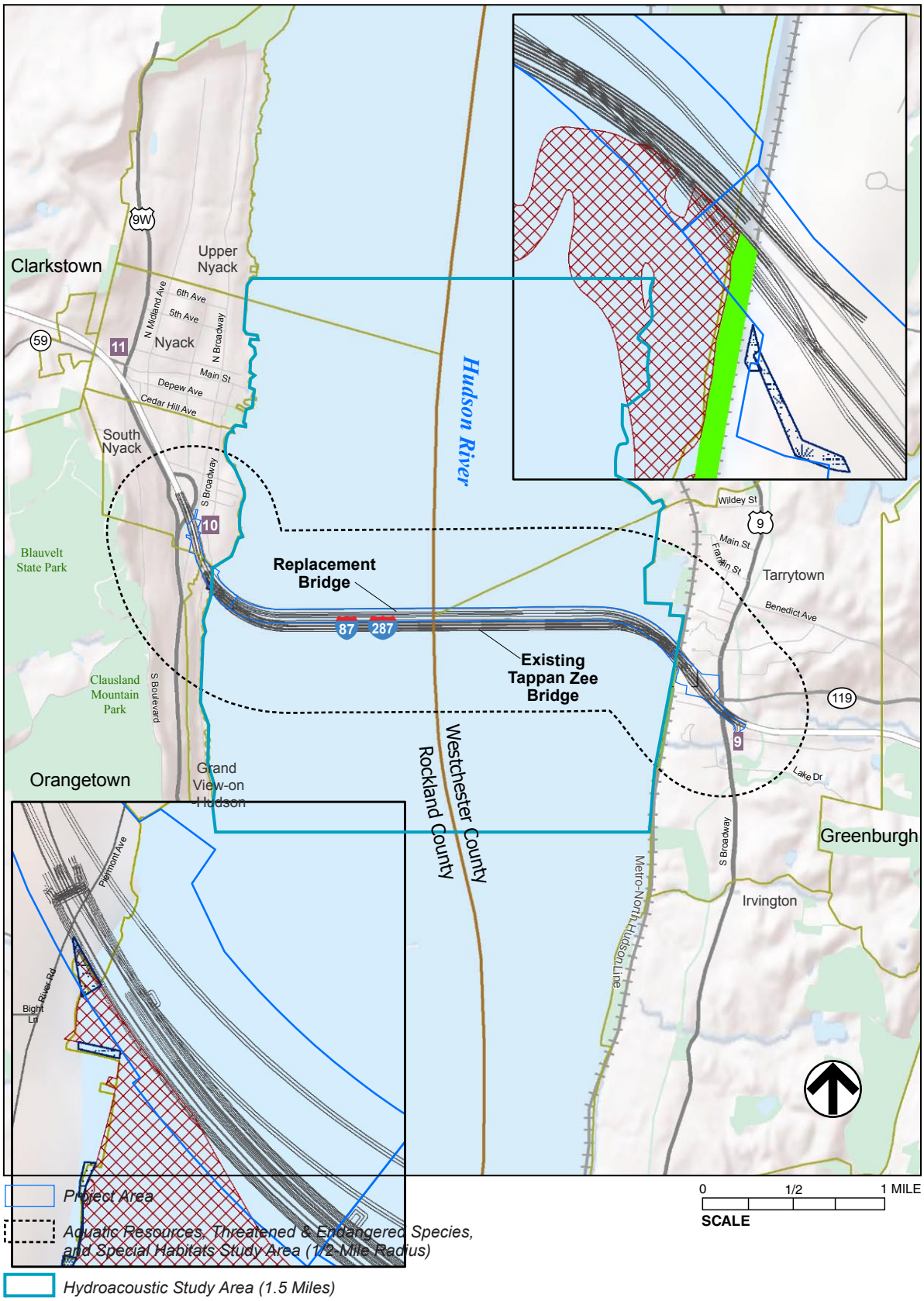
The study area may also include the Historic Area Remediation Site (HARS) in the New York Bight for the ultimate disposal area of dredge spoils from construction of the access channel. Transport by ocean scow and placement at HARS in the New York Bight would offer a number of benefits to the project including cost, schedule, logistics and the avoidance of impacts to the surrounding residential communities on the Rockland and/or Westchester shorelines. Should the HARS site prove to be acceptable, additional coordination with NMFS for listed and proposed species (e.g. Atlantic sturgeon) and Essential Fish Habitat will be needed.

16-3-2 DATA SOURCES

Existing conditions for ecological resources within the study area are summarized from a number of data sources, including:

- Existing information identified in literature and obtained from governmental and nongovernmental sources, including the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps; NYSDEC freshwater and tidal wetlands maps; New York Natural Heritage Program (NYNHP) Environmental Resource Mapper; 2000-2005 New York State Breeding Bird Atlas; NYSDEC Herp Atlas

1.4.12



TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 16-1
Ecology Study Areas

Project; National Audubon Society 2010 Christmas Bird Count; and Hook Mountain Hawk Watch data.

- Responses to requests for information on rare, threatened, or endangered, candidate, or proposed species in the vicinity of the project site. These requests were submitted to NMFS and the New York Natural Heritage Program (NYNHP), a joint venture of NYSDEC and the Nature Conservancy. Additionally, online lists for federally threatened, endangered, candidate, and proposed species for Westchester and Rockland Counties maintained by USFWS were reviewed for this assessment.
- Existing information from wetlands, vegetation, and wildlife surveys previously conducted in the bridge project area from 2006-2008 and during a follow-up ecological survey conducted on October 18, 2011.
- Sampling surveys completed for the project including fish catch surveys, oyster and submerged aquatic vegetation (SAV) surveys, sonar and grab samples, benthic invertebrate sampling, and surveys of bridge piers for attached fauna and flora (see **Appendix F-1**).
- Fish abundance data obtained from the Hudson River Utilities Year Class Reports for the Hudson River Biological Monitoring Program (ASA, 2006). Fish and blue crab contaminant data from various sources compiled in the National Oceanic and Atmospheric Administration (NOAA) Hudson River database (NOAA, 2002).
- Hudson River Long River and Fall Shoals Biological Monitoring Program data sets obtained from Hudson River Utilities and NYSDEC from 2000 to 2009, and shortnose and Atlantic sturgeon data obtained from NYSDEC from 1980 to 2002.
- Literature on the ecology and life history of Hudson River aquatic resources, as cited throughout the chapter.

16-4 AFFECTED ENVIRONMENT

This section characterizes existing terrestrial resources, including ecological communities and wildlife; aquatic resources, including wetlands and aquatic biota; threatened and endangered species; and special habitats for the study area for each resource. Existing conditions for ecological resources in the potential construction staging areas are described in Chapter 18, “Construction Impacts.”

16-4-1 TERRESTRIAL RESOURCES

16-4-1-1 TERRESTRIAL ECOLOGICAL COMMUNITIES

The majority of the project area is comprised of Interstate 87/287 and its associated ramps, overpasses, and structures (i.e., NYSTA/New York State Police [NYSP] facilities, toll plaza, and noise walls), with pockets or strips of vegetation bordering these features. The vegetated ecological communities of the project area are dominated by non-native and invasive species associated with disturbed habitats. In New York State, disturbed habitats are generally defined as terrestrial cultural communities (Edinger et al. 2002). Terrestrial cultural ecological communities are those that “are either created and maintained by human activities, or are modified by human influence to such a degree that the physical conformation of the substrate, or the

biological composition of the resident community is substantially different from the character of the substrate or community as it existed prior to human influence." Terrestrial ecological communities within the project area include urban vacant lots, mowed lawn, mowed lawn with trees, paved path/road, and railroad. In the project area, characteristic species include non-native invasive species including Norway maple (*Acer platanoides*) and tree-of-heaven (*Ailanthus altissima*) scattered in the canopy and shrub strata, and mugwort (*Artemisia vulgaris*), foxtail grasses (*Setaria faberi*, *Setaria* sp.), and Japanese honeysuckle (*Lonicera japonica*) in the herbaceous layer. Asiatic bittersweet (*Celastrus orbiculatus*) and porcelainberry (*Ampelopsis brevipedunculata*) are present in all strata in some locations. Because these areas are constantly disturbed by human activities (e.g., clearing, mowing, roadway and rail traffic), have little vegetation, or are dominated by non-native invasive vegetation, terrestrial ecological communities tend to be of low ecological value. However, there is a large ginkgo tree (*Ginkgo biloba*) that was recorded on the NYSDEC's "Big Tree Register" in 1990 located at the NYSTA/NYSP facilities. The NYSDEC Big Tree Register recognizes native and naturalized tree species of record size and promotes an interest of their care and preservation. In 1990, the ginkgo tree measured 98 ft in height with a 69 ft crown (NYSDEC 1990).

In addition to these terrestrial cultural communities, successional forest communities are also present within the project area. In Rockland County, the successional forests comprise the Interstate 87/287 right-of-way area south of the roadway. In Westchester County, one area of successional forest is located south of the roadway to the west of the toll plaza and another area is located south of the roadway to the east of South Broadway. Successional forests are forests that develop on sites that have been cleared or otherwise disturbed. These forests tend to have the following characteristics: consist of wind dispersed species with high light requirements that are well adapted to disturbed areas; contain young (less than 25 to 50 years old) canopy species of small diameter with low or no regeneration of these species in other strata; and have relatively low canopy height with low tree diversity and poor development of strata. Species in the shrub and herbaceous strata may be similar to those of old fields (i.e., they are dominated by forbs or grasses) or they may include species that occurred on or near the site prior to disturbance (Edinger et al. 2002).Evidence of disturbance (i.e., brush piles) may be present in this community. Within the project area, this community is best defined as a successional southern hardwoods forest. Norway maple and black locust are the most common trees. Each species forms a monotypic stand in some locations within the project area, and in other locations, all three species are present in the canopy. The understory of this community includes Japanese knotweed (*Polygonum cuspidatum*) and mugwort. Vines, particularly porcelainberry and Asiatic bittersweet, form dense blankets over vegetation within the herbaceous and shrub layers, and in some cases, reach into the canopy. In other locations, non-native and native species tolerant of urban conditions such as foxtail grasses, mugwort, common burdock (*Arctium minus*), multi-flora rose (*Rosa multiflora*), white snakeroot (*Ageratina altissima*), and seaside goldenrod (*Solidago sempervirens*) are present. This community tends to be of low ecological value due to the low species diversity, dominance of non-native and invasive vegetation, and poor development of strata.

16-4-1-2 WILDLIFE

Terrestrial sections of the project area in Westchester and Rockland Counties are heavily developed and characteristic of a suburbanized landscape. Undisturbed habitats are lacking, and most of the habitat available to wildlife is constrained to small woodlots, residential yards, tree-lined streets, and recreational parks. The project area includes the eastern edge of Blauvelt State Park, but does not encompass any of the park's interior forest habitat that is farther to the west. As such, terrestrial wildlife communities in the project area are largely composed of disturbance-tolerant species that are associated with fragmented habitats and forest edges and can co-exist with anthropogenic activities in highly disturbed areas. See **Appendix F-2** for tables of wildlife with the potential to occur in the project area.

The Hudson River section of the project area provides foraging habitat for many species of waterfowl and seabirds, as well as wintering bald eagles (*Haliaeetus leucocephalus*). The Palisades ridgeline is a concentration point of birds of prey migrating south during autumn. Peregrine falcons (*Falco peregrinus*), which have increasingly adapted to life in urban areas, have consistently nested on the Tappan Zee Bridge since the 1980s (Mildner 1988, USFWS 1997).

Birds

Over 200 species of birds occur in the lower Hudson Valley, owing to the region's geographical position and habitat diversity. Some are present year-round, whereas others only nest in, overwinter in, or migrate through the area. These species are listed in **Appendix F-2** along with the seasons in which they occur and their relative commonness in the region (DeOrsey and Butler 2006, Bochnik 2011).

Breeding

The Breeding Bird Atlas is a survey to document the distribution of breeding birds across New York State. The most recent survey was conducted from 2000–2005 and documented 90 species as confirmed or probable/possible breeders in the survey blocks in which the study area is located (Blocks 5854B and 5954A). Block 5854B covers sections of Blauvelt State Park and Clausland Mountain County Park which are relatively large tracts of contiguous forest. Therefore, forest-interior bird species such as scarlet tanager (*Piranga olivacea*) and black-throated blue warbler (*Dendroica caerulescens*) appear in the atlas but are unlikely to breed in the project area, which lacks habitat to meet the requirements of such area-sensitive species (Robbins et al. 1989, Poole 2005). Sixty seven of the 90 species in the atlas are considered to have the potential to breed in project area on the basis of their habitat requirements and relative commonness in the region. The majority are disturbance-tolerant, generalist species that have small area requirements, thrive along forest edges, and are ubiquitous to suburban woodlots and residential yards.

Waterbirds can be found on or flying over the Hudson River during the breeding season, including double-crested cormorant (*Phalacrocorax auritus*), Canada goose (*Branta canadensis*), ring-billed gull (*Larus delawarensis*), great black-backed gull (*Larus marinus*), herring gull (*Larus argentatus*), mallard (*Anas platyrhynchos*), and mute swan (*Cygnus olor*). Most of the river's shorelines in the project area are rip-rapped and lack shallow waters and exposed mudflats which limits foraging habitat

suitability for wading birds such as snowy egret (*Egretta thula*), great egret (*Ardea alba*), great blue heron (*Ardea herodias*), and green heron (*Butorides virescens*). Appropriate nesting habitat for colonial waterbirds is not present in the project area, although black-crowned night herons (*Nycticorax nycticorax*), an extreme habitat generalist relative to other species (Hothem et al. 2010), may nest in the project area.

Peregrine falcons, a NYS endangered species, are known to nest in nest boxes on the Tappan Zee Bridge (Mildner 1988, USFWS 1997). Any pair nesting on the bridge is likely the only breeding pair in the project area, as peregrine falcons defend large territories that often extend well over a mile beyond the nest (White et al. 2002) and no other suitable nesting locations are present.

Winter

Many of the birds that occur in the project area during the breeding season are year-round residents that remain during winter. The National Audubon Society's 2010 Christmas Bird Count documented 117 species wintering in Rockland and Westchester Counties. However, due to the high level of anthropogenic activities and lack of appropriate habitats, many of these species would not occur in the project area. Landbird species expected to occur in the terrestrial habitats of the project area during winter include mostly urban-adapted species. Waterfowl and other waterbirds are commonly found on the lower Hudson River during winter, while bald eagles also overwinter along the lower Hudson River where they often sit on ice flows amidst areas with open water.

Migration

Most of New York State is overlapped by major migration flyways for waterfowl, shorebirds, and birds of prey. Broad-front migrants, such as warblers and other songbirds, which do not follow distinct flyways like these other groups of birds, generally pass through the state in high numbers as well.

The location of the replacement bridge on the lower Hudson River is not in proximity to any significant ecological barrier to birds that would create a funnel or otherwise concentrate migrating landbirds through this specific area. Migrating birds of prey occur in increased abundance along the Palisades, but well above the study area where they ride daytime updrafts coming off the ridgeline. Based on count data from the nearby Hook Mountain Hawk Watch in Nyack, NY (NEHW 2008), birds of prey that are expected to pass over the project area during the daytime include turkey vulture (*Cathartes aura*), black vulture (*Coragyps atratus*), osprey (*Pandion haliaetus*), bald eagle, northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), red-shouldered hawk (*Buteo lineatus*), broad-winged hawk (*Buteo platypterus*), red-tailed hawk, American kestrel (*Falco sparverius*), merlin (*Falco columbarius*), and peregrine falcon. On relatively rare occasions, northern goshawk (*Accipiter gentilis*), rough-legged hawk (*Buteo lagopus*), and golden eagle (*Aquila chrysaetos*) may also pass over the study area.

Although the terrestrial habitats in the project area provide breeding and wintering habitat for only a limited number of bird species, they may represent suitable stopover habitats for numerous other bird species migrating through the region. Most species are more generalistic in their habitat preferences during migration than during the non-

migratory periods, and thus, more species are likely to occur in the project area during spring and autumn than at other times of year.

Mammals

As with the bird community, the degree of forest fragmentation and development in the project area limits the mammal community to species accustomed to disturbed habitats in urban and suburban residential areas. Mammals expected to occur in the terrestrial sections of the project area include white-tailed deer (*Odocoileus virginianus*), striped skunk (*Mephitis mephitis*), eastern cottontail (*Sylvilagus floridanus*), groundhog (*Marmota monax*), raccoon (*Procyon lotor*), white-footed mouse (*Peromyscus leucopus*), house mouse (*Mus musculus*), moles (*Scalopus* spp.), eastern chipmunk (*Tamias striatus*), gray squirrel (*Sciurus carolinensis*), and Virginia opossum (*Didelphis virginiana*). In addition, eastern coyote (*Canis latrans*), red fox (*Vulpes vulpes*), little brown bat (*Myotis lucifugus*), big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cenerius*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*) have the potential to occur in the project area (see **Appendix F-2**).

Reptiles and Amphibians

Reptile and amphibian species richness and diversity are particularly high in the lower Hudson Valley, where the range limits of many northern and southern species converge (Gibbs et al. 2007). However, most habitats present in the project area are human-modified and degraded, and unable to support many reptiles and amphibians other than those species that are disturbance-tolerant (see **Appendix F-2**).

The NYSDEC Herp Atlas Project was a 10-year survey (1990-1999) of the geographic distribution of herpetofauna in New York State. Of the 73 species of amphibians and reptiles that occur in the state, 25 were documented in the atlas blocks that cover the project area (*White Plains* and *Nyack* USGS quadrangles). These blocks span areas with larger and higher quality habitats than those within the project area, and thus many species represented in the atlas are unlikely to occur in the project area. Manicured lawn and upland disturbed forest, which support low levels of reptile and amphibian species richness, are dominant habitat types in the project area. Aquatic habitats such as lakes, streams, and vernal pools, which are required by many of the region's reptile and amphibian species, are scant in the project area and limited to man-made ponds surrounded mostly by manicured lawn and a small freshwater wetland on the campus of the Lyndhurst Museum on the Westchester County side. On the basis of their habitat associations (Mitchell et al. 2006, Gibbs et al. 2007) and habitat availability in the study area, the following reptiles and amphibians are considered to have the potential to occur: red-backed salamander (*Plethodon cinereus*), American toad (*Bufo americanus*), Fowler's toad (*Bufo fowleri*), spring peeper (*Pseudacris crucifer*), bullfrog (*Rana catesbeiana*), snapping turtle (*Chelydra serpentina*), red-eared slider (*Trachemys scripta elegans*), garter snake (*Thamnophis sirtalis*), northern brown snake (*Storeria dekayi*), ring-neck snake (*Diadophis punctatus*), and black rat snake (*Elaphe obsoleta obsoleta*)..

16-4-1-3 THREATENED, ENDANGERED, AND SPECIAL CONCERN SPECIES

Table 16-1 lists the threatened or endangered species and species of special concern with the potential to occur within the study area.

Table 16-1
Threatened, Endangered, Candidate, and Special Concern Species

Species	Scientific name	Status
Plants		
Late flowering boneset	*Eupatorium serotinum*	NY-E
Birds		
Golden eagle[1]	*Aquila chrysaetos*	NY-E
Bald eagle	*Haliaeetus leucocephalus*	NY-T
Peregrine falcon	*Falco peregrinus*	NY-E
Osprey	*Pandion haliaetus*	NY-SC
Sharp-shinned hawk	*Accipiter striatus*	NY-SC
Cooper's hawk	*Accipiter cooperii*	NY-SC
Red-shouldered hawk[1]	*Buteo lineatus*	NY-SC
Northern goshawk[1]	*Accipiter gentilis*	NY-SC
Northern harrier[1]	*Circus cyaneus*	NY-T
Pied-billed grebe	*Podilymbus podiceps*	NY-T
Common loon	*Gavia immer*	NY-SC
Mammals		
Indiana bat	*Myotis sodalis*	US-E
New England cottontail	*Sylvilagus transitionalis*	US-C
Reptiles and amphibians		
Bog turtle	*Clemmys* [*Glyptemys*] *muhlenbergii*	US-T, NY-E
Eastern box turtle	*Terrapene carolina*	NY-SC
Spotted turtle	*Clemmys guttata*	NY-SC
Marbled salamander	*Ambystoma opacum*	NY-SC
Southern leopard frog	*Rana sphenocephala*	NY-SC

Notes:
[1]Occurance in study area primarily limited to passage overhead during migration.
E=Endangered; T=Threatened; C=Candidate; SC=Special Concern. All US endangered species are also listed as endangered at the NY State level.
Sources: USFWS County Lists; NYNHP Environmental Resource Mapper; NYNHP request letters; Hook Mountain Hawk Watch data; 2000-2005 NYS Breeding Bird Atlas; 2010 Audubon Christmas Bird Count.

Late flowering boneset (*Eupatorium serotinum*) is a state-listed endangered herbaceous plant of thickets and clearings (Newcomb 1977), bottomlands, moist woods, and sometimes in dry open spaces (Gleason and Cronquist 1963; Clemants and Gracie 2006). Currently, this species is on NYNHP's "2010 Rare Plant Status List—Native Pioneer Plant Watch List." This list contains native species that have fewer than 21 occurrences but are considered pioneer species, or weedy in nature, and predicted to increase in numbers over time. They are usually recent additions to the state and are actively colonizing disturbed sites. This plant was observed throughout the study area growing in disturbed habitats.

Threatened, endangered, and New York State special concern reptile and amphibian species documented during the NYSDEC Herp Atlas Project in the survey blocks that contain the study area include marbled salamander (*Ambystoma opacum*; special concern), southern leopard frog (*Rana sphenocephala*; special concern), spotted turtle (*Clemmys guttata*; special concern), and eastern box turtle (*Terrapene carolina*; special concern).

Peregrine falcon (NYS endangered) and osprey (NYS special concern) were the only state- or federally listed bird species documented during the 2000-2005 Breeding Bird Atlas in the survey blocks encompassing the study area. Threatened, endangered, and special concern species documented during the National Audubon Society's Christmas Bird Counts in Rockland and Westchester Counties in 2010 include bald eagle (NYS threatened), sharp-shinned hawk (special concern), Cooper's hawk (special concern), red-shouldered hawk (special concern), and common loon (special concern).

The Hook Mountain Hawk Watch in Nyack, NY has documented the extensive use of the Palisades ridgeline as a migration pathway by birds of prey during fall (NEHW 2008, HMHW 2011). Threatened, endangered, and special concern species of birds of prey that are known to routinely migrate over the study area include bald eagle (NY threatened), sharp-shinned hawk (NY special concern), Cooper's hawk (NY special concern), red-shouldered hawk (NY special concern), northern harrier (NY threatened), and osprey (NY special concern). Golden eagle (NY endangered) and northern goshawk (NY special concern) also migrate through the area on relatively rare occasions.

Bog Turtle

The bog turtle is a federally threatened and New York State endangered species, and appears on USFWS lists of endangered, threatened, candidate, and proposed species for Rockland and Westchester Counties. However, bog turtles have been extirpated from Rockland County (USFWS 2001) and their extant status in Westchester County is based on a few observations from the early 1990's (USFWS 2001, NYNHP 2011). Any bog turtle populations that are potentially persisting in Westchester County are expected to occur in its northeastern corner, near the Connecticut border (Klemens 1993, Miller and Klemens 2002, Gibbs et al. 2007), where some of the last appropriate habitat for the species in the county remains (Miller and Klemens 2002). This is also the only portion of Westchester County in which the bog turtle was documented during the 1990-1999 NYSDEC Herp Atlas.

Bog turtles are habitat specialists, requiring calcareous fens or wet meadows with cool, shallow, slow-moving water, deep and soft soils, and tussock-forming herbaceous vegetation (Gibbs et al. 2007). During the October 18, 2011 field survey, it was clear that no habitat types within the study area (see *Terrestrial Ecological Communities* above) are remotely suitable for the bog turtle (Mitchell et al. 2006). The NYNHP Environmental Resource Mapper also indicates no non-historical records of the bog turtle within 0.5 miles of the study area. Given the lack of suitable habitat in the study area and the questionable status of the species in Westchester County, occurrence of bog turtles in the study area is extremely improbable and the project will have no impact on the species or habitat on which it depends.

Indiana Bat

The Indiana bat is a temperate, insectivorous bat that is a New York State and federally listed endangered species. The Indiana bat's life cycle can be coarsely divided into two primary phases- hibernation and reproduction. Indiana bats emerge from the caves in which they hibernate (i.e., hibernacula) in early spring. Males disperse and remain solitary until mating season at the end of the summer. Pregnant females form maternity colonies in which to rear the young. Maternity roosts, roosting sites of post-lactating females, and roosting sites of solitary males are usually under loose bark or in the crevices of trees. Indiana bat roosting sites have been documented in numerous species of deciduous trees. Tree availability, diameter, altitude, bark characteristics, and sun exposure appear to be the most important factors in roost site selection (Kurta 2004, USFWS 2007). Roosts in New York (Britzke et al. 2006) and elsewhere (USFWS 2007) are typically in large trees with a diameter greater than 16 inches and a height taller than 52 feet, but roosts in smaller trees can occur (USFWS 2007). The trees are usually dead or nearly dead and decayed (Menzel et al. 2001, Kitchell 2008).

Indiana bats often roost near forest gaps or edges where trees receive direct sunlight for much of the day (Callahan et al. 1997, Menzel et al. 2001). Habitats used by Indiana bats during summer are varied and include riparian, bottomland/floodplain, and upland forests (Humphrey et al. 1977, Britzke et al. 2006, Watrous et al. 2006) often within agricultural landscapes (Murray and Kurta 2004, Watrous et al. 2006, USFWS 2007). Maternity colonies are typically located in areas with abundant natural or artificial freshwater sources (Carter et al. 2002, Kurta et al. 2002, Watrous et al. 2006, USFWS 2007). Spring and autumn habitats of Indiana bats have not been well described, but appear to be largely similar to their summer habitat (Britzke et al. 2006, USFWS 2007).

During autumn, Indiana bats mate and deposit fat stores in preparation for winter hibernation. Hibernacula are typically in caves or abandoned mines where ambient temperatures remain above freezing (USFWS 2007). Only eight Indiana bat hibernacula are currently known in New York State, none of which are located within the study area or elsewhere in Rockland and Westchester Counties (NYSDEC Undated).The terrestrial ecological communities observed within the study area during the October 18, 2011 field survey, including mowed lawn, mowed lawn with trees, and successional forest, are not among those that support Indiana bats. Typical foraging habitats of the species, such as forested wetlands and forested stream and lake borders (Humphrey et al. 1977, Menzel et al. 2001, Murray and Kurta 2004), are lacking in the study area, as are large, dead or dying trees in forest gaps that would provide suitable roosting locations.

However, this project is within 40 miles of a known hibernaculum, which is the typical range of Indiana bats. A study in NY found that most reproductive female bats emerging from winter hibernacula migrate less than 40 miles to their maternity sites (Sanders et al. 2001 and Hicks 2004, as cited in USFWS 2007). Therefore, the study area is within sufficient proximity to a known hibernaculum in Ulster County for individuals associated with this hibernaculum to possibly migrate to, and establish a breeding site within, the study area. There is the potential for the removal of trees greater than four inches diameter at breast height. Prior to any removal of these trees and before the Final EIS (FEIS), coordination with USFWS will occur.

New England Cottontail

The New England cottontail is a species of Special Concern in New York State and a candidate for federal protection under the Endangered Species Act. The current distribution of the New England cottontail in New York is limited to areas east of the Hudson River in Columbia, Dutchess, Putnam, and Westchester Counties (Litvaitis et al. 2006, Tash and Litvaitis 2007).

New England cottontails are found in shrubland, thicket, and similar dense, early successional habitats. Although they will utilize small and isolated fragments of these habitats, including unmaintained and densely vegetated highway margins (Litvaitis et al. 2006, 2008), the field survey conducted on October 18, 2011 identified no densely vegetated margins or other such habitat in the study area that would be appropriate for the species. Additionally, most known populations of New England cottontails in Westchester County occur in the eastern side of the county (Novak 2011), distant from the study area. Therefore, the project will have no effect on this species based on lack of appropriate habitat in the study area.

16-4-2 AQUATIC RESOURCES

The project area encompasses intertidal and subtidal habitats of varying depths, ranging from shallow intertidal shorelines to shallow subtidal shoals and deeper channel habitats. Along the shorelines, coarse woody and rocky debris provide structural refuge and foraging substrates for fishes. Benthic habitat includes submerged aquatic vegetation and oyster beds, as well as unvegetated areas of coarse sandy to fine silty sediments. The navigation channel provides deeper open-water and deep-water benthic habitats. NMFS has identified this region of the Hudson as essential fish habitat (EFH) for 13 federally managed species, and an attached report provides a comprehensive evaluation of potential project impacts to EFH and EFH fish species (see **Appendix F-3**). Only one federally endangered fish species occurs in this region of the Hudson River, the shortnose sturgeon (*Acipenser brevirostrum*). The Atlantic sturgeon (*Acipenser oxyrinchus*), proposed for listing as endangered for the New York Bight population, is also known to occur in the Hudson River. Furthermore, there is a possibility that individual fish from four other Distinct Population Segments (DPS) could occur in the Hudson River. This issue is addressed in detail in the Biological Assessment (**Appendix F-4**).

Both species forage in this portion of the river as they migrate to and from their upriver spawning grounds far to the north of the Tappan Zee Bridge. This portion of the river is not used as spawning grounds for either ESA species. Critical habitat has not been designated for shortnose sturgeon and, at this time, no critical habitat has been proposed for any DPS of Atlantic sturgeon. However, NYSDOS has identified several areas in the Hudson River that are essential to shortnose reproduction and survival (NYSDOS 2012 http://www.nyswaterfronts.com). These areas are located far north of the project area. An attached Biological Assessment provides a comprehensive evaluation of the status of these two species in the Hudson River and an effects determination of the project activities at individual and population levels (see **Appendix F-4**). A comprehensive list of references concerning sturgeon life history and distribution is also provided in Appendix **F-4.**

Inputs from freshwater tributaries and tidal exchange create a salinity gradient along the 150 miles of the Hudson River estuary, which is especially dynamic within the Tappan Zee region. Seasonal variations in temperature and precipitation further influence the salinity regime within this region. At the mouth of the river, salinities approach full-strength seawater, but with increasing distance upstream from the mouth of the estuary, salinities decrease, with the extent of saline waters usually limited to the Cornwall region (RM 55). The northern portions of the River are fresh, but water levels there remain influenced by tidal fluctuations downstream. The result of tidal exchange in the downstream portion of the estuary and freshwater contribution from upstream and from the surrounding watershed, along with the diversity of aquatic habitats, creates a dynamic ecosystem that provides a range of habitat for marine, estuarine, and freshwater fish species.

16-4-2-1 WETLANDS

National Wetland Inventory Wetlands

The USFWS NWI (see **Figure 16-2**) classified the waters of the Hudson River within the vicinity of the project as estuarine subtidal oligohaline (salinity of 0.5 to 5 parts per thousand [ppt]) wetlands with an unconsolidated bottom (E1UBL6).

State-Mapped Wetlands

The NYSDEC-mapped tidal wetlands in the project area include littoral zone[1] with some small areas of intertidal wetlands[2] along both the Westchester County and Rockland County shorelines (see **Figure 16-2**). One mapped intertidal wetland is also mapped just south of the project area on the east side of the river. The limit of NYSDEC's tidal wetland jurisdiction is the south side of the existing bridge. No NYSDEC tidal wetlands are mapped north of the bridge. No NYSDEC freshwater wetlands are mapped within the project area.

Federal Jurisdictional Wetlands

On the east side of the river, a small stream is located approximately 200 feet south of the existing bridge and immediately west of the toll plaza, at the bottom of a steep slope. The 0.06-acre stream flows through a forested wetland (0.63 acres) dominated by red maple and alder (*Alnus* sp.) in the canopy with Japanese knotweed and white snakeroot (*Eupatorium rugosum*) in a sparse understory. The cobble-bottom stream travels below the rail line through a culvert before discharging into the Hudson River. Based on observations from wetland screening surveys performed for the project, two small streams (totaling 0.002 acres) are located in the successional forest area south of the Interstate 87/287 roadway and a 0.12-acre channel exhibiting wetland characteristics located east of the Metro–North Railroad tracks drain into the stream.

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[1] Littoral Zone is in the tidal wetland zone that that includes all lands under tidal waters which are not included in any other category. Provided, there shall be no littoral zone under waters deeper than six feet at mean low water (NYSDEC 2010).

[2] Intertidal Wetland is the vegetated tidal wetland zone, designated IM on an inventory map, lying generally between average high and low tidal elevation. The predominant vegetation in this zone is low marsh cordgrass, *Spartina alterniflora*.

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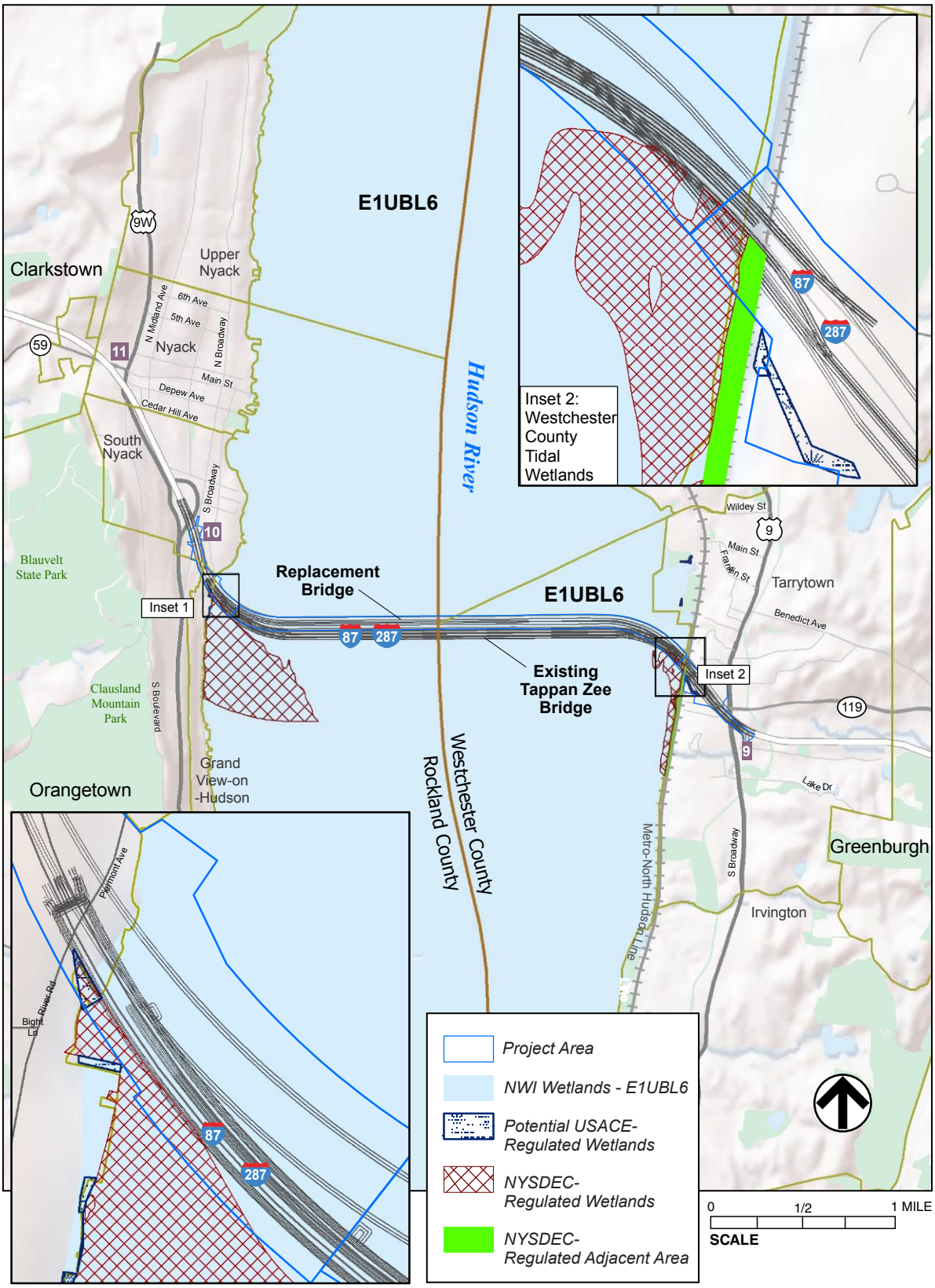

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 16-2
Tidal Wetlands

These areas exhibit indicators of the required wetland parameters—vegetation, hydrology, and soil—and potentially meet the federal wetland criteria under the USACE *Wetlands Delineation Manual*.[1] The assessment of impacts on wetlands was conservatively estimated using mapping resources and visual inspections. Once engineering design has sufficiently progressed and the permitting phase of the project has begun, the acreage of potential wetland impact will be delineated based on the USACE *Wetland Delineation Manual*.

On the west side of the river, the shoreline typically consists of unvegetated intertidal beaches composed of coarse sand with scattered boulders. Immediately north of the bridge, the shoreline is bulkheaded. South of the bridge, a stormwater channel that potentially meets the federal wetland criteria under the USACE *Wetlands Delineation Manual* discharges into the Hudson River. This 0.11-acre channel emanates from a stormwater culvert located below Interstate 87/287 in Rockland County and is partially influenced by tidal fluctuation at its southern end. The channel cuts through a small woodlot that is dominated by red and Norway maples, with sparse stands of common reed and purple loosestrife lining the channel.

16-4-2-2 AQUATIC BIOTA

Phytoplankton

Phytoplankton are microscopic plants whose movements within the system are largely governed by prevailing tides and currents. Several species can obtain larger sizes as chains or in colonial forms. Light penetration, turbidity and nutrient concentrations are important factors in determining phytoplankton productivity and biomass.

In one 1998 study focusing on the Hudson River, investigators collected 161 phytoplankton species. Diatoms are generally the most widely represented class of phytoplankton, accounting for 78 percent of the different taxa collected, with green algae (15 percent), blue-green algae (cyanobacteria) (3 percent), golden algae (chrysophyceae) (2.5 percent), dinoflagellates (1 percent), and cryptophyceae (a type of flagellate algae) (0.6 percent) comprising the remainder of the phytoplankton community. High turbidity and rapid mixing of the Hudson River (which lower light availability) limit primary production by phytoplankton (Smith et al. 1998).

Submerged Aquatic Vegetation and Benthic Algae

Submerged aquatic vegetation (SAV) are rooted aquatic plants that are often found in shallow areas of estuaries, at water depths of up to six feet at low water (Holochuck 2000). SAV communities exhibit high rates of primary productivity and are known to support abundant and diverse epifaunal and benthic communities. These organisms are important because they provide nursery and refuge habitat for fish. Light penetration, turbidity and nutrient concentrations are all important factors in determining SAV and benthic algae productivity and biomass.

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[1] USACE 1987 Wetland Delineation Manual and 2009 Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region.

NYSDEC has mapped the distribution of SAV in the Hudson River from Hastings-on-Hudson to Troy using 1997, 2002, and 2007 data. No SAV is mapped in the immediate area of disturbance; however, SAV beds are mapped within a ½-mile radius of the bridge on the Rockland County shoreline both north and south of the bridge (see **Figure 16-3**). SAV surveys were conducted as part of the project in 2009 to confirm the locations identified on the NYSDEC maps. The dominant species of SAV collected as part of the surveys is the native water celery (*Vallisneria americana*); two other species were collected in the vicinity of the project area, including Eurasian water-milfoil (*Myriophyllum spicatum*) and sago pondweed (*Potamogeton pectinatus*). SAV beds were found along the western bank of the river; on the east bank, SAV was only found north of the bridge. These SAV areas are not within the project's construction limits.

Zooplankton

Zooplankton are an integral component of aquatic food webs—they are primary grazers on phytoplankton and detritus material, and are themselves used by organisms of higher trophic levels as food. Copepods, cladocerans, and rotifers are the primary representatives of zooplankton species in the Hudson River. Zooplankton also include life stages of other organisms such as fish eggs and larvae (i.e., ichthyoplankton) that spend only part of their life cycle as plankton. Analysis of long-term data from the Hudson River Utilities monitoring program indicates Atlantic tomcod (*Microgadus tomcod*), bay anchovy (*Anchoa mitchilli*), striped bass (*Morone saxatilis*), and white perch (*Morone americana*) are the dominant ichthyoplankton species. The higher-level consumers of zooplankton typically include forage fish, such as bay anchovy, as well as commercially and recreationally important species, such as striped bass and white perch during their early life stages.

Benthic Invertebrates

Invertebrate organisms that inhabit river bottom sediments as well as surfaces of submerged objects (such as bridge piers, riprap, and debris) are commonly referred to as benthic invertebrates. These organisms are important to an ecosystem's energy flow because they convert detrital and suspended organic material into carbon (or living material); moreover, they are also integral components of the diets of ecologically and commercially important fish and waterfowl species.

Some of these animals live on top of the substratum (epifauna) and some live within the substratum (infauna). Substrate type (rocks, pilings, sediment grain size, etc.), salinity, and DO levels are the primary factors influencing benthic invertebrate communities; secondary factors include currents, wave action, predation, succession, and disturbance.

Versar (NYSDEC 2009) collected benthic samples from the lower Hudson River estuary (RM 11 to 40) in 2000 and 2001 which included the vicinity of the project area. In general, they found the greatest numbers of species per sample in the lower portions of the project area (south of the Tappan Zee Bridge) and lowest numbers north of the bridge. The greatest benthic biomass occurred in shallow regions of Croton Bay and north of Piermont Pier on the western side of the river. Taxa which showed the greatest densities included oligochaete worms (*Tubificoides spp*.), the clam *Rangia cuneata*, and the amphipod *Leptocheirus plumulosus*. They also found the barnacle *Balanus*

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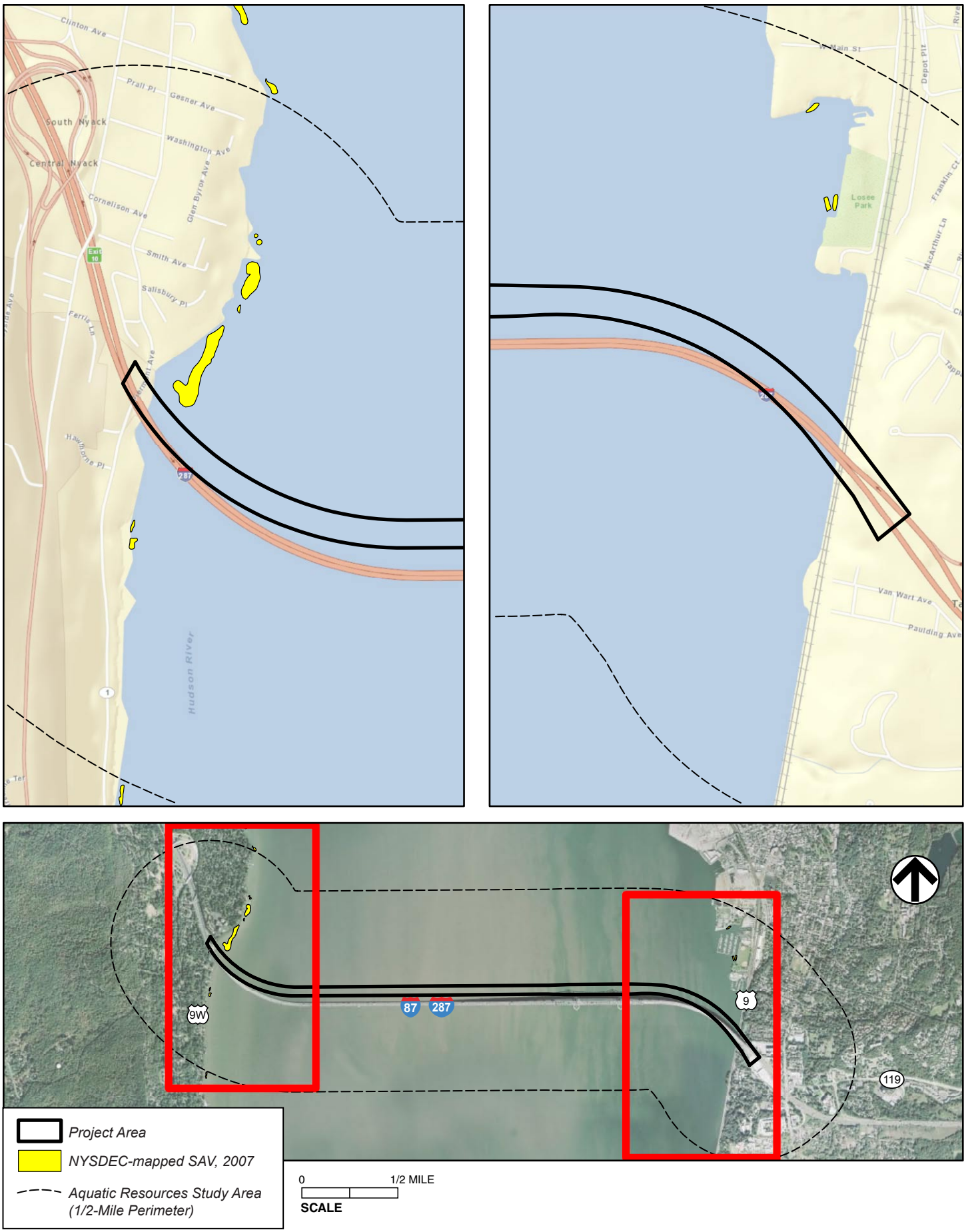

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 16-3
Submerged Aquatic Vegetation (SAV)

improvisus and the pollution-tolerant polychaete worms *Marenzelleria viridis* and *Heteromastus filiformis* to be present in relatively high abundances.

Bimonthly sampling of benthic resources in the bridge vicinity was conducted between March 2007 and January 2008 (see **Appendix F-1)**. Samples were taken in the vicinity of the footprint of the existing and proposed bridges as well as the locations of the proposed temporary causeways along the southeast and southwest portions of the existing bridge (see **Figure 16-4**). Forty-one bottom benthic locations and six bridge pier locations were sampled for the project.

A total of 48 species was collected during the bottom sediment sampling program. Total numbers, species richness, and species diversity (which considers both the number of species and the evenness of distribution) were calculated. Generally, the species richness and numbers of individuals were lower in late winter and early spring, and higher in the summer and fall. Species diversity, while relatively constant throughout the year, was observed to be highest in July and lowest in January. Barnacles (*Balanus spp.*) and the amphipod *Leptocheirus plumulosus* were two of the dominant taxa collected in each of the six sampled months. A one-way analysis of variance (ANOVA) indicated that, for the most part, there was no statistically significant difference in benthic diversity, total numbers of individuals, or species richness between the current and proposed bridge alignments. There was often a statistical difference for the benthic metrics between the approach areas for the causeways and the other locations. These approach areas south of the bridge are thought to accumulate thick sediment deposits, which may account for the observed lower metrics associated with benthic community characteristics.

Benthic invertebrate sampling of the existing bridge piers conducted for the project in 2007 identified a total of 8 taxa and 2 taxa of benthic algae. The polychaete worm *Nereis spp.*, amphipods, barnacles, grass shrimp, mud crabs, isopods, oysters, and ribbed mussels were collected from the piers, as well as red and green algae. These organisms were collected in similar densities on three types of pier structure, namely, steel, concrete and timber.

The eastern oyster (*Crassostera virginica*) is a reef-building organism found in intertidal and subtidal zones of estuaries along the east coast of the United States. Because they are filter feeders, oysters can greatly influence nutrient cycling in estuaries and affect phytoplankton biomass and water clarity. Oysters require a hard surface to grow. Juveniles attach themselves to adult oysters that are already attached to rocks, shell, or other oysters. Excessive deposition of soft, fine sediments can have a deleterious effect on oyster beds by modifying bottom habitat to the point where juvenile oyster settlement is no longer successful. A survey to determine the boundaries of existing oyster bed habitat was conducted in October, 2009 using seismic profiling and side-scan sonar with grab samples confirming the findings of the sonar. The boundaries of historical and 2009 mapped oyster habitats are shown in **Figure 16-5**. Oyster beds were mapped approximately two miles north and south of the existing bridge from depths of 8 to 30 feet. Seven potential oyster beds were identified south of the bridge and six potential beds to the north. All identified oyster beds except one were confirmed to contain at least some live organisms, with beds exhibiting differences in terms of oyster density, amount of shell hash, gravel, or sandstone fragments. See **Appendix F-1** for a more

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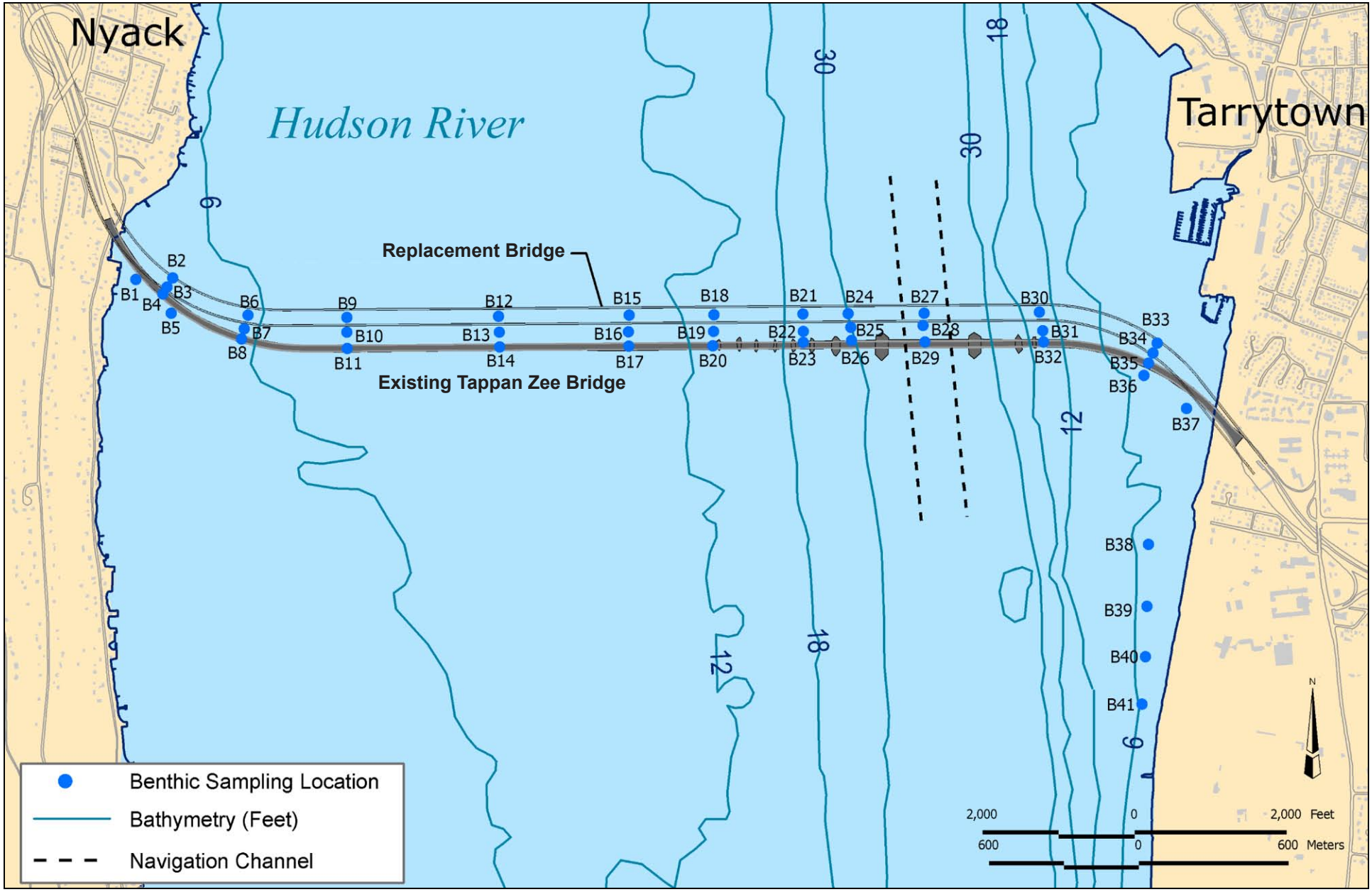

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 16-4
Benthic Sampling Locations

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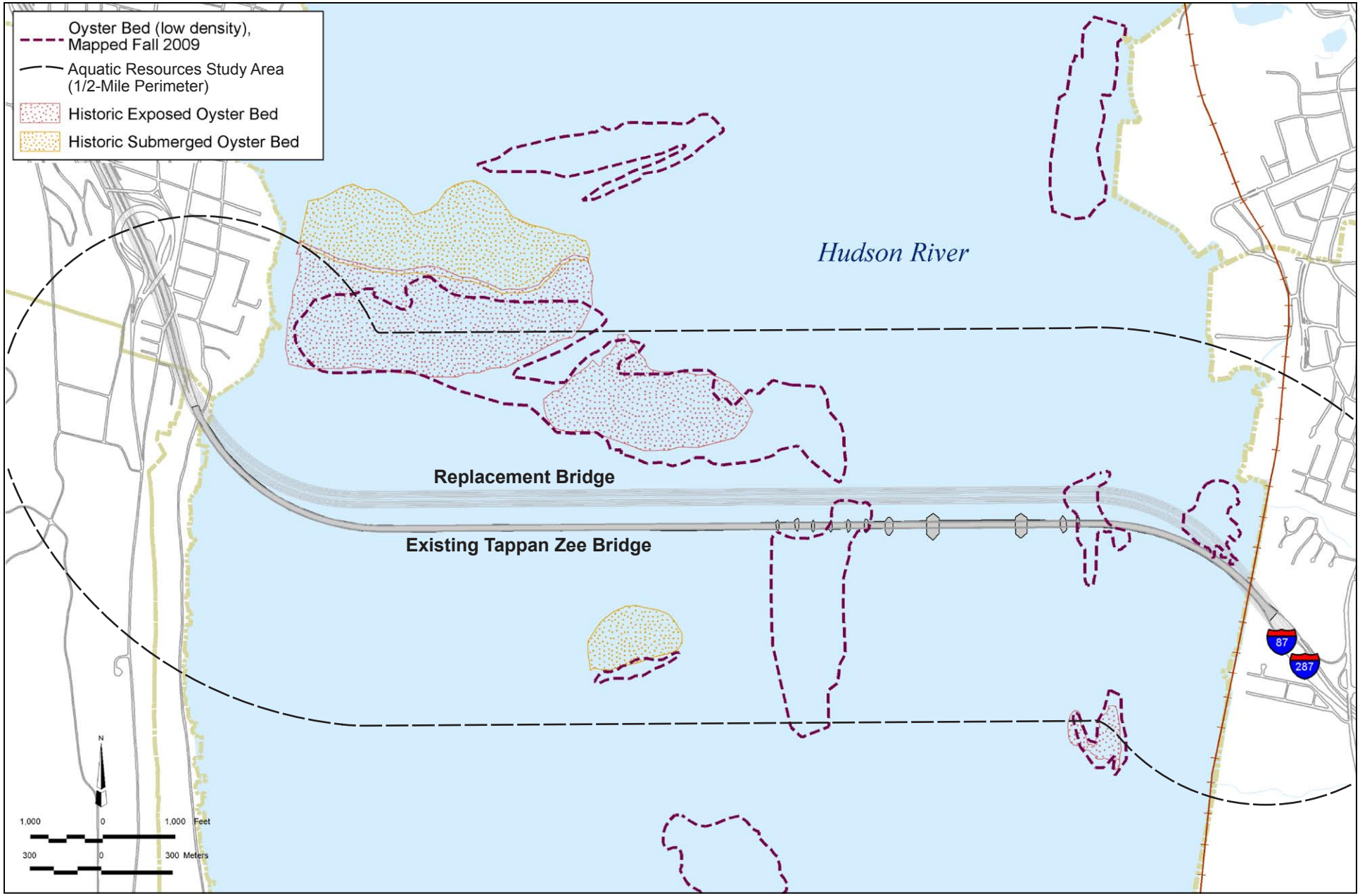

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 16-5
Oyster Beds

complete description of the differing character and status of the individual oyster beds (e.g., either dense, diffuse, or remnant).

Fish

The Hudson River estuary's fish community is species-rich. The estuary's species diversity is enhanced by its mid-latitude location on the Atlantic Coast. Southern tropical marine forms enter the Hudson River during the summer, and a number of northern fishes are near their southern limit. A report by Smith and Lake (1990) noted that 201 species have been documented in the Hudson River. These species were classified by their probable origin, which demonstrated that the Hudson River fish community, particularly in the estuarine reach, is a mixture of both temperate and tropical marine forms, freshwater forms, and intentional and accidental introductions (ASA 2006).Over the period from 1974 to 2006, the total number of species collected annually in the Utilities monitoring program has varied from 64 to 104. Despite the large number of species that are occasionally found in the estuary, the majority of the fish represent only a limited number of species. More than 99 percent of the total fish community is comprised of only 10–15 percent of the species. In stable ecosystems, low species diversity may be an indicator of environmental stress. However, in highly dynamic and unstable ecosystems such as the Hudson River estuary, the biological community may be dominated by only a few species that are well adapted to such naturally dynamic conditions (ASA 2006).

Each of the fish species that occurs in the river can be classified by their salinity tolerance. Marine species live in the open Atlantic Ocean and nearshore waters and venture into the estuary during the warmer months of the year when salinity is relatively high. These species typically occupy the lower reaches of the estuary. Estuarine species occupy a large portion of the brackish estuary year-round and may be occasionally found in freshwater and marine reaches. Freshwater species live in the Hudson River and rarely, if ever, venture into low-salinity areas of the estuary such as the region in the vicinity of the Tappan Zee Bridge. Several fish species that occur in the Hudson River migrate between the Atlantic Ocean and freshwater habitats of the River (diadromous fish). These include anadromous fish, which migrate from the Atlantic Ocean into freshwater habitats, typically for spawning, and catadromous fish, which leave the river to spawn in the open ocean.

The dominant marine species collected in the Utilities monitoring program in the Tappan Zee region from 2000–2009 was the bay anchovy. Bay anchovies are found in salinities ranging from fresh to seawater and may be the most abundant species in the western north Atlantic (Newberger and Houde 1995). Other marine species which were abundant in the Utilities program included weakfish, Atlantic menhaden, Atlantic croaker, butterfish, and bluefish. Estuarine species are generally euryhaline (i.e., tolerant of wide salinity ranges), and are year-round residents of the saline portions of the Hudson River. Abundant estuarine species collected by the Utilities monitoring program included white perch, banded killifish, Atlantic silverside, and hogchoker. Anadromous species, which use the estuary as spawning and nursery grounds, include alewife, American shad, Atlantic sturgeon, Atlantic tomcod, blueback herring, and striped bass. Adults typically enter the estuary in the spring (except for tomcod which typically spawn in late winter and juveniles are present by late April) and migrate upstream to low-salinity brackish and freshwater areas to spawn. The young fish then

use the near-shore shoal areas for food and habitat as they make their way downstream, and generally leave the estuary in the fall. American eel (*Anguilla rostrata*) is the only catadromous species that occurs in the Hudson. Although the Utilities data indicate that there are wide variations in the annual totals of collected eels, overall there has been a sharp decline in the number of individuals captured during these surveys since the mid-1980s.

A number of changes in abundance trends within the Hudson River fish community have occurred in recent years. Heimbuch (2008) reported that average biomass of age 1 and older striped bass has increased over fivefold during the periods 1981–1990 and 1991–2005. This increase has been accompanied by declines in the populations of blueback herring, alewife, white perch, and Atlantic tomcod. Blueback herring and alewife have also been designated as candidate species under the ESA on November 2, 2011 due to population declines. It has been postulated that the increase in the predatory demand of striped bass could have been responsible for the decline of these other species (Heimbuch 2008). These five species comprised 85 percent of the catch of estuarine and diadromous species collected by beach seines from 1980 through 2000 (Hurst et al. 2004). Also, a stock assessment performed on American shad in 2007 indicated that the spawning stock, including the Hudson River population, has substantially declined (ASMFC 2007). Since March 2010 recreational and commercial fishing for American shad has been prohibited. This can be contrasted with the ASMFC's assessment of bluefish which considered the coastal stock to be rebuilt and not overfished (ASMFC 2009).

Fish Utilization of the Project Area

A year-long fish survey was conducted for the project between April 2007 and May 2008 to further characterize the fish community and examine seasonal differences in abundance. These surveys combined hydroacoustics, gill nets, and trap nets to characterize the species composition, relative abundances, and distributions of fish populations within the project area (see **Appendix F-1**).

Results of the hydroacoustic surveys indicate that the horizontal, vertical, and geographical distribution of fishes within the Tappan Zee region and in the project area, in particular, is substantially influenced by temperature and salinity. In the colder months of the year (December through April), the fish populations are concentrated in deeper waters with higher salinities. In the late winter and early spring, a distinct halocline (i.e., salinity gradient) was observed at a depth of approximately 19.7 feet (6 meters), below which fish densities increased. As the water temperature increased during late spring, the halocline dissipated and the salinity in the project area increased in the shallower depths. Also observed was a marked increase in the abundance of fishes at those depths, although the greatest abundances continued to occur in the deepest portion of the channel. In the warmer summer months of the year, early life stages of many species were present within the project area. Presumably these concentrations are salinity driven with higher salinities south of the bridge during winter and increased salinities throughout the Tappan Zee region during the warmer months from June through October. A large percentage of the individuals that were captured were members of schooling species.

A total of 25 species and just over 2,000 individual fishes and hundreds of blue crabs were collected during approximately 700 hours of gill-net sampling within the project area between April 2007 and May 2008 (see **Table 16-2**). Fish were caught at all sampling locations within the project area throughout the year. In the colder months of the year, the total numbers of fish caught at all locations were markedly lower than the numbers of fish caught during the warmer months of the year. Moreover, there were higher numbers of fish caught at the sampling locations with greater water depths. Anadromous and estuarine fish were captured in every sampling event. Marine fish were only captured in the warmer months of the year.

Table 16-2
List of Fish Species Occurring within the Project Area Based on Gill-net Sampling, 2007-2008

Common name	Scientific name	Assemblage
Alewife	*Alosa pseudoharengus*	Anadromous
American eel*	*Anguilla rostrata*	Catadromous
American shad	*Alosa sapidissima*	Anadromous
Atlantic butterfish	*Peprilus triacanthus*	Marine
Atlantic menhaden	*Brevoortia tyrannus*	Marine
Atlantic tomcod	*Microgadus tomcod*	Estuarine
Bluefish	*Pomatomus saltatrix*	Marine
Blueback herring	*Alosa aestivalis*	Anadromous
Blue runner	*Caranx crysos*	Marine
Common carp	*Cyprinus carpio*	Freshwater
Gizzard shad	*Dorosoma cepedianum*	Freshwater
Hickory shad	*Alosa mediocris*	Marine
Hogchoker	*Trinectes maculatus*	Estuarine
Naked goby*	*Gobiosoma bosci*	Estuarine/Marine
Northern kingfish	*Menticirrhus saxatilis*	Estuarine/Marine
Northern sea robin	*Prionotus carolinus*	Marine
Oyster toad fish*	*Opsanus tau*	Estuarine/Marine
Porgy	Family Sparidae	Marine
Shortnose sturgeon	*Acipenser brevirostrum*	Anadromous
Spot	*Leiostomus xanthurus*	Estuarine/Marine
Striped bass	*Morone saxitalis*	Anadromous
Summer flounder	*Paralichthys dentatus*	Estuarine/Marine
Weakfish	*Cynoscion regalis*	Estuarine
White catfish	*Ameiurus catus*	Freshwater
White perch	*Morone americana*	Estuarine

Note: * Species only captured in fish traps.

As shown in **Table 16-3** and discussed below under “Essential Fish Habitat”, the project area is within a portion of the Hudson River/Raritan/Sandy Hook Bays, New York/New Jersey Estuary EFH (see **Appendix F-3** for a comprehensive evaluation of project impacts to EFH and EFH species).

Table 16-3
Federally Managed Species with Essential Fish Habitat (EFH) Designations in the Project Sites

Species	Eggs	Larvae	Juvenile	Adult	Spawning Adult
Red Hake		M,S	M,S	M,S	
Winter Flounder	M,S	M,S	M,S	M,S	M,S
Windowpane Flounder	M,S	M,S	M,S	M,S	M,S
Atlantic Sea Herring		M,S	M,S	M,S	
Bluefish			M,S	M,S	
Atlantic Butterfish		M	M,S	M,S	
Atlantic Mackerel			S	S	
Summer Flounder		F,M,S	M,S	M,S	
Scup	S	S	S	S	
Black Sea Bass			M,S	M,S	
King Mackerel	X	X	X	X	
Spanish Mackerel	X	X	X	X	
Cobia	X	X	X	X	

Notes:
S = EFH designation includes the seawater salinity zone (salinity > or = 25ppt).
M = EFH designation includes the mixing water/brackish salinity zone (0.5 ppt < salinity < 25 ppt).
F = EFH designation includes the tidal freshwater salinity zone (0 ppt < salinity < 0.5 ppt).
X = EFH has been designated for a given species and life stage.
Source: NOAA 2011

Threatened and Endangered Species

The USFWS database list of federally threatened, endangered, candidate, and proposed species for Westchester and Rockland Counties includes several listed fish species: the shortnose sturgeon, alewife, blueback herring, and Atlantic sturgeon. All are known to occur within the study area. Because shortnose sturgeon are anadromous, this species falls under the jurisdiction of NMFS under the ESA. Shortnose sturgeon are also currently listed for protection by the State of New York as an endangered species. Atlantic sturgeon (*Acipenser oxyrhynchus*) are also known to occur in the study area, and although they are not currently federally listed as threatened or endangered, 5 DPSs of Atlantic sturgeon have been proposed for listing as either threatened or endangered under the ESA. A Biological Assessment (BA) has been prepared as part of the formal consultation process under Section 7 of the ESA with NMFS for both the shortnose and Atlantic sturgeons (see **Appendix F-4**). There is no federally designated critical habitat for either shortnose or Atlantic sturgeon in the Hudson River. However, NYSDOS has identified several areas in the Hudson River essential to shortnose reproduction and survival (NYSDOS 2012 http://www.nyswaterfronts.com). These fish spawn, develop, and most overwinter in the mid-Hudson River north of the project area. Dovel et al. (1992) indicated that the spawning grounds for shortnose sturgeon extends from just below the Troy Dam to river kilometer 212 (RM 131) and eggs and larvae can be expected to remain in this region for approximately four weeks post spawning (NYSDEC 2003).

Shortnose Sturgeon

The federally and state -endangered shortnose sturgeon is an anadromous bottom-feeding fish that can be found throughout the Hudson River, ranging from New York Harbor to the Troy Dam. These fish spawn and develop, and most overwinter, in the mid-Hudson River north of the Tappan Zee Bridge (NYSDEC 2003). Shortnose sturgeon spend most of their lives in the Hudson River estuary and prefer colder, deeper waters for all life stages (Bain 1997) but can also forage in shallower water where suitable food sources are present. In early spring, shortnose Shortnose sturgeon migrate upstream to spawn in the freshwater reach of the river between the Troy Dam and RM 131 (Dovel et al. 1992), which is well upstream of Tappan Zee.

Eggs and larvae are predominately confined to freshwater reaches above the saline area and would not be expected to occur in the Tappan Zee region. The juveniles (fish ranging from 2 to 8 years old) can be found in brackish areas of the Hudson River. Although some shortnose adults and juveniles may be found in the Tappan Zee region, the primary summer habitat for shortnose sturgeon appears to be located above Beacon, NY (Bain 1997, 2007). Dovel et al. (1992) concluded that most or all adults form an overwintering concentration near Kingston. Bain (1997), however, described a second late fall and overwintering area near Haverstraw Bay between km 54 and 61 (RM 33-37).

The Hudson River shortnose sturgeon population was estimated to contain approximately 60,000 fish (Bain et al. 1998,2007). These studies show that the population has increased by more than 400 percent since the 1970s. According to Woodland and Secor (2007), the shortnose sturgeon is showing signs of strong recovery in the Hudson River, although some population segments, especially in the south, still display low abundance. Size and body condition of the fish caught in these studies indicate the population is primarily healthy, long-lived adults. Hoff et al. (1988, in Bain 1997) reported most captures of adult shortnose sturgeon during river monitoring of fish distributions by the Hudson River electric utilities from 1969 to 1980 occurred between river miles (RM) 24 to 76 (from near the New York/New Jersey border up to near Poughkeepsie).

From 2000-2009, the utilities monitoring program collected 289 juvenile and adult shortnose sturgeon using a beam trawl during the Fall Shoals survey. The majority of these fish were collected north of West Point (RM 47) and were adults. Only 8 shortnose sturgeon were collected in the Tappan Zee region. Greater than 90 percent of all shortnose sturgeon was collected from bottom habitats in waters greater than 20 feet in depth. A review of commercial catch data provided by NYSDEC indicated that from the years 1980–2002, shortnose sturgeon were collected in the Tappan Zee vicinity (RM 25-27) in 14 of 23 years. The Utilities also report the number and size of shortnose sturgeon collected as part of their Striped Bass and Atlantic tomcod sampling program.

A total of 12 shortnose sturgeon were captured in gill nets during the project's bi-monthly fish-sampling effort within the Tappan Zee project area between April 2007 and May 2008. The sturgeon were captured primarily in the warmer months of the year—between May and October—at both the bridge and reference locations in water depths between 6 and 30 feet (1.8 and 9.1 m). Although no individuals were captured during

the December, February, and April sampling events, it is possible that the species is present during those months, though not in significant numbers, within the Tappan Zee region. Cold waters may have slowed its movements enough so that the fish would not to be captured by the gill net, a stationary and passive gear type.

Atlantic Sturgeon

There are seven to ten genetically diverse populations of Atlantic sturgeon along the east coast of the United States and Canada. Of these, five DPSs are proposed for listing as threatened or endangered under the ESA. The New York Bight DPS is proposed for listing as endangered by NMFS, and includes Atlantic sturgeon spawned in the River. There is potential for individuals originating from other DPS to occur in the Hudson River and in the project area. This issue is addressed in the Biological Assessment (see **Appendix F-4**).

Contrary to shortnose sturgeon, which spend a great deal of their lives in the Hudson River, Atlantic sturgeon spend most of their lives in marine waters along the Atlantic coast. It is a large, anadromous, bottom-feeding species that spawns in the Hudson River and matures in marine waters; females return to spawn at age 15 or older and males return earlier at 12 years or older (Bain 1997, citing other authors). Young et al. (1988) reported that in the Hudson River, maturity of female Atlantic sturgeon begins at age 11 and increases gradually for the next ten years until all females are mature. In the Hudson River, Atlantic sturgeon are found in the deeper portions and do not occur farther upstream than Hudson, New York.

Atlantic sturgeon migrate from the ocean upriver to spawn above the salt front from April to early July (Smith 1985, Stegemann 1999). An NYSDEC tracking study which tagged fish with sonic tags indicated that most fish arrived in the Hudson River from early April to late June and left the river by late July (NYSDEC 2011).

Eggs and larvae would not be expected to occur in the Tappan Zee region. Overfishing, reduction of key spawning areas, and pollution have been suggested as reasons for the range-wide decline of this species (Smith 1985, Bain 2004). Individuals are only expected to occur near the project site as transient individuals while traveling to or from Hudson River spawning, nursery, and overwintering areas. NMFS cites locks and dams, overfishing and the more recent impact of bycatch and habitat degradation as causes for the decline in Atlantic sturgeon populations throughout the Northeast (NMFS, Species of Concern Atlantic sturgeon www.nmfs.noaa.gov/). The Atlantic Sturgeon Status Review Team (2007) identified bycatch, water quality, lack of state and/or Federal regulatory mechanisms and dredging activities as the most significant stressors to Atlantic sturgeon. Kahnle et al. (1998) estimated the age-zero Hudson River population in 1994 to be 9,529, based on the capture of 15 captive-hatched and 14 wild origin, age-1 Atlantic sturgeon in 1995. Of the total, 4929 would have been captive-hatched and 4,600 of wild origin. An estimate of 870 spawning adult fish per year, consisting of approximately 600 males and 270 females, was calculated based on fishery dependent data collected from 1985-1995 (Kahnle et al. 2007). Because Atlantic sturgeon do not necessarily spawn each year, the 870 value is not expected to be a total estimate of the spawning adults of Hudson River origin.

From 2000–2009, the Utilities Monitoring Program has collected 241 juvenile and sub-adult Atlantic sturgeon using a beam trawl during the Fall Shoals survey. The majority

of these fish were collected north of West Point (RM 47). Only five Atlantic sturgeon were collected in the Tappan Zee region. Greater than 95 percent of all Atlantic sturgeon were collected from bottom habitats in waters greater than 20 feet in depth. Between 2000–2009 the Utilities Long River Program collected 16 yolk and post yolksac larvae, all upstream of Cornwall (RM 58). The Utilities also report the number and size of Atlantic sturgeon collected as part of their Striped Bass and Atlantic tomcod sampling program.

No Atlantic sturgeon were captured in gill nets during the project's bi-monthly fish-sampling effort within the project area. However, the carcass of an Atlantic sturgeon was observed floating approximately 500 feet (152.4 meters) north of the bridge in May 2008.

Commercial catch data provided by NYSDEC from observed fishing trips for the American shad gill net fishery (NYSDEC unpublished data) indicated that, from the years 1980–2002, Atlantic sturgeon were collected in the Tappan Zee vicinity (RM 25-27) in 14 of 23 years. However, Atlantic sturgeon were collected in only one year after 1992, which was accompanied by a reduction in commercial fishing effort. A separate adult Atlantic sturgeon tracking program was developed by NYSDEC which began tagging fish in 2006 with digital sonic tags. The study results confirm that the Tappan Zee Bridge area serves as a migration corridor for adult Atlantic sturgeon. Most of the fish that were tagged arrived in the Hudson from early April to late June and left the river by late July.

Candidate Species

Alewife and blueback herring were designated as candidate species on November 2, 2011. These species are being considered for listing as endangered or threatened under the ESA. Candidate status does not carry any procedural or substantive protections under the ESA. Existing conditions and impact analyses for blueback herring and alewife are included in this document with the general fish discussions.

16-4-3 SPECIAL HABITAT AREAS

16-4-3-1 USFWS SIGNIFICANT HABITATS

The Lower Hudson River Estuary, the northern extent of which is the Haverstraw Bay, has been designated as a USFWS Significant Habitat of the New York Bight. The Lower Hudson supports regionally significant fish populations and wintering and migratory birds that feed there. It is the primary nursery and overwintering area for striped bass in the Hudson River estuary. There are 151 bird species and 80 fish species designated by the USFWS as of special emphasis (e.g., federally and state-listed species) that use the Lower Hudson (USFWS 1997).

16-4-3-2 SIGNIFICANT COASTAL FISH AND WILDLIFE HABITAT

The New York State Department of State (NYSDOS) has designated several Significant Coastal Fish and Wildlife Habitats (SCFWH) within the stretch of the Hudson River between River Miles 11 and 40. These SCFWHs include Haverstraw Bay and Croton River and Bay (9.7 m, or 6 miles, north of the bridge), the Lower Hudson Reach (6.4 m, or 4 miles, south of the bridge), and Piermont Marsh (3.2 m, or 2 miles, south of the

bridge). The NOAA and NYSDEC have designated Piermont Marsh part of the Hudson River National Estuarine Research Reserve. No SCFWHs occur within the study area.

16-4-3-3 ESSENTIAL FISH HABITAT (EFH)

The project area for aquatic resources is within a portion of the Hudson River Estuary/Raritan/ Sandy Hook Bays, New York/New Jersey Estuary EFH (NOAA 2012). **Table 16-3** lists the species and life stages of fish identified as having EFH in this broad area. An EFH Assessment has been prepared as part of the consultation process under the Magnuson-Stevens Act (see **Appendix F-3**).

Although the salinity of the Hudson River within the study area, considered to typically fall in the mesohaline to oligohaline range, would exclude many EFH species, it is appropriate for certain life stages of red hake, winter flounder, windowpane, bluefish, summer flounder and scup. In years of especially low freshwater flow when the salt wedge extends further upriver, salinities within the study area may be suitable for Atlantic butterfish, black sea bass, king mackerel and possibly Atlantic mackerel, Spanish mackerel, and cobia. Of the 13 EFH species identified for the Hudson River estuary, the majority were found in highest abundance in the lower reaches of the estuary from the Battery to Yonkers (river miles 0-23). Only three of these species—Atlantic butterfish, bluefish and summer flounder—were captured during the 2007-2008 sampling program for the project. These marine species were captured in the warmer months of the year when higher water temperatures and salinities are present within the project area. Six additional EFH species were collected in the Utilities Long River Monitoring Program between 1998 and 2007, albeit relatively infrequently in the Tappan Zee region (RM 24-33) compared to collections in the lower reaches of the estuary. Among these species were winter flounder (egg, larvae, young of year and yearling or older), bluefish (young of year, yearling and older), Atlantic herring (larvae, young of year, yearling and older), windowpane flounder (eggs, larvae, young of year, yearling and older), summer flounder (larvae, young of year), and Atlantic butterfish (larvae, young of year, yearling and older). The Utilities Fall Shoals Program also collected winter and summer flounder, bluefish and Atlantic butterfish, but in relatively few of the samples taken between 1998 and 2007. Atlantic mackerel, Spanish mackerel and scup were each collected in fewer than 3 of over 1,800 samples taken in the Tappan Zee region (RM 24-33) over the ten year period.

16-5 ENVIRONMENTAL EFFECTS

16-5-1 NO BUILD ALTERNATIVE

In the future without the project, terrestrial and aquatic resources within the project site would remain in their current conditions and would continue to provide habitat to wildlife, as described in the previous sections.

The No Build Alternative would continue operation of the existing Tappan Zee Bridge. NYSTA would continue to coordinate maintenance and repair activities with NYSDEC and the New York City Department of Environmental Protection (NYCDEP) to implement peregrine falcon protection measures developed with these agencies. Therefore, there would be no impacts from continued operation of the existing bridge.

16-5-2 REPLACEMENT BRIDGE ALTERNATIVE

The Replacement Bridge Alternative would replace the existing Tappan Zee Bridge with two new parallel structures to the north of its existing location. As described in Chapter 2, "Alternatives," there are two options for the Replacement Bridge Alternative's approach spans (Short Span and Long Span Options) and two for the main span (Cable-stayed and Arch Option). The evaluation of potential impacts from these options considers the potential impacts from the Replacement Bridge Alternative in general, noting differences in the potential for adverse impacts for the two approach span options as appropriate.

16-5-2-1 TERRESTRIAL RESOURCES

Terrestrial Ecological Communities

As discussed in Chapter 18, "Construction Impacts," the construction of the Rockland County and Westchester County landings, maintenance ramps, toll plaza, and associated interchanges of the project would take place mostly within the paved road communities of the project area. There would be a permanent impact on approximately 2 acres of the vegetated ecological communities (i.e., mowed lawn, mowed lawn with trees, successional southern hardwoods, and urban vacant lot) due to added paved service roads under both the Long Span and Short Span Options. These ecological communities are common throughout the region and are of low ecological value due to low species diversity, high level of anthropogenic activities, and dominance of non native, invasive vegetation. Therefore, the removal of 2 acres would not result in any adverse impacts to these ecological communities throughout the region. Disturbed areas not occupied by permanent structures (about 7 acres) would be revegetated with native species indigenous to this region of New York to the greatest extent practicable in accordance with a landscape plan that would be in compliance with E.O.13112, "Invasive Species."

Wildlife

Noise disturbance

Operation of the project would involve traffic noise from vehicles crossing the bridge. Anthropogenic noise levels can influence wildlife community composition by displacing some species while increasing the abundance of others (Bayne et al. 2008, Francis et al. 2009). Anthropogenic noise can decrease fecundity (Habib et al. 2007) and increase predation rates (Chan et al. 2010). At the individual level, physiological and behavioral responses of animals to anthropogenic noise generally include increased acute stress levels, increased heart rates, and fleeing from the source of the noise. However, such responses are usually in response to unusual, newly introduced disturbances, and animals often gradually habituate to and tolerate loud noises after initial exposure (Bowles 1995).

Because the project area has been developed with present land use for many years, the wildlife communities in the project area have already been shaped in part by existing noise levels. These communities are primarily composed of urban-adapted, disturbance-tolerant species that inhabit areas with high noise levels and other disturbances resulting from the existing bridge and heavily traveled roadways. Operation of the replacement bridge is not expected to increase disturbance levels

above what is currently attributable to the existing bridge, and thus any species currently inhabiting the area would continue to occur in the area in the future. Individual animals currently inhabiting the area are habituated to existing noise levels from roadway traffic; operation of the replacement bridge would not elicit any new incremental negative physiological or behavioral responses, and would not alter current rates of predation or reproductive success. Overall, noise resulting from operation of the Replacement Bridge Alternative would not have any adverse impacts to wildlife.

Bird collisions and disorientation

Obstruction beacons and other lights can disorient night-migrating birds and result in collisions with structures, particularly in foggy conditions with low cloud cover when birds migrate at lower altitudes (Gauthreaux and Belser 2006, Longcore et al. 2008, Gehring et al. 2011). Thus, lighting used during operation of the replacement bridge could impact birds migrating over the Hudson River at night (primarily songbirds). Collision risk, however, would be highly dependent on the light characteristics, and could be diminished through the selection of particular lighting schemes.

Bird collision risk would also be influenced by the bridge's design features and height. Both design options for the main span (Cable-stayed and Arch) include steel support cables, with which birds may collide when used to support communication towers (Longcore et al. 2008). Because they share many similar characteristics and bird collisions with bridges have yet to be well-studied, USFWS uses data from communication towers as a proxy for analyzing potential impacts from cable-stayed bridges. Communication towers with support cables have been found to kill 16 times as many birds as free-standing towers of the same height (Gehring et al. 2011), although cables used for bridges are substantially wider and more visible to birds than those that are typically used for communications towers. The Cable-stayed Option for the replacement bridge would likely require the use of more support cables than the arch option, and by intersecting more air space, could pose a slightly greater risk for bird collisions.

The Cable-Stayed Option would also be taller than the Arch Option. The maximum height of the support towers used in the Cable-stayed Option would be approximately 539 feet above mean high tide, and the maximum height of the arch would be approximately 339 feet above mean tide (the tallest point of the existing bridge stands approximately 300 feet above mean tide). Bird collisions with artificial structures are often strongly related to structure height (Kerlinger 2000). For example, several studies have found bird mortality at communication towers taller than 300 meters (984 feet) to be significantly greater than mortality at towers that are less than 150 meters (492 feet) tall (Longcore et al. 2008). Most birds migrate at altitudes of 200-750 meters (656-2461 feet; Able 1970, Mabee et al. 2006) and rarely fly below 90 meters (295 feet) during clear weather (Mabee and Cooper 2004). At 539 feet and 339 feet, neither design option would intersect the strata of airspace in which migrating birds most commonly fly. However, relatively short structures may represent collision hazards during inclement weather and when their lighting scheme is such that birds are attracted to and/or disoriented by the light. Ultimately, the potential for bird collisions with the replacement bridge would be most dependent on the bridge's lighting characteristics.

The USFWS recommends the following lighting scheme to reduce the potential for bird collisions with bridges:

- Use low-intensity, low-wavelength blue, turquoise, or green lights. Avoid red and yellow lights.
- Use blue jelly jar LED (light emitting diodes) lights on suspension cables and rectangular blue LED lights on bridge deck. These lights have low energy consumption, produce bright but directional light (25 percent as bright as 100W bulb), and provide long-distance viewing while minimizing light pollution.
- Minimize the use of lights during spring and fall bird migration periods, particularly during overcast, cloudy, or foggy conditions.

In addition, collision risk can be dramatically reduced by using flashing obstruction lights instead of steady-burning lights (Longcore et al. 2008, Gehring et al. 2009). As design progresses, NYSDOT/NYSTA will look to implement as many of these measures as possible while remaining compliant with USCG and Federal Aviation Administration (FAA) obstruction lighting regulations. .

Unlike other structures such as communications towers, wind turbines, power lines, and buildings, bird collisions with bridges have seldom been documented and bridges have not been implicated as significant causes of bird collision mortality (Banks 1979, Avery 1979, Evans-Ogden 1996, Erickson et al. 2005, Drewitt and Langston 2008, Manville 2009, Lebbin et al. 2010, Arnold and Zink 2011). With thoughtful selection of lighting characteristics, such as those above, there is little reason to expect the replacement bridge to be a significant collision hazard to night-migrant birds. Unless attracted by navigational or decorative lighting, night-migrating birds would typically fly at altitudes well above the airspace intersected by the replacement bridge (Able 1970, Mabee and Cooper 2004, Mabee et al. 2006). Further, the location of the replacement bridge on the lower Hudson River is not a significant funnel or geographical barrier for migrating landbirds that would bring substantial concentrations of birds past the structure. Collisions of birds with the replacement bridge would likely be restricted to nighttime periods of dense fog and extremely low cloud cover, and would not be expected to amount to a source of mortality that would be capable of affecting their population sizes (cf. Arnold and Zink 2011). For perspective from a recent and nearby study of bird collisions, extensive observations of night-migrants from the top of a brightly illuminated skyscraper in New York City found that only 22% of the autumn migration periods of 2004 and 2005 had overcast conditions that brought migrants close to the building and caused them to briefly circle before continuing onwards. Out of the 33,800 total migrants observed during the study, only 7 individuals collided with the building (all of which occurred on 1 rainy night) (DeCandido 2007). During spring 2004, none of the 3,415 observed migrants collided with the building (DeCandido and Allen 2006). Night-time collisions of migratory birds with illuminated city skyscrapers have been well publicized, but the reality is that collisions with buildings at night are relatively rare and are largely limited to sporadic episodes of mass mortality that can occur with the right mix of extremely poor weather conditions and particularly disorienting lighting characteristics (DeCandido and Allen 2006). Throughout the city, bird collisions with buildings are mostly attributable to daytime strikes with lower story reflective glass windows, not nighttime collisions with upper floors of skyscrapers (Gelb and Delecretaz

2006, 2009; Klem et al. 2009). Night-time collisions with the replacement bridge would likely be a similarly rare occurrence and have no significant impact on migratory birds with the use of proper lighting.

Threatened, Endangered, and Special Concern Species

Plants

The state-listed endangered late flowering boneset (*Eupatorium serotinum*) is present within portions of the successional southern hardwoods community of the project site. Currently, this species is on the New York Natural Heritage Program's (NYNHP) "2010 Rare Plant Status List - Native Pioneer Plant Watch List." This list contains species that are under review for potential delisting by the state.

Should late flowering boneset be delisted by the state prior to project construction, it would be assumed that populations of this plant are secure and that the construction of the project would not result in an adverse impact on populations of this species within the region. However, if late flowering boneset remains listed by the state when construction is scheduled to commence, then there would have to be coordination with NYNHP to develop a conservation strategy (e.g., the implementation of protection measures during construction or relocation of plants) to protect these plants during construction and operation of the project. With this conservation strategy in place, operation of the project would not result in an adverse impact on late flowering boneset populations within the region.

Wildlife

Threatened, endangered, or special concern species that are considered to have the potential to occur within the bridge study area include bald eagle, peregrine falcon, common loon, and pied-billed grebe. Because operation of the replacement bridge is not expected to increase disturbance levels above what is generated by the existing bridge and approach roadways, none of these species would be impacted by the operation of the project. Each species would have the potential to occur in the area with the same likelihood as at present. As described in Chapter 18, "Construction Impacts," the peregrine falcon nest boxes would be relocated to the replacement bridge to provide an alternative nest site for the resident pair of peregrine falcons. The boxes were placed on the existing bridge over 20 years ago by NYSTA and have been adopted by the falcons. Nest site abandonment in urban peregrine falcons is extremely rare when successful nesting has occurred in prior years (Cade et al 1996). The nesting season of peregrine falcons in New York City is generally from February through August. The timing of nest box relocation and the siting of the boxes on the replacement bridge would be performed consistent with an Article 11 incidental take permit and in consultation with NYSDEC and NYCDEP wildlife biologists to help ensure a successful transition. As such, it is expected that the falcons would relocate to boxes on the new bridge. Therefore, there would be no adverse impact to peregrine falcons from operation of the project.

As discussed above, due to lack of appropriate habitat in the study area, the project would have no effect on bog turtle, New England cottontail, or Indiana bat. All of the terrestrial threatened, endangered, and special concern wildlife species that are considered to occur within the study area are birds. Each species is primarily a daytime

migrant, and none is a common victim of collisions with artificial structures (Drewitt and Langston 2008, Gehring et al. 2009, Smallwood and Karas 2009). As such, operation of the project would not present a collision risk for threatened, endangered, and special concern species of birds.

16-5-2-2 AQUATIC RESOURCES

Wetlands

As described above under "Existing Conditions," wetlands identified by NYSDEC in the vicinity of the project include littoral zone and intertidal wetlands. These wetlands are located south of the existing bridge. No vegetated intertidal wetlands under the jurisdiction of NYSDEC or USACE are present in the project area. The new bridge and associated permanent platform structure on the west bank of the river would be constructed north of the existing bridge, outside of the NYSDEC littoral zone. Therefore, there would be no loss of tidal wetlands as a result of the project.

The Rockland Bridge Staging Area would be constructed north of the existing bridge, and would avoid the small (approximately 0.11 acres) depression exhibiting freshwater wetland characteristics south of the bridge. As discussed in Chapter 18, "Construction Impacts," there would be a temporary impact of 0.15 acres to the small stream and forested wetland corridor (totaling 0.63 acres) due to upland construction of the temporary access road for the temporary work platform at the Westchester Bridge Staging Area. After construction is complete, the area would be restored as forested wetland habitat with equal or lesser value and re-planted with native wetland vegetation in accordance with a mitigation plan developed in coordination with the USACE. Therefore, there would be no permanent adverse effect to wetlands.

As discussed above, implementation of erosion and sediment control measures (e.g., silt fences and straw bale dikes) and stormwater management measures implanted through the development of a stormwater pollution prevention plan (SWPPP) would minimize the potential for stormwater runoff from construction of the access road to affect the forested corridor (0.63 acres) at the Westchester Bridge Staging Area and small potential wetland (approximately 0.11 acres) at the Rockland Bridge Staging Area.

Because the projected wetland impacts would be small in size (0.15 acres) and temporary and restored post-construction, and because remaining wetlands would retain their functions and values, the intent of E.O. 11990 would be met. There would be no net loss to functions and values of impacted wetlands.

Aquatic Biota and Habitat

The new bridge would occupy similar acreage as the existing structure. After demolition of the existing bridge, there would be a net loss of open water benthic habitat under the Short Span Option of 0.9 acres and a gain of 0.6 acres of open water benthic habitat under the Long Span Option.

It has been maintained that shading of estuarine habitats can result in decreased light levels and reduced benthic and water-column primary production, both of which may adversely affect invertebrates and fishes that use these areas, particularly with respect to use as refuge and foraging habitat (Able et al. 1998, and Struck et al. 2004). The

amount of area shaded by overwater structures will be affected by the height and width of the structure, construction materials and orientation of the structure relative to the arc of the sun (Burdick and Short 1995, Fresh et al. 1995 and 2000, Olson 1996, 1997 in Nightingale and Simenstad 2001) and piling density. Shading due to bridges has been found to affect plant communities such as tidal marshes and SAV, as well as benthic invertebrate communities within tidal marshes (Struck et al. 2004, and Broome et al., 2005 in CZR 2009). However, adverse effects on marsh vegetation and benthic macroinvertebrates have been found to be minimal when the bridge height-to-width ratio is greater than 0.7 (Struck et al, 2004, Broome et al. 2005 in CZR 2009). Significantly fewer oligochaete worms, which are common in the Hudson River, were found under bridges with a height-to-width ratio less than 0.7 when compared to marshes not affected by shading (Struck et al. 2004). Struck et al. (2004) found that bridges with height-to-width ratios greater than 1.5 had the lowest light attenuation beneath the bridge.

Because the elevations of the existing Tappan Zee Bridge and the Replacement Bridge Alternative are not consistent over the length of the structure (see **Figure 2-5**), the height-to-width ratio of the bridge varies along its length. Table 7 compares the ratio of the existing bridge and the Short and Long Span Options for the Replacement Bridge Alternative at the stations indicated in **Figure 2-5**. The two spans of the Replacement Bridge Alternative would be separated by a gap of up to 70 feet. While there are no vegetated wetlands or SAV that could be affected by the construction of the Replacement Bridge Alternative, the height-to-width ratios presented below provide an indication of the potential for the existing and Replacement Bridge Alternative to result in shading impacts. As indicated below, the height-to-width ratio for the portion of the existing bridge within the causeway (the western approach to the main span comprising Stations 845+00 to approximately 905+00) is low, ranging from 0.22 to 0.29. The ratio for these same stations for the Replacement Bridge Alternative, Short and Long Span Options, are much higher, ranging from 0.348 near the shoreline to 1.20, with the ratios for the Long Span Option being slightly greater because the height for this approach option is higher. The portion of the western approach just prior to the main span (Stations 920+00 to 935+00) has a ratio that ranges from 0.54 to 1.05 for the existing bridge. Again, the ratios of these stations for the Replacement Bridge Alternative are much greater, ranging from 1.23 to 1.82. The ratios for the main span of the existing bridge range from 1.51 to 1.52 and for the Replacement Bridge Alternative 1.4896 to 1.8161, whereas the ratios for the eastern approach are fairly similar for the existing and Replacement Bridge Alternative, ranging from 0.89 to 1.31 with the Long Span Option for the Replacement Bridge Alternative having the higher ratios.

The ratios in Table 16-4 consider the height-to-width ratio separately for the two spans of the Replacement Bridge Alternative, assuming that the separation between the decks of the two spans (i.e., 70 feet at the main span and then decreasing toward the shorelines) allows light to penetrate between the two structures. This represents the best case analysis. Under this case, the Replacement Bridge Alternative would clearly result in a lower potential for shading of aquatic habitat compared to the existing bridge, particularly along the causeway (western approach to the main span). Even under the worst case, which assumes no separation between the spans of the Replacement

Bridge Alternative and which would conservatively result in a halving of the height-to-width ratios presented in **Table 16-4**, the Replacement Bridge Alternative would still result in greater ratios (i.e., less shading) than the existing bridge for the western approach, but may result in more shading than the existing bridge for the eastern approach. Overall, the height-to-width ratios imply that even if the Replacement Bridge Alternative was treated as a single structure, with no separation between the spans, there would be a decrease in the potential for shading impacts to aquatic resources.

Table 16-4
Height-to-Width Ratios for the Existing Bridge and Short and Long Span Options for the Replacement Bridge Alternative at Various Stations Across the Length of the Bridge

	Existing	Short Span		Long Span	
Location	91 ft-wide deck	96ft-wide	87ft-wide	96ft-wide	87ft-wide
845+00	0.29	0.34	0.38	0.44	0.48
860+00	0.22	0.52	0.57	0.60	0.67
875+00	0.22	0.70	0.78	0.78	0.86
890+00	0.22	0.91	1.00	0.96	1.06
905+00	0.22	1.08	1.20	1.13	1.24
920+00	0.54	1.23	1.36	1.24	1.37
935+00	1.05	1.46	1.61	1.46	1.61
950+00	1.52	1.65	1.82	1.65	1.82
965+00	1.51	1.49	1.64	1.49	1.64
980+00	1.01	1.19	1.31	1.19	1.31
995+00	1.07	0.99	1.09	0.89	0.98

The approximately 2-acre permanent platform at the Rockland Bridge Landing would result in additional aquatic habitat affected by shading. While, the additional shading caused by the platform would result in impacts to the immediate area below the platform, adverse impacts are not anticipated to aquatic resources in the study area due to the abundance of remaining habitat.

Approximately 13 acres of oyster habitat would be adversely impacted during construction operations (discussed in Chapter 18, “Construction Impacts”), some or all of which may be permanently lost due to dredging and armoring of the bottom. Potential for implementation of oyster enhancement or restoration projects will be explored and other mitigation strategies will be developed through consultation with the appropriate regulatory agencies.

Other habitat changes associated with dredging, armoring and introduction of hard substrates are evaluated in Chapter 18, “Construction Impacts.”

Fish

Operation of the project would involve traffic noise from vehicles using the bridge. However, because the bridge has existed for nearly 60 years in this location, the fish community currently in the project area has already been acclimated to existing noise levels from roadway traffic. Operation of the replacement bridge is not expected to increase disturbance levels above what is currently attributable to the existing bridge,

and thus any species currently inhabiting the area would continue to occur in the area during operation of the replacement bridge. Presumably any noise levels which currently elicit a behavioral response under the current condition would continue to elicit a similar response after completion of the replacement bridge. Overall, noise resulting from operation of the replacement bridge would likely not have any adverse impacts on the fish community.

Currently stormwater runoff from Interstate 87/287 along the roadway approach to the bridge is conveyed in a system of catch basins, ultimately discharging directly to the Hudson River. As discussed in Chapter 15, “Water Resources”, stormwater management practices (SMPs) to treat stormwater quality would be designed and constructed in accordance with the NYSDEC's SWMDM, NYSDOT’s Highway Design Manual, NYSDOT’s The Environmental Manual, and NYSTA’s engineering guidance. With the implementation of the SMPs at the landing areas for the Replacement Bridge Alternative, the discharge of stormwater runoff from the project would result in a net decrease in pollutant loading to the Hudson River for total suspended solids (TSS) and would result in just a small increase in pollutant loading for phosphorus (TP). In addition to TSS and TP, the SMPs would collect the water quality volume or ”first flush” stormwater runoff from the bridge landings in Rockland and Westchester Counties and would also capture and convey oil and grease to the water quality treatment facilities located in these two areas. Thus, the SMPs would minimize the potential for adverse changes to Hudson River water quality from the discharge of stormwater from the Replacement Bridge Alternative, and therefore, the project would nothave the potential to result in adverse impacts on aquatic biota.

Threatened, Endangered, and Special Concern Species

Threatened, endangered, or special concern species that are considered to have the potential to occur within the bridge study area include shortnose sturgeon and Atlantic sturgeon. Because operation of the replacement bridge is not expected to increase noise levels above what is generated by the existing bridge outside the construction period, neither of these species would be impacted by the operation of the project after construction of the proposed bridge and demolition of the existing bridge has been completed. Both species would have the potential to occur in the area with the same likelihood as at present.

The project area does not represent a spawning area for Atlantic or shortnose sturgeon, which occurs in more northern reaches of the estuary. Furthermore, eggs and larval stages of either species would not be expected to occur in the Tappan Zee region.

There is no federally designated critical habitat for the shortnose or Atlantic sturgeon in the Hudson River. As a consequence, there can be no effect or impact on critical habitat due to replacement bridge operations. However, NYSDOS has identified several areas in the Hudson River that are essential to shortnose reproduction and survival. However, these are located far north of the project area.

16-5-2-3 SPECIAL HABITATS

USFWS Significant Habitat

As discussed above and in Chapter 15, “Water Resources”, the project operation would not result in significant adverse impacts on water quality or the species identified as

important for the USFWS Significant Habitat of the Hudson River. In addition, with the implementation of lighting measures, relocation of the peregrine falcon nests, stormwater management plans to treat stormwater quality for the landing areas for the Replacement Bridge Alternative, erosion and sediment control measures to prevent degradation of potential wetland areas, and a wetland mitigation plan, operation of the Replacement Bridge Alternative would not result in adverse effects to terrestrial resources, wetlands, or threatened and endangered species. .

Significant Fish and Wildlife Habitat

The project is not located in an area that is considered SCFWH by the New York State Department of State (NYSDOS). The closest SCFWH is the Piermont Marsh, which is located two miles south of the bridge, far outside the projected plumes of increased suspended sediment for the worst-case in-water construction scenarios discussed in Chapter 18, "Construction Impacts." Therefore, operation of the project would not result in adverse impacts to the resources of Piermont Marsh.

Essential Fish Habitat (EFH)

The primary potential indirect impacts to EFH species from the project include the physical disturbance as a result of loss of habitat change, changes in interpier water velocities, total suspended solids (TSS), re-deposition of sediments from dredging activities, and operational impacts on water quality. Loss of bottom habitat due to the placement of the piles and other structures (including armoring of the dredged channel) would be minimal and would not be expected to result in significant reductions in fish habitat or prey availability. Furthermore, the loss of these habitats will be fully or nearly fully offset by the removal of the existing bridge and associated piles to below the mud line. Therefore, habitat changes from the project would not adversely affect EFH.

Upon completion of construction, the operational impacts of either option would be largely positive. The wider spacing of piers for both options would reduce benthic scour and allow for more sunlight to enter the water column, thereby reducing the conditions currently experienced along the western cause way of the existing bridge. The Replacement Bridge Alternative would result in a decrease in the potential for shading impacts to aquatic resources, and the overwater shading resulting from the proposed project would also be offset by the removal of the existing bridge. Operation of the project would not result in adverse impacts to water quality of the Hudson River, or adversely affect aquatic habitat due to under-bridge lighting. Therefore, the project would not result in adverse impacts to the EFH.

16-6 MITIGATION

As discussed above, with the implementation of lighting measures, relocation of the peregrine falcon nests, stormwater management plans to treat stormwater quality for the landing areas for the Replacement Bridge Alternative, and erosion and sediment control measures to prevent degradation of potential wetland areas, operation of the Replacement Bridge Alternative would not result in adverse impacts to terrestrial resources, wetlands, or threatened and endangered species. However, adverse impacts would occur due to the permanent loss of 13 acres of oyster beds caused by dredging and construction of the new bridge piers, and the loss of two acres of benthic habitat caused by shading from the permanent work platform on the west shoreline of

the river. As discussed in Chapter 18, “Construction Impacts,” mitigation for loss of oyster reefs and impacts to benthic habitat would be finalized after consultation with NYSDEC, USFWS, USACE, and NMFS. A wetland mitigation plan would also be developed with USACE for the loss of 0.15 acres of forested wetland at the Westchester Bridge Staging Area.

Chapter 17: Hazardous Waste and Contaminated Materials

17-1 INTRODUCTION

This chapter assesses the potential for the presence of hazardous materials resulting from previous and existing uses both within the upland study area and in the surrounding area, as well as the potential for the proposed bridge's operation to cause adverse impacts related to hazardous waste and contaminated materials. Note that potential impacts associated with the project's construction are discussed in Chapter 18, "Construction Impacts." The potential for the presence of hazardous materials in Hudson River sediments disturbed during construction, and measures to avoid or minimize those impacts, are discussed in Chapter 15, "Water Resources," and Chapter 18, "Construction Impacts." As described below, project operation would not result in adverse impacts because the potential for exposure to any such materials in the subsurface (i.e., soil and groundwater) would be limited and controlled following construction, and any hazardous materials used, stored or disturbed as part of operation would be properly managed to avoid the potential for exposure.

17-2 REGULATORY CONTEXT

The management of subsurface contamination is subject to various regulatory programs including the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, commonly referred to as "Superfund") and Resource Conservation and Recovery Act (RCRA), as well as the state Inactive Hazardous Waste Disposal Site Remedial Program, Brownfield Cleanup Program, New York State Environmental Conservation Law and Article 12 of the New York State Navigation Law (relating to petroleum spills). NYSDEC's Technical Guidance for Site Investigation and Remediation (DER-10) establishes methods for site investigation and clean-up, and the Solid Waste Management Facilities Regulations control disposal of excavated materials (6 NYCRR Part 360). As such, the non-ground intrusive study summarized in this chapter was conducted to determine whether site or building contamination is reasonably believed to exist within the study area due to on-site sources or migration of contaminants from nearby sites. As discussed in Chapter 18, "Construction Impacts," hazardous waste and contaminated materials may be encountered during project construction and/or may remain in the subsurface following the construction and certain post-construction operations (e.g., utility repair) could encounter these.

Bridge maintenance and other operations could require handling and disposal of asbestos-containing materials (ACM), managing historical lead-based paint waste, storage, use and disposal of fuels and chemicals, maintenance of petroleum and chemical storage tanks, management and disposal of polychlorinated biphenyl (PCB) containing equipment and/or lighting fixtures, etc. These activities, performed in a

manner consistent with existing NYSTA/NYSDOT procedures, are subject to a wide variety of federal, state, and/or local regulatory requirements.

17-3 METHODOLOGY

The following methodology was used to evaluate the potential presence of existing hazardous and contaminated materials within the areas to be disturbed by the project: site reconnaissance, research on current/historical use, and review of federal and state regulatory listings for both the limits of project construction activities and adjacent properties within distances specified by the American Society for Testing and Materials (ASTM) Standard E1527-05 (*Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process*) were conducted as part of a non-ground-intrusive study. The locations of some construction staging areas and future maintenance or fueling, paint operations and other material storage area were not determined at the time of the study, so Chapter 18, "Construction Impacts," specifies that these areas be investigated for potential hazardous materials prior to any soil disturbance. Potential sources of contamination that may be encountered during construction would be addressed prior to and/or during construction with the measures described in Chapter 18, "Construction Impacts," which would include subsurface investigations and, if appropriate, remediation. Following construction, no significant potential for exposure to any remaining subsurface contamination would exist unless additional disturbance were to be required, e.g. for subsurface utility repairs. The possibility that post-construction excavation would be required again in areas investigated prior to construction or in other areas not previously investigated is addressed below.

The non-ground-intrusive study was also used to determine the potential nature and extent of non-subsurface hazardous materials typically associated with existing structures such as ACM, historical lead-based paint and/or PCB-containing equipment, which may be encountered during construction as addressed in Chapter 18, "Construction Impacts," or may be present following construction in remaining portions of the current structures in existing or new facilities and associated with day-to-day operation. Post-construction handling of such hazardous materials is addressed below.

This Environmental Impact Statement (EIS) also considers the generation, storage, use and/or disposal of a variety of hazardous materials associated with the operation of the proposed bridge, including (but not limited to):

- Storage and use of fuels for maintenance vehicles, emergency generators or other equipment;
- Storage and use of maintenance chemicals (e.g., paints, solvents and lubricating oils); and
- Generation and off-site disposal of wastes (e.g., removed paint, wastes from cleanup of vehicle accidents, and lighting components).

17-4 AFFECTED ENVIRONMENT

The study area consists of the existing Tappan Zee Bridge and adjacent upland parcels on both sides of the Hudson River. A preliminary site investigation for the project

identified potential sources of contamination within or in close proximity to the study area, including: two bridge maintenance facilities; historical manufacturing, commercial and/or railroad uses; the historical Tappan Zee Bridge landfill; the Tappan Zee hazardous waste accumulation and temporary storage areas, and suspect ACM and lead-based paint (see **Figure 17-1**). The November 2011 update of the study identified the following within the study area:

- The existing Tappan Zee Bridge and associated maintenance areas, located within the study area at 333 South Broadway in Tarrytown and within the Exit 10 ramp and at Piermont Avenue in Nyack, were listed in State regulatory databases with 33 spills reported between 1988 and 2009 and closed between 1988 and 2009. The majority of these related to auto accidents and occurred on the main span rather than upland areas. One 1989 spill involved a report of oil dumping and leaking drums in a fenced construction yard near Exit 10 (in Nyack) from Interstate 87/287. Another spill, reported in 2001, involved the discovery of contaminated soil and groundwater during excavation near the intersection of Interstate 87/287 and Route 9 in Tarrytown, and appeared to be associated with an off-site spill at a filling station. The Tappan Zee Bridge and associated maintenance facilities were listed as a generator of various hazardous wastes including heavy metals and solvents. Hazardous waste generator inspections for RCRA regulations identified non-compliant items in 1990 through 2006 with resolution in 1994 through 2010. The components of the maintenance facilities include heavy equipment storage, petroleum bulk storage tanks, power generators (fueled by petroleum) and miscellaneous maintenance/paint product storage. Six active petroleum aboveground storage tanks (ASTs) were reported at the maintenance facilities in the regulatory database. A duplicate listing in the regulatory database identified additional tanks (four closed and removed USTs and ASTs, one UST closed in place, one active AST and one active UST). However, information provided by the New York State Thruway Authority (NYSTA) indicated that the maintenance facilities currently include seven active ASTs (including a recently installed tank which is to be added to the regulatory listing) and one UST which has been closed in place. In 1992, an approximately 25-gallon gasoline spill onto a dirt area occurred due to a tank overfill at the Tarrytown maintenance facility. The spill was reportedly cleaned up, and was closed within a month of being reported. No other spills were reported for the tanks associated with the maintenance facilities.
- Regulatory databases identified a historical Tappan Zee Bridge landfill within the Tarrytown study area. This landfill, historically used for disposal of construction and demolition debris, paint and solvents, was listed as a State Inactive Hazardous Waste Disposal Site. The listing indicated that the wastes were reportedly removed in 1987 with subsequent investigations indicating no significant remaining contamination. A former funeral home (which may have used chemicals such as formaldehyde) was also identified within the upland Nyack study area.
- Fill material of unknown origin associated with bridge construction or other shoreline changes may be present within the upland site limits.
- The existing bridge and other structures within the study area may be covered with lead-based paint and may contain suspect ACM, suspect polychlorinated biphenyl

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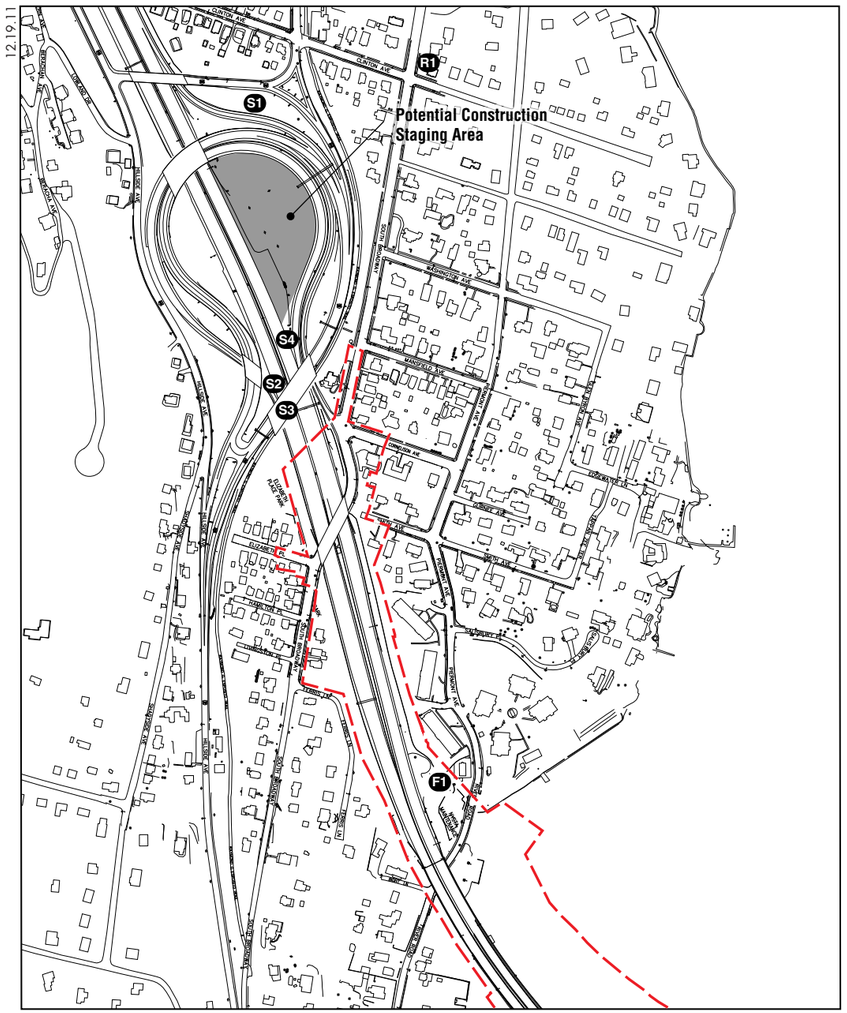

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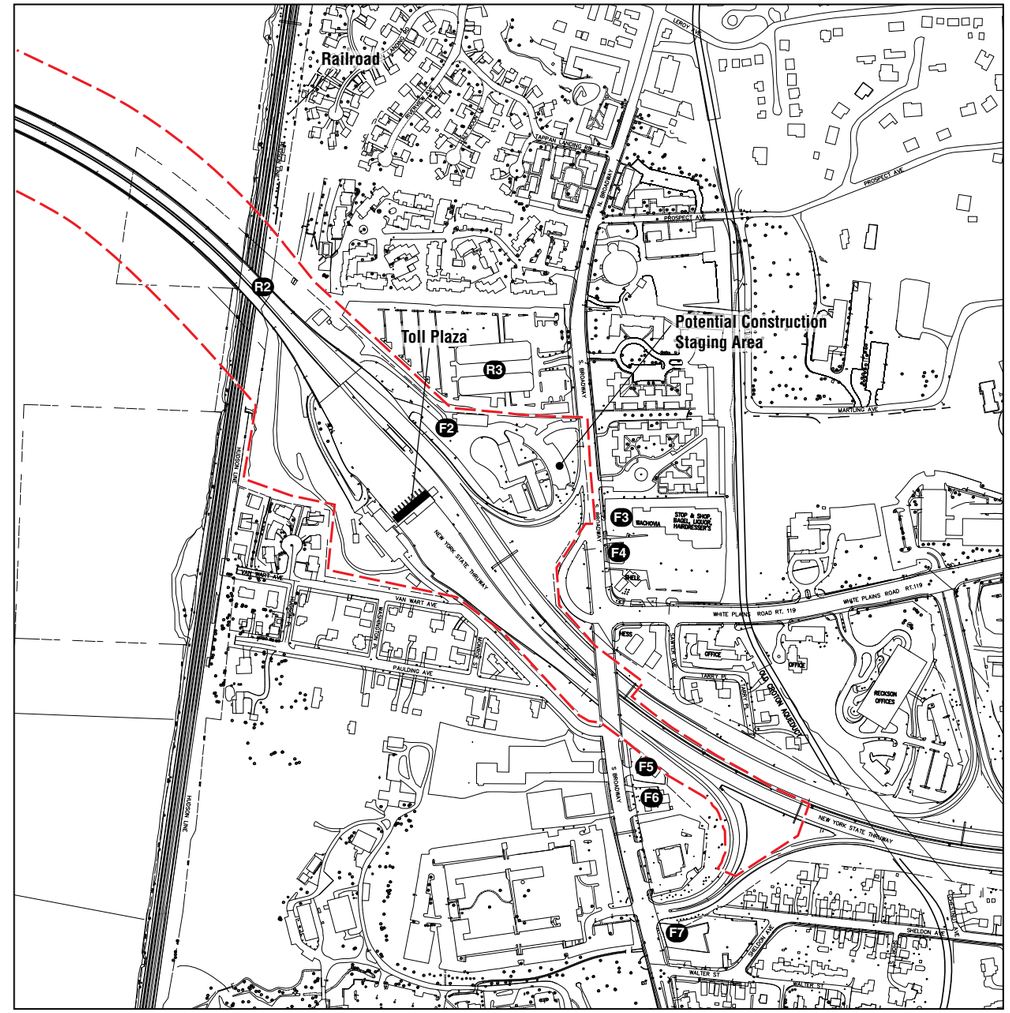
SCALE

Rockland County



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SCALE

Westchester County

LEGEND

Study Area

Hazardous Waste and Contaminated Materials Potential Sites of Concern:

S	*Sanborn Maps*
R	*Government Records*
F	*Field Surveys*
F1	*Roadway/Bridge Maintenance Facility*
F2	*Roadway/Bridge Maintenance Facility with Regulatory Listings*
F3	*Dry Cleaner*
F4	*Filling Stations*
F5	*Tire Shop*
F6	*Filling Station*
F7	*Auto Sales/Services*
R1	*Former Nyack Ice Co. Brownfield Site*
R2	*Tappan Zee Bridge Landfill*
R3	*Nissan Chemical America Corp.*
S1	*Heart Ease Home & Chapel (Former Funeral Home)*
S2	*Unspecified Historical Commercial Use*
S3	*Unspecified Historical Commercial Use*
S4	*Former Railroad Station*

Figure 17-1

Hazardous Waste and Contaminated Materials Potential Sites of Concern

(PCB) containing electrical equipment (e.g. transformers or switches) and/or suspect PCB and mercury-containing fluorescent lighting fixtures.

The following were identified nearby, but not within the study area:

- Historical and current commercial, industrial, auto-related (filling stations, auto sales and service) and/or railroad uses were identified, predominantly in the vicinity of the Tarrytown upland study area. Filling stations with active-status spills affecting groundwater were listed at 372 and 386 South Broadway in Tarrytown, immediately southeast of the Tarrytown study area.
- A dry cleaner, listed as a hazardous waste generator, was observed at 350 South Broadway in Tarrytown (approximately 185 feet east-southeast of the Tarrytown study area).
- The Nissan Chemical America Corp. was listed at 303 South Broadway in Tarrytown (approximately 300 feet east-northeast of the Tarrytown study area) with a closed-status violation of the Toxic Substances Control Act.
- The former Nyack Ice Co., located at 90 Clinton Avenue in Nyack (approximately 350 feet north of the Nyack study area) was listed with two closed-status spills and identified as a former State Brownfield Cleanup Program site with soil, soil vapor and groundwater contamination (petroleum compounds and semi-volatile organic chemicals) at which interim remedial actions were implemented.
- Regulatory databases identified numerous other UST facilities, hazardous waste generators and closed-status spills with limited subsurface contamination in the vicinity of the Interstate 87/287 right-of-way.

Based on these past and present uses within and near the study area, subsurface contamination may be encountered during construction as addressed in Chapter 18, “Construction Impacts.” During bridge operation, no significant potential for exposure to any remaining subsurface contamination would exist unless additional disturbance were to be required, for example for subsurface utility repairs. Where known or potential contamination is identified, this contingency would be addressed through a set of institutional and/or engineering controls (e.g. requiring areas to remain paved or requiring implementation of health and safety plans for subsurface utility repairs).

The operation of the new bridge would be associated with generation, storage, use and/or disposal of a variety of hazardous materials including (but not limited to): fuels, paints, solvents, lubricating oils, lighting components and wastes from cleanup of vehicle accidents.

17-5 ENVIRONMENTAL EFFECTS

17-5-1 NO BUILD ALTERNATIVE

Under the No Build Alternative, the existing bridge and the remainder of the study area would continue in their current uses. No new bridge or associated new maintenance facilities would be constructed for the project. As with the current conditions, all applicable regulatory requirements, for example those relating to excavation or disturbance of subsurface contamination, asbestos, lead-based paint, fuel, solvent, salt and maintenance product storage and waste disposal would need to be followed in

accordance with existing NYSTA/NYSDOT procedures. As such, there would be no adverse impacts associated with the No Build Alternative.

17-5-2 REPLACEMENT BRIDGE ALTERNATIVE

Following construction of the Replacement Bridge Alternative, all facilities would be managed in accordance with existing NYSTA/NYSDOT procedures, i.e., in a similar manner to the No Build Alternative. The potential for adverse impacts would be further reduced by removal of the existing bridge (which includes suspect historical lead-based paint, potential PCB-containing electrical equipment and lighting fixtures, and ACM. Construction of more modern facilities would reduce the potential for spills and releases as would the enhanced traffic safety associated with the new design. Cleanup of hazardous spills and accidents and management of petroleum bulk storage, solvents, road salt, etc., would be performed in accordance with applicable laws and standard NYSTA/NYSDOT operating procedures.

Following construction, less subsurface contamination would remain to the extent that construction necessitated removal of identified contaminated material. Any remaining subsurface contamination would not present a potential for exposure, unless additional subsurface disturbance were to be required. However, given that some could remain (especially in portions of the study areas which were not disturbed by construction), during utility repairs or other activities necessitating subsurface construction, existing NYSTA/NYSDOT procedures would continue to be followed. If appropriate, following construction a set of institutional and/or engineering controls would be applied (e.g. requiring areas to remain paved or requiring implementation of specific health and safety measures at certain locations).

17-6 MITIGATION

Conducting construction-related mitigation measures as specified in Chapter 18, “Construction Impacts,” and compliance with NYSTA/NYSDOT procedures after project construction would eliminate the potential for the Replacement Bridge Alternative to have adverse impacts relating to hazardous wastes or contaminated materials. Therefore, no post-construction mitigation would be required for the Replacement Bridge Alternative.

Chapter 18: Construction Impacts

18-1 INTRODUCTION

This chapter describes the construction means and methods of the Long Span and Short Span Options for the Replacement Bridge Alternative and assesses the potential environmental impacts associated with these activities. The two options would be constructed using the same general construction sequencing and methods over an approximately 4½ to 5½ year period. Provided in Section 18-2 of this chapter is a description of the overall construction sequencing and schedule for both the Long and Short Span Options. Section 18-3 includes a more detailed description of the construction methods and equipment that would be used to complete each of the key project elements. As discussed below, much of the work for the project would be performed from barges in the river as well as temporary platforms along both shorelines of the Hudson River. The potential adverse environmental effects as well as any proposed measures to avoid, minimize, or mitigate adverse effects are also discussed.

The construction means and methods presented in this chapter are based on the current level of engineering design, discussions with contractors, and past experience on similar projects. While the techniques ultimately utilized for the project may vary to some degree, the process described below presents the most likely scenario for construction of the project. While some flexibility is available within the overall means and methods, the environmental impacts and types of mitigation measures would likely be the same.

With the above in mind, this chapter does not include an analysis of those elements of construction that would be at the contractor's discretion and are unknown at this time. Those elements would include construction staging, in lieu of, or in addition to the two privately owned sites discussed below; disposal and borrow sites; sites used for the pre-fabrication of bridge components outside the immediate vicinity of the project and the production of concrete at existing permitted batch plants. In accordance with FHWA policy independent decisions by the contractor, unless effectively dictated by the project sponsor, are beyond the scope of the federal action. Furthermore, NYSDOT and NYSTA Standard Specifications for all construction contracts require the contractor to comply with all applicable environmental regulations and obtain all necessary approvals and permits for the course of construction.

In an effort to avoid and/or minimize potential adverse effects during construction of the project, a number of Environmental Performance Commitments (EPCs) have been identified which will be included as part of the project's construction contracts. Many of these EPCs are expected to become permit conditions. The EPCs are identified and discussed where applicable below

18-2 CONSTRUCTION SEQUENCE AND SCHEDULE

As shown in **Figure 18-1**, construction of the Short Span Option would take approximately 5½ years. The schedule shows both preliminary activities used to support the construction of the project (i.e., dredging and temporary platforms) as well as individual elements of bridge construction (i.e., main span and approaches). Throughout the construction period roadway work would be required at various times. During that time, the approach roadways would be shifted and remain in the new location for an extended period before being shifted again. The dredging would occur in three 3-month phases over a 4-year period, and construction of the main span would consist of approximately 3½ years of construction. Completion of the short span approaches would involve approximately 3½ to 4 years of construction. Demolition of the existing Tappan Zee Bridge would be expected to span approximately 1 year.

Construction of the Long Span Option would last approximately 4½ years. The construction sequence and schedule would be similar to that of the Short-Span Option with the exception of the construction of the approaches, which would be expected to take approximately 2½ to 3 years.

18-2-1 LANDINGS

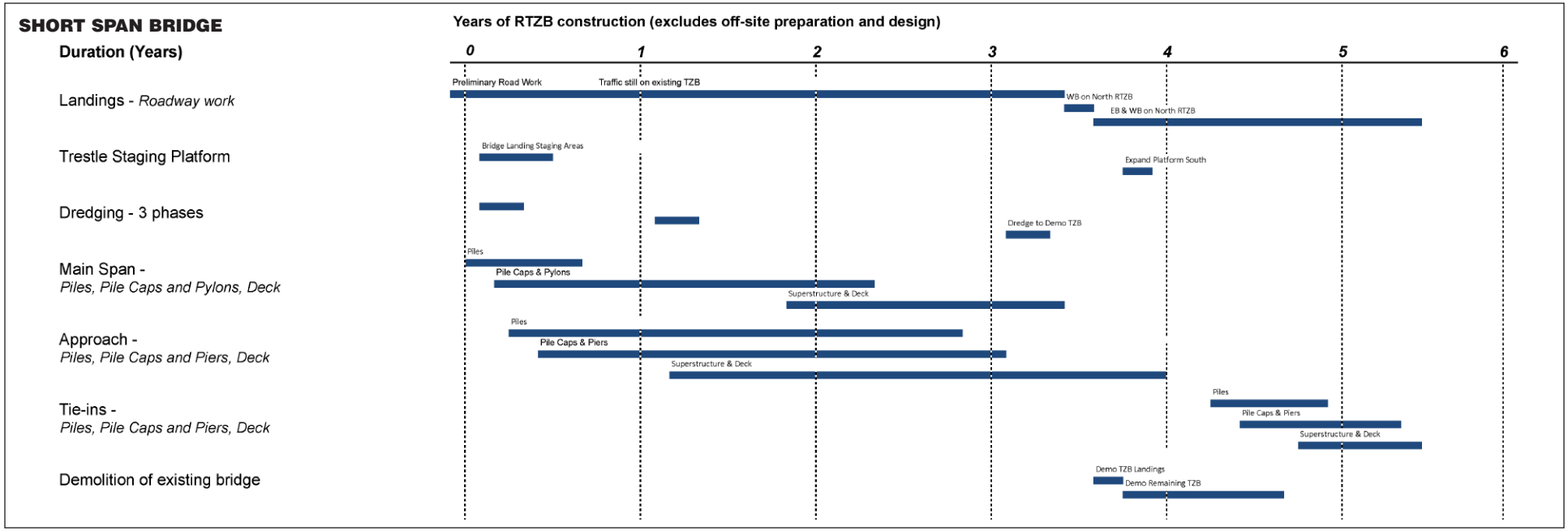
Landings would employ typical highway construction techniques and would be completed on both the Westchester and Rockland sides of the Hudson River upland from the bridge abutment to the tie in with the existing roadway. Construction of the landings would occur throughout the duration of the construction. The construction activity for the landings, however, would be gradual, as the roadways on both sides would be altered and then maintained for lengthy spans of time before being altered again. The alterations to the landings would consist of changes in roadway grade, elevation, direction, and general configuration.

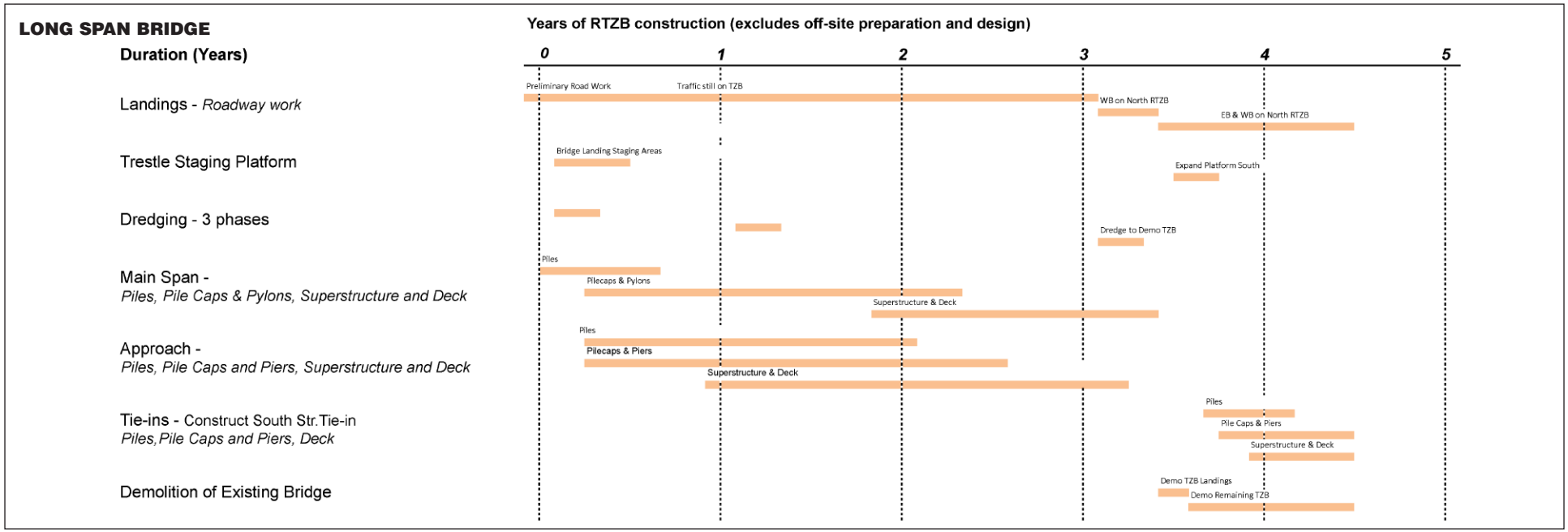
18-2-2 APPROACHES

Beginning at the abutments, the approaches carry traffic from the land to the main span of the bridge. Construction of the approaches would last for approximately three and a half to four years for the short-span alternative, and two and a half to three years for the long-span alternative. The piles, pile caps, piers, and deck that compose this segment of the bridge would be built sequentially so that as a new pile is being constructed, a completed pile would be undergoing further transformation with, for example, the addition of a pile cap.

18-2-3 MAIN SPANS

The main span would stretch between the Westchester and Rockland approaches. It is the segment of the bridge that would be defined largely by its superstructure design as an arch or cable stayed bridge. Within its substructure, the piers would be more substantial than those of the approaches. All main span work would be done sequentially and in a similar manner as that of the approaches. The piles, pile caps, pylons, and deck construction would last approximately three and a half years.





TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 18-1
Project Schedule

18-3 CONSTRUCTION OF KEY ELEMENTS

Construction of either option of the Replacement Bridge Alternative would require a wide range of activities on both sides of the river as well as from within the waterway itself. In addition, due to the lack of available land along the waterfront in the vicinity of the bridge, staging areas at some distance from the construction site would be required. Furthermore, it is likely that some bridge components would be pre-fabricated well outside the study area and transported to the site via barge.

To support construction of the main span and bridge approaches, materials, equipment, and crews would be transported from upland staging areas in Westchester and Rockland counties to temporary platforms that would be constructed on the shoreline of the river, as shown in **Figure 18-2**. Dredged channels would provide access to the two work areas in the shallow portion of the river crossing: the Rockland and Westchester approaches. Substructure construction would establish the foundation of the bridge through the processes of pile driving, construction of pile caps, and construction of columns. Superstructure construction would then take place either with a gantry that would move from pier to pier lifting segments from barges below (as in the case of the short-span design option) or a short pier-head truss segment would be lifted atop the next open pier column and secured (as in the case of the long-span option).

18-3-1 WATERFRONT CONSTRUCTION STAGING

The shoreline areas near the proposed bridge site are limited by adjacent development. In order to provide space for the docking of vessels, the transfer of materials and personnel, and the preparation of construction elements, temporary platforms would be extended out from the shoreline over the Hudson River (see **Figures 18-3** and **18-4**). The Rockland platforms would protect the shoreline and also enable the continued maintenance of the original Tappan Zee Bridge as well as providing continued support for the New York State Thruway Authority (NYSTA) Dockside Maintenance facility operation. The number of acres that the footprint of the platforms would occupy would depend upon the available upland area and the bridge option selected. Upon the delineation of the work area, steel piles would be driven to support the platforms. These platforms would provide access to the replacement bridge site via temporary trestles. Their main purposes would be to facilitate delivery of heavy duty bridge elements from an offsite fabrication facility, receive deliveries from the concrete batch plant, receive deliveries (i.e., construction equipment and light duty bridge elements) from the staging areas, and allow for barge-mounted cranes to erect heavy duty bridge elements. Upon completion of construction, the temporary platforms and the piles that support them would be removed.

As the construction of the temporary platforms and access trestles would begin at the shoreline, an access road and work area near the shore would also be constructed. A channel would be dredged specifically to provide barge access to the temporary platforms from in-river work sites.

18-3-2 IN-LAND CONSTRUCTION STAGING

For a project of this size, additional construction staging beyond the waterfront staging areas would be required to accommodate a number of functions. A contractor may utilize one large site or possibly use multiple sites to satisfy their specific construction

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Construction Truck Routes

Potential Temporary Staging Areas

0 1/2 MILE
SCALE

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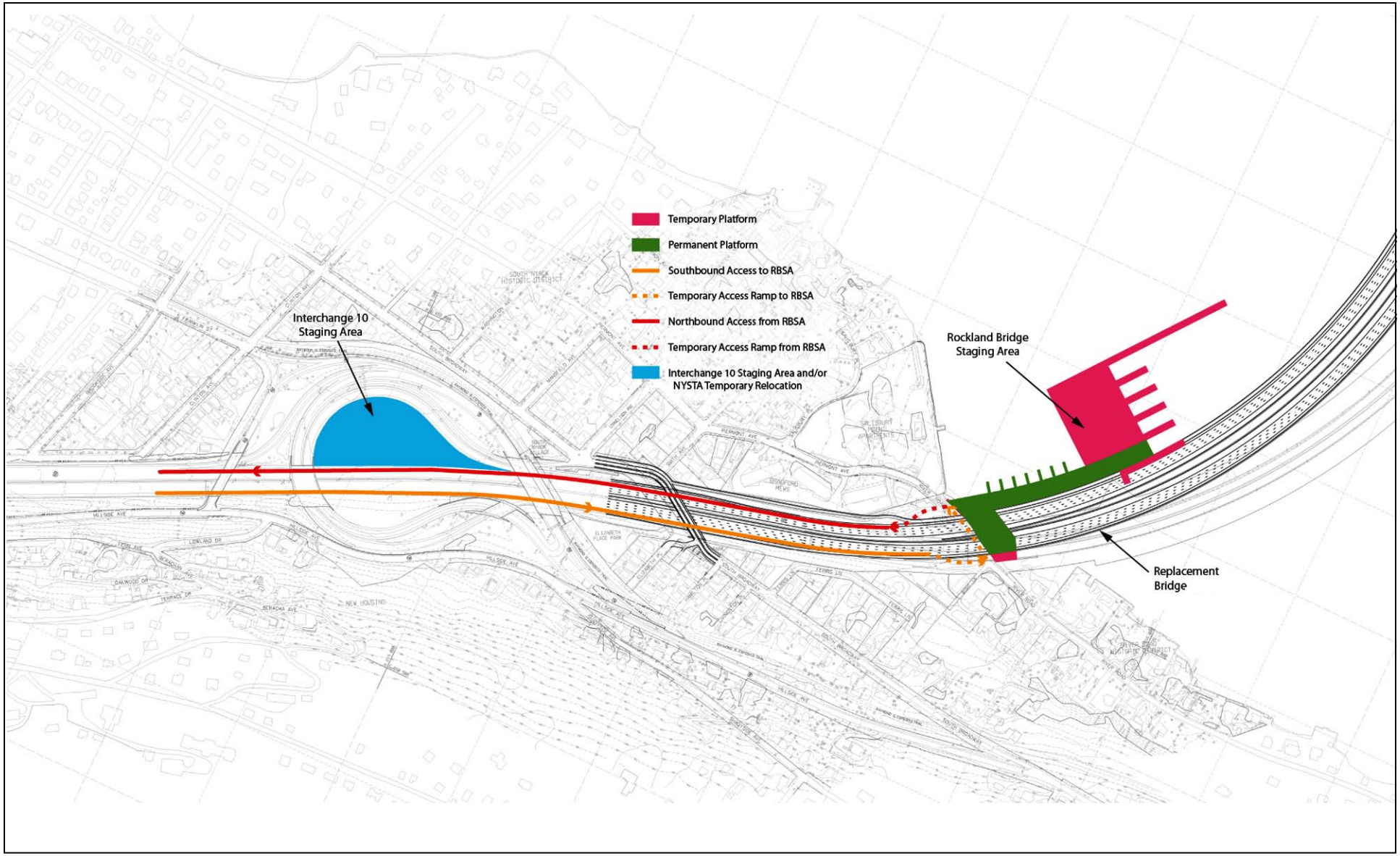
Environmental Impact Statement

Figure 18-2
Potential Upland Staging Areas



TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 18-3
Rockland Landing Construction Access

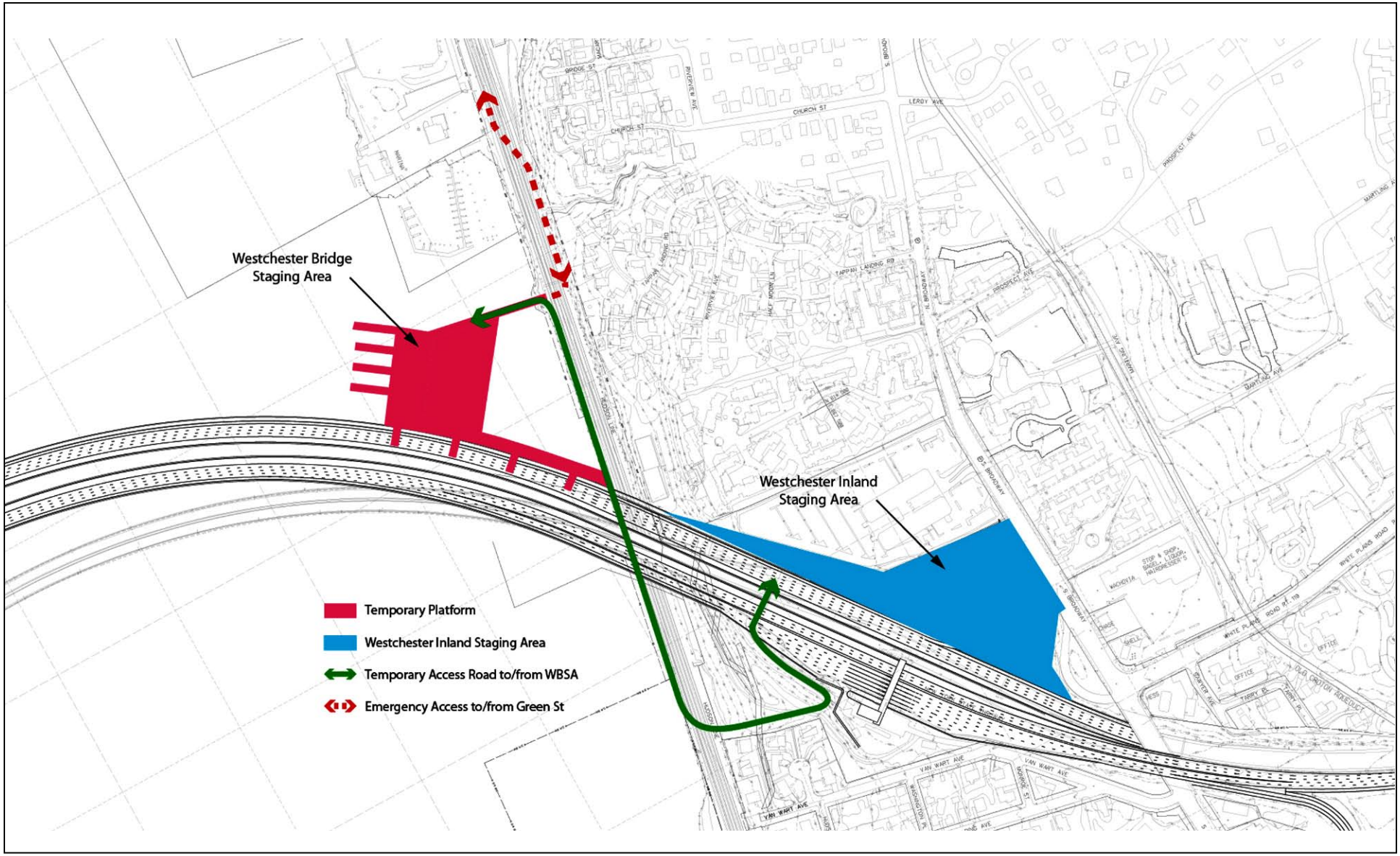


Figure 18-4

Westchester Landing Construction Access

needs. While the contractor may or may not choose to use the sites discussed below, based on their proximity to the project site, available size, surrounding land uses and access to the Thruway, these sites are likely candidates and provide a reasonable scenario to assess the potential impacts that may occur from the operation of a construction staging area in Westchester or Rockland Counties. While it is likely that the contractor may use a number of sites throughout the area to stage construction, the analysis in this document for the two in-land sites conservatively assumes that all activities would occur at one of the two sites. As noted above, at any staging areas ultimately utilized for construction of the project, the contractor would be required to obtain all of the necessary permits and approvals for each and any site.

18-3-2-1 FUNCTIONS

Concrete Batch Plant

One or more concrete batch plants could be utilized to provide the concrete needed to construct the bridge foundation, piers, and deck. Typically, a batch plant would occupy approximately 3 acres of land. The location for the plant would be strategically assigned such that the material will be deliverable to the construction site within 90 minutes of load-out at the plant in order to allow concrete to be poured placed before curing initial set in the truck. For the purpose of this analysis, it was assumed that 40 percent of the concrete needed for construction would be supplied by a batch plant at one of the two sites discussed below. The remaining 60 percent would be supplied by existing concrete batching facilities in Rockland and/or Westchester Counties.

Laydown/Storage Area

The assembly sites would offer space to complete many tasks throughout the course of construction. Unassembled construction equipment would be delivered to and assembled within these sites. Light duty bridge components would also be delivered to and stored within the assembly sites until they are ready to be utilized at the construction site.

Office/Administrative and Support Space

Office space would be required for construction administration and engineering staff. Interconnected trailers adjacent to the assembly sites would be ideal structures to support this need. It would also be possible, however, for the contractor to rent office space in nearby communities if the trailers are unattainable for any reason. Designated parking for all employees would be a consideration. It will be preferable to have on site space allocated for this purpose but, if necessary, employees would be shuttled from remote parking areas to the construction sites.

18-3-2-2 POTENTIAL CONSTRUCTION STAGING AREAS

Four inland staging sites are discussed below—two privately-owned properties and two parcels within the NYSTA's right-of-way. While the sites within the Thruway right-of-way would definitely be used for construction staging, additional sites would be required. The two privately-owned properties in Rockland County discussed below are likely candidate sites which could supply the needed area for construction staging outside the project's right-of-way. As such, an analysis of these two sites is included in the construction impact assessment. However, as noted above, the contractor is not

obliged to use the privately owned sites and they are included in this document for a discussion of the possible environmental effects if they were used as part of the project's construction. With this analysis, the impacts can be understood wherever the staging area may be.

West Nyack Staging Area (WNSA) Site

The potential West Nyack Staging Area Site occupies approximately 33 acres of land near Interchange 12 south of the Palisades Mall at the intersection of Routes 59 and 303. Only 3.7 miles from the Rockland Bridge Staging Area (RBSA), WNSA has the additional benefit of currently operating its own concrete batch plant. In addition, the relatively large expanse allows for potential accommodation of office trailers and parking lots. Light duty items may be stored and assembled here. To access the construction site, vehicles would travel on Route 303, entering the Thruway at Interchange 12 before exiting onto a temporary ramp located west of the bridge. From the temporary ramp, vehicles would pass onto River Road and travel under the existing Tappan Zee Bridge onto the temporary platforms of the Rockland Landing Dock Facility, as shown in **Figure 18-3**. Concrete trucks would drive onto barges by way of the docks. All other vehicles would deliver their stock to waterborne vessels. Delivery of batched concrete to the Tarrytown abutment is expected to take about 90 minutes.

Tilcon Quarry Staging Area (TQSA) Site

The potential Tilcon Quarry Staging Area, which is directly north of the Thruway and opposite the Palisades Mall, is an exceptionally large quarry site operated by Tilcon. Measuring approximately 120 acres, this site would have the capacity to contain many of the facets required for construction operations. In addition, this site is adjacent to the CSX West Shore Line and could potentially provide materials to be used during construction. Although the site is currently in operation, it may be possible to lease a portion of the space. The site is accessible via Interchange 12 of the Thruway and access to the construction site would be similar to that described above for the WNSA.

Westchester Inland Staging Area (WISA) Site

Presently used by the NYSTA's Tappan Zee Bridge Maintenance Facility, Bridge Patrol, Equipment Maintenance, and the local station of New York State Police (NYSP) Troop T, the triangle of land located north of I-87 and opposite the toll plaza is a possible location for staging on the Westchester side of the Hudson River, as shown in **Figure 18-4**. The Westchester Inland Staging Area currently contains a westbound on-ramp from southbound Route 9 which would be removed during construction staging. Highway access to WISA is available directly to the westbound I-287 shoulder, eastbound from I-287 by a short restricted-use ramp leading south of the Toll Plaza to the administrative area, and from South Broadway via Interchange 9. In order to access the Westchester Bridge Staging Area, vehicles would travel along the north-south access road under the Tappan Zee Bridge. From there, they would pass onto a temporary haul road that will be constructed in order to bring trucks over the Metro-North Railroad (MNR) Hudson Line to the Westchester Bridge Staging Area (WBSA).

Interchange 10

The vacant land included within the footprint of the existing interchange may be utilized for construction support for the RBSA. This site measures approximately 7.4 acres. This

site would most likely be used as a laydown/storage area for unassembled construction equipment, light duty bridge elements such as sheet piles, reinforcing bars and cables and other material delivery and storage.

18-3-3 DREDGED ACCESS CHANNEL

Since the proposed bridge alignment spans extensive shallows, it would be necessary to dredge an access channel for tugboats and barges to utilize during construction of the approach spans. These vessels would be instrumental in the installation of cofferdams, pile driving, the construction of pile caps and bridge piers, and the erection of bridge decks and other superstructure components. As noted earlier, temporary, trestle-type access platforms would be constructed near the shoreline to provide access for construction vehicles that would operate on the trestles. This would avoid the need to dredge the near-shoreline area.

Two alternate construction methods were evaluated in an effort to avoid the need to dredge an access channel. One method involved the use of overhead gantries for the construction of foundations and the other consisted of the implementation of a full-length temporary trestle for access. Both of these alternatives were found to be impractical: the former because it is not practicable for the heavy-duty pile-driving requirements of the replacement bridge and the latter because the deep soft soils in the shallow waters of the construction zone would require foundations that would be expensive and time-consuming to construct.

As shown in **Figure 18-5**, dredging would be conducted in three stages over a 4-year period for a duration of 3 months each year (August 1 through November 1). The purpose of the first two dredging stages (Years 1 and 2) would be to provide access for bridge construction, while the final dredging stage (Year 4) would provide access for demolition of portions of the existing bridge allowing completion of the remaining portions of the new structure. Each of these three-month spans would occur during the limited fall window when dredging is typically allowed in the New York Harbor/Hudson River Estuary area; this is the period when dredging activities would have the minimum effect on aquatic resources.

Based on an analysis of the types, number, size and operation of vessels that would operate in the access channel during construction, it was determined that a clear draft of 12 feet would be required within the access channel. To avoid the potential for grounding of vessels, an additional two feet would be added to provide a working channel depth of 14 feet at the lowest observed water level, which occurs during the Spring Neap Tide. The lowest observed water level is referred to as Mean Low Low Water (MLLW).

In addition, to minimize any adverse effects from the re-suspension of the fine sediment material due to movement of vessels, particularly tugboats, within the dredged channel, a layer of sand and gravel (referred to as “armor”) would be placed at the bottom of the channel following dredging. As discussed below in Section 18-4-12 (Water Resources) the sediments in the vicinity of the area to be dredged are highly susceptible to resuspension into the water column. Without “armoring,” prop scour from working tugboats in the channel would result in the generation of suspended sediment at rates several orders of magnitude greater than what would occur from the dredging operation itself. Therefore, it was concluded that this level of sediment resuspension and ultimate

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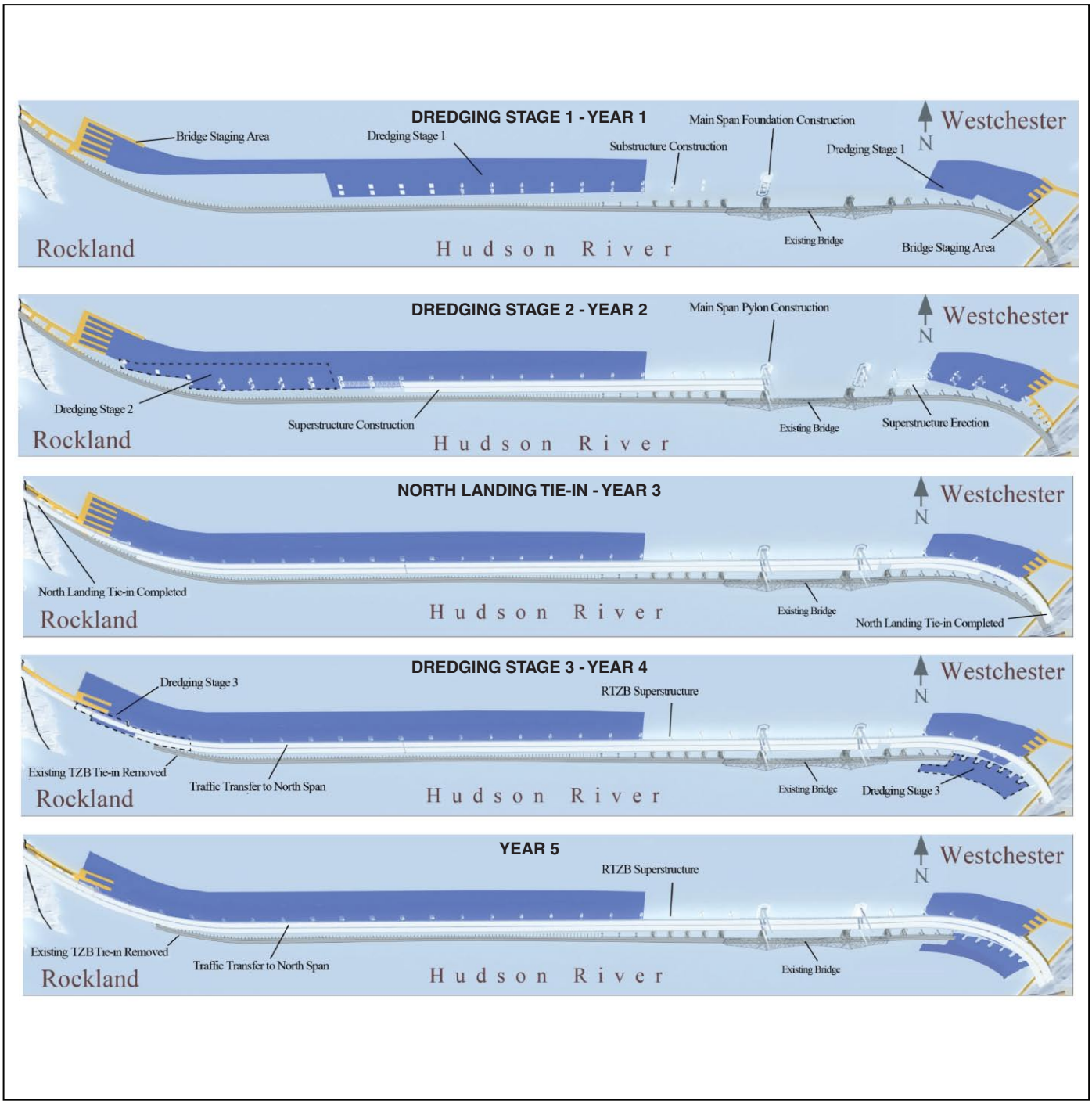

Note: Long Span Option is depicted, Short Span Option will be similar

Figure 18-5
Construction Sequence, Year 1- 5

transport into the river would pose an unnecessary and potentially substantive adverse effect to the environment.

The installation of the sand or gravel would take place as soon as the dredging for that section of the channel was successfully completed, forming a protective layer to keep sediment from further disturbance. Without this protective layer, additional maintenance dredging would be required to maintain a deeper work zone. As discussed in the Water Resources section below, the armoring materials would be placed within the channel by methods that would minimize the re-suspension of sediment into the water column. The materials would not be removed after the project completion, since they would become fully buried by the gradual deposition of river sediments over time. The dredging depth required assumes that two feet of sand or gravel armor is placed on the bottom. In total, the channel would be dredged to a depth corresponding to 16 feet below MLLW[1].

Table 18-1 shows the amount of material to be dredged during each stage for the two bridge design options. For either design option, the channel width would measure approximately 475 to 530 feet, and it would extend approximately 7,000 feet from the Rockland County side into deeper waters and 2,000 feet from the Tarrytown access trestle into deeper waters. Because the long span alternative would occupy a wider footprint, a slightly larger area must be dredged for that alternative. It is estimated that approximately 1.68 and 1.74 million cubic yards of sediment would be dredged for the short and long span options, respectively.

Table 18-1
Dredging Quantities for the Replacement Bridge Alternatives

Construction Stage	Short Span		Long Span	
	Quantity (million CY)	Percent of Total	Quantity (million CY)	Percent of Total
Stage 1	1.08	64%	1.12	64%
Stage 2	0.42	25%	0.43	25%
Stage 3	0.18	11%	0.19	11%
Total	1.68	100%	1.74	100%

Notes:
CY = cubic yards
Dredging for bridge demolition (Stage 3) includes that portion of the bridge which must be removed to complete the Replacement Bridge Alternative tie-in.

Environmental Performance Commitments (EPCs) to be used during dredging operations include:

- Dredging would only be conducted during a three-month period from August 1 to November 1 for the three years of the construction period in which dredging would occur, in order to minimize the potential for impacts to anadromous fish migration, including shortnose and atlantic sturgeon, as well as migration by other fish species;

[1] Since the elevation of MLLW is -1.9 feet below datum in the project's design drawings the actual elevation of the dredging as referenced in the design and permit documents is -17.9 feet or approximately -18 feet. An addition one foot is assumed for over-dredge bringing the total depth to -19 feet.

- Use of an environmental bucket with no barge overflow unless the contractor develops a method of treating the overflow water to ensure that any discharge does not result in a substantial visible contrast with the receiving water.
- Armoring of the channel to prevent re-suspension of sediment during the movement of construction vessels, installation and removal of cofferdams, and pile driving.

18-3-4 TRANSPORT AND DISPOSAL OF DREDGED MATERIAL

During each three-month period when dredging is occurring, dredged materials would be collected from the bottom of the river by barge-mounted cranes placed into hopper scows, which are boats with a capacity of approximately 2,500 cubic yards. To ensure that the scows do not exceed the maximum allowable draft of the river work zone, they would be limited to 80 percent of their maximum load, or 2,000 cubic yards per load.

Each dredging stage would occur during a 90-day period (August 1 to November 1). During that period, it is estimated that dredging would occur up to 75 of the 90 days, with two dredge operations occurring at a time. During the busiest dredging stage, Stage 1, up to 15,000 cubic yards of materials would be dredged each day. **Table 18-2** presents the estimated daily volumes of materials removed for each dredging stage for the two replacement bridge alternatives.

Table 18-2
Daily Materials Removal by Construction Stage

Construction Stage	Short Span Daily Volume (cubic yards)	Long Span Daily Volume (cubic yards)
Stage 1	14,600	15,000
Stage 2	5,700	5,800
Stage 3	2,400	2,600

After placement in the hopper scows, the next step in the dredge materials handling would depend on the dredge placement option selected.

As discussed above in the introduction of this chapter, certain activities related to project construction are left to the discretion of the contractor. One of these specific activities would be the ultimate transport and disposal of dredge spoils from construction of the access channel. Transport by ocean scow and placement in the Historic Area Remediation Site (HARS) in the New York Bight would offer a number of benefits to the project including cost, schedule, logistics and the avoidance of impacts to the surrounding residential communities on the Rockland and/or Westchester shorelines.

In this option, the dredged materials would be placed in shallow draft dredge scows and transferred to the ocean scows in the deeper water adjacent to the navigation channel. The contractor may elect to allow the dredged material to settle overnight in the shallow scows before transferring the material to the ocean scow. The water from the dredge scow would be decanted to a second tank or scow to settle out the suspended sediments before discharge to the water. The dewatered dredge material would be placed in the ocean scow allowing for a more economical load for transport to HARS. As discussed above, if the contractor elects to discharge the decant water to the river,

they would be required to meet the “no substantial visible contrast” requirement. The deeper draft ocean scows would then transport the material to HARS, 3.5 miles east of Sandy Hook, NJ. The HARS is overseen by the U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (USEPA). This site was historically used for ocean disposal of dredged material. Today, the site is being remediated through a program to cap those historic sediments with cleaner sediments dredged from New York Harbor that meet certain criteria established by the Ocean Dumping Act.

A permit is required for dredged material to be placed at the HARS from the USACE for that placement. To receive the permit, the materials must be suitable for remediation, in that they meet certain criteria related to contaminants based on sediment toxicity and bioaccumulation tests. In addition, in accordance with 40 CFR §227.16, the USEPA must evaluate alternative disposal options before permitting placement of dredged material at the HARS, and must find that there are no practicable alternative locations and methods of disposal or recycling available. In support of this required finding, an analysis was prepared documenting that there are no practicable alternatives locations for the placement of the dredged material at the HARS (see **Appendix H**).

In recognition of the many benefits offered by the HARS site, the project is proceeding with sampling and analysis of the dredged material in support of a permit under Section 103 of the Marine, Protection, Research, and Sanctuaries Act of 1972 from the USACE. If approved the dredged materials from the Tappan Zee Hudson River Crossing Project placed at the HARS would be transferred from the hopper scows to larger capacity (up to 4,500 cubic yards) ocean scows. These vessels have large drafts, typically up to 18 feet, that would be too large to be accommodated in the dredged construction channel. Therefore, materials would be transferred from the hopper scows to the ocean scows in deeper water adjacent to the navigation channel. The ocean scows would then travel to the HARS, where materials would be placed at the site in accordance with the permit conditions for that placement. Should the HARS site prove to be acceptable, additional coordination with NMFS for listed and proposed species (e.g. Shortnose and Atlantic sturgeon) and Essential Fish Habitat will be needed. Protocols for transport to the HARS and contingency plans will be developed as part of the Section 103 permitting process.

If the permit application for the use of HARS is denied in whole or in part, the contractor would be required to dispose of the dredged material at an approved facility in accordance with all applicable laws and regulations. However, due to the estimated number of truck trips that would be required (nearly 800 round trips daily) and the potential for adverse traffic, air quality and noise impacts on the local community the contractor would not be allowed to transport the dredged material by truck from the waterfront staging areas in Rockland or Westchester Counties. The contract documents would specify that alternate means of transport of the dredged material such as barge, barge to rail or barge to truck would be required for disposal.

18-3-5 SUBSTRUCTURE CONSTRUCTION

Substructure construction would vary as a function of water depth and sediment conditions at each location. Work on the foundations can be categorized into three segments referred to as Zone A, Zone B, and Zone C (see **Figures 18-6** and **18-7**). Pile

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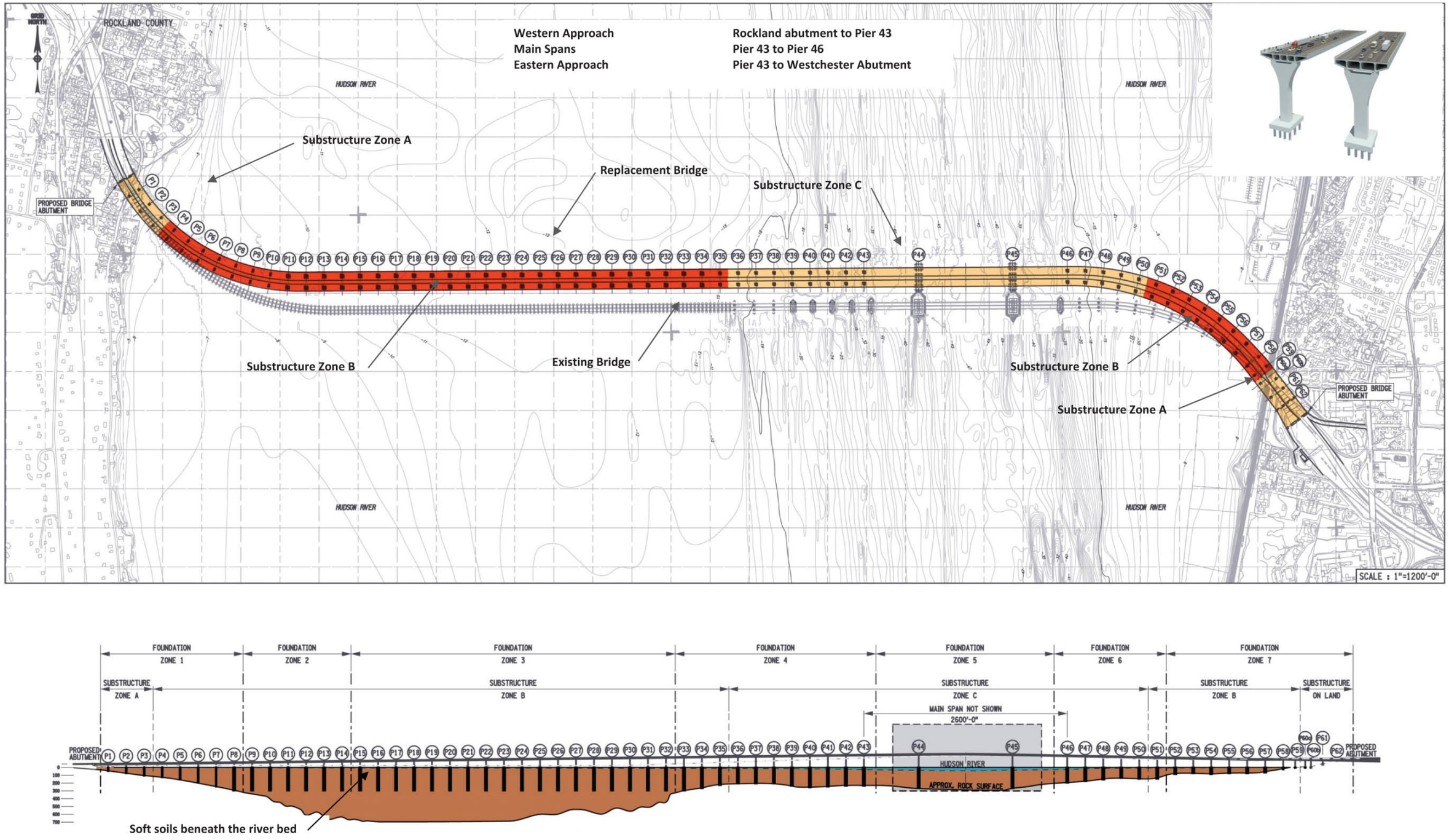

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 18-6
Short Span Bridge Option - Indicative Plan and Elevation

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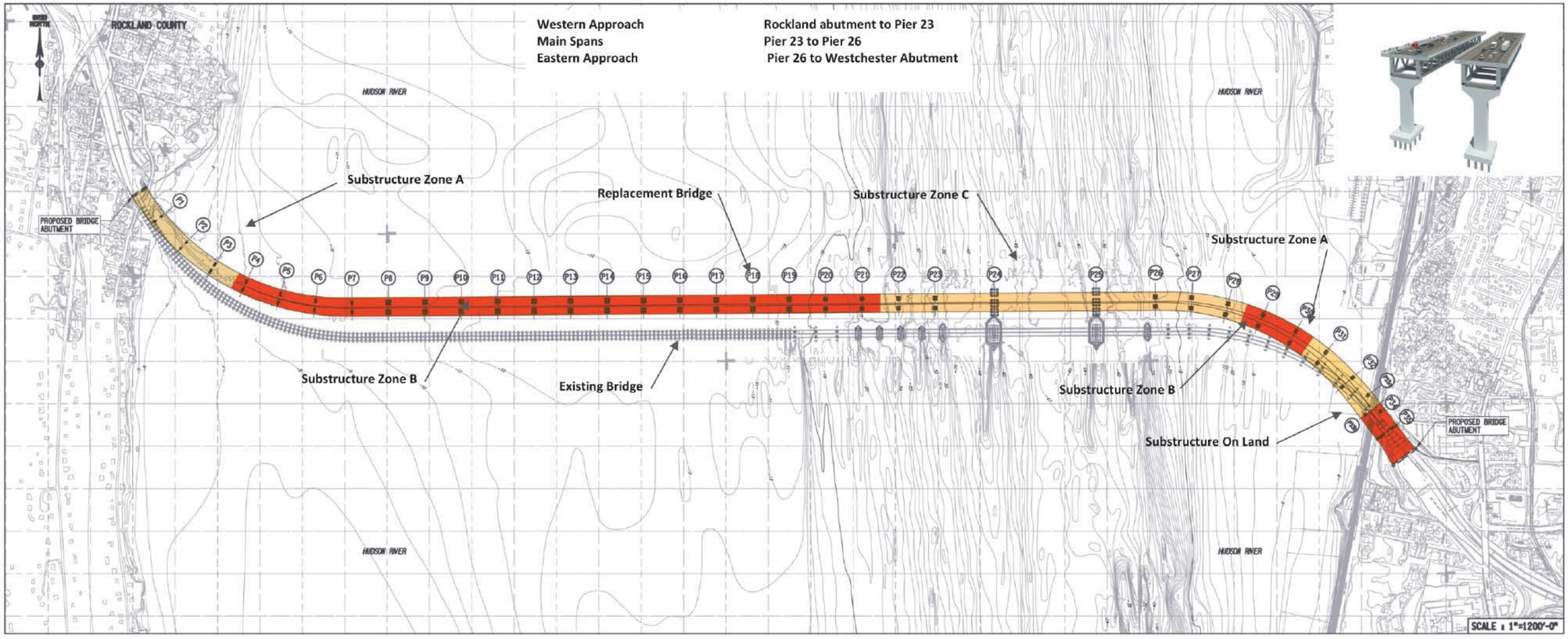

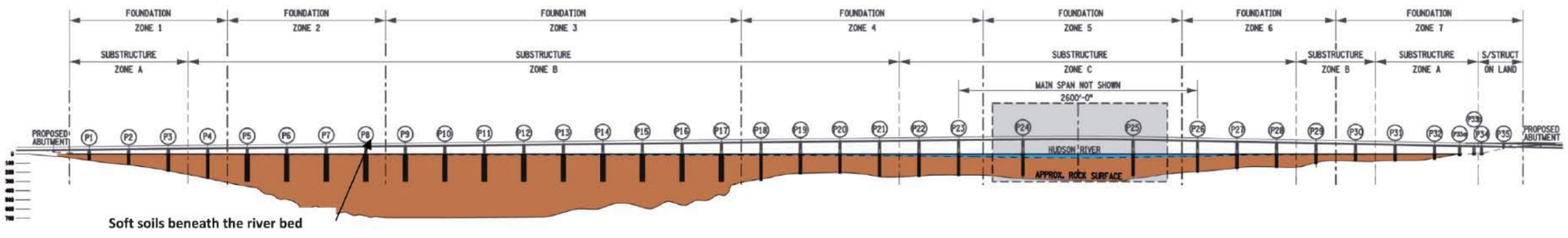

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 18-7
Long Span Bridge Option - Indicative Plan and Elevation

installation would typically be performed one row of piles at a time. The actual pile driving is done one pile at a time. Pile driving of large diameter piles, defined as those greater than 6-feet in diameter, will be limited to 5 hours per day in the main channel during the period of April to August. Main channel is defined as 1,000 feet each side of the centerline of the shipping channel. Pile installation will be from 7Am to 7PM, a 12-hour maximum in one day.

As shown in **Table 18-3**, a total of 1,326 piles for Piers 1 to 57 would be required for the Short Span Option. **Table 18-4** includes similar information for the Long Span Option at Piers 1 thru 32. The Long Span Option would require 836 piles. In terms of the largest piles, the number of the 10-foot piles would be the same (50) for either option. The greatest difference between the two options would be the number of smaller 4-foot piles with the Sport Span Option requiring approximately 346 more piles than the Long Span Option. The Long Span Option would also require 104 less 6-foot piles and 40 less 8-foot piles for a total difference of 490 piles. Under either option, the driving of the largest piles (8- and 10-foot) would only occur for a few months in the first year of construction.

Table 18-3
Pile Driving, Short Span Option

Pier No.	Substructure Zone	Pile Size (diameter ft)	No. of Piles Within each Pier	Total No. of Piles
1-3	A1	6	4	24
4-8	B1	6	6	60
9 - 14	B1	4	20	240
15-32	B1	4	20	720
33-35	B1	8	4	24
36-43	C	8	4	64
44-45	C	10	25	50
46-50	C	6	6	60
51-57	B2	6	6	84
Total				**1,326**

Table 18-4
Pile Driving, Long Span Option

Pier No.	Substructure Zone	Pile Size (diameter ft)	No. of Piles Within each Pier	Total No. of Piles
1-2	A1	6	4	16
3	A1	6	6	12
4	B1	6	6	12
5-17	B1	4	25	614
18-21	B1	8	4	32
22-23	C	8	4	16
24-25	C	10	25	50
26-28	C	6	6	36
29-30	B2	6	6	24
31-32	A2	6	6	24
Total				**836**

EPCs to be employed during construction of the substructure include:

- Driving the largest [3 and 2.4 m (10 and 8 ft)] diameter piles within the first few months of the project thereby limiting the period of greatest potential impact.
- Using cofferdams and silt curtains, where feasible, to minimize discharge of sediment into the river.
- Using a vibratory pile driver to the extent feasible (i.e., all piles will be vibrated at least to 120ft depth or to vibration refusal) particularly for the initial pile segment.
- Using bubble curtain, cofferdams, isolation casings, Gunderboom, or other technologies to achieve a reduction of at least 10 dB of noise attenuation.
- Using the results of the Hudson River site specific Pile Demonstration Implementation Project (PIDP) to inform the project on the effectiveness of BMP technologies for reducing sound levels, and implementing BMPs to achieve maximum sound reduction.
- Limiting the periods of pile driving to no more than 12-hours/day (in rare circumstances, it is possible that piling may extend further than 12 hours depending on the practicality of driving).
- Limiting driving of piles with an impact hammer within Zone C [water depths 5.5-13.7 m (18-45 feet)] to pile for 5 hours per day during the period of spawning migration for shortnose and Atlantic sturgeon (April 1 to August 1).
- Maintaining an acoustic corridor where the sound level will be below 150 dB re 1 µPa (rms) of at least 5000-ft at all times from impact hammer pile driving. Refuge shall be continuous to the maximum extent possible but at no point shall any contributing section be smaller than 1500 ft.
- Pile tapping (i.e. a series of minimal energy strikes) for an initial period to frighten fish so that they move from the immediate area of pile driving activity.
- Development of a comprehensive monitoring plan. Elements would include:
    - Monitoring locations to characterize the hydroacoustic field surrounding pile driving operations, which also includes a nearfield component to evaluate the performance of underwater noise attenuation systems that are integral to the project.
    - Monitoring water quality parameters such as temperature, salinity, and suspended sediment concentrations in the vicinity of the pile driving.
    - Monitoring fish mortality and inspection of fish for types of injury.
    - Monitoring predation levels by gulls and other piscivorous birds, which would indicate that they are finding an increased number of dead or dying fish at the surface.
    - Developing criteria for re-initiating consultation with NMFS should specific numbers of shortnose or Atlantic sturgeon come to the surface injured or dead.
    - Preparing a Standard Operating Procedures Manual outlining the monitoring and reporting methods to be implemented during the program.

18-3-5-1 FOUNDATION ZONE A

The two areas of shallowest water depth extend from the shorelines on the Rockland and Westchester sides of the Hudson. These areas, where the water measures less than 7 feet in depth, are labeled as Zone A. The area adjacent to the Rockland shoreline is labeled Zone A1, while the area adjacent to the Westchester shoreline is Zone A2. Zone A substructure elements would be constructed within cofferdams from adjacent temporary trestle platforms. These cofferdams would be constructed prior to pile driving the bridge foundation piles. The cofferdam would remain flooded during pile installation.

Cofferdams

A cofferdam is a watertight chamber designed to facilitate construction in an area that would otherwise be underwater. In this case, the cofferdams would be composed of interlocking sheet piles extending into the riverbed a distance of up to 20 feet. Upon completion of the cofferdam, foundation piles would be driven into the riverbed prior to dewatering. The remaining work of pile cap and pier construction would follow the dewatering process.

Pile installation

Prior to pile driving, a template to guide piles would be placed within the cofferdam to ensure that they are in position and to hold them when pile driving is not taking place. Once all piles are driven, the template and its supports would be transitioned to the next cofferdam. A quick, low-noise, moderate-energy vibratory hammer would be used to install much of the length of the pile, after which a high efficiency hydraulic impact hammer suspended from cranes operating on the two temporary shoreline access trestles would be used to apply force to the tops of the piles so as to deliver the piles more deeply into the riverbed. It should be noted that the use of vibratory hammer for the entire driving operation may not possible due to the excessive depths to solid founding layers. Feasibility of deep vibratory techniques will be tested in the PIDP. From these tests, it is anticipated that the initial set for these deep piles cannot be overcome with vibratory techniques after pile sections are spliced. The introduction of vibratory methods throughout would require the addition of substantially more pilings to achieve the desired capacity and settlement characteristics. The extent of vibratory piling will be reconsidered after the results from the PIDP are available.

A 300-ton crawler crane would suspend the 150-foot pile sections and support the pile driving hammer during operation. Upon completion of pile installation, the soil within each pile would be excavated and transported to an off-site disposal facility. Finally, a tremie concrete plug, which braces the bottom of the sheet pile cofferdam and provides a seal at the base of the cofferdam to allow for dewatering of the cofferdam, would be poured inside the pile and a steel reinforcing cage would be inserted into the pile. River water recovered during dewatering of the cofferdams would be treated (e.g., tanks to settle out any suspended sediments and water filtration system as necessary) and discharged back to the Hudson River in accordance with conditions issued by the NYSDEC under the Section 401 water quality certification for the project and would not result in adverse impacts to water quality of the Hudson River.

Pile caps

As previously mentioned, a tremie concrete plug would be poured into the hollowed pile. The pile itself would be dewatered down to the plug. Prior to the installation of the pile cap, pier reinforcement, post tensioning ducts, and pile reinforcement would be secured. A pile cap, which is a reinforced concrete slab constructed atop a cluster of foundations piles, would then be constructed to form a single structural element that would allow for even distribution of the weight that the piles bear, avoiding over stressing any individual component. These slabs would also provide a larger area for the construction of the columns that they will support.

18-3-5-2 FOUNDATION ZONE B

The water depths in Zone B range from 5 to 18 feet, and the zone is characterized by a relatively deep soft-soil profile. Zones B1 (close to the Rockland shoreline) and B2 (close to the Westchester shoreline) are located adjacent to Zones A1 and A2 and are closer to the centerline of the river. The functions performed in Zone B substructure construction would take place in cofferdams, as in Zone A, but the tasks would be completed from barges and support vessels.

Pile installation

Piles, which would be transported in two pieces to Zone B by barge, would measure between 250 and 300 feet due to the relatively deep soft-soil profile within the zone. Pile driving would begin immediately upon completion of the cofferdam construction. As in Zone A, a 300 ton crawler crane would lift the pile sections. A pile-driving rig would supply a hammer suspended from the barge mounted crane. The template would be positioned to guide the lower pile section into proper position before the pile would be allowed to delve into the soft stratum under its own weight. The depth achieved in this manner would be considerable, and should the application of further pressure be called for, a vibratory hammer would be used to drive the remainder of the pile into place. Upon the placement of the lower segment of the pile, preparations to begin welding the two segments together will commence. In order for the two segments to be joined, the upper segment would be hovered over the lower until the automated welding process was complete. Upon the completion and inspection of the welding, the remaining length of the conjoined pile would be driven to required depth or specified penetration resistance with a hydraulic hammer. As in Zone A, the soil within the pile would be excavated and transported to an off-site disposal facility in order to create space for the tremie plug and steel reinforcing cage.

Pile caps

The construction process of pile caps in Zone B would be similar to that of Zone A. One difference would be that a granular fill material would be distributed inside of the cofferdam to enable the tremie seal to be poured to its planned elevation. This granular material would remain after the removal of the cofferdam.

18-3-5-3 FOUNDATION ZONE C

Foundation Zone C lies between Zones B1 and B2, connecting the two sides of the river. This zone is defined by the greatest water depths, which range from 18 to 45 feet.

Construction in this zone would encompass the construction of the main span as well as that of both approaches.

The first substructure construction activity in Zone C would be the installation of the foundation piles. In this zone, due to the greater depths than Zones A or B, cofferdam construction would follow the pile installation, thus requiring that the cofferdam be constructed around the installed pile to create a dry environment in which to construct the tremie seal. The cofferdam in Zone C would be constructed using a different method than that utilized in Zones A and B. This alternative method, the "hanging cofferdam method", would begin with the installation of a temporary support structure above the foundation piles on which the cofferdam would be assembled. The cofferdam components would then be pieced together from pulleys secured to the top beams of the support structure. After the placement of the cofferdam, the tremie slab would be poured onto a steel deck acting as the cofferdam floor. Divers would seal the gaps between the piles and the cofferdam deck before the dewatering process. The tremie slab would then be poured, and the unreinforced slab would bond the piles to the cofferdam pending the construction of the reinforced pile cap.

18-3-6 CONSTRUCTION OF BRIDGE SUPERSTRUCTURE

Completion of the bridge superstructure would include piers, columns, pylons (for a cable-stayed option), bridge deck, roadway finishes, lighting, and the shared use path. Much of the material would be pre-fabricated at various locations and delivered to the project site via barge. At the construction site, these elements would be lifted into place by gantries and cranes operating on barges, the temporary work platforms, or completed portions of the structure.

18-3-7 EXISTING BRIDGE DEMOLITION

The existing Tappan Zee Bridge contains five segments: causeway, east trestle, east deck truss, west deck truss, and main spans. The demolition of the existing bridge will be performed in two stages. The first stage will include partial demolition to allow for construction of the new bridge, and the second stage will occur after the completion of the new bridge. No blasting of the existing structure would occur. As described in more detail in the Energy and Climate Change section below, the project will employ a recycling and re-use program, as practicable, as part of the project construction including demolition of the existing structure.

18-3-7-1 CAUSEWAY AND EAST TRESTLE SPANS

The causeway is a simple span construction composed of 166 spans measuring 50 feet, with the exception of one 100-foot span. The east trestle is comprised of 6 spans. Within its simple span construction, the causeway contains a stringer and deck superstructure and a substructure of concrete columns and footings on timber piles. Initially, the deck and stringers would be lifted out and placed onto awaiting barges. Then, the protective dolphins would be cut so as to offer unrestricted access for pier removal. Columns and footings would either be cut with diamond wire or broken by pneumatic hammers. Finally, the timber piles forming the causeway foundation would be cut to just below the mud line. All materials would be transported to an appropriate permitted off-site disposal facility, and a turbidity curtain would be utilized to ensure that

demolition debris would not be dispersed. Side-scan sonar surveys would be performed in order to verify that all generated debris would be removed from the river.

18-3-7-2 DECK TRUSS SPANS

The deck truss spans, including 13 east deck, 7 west deck, and all approach truss spans, each contain a deck slab, steel trusses, and concrete piers supported on buoyant foundations or caissons. The deck slabs would be removed and transported off-site by an awaiting barge. A channel would then be dredged in Stage 3 to provide access to the trusses near the Westchester shoreline, and steelwork would either be removed by barge-mounted crane or a crane mounted on an adjacent in-tact span. Caisson-supported piers would be demolished using the same process as in the causeway and east trestle spans, and would then be removed to the mud line using diamond cutting wire devices or pneumatic hammers. Steel H piles would remain below the mud line. Turbidity curtains and netting would also be used in this stage.

18-3-7-3 MAIN SPAN

The main span stretches 2,412 feet and is structurally formed by a through truss above a deck supported by four latticework piers on buoyant foundations, ice deflectors around the two central piers, and pre-stressed concrete beams on 30-inch diameter steel piles. Initially, the main span deck slab would be lifted and removed off-site by barge. Then, the entire suspended span would be lowered onto a barge via a strand jack or winch system. Conventional barge-mounted cranes would then deconstruct the anchor span steelwork piece by piece and the ice-breaker and fender structures protecting the main span piers would be demolished by divers and barge-mounted cranes. The pier steelwork would also be removed piece by piece, and the buoyant caissons would be cut and flooded. Following main span demolition, a barge-mounted crane operated clam shell bucket would clear the river bottom of debris. Side-scan sonar surveys would verify that all debris and concrete were removed from the river.

18-3-8 CONSTRUCTION ANALYSIS FRAMEWORK

For construction projects that extend over multiple years, a critical period is identified to isolate the greatest potential for adverse effects. The assessment of impacts in the critical or peak construction period results in and the determination of mitigation measures that would also alleviate adverse effects in other phases of the construction period, since activities would be less intense than in the critical period. For each stage of construction, a peak condition has been developed that replicates the daily activities that may be encountered for each stage. These activities include the type and location of construction activities, a roster of (onsite) construction equipment, the hours of operation for each equipment type, and the numbers of trucks providing material or demolition transport. It was also necessary to develop estimates of construction worker vehicle trips, even though these are not expected to occur in the peak analysis hours, because they may be substantial over a 24-hour period. Once these details were established for the individual construction stages, an analysis scenario was developed to assess the potential environmental impacts.

To develop the analysis framework, different critical analysis periods were selected for different resource impact assessment (i.e., Air Quality, Noise and Vibration, Ecology, etc.). For example, the peak period for the construction noise analysis would occur

when both the landing and bridge construction equipment would be operating simultaneously in close proximity to sensitive receptors near the shoreline. However, for potential water quality impacts, the peak dredging period was analyzed, while the bioacoustics analysis focuses on the peak pile driving activities.

Table 18-5 includes a list of the major pieces of construction equipment that is anticipated to be used for construction of the bridge. **Table 18-6** includes the equipment that would be used to support construction of the roadway segments on the upland portion of the project. This equipment roster was utilized in the air quality as well as the noise and vibration analyses discussed later in this chapter of the DEIS.

Table 18-5
Major Construction Equipment Required for Bridge Construction

Equipment	Short Span Option	Long Span Option	Required
Sheetpile Vibratory Hammer	X	X	2
Barge Mounted 500 Ton Crane	X	X	1
Barge Mounted 200 Ton Crane	X	X	2
Barge Mounted 100 ton Crane	X	X	4
Pile Vibratory Hammer	X	X	1
Pile Driving Hammer - 500 kJ	X	X	1
Pile Driving Hammer – 800 kJ	X		1
Compressors	X	X	20
Generators	X	X	20
Water Pumps	X	X	20
Welding Huts	X	X	8
Rock Socket Drilling Rig	X	X	4
Tugboats	X	X	8-10
Dredgers	X	X	2
Hopper Scows	X	X	10
Dump Scows	X	X	3
Flat Deck Barges	X	X	20
Concrete Delivery Barges	X	X	20
Concrete Pumping Barges	X	X	6
Pile Delivery Barges	X	X	3-5*
Segment Delivery Barges	X		5-10*
Truss Delivery Barges		X	3-5*
Deck Segment Erection Gantry	X		2 Units
Truss Lifting winches		X	2 Sets
Jacking T-cranes (pylons)	X	X	6-8
Temporary Cable Stayed Pylon	X	X	6

Note:
* Supplier provided, depends upon travel distance, capacity and installation rates.

Table 18-6
Major Construction Equipment Required for Roadway Construction

Equipment	Rockland	Westchester
Compressors - surface tools	2	2
Concrete pump - general	2	2
Crane - all-terrain (80t)	1	1
Crane - crawler (100t)	1	1
Crew Buses	2	1
Excavator - long reach, tracked	1	1
Excavator - mini-excavator	2	2
Front-end loader - wheeled, large	1	1
Front-end loader - wheeled, mid	1	1
Generator - mid	1	1
Pump - general, water	1	1
Telescopic boom - self-propelled	1	1
Telescopic forklift handler	1	1
Vibratory Compactor Roller	1	1
Truck - concrete	2	2
Truck - delivery & haul-away	1	1
Truck - muck-away	4	4
Construction Lights	6	6
Highway Advisory Signs	4	4
Truck Wash Station	**1**	**1**

18-3-9 OTHER ENVIRONMENTAL PERFORMANCE COMMITMENTS

In addition to those EPCs already discussed above, there are a number of measures that the project would employ during construction to avoid or minimize adverse environmental impacts as follows:

18-3-9-1 TRANSPORTATION

Traffic and transportation issues as they relate to the construction effort would be managed by a comprehensive and detailed Work Zone Traffic Control (WZTC) management plan. The contract specifications would require road closures and detours to be strictly coordinated so that traffic can take safe, practical and short detour routes. This coordination would serve to avoid or minimize, to the extent feasible, traffic diversions through residential neighborhoods. Further, the construction would be staged to maintain through traffic, perhaps with only one direction being detoured at a time. Temporary closures and detours would be done in sequence as the project progresses geographically through a particular construction zone. During such closures and detours, the construction contractor would be required to post detours for traffic and implement other measures to ensure that traffic flow can be accommodated in an efficient manner as may be both practical and safe. Intelligent Transportation System (ITS) measures, such as variable message signs (VMS), would be deployed at strategic locations during construction to provide accurate, timely information to motorists to enable them to make rational decisions on routing choices.

While much of the material needed for construction of the project is anticipated to arrive by barge directly to the work platforms within the river, the project sponsors would also coordinate with local agencies regarding the hauling of any construction materials to identify acceptable routes and times of operation, and roadways to be used. The contractor, in coordination with NYSDOT and NYSTA, would coordinate with potentially affected public services in planning traffic control measures. Construction activities that might substantially disrupt traffic would not be performed during peak travel periods to the maximum extent practicable. Access to all businesses and residences would be maintained.

Warning signs would be used as appropriate to provide notice of road hazards and other pertinent information to the traveling public. Signage and barricades would be used as part of the typical roadway construction traffic controls. Temporary traffic signal adjustments and/or temporary manual traffic control could be required when construction occurs at signalized intersections on adjacent arterials or roadways. The effectiveness of the traffic control measures would be monitored during construction and adjustments would be made, as necessary. The local news media would be notified in advance of road closures, detours, and other construction activities. Information would also be posted on the project website.

The ability for boats to travel along the Hudson River would be maintained throughout the construction period. The NYSDOT and NYSTA would coordinate with the U.S. Coast Guard to develop acceptable navigation windows, notice protocols and limit any channel closures to the minimum time necessary to provide a safe construction process. Signage and channel markers would be utilized to advise recreational boaters of preferred routes and potential dangers within the construction zone. While some boaters, due to water craft size or power source, may experience difficulty navigating through the construction zone during this time period, this temporary disruption is not considered an adverse impact.

18-3-9-2 AIR QUALITY

Construction activity in general, and large-scale construction in particular, has the potential to adversely affect air quality as a result of diesel emissions. The main component of diesel exhaust that has been identified as having an adverse effect on human health is fine PM. To ensure that the construction of the project results in the lowest practicable diesel particulate matter (DPM) emissions, the construction contracts will require several EPC, including the following components:

- Clean Fuel—All diesel fuel will be ultra-low sulfur diesel.
- Best Available Tailpipe Reduction Technologies—All land-based diesel nonroad engines with a power rating of 50 horsepower (hp) or greater will be fitted with a diesel particle filter.
- Utilization of Newer Equipment—All land-based nonroad engines will be certified Tier 3 where conforming equipment is available, and the use of such equipment is practicable, and otherwise will be certified Tier 2 at a minimum.
- Tug Boat Emissions Reduction—total tug boat emissions will be limited to 3,700 grams per hour at peak power.

- Concrete Batch Plant Controls—the concrete batch plant will vent all hoppers and mixing via baghouse of filter sock, with control efficiency of 99.9 percent. Roadway and materials movement will be controlled via wet suppression so as to avoid resuspension of dust.
- All efforts will be made to avoid unnecessary heavy duty vehicle and nonroad engine idling.

More detail about these EPCs can be found in section 18-4-8.

18-3-9-3 NOISE AND VIBRATION

Noise abatement measures would be utilized where practicable and feasible, including:

- Electric powered equipment, rather than diesel powered mechanical equipment would be utilized;
- Use of impact devices such as jackhammer, pavement breakers and pneumatic tools should be limited and shrouds would be utilized to limit noise exposure;
- Construction staging areas would have appropriate noise attenuation installed around the areas and would be configured to minimize backup alarm and other noises; and
- Contractors and subcontractors would be required to properly maintain and service their equipment and install quality mufflers so they meet noise specifications;
- Sound attenuating curtains or shrouds would be used on the pile driving hammers to reduce noise when operating in close proximity to residential uses (i.e. for pile driving activities near the Westchester and Rockland shorelines); and
- Movable noise attenuation measures would be erected around pumps, trucks, and other noisy equipment when operating in close proximity to residential areas.

18-3-9-4 ENERGY AND CLIMATE CHANGE

Construction contracts will require, as practicable, the use of recycled materials, locally resourced materials, and renewable fuels, which would substantially reduce the potential greenhouse gas (GHG) emissions during construction.

18-3-9-5 ARCHAEOLOGICAL RESOURCES

Ongoing geo-archaeological survey work has been designed to collect sufficient data on potential prehistoric sites previously identified, in order to mitigate any adverse effects that may occur on these potential resources as a result of the replacement bridge alternative. If S/NR-eligible historic-period submerged resources such as shipwrecks are identified on the river bottom, an appropriate data recovery plan will be implemented in coordination with SHPO and consulting parties to mitigate unavoidable adverse effects of implementation of the project. Ongoing archaeological investigations and analysis to assess the sensitivity of the Hudson River portion of the APE have identified an area of potential sensitivity associated with a submerged and deeply buried Paleo landform, and possible historic resources lying on the river bottom, including shipwrecks and historic piers. If, as a result of further investigations and consultation, National Register archaeological properties are identified, FHWA in

coordination with NYSTA and NYSDOT, and in consultation with the SHPO and other consulting parties as appropriate, will consider measures to avoid, minimize or mitigate adverse effects on those resources. These measures are set forth in the project Section 106 Draft MOA (see **Appendix C**).

18-4 SOCIAL, ECONOMIC, AND ENVIRONMENTAL IMPACTS

This section addresses the potential adverse social, environmental and economic impacts due to construction of the Replacement Bridge Alternative. As discussed in Chapter 2, "Project Alternatives," two feasible build options (Short Span and Long Span) have been identified. Generally, the short-term construction impacts of each build alternative are similar since the methods used to construct the river crossing would be the similar for both Short Span and Long Span Options. The difference in the bridge span options would not substantially alter any of the short-term effects. Much of the following discussion of potential construction impacts would apply to both the Short Span and Long Span Options being considered for the Replacement Bridge Alternative. The analysis below identifies impacts that would occur under both the Short Span and Long Span Options.

Since the No Build Alternative would involve the continued operation of the existing seven-lane bridge with ongoing maintenance to keep the bridge in a state of good repair, it is not analyzed further for construction-related impacts. The New York State Thruway Authority (NYSTA) would continue maintenance of the bridge and would invest capital funds to keep it in a state of good repair. NYSTA estimates that it would spend $1.3 billion to maintain and repair over the next decade. Major work activities would include seismic upgrades to portions of the bridge, navigational safety improvements, steel and concrete repairs, and other miscellaneous work to continue to keep the bridge safe for the traveling public. At times, these activities would be disruptive of traffic movement on the bridge.

Extraordinary maintenance efforts and capital projects would ensure that the bridge continues to be safe to the traveling public, but these projects would not correct all of the structural, operational, safety, security, or mobility needs of the bridge as described in Chapter 1, "Purpose and Need." Therefore, given the age of the bridge and its vulnerabilities in extreme events, it is possible that under the No Build Alternative, the crossing could be closed altogether at some point in the future, resulting in the loss of a critical infrastructure element to an important transportation corridor.

18-4-1 TRANSPORTATION

The potential transportation impacts due to the construction of the project may be summarized in three areas; (1) the potential impact on traffic operations due to construction activities on the bridge and along the highway approaches; (2) the potential impact due to the increase in traffic generated by construction worker trips and truck trips from the proposed staging areas; and, (3) the impact of bridge construction on marine traffic. These potential impact areas were studied and the findings of which determined the Replacement Bridge Alternative would not constitute an adverse impact provided the environmental performance commitments are implemented. These commitments include the preparation of a comprehensive and detailed Work Zone Traffic Control Plan.

18-4-1-1 CONSTRUCTION ACTIVITY ALONG THE HIGHWAY AND BRIDGE APPROACHES

Although the construction site and staging areas would benefit from direct access to the New York State Thruway and New York State highways, temporary closures are anticipated that would inconvenience local residents and create delays for users of the Tappan Zee Bridge.

For the Tappan Zee Bridge users, these delays would be comparable to conditions currently experienced on the existing Tappan Zee Bridge due to recurring maintenance projects. Construction activities along the bridge and highway approaches would involve traditional construction lane closures, lane narrowing and shifting of lanes requiring traffic to slow down at the construction areas. Four lanes of traffic would be maintained on the Tappan Zee Bridge in the peak direction during all peak hours during construction.

Construction-related vehicles would also create temporary traffic impacts at the approaches to the Tappan Zee Bridge and at construction staging areas. Slow-moving construction vehicles on the roadway near the construction exits or staging area would create delays. A qualitative review indicates that the magnitude of these impacts would vary depending on the final location of the construction staging areas relative to the construction sites, the concrete batch plant, laydown/storage areas, and administrative facilities. Other factors to be determined include the sources of fill material, disposal sites for surplus material, land uses along the haul roads, amount and duration of hauling operations, and construction phasing strategies.

In Rockland County, temporary closures are anticipated on River Road and South Broadway (Route 9W). Since River Road provides direct access to the waterfront staging area, temporary closures would occur on River Road throughout the construction period to support roadway improvements, movement of heavy machinery and delivery of construction materials. River Road is likely to be signalized to allow for improved construction access.

The construction effort would also require improvements to the existing service roads (on ramp and off ramp) providing access to and from River Road in South Nyack. These ramps would provide access for construction vehicles to the waterfront construction staging area. These highway elements would create merge, diverge and weave conditions in both directions on I-287/I-87. To address the potential impact that the additional construction-related traffic would have on highway users, a weaving analysis was conducted utilizing Highway Capacity Manual methodologies. The weaving analysis focused on Level of Service (LOS) conditions in both directions on the highway between Interchange 10 and the construction access ramps, a length of approximately 1,500 feet. In the eastbound direction, the results of the analysis indicated an acceptable LOS D during the weekday AM peak hour and LOS B during the PM peak hour. In the westbound direction, the weaving analysis indicated a LOS B during the weekday AM peak hour and LOS D during the PM peak hour. The details supporting the technical analysis are presented in a technical memorandum provided in **Appendix B**.

Interchange 10 (Route 9W) would not be closed for any extended duration; however, the construction sequence may require closure for short durations to allow for the

movement of heavy machinery. The closures would be limited to less than six hours and confined to off-peak commuter periods.

In Westchester County, the on-ramp from South Broadway (Route 9) to the Tappan Zee Bridge would be closed for approximately 24 months. The closure is anticipated to take effect approximately 12 months into the construction effort. Vehicles currently utilizing the on-ramp would be rerouted to the primary access ramp (Interchange 9) at White Plains Road (NY119) via the jug handle at the intersection of South Broadway (US 9) and White Plains Road (NY119). An LOS capacity analysis was conducted to analyze the impacts of this detour. The analysis focused on operations at the intersection of South Broadway (Route 9) at White Plains Road (NY119) and the intersection of White Plains Road (NY 119) at the westbound I-287/I-87 ramp (Interchange 9). The findings indicated that the existing LOS would be maintained under the future detour condition with minor adjustments (a five second green time allocation) to the traffic signal at South Broadway (Route 9) and White Plains Road (NY119). Currently, both intersections operate at LOS A during the weekday AM peak hour and LOS E during the weekday PM peak hour. The details supporting the technical analysis are presented in a technical memorandum provided in **Appendix B**.

As previously stated, the actual construction means and methods would be determined by the contractor; the final details of the traffic management plan would be included in a Work Zone Traffic Control (WZTC) management plan to be prepared by the contractor in advance of any construction activity.

18-4-1-2 CONSTRUCTION TRAFFIC GENERATED FROM THE PROPOSED ROCKLAND INLAND STAGING AREA

As previously discussed, two sites near Interchange 12 in Rockland County could serve as potential inland staging areas for construction activities that would generate construction worker trips and truck trips. For purposes of evaluating potential impacts associated with construction activities and the delivery of material, the primary staging area was assumed to be located west of the Tappan Zee Bridge in the vicinity of Interchange 12 either at the West Nyack Staging Area (WNSA) or the Tilcon Quarry Staging Area (TQSA).

Current projections of construction activities between the in-land and waterfront staging areas include the movement of concrete trucks, heavy equipment, and construction workers and staff using shuttle buses. **Table 18-7** provides a summary of the daily construction trips projected for the busiest construction period. The projections correspond to the 8-month period starting approximately 10 months into the construction effort.

As shown in **Table 18-7**, concrete trucks would make approximately 47 daily trips between the Interchange 12 (TQSA or WNSA) and the Rockland Bridge Staging Area (RBSA), and ten daily trips between Interchange 12 and the Westchester Bridge Staging Area (WBSA).

Heavy equipment activities would generate daily trips of 74 between Interchanges 12 and RBSA, and 36 between Interchange 12 and the WBSA.

Table 18-7
One-Way Peak Daily Construction Trips
In-land to Waterfront Staging Area (near Interchange #12)

Item	Int. #12 to RBSA	Int. #12 to WBSA	Total
Concrete Trucks	47	10	57
Heavy Equipment/Haul Away/Deliveries	74	36	110
Shuttle Buses/Construction Workers*	19	12	31
Total	140	58	198

Note:
* Assumes a peak condition of approximately 930 construction workers; 570 accessing the job site from Rockland County and 360 from Westchester County. Assumes 30 workers per shuttle bus.

Shuttle buses for construction workers would have a capacity of 30 passengers and would create 19 and 12 daily trips between the two bridge staging areas, respectively. This represents approximately 570 construction workers shuttled between Interchange 12 and the RBSA, and 360 workers shuttled between Interchange 12 and the WBSA.

Construction workers would arrive at the designated staging area by 6:30 AM. The origins of the construction worker trips is difficult to identify but assuming the project would utilize the local construction worker population, a majority of the trips would come from Rockland, Orange, Westchester, and Putnam counties. The weekday AM peak hour on the Tappan Zee Bridge typically occurs between 7:00 AM and 9:00 AM. During the 6:00 AM hour, typical volumes on the Tappan Zee Bridge are approximately 1,800 vehicles in the westbound direction and 4,800 vehicles in the eastbound direction. The two-way volume of 6,600 vehicles is approximately 83 percent of the traffic volumes experienced during the peak hour.

At the end of a typical day, construction workers would board shuttle buses at approximately 3:00 PM to take them from the job site to the staging area where their vehicles are parked. At approximately 3:30 PM construction workers would depart the staging area. Those with destinations in Westchester and Putnam counties would travel east crossing the Tappan Zee Bridge while a majority of the remainder, with destinations in Rockland and Orange counties, will likely travel westbound on I-287/I-87. While construction worker trips are expected to overlap with the start of the weekday PM peak period (3:00PM to 6:00PM); those workers with destinations in Westchester and Putnam counties will be traveling in the off-peak direction (eastbound).

No adverse effect on traffic flow is anticipated due to the increase in construction worker trips for either the AM or PM peak conditions.

The construction schedule identifies single eight hour shifts for work crews without weekend work; however, on occasion, shifts may extend past eight hours and up to 12 hours, depending on the crew type and detail of the work to be completed. It should be anticipated, that some activities may required the contractor to work late shifts or possibly weekends on critical activities. Some of these activities would include cable erection of the main spans, heavy lifts or, potentially, the delivery of material by barge.

With new ramps to/from River Road proposed in the eastbound and westbound directions on I-287/I-87, weaving maneuvers involving heavy vehicles to/from Interchange 12 would occur, but operations would remain acceptable, as previously discussed.

18-4-1-3 MARINE TRAFFIC

In addition to roadway traffic, construction of the new bridge and demolition of the existing bridge could affect marine traffic in the Hudson River. Impacts to navigation could occur during construction of the project from the following activities:

- Delivery of material by vessel would increase usage of the navigation channel;
- Scow movements related to dredging would increase usage of the navigational channel;
- Construction of the main spans' substructure and superstructure would result in some restrictions to navigation; and
- Demolition of the existing bridge's main span substructure and superstructure would result in some restrictions to navigation.

The dredging required as part of the replacement bridge's construction would occur outside of the navigational shipping channel, with no projected impacts on navigation.

Disruption to river shipping during overall construction would be minimized, but cannot be eliminated, as some of the main span construction activities would restrict the channel for a short period. For the Cable-stayed Option, it is anticipated that deck segments may be delivered via barge and hoisted up to the deck. Up to 40 segments may be delivered in the main channel with an additional 20 segments in each of the adjacent spans. Delivery and installation of the segments would be coordinated with the U.S. Coast Guard to minimize the effect on shipping. It is anticipated that two hours would be required for the delivery of each section, with time included for the segment to reach the required clearance and be stabilized. For the Arch Option, bridge segments may also be delivered by barge, with a similar number of segments required. However, instead of construction in segments, there is the potential that the contractor may construct the Arch in one large full span lift—a method that would require closing of the main shipping channel for a weekend or possibly several days.

To minimize any adverse effects on marine navigation, the NYSDOT and NYSTA would coordinate with the U.S. Coast Guard in conjunction with the Bridge Permit process to develop acceptable navigation windows, notice protocols and limit any channel closures to the minimum time necessary to provide a safe construction process.

18-4-2 COMMUNITY CHARACTER

Major construction projects have the potential to inconvenience or disturb persons who reside in or use the areas adjacent to construction and staging areas. Temporary effects to adjacent neighborhoods could include:

- Traffic congestion and detours;
- Disrupted access to residences and businesses;
- Loss of roadside parking;

- Disruption of utility services;
- Presence of construction workers, equipment, materials and staging areas including potential concrete batch;
- Noise and vibrations from construction equipment and vehicles;
- Airborne dust and possible mud on roadway surfaces; and
- Removal of or damage to vegetation (e.g., trees, shrubs, grass, etc.).

Without proper planning and implementation of controls, these construction-related impacts could adversely affect the comfort and daily life of residents and inconvenience or disrupt the flow of customers, employees, and materials/supplies to and from businesses. For residents living along the roadway alignment, some materials stored for the project may be visually displeasing. This is a temporary condition and should pose no substantial problem in the long term. Nevertheless, the construction contract documents would stipulate that the contractor must maintain a clean and orderly worksite and would include metrics for determining compliance, provisions for enforcement, and penalties for non-compliance.

Provisions for construction phasing and traffic control plans, as mentioned under transportation would be used to avoid the potential for adverse effects of traffic on community character. In addition, an emergency access plan for the construction phase of the project will be developed as part of the project's safety program. As described above under air quality and noise EPCs, other measures that would be incorporated into the contract documents which would avoid or minimize, in the case of noise, the adverse effects of construction on community character.

18-4-2-1 ROCKLAND BRIDGE STAGING AREA

The land use context near the proposed temporary platform on the Rockland County side is exclusively residential, with the seven-story Salisbury Point apartments and three-story Bradford Mews apartments immediately north of the bridge landing. Other areas to the north and south of the bridge landing are medium density single-family residences. The existing bridge would screen most of the temporary platform and its activity from residences to the south. However, the residents near the river to the north would have direct views of the platform. Visibility of the temporary construction platform would not constitute an adverse impact, and would not alter the existing community character.

18-4-2-2 WEST NYACK STAGING AREA (WNSA)

As discussed above, the WNSA site occupies approximately 33 acres of land near Interchange 12 south of the Palisades Mall at the intersection of Routes 59 and 303. With respect to land use compatibility, this potential staging area is currently an industrial site with an existing concrete batch plant. The potential staging area is zoned Manufacturing (M) and Regional Shopping (RS) by the Town of Clarkstown. Land uses surrounding the site include industrial, transportation and utilities, commercial, a closed sanitary landfill that is currently used as a waste transfer station, and vacant land. There are no residential uses adjacent to the site.

The proposed construction facilities would not be out of character with existing uses at and around the site. Operations at the site during the construction phase may be more intensive than those operating presently, but all truck traffic would be using the major arterials of Route 59 and Route 303 and would have immediate access to the Thruway at Interchange 12 on NYS Route 303. Consequently, there would be little spillover of operational effects to nearby residential neighborhoods on Greenbush Road, and none to the West Nyack neighborhood. Consequently, no adverse impacts to community character are anticipated.

18-4-2-3 TILCON QUARRY STAGING AREA (TQSA)

As discussed above, the TQSA is an approximately 120-acre site located directly north of the Thruway and opposite the Palisades Mall. This potential staging is currently an active industrial site. The potential staging area is zoned Manufacturing (M) by the Town of Clarkstown. Land uses surrounding the site include industrial, transportation and utilities, commercial, and vacant land. There are residential uses located to the northeast of the potential staging area, which are in the southern portion of the Valley Cottage neighborhood.

The proposed construction facilities would not be out of character with existing industrial uses and character at and around the site. Consequently, no adverse impacts to community character are anticipated.

18-4-2-4 WESTCHESTER BRIDGE STAGING AREA (WBSA)

On the Tarrytown waterfront, the temporary platform would be approximately 600 feet from the shore, opposite the Tarry Landing neighborhood and approximately 400 feet south of the entrance to the Tarrytown Boat Club Marina. While the existing bridge would screen most of the platform and its activity from residences to the south, the residents near the river to the north would have direct views of the platform. Visibility of the temporary platform would not alter the existing community character.

18-4-2-5 WESTCHESTER INLAND STAGING AREA (WISA)

Another staging area is the triangle of land located north of Interstate 87/287 and opposite the toll plaza. As discussed above, this staging area currently comprises NYSTA's Tappan Zee Bridge Maintenance Facility, Bridge Patrol, Equipment Maintenance, and the local station of NYSP Troop T.

Although this area is completely within the existing Interstate 87/287 right-of-way, it is currently zoned R-7.5 (One-Family Residence on 7,500 square foot lots) by the Village of Tarrytown. Existing land uses in close proximity to the potential staging area site include commercial and multi-family residential.

The proposed truck route from the WISA and the Westchester Bridge Staging Area would traverse in close proximity to the Van Wart and Paulding Avenue neighborhoods south of Interstate 87/287. Although there is an existing noise barrier screening much of the Van Wart and Paulding Avenues neighborhood from Interstate 87/287 and the toll plaza, the temporary access road would pass adjacent to the homes on Hudson Place (north of Van Wart Avenue) before crossing over the MNR tracks to the temporary river platform. The temporary access road would also connect with Green Street and the Tarrytown street network in the north, and would be within the viewshed of the Quays

and Tarry Landing residential neighborhoods. The WISA or temporary access road would not change community character of the adjacent residential neighborhoods and business districts in the Village of Tarrytown.

18-4-3 LAND ACQUISITION, DISPLACEMENT, AND RELOCATION

The Replacement Bridge Alternative would result in several temporary easements on parcels in Rockland County during construction (permanent land acquisitions are discussed fully in Chapter 6, "Land Acquisition, Displacement, and Relocation"). In the Village of South Nyack, a 0.03-acre temporary easement on a portion of Elizabeth Place Park and a 0.04-acre temporary easement on a nearby green space area would be required for the purposes of reconstructing and realigning the South Broadway bridge over Interstate 87/287. These temporary easements would be returned to the Village of South Nyack after construction for continued use. Access to and use of Elizabeth Place Park would remain unaffected during construction. The small green space area would be inaccessible during construction.

North of the existing highway, a temporary easement on a portion of a multi-family residential parcel in Rockland County would be required for purposes of realigning Interstate 87/287 with the replacement bridge. The temporary easement on this parcel would be substantially similar under both the Short and Long Span Options (slightly less than 0.05 acres for the Short Span Option and slightly greater than 0.05 acres for the Long Span Option). This temporary easement would displace existing parking spaces. In addition, a 0.01-acre temporary easement of an adjacent single-family residential property would be required during construction. This temporary easement would not be expected to affect the use of the parcel.

18-4-4 PARKLANDS AND RECREATIONAL RESOURCES

The construction of the Replacement Bridge Alternative would temporarily impact two open spaces in Rockland County: Elizabeth Place Park and an adjacent green space area. Both are located in the Village of South Nyack near the proposed bridge landing. In addition, potential impacts to Hudson River recreational uses are also discussed below.

18-4-4-1 ELIZABETH PLACE PARK AND ADJACENT GREEN SPACE AREA

As discussed in Chapter 7, "Parklands and Recreational Resources," Elizabeth Place Park is a public park in the Village of South Nyack that is situated on an approximately 0.81-acre triangular parcel on the southwest side of Interstate 87/287. Southeast of Elizabeth Place Park is a 0.05 acre triangular green space area located on the opposite side of South Broadway.

Implementation of the Replacement Bridge Alternative would require a 0.03-acre temporary easement from Elizabeth Place Park, which represents 3.7 percent of the total park area. The temporary easement would occur only during the construction period of the project. This easement would not affect access to Elizabeth Place Park and all active features of the park would continue to be accessible during the construction period.

The construction of the Replacement Bridge Alternative would also require a temporary easement of 0.04 acres and acquisition of 0.01 acres of the 0.05 acre green space area

located southeast of Elizabeth Place Park. This green space area would be inaccessible during construction, but the 0.04-acre temporary easement would be returned to the Village of South Nyack after construction for continued open space use. This temporary easement and partial acquisition would be required for purposes of reconstructing and realigning the South Broadway bridge over Interstate 87/287 and to avoid the closure of South Broadway during construction which would otherwise have potential adverse traffic and economic impacts in the area.

18-4-4-2 HUDSON RIVER GREENWAY WATER TRAIL

As further discussed in Chapter 7, “Parklands and Recreational Resources,” the Hudson River Greenway Water Trail, which accommodates canoeists and kayakers, traverses through the study area and beneath the existing Tappan Zee Bridge. Although the Replacement Bridge Alternative would not directly affect the existing Hudson River Greenway Water Trail landing sites, temporary disruptions to small water craft navigation beneath the bridge during the construction period can be expected. No long-term impacts to the Hudson River Greenway Water Trail are anticipated once the Replacement Bridge Alternative is operational.

18-4-4-3 HUDSON RIVER RECREATIONAL BOATING

The Hudson River is also used by sail boaters, power boaters, and other personal water craft users for recreational purposes. Temporary disruptions to recreational boating through the study area can be expected during the construction period for the Replacement Bridge Alternative, and sail boaters may be precluded from using sails while traversing through the construction zone. However, no long-term impacts to recreational boating on the Hudson River are anticipated once the Replacement Bridge Alternative is operational.

18-4-5 SOCIOECONOMIC CONDITIONS

The economic benefits associated with construction activities are directly related to the cost of constructing the Tappan Zee Hudson River Crossing. Those benefits were estimated using the IMPLAN (IMpact analysis for PLANning) input-output modeling system. IMPLAN was originally developed by the U.S. Department of Agriculture Forest Service in 1979 and was subsequently privatized by the Minnesota IMPLAN Group (MIG). This analysis is based on the 2009 models for Rockland and Westchester Counties, and uses economic data from sources such as the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor Statistics, and the U.S. Census Bureau to predict effects on the local economy from direct changes in spending. The model contains data for Rockland and Westchester Counties on 440 economic sectors, showing how each sector affects every other sector as a result of a change in the quantity of a product or service. A similar IMPLAN model for New York State was used to trace the effects on the state economy. Using these models and the specific characteristics of the projected development, the total effect has been projected for Rockland and Westchester Counties and New York State.

18-4-5-1 IMPLAN OVERVIEW

Using IMPLAN terminology, economic impacts are broken into three components: direct, indirect, and induced effects:

- Direct effects represent the initial benefits to the economy of new investment (e.g., a construction project, changes in employment, or changes in employee compensation).
- Indirect effects represent the benefits generated by industries purchasing from other industries as a result of the direct investment (e.g., indirect employment resulting from construction expenditures would include jobs in industries that provide goods and services to the contractors). A direct investment triggers changes in other industries as businesses alter their production to meet the needs of the industry in which the direct impact has occurred. These businesses in turn purchase goods and services from other businesses, causing a ripple effect through the economy. The ripple effect continues until leakages from the region (caused, for example, by imported goods) stop the cycle. The sum of these iterative inter-industry purchases is called the indirect effect.
- Induced effects represent the impacts caused by increased income in a region. Direct and indirect effects generate more worker income by increasing employment and/or salaries in certain industries. Households spend some of this additional income on local goods and services, such as food and drink, recreation, and medical services. Benefits generated by these household expenditures are quantified as induced effects.

18-4-5-2 CONSTRUCTION PERIOD EFFECTS

Value of Construction

Based on preliminary estimates, the cost of constructing the Tappan Zee Hudson River Crossing (at the 90 percent confidence level) is estimated at $4.64 billion dollars in 2012 dollars. The construction cost includes sitework, hard costs (actual construction), and soft costs (such as engineering and permitting).

For purposes of the economic and fiscal benefits analysis, the $4.64 billion construction cost estimate was reduced by $1.285 billion (or 27.7 percent) to deduct escalation costs and equipment and steel that would be manufactured outside of New York State. These costs were deducted since the purchase of out-of-state equipment and material would not have a direct effect on the regional or statewide economy. Therefore, the construction cost assumed for this economic benefits analysis is $3.36 billion. The following analysis presents the economic and fiscal benefits that would result during the construction period.

Employment and Economic Effects

Employment

The $3.36 billion represents the direct expenditures during the construction period. As a result of the direct expenditures, the direct employment demand from construction is estimated at 14,094 person-years of employment (see **Table 18-8**). A person-year is the equivalent of one person working full-time for a year. Over the estimated five-year construction build-out, the project would directly generate an average of 2,819 full-time equivalent jobs.

Table 18-8
Economic Benefits from Construction

	Rockland and Westchester Counties	New York State
Employment (Person-Years)		
Direct (jobs in construction)	14,094	14,094
Indirect (jobs in support industries)	3,394	4,185
Induced (jobs from household spending)	4,611	6,589
Total	22,099	24,868
Employee Compensation (Millions of 2011 dollars)		
Direct (earnings in construction)	$1,141.74	$1,141.74
Indirect (earnings in support industries)	$314.66	$377.13
Induced (earnings from household spending)	$323.70	$464.53
Total	$1,780.10	$1,983.40
Total Economic Output (Millions of 2011 dollars)[1]		
Direct (output from construction)	$3,355.00	$3,355.00
Indirect (output from support industries)	$997.63	$1,225.26
Induced (output from household spending)	$1,097.10	$1,550.96
Total	$5,449.73	$6,131.22

Note:
[1] Economic output is defined as the total cost of production, including intermediate goods and services (raw materials, transportation, utilities, contracted services) and value added (employee compensation, proprietary income, and indirect business taxes).
Source: The characteristics and construction cost of the proposed development; the IMPLAN economic modeling system.

As discussed above, when new direct jobs are introduced to an area, those jobs lead to the creation of additional indirect and induced jobs. Indirect employment resulting from construction expenditures would include jobs in industries that provide goods and services to the contractors, and induced employment would include jobs generated by new economic demand from households spending salaries earned through the direct and indirect jobs. Based on the IMPLAN model's economic multipliers for Rockland and Westchester Counties, the project would generate an additional 3,394 person-years of indirect employment and 4,611 person-years of induced employment within Rockland and Westchester Counties, bringing the total number of jobs from construction to 22,099 person-years of employment (see Table 18-8). In the larger New York State economy, the model estimates that the Tappan Zee Hudson River Crossing Project would generate 10,774 person-years of indirect and induced employment, bringing the total direct and generated jobs from construction of the project to 24,868 person-years of employment over the estimated five-year construction period.

Employee Compensation

The direct employee compensation during the construction period is estimated at $1.14 billion (see Table 18-8). Total direct, indirect, and induced employee compensation resulting in Rockland and Westchester Counties from construction of the Tappan Zee Hudson River Crossing Project is estimated at $1.78 billion. In the broader state

economy, total direct, indirect, and induced employee compensation from construction of the project is estimated at $1.98 billion.

Total Effect on the Local Community

As indicated above, the total construction cost for the project (excluding escalation costs and materials/specialized equipment from outside of New York State) is expected to be $3.36 billion. Based on the IMPLAN models for Rockland and Westchester Counties and New York State, the total economic activity that would result from construction of the project is estimated at $6.13 billion in New York State, of which $5.45 billion would occur in Rockland and Westchester Counties (see Table 18-8).

Taxes

Even though the project would be exempt from sales tax on construction materials, the construction activity would have associated with it tax revenues for New York State, the Metropolitan Transportation Authority (MTA), Rockland and Westchester Counties, and other local jurisdictions. Of these tax revenues, the largest portion would come from personal income tax, sales tax from workers' expenditures, corporate and business taxes, and numerous other taxes on direct and secondary economic activity. These public sector revenues are estimated to have an order-of-magnitude value of approximately $166.95 million.

18-4-6 VISUAL AND AESTHETIC RESOURCES

During construction, there would be an increase in the level of activity within the study area, especially in the location of the Hudson River crossing for the bridge replacement. As the project proceeds, cranes, vessels, and other large pieces of equipment, as shown in Table 18-5, would be utilized and visible to a variety of viewer groups. As described previously in Chapter 9, "Visual and Aesthetic Resources," Interstate 87/287 is screened from view from the majority of the surrounding neighborhoods in the study area by dense vegetation and sound walls along the rights-of-way on both sides of the river. However, in some locations, the vegetative screenings and sound walls would need to be removed for creation of the shared-use path and other project construction activities. In addition, those who have views of the Hudson River crossing would have views altered during construction. The Hudson River crossing would become a large construction site that would be visible to sensitive viewers such as residents, park users, and rail travelers along the river. Commercial and/or recreational boaters would also be sensitive to the possible effects upon the quality of the view within the study area during construction. Other groups, including local motorists and employees and visitors of commercial activity have been estimated to have lower sensitivity to the visual alterations arising during the construction phase. Because the largest group of viewers in the study area is motorists passing through the region on Interstate 87/287 at generally greater speeds than 55 mph, viewer sensitivity during construction would be considered low for these viewers.

The character and quality of views of the Hudson River during construction of the project would be impaired for sensitive viewers who have views of this visual resource. Therefore, the construction of Replacement Bridge Alternative would result in temporary unavoidable adverse impacts to visual and aesthetic resources during construction.

18-4-7 HISTORIC AND CULTURAL RESOURCES

18-4-7-1 ARCHAEOLOGICAL RESOURCES

A Phase I Archaeological survey of the terrestrial portions of the Area of Potential Effect (APE) for potential direct effects concluded that no archaeological resources are present in that area. However, two classes of potential archaeological resources have been identified within the river portion of the APE that could potentially be affected by the proposed project: a submerged landform that may have been occupied during the Archaic Period or the Paleo-Indian Period; and possible submerged historic resources including potential shipwrecks lying on the river bottom. Further analysis will be undertaken to determine whether submerged S/NR eligible resources are present in the river portion of the APE for direct effects. If submerged resources are identified and determined to be S/NR eligible, the project may adversely affect those resources as a result of dredging and construction of the replacement bridge. The FEIS will provide the results of this further analysis. Consultation with SHPO and any appropriate tribal nations and consulting parties would be undertaken to identify measures to avoid, minimize or mitigate any potential S/NR-eligible resources that may be adversely affected by the proposed project.

18-4-7-2 ARCHITECTURAL RESOURCES

Direct impacts upon a property could include demolition, alteration, or damage from construction. Indirect effects could include the isolation of a property from its surrounding environment, or the introduction of visual, audible, or atmospheric (e.g., pollutants) elements that are out of character with a property or that alter its historic setting and context (e.g., contextual effects).

As described in “Chapter 10, “Historic and Cultural Resources,” two resources that have been determined eligible for the State/National Register of Historic Places (S/NR) are located within the APE for potential direct effects. The Tappan Zee Bridge would be removed under the bridge replacement alternative. The South Nyack Historic District is also partially located within the APE for potential direct effects. Two properties that contribute to the Historic District, 21 Cornelison Avenue and 78 Smith Avenue, would be removed in order to construct the bridge replacement alternative. Therefore, the Tappan Zee Bridge and the South Nyack Historic District would be adversely affected by the construction for this project.

In order to mitigate the adverse effect on the Tappan Zee Bridge that would result under the bridge replacement alternatives, mitigation measures have been proposed in a Draft Memorandum of Agreement (MOA), included in **Appendix C**. Potential mitigation measures include Historic American Engineering Record (HAER) documentation of the existing Tappan Zee Bridge and the production of an educational brochure for use by local libraries, historical societies, and educational institutions development of educational and interpretive materials for use by the local community.

Preliminary findings indicate that the project may have an adverse effect on the S/NR-eligible South Nyack Historic District in Rockland County. This effect would result from the removal of two contributing resources within that district, 21 Cornelison Avenue and 78 Smith Avenue. Proposed measures to mitigate this direct adverse effect on the South Nyack Historic appear to have been identified in the Draft MOA included in

Appendix C, and include planting vegetation along sound walls along the western edge of the district and preparing Historic American Building Survey (HABS) recordation to document the two contributing resources that would be removed. Furthermore, it is proposed that signage interpreting the history and architecture of the South Nyack Historic District be created for installation within the South Nyack Historic District or along the shared-use path that would be constructed along the western edge of the Historic District as part of the project.

The development of a Construction Protection Plan is proposed to protect historic properties, including the South Nyack Historic District, the River Road Historic District, and 10 Ferris Lane in Rockland County, and properties in the Irving Historic District in Westchester County from inadvertent impacts during construction. The Draft MOA includes a stipulation to develop such a plan as part of the Section 106 consultation process, and in accordance with standard construction management practices.

18-4-8 AIR QUALITY

This section examines the potential air quality impacts from the construction of the project. Emissions from on-site construction equipment and on-road construction-related vehicles, and the effect of construction vehicles on background traffic congestion, have the potential to affect air quality. The analysis of potential impacts of the construction of the project on air quality includes a quantitative analysis of both on-site and on-road sources of air emissions, and the overall combined impact of both sources, where applicable. The analysis addresses both local (microscale) concentrations and regional (mesoscale) emissions.

In general, most construction engines are diesel-powered, and produce relatively high levels of nitrogen oxides (NO_x) and particulate matter (PM). Some construction activities also emit fugitive dust. Although diesel engines emit much lower levels of carbon monoxide (CO) than gasoline engines, the stationary nature of construction emissions and the large quantity of engines could lead to elevated CO concentrations, and impacts on traffic could increase mobile source-related emissions of CO as well. Therefore, the pollutants analyzed for the construction period are nitrogen dioxide (NO_2), particles with an aerodynamic diameter of less than or equal to 10 micrometers (PM_{10}), particles with an aerodynamic diameter of less than or equal to 2.5 micrometers ($PM_{2.5}$), and CO. For each pollutant, concentrations were modeled for each averaging period regulated in the National Ambient Air Quality Standards (NAAQS): short-term analyses address 24-hour averages for PM, and 8-hour and 1-hour concentration averages for CO, and long-term analyses address annual averages for $PM_{2.5}$ and NO_2. For more details on air pollutants and NAAQS see Chapter 11, “Air Quality.”

As defined in 40 Code of Federal Regulations (CFR) Part 80 Subpart I, diesel fuel supplied by large refiners and exporters must limited to a sulfur content of 15 parts per million (ppm) for nonroad engines beginning June 1, 2010, and for marine engines beginning June 1, 2012; purchase by wholesale purchaser consumers in the locomotive and marine sectors by October 1, 2012. Ultra-low-sulfur diesel (ULSD) would be used exclusively for all diesel engines throughout the construction sites, including marine engines; therefore, sulfur oxides emitted from construction activities would be negligible.

Construction activity in general, and large-scale construction in particular, has the potential to adversely affect air quality as a result of diesel emissions. The main component of diesel exhaust that has been identified as having an adverse effect on human health is fine PM. To ensure that the construction of the project results in the lowest practicable diesel particulate matter (DPM) emissions, the construction contracts will require the following EPCs:

- *Clean Fuel.* All diesel fuel used for the project will contain 15 parts per million (ppm) or less sulfur by weight. This includes on-road, non-road, and tug boats operating on-site.
- *Best Available Tailpipe Reduction Technologies.* Nonroad diesel engines with a power rating of 50 horsepower (hp) or greater and controlled truck fleets (i.e., truck fleets under long-term contract) including but not limited to concrete mixing and pumping trucks, would utilize the best available tailpipe (BAT) technology for reducing DPM emissions. Diesel particulate filters (DPFs) have been identified as being the tailpipe technology currently proven to have the highest PM reduction capability. Construction contracts would specify that all diesel nonroad engines rated at 50 hp or greater would utilize DPFs, either installed on the engine by the original equipment manufacturer (OEM) or retrofit with a DPF verified by the United States Environmental Protection Agency (USEPA) or the California Air Resources Board, and may include active DPFs,[1] if necessary; or other technology proven to reduce DPM by at least 90 percent.
- *Utilization of Newer Equipment.* EPA's Tier 1 through 4 standards for nonroad engines regulate the emission of criteria pollutants from new engines, including PM, CO, oxides of nitrogen (NO_x), and hydrocarbons (HC). All nonroad construction equipment in the project would meet at least the Tier 3 emissions standard.
- *Tug Boat Emissions Reduction.* The total combined PM emission rate from all tug boats used for the project will be limited to 3,700 grams per hour at peak power, including auxiliary engine emissions.[2] This limit may be achieved by installing retrofits, using new engines, repowering or engine replacement, or various combinations of these measures, along with limitations on the engine size and number of tug boats on site.[3]
- *Concrete Batch Plant Controls.* The concrete batch plant would vent the cement weigh hopper, gathering hopper, and mixing loading operations to a baghouse or filter sock. Storage silo chutes would be vented to a baghouse. Baghouses should

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[1] There are two types of DPFs currently in use: passive and active. Most DPFs currently in use are the "passive" type, which means that the heat from the exhaust is used to regenerate (burn off) the PM to eliminate the buildup of PM in the filter. Some engines do not maintain temperatures high enough for passive regeneration. In such cases, "active" DPFs can be used (i.e., DPFs that are heated either by an electrical connection from the engine, by plugging in during periods of inactivity, or by removal of the filter for external regeneration).

[2] This level of emissions would occur with available retrofit technology and the number and size of tug boats currently estimated to be necessary to perform the construction work. Subsequently, later in this section, this level of emissions was found to achieve the air quality goals of the project.

[3] For example, the analysis in this section assumed eight 1,500 hp tug boats with EPA Tier 2 rating each with an 80 kw auxiliary engine, with all engines retrofit with a diesel oxidation catalyst.

have a control efficiency of at least 99.9 percent. Roadways and all unloading and loading material handling operations at the concrete batch plant would have a dust control plan providing at least a 50 percent reduction in PM_{10} and $PM_{2.5}$ emissions from fugitive dust through wet suppression.

- *Idling Restrictions.* All efforts will be made to address heavy duty vehicle idling at the project site in order to reduce fuel usage (and associated costs) and emissions. On-road diesel fueled trucks are subject to New York's heavy duty vehicle idling prohibition. These vehicles may not idle for more than five consecutive minutes except under certain specific conditions as described in Subpart 217-3. In addition to enforcing the on-road idling prohibition, all reasonable efforts will be made to reduce non-productive idling of nonroad diesel powered equipment.

18-4-8-1 METHODOLOGY

Chapter 11, "Air Quality," contains a review of the pollutants for analysis; applicable regulations, standards, and benchmarks; and general methodology for mobile source air quality analyses. Additional details relevant only to the construction air quality analysis methodology are presented in the following section.

Local (Microscale) On-Site Construction Activity Assessment

As described in Section B above, there are two construction options: Short Span Option and Long Span Option. The Short Span Option would require approximately twenty-seven more spans than the Long Span Option and would have more construction equipment working simultaneously. In addition, the Short Span Option would take approximately one year longer to construct than the Long Span Option. The Short Span Option was selected for analysis because it would represent the worst-case scenario for air quality.

The construction periods with activities closest to sensitive receptors (i.e., residences, institutional buildings, and open spaces) and with the most intense activities and highest emissions were selected as the worst-case periods for analysis. Construction-related $PM_{2.5}$ emissions were estimated for the different subtasks of construction, including the reconstruction of the approach roadway areas in Rockland and Westchester counties, dredging, trestle construction, abutment construction, cofferdam construction, pile installation, pile cap construction, column construction, deck installation, and demolition of the existing TZB.

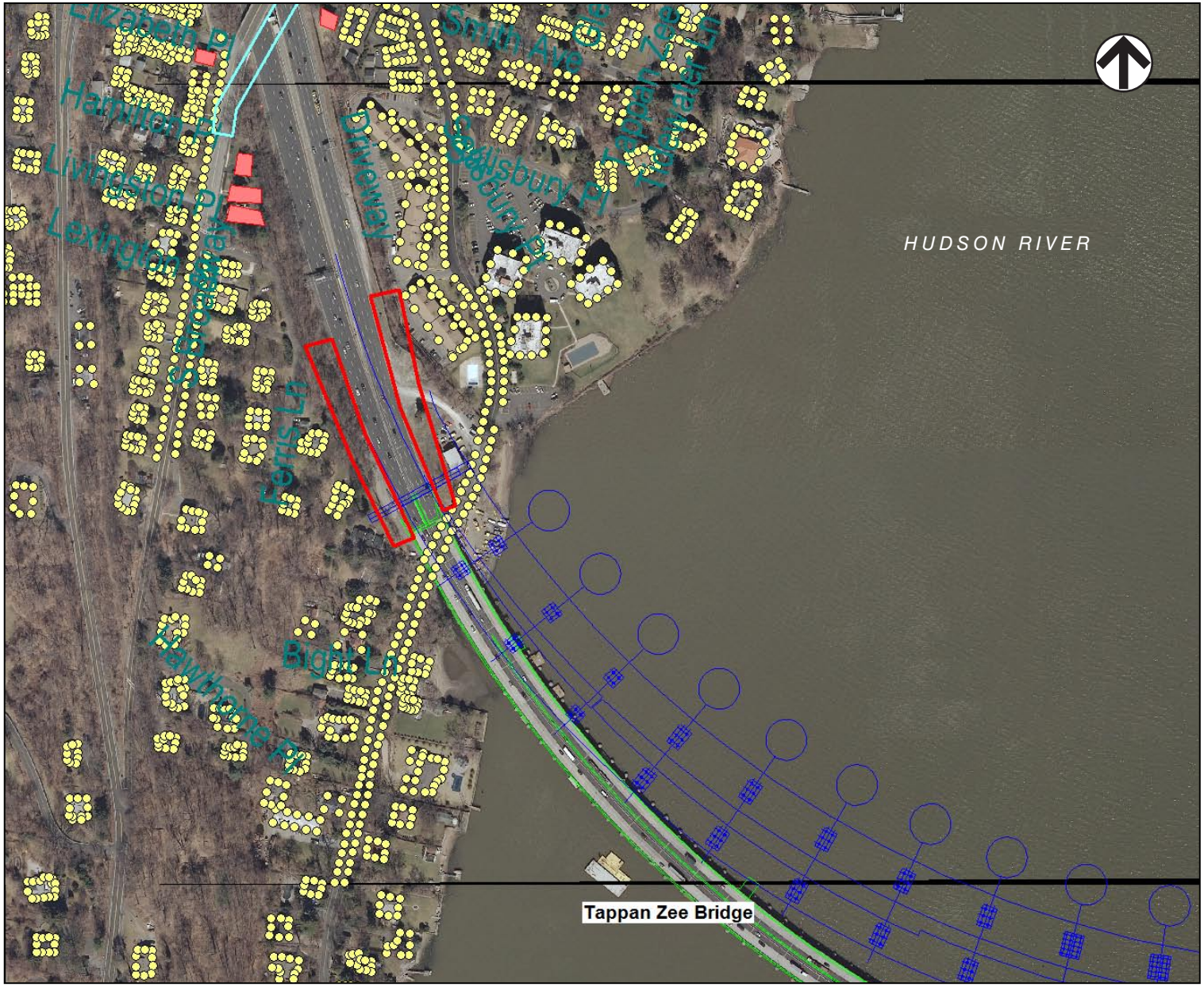
Detailed analyses were performed for the following construction periods, as shown in **Figures 18-8** through **18-11**:

- *Rockland Landing—Reconstruction of the South Broadway Bridge*: The Rockland landing is defined as the portion of the corridor that extends from the abutment of the bridge to just west of the South Broadway Bridge. During this period of construction, the South Broadway Bridge would be replaced and heavy diesel equipment such as cranes, excavators and loaders would be used. The peak construction activities during this period would occur near sensitive residential receptors and would last for several months.
- *Rockland Landing—Approach Roadway Construction*: The side slopes south of existing Interstate 87/287 from South Broadway to the river would be removed, the

Sensitive Receptors Source Locations

Figure 18-8

Rockland Landing - Reconstruction of the South Broadway Bridge

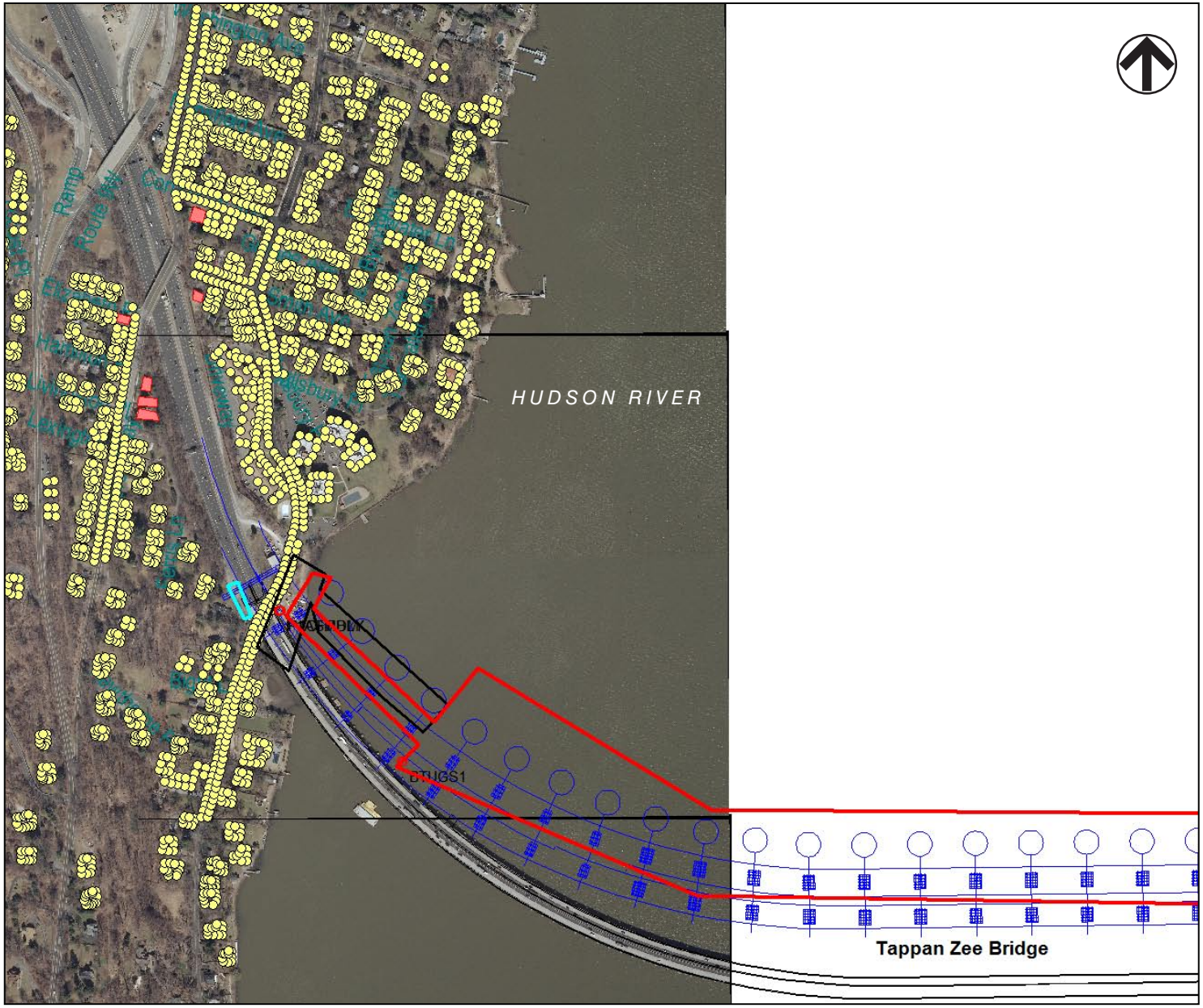


Sensitive Receptors Landing Approach Work

Figure 18-9

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Rockland Landing - Approach Roadway Construction



Sensitive Receptors Bridge Work Shifting/Raising of Roadway

Figure 18-10

Bridge Construction - Rockland Approach and Main Span

Sensitive Receptors Bridge Work

Figure 18-11

Bridge Construction - Westchester Approach and Main Span

retaining walls would be constructed and temporary pavement would be placed. Heavy diesel equipment such as cranes, excavators and loaders would be used. The peak construction activities during this period would occur near sensitive residential receptors and would last for several months.

- *Rockland Inland Staging Area*: A staging area would be required for a concrete batch plant and miscellaneous construction vehicle storage. The precise location of this area is unknown at this time, and therefore this analysis was performed for a generic plant meeting the needs of the project. The concrete batch plant would be a source of particulate matter emissions. Fugitive sources associated with a concrete batch plant include the transfer of sand and aggregate, truck loading, mixer loading, vehicle traffic, and wind erosion from sand and aggregate storage piles. Estimates of air emissions from these activities were derived based on EPA procedures delineated in AP-42 Section 11.12.
- *Bridge Construction—Rockland Approach and Main Span*: There would be 3 principal in-river work areas, including the main span, Rockland approach, and Westchester approach. Tug boats and barges would be used during in-river construction activities. The substructure construction at each area would include dredging, cofferdam construction, assembly work, pile driving, construction of the pile cap, construction of the columns and deck erection. Pile driving was identified as the substructure construction activity with the highest air quality emissions due to the high amount of heavy equipment employed during this task, including pile drivers and large generators. The period when pile driving would occur at spans that are closest to the Rockland shoreline and therefore closest to sensitive receptors was selected for analysis. Pile driving at spans near the shoreline would last for approximately two months for the north structures and another two months for the south structures at a later period. Similar pile driving work would occur at spans further away from the shoreline at an earlier time. Construction activities at the Main Span that would overlap with the Rockland Approach during this peak period were also included in the analysis, as well as roadway and earthworks at the Rockland Landing.
- *Westchester Landing*: This period of construction would include the relocation of the NYSTA Tappan Zee Bridge Maintenance Facility and New York State Police (NYSP) facilities directly north of the Interstate 87/287 near the Toll Plaza. In addition, a temporary bridge would be constructed to connect the temporary access road west of the railroad tracks and the existing bridge area east of the railroad tracks. Heavy diesel equipment such as cranes, excavators and loaders would be used. The peak construction activities during this period would occur near sensitive residential receptors and would last for several months.
- *Bridge Construction—Westchester Approach and Main Span*: Tug boats and barges would be used during in-river construction activities for the Westchester Approach. Pile driving was identified as the substructure construction activity with the highest air quality emissions due to the high amount of heavy equipment employed during this task, including pile drivers and large generators. The period when pile driving would occur at spans that are closest to the Westchester shoreline and therefore closest to sensitive receptors was selected for analysis. Pile driving at spans near the shoreline would last for approximately two months for the north structures and

another two months for the south structures at a later period. Similar pile driving work would occur at spans further away from the shoreline at an earlier time. Construction activities at the main span that would overlap with the Westchester approach during this peak period were also included in the analysis, as well as roadway and earthworks at the Westchester landing.

Engine Exhaust Emissions

The projected usage factors, sizes, types, and number of construction equipment were estimated based on the construction activity schedule. Emission factors for NO_x, CO, PM_{10}, and $PM_{2.5}$ from on-site construction engines were developed using the EPA's NONROAD2008 Emission Model (NONROAD). Since emission factors for truck-mounted concrete pumps are not available from either the EPA MOBILE6.2 emission model (MOBILE6) or NONROAD, emission factors specifically developed for this type of application were used.[1] With respect to trucks, emission rates for $NO_{X,}$ CO, PM_{10}, and $PM_{2.5}$ for truck engines were developed using MOBILE6. A maximum of 5-minute idle time was employed for the heavy trucks. For analysis purposes, it was assumed that each concrete truck would operate on-site for 45 minutes per delivery. Tugboat emissions were estimated according to the latest emission factors and methodologies delineated by US. Environmental Protection Agency (EPA)[2].

Fugitive Emission Sources

Particulate matter emissions would be generated by material handling activities (i.e., loading/drop operations for fill materials and excavate), truck transports, and concrete batching at the Inland Staging Area. Estimates of air emissions from these activities were developed based on EPA procedures delineated in AP-42 Table 13.2.3-1.

Dispersion Modeling

Projected NO_2, CO, PM_{10} and $PM_{2.5}$ concentration increments resulting from the construction of the project were predicted using the EPA/AMS AERMOD dispersion model.[3] AERMOD is a state-of-the-art dispersion model, applicable to rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources. AERMOD is a steady-state plume model that incorporates current concepts with respect to flow and dispersion in complex terrain.

For the short-term model scenarios, all stationary sources that idle in a single location while unloading, were simulated as point sources. Other engines, which would move around the site on any given day, were simulated as area sources. In the annual

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[1] Concrete pumps are usually truck mounted and use the truck engine to power pumps at high load. This application of truck engines is not addressed by the MOBILE6 model, and since it is not a non-road engine, it is not included in the NONROAD model. Emission factors were obtained from a study which developed factors specifically for this type of activity. *FEIS for the Proposed Manhattanville in West Harlem Rezoning and Academic Mixed-Use Development*, CPC–NYCDCP, November 16, 2007.

[2] EPA, Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, April 2009.

[3] EPA, AERMOD: Description Of Model Formulation, 454/R-03-004, September 2004; and EPA, User's Guide for the AMS/EPA Regulatory Model AERMOD, 454/B-03-001, September 2004 and Addendum December 2006.

analyses, all sources would move around the site throughout the year and were therefore simulated as area sources.

Meteorological Data

The meteorological data set consisted of five consecutive years of meteorological data: surface data collected at LaGuardia Airport (2006–2010) and concurrent upper air data collected at Brookhaven, New York.

Receptor Locations

Thousands of receptors (locations in the model where concentrations are predicted) were placed along the sidewalks closest to the construction sites that would be publicly accessible, at residential and other sensitive uses at both ground-level and elevated locations (e.g., residential windows), and at open spaces. In addition, a ground-level receptor grid of approximately two thousand receptors was also included in the dispersion modeling to assist in the analysis of potential impacts.

Local (Microscale) Mobile Source Assessment

The general methodology for mobile source modeling presented in Chapter 11, “Air Quality” was followed.

Traffic flow on Interstate 87/287 would be maintained throughout the construction period while roadway work is performed. During those times, traffic would be diverted to temporary roadway segments and remain in the temporary location for an extended period before being shifted again. A shift in the roadway would reduce the distance between the heavily traveled Interstate 87/287 and residences located near the temporary segment, potentially increasing pollutant concentrations at those locations. Microscale analyses were performed for both the Rockland and the Westchester sides to assess the effect of these temporary roadway shifts on air quality.

Combined Impact

Since emissions from on-site construction equipment and mobile sources may contribute to concentration increments concurrently, the combined effect was assessed. Total concentrations were estimated by combining the results from the on-site construction analysis with the construction-related mobile source increments at the same location. The combined total is a conservatively high estimate of potential impacts, since it is likely that the highest results from different sources would occur under different meteorological conditions (e.g., different wind direction and speed), and would not necessarily occur when the highest background concentrations are present.

Conformity with State Implementation Plans

As described in Chapter 11, “Air Quality”, the conformity requirements of the CAA and regulations promulgated thereunder (conformity requirements) limit the ability of federal agencies to assist, fund, permit, and approve projects in non-attainment or maintenance areas that do not conform to the applicable SIP. Since the U.S. Army Corps of Engineers (USACE) would be authorizing the discharge of dredged material, USACE would be responsible for demonstrating conformity of that action with state implementation plans as per the general conformity regulations (40 CFR §93, Subpart B). Therefore, total annual emissions associated with the dredging activity only were

calculated. The emissions were evaluated per the interagency consultation process for general conformity that occurred in December 2011 and January 2012.

The pollutants of concern on a regional basis are CO, PM_{10}, $PM_{2.5,}$ NO_x, and volatile organic compounds (VOC). (Although CO reacts rapidly in the atmosphere and is therefore not transported throughout the region, it is accounted for on a mesoscale in order to ensure that areawide emissions do not exceed the emissions budgets in the applicable maintenance plan.) Dredging emissions from on-road trucks and worker vehicles and from non-road construction equipment, including marine engines, were calculated on an annual basis based on the emissions modeling procedures described above for the microscale analysis.

Under the general conformity regulations, a general conformity determination for federal actions is required for each criteria pollutant or precursor in non-attainment or maintenance areas where the action's direct and indirect emissions have the potential to emit one or more of the six criteria pollutants at rates equal to or exceeding the prescribed rates for that pollutant. In the case of this project, the prescribed annual rates are 50 tons of VOCs and 100 tons of NO_x (ozone precursors, ozone non-attainment area in transport region), 100 tons of CO (CO maintenance area), and 100 tons of $PM_{2.5}$, SO_2, or NO_x ($PM_{2.5}$ and precursors in $PM_{2.5}$ non-attainment area).

18-4-8-2 ENVIRONMENTAL EFFECTS

Local (Microscale) On-Site Construction Activity Assessment

Rockland Landing—Reconstruction of the South Broadway Bridge

Maximum predicted concentration increments from construction activities associated with the South Broadway Bridge replacement and overall concentrations (including background[1]) are presented in **Table 18-9**. The maximum predicted total concentrations of $PM_{2.5}$, PM_{10}, CO, and annual-average NO_2 would not exceed the NAAQS.

Table 18-9
Maximum Predicted Pollutant Concentrations from Construction Site Sources—Rockland Landing, Reconstruction of the South Broadway Bridge (µg/m^3)

Pollutant	Averaging Period	No Build Alternative	Project	Increment	NAAQS
$PM_{2.5}$	24-hour	28.0	28.4	0.4	35
	Annual Local	9.6	9.7	0.1	15
PM_{10}	24-hour	64	65	1	150
NO_2	Annual	45	51	6	100
CO	1-hour	3.4 ppm	7.2 ppm	3.8 ppm	35 ppm
	8-hour	2.5 ppm	2.8 ppm	0.3 ppm	9 ppm

[1] Background concentrations and the monitoring stations at which they were measured are discussed in Chapter 11, "Air Quality" and presented in Table 11-4. Background concentrations are assumed to be the most recently measured concentrations (2008-2010).

Rockland Landing-Approach Roadway Construction

Maximum predicted concentration increments from construction activities associated with the Rockland landing approach roadway and overall concentrations (including background) are presented in **Table 18-10**. As shown, the maximum predicted total concentrations of $PM_{2.5}$, PM_{10}, CO, and annual-average NO_2 would not exceed the NAAQS.

Table 18-10
Maximum Predicted Pollutant Concentrations from Construction Site Sources—Rockland Landing, Approach Roadway Construction (µg/m^3)

Pollutant	Averaging Period	No Build Alternative	Project	Increment	NAAQS
$PM_{2.5}$	24-hour	28.0	29.2	1.2	35
	Annual Local	9.6	9.7	0.1	15
PM_{10}	24-hour	64	66	2	150
NO_2	Annual	45	52	7	100
CO	1-hour	3.4 ppm	6.2 ppm	2.8 ppm	35 ppm
	8-hour	2.5 ppm	2.8 ppm	0.3 ppm	9 ppm

Rockland Inland Staging Area

Maximum predicted concentration increments from construction activities associated with the construction staging activities including the concrete batch plant at the Rockland inland staging area and overall concentrations (including background) are presented in **Table 18-11**.

Table 18-11
Maximum Predicted Pollutant Concentrations from Construction Site Sources—Rockland Inland Staging Area (µg/m^3)

Pollutant	Averaging Period	No Build Alternative	Project	Increment	NAAQS
$PM_{2.5}$	24-hour	28.0	32.6	4.6	35
	Annual Local	9.6	9.9	0.3	15
PM_{10}	24-hour	64	94	30	150
NO_2	Annual	45	48	3	100
CO	1-hour	3.4 ppm	3.5	0.1	35 ppm
	8-hour	2.5 ppm	2.53	0.03	9 ppm

Since the location of the project concrete batch plant has not been determined, a grid receptor network was used for modeling to capture the potential area of effect from operations at the concrete batch plant.

The maximum total concentrations of $PM_{2.5}$, PM_{10}, CO, and annual-average NO_2 were predicted at fenceline receptors adjacent to the project concrete batch plant, and would not exceed the NAAQS.

Bridge Construction-Rockland Approach and Main Span

Maximum predicted concentration increments from construction activities associated with the construction activities at the Rockland approach and the bridge main span and

overall concentrations (including background) are presented in **Table 18-12**. As shown, the maximum predicted total concentrations of $PM_{2.5}$, PM_{10}, CO, and annual-average NO_2 would not exceed the NAAQS.

Table 18-12
Maximum Predicted Pollutant Concentrations from Construction Site Sources—Bridge Construction, Rockland Approach and Main Span (µg/m^3)

Pollutant	Averaging Period	No Build Alternative	Project	Increment	NAAQS
$PM_{2.5}$	24-hour	28.0	34.1	6.1	35
	Annual Local	9.6	10.0	0.4	15
PM_{10}	24-hour	64	71	7	150
NO_2	Annual	45	52	7	100
CO	1-hour	3.4 ppm	6.0 ppm	2.6 ppm	35 ppm
	8-hour	2.5 ppm	3.0 ppm	0.5 ppm	9 ppm

Westchester Landing

Maximum predicted concentration increments from construction activities associated with the construction activities at the Westchester landing and overall concentrations (including background) are presented in **Table 18-13**. As shown, the maximum predicted total concentrations of $PM_{2.5}$, PM_{10}, CO, and annual-average NO_2 are not expected to exceed the NAAQS.

Table 18-13
Maximum Predicted Pollutant Concentrations from Construction Site Sources—Westchester Landing (µg/m^3)

Pollutant	Averaging Period	No Build Alternative	Project	Increment	NAAQS
$PM_{2.5}$	24-hour	28.0	28.5	0.5	35
	Annual Local	9.6	9.63	0.03	15
PM_{10}	24-hour	64	65	1	150
NO_2	Annual	45	48	3	100
CO	1-hour	3.4 ppm	4.0 ppm	0.6 ppm	35 ppm
	8-hour	2.5 ppm	2.6 ppm	0.1 ppm	9 ppm

Bridge Construction-Westchester Approach and Main Span

Maximum predicted concentration increments from construction activities associated with the construction activities at the Rockland approach and the bridge main span and overall concentrations (including background) are presented in **Table 18-14**. As shown, the maximum predicted total concentrations of $PM_{2.5}$, PM_{10}, CO, and annual-average NO_2 are not expected to exceed the NAAQS.

Table 18-14
Maximum Predicted Pollutant Concentrations from Construction Site Sources—Bridge Construction, Westchester Approach and Main Span ($\mu g/m^3$)

Pollutant	Averaging Period	No Build Alternative	Project	Increment	NAAQS
$PM_{2.5}$	24-hour	28.0	34.3	6.3	35
	Annual Local	9.6	10.4	0.8	15
PM_{10}	24-hour	64	73	9	150
NO_2	Annual	45	63	18	100
CO	1-hour	3.4 ppm	13.5 ppm	10.1 ppm	35 ppm
	8-hour	2.5 ppm	6.3 ppm	3.8 ppm	9 ppm

Other Periods of Construction

The modeled results are based on construction scenarios for specific worst-case periods. Lower concentration increments from construction would generally be expected during periods with lower construction emissions. Since worst-case short-term results may often be indicative of very local impacts, similar maximum local impacts may occur at any stage at various locations but would not persist in any single location, since emission sources would not be located continuously at any single location throughout construction, but would not exceed the concentrations projected for the worst-case scenarios.

Local (Microscale) Mobile Source Assessment

Maximum predicted concentration increments from mobile sources from roadway shifts at both the Rockland and Westchester sides, and overall concentrations (including background) are presented in **Tables 18-15** and **18-16**. The maximum predicted total concentrations of $PM_{2.5}$, PM_{10}, and CO are not expected to exceed the NAAQS.

Table 18-15
Maximum Predicted Pollutant Concentrations from Mobile Sources—Rockland County ($\mu g/m^3$)

Pollutant	Averaging Period	No Build Alternative	Project	Increment	NAAQS
$PM_{2.5}$	24-hour	28.0	31.2	3.2	35
	Annual Local	9.6	10.2	0.6	15
PM_{10}	24-hour	64	76	12	150
CO	1-hour	3.4 ppm	7.4 ppm	4.0 ppm	35 ppm
	8-hour	2.5 ppm	5.3 ppm	2.8 ppm	9 ppm

Table 18-16
Maximum Predicted Pollutant Concentrations from Mobile Sources—Westchester County (µg/m^3)

Pollutant	Averaging Period	No Build Alternative	Project	Increment	NAAQS
$PM_{2.5}$	24-hour	28.0	31.9	3.9	35
	Annual Local	9.6	10.6	1.3	15
PM_{10}	24-hour	64	72	8	150
CO	1-hour	3.4 ppm	12.0 ppm	8.6 ppm	35 ppm
	8-hour	2.5 ppm	6.5 ppm	4.0 ppm	9 ppm

Summary of Total Combined Concentrations

Total combined concentration increments were estimated by combining the results from the on-site construction analysis with the construction-related mobile source increments from the mobile source receptor closest to the location of the on-site increment. The overall combined concentrations of PM_{10}, CO, and annual-average $PM_{2.5}$, including background concentrations, are not expected to exceed the NAAQS.

At the Rockland side, the maximum total combined $PM_{2.5}$ 24-hour concentration is estimated to be 34.9 µg/m^3 which is less than the applicable air quality standard of 35 µg/m^3. This maximum concentration includes a background value of 28.0 µg/m^3, a stationary source contribution of 5.5 µg/m^3, and a mobile source contribution of 1.2 µg/m^3, and was predicted at a receptor location along the Rockland shoreline adjacent to Interstate 87/287.

At the Westchester side, the maximum total combined $PM_{2.5}$ 24-hour concentration is estimated to be 35.6 µg/m^3. This maximum concentration includes a background value of 28.0 µg/m^3, a stationary source contribution of 5.7 µg/m^3, and a mobile source contribution of 1.9 µg/m^3, and was predicted at several residential receptor locations along the Westchester shoreline north of the Interstate 87/287. The meteorological conditions required to produce predicted 24-hour average concentration increments, which when combined with the peak background would result in a total concentration above 35 µg/m^3 at each of these locations occurred on only one day in the five years of meteorological data used for modeling. These maximum increments are very unlikely to occur because these very uncommon meteorological conditions and are unlikely to coincide with the highest background level and to occur during the peak activity at the locations immediately adjacent to the affected receptors. The peak construction activity in this area would be limited to approximately 2 to 3 months, the specific meteorological condition occurred once in five years, and background concentrations of 28 µg/m^3 or higher occurred only 2 percent of the time; combining these three probabilities results in a probability of approximately 0.1 percent, or a 1-in-1,000 chance of this single-day event occurring. Therefore, 24-hour exceedance would be unlikely to occur, and if it does, would be limited to a single occurrence (one day) and a single location. Based on the low probability of occurrence, the limited duration and extent of this peak concentration, the low frequency of occurrence, and the limited potential for exposure, this would not be considered an adverse impact.

Conformity with State Implementation Plans

Annual construction activity and on-road emissions associated with the dredging activity only are presented in **Table 18-17**. The annual emissions from dredging activity would be lower than the de minimis rates defined in the general conformity regulations. Since all diesel engines will be using ultra low sulfur diesel, SO_2 emissions would be negligible.

Table 18-17
Emissions from Dredging Activities (ton/yr)

	$PM_{2.5}$	NO_x	VOC	CO
De minimis level:	*100*	*100*	*50*	*100*
Year 1	2.8	71.3	2.9	8.2
Year 2	1.1	30.0	1.2	3.3
Year 3	0.0	0.0	0.0	0.0
Year 4	0.7	17.3	0.7	2.0
Year 5	0.0	0.0	0.0	0.0
Year 6*	0.0	0.0	0.0	0.0

Note: * The last year of construction includes only a few months of activity, and no dredging activity.

18-4-8-3 1-HOUR NO_2 NATIONAL AMBIENT AIR QUALITY STANDARD

EPA recently established a new 1-hour average NO_2 standard of 100 parts per billion (ppb), effective April 12, 2010, in addition to the current annual standard. The statistical form is the 3-year average of the 98th percentile of daily maximum 1-hour average concentrations in a year. EPA is considering the need for changes to the secondary NO_2 standard under a separate review.

By promulgating the 1-hour NO_2 standard, EPA has initiated a process under the CAA that will ultimately result in the adoption of strategies designed to attain and maintain ambient NO_2 concentrations at levels below the standard. This process will first involve installation of additional ambient NO_2 monitoring stations near roadways. With respect to those areas that are identified as in non-attainment, states will be required to develop SIPs designed to meet the standard by specified time frames. EPA and the states also can be expected to issue new regulations and guidance that will address methodologies and criteria for performing assessments of 1-hour NO_2 concentrations from project-level emission sources and for evaluating their impacts. This information is not currently available. Therefore, although EPA has promulgated the 1-hour standard, it has yet to be fully implemented.

Uncertainty exists as to 1-hour NO_2 background concentrations at ground level, especially near roadways, since these concentrations have not been measured within the current monitoring network. In the New York downstate region and adjacent counties in New Jersey and Connecticut, background concentrations at existing rooftop monitors range from 41 ppb to 67 ppb (there are no stations in the immediate area of the project). In addition, there are no clear methods to predict the rate of transformation of NO to NO_2 at ground-level given the level of existing data and models. EPA, in promulgating the standard, has expressed specific concern regarding mobile source impacts, and estimated that ambient concentrations of NO_2 adjacent to roadways could

be 30 to 100 percent higher than the concentrations measured at community scale (rooftop) monitoring stations.[1] Similar concerns exist regarding areas adjacent to large construction sites.

Therefore, predicted construction impacts cannot be based on comparison with the new 1-hour NO_2 NAAQS since total 98th percentile values, including local area roadway contributions, cannot be estimated. In addition, methods for accurately predicting 1-hour NO_2 concentrations from construction activities have not been developed. However, given the magnitude of the NOx emissions associated with the project's construction, exceedances of the 1-hour NO_2 standard resulting from construction activities cannot be ruled out; however, as discussed above, land-based non-road diesel-powered vehicles and construction equipment rated Tier 3 or higher would be used where conforming equipment is available, and the use of such equipment is practicable.

18-4-9 NOISE AND VIBRATION

Although they are temporary, construction activities can create noise levels sufficient to cause community annoyance and interfere with daily activities. Similarly, construction activities can cause vibration levels that may result in structural or architectural damage, and/or community annoyance or interference with vibration-sensitive activities. This section assesses the potential noise and vibration effects resulting from construction of the Tappan Zee Bridge Hudson River Crossing Project.

Construction noise differs from traffic noise in a number of ways, including the following:

- Construction noise is temporary and only lasts for the is temporary of the construction contract(s);
- Construction activities generally take place for a limited period of time at any specific location;
- Construction noise may be intermittent and variable depending upon the type of construction activities taking place at a specific location and time period; and
- Construction noise is sporadic in nature, whereas traffic noise occurs continuously over the life of a facility.

Construction activities that may cause noise impacts include earthwork, land clearing, pile driving, paving, structure demolition and construction. Noise and vibration levels due to construction at specific locations are a function of the number and types of construction equipment that would be utilized for a specific phase of project construction, and are highly variable throughout the various phases of construction.

At locations where construction-related noise and/or vibration levels would have the potential for resulting in adverse impacts, the feasibility and practicability of implementing abatement measures to reduce or eliminate predicted adverse impacts has been examined.

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[1] EPA, Final Regulatory Impact Analysi s (RIA) for the NO_2 National Ambient Air Quality Standards (NAAQS), January 2010.

18-4-9-1 NOISE

Methodology

The methodology used to determine noise levels due to construction-related activities are in accordance with FHWA regulations and NYSDOT policy. NYSTA follows both federal regulation and state policy to determine construction noise impacts.

The FHWA Road Construction Noise Model (RCNM 1.1) has been used to predict noise levels due to stationary highway construction operations. This model is based on a compilation of empirical data and the application of acoustical propagation formulas. The model takes into account the noise emission generated by the equipment used for various construction operations, an acoustical usage factor (which accounts for the percentage of time the equipment is operating at full power), attenuation with distance, attenuation due to shielding, etc. The RCNM 1.1 determines the total noise level by combining the noise resulting from significant pieces of construction equipment operating during the analysis time period.

Since the RCNM 1.1 does not account for excess ground attenuation or atmospheric absorption, the model is particularly appropriate for those shoreline receptors when the Hudson River water surface is between the equipment and a receptor.

Noise emission levels and acoustical use factors for generic types of heavy equipment are contained in a database contained in the model. The data contained in the model is largely based upon data gathered as part of the noise studies for the Central Artery/Tunnel project in Boston, Massachusetts in the 1990s. However, the model allows users to supplement the data contained in the model. **Table 18-**18 shows the highway construction equipment noise reference levels and usage factors contained in the RCNM 1.1.

While the RCNM 1.1 does account for construction-related trucks when they are stationary on-site, it does not account for them when they are travelling to and from the construction site. To account for noise from these sources the FHWA Traffic Noise Model (TNM 2.5) was used. TNM 2.5 calculates the noise contribution of each roadway segment to a given noise receptor and sums the contributions to estimate the noise level at a given receptor location. The noise from each vehicle type is determined as a function of the reference energy-mean emission level, corrected for vehicle volume, speed, roadway grade, roadway segment length, and source receptor distance.

Receptor Locations

Eleven (11) locations were selected as noise receptor locations for the construction noise analysis. **Table 18-19** lists each of the selected noise receptor locations and they are also shown in **Figure 18-12**. These selected locations are representative of locations at which the maximum construction-related noise impacts would be expected to occur.

1.12.12

- - - Study Area Boundary

1 Construction Noise Receptors

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 18-12
Noise Monitoring Locations

Table 18-18
Highway Construction Equipment Noise Reference Levels and Usage Factors from RCNM 1.1

Equipment Description	Impact Device[1]	Acoustical Use Factor (Percent)[2]	Spec 721.560 Lmax @ 50 feet (dBA, slow)[3]
All Other Equipment > 5 HP	No	50	85
Auger Drill Rig	No	20	85
Backhoe	No	40	80
Bar Bender	No	20	80
Blasting	Yes	N/A	94
Boring Jack Power Unit	No	50	80
Chain Saw	No	20	85
Clam Shovel (dropping)	Yes	20	93
Compactor (ground)	No	20	80
Compressor (air)	No	40	80
Concrete Batch Plant	No	15	83
Concrete Mixer Truck	No	40	85
Concrete Pump Truck	No	20	82
Concrete Saw	No	20	90
Crane	No	16	85
Dozer	No	40	85
Drill Rig Truck	No	20	84
Drum Mixer	No	50	80
Dump Truck	No	40	84
Excavator	No	40	85
Flat Bed Truck	No	40	84
Front End Loader	No	40	80
Generator	No	50	82
Generator (<25KVA, VMS signs)	No	50	70
Gradall	No	40	85
Grader	No	40	85
Grapple (on backhoe)	No	40	85
Horizontal Boring Hydr. Jack	No	25	80
Hydra Break Ram	Yes	10	90
Impact Pile Driver	Yes	20	95
Jackhammer	Yes	20	85
Man Lift	No	20	85
Mounted Impact Hammer (hoe ram)	Yes	20	90
Pavement Scarafier	No	20	85
Paver	No	50	85
Pickup Truck	No	40	55
Pneumatic Tools	No	50	85
Pumps	No	50	77
Refrigerator Unit	No	100	82

Notes:

1 Denotes percussive construction equipment that strikes another surface or material.

2 An estimation of the fraction of time each piece of construction equipment is operating at full power (i.e., its loudest condition) during a construction operation.

3 A-Weighted Maximum sound level, measured at a distance of 50 feet from the construction equipment.

Table 18-19
Selected Noise Receptor Locations

Site #	Location	Town
1	15 North Tappan Zee Landing	Tarrytown
2	Thruway Property	Tarrytown
3	Thruway Property	Tarrytown
4	92 Paulding Avenue	Tarrytown
5	5 Edgewater Lane	Upper Grand View
6	Thruway Property	Upper Grand View
7	24 River Road	South Nyack
8	66 River Road	South Nyack
9	Smith Avenue near Broadway	Upper Grand View
10	Elizabeth Place and Broadway	South Nyack
11	Greenbush Road North and Stony Hill Lane	Central Nyack
Note: Sites 9 and 10 are listed as Sites 1 and 2, respectively, in Chapter 12 "Noise and Vibration."		

Sites 1-8 were chosen to represent the surrounding areas for the time periods when noise due to construction activities from both the bridge and the landing areas would be occurring simultaneously. This would be expected to be the noisiest time period at these receptor sites. Sites 9 and 10 were chosen to represent the area immediately adjacent to the South Broadway overpass which will be demolished and rebuilt at the beginning of construction activities. Site 11 was chosen to represent the area adjacent to the potential concrete batching plant located south of the Palisades Center Mall. This location represents the location where maximum noise levels would be expected since it is the location that is closest to sensitive receptors.

Existing Noise Levels

Existing noise levels were determined by field measurements at each of the 11 construction noise receptor locations. Twenty-four hour measurements were made at Sites 1 through 8. Twenty minute short-term measurements were made at Sites 9, 10, and 11 during the AM peak hour only. These measurements are summarized below in **Table 18-20**. A range of the hourly $L_{eq(1)}$ noise levels is shown for Sites 1 through 8 based on measured values between 7:00AM and 4:00 PM (i.e., the typical hours of construction).

Analysis Results

There are no federal or state regulations which define what constitutes a construction noise impact. In general, three factors should be considered when determining whether construction-related activities would results in a noise impact at a receptor location—, the magnitude of the increase in noise levels (the difference in noise levels with construction-related activities minus existing noise levels), the magnitude of noise produced by construction-related noise activities (alone) and the duration of the increased noise levels. NYSDOT in their guidance document, Environmental Manual (TEM), Chapter 4.4.18, "Noise Analysis Policy and Procedures" states that construction

Table 18-20
Existing Noise Levels at Construction Noise Receptors

Site #	Measurement	$L_{eq(1)}$ (in dBA)
1	24 hour	60-68
2	24 hour	67-70
3	24 hour	56-61
4	24 hour	63-71
5	24 hour	49-56
6	24 hour	64-68
7	24 hour	65-67
8	24 hour	56-63
9	20 minute AM peak period	69
10	20 minute AM peak period	61
11	20 minute AM peak period	58

Note: The $L_{eq(1)}$ noise levels shown for Sites 1-8 are values measured between 7:00AM and 4:00PM.

noise impact will not normally occur for projects outside of New York City when construction-related noise levels are under 80 dBA $L_{eq(1)}$. In terms of magnitude of change, typically, an increase in noise level of 2-3 decibels is considered by most people as a barely perceptible change in noise level, an increase in noise level of 5 decibels is considered by most people as a readily noticeable change in noise level, an increase in noise level of 10 decibels is considered by most people as a doubling in noise level, and an increase in noise level of 20 decibels is considered by most people as a dramatic change in noise level. Noise level increases which substantially exceed the existing noise levels may not be considered impacts if they would occur for only a limited duration.

Table 18-21 shows the construction noise analysis results. The values shown in this table do not assume the implementation of any noise abatement measures. For each of the eleven receptor locations the following $L_{eq(1)}$ noise levels are shown: existing noise levels; noise level due to construction-related activities alone; total ambient noise levels with construction-related activities (i.e., the sum of existing noise levels and noise levels due to construction-related activities); and the increase in noise levels due to construction-related activities (i.e., the total noise levels with construction-related activities minus existing noise levels). The noise levels shown in the table reflect the time period when the noisiest operations (i.e., pile driving) are occurring at locations closest to the receptor locations.

At Sites 1 through 8, construction-related activities from the bridge and landing areas would increase $L_{eq(1)}$ noise levels by between 2 and 20 dBA, depending upon the site and hour. Construction-related activities alone would result in $L_{eq(1)}$ noise levels that would range from 67 to 87 dBA. During one or more hours of the day, construction activities would result in an increase of 6 or more dBA at all eight sites. At Sites 2 and 5 during one or more hours of the day there would be an increase of 20 dBA (a dramatic change in noise level). Increase in noise level of this magnitude would be expected to occur throughout the time period when pile driving would take place in this area. While

Table 18-21
Construction Noise Analysis Results Without Noise Abatement Measures

Site #	Location	Existing Noise Levels $L_{eq(1)}$	Noise Levels due to Construction Activities Alone $L_{eq(1)}$	Total Ambient Noise Levels With Construction Activities $L_{eq(1)}$	Increases in Noise Levels with Construction Activities $L_{eq(1)}$
1	15 North Tappan Zee Landing	60-68	68	69-71	3-9
2	Thruway Property	67-70	87	87	17-20
3	Thruway Property	56-61	74	74	13-18
4	92 Paulding Avenue	63-71	68	69-73	2-6
5	5 Edgewater Lane	49-56	69	69	13-20
6	Thruway Property	64-68	81	81	13-17
7	24 River Road	65-67	81	81	14-16
8	66 River Road	56-63	67	67-68	5-11
9	Smith Avenue near Broadway	63-69*	71	72-73	4-9
10	Elizabeth Place and Broadway	56-61*	80	80	19-24
11	Greenbush Road North and Stony Hill Lane	52-58*	60	61-62	4-9

Note: * For analysis purposes, off-peak noise levels are assumed to be up to 6 dBA less than measured AM peak values.

noise levels would decrease by between 0 and 4 dBA when pile driving is completed in this area, substantial increases in noise levels would be expected to persist for an extended time period. Consequently, construction-related activities would be expected to produce noise levels at Sites 1 through 8, and at locations near these receptor sites, which would be intrusive and noisy, and result in noise impacts in these areas.

The noise results presented above are primarily a function of the construction equipment operation. Construction vehicles idling on the project site and traveling to and from the construction site made negligible additions to the noise levels. Tug boats in operation for staging and transporting equipment and crew are similarly expected to contribute negligible amounts due to their distance from any noise sensitive receptors.

At Sites 9 and 10, construction-related activities from the South Broadway overpass would increase $L_{eq(1)}$ noise levels by 4 to 9 dBA at Site 9 and by 19 to 24 dBA at Site 10. (The higher increase in noise levels at Site 10 is due to the distance between the receptor and the construction activities and the lower existing noise levels at Site 10.) Construction-related activities alone from the South Broadway overpass would result in $L_{eq(1)}$ noise levels of 71 and 80 dBA, at Sites 9 and 10 respectively. During one or more hours of the day, construction activities would result in an increase of 9 or more dBA at both Sites 9 and 10. At Site 10 during one or more hours of the day there would be an increase of 20 or more dBA. Consequently, construction-related activities would be expected to produce noise levels at Sites 9 through 10, and at locations near these receptor sites, which would be intrusive and noisy, and result in noise impacts in these areas.

At Site 11, construction-related activities from the concrete batching plant south of the Palisades Center Mall would increase $L_{eq(1)}$ noise levels at Site 11 by 4 to 9 dBA. Construction-related activities alone from the concrete batching plant south of the Palisades Center Mall would result in $L_{eq(1)}$ noise levels of 60 dBA. While construction-related activities alone result in a relatively low noise level (i.e., 60 dBA), existing noise levels are so low that construction activities would result in a substantial increase in ambient noise levels. During one or more hours of the day, construction activities would result in an increase of 9 dBA at Site 11. Consequently, construction-related activities would be expected to produce noise levels at Site 11 and at locations near this receptor site, which would be intrusive and noisy, and result in noise impacts in these areas.

Although in most cases construction noise is unavoidable in its entirety, NYSDOT and NYSTA are committed to requiring the use of a wide variety of noise abatement measures, which have been found to be effective, feasible and practicable to minimize and reduce noise due to construction activities. These measures include the EPCs previously discussed in this chapter, as well as the following generalized source control, site control, and community awareness measures:

- Source Control Measures:
  - Use of properly designed and well-maintained mufflers in all internal combustion engines, engine enclosures, and intake silencers;
  - Require contractors to perform regular periodic equipment maintenance; and
  - Use of new equipment subject to new product noise emission standards;
- Site Control Measures:
  - Place stationary equipment as far away as feasible and practicable from sensitive receptor locations;
  - Strategically select waste disposal sites to minimize potential noise concerns;
  - Where feasible, coordinate work operations to coincide with time periods when people would be least likely to be affected by construction-related noise;
  - Where feasible eliminate nighttime operations;
  - Eliminate “tail gate banging”;

  - Reduce backing-up procedures for equipment with backup alarms, and replace backup alarms with strobes where acceptable per OSHA and other regulations; and
  - Where feasible, construct noise barriers described in Chapter 12 proposed to mitigate post construction conditions prior to construction operations commencing.
- Community Awareness Measures:
  - Notify the public of construction activities that may be perceived of as noisy and intrusive prior to starting construction; and
  - Establish means for the public to contact the engineer-in-charge (i.e., provide telephone number, email, etc.) and methods to handle complaints.

In order to quantify the effectiveness of noise abatement measures, an additional quantified noise construction analysis was performed. This analysis examined each of the eleven receptor sites previously analyzed and made the following assumptions regarding source and site control measures:

- Use of the following quiet equipment:
  - Generators;
  - Compressors;
  - Pumps;
  - Pile Drivers (with shrouds to further reduce noise levels);
  - Loaders; and
  - Crawler Cranes.
- Use of moveable barriers around the excavator area; and
- Use of a sound barrier on north and west sides of the staging area on South Broadway.

Table 18-22 shows the construction noise analysis results assuming implementation of the noise abatement measures described above. For each of the eleven receptor locations the following $L_{eq(1)}$ noise levels are shown: existing noise levels; noise level due to construction-related activities alone with noise abatement measures; total noise levels with construction-related activities and with noise abatement measures (i.e., the sum of existing noise levels and noise levels due to construction-related activities with noise abatement measures); and the increase in noise levels due to construction-related activities with noise abatement measures (i.e., the total noise levels with construction-related activities and with noise abatement measures minus existing noise levels). The noise levels shown in the table reflect the time period when the noisiest operations (i.e., pile driving) are occurring at locations closest to the receptor locations.

Table 18-22
Construction Noise Analysis Results
With Noise Abatement Measures

Site #	Location	Existing Noise Levels $L_{eq(1)}$	Noise Levels due to Construction Activities Alone and With Noise Abatement Measures $L_{eq(1)}$	Total Ambient Noise Levels With Construction Activities and With Noise Abatement Measures $L_{eq(1)}$	Increases in Noise Levels with Construction Activities and With Noise Abatement Measures $L_{eq(1)}$
1	15 North Tappan Zee Landing	60-68	66	67-70	2-7
2	Thruway Property	67-70	77	77-78	8-10
3	Thruway Property	56-61	71	71	10-15
4	92 Paulding Avenue	63-71	67	68-74	1-5
5	5 Edgewater Lane	49-56	60	61-62	6-12
6	Thruway Property	64-68	74	75	7-11
7	24 River Road	65-67	72	72-73	6-7
8	66 River Road	56-63	61	62-66	2-6
9	Smith Avenue near Broadway	63-69*	67	69-71	2-6
10	Elizabeth Place and Broadway	56-61*	74	74	13-18
11	Greenbush Road North and Stony Hill Lane	52-58*	60	61-62	4-8

Note: * For analysis purposes, off-peak noise levels are assumed to be up to 6 dBA less than measured AM peak values.

At Sites 1 through 8, construction-related activities from the bridge and landing areas, with noise abatement measures, would increase $L_{eq(1)}$ noise levels by between 1 and 15 dBA (versus between 2 and 20 dBA without noise abatement), depending upon the site and hour. Construction-related activities alone, with noise abatement measures, would result in $L_{eq(1)}$ noise levels that would range from 60 to 77 versus between 67 and 87 dBA without noise abatement measures). During one or more hours of the day, construction activities with noise abatement measures would result in an increase of 10 or more dBA at Sites 2, 3, 5, and 6 (versus six sites without noise abatement measures). While the noise abatement measures would result in decrease of

construction noise of up to 10 dBA, the substantial increases in noise levels at Sites 1 through 8 would be expected to persist for an extended time period. There are no additional noise abatement measures that are feasible and practicable that could be utilized to eliminate and/or further reduce the noise levels at these locations. Consequently, construction-related activities would be expected to produce noise levels at Sites 1 through 8, and at locations near these receptor sites, which would be intrusive and noisy, and result in unmitigated noise impacts in these areas.

At Sites 9 and 10, construction-related activities from the South Broadway overpass with noise abatement measures would increase $L_{eq(1)}$ noise levels by 2 to 6 dBA (versus 4 to 9 dBA without noise abatement) at Site 9 and by 13 to 18 dBA (versus 19 to 24 dBA without noise abatement measures) at Site 10. Construction-related activities alone from the South Broadway overpass would result in $L_{eq(1)}$ noise levels of 67 and 74 dBA (versus 71 and 80 dBA without noise abatement measures), at Sites 9 and 10 respectively. During one or more hours of the day, construction activities would result in an increase of 10 or more dBA at Site 10. While the noise abatement measures would result in decrease of construction noise of 4 dBA at Site 9 and 6 dBA at Site 10, the substantial increases in noise levels at Sites 9 through 10 would be expected to persist for an extended time period. There are no additional noise abatement measures that are feasible and practicable that could be utilized to eliminate and/or further reduce the noise levels at these locations. Consequently, construction-related activities would be expected to produce noise levels at Sites 9 and 10, and at locations near these receptor sites, which would be intrusive and noisy, and result in unmitigated noise impacts in these areas.

At Site 11, there are no noise abatement measures that are feasible and practicable noise abatement measures that would result in a reduction in noise levels construction-related activities from the concrete batching plant south of the Palisades Center Mall below the 60 dBA that are predicted to occur without abatement measures. Consequently construction-related activities from the concrete batching plant south of the Palisades Center Mall would increase $L_{eq(1)}$ noise levels at Site 11 by 4 to 9 dBA, and construction-related activities alone from the concrete batching plant south of the Palisades Center Mall would result in $L_{eq(1)}$ noise levels of 60 dBA. Consequently, construction-related activities would be expected to produce noise levels at Site 11 and at locations near this receptor site, which would be intrusive and noisy, and result in unmitigated noise impacts in these areas.

18-4-9-2 VIBRATION

Construction activities have the potential to result in vibration levels that may in turn result in structural or architectural damage, and/or annoyance or interference with vibration-sensitive activities. In general, vibration levels at a location are a function of the source strength (which in turn is dependent upon the construction equipment and methods utilized), the distance between the equipment and the location, the characteristics of the transmitting medium, and the building construction type at the location. Construction equipment operation causes ground vibrations which spread through the ground and decrease in strength with distance. Vehicular traffic, even construction-related vehicular and equipment traffic, typically does not result in perceptible vibration levels unless there are discontinuities in the roadway surface. With the exception of the case of fragile and possibly historically significant structures or

buildings, construction activities typically do not reach vibration levels that can cause architectural or structural damage, but can achieve levels that may be perceptible and annoying in buildings very close to a construction site. An assessment has been prepared to quantitatively assess potential vibration impacts of construction activities on structures and residences near the project area.

Construction Vibration Criteria

For purposes of assessing potential structural or architectural damage, the determination of a significant impact was based on the vibration impact criterion of a peak particle velocity (PPV) of 0.50 inches per second. For non-fragile buildings, vibration levels below 0.50 inches per second would not be expected to result in any structural or architectural damage. For fragile buildings, vibration levels should be below 0.20 inches per second.

For purposes of evaluating potential annoyance or interference with vibration-sensitive activities, vibration levels greater than 65 vibration decibels (VdB) would have the potential to result in adverse impacts if they were to occur for a prolonged period of time.

Methodology

For purposes of assessing potential structural or architectural damage, Peak Particle Velocity (PPV) was used while the vibration level in VdB L_v(D) was used assess potential annoyance or interference with vibration sensitive activities.

Table 18-23 shows vibration source levels for typical construction equipment.

Table 18-23
Vibration Source Levels for Construction Equipment

Equipment		PPVref (in/sec)	Approximate Lv (ref) (VdB)
Pile Driver (sonic)	upper range	0.734	105
	Typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Vibratory Roller		0.210	94
Ram Hoe		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

Source: Transit Noise and Vibration Impact Assessment, FTA-VA-90-1003-06, May 2006.

Analysis Results

Generally, the types of construction equipment involved in construction activities that have the highest potential for resulting in architectural damage due to vibration are pile driving, ram hoes, truck loading/unloading, and jackhammers. In terms of potential vibration levels that would result in architectural damage, construction would have the most potential for producing levels which would exceed the 0.50 inches per second

PPV limit at receptor locations within a distance of approximately 50 feet from the operation of the pile driving rig; approximately 8 feet from the operation of ram hoe or truck loading/unloading; and approximately 5 feet from the operation of jackhammer. Since all receptors are located substantially beyond these distances, there would not be the potential for architectural damage due to construction activities.

In terms of potential vibration levels that would be perceptible and annoying, pile driving, vibratory roller activities, and truck loading activities would have the most potential for producing levels which exceed the 65 VdB limit. It is likely that at receptor locations within a distance of approximately 900 feet pile driving would produce perceptible and annoying vibration levels, within a distance of 230 feet vibratory roller activities would produce perceptible and annoying vibration levels, and within a distance of 125 feet truck loading activities would produce perceptible and annoying vibration levels. However, these operations would only occur for limited periods of time at a particular location and therefore would not result in any significant adverse impacts. In no case are significant adverse impacts from vibrations expected to occur.

18-4-10 ENERGY AND CLIMATE CHANGE

The potential effect of project construction on energy consumption and greenhouse gas (GHG) emissions is assessed in this section.

While the contribution of any single project to climate change is infinitesimal, the combined GHG emissions from all human activity severely impact global climate—an impact that is expected to increase in the future. The nature of the impact dictates that all sectors address GHG emissions by identifying GHG sources and practicable means to reduce them. Therefore, this chapter does not identify specific contributions of the proposed project to climate impacts, but rather addresses the changes in GHG emission associated with the project construction.

18-4-10-1 POLICY, REGULATIONS, STANDARDS, AND BENCHMARKS

In a step toward the development of national climate change regulation, the U.S. has committed to reducing emissions to 17 percent lower than 2005 levels by 2020 and to 83 percent lower than 2005 levels by 2050 (pending legislation) via the Copenhagen Accord.[1] Without legislation focused on this goal, the U.S. Environmental Protection Agency (USEPA) is required to regulate GHGs under the Clean Air Act, and has already begun preparing and implementing regulations. USEPA has established various voluntary programs to reduce emissions and increase energy efficiency and has recently embarked on regulatory initiatives related to GHG emissions.

There are also regional, state, and local efforts to reduce GHG emissions. In 2009, Governor Paterson issued Executive Order No. 24, establishing a goal of reducing GHG emissions in New York by 80 percent, compared to 1990 levels, by 2050, and creating a Climate Action Council tasked with preparing a climate action plan outlining

[1] Todd Stern, U.S. Special Envoy for Climate Change, letter to Mr. Yvo de Boer, UNFCCC, January 28, 2010.

the policies required to attain the GHG reduction goal—that effort is currently under way, and an interim draft plan has been published.[1]

The 2009 New York State Energy Plan[2] outlines the state's energy goals and provides strategies and recommendations for meeting those goals.

The 2009 New York State Smart Growth Public Infrastructure Policy Act requires that State infrastructure agencies (including NYSDOT, NYSTA, and others) ensure that, to the extent practicable, public infrastructure projects they approve, undertake, support, or finance be consistent with a series of smart-growth criteria.

A number of benchmarks for energy efficiency and green building design have also been developed. For example, NYSDOT'S Green Leadership in Transportation Environmental Sustainability (GreenLITES) Project Design Certification Program[3] is a self-certification rating system for enhancing the environmental performance of transportation projects. The certification addresses issues such as recycled content of materials, local materials, reducing electricity and petroleum consumption, improving cycling and pedestrian facilities, and many other sustainability items.

Currently, there are no standards or regulations applicable to GHG emission levels or for determining adverse impacts from actions subject to environmental review under NEPA or SEQRA. Accordingly, the potential effects of the project have been evaluated in the context of their consistency with the objectives stated in federal and state policies. Potential GHG emissions from the project are assessed and disclosed, and the feasibility and practicability of various measures available for reducing GHG emissions are discussed.

18-4-10-2 METHODOLOGY FOR GREENHOUSE GAS EMISSIONS ANALYSIS

Approach and Scope

Since the impact of GHGs emitted in the troposphere is generally the same regardless of where they are emitted, the analysis of GHGs addresses emissions resulting from project construction regardless of their location and timing. However, since project operations are expected to affect only a small reduction in GHG emissions from vehicles, the construction emissions represent the net total GHG emissions associated with the project.

The analysis includes both direct emissions from sources such as construction equipment and vehicles, and indirect emissions associated with electricity consumption. In addition, there are emissions preceding and following the proposed project, referred to as upstream and downstream emissions, such as emissions associated with the transport and production of fuels and construction materials, and emissions associated with disposal of materials after their use. The GHG analysis addresses both direct and

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[1] http://www.nyclimatechange.us/

[2] New York State, *2009 New York State Energy Plan*, December 2009.

[3] https://www.dot.ny.gov/programs/greenlites

indirect emissions, and, where practicable and substantial, upstream and downstream emissions.

NYSDOT's Draft Energy Analysis Guidelines for Project-Level Analysis, November 25, 2003 (NYSDOT guidance) and associated MOVES Roadway and Rail Energy and Greenhouse Gas Analysis Extension (MOVES-RREGGAE) enable analysis of transportation project, using EPA's MOVES model for on-road emissions and other analysis procedures for construction emissions. The construction analysis procedures used in MOVES-RREGGAE rely on available information, mostly associated with standard roadway and rail projects, including in some cases estimates associated with the correlation between project costs and energy expenditure. Given the scale and complexity of the project, and the availability of more detailed construction information, a more detailed approach was applied here, relying on project data and existing information from USEPA, the US Department of Energy's Energy Information Administration (EIA), and other sources when necessary, as detailed below.

Greenhouse Gases Analyzed

Six GHGs are included in the analysis where relevant: Carbon dioxide (CO_2), nitrous oxide (N_2O), methane, Hydrofluorocarbons, Perfluorocarbons, and Sulfur Hexafluoride. To present a complete inventory of all GHGs, component emissions are added together and presented as CO_2 equivalent (CO_2e)—a unit representing the quantity of each GHG weighted by its effectiveness using CO_2 as a reference.

Non-Road Construction Engines

Fuel use for nonroad engines used on-site, including all construction engines, generators, and tug boats for all construction years and sites was estimated, similar to the detailed estimates of engine use described above for air quality and noise analyses. The total diesel fuel use was estimated to be 13.2 million gallons for the Short Span Option and 12.1 million gallons for the Long Span Option. This quantity of fuel was multiplied by an emission factor of 10.14 kg CO_2e per gallon of diesel to calculate total GHG emissions from these sources.

On-Road Vehicles

The total number of construction worker trips was estimated using the detailed construction schedule. The total number of trips, 893,712 for the Short Span Option and 254,118 for the Long Span Option, was then divided by an average vehicle occupancy of 1.2 and multiplied by an average round-trip distance of 30.3 miles[1] to obtain a total personal vehicle miles traveled of 11.27 million for the Short Span Option and 3.20 million miles for the Long Span Option. An average combined emission factor of 406 grams CO_2e per mile was applied; this was derived from the EPA MOVES emission

[1] A one-way average commuting distance in the Poughkeepsie area of 15.13 miles was obtained from—Oak Ridge National Laboratory, 2001 National Household Travel Survey, New York Add-On— Putnam, Rockland, Westchester, May 2004.

model, assuming a roadway classification mix of 23.0 percent, 27.6 percent, and 49.4 percent on local, arterial, and freeway/expressway, respectively.[1]

Concrete and general deliveries (fuel, potable water, and other miscellaneous materials) were assumed to travel 50 miles round-trip (ready-mix concrete needs to be delivered within a short time, and other materials are available locally). Other truck trips, including raw material delivery, such as materials for concrete batching, and removal of dredge and demolition materials would travel to/from unknown sites. It is estimated that these trips could range from 25 to 150 miles in each direction. Since these trips represent a large fraction of the total trips, emissions associated with these trips were calculated for round trip distances of 50 and 300 miles, and the range of results is presented. The trips, distances, and resulting total VMT are presented in **Table 18-24**.

Table 18-24
Total Construction Truck Trips and Distances

Type	Number	Distance (round-trip miles)	Vehicle Miles Traveled
Short Span Option			
Muck trucks	14,841	50 to 300	742,054 to 4,452,323
Raw material trucks	22,812	50 to 300	1,140,611 to 6,843,665
Concrete trucks	75,123	50	3,756,157
General deliveries	30,979	50	1,548,929
Structural Steel (truck to barge)	1,813	730	1,323,125
		Total	**8,510,875 to 17,924,198**
Long Span Option			
Muck trucks	29,625	50 to 300	1,481,250 to 8,887,500
Raw material trucks	10,557	50 to 300	527,840 to 3,167,100
Concrete trucks	36,165	50	1,808,267
General deliveries	25,764	50	1,288,214
Structural Steel (truck to barge)	1,273	730	928,925
		Total	**6,034,496 to 16,079,946**

An average combined emission factor of 1,201 grams CO_2e per mile was applied; this was derived from the EPA MOVES emission model, assuming a roadway classification breakdown of 10 percent local roads, 10 percent arterial roads, and 80 percent freeway or interstate.

EPA estimates that the well-to-pump GHG emissions of gasoline and diesel are approximately 22 percent of tailpipe emissions. Upstream emissions (emissions associated with production, processing, and transportation) of all fuels can be substantial and are important to consider when comparing emissions associated with

[1] Average 2007 vehicle miles traveled mix by roadway classification for Rockland and Westchester counties. Data provided by NYSDOT.

the consumption of different fuels.[1] Since this analysis does not include different fuels and since the upstream fuel component for materials is unknown and therefore not included, well-to-pump emissions were not included for the on-road component either. However, well-to-pump emissions are included in the consideration of the use of alternative fuels for construction (see "Measures to Reduce Greenhouse Gas Emissions").

Electricity Use

Although some grid-supplied electric power would be used for the Project, this would be limited to office use and other uses in the various staging areas. These uses are unknown at this time, but are expected to be minor on the scale of the other emissions quantified here, and were therefore not included.

Construction Materials

Upstream emissions related to the production of construction materials were estimated based on the expected quantity of iron or steel and cement. Although other materials will be used, cement and metals have the largest energy and direct GHG emissions from their production ('embodied' energy and emissions), and large quantities would be used for the project.

The construction is estimated to require 739 and 351 thousand cubic yards of cement for the Short and Long Span Options, respectively. Concrete is estimated to have a density of 1.8 metric tons per cubic yard, and 10 percent cement content by weight, resulting in approximately 134 and 64 thousand metric tons of cement used for the Short and Long Span Options, respectively. An emission factor of 0.928 metric tons of CO_2e per metric ton of cement produced was applied to estimate emissions associated with energy consumption and process emissions for cement production.[2]

The construction is estimated to require approximately 295 and 301 thousand tons of steel for the Short and Long Span Options, respectively. An emission factor of 0.6 metric tons of CO_2e per metric ton of steel product produced was applied to estimate emissions associated with production energy consumption,[3] and a factor of 0.65 metric tons of CO_2e per metric ton of steel product produced was applied for process emissions associated with iron and steel production.[4]

18-4-10-3 ANALYSIS RESULTS

The projected maximum GHG emissions by component for the duration of construction of the Short Span and Long Span Options, along with the quantities and emissions factors for each component, are presented in **Tables 18-25** and **18-26**, respectively.

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1 Environmental Protection Agency, MOVES2004 Energy and Emission Inputs, Draft Report, EPA420-P-05-003, March 2005.

2 The Portland Cement Association, Life Cycle Inventory of Portland Cement Manufacture, 2006

3 Arpad Horvath et al., Pavement Life-cycle Assessment Tool for Environmental and Economic Effects, Consortium on Green Design and Manufacturing, UC Berkeley, 2007.

4 Based on 42.3 teragrams of CO_2e emitted and 65,460 thousand tons produced; EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2009, April 15, 2011.

Table 18-25
Greenhouse Gas Emissions—Short Span Option

Component	Quantity	Units	Emission Factor (metric tons CO_2e/unit)	Total Emissions (metric tons CO_2e)
Materials Embedded:*				
Cement	133,900	metric tons	0.928	124,300
Steel	267,400	metric tons	1.25	333,100
Non-road Engines (diesel):				
On-Site Construction**	11,175,000	gallons	0.0101	113,400
Delivery via Barge	1,935,000	gallons	0.0101	19,600
Delivery via Rail (to barge)	72,000	gallons	0.0101	700
On-Road Vehicles:				
Trucks***	17,920,000	VMT	0.00120	21,500
Worker vehicles	11,270,000	VMT	0.00041	4,600
			Total:	**617,000**

Notes:

Numbers are presented at analysis precision level. Sums may not add up due to rounding.

* Emissions do not include extensive additional shipping such as international shipping of steel, if steel is imported. For example, shipping all steel products from South America could add 60 thousand metric tons of CO_2e, and from China could be double that amount.

** On-site construction engines include on-site tug boat operations.

*** Truck emissions presented are based on the high-end assumption of 300-mile round trip distance. The lower-end scenario of 50-mile round trip would result in 10,220 metric tons of CO_2e from truck trips, reducing the total by 11,300 metric tons CO_2e.

Table 18-26
Greenhouse Gas Emissions—Long Span Option

Component	Quantity	Units	Emission Factor (metric tons CO_2e/unit)	Total Emissions (metric tons CO_2e)
Materials Embedded:*				
Cement	63,600	metric tons	0.928	59,100
Steel	272,700	metric tons	1.25	339,700
Non-road Engines (diesel):				
On-Site Construction**	10,571,000	gallons	0.0101	107,200
Delivery via Barge	1,453,000	gallons	0.0101	14,700
Delivery via Rail (to barge)	50000	gallons	0.0101	500
On-Road Vehicles:				
Trucks***	16,080,000	VMT	0.00120	19,300
Worker vehicles	3,200,000	VMT	0.00041	1,300
			Total:	**542,000**

Notes:

Numbers are presented at analysis precision level. Sums may not add up due to rounding.

* Emissions do not include extensive additional shipping such as international shipping of steel, if steel is imported. For example, shipping all steel products from South America could add 60 thousand metric tons of CO_2e, and from China could be double that amount.

** Non-road engines include on-site tug boat operations.

*** Truck emissions presented are based on the high-end assumption of 300-mile round trip distance. The lower-end scenario of 50-mile round trip would result in 7,350metric tons of CO_2e from truck trips, reducing the total by 12,100 metric tons CO_2e.

Total GHG emissions associated with construction of the project are projected to be approximately 0.5 million metric tons, with emissions from the Short Span Option approximately 12 percent higher than the Long Span Option. It is unknown at this time if steel for the bridge will be produced in the US or imported; if the steel for the project

needs to be shipped for long distances emissions could be considerably higher. For example, shipping all steel products 12,500 miles (approximate distance from Shanghai to an east coast port) would result in an additional 130 thousand metric tons CO_2e (both options require approximately 300 thousand tons of steel in total).

18-4-10-4 MEASURES TO REDUCE GREENHOUSE GAS EMISSIONS

Potential measures to reduce GHG emissions could address any of the GHG emission categories analyzed above for construction. In addition, there are some measures that could be incorporated in the project design and operations which could further reduce GHG emissions for years to come—see Chapter 13, "Energy and Climate Change for a discussion of project design and operational measures and features.

To address emissions associated with construction, several measures will be required via construction contracts to reduce direct emissions and upstream emissions associated with construction materials and their transportation:

- *Supplementary Cementitious Materials (SCM)*: Construction contracts would require the use of fly ash, slag, silica fume, calcined clay, and/or interground limestone to the extent practicable, contingent upon meeting the project's concrete specifications. Depending on the practicable level of implementation, these measures may reduce emissions by as much as 15,000 or 30,000 metric tons CO_2e for the Long Span Option and the Short Span Option, respectively.
- *Reducing Concrete Waste*: Construction contracts would require contractors to make efforts to reduce concrete waste. Concrete is wasted when concrete cannot be poured on site for reasons such as timing, quality control, or quantity estimates (e.g., leftover concrete from the last pour of the day). In such cases, concrete can be poured as blocks or sidewalk slabs for later use.
- *Optimize Cement Content*: Contractors will be required to optimize cement content according to project specifications.

In addition, the following measures will be implemented where practicable:

- *Biodiesel*: Biodiesel could be used for non-road engines during construction. The feasibility of using biodiesel for some or all construction engines and/or tug boats will be investigated, and included in construction contracts if found to be practicable. This would reduce project emissions in the range of 12,000 to 117,000 metric tons CO_2e depending on the biodiesel blend used.
- *Recycled Steel*: Requiring the use of recycled steel in construction contracts where practicable could ensure lower GHG emissions from steel production. If all project steel is from recycled sources, emissions could be reduced by approximately 220,000 metric tons CO_2e (40 to 45 percent of total emissions).
- *Local Materials Sourcing*: The use of local materials can substantially reduce emissions from transportation. For example, the difference between the 50-mile round trip scenario and the 300-mile trip scenario for project truck trips is approximately 14,000 metric tons CO_2e for the Long Span Option, and 10,000 for the Short Span Option. More importantly, as discussed above, if steel is shipped from distant international origins, additional emissions associated with the shipping could amount to 60,000 to 130,000 metric tons CO_2e. In addition to the request for

the use of local materials where practicable in the construction bid documents, the "buy American" provisions would require the use of American materials unless savings amounting to 25 percent of the entire cost of the project could be made by purchasing materials from other countries; therefore, it is unlikely that materials would be sourced from international origins. The construction documents will require that excavated material at the land-based sites are reused on-site as fill to the extent practicable. If any materials do need to be removed, they will be transported to the nearest reuse or disposal site practicable.

18-4-11 TOPOGRAPHY, GEOLOGY, AND SOILS

As described in Chapter 14, "Topography, Geology, and Soils," the limit of disturbance area for the replacement bridge is characterized by rolling and gently sloped topography, primarily comprising 0-15 percent slopes. The only area of steep slopes (25-35 percent) is along the Hudson River shoreline in Westchester County. The TQSA and WNSA are located in areas of primarily minimal slopes (0-15 percent).

The majority of ground disturbance related to construction of the Replacement Bridge Alternative would occur in areas of 0-15 percent slopes. The roadway would be elevated over the areas of 25-35 percent slopes in Westchester County; therefore, substantial regrading would not be required.

The primary concerns related to soils are erosion and suitability for construction. Ground disturbance can expose soils to wind, rain, and other erosive forces, thereby potentially creating dust or sedimentation of waterbodies. Erosion hazards for the soils in the limit of disturbance area range from moderate to very severe. To minimize potential impacts associated with soil erosion, all construction activities would be conducted in accordance with any applicable NYSDEC-approved SWPPP and ESC plan developed pursuant to NYSDEC's SPDES General Permit for Stormwater Discharges from Construction Activity (GP-0-10-001). In the post-construction (i.e., operation) condition, any previously exposed areas during construction would either be developed with highway improvements or maintenance facilities or would be re-vegetated, thereby limiting long-term erosion concerns.

18-4-12 WATER RESOURCES

Construction of the Replacement Bridge Alternative has the potential to affect the water quality of the Hudson River within the study area due to in-water construction activities that include dredging of bottom sediments, installation of cofferdams, driving of piles, vessel movement, and demolition of the existing bridge. Additionally, upland construction activities within the upland staging areas, the bridge landings within Rockland and Westchester Counties, upland activities associated with establishing access to the waterfront staging areas have the potential to affect floodplains, and surface and groundwater resources within the vicinity of these sites. Activities within the floodplain, discharges to surface water and groundwater, and dredging and disposal of dredge material must comply with the federal and state legislation and regulatory programs described previously in Chapter 15, "Water Resources".

Potential impacts on groundwater, floodplains, and water quality of the Hudson River were assessed by considering the following:

- The existing groundwater and floodplain resources and Hudson River water quality, including existing contaminants in the sediment, within the study areas, as discussed in Chapter 15, "Water Resources;"
- Results of modeling conducted to assess the potential for sediment disturbance resulting from in-water construction activities (i.e., dredging, cofferdam installation, pile driving, and vessel movement) to result in adverse environmental impacts to Hudson River water and sediment quality, as described in greater detail below;
- The potential for cofferdam dewatering to affect water quality; and
- The potential for demolition of the existing bridge to impact water quality.
- The potential for land-based construction activities to result in soil erosion and the discharge of stormwater runoff.

18-4-12-1 SEDIMENT RESUSPENSION ANALYSIS METHODOLOGY

For the Hudson River, the principal water quality resources issues for the construction of the Replacement Bridge Alternative is the resuspension of river sediments during construction and removal of the existing bridge foundations, and the transport[1] and eventual deposition[2] of this resuspended sediment elsewhere in the Hudson River. While the sand fraction of river sediment settles out relatively quickly after being resuspended, the finer sediment fractions will remain suspended and will be transported away from the construction area and will be deposited elsewhere in the estuary or leave the estuary altogether. Hydrodynamic modeling was used to project the plume of resuspended sediment that would result from sediment disturbing construction activities and the fate and transport of this plume within the Hudson River estuary. As discussed in detail in **Appendix E**, two public domain models were employed in the modeling; the Environmental Fluid Dynamics Code (EFDC) model and Research Management Associates (RMA) model. The EFDC is a state-of-the-art hydrodynamic model that can be used to simulate aquatic systems in one, two, and three dimensions. It is one of the most widely used and technically defensible hydrodynamic models in the world (www. Epa.gov/Athens/wwqtsc/html/efdc.html). The EFDC model and technical support is available from the USEPA and is the most widely used hydrodynamic model. The RMA model is a dynamic two-dimensional depth-averaged finite element hydrodynamic model that was developed for the USACE and is used extensively for bridge scour evaluations in estuaries. It is one component of the US Army Corps of Engineers TABS-MD System (US Geological Service (USGS) Surface Water and Water Quality Models Information Clearinghouse (http://smig.usgs.gov/cgi-bin/SMIC/model_home_pages /model_home?selection=rma2).

Inputs to the hydrodynamic models included the following:

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[1] Resuspended sediment will be transported by river flow. During transport the sediment is subject to a variety of processes, including dispersion, which tends to dilute concentrations over time.

[2] At some point after being resuspended, sediment will settle in depositional areas within the estuary system. This material will become part of the natural sediment transport cycle in the Hudson River estuary and will undergo additional cycles of resuspension and deposition.

- Results of SedFlume[1] analysis of sediments within the vicinity of the area to be dredged conducted by Dr. Donald Hayes, that indicated sediments within the study area are highly susceptible to resuspension. Dr. Hayes is the director of the Institute for Coastal Ecology and Engineering at the Universtiy of Louisiana at Lafayette Department of Civil Engineering and a recognized expert in the areas of dredging, sediment management, beneficial uses and contaminated sediment (Louisiana Sea Grant program http://www.laseagrant.org/comm/experts/hayes.htm).
- Existing information to characterize the Hudson River Estuary within the study area, examples of which include bathymetry from the National Oceanic and Atmospheric Administration (NOAA) navigational charts, tidal data from US Geological Survey (USGS) and NOAA tide stations, USGS freshwater discharge, salinity and suspended sediment concentration data, and USGS suspended sediment concentration data.
- Results of numeric models developed by Dr. Hayes to estimate suspended sediment loadings that would result from dredging; pile driving, coffer dam installation, dewatering, and removal; and vessel movement as described below. Inputs to these models are presented below.
    - Suspended sediment generated by dredging—dredging area (up to approximately 173 acres (about 0.2 square miles) and volume (up to 1.8 million cubic yards), rate of dredging (about 7,500 cubic yards per dredge per 24 hour period with two dredges operating concurrently), use of environmental/closed bucket with no barge overflow and a conservative sediment loss rate of about 1 percent. This conservative loss rate, combined with the projected dredging rate and the sediment characteristics results in an average sediment resuspension rate for each dredge of 39 kilograms per minute (kg/min), and a maximum rate of 94 kg/min (see **Appendix E**, Attachment 4).
    - Suspended sediment generated by cofferdam construction and dewatering—In the absence of existing information on sediment resuspension rates associated with cofferdam construction, resuspension of sediment during installation of sheet pile for cofferdams was developed on the basis of results of suspended sediment monitoring conducted for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project during dredging and in-water construction activities (http://biomitigation.org/bio_overview/subjects_overview.asp#water). Results of monitoring for that project indicated that installation of sheet pile for cofferdam construction resulted in average resuspension of bottom material that was about 30 percent of the average resuspension during dredging (see **Appendix E**, Attachment 4).

[1] High Shear Stress flume (SEDflume http://www.erdc.usace.army.mil) is designed for estimating gross erosion rates of fine-grained and mixed fine/coarse-grained sediments and the variation of the erosion rate with depth below the sediment-water interface. The erosion data are used to predict stability for contaminated sediments, capping material, native sediment, or dredged material and are often incorporated into numerical sediment transport models. The flume is designed to erode sediment cores layer by layer. Each core layer is eroded by regulating flow over the core surface. The flume is operator-controlled, so the operator selects the range of shear stresses (starting at a low value and proceeding through higher values) for measuring erosion rate.

- Suspended sediment generated by pile driving and dewatering—Existing information on sediment resuspension from pile driving and dewatering was similarly absent and was estimated to be approximately 40 percent of that observed during dredging on the basis of the suspended sediment monitoring for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project (see **Appendix E**, Attachment 4).
- Suspended sediment generated by vessel movement and prop scour—As discussed previously a layer of gravel and sand would be placed at the bottom of the dredged channel to minimize sediment re-suspension. However, this layer would not prevent the resuspension of sediment that would be naturally deposited each day. Using an estimated depositional rate of sediment within the dredged channel of 104 kilograms per meter per day developed on the basis of van Rijn (1986) and total suspended sediment concentrations measured during studies conducted for the Replacement Bridge Alternative, the hourly scour rate of sediment as the vessels move along the channel was estimated as 8.7 kg per meter per hour (kg/m/hr) (see **Appendix E**, Attachment 4).

As indicated in the construction timeline presented in **Figure 18-1**, there are periods when sediment disturbing activities evaluated in the hydrodynamic modeling would occur concurrently, with the majority of the potential for sediment resuspension occurring during the first two dredging periods. The hydrodynamic modeling results evaluated in this EIS comprise conservative scenarios that would be expected to result in the greatest sediment resuspension:

- Stage 1 dredging with pile driving for the main span (Zone C) and trestles;
- Pile driving and cofferdam installation and dewatering for Zones C and B, movement of construction vessels, and trestle construction after Stage 1 dredging is complete; and
- Stage 2 dredging combined with pile driving and cofferdam installation and dewatering for Zones C and B, and movement of construction vessels.

Appendix E to this chapter presents the results of the hydrodynamic modeling for all of the scenarios evaluated for the project. The worst case scenarios evaluated in this EIS were developed on the basis of these analyses.

18-4-12-2 SEDIMENT RESUSPENSION AND TRANSPORT

The Long Span Option would have fewer total number of piers (35) than the Short Span Option (62) (see **Figures 18-6** and **18-7**), resulting in a shorter construction duration (4½ years) than the short span option (5½ years). While the number of main span piers is the same between the two options, the long span option has far fewer piers in the approaches.

Sediment disturbing construction activities include dredging, cofferdam construction, and pile driving within Substructure Zones A and B, pile driving within Substructure Zone C (see **Figures 18-6** and **18-7** for the location of these zones) and the movement of construction vessels within the construction access channel for the Long and Short Span options. Within Construction Zones A and B (see **Figures 18-6** and **18-7**) pile driving would occur within the cofferdams and would not have the potential to re-suspend sediment within the river. Within Zone C, piles would be driven first and then

the pile caps installed within hanging cofferdams. Therefore, only the Zone C piles would have the potential to result in additional sediment re-suspension. Hydrodynamic modeling was used to project the plume of resuspended sediment that would result from these concurrent sediment disturbing construction activities and the fate and transport of this plume within the river estuary.

The results of the modeling of the scenarios expected to result in the greatest resuspension of sediment indicated in **Figures 18-13** through **18-16** are similar for the Long Span and Short Span Options and indicate that total suspended sediment concentrations in the range of 50 to 100 mg/L above ambient conditions would only occur in the immediate vicinity of the dredges, at distances of less than a few hundred feet. This level of increase would be expected to occur within the allowable mixing zone[1] for dredging. Other sediment disturbing construction activities would result in a much smaller contribution of suspended sediment (i.e., driving of piles for the cofferdams, pile driving, vessel movement and cofferdam dewatering). On flood and ebb tides, concentrations of 10 mg/L above ambient conditions may extend in a relatively thin band approximately 1,000 to 2,000 feet from the dredges, while concentrations of 5 mg/L may extend a greater distance. Total suspended sediment concentrations recorded during sampling conducted for the project ranged from 13 to 111 mg/L. Additionally, the approximately 8-year record of suspended sediment concentration (SSC) recorded by the USGS at Poughkeepsie (see Chapter 15, "Water Resources," **Figure 15-8**) indicates there is considerable variation in the suspended sediment concentration within the Hudson River, as would be expected with an estuarine environment. During periods of higher freshwater flow the differences between low and high SSCs range between approximately 20 to 40 mg/L, during periods of low freshwater inflow the differences between low and high SSCs range from about 5 to 20 mg/L. Therefore, the projected increases in suspended sediment due to dredging concurrent with other sediment-disturbing construction activities would be well within the natural variation in suspended sediment concentration and would not result in adverse impacts to water quality and would be expected to meet the turbidity standard[2] for Class SB waters at the edge of the mixing zone. Concentrations of total suspended sediment from cofferdam construction (which include the discharge of river water recovered during dewatering) and pile driving would be approximately 5 to 10 mg/L in the immediate vicinity of the activity (within a few hundred feet) which would be much less than that projected to result from dredging and would not result in adverse water quality impacts. Concentrations of total suspended sediment resulting from construction vessel movement are projected to be less than 5 mg/L. Increases of total suspended sediment concentration above ambient would be greatest during slack tide, without tidal action to disperse it (see **Figures 18-13** and **18-15**).

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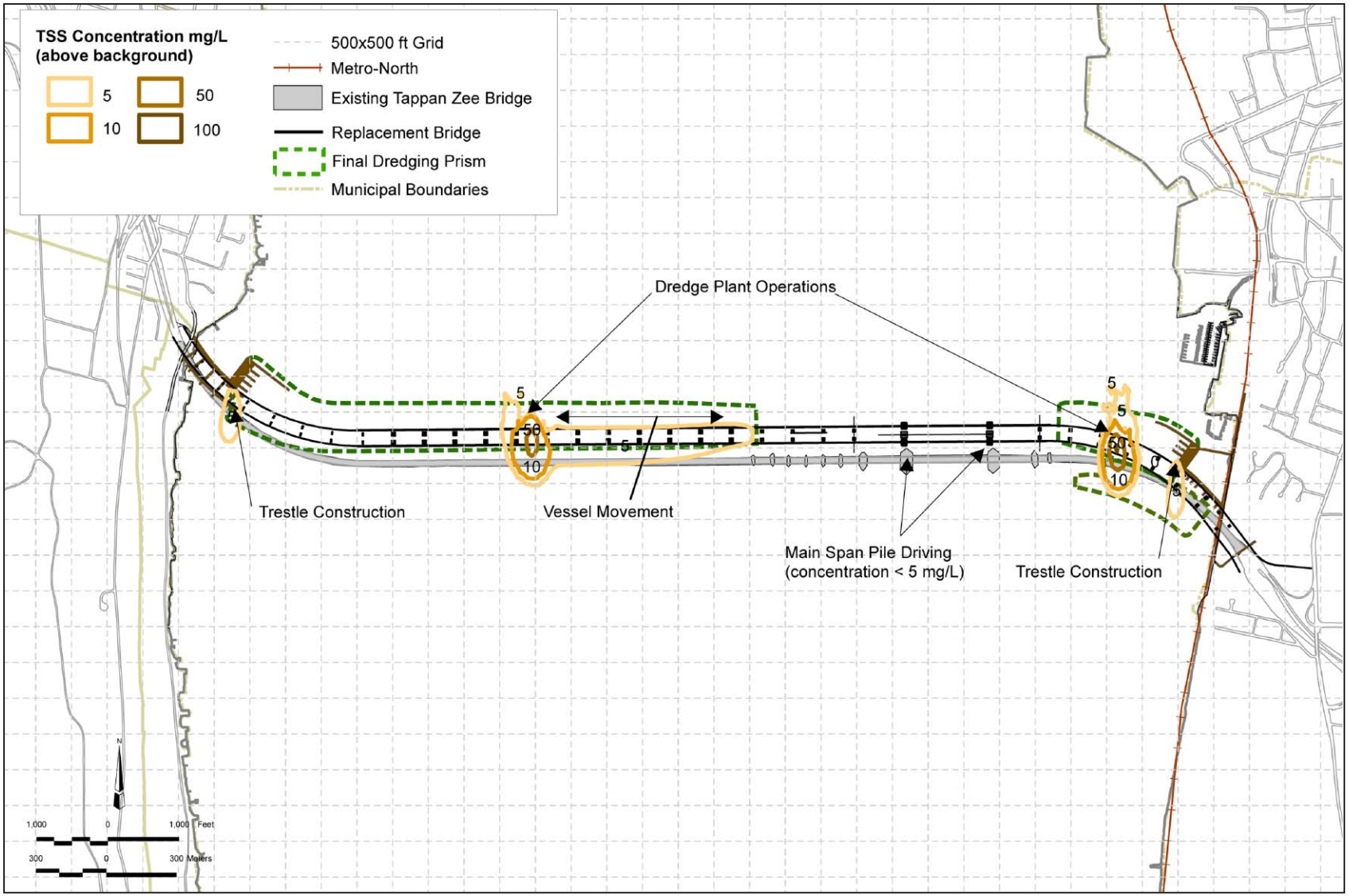
[1] A mixing zone is an area in a water body within which the NYSDEC will accept temporary exceedances of water quality standards resulting from short-term disruptions to the water body caused by dredging or the management of dredged material. A mixing zone can be assigned at the site of dredging. The size of the mixing zone should be such that the integrity of the water body as a whole is not impaired and there is no lethality to organisms passing through or enveloped by the mixing zone. The default mixing zone assigned by NYSDEC is 500 feet; however, in some cases a mixing zone analysis is required in order to determine the extent of the mixing zone (NYSDEC 2004).

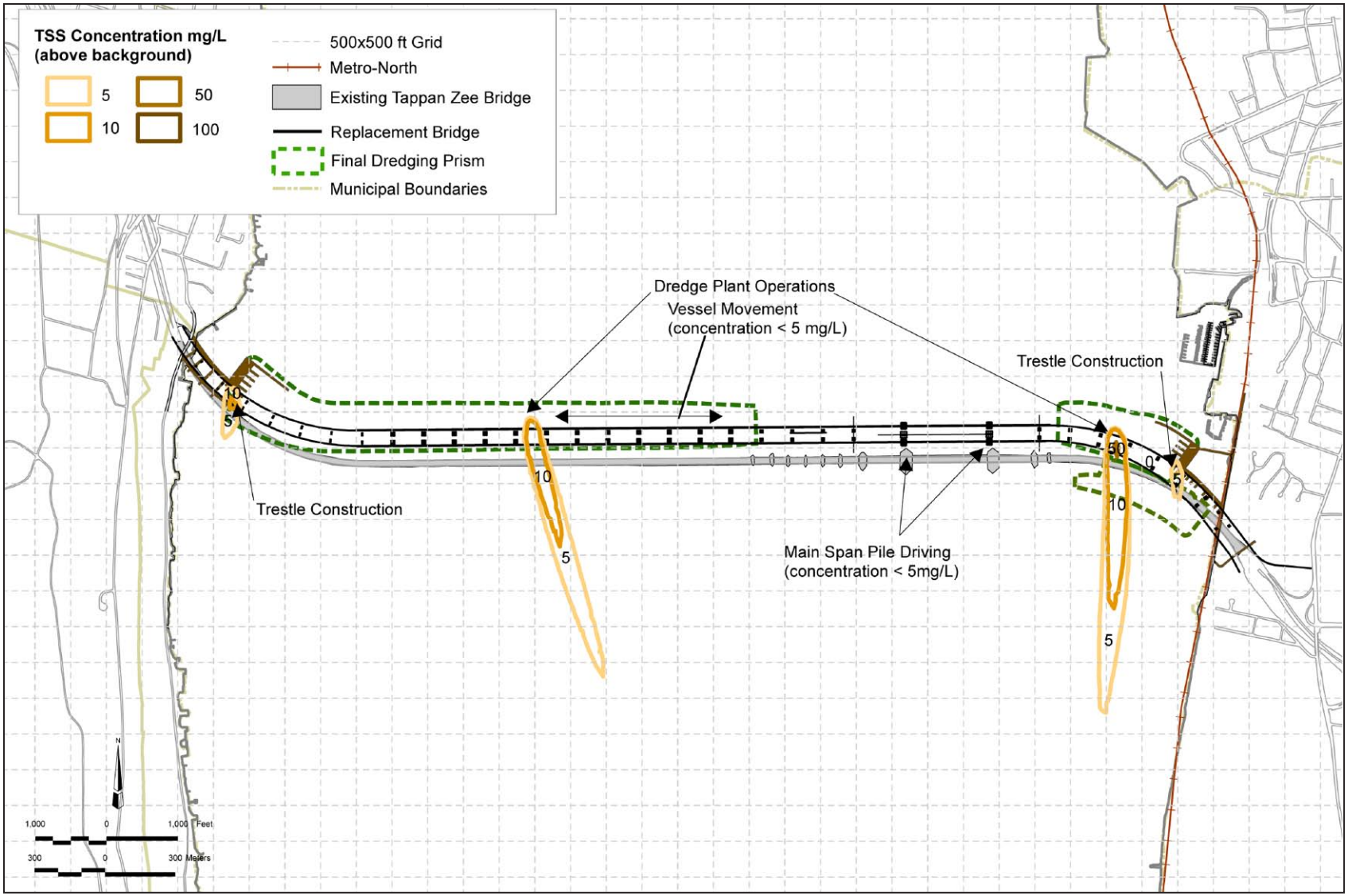
[2] The turbidity standard for Class SB waters is "No increase that will cause a substantial visible contrast to natural conditions."



Projected Total Suspended Sediment Concentration for the Long Span Replacement Bridge Option* During Stage 1 Dredging-Near Slack Tide

*Note: Short Span Option would be similar

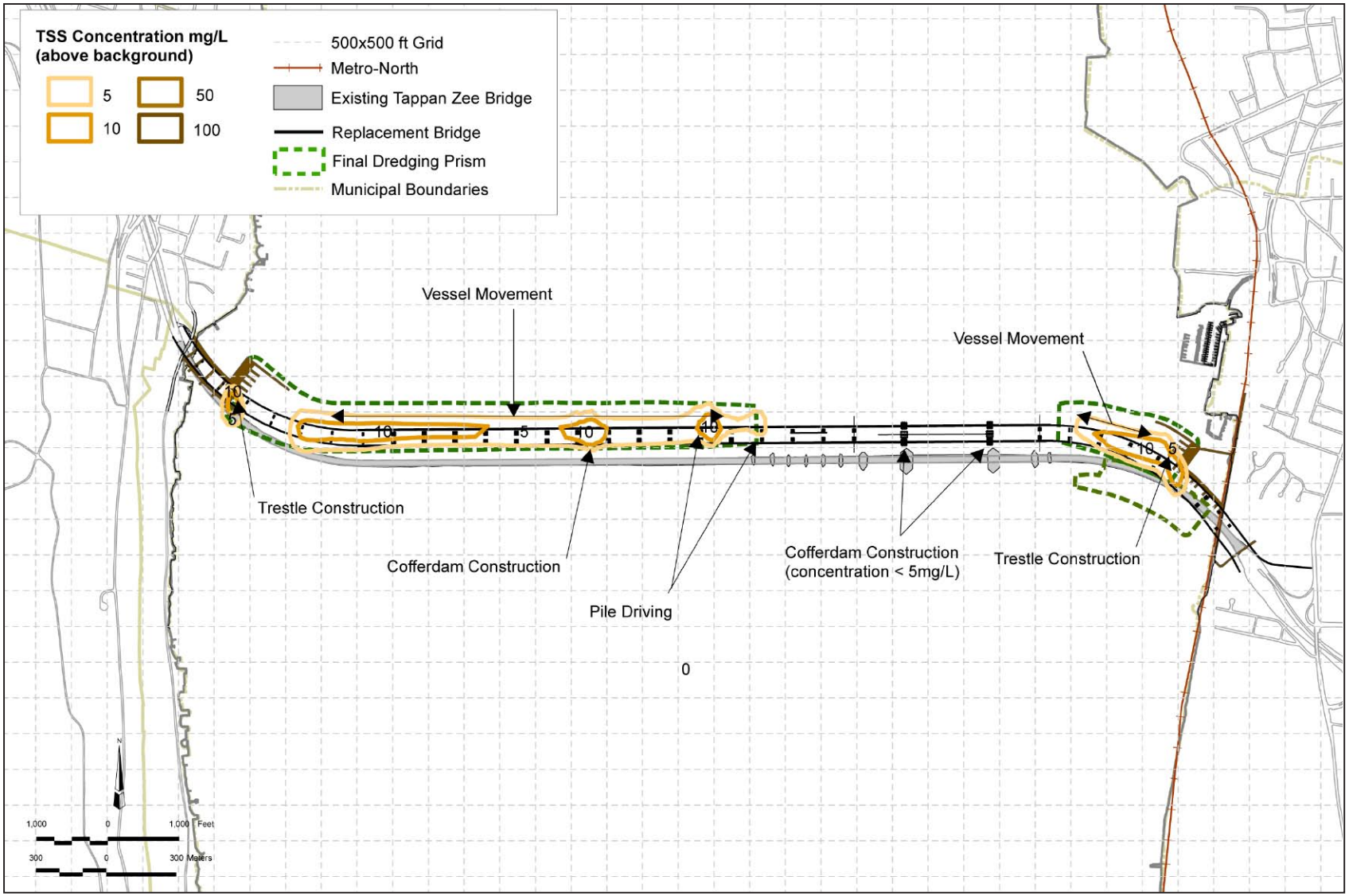
Figure 18-13
Stage 1 - Near Slack Tide



Projected Total Suspended Sediment Concentration for the Long Span Replacement Bridge Option* During Stage 1 Dredging-Ebb Tide

*Note: Short Span Option would be similar

Figure 18-14
Stage 1 - Ebb Tide

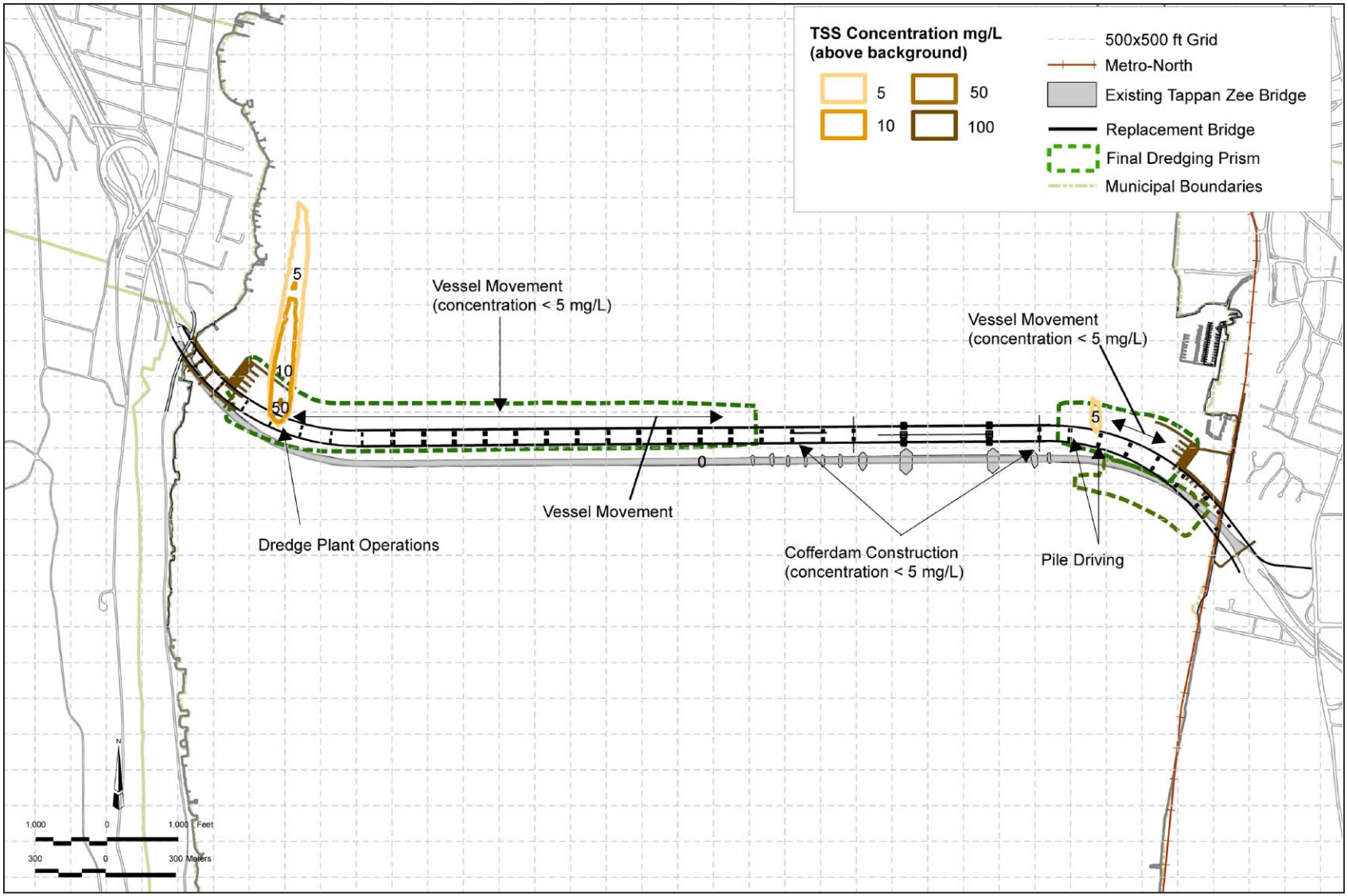


Projected Total Suspended Sediment Concentration for the Long Span Replacement Bridge Option* Zones C and B Construction After Dredging and Armoring – Near Slack Tide

*Note: Short Span Option would be similar

Figure 18-15

Zoning B & C Construction After Dredging and Armoring - Near Slack Tide



Projected Total Suspended Sediment Concentration for the Long Span Replacement Bridge Option* During Stage 2 Dredging and Zones C and B Construction– Flood Tide

*Note: Short Span Option would be similar

Figure 18-16
Stage 2 - Flood Tide

Placement of the sand/gravel armoring material within the dredged area, similar to the placement of granular capping material over contaminated sediment, has the potential to result in sediment resuspension when the capping material is deposited upon the sediment, but would not be expected to affect the magnitude of sediment resuspension projected through the hydrodynamic modeling. Results of monitoring conducted during placement of granular capping material on soft sediment indicated that resuspended sediment plumes were due to fines washed of the sand cap material and not due to resuspension of bottom sediment as the capping material was put in place (USACE 2005). Measures would be implemented during placement of the sand layer of the armoring to minimize resuspension of the newly exposed sediment. These measures are the same type of measures that have been demonstrated to successfully cap contaminated sediment with minimal mixing of the cap with contaminated sediment (Palermo et al. 2011), and for the capping of subaqueous dredged material (Palermo et al. 1998). They include both mechanical (dry sand capping material with bottom-dump barge, side-casting, bucket/clamshell, tremie (gravity-fed downpipe)) and hydraulical (wet/slurry of sand placed from a pipe or tremie, or from a spreader barge) placement of the capping material (USACE 2005 and 2006, USEPA 1994, Palermo et al. 2011). Mechanical methods rely on the gravity settling of the granular capping materials in the water column (Palermo et al. 2011) which can result in less water column dispersion than discharge of hydraulically-handled cap material because it settles faster in the water column (USACE 1991). Hydraulic methods can allow for a more precise placement of the material at the surface or depth but may require use of a dissipation devise to reduce sediment resuspension (Palermo et al. 2011, USACE 1991).

Placing sand capping material in layers has been found to allow gentle spreading, resulting in a more stable sand cap (Ling and Leshchinsky undated), and avoiding displacement of or mixing with the underlying sediment (USEPA 2005) This results in a decrease in the turbidity plume with each successive cap layer. The reduction in sediment resuspension observed by placing granular capping material in lifts or layers may afford the ability to place subsequent layers using an alternative methodology that may allow faster placement (USEPA 2008). Therefore, once the sand layer of the proposed armoring is in place, the placement of the gravel would have limited potential to result in sediment resuspension. With the implementation of these methods of placement of granular capping material that have been proven to reduce sediment resuspension during placement, additional sediment resuspension that would occur during the placement of the armoring material would be minimized and would not be expected to result in adverse water quality impacts.

In summary, the results of the hydrodynamic modeling of changes in suspended sediment resulting from construction activities—dredging, pile driving, cofferdam construction, and vessel movement—indicate that with the exception of the portion of the mixing zone within the immediate vicinity of the dredge, increases in suspended sediment would be minimal for the Long and Short Span Options and within the natural range of variation of suspended sediment concentration within this portion of the river. Sediment resuspension resulting from dredging and other sediment disturbing activities would be expected to meet the Class SB turbidity standard at the edge of the mixing zone. Resuspended sediment would dissipate shortly after the completion of the dredging activities, and would not result in adverse impacts to water quality. During the periods of in-water construction when no dredging is occurring, the limited sediment

resuspension during pile driving, cofferdam installation and removal, and vessel movement would be localized, would be expected to dissipate shortly after the completion of in-water construction activity and would not result in adverse water quality impacts. Similarly, with the implementation of measures demonstrated to minimize sediment resuspension during placement of capping or armoring material, the placement of the armoring material within the dredged area would not result in adverse water quality impacts. For all of the reasons presented above the increase in suspended sediment projected to result from dredging and other in-water sediment-disturbing construction activities, even under the worst case scenarios, and the placement of armoring within the dredged channel, would not result in adverse impacts to water quality of the Hudson River.

18-4-12-3 SEDIMENT QUALITY

Chapter 15, "Water Resources," presents a detailed discussion of sediment quality on the basis of results of laboratory analysis of sediment samples collected within the study area in 2006 and 2008 (see **Figures 15-13** through **15-18**). The results of these analyses are summarized in **Table 15-3**, and the samples classified as Class B (moderate contamination) or Class C (high contamination) in accordance with NYSDEC's In-Water and Riparian Management of Sediment and Dredged Material (NYSDEC 2004). Contaminants observed that were classified as Class B or Class C included Total PCBs, Total PAH, mercury, dioxin/furan TEQ, Total DDT, DDD and DDE, arsenic, copper, and cadmium. While there are some locations for which certain contaminants fall under the Class B or Class C category, these concentrations typically apply to only the upper few feet and the concentrations of these contaminants decline to those meeting Class A (no appreciable contamination) category within a few feet of the mudline. Resuspension of sediments during dredging[1] can also affect water quality through the release of contaminants dissolved in the sediment pore water (i.e., the water occupying the spaces between sediment particles). Considering the limited plume of increased suspended sediment above ambient concentrations projected to occur during the three-month dredging periods (as discussed above in Section 18-4-12-2, Sediment Resuspension and Transport), and the limited area and depth of sediments with low to moderate levels of contamination within the area to be dredged, the release of any contaminants would not result in adverse impacts to water quality.

The other in-water construction activities with the potential to result in sediment resuspension (pile driving, installation of the cofferdam and vessel movement) for the Long and Short Span Options are projected to result in an increase in SSC above ambient concentrations. These projected increases would be much lower, because within Zones A and B, the sand/gravel armoring layer installed throughout these two zones to minimize scouring would also minimize any resuspension of sediment resulting from the installation of the cofferdams. River water recovered during dewatering of the cofferdams would be treated (e.g., tanks to settle out any suspended

[1] Use of an environmental/closed bucket would minimize the amount of sediment lost to the water column; however, certain types of buckets (e.g., level cut buckets) can produce a thick slurry near the river bottom. Rehandling buckets with offset pivots or enclosed buckets with an articulated arm are better able to remove the dredge material from the river bottom with minimal creation of the thick bottom slurry (Palermo et al. 2008, USEPA 2005).

sediments and water filtration system as necessary) and discharged back to the Hudson River in accordance with conditions issued by the NYSDEC under the Section 401 water quality certification for the project and would not result in adverse impacts to water quality of the Hudson River.

18-4-12-4 EXISTING BRIDGE DEMOLITION

Bridge demolition would occur in two stages. The first stage includes partial demolition to allow for construction of the replacement bridge in the vicinity of the Westchester shoreline. The second stage includes the remaining demolition after completion of the replacement bridge. Refer to Chapter 13, "Energy and Climate Change," for a discussion on final disposition and potential recycling of the existing bridge components. Use of turbidity curtains during removal of the columns and footings and cutting of the timber piles would minimize the potential for sediment resuspended during the bridge removal activities to adversely affect water quality. Following removal of the existing bridge, sediment that has been deposited within mounds in the vicinity of the existing bridge piers is expected to erode over time until reaching a new equilibrium elevation. Because the Tappan Zee portion of the Hudson River is considered to be neither a depositional nor an erosional environment (i.e., in equilibrium) (Nitsche et al. 2007), as indicated by the results of the 20th century sediment mapping presented in Chapter 15, "Water Resources" (see **Appendix E),** minimal erosion of sediments in the vicinity of the existing bridge would be expected to occur under normal river conditions, and would most likely occur only during high flow events. While some of these sediment deposits have elevated concentrations of certain contaminants (Class B or Class C categories), these elevated concentrations do not extend more than a few feet below the mudline. Therefore, the gradual erosion of some areas of contaminated sediment following the removal of the bridge in accordance with conditions issued by the NYSDEC would not be expected to result in adverse impacts to water quality or result in water quality conditions that fail to meet the Class SB standards.

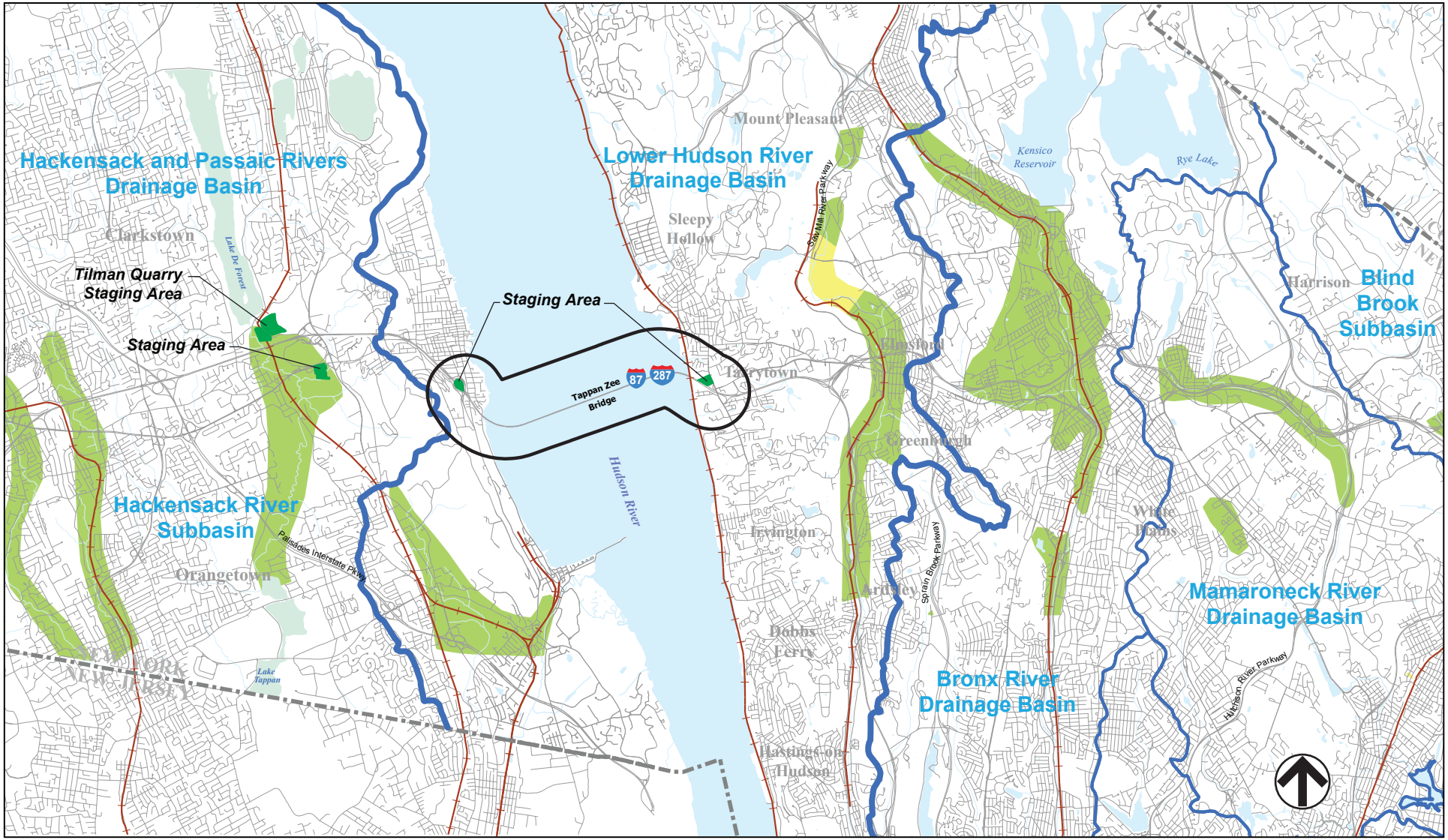
18-4-12-5 INLAND STAGING AREAS

Groundwater Resources

West Nyack Staging Area

This approximately 33-acre site contains a concrete batch plant, and areas of paved and unpaved surfaces. The use of the WNSA for the construction staging activities described in Section 18-3-2, "Inland Construction Staging," of this chapter would not be expected to adversely affect the designation of the aquifer at the site as a Principal Aquifer with maximum obtainable well yields of 10 to 100 gallons per minute (gpm)(see **Figure 18-17**). As described in Chapter 15, "Water Resources," principal Aquifers are known to be highly productive, but are not used as a public water supply (NYSDEC 1990). Any storage and use of petroleum and other chemical products (e.g., diesel fuel, lubricating oil and miscellaneous cleaning and maintenance chemicals) would be in accordance with applicable regulatory requirements, including those relating to federal Spill Prevention, Control, and Countermeasures (SPCC) requirements and state petroleum bulk storage, chemical bulk storage (CBS), and spill requirements. With implementation of these measures, potential impacts to groundwater resources would be minimized. Furthermore, once specific locations of soil disturbance are identified, environmental site investigation(s) would be conducted to identify potential areas of

12.2.11



Project Site Boundary

Drainage Basins

Subbasins

Principal Aquifers 10-100 gallons per minute (gpm)

Principal Aquifers >100 gallons per minute (gpm)

0 1 2 MILES

SCALE

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 18-17
Aquifer and Drainage Basins

subsurface contamination to minimize the potential for adversely affecting groundwater quality.

Tilcon Quarry Staging Area

Use of the quarry site or adjacent commercial properties for construction staging activities described in Section 18-3-2, “Inland Construction Staging,” of this chapter would not result in significant adverse impacts to the Principal Aquifer near the site. Implementation of the SPCC requirements as necessary would minimize the potential for the storage of petroleum or chemical products on the site to adversely affect groundwater resources. With implementation of these measures, potential impacts to groundwater resources would be minimized. As discussed for the WNSA environmental site investigation(s) would be conducted to identify potential areas of subsurface contamination prior to any soil disturbing activities to minimize the potential for adversely affecting groundwater quality.

In the event the contractor decides to use either the TQSA site, or the previously discussed WNSA site for construction staging, in accordance with NYSDOT Standard Specifications, they would be required to conduct its operations in compliance with all applicable federal, state and local laws and regulations and obtain all licenses and permits necessitated by their operations. Therefore, the contractor would be required to avoid, minimize or mitigate any potential impacts as part of their construction operations for the project at these sites.

Westchester Staging Area

The WISA is currently used by the NYSTA’s TZB maintenance facility, Bridge patrol, Equipment Maintenance, and the NYSP Troop T unit. It contains impervious surfaces, such as buildings and paved road/parking areas, and landscaped areas. There are no Principal or Primary Aquifers designated by the NYSDEC or Sole Source Aquifers (SSAs) designated by the EPA within the vicinity of the WISA (see **Figure 18-17**). Implementation of the SPCC requirements as necessary would minimize the potential for the storage of petroleum or chemical products on the site to adversely affect groundwater resources. With implementation of these measures, potential impacts to groundwater resources would be minimized. Use of this site for construction staging activities described in Section 18-3-2, “Inland Construction Staging,” of this chapter would not result in adverse impacts to groundwater resources.

Watersheds and Waterbodies

Rockland Inland Staging Areas

On the Rockland Inland Staging Area sites, any soil disturbance that would occur as a result of use of the WNSA and TQSA in preparation for their use for construction staging would employ erosion and sediment control measures (e.g., silt fences and straw bale dikes) in accordance with the New York Standards and Specifications for Erosion and Sediment Controls (last revised August, 2005). Stormwater management measures would be implemented in accordance with the Stormwater Pollution Prevention Plan (SWPPP) developed for the site in accordance with the New York State Stormwater Management Design Manual (NYSSMDM) (last revised August, 2010). These measures would minimize potential impacts to water quality of the

Hackensack Tributary 9AA and Hackensack River associated with stormwater runoff from the WNSA and TQSA, respectively.

In the event the contractor decides to use the Rockland Inland Staging Area sites for construction staging, as described above, they would be required to conduct its operations in compliance with all applicable federal, state and local laws and regulations and obtain all licenses and permits necessitated by their operations.

Westchester Inland Staging Area

Use of the WISA for construction staging activities would not result in significant adverse environmental impacts to surface water resources. Any soil disturbance that would occur on this primarily paved site in preparation for its use for construction staging would employ erosion and sediment control measures (e.g., silt fences and straw bale dikes) in accordance with the New York Standards and Specifications for Erosion and Sediment Controls. Stormwater management measures would be implemented in accordance with the SWPPP developed for the site in accordance with the NYSSMDM. These measures would minimize potential impacts to surface waters associated with stormwater runoff from the WISA, and the use of this site as a staging area would not result in adverse impacts to surface waters.

Floodplains

West Nyack Staging Area

While a portion of the site is within the 100- and 500-year floodplain, no activities would be conducted in this portion of the site that would impede floodwaters or result in increased flooding of adjacent areas (see **Figure 18-18**).

Tilcon Quarry Staging Area

The TWSA is located outside the 100- and 500-year floodplain (see **Figure 18-18**) and would not result in adverse impacts to floodplain resources.

Westchester Inland Staging Area

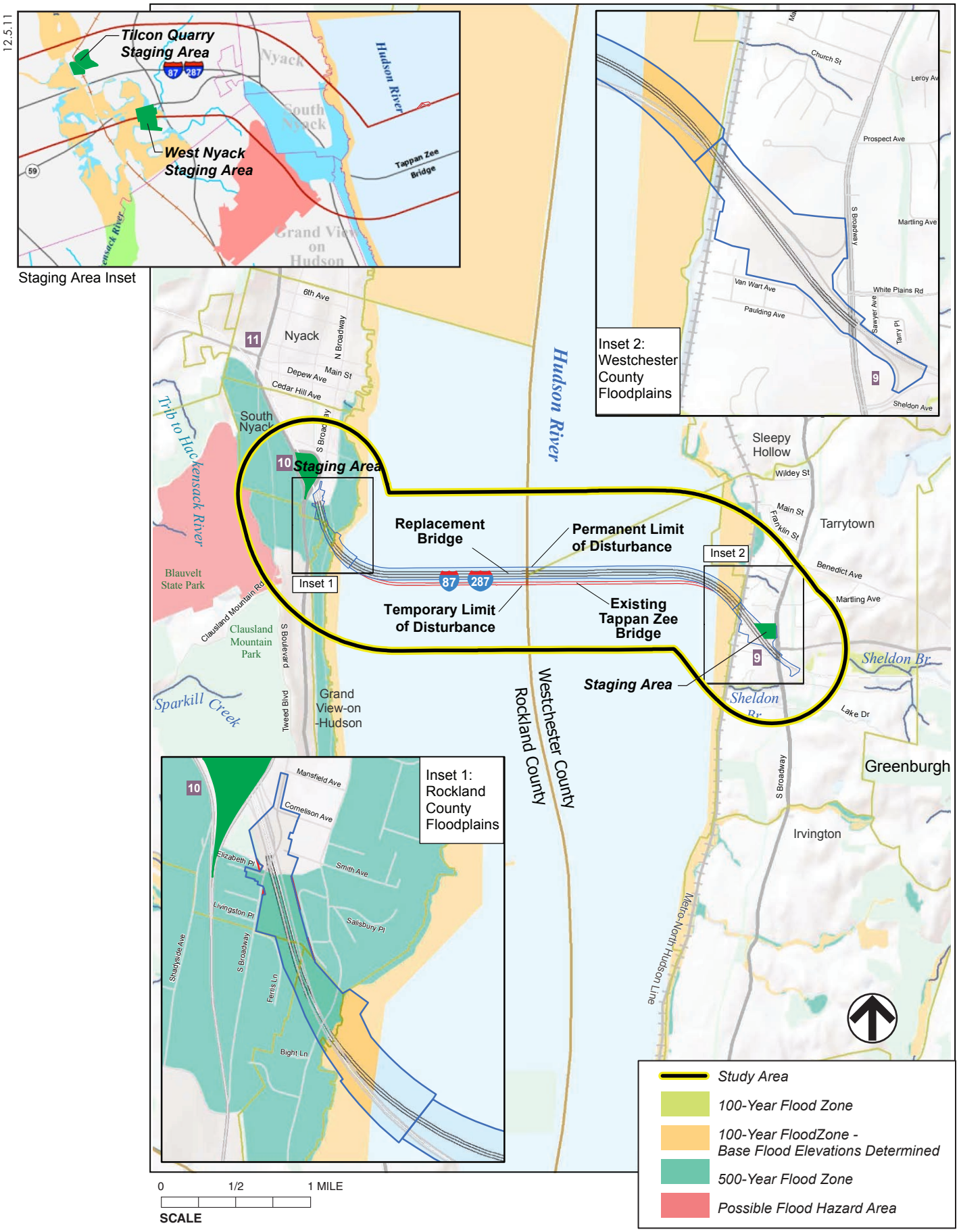
The WISA is located outside the 100- and 500-year floodplain (see **Figure 18-18**) and would not result in adverse impacts to floodplain resources.

Bridge Staging Areas

The temporary platforms constructed for the Rockland and Westchester Bridge Staging areas would be within the 100-year flood plain. As discussed in Chapter 15, “Water Resources,” the Hudson River within the study area is tidally influenced and as such is affected by coastal flooding, which is influenced by astronomic tide and meteorological forces and would not be affected by the platforms proposed within the Bridge Staging Areas for the Replacement Bridge Alternative. Therefore, the platforms within the bridge staging areas would not result in adverse impacts to wetland resources and would be in compliance with Executive Order 11988.

18-4-12-6 STORMWATER MANAGEMENT

During upland construction activities such as those associated with the previously described upland staging areas, the bridge landings for the Replacement Bridge Alternative, and development of construction access to the waterfront staging areas,



TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 18-18
Floodplain

erosion and sediment control measures (e.g., silt fences and straw bale dikes) would be implemented in accordance with the New York Standards and Specifications for Erosion and Sediment Controls. Stormwater management measures would be implemented through development of a SWPPP, in accordance with the New York State Stormwater Management Design Manual (NYSSMDM) (last revised August, 2010) and the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity (GP-0-10-001). Implementation of these measures would minimize the potential for stormwater runoff from upland construction areas to adversely affect water quality of the Hudson River, Sheldon Brook, or the freshwater wetland adjacent to the access road to the Westchester Bridge Staging Area. Therefore, upland soil disturbance and discharge of stormwater runoff from construction access and inland staging areas would not result in adverse impacts to water quality of the Hudson River or Sheldon Brook.

18-4-13 ECOLOGY

Construction of the Replacement Bridge Alternative has the potential to affect wetlands, terrestrial resources including vegetation, wildlife, and threatened or endangered terrestrial species, due to disturbance for construction of the new bridge landings, staging areas and development of construction access to the waterfront staging areas. In-water construction activities such as dredging, armoring of the dredged channel, installation of cofferdams and bulkhead, driving of piles, and demolition of the existing bridge have the potential to affect aquatic biota, including threatened or endangered species, and significant habitat areas of the Hudson River (e.g., Significant Coastal Fish and Wildlife Habitat, USFWS Significant Habitats, and Essential Fish Habitat (EFH)) within the study area. Activities within wetlands or special habitats, or those that have the potential to affect federal or state-listed threatened or endangered species, EFH, or affect the presence of invasive species must comply with the federal and state legislation and regulatory programs described previously in Chapter 16, “Ecology.”

Potential impacts to terrestrial biota, wetlands and aquatic biota within the study area were assessed by considering the following:

- Temporary impacts to wetlands due to dredging and temporary structures;
- Permanent impacts to NYSDEC littoral zone wetlands and a possible freshwater wetland due to placement of fill or structure;
- Temporary and permanent loss of terrestrial vegetation and it use as wildlife habitat due to land clearing, grading and other construction activities;
- Airborne noise disturbances to wildlife, including threatened and endangered species;
- The potential for temporary increases in suspended sediment resulting from dredging, in-water construction activities, and demolition of the existing bridge, to affect benthic invertebrates, fish (including threatened and endangered species), and Submerged Aquatic Vegetation (SAV)
- The loss or temporary modification of bottom habitat due to dredging, armoring of the dredged channel, and pile-driving;

- Permanent loss of bottom habitat due to construction of in-water components of the project; and
- Hydroacoustic effects to fish (including threatened or endangered species) and benthic invertebrates.

18-4-13-1 WETLANDS

Tidal Wetlands

Tidal wetlands would be affected within the Bridge Study Area by construction of the temporary access roadway to the temporary platform for the Westchester Bridge Staging Area, construction of the permanent work platform within the Rockland Bridge Staging Area; and dredging activities for the project as described below and summarized in **Tables 18-27** and **18-28**.

Temporary Access Roadway

Two temporary work platforms would be constructed north of the existing bridge, one platform within each Bridge Staging Area, to provide space for the docking of vessels, the transfer of materials and personnel, and the preparation of construction elements for the Replacement Bridge Alternative. Neither temporary platform would be located within mapped NYSDEC littoral zone tidal wetlands. However the construction of the temporary access road leading to the Westchester Bridge Staging Area would result in temporary impacts to approximately 0.03 acres of mapped NYSDEC littoral zone tidal wetland within the footprint of the piles driven to support the pile-supported access roadway platform. Approximately 0.5 acres of mapped NYSDEC littoral zone tidal wetlands would be covered by the access roadway platform. In addition, approximately 0.4 acres within the associated tidal wetland adjacent area would be affected. After construction, the temporary roadway platform and pilings would be removed. Areas that were shaded by platform coverage would remain as littoral zone habitat during construction, although the value of such habitat would be diminished for some organisms during the 4½ to 5½ year construction period. After construction, these areas would be re-exposed to sunlight and light-dependent organisms (e.g., algae, epifaunal benthic macroinvertebrates, fish) would be expected to quickly re-colonize the area. After pilings are removed, the natural sedimentation process of the river would occur and the areas occupied by pilings would be restored. The area disturbed within the adjacent area would be revegetated with species indigenous to this region of New York to the greatest extent practicable in accordance with a landscaping plan that would be in compliance with E.O. 13112, “Invasive Species.” Therefore, the construction of the temporary access roadway for the Westchester Bridge Staging Area would not result in adverse impacts to mapped NYSDEC tidal wetlands or adjacent area.

Rockland Bridge Staging Area

The Rockland Bridge Staging Area would be constructed north of the existing bridge, outside of NYSDEC tidal weltands or potential USACE wetlands.

Table 18-27
Overwater Coverage from Platforms

	Habitat	Acres
Temporary Overwater Coverage		
West Platform-Storage Platform Area	Open Water	4.26
East Platform-Storage Platform Area	Open Water	2.30
East Platform-Docking Platform Area	Open Water	1.84
East Platform-Access Road	Littoral Zone	0.50
TOTAL		**8.9**
Permanent Overwater Coverage		
Permanent Platform	Littoral Zone	0
Permanent Platform	Open Water	2.16
TOTAL		**2.16**

Table 18-28
Potential Loss of River Bottom, Wetlands, and Adjacent Area Habitats due to Project Activities

	Possible Freshwater Wetland Areas (acres)	NYSDEC Littoral Zone Tidal Wetlands (acres)	NYSDEC Tidal Wetland Adjacent Area (acres)	Open Water Benthic Habitat (acres)	Total Short Span (acres)	Total Long Span (acres)
Temporary						
West Platform-Storage Platform Area	-	-	-	0.21	0.21	0.21
East Platform-Storage Platform Area	-	-	-	0.12	0.12	0.12
East Platform-Docking Platform Area	-	-	-	0.09	0.09	0.09
East Platform-Access Road	0.15	0.03	0.4	-	0.58	0.58
Dredging/Armoring	-	5.3	-	160-170/155-165	175/165	165/160
West Nyack Staging Area	2.0	-	-	-	2.0	2.0
Tilcon Quarry Staging Area	-	-	-	-	-	0
TOTAL TEMPORARY	3.5	5.3	0.4	160.4-170.4	178	168
Permanent						
Permanent Work Platform-Pile-supported	-	-	-	0.11	0.11	0.11
Permanent Work Platform-Bulkheaded	-	-	-	0.21	0.21	0.21
New Bridge	-	-	-	6.5-8.0	8	6.5
Removal of Existing Structure	-	-	-	(7.1)	(7.1)	(7.1)
TOTAL PERMANENT	0	0	0	(0.28)-1.22	1.22	(0.28)-

Dredging

As discussed above in Section 18-3-3, "Dredged Access Channel," dredging of the Hudson River is required to allow access for construction barges. While the majority of dredging would occur in water depths of greater than 6 feet at mean lower low water (MLLW), approximately 5.3 acres of mapped NYSDEC littoral zone tidal wetland south of the existing bridge on the east bank of the River would be dredged to construct the eastern portion of the Replacement Bridge Alternative. The area that would be dredged is flat, unvegetated, with a silty bottom. Upon completion of construction activities, natural deposition of sediment within the dredged channel over time would be expected to restore some or all of this area to a depth that would be classified as NYSDEC littoral zone tidal wetland (i.e., no deeper than 6 feet at mean low water (MLW)). The temporary loss of this small area of mapped NYSDEC littoral zone tidal wetlands would not result in adverse impacts to NYSDEC littoral zone tidal wetland resources within the Lower Hudson River.

Freshwater Wetlands

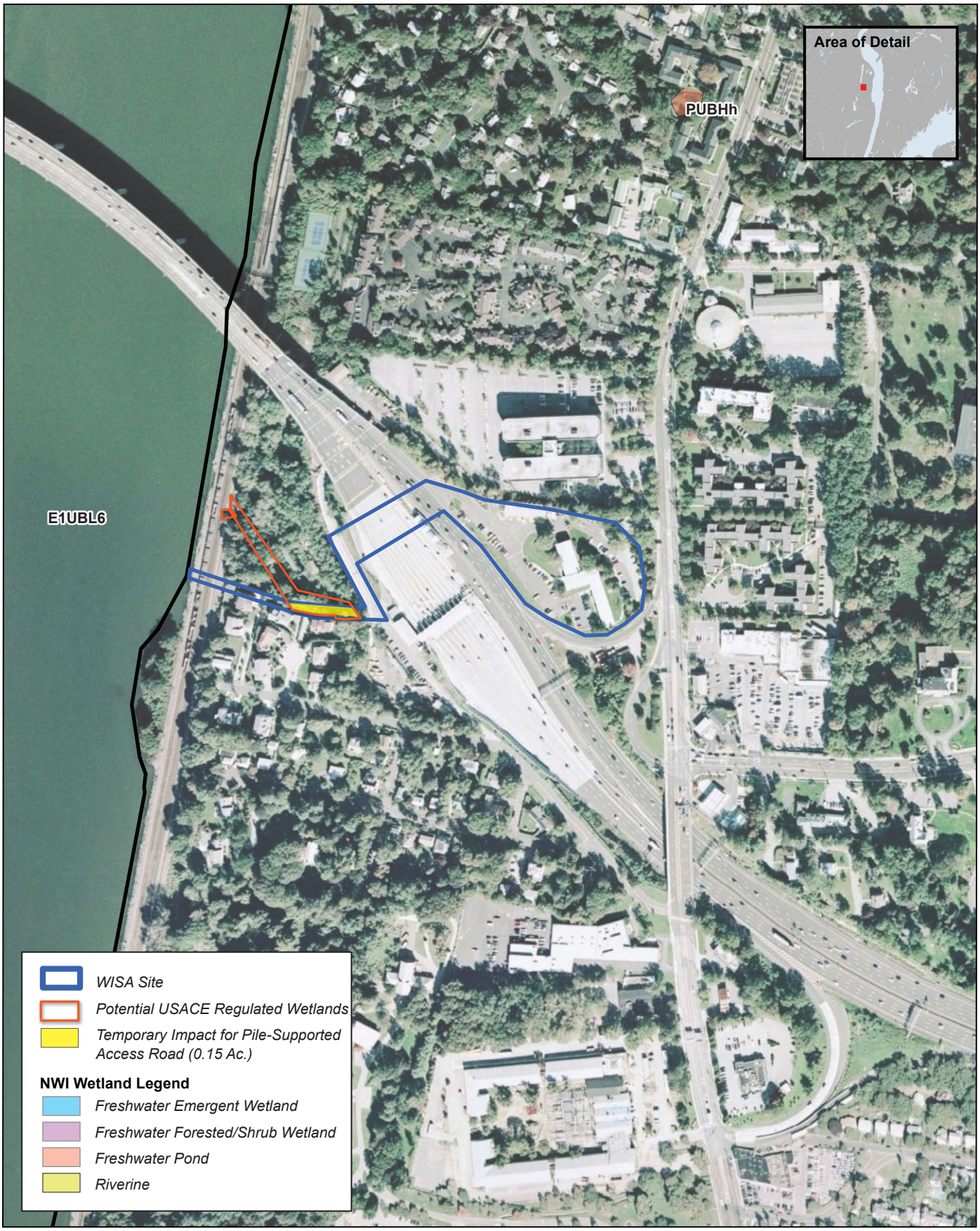
Bridge Study Area

The Rockland Bridge Staging Area would be constructed north of the existing bridge, and would avoid the small (approximately 0.11 acres) depression exhibiting freshwater wetland characteristics south of the bridge. However, upland construction of the access road to the temporary platform within the Westchester Inland Staging Area (WISA) would deck over approximately 0.15 acres of a 0.63-acre small stream and forested wetland corridor on the east bank of the river, as discussed below under Westchester Inland Staging Area (see **Figure 18-19**). Construction activities would have the potential to affect the freshwater wetland areas located at the Rockland Bridge Staging Area and WISA through the discharge of sediment in stormwater runoff. However, as discussed above in Section 18-4-12-5, "Stormwater Management," implementation of erosion and sediment control measures (e.g., silt fences and straw bale dikes) and stormwater management measures implanted through the development of a SWPPP would minimize the potential for stormwater runoff from construction of the access road to affect this small wetland area. Therefore the project would not adversely affect this freshwater wetland.

Westchester Inland Study Area

No mapped NYSDEC freshwater wetlands are present on the WISA. In addition, no National Wetland Inventory (NWI)-mapped wetlands are present on the WISA (see **Figure 18-19**). However, upland construction of the access road to the temporary platform within the WISA would deck over approximately 0.15 acres of a 0.63-acre small stream and forested wetland corridor on the east bank of the river. Trees would be removed and pilings placed every 200 feet to support the roadway. As the roadway would consist of a platform over the wetland areas, it is not expected that wetland hydrology would be altered or indirectly effect wetlands downstream. Once engineering design has sufficiently progressed and the permitting phase of the project has begun, this freshwater wetland would be evaluated and the boundary delineated in accordance

1.10.12



Source: National Wetlands Inventory, USFWS

0 200 500 FEET

SCALE

Figure 18-19

National Wetland Inventory Mapped Wetlands and Potential USACE Wetlands Westchester Inland Staging Area (WISA)

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

with the USACE *Wetlands Delineation Manual*.[1] After construction is complete, the area would be restored as forested wetland habitat with equal or greater value and re-planted with native wetland vegetation in accordance with a wetland mitigation plan to be developed in coordination with the USACE. Therefore, there would be no adverse impact to this resource.

West Nyack Staging Area

No mapped NYSDEC freshwater wetlands are present on the WNSA. As shown in **Figure 18-20**, National Wetland Inventory (NWI)-mapped wetlands consist of a palustrine forested wetland with broad-leaved deciduous vegetation that is seasonally flooded or saturated (PFO1E). However, most of the PFO1E wetland appears as unvegetated land that is part of the current industrial activities and concrete batch plant operations. If the WNSA is selected and completely developed, about 2 acres of palustrine forest would be lost.

In the event the contractor decides to use the WNSA site for construction staging, in accordance with NYSDOT Standard Specifications, they would be required to conduct its operations in compliance with all applicable federal, state and local laws and regulations and obtain all licenses and permits necessitated by their operations. Therefore, once a site plan was developed, a wetland delineation would be performed to confirm the presence, area, and condition of potential wetlands on the WNSA per the USACE *Wetlands Delineation Manual*. If any wetlands were potentially affected the contractor would be required to avoid, minimize or mitigate any potential impacts on WNSA as part of the permitting process for this site.

Tilcon Quarry Staging Area

As stated above, the majority of the TQSA is an active excavation site devoid of vegetation. No mapped NYSDEC freshwater wetlands are present on this site. As shown in **Figure 18-21**, NWI-mapped wetlands within the site comprise: excavated palustrine wetland with an unconsolidated bottom that is permanently flooded (PUBHx), excavated palustrine wetland with an unconsolidated bottom that is semi-permanently flooded (PUBFx), excavated palustrine wetland with an unconsolidated shore that is seasonally flooded (PUSCx), and palustrine forested wetland with broad-leaved deciduous vegetation that is saturated (PFO1B). The area in the vicinity of the PFO1B was observed to be cleared during the site visit. In addition, the mapped palustrine excavated areas are not visible on aerial mapping of the TQSA and have likely been altered quarry activities. Additionally, under guidance issued by the USACE[2] surface waters created as a result of construction activity and pits excavated in dry land for the purpose of obtaining fill, sand, or gravel are not considered Waters of the United States until the construction or excavation operation is abandoned.

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[1] USACE 1987 Wetland Delineation Manual and 2009 Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region.

[2] The U.S. Army Corps of Engineers issued guidance clarifying the definitions of waters of the United States under their Section 404 regulatory program (33 CFR Parts 320 through 330) as a Final Rule published in the Federal Register (Vol 51, No 219) on November 13, 1986

12.5.11

Source: National Wetlands Inventory, USFWS

WNSA Site

NWI Wetland Legend

- *Freshwater Emergent Wetland*
- *Freshwater Forested/Shrub Wetland*
- *Freshwater Pond*
- *Riverine*

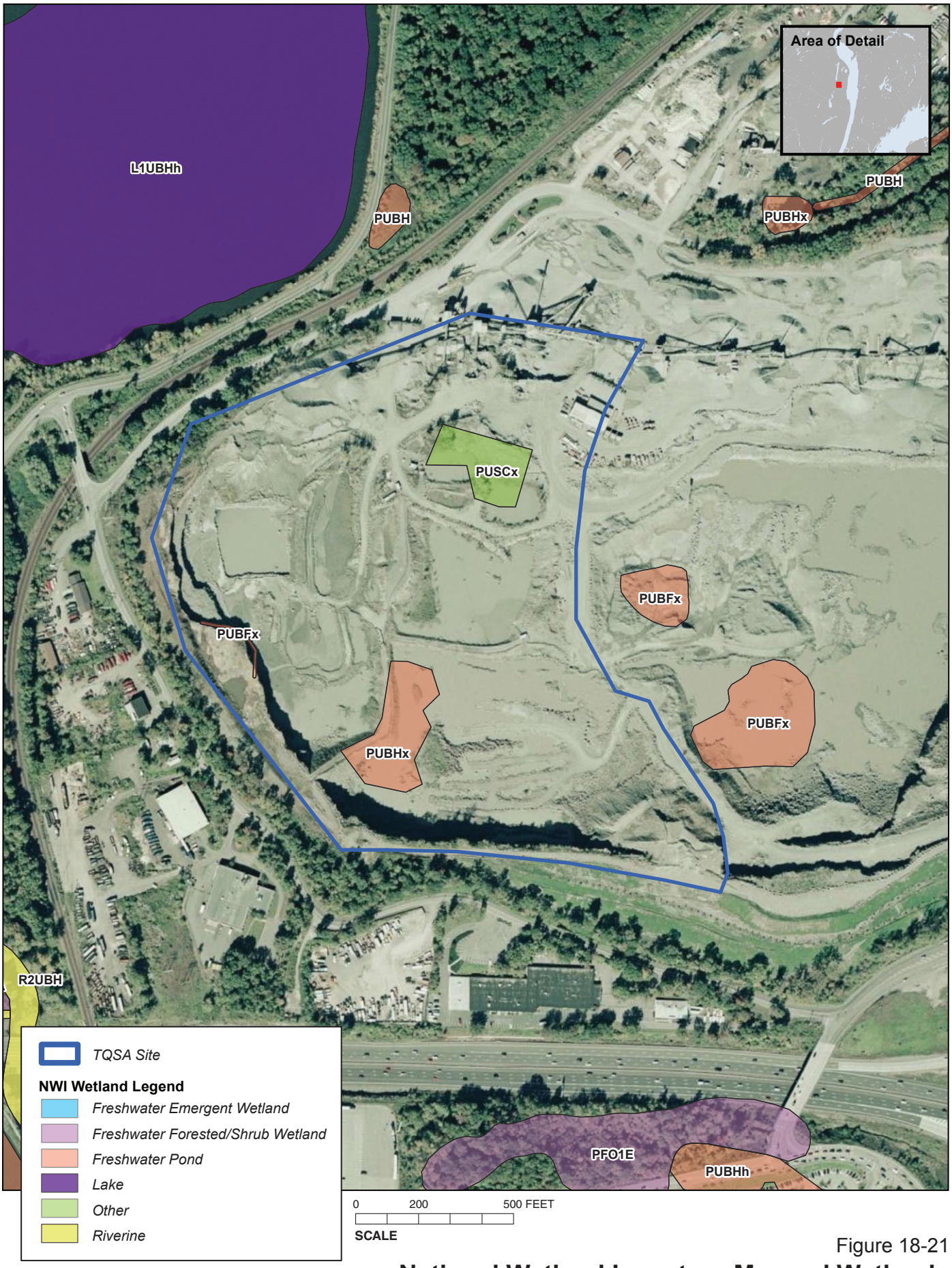
0 200 500 FEET

SCALE

Figure 18-20

National Wetland Inventory Mapped Wetlands West Nyack Staging Area (WNSA)

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement



12.5.11

Source: National Wetlands Inventory, USFWS

Figure 18-21

National Wetland Inventory Mapped Wetlands
Tilcon Quarry Staging Area (TQSA)

Similar to discussion above in connection with the WNSA, in the event the contractor decides to use the TQSA site for construction staging, they would be required to conduct its operations in compliance with all applicable federal, state and local laws and regulations and obtain all licenses and permits necessitated by their operations. Depending upon their actual site plan, this could potentially include wetland permits from the ACOE and the avoidance, minimization or mitigation of any adverse impacts on ecological resources of the TQSA.

Executive Order 11990, "Protection of Wetands"

As described in Chapter 16, "Ecology," under E.O. 11990, federal agencies must avoid undertaking or providing assistance for new construction in wetlands unless there is no practical alternative to such construction and the proposed action includes all practicable measures to minimize harm to the wetland. NYSDEC-regulated littoral zone wetlands and open water benthic habitats are considered deepwater habitats and as such, are not included as E.O. 11990 wetland resources.

Wetland habitats with the potential to be affected per E.O. 11990 include the small (0.11-acre) possible freshwater wetland depression at the Rockland Bridge Staging Area, the 0.63-acre stream and forested wetland corridor at the WISA, and approximately 2 acres of forested wetlands at the WNSA. As described above, all practicable measures (i.e., avoidance, minimizing intrusion, implementation of erosion and sediment control measures) will be taken to minimize harm to wetland areas.

As discussed above, implementation of erosion and sediment control measures (e.g., silt fences and straw bale dikes) and stormwater management measures implanted through the development of a SWPPP would minimize the potential for stormwater runoff from construction of the access road to affect the small wetland area at the Westchester landing. In addition, the project would first seek to avoid and minimize impacts to wetlands on the WNSA. If there is no feasible or practical alternative to filling wetlands, a wetland mitigation plan will be developed in coordination with the USACE.

A portion of the stream and forested wetland at the WISA (approximately 0.15 acres) would be temporarily lost due to the pile-supported temporary access roadway for the Westchester Bridge Staging Area. There is no feasible or practicable alternative to construction within this potential wetland area. However, measures have been taken to minimize impacts. Instead of filling the wetland for the roadway, the roadway will be a pile-supported platform that will deck over the wetlands. Although plants will be removed for this effort, wetland hydrology will be maintained. The roadway was designed with the smallest footprint feasible to keep with the project goals of providing access to the Westchester Bridge Staging Area, while to accommodating the width required for construction equipment and emergency vehicles. Once engineering design has sufficiently progressed and the permitting phase of the project has begun, this freshwater wetland would be evaluated and the boundary delineated in accordance with the USACE *Wetlands Delineation Manual.* After construction is complete, the area would be restored as forested wetland habitat with equal or greater value and re-planted with native wetland vegetation in accordance with a wetland mitigation plan to be developed in coordination with the USACE.

Therefore, the project is consistent with the intent of E.O. 11990.

18-4-13-2 TERRESTRIAL RESOURCES

Construction of the project would require the temporary loss of terrestrial vegetation in addition to permanent changes discussed in Chapter 16, “Ecology.” The temporary loss of vegetative communities (i.e., successional forest) would occur as a result of construction at the bridge landings, staging areas, and access roads would have the potential to affect wildlife using these areas. Noise and increased human activity associated with the in-water construction activities would have the potential to result in the loss of foraging habitat due to avoidance of the area in the vicinity of these activities, as described below.

Terrestrial Vegetation

Bridge Study Area

Less than 9 acres of habitat that would be characterized as disturbed roadside (mowed lawn, paved areas, etc.) and successional forest terrestrial habitats following Edinger et al. (2002) would be disturbed due to staging areas, access roads, etc. These ecological communities are common throughout the region and are of low ecological value due to low species diversity, high level of anthropogenic activities, and dominance of non native, invasive vegetation. Therefore, the loss of these habitats during construction of the project would not result in adverse impacts to these ecological communities throughout the region. Disturbed areas not occupied by permanent structures (about 7 acres) would be revegetated with native species indigenous to this region of New York to the greatest extent practicable in accordance with a landscape plan that would be in compliance with E.O.13112, “Invasive Species.”

Interchange 10 Staging Area

The ecological communities of the Interchange 10 Staging Area would be characterized as unpaved and paved areas and mowed lawn communities following Edinger et al. (2002). The site is an existing staging area for the NYSTA located north-adjacent of Interstate 87/287 and is nearly devoid of vegetation. The habitat value of this site is low due to limited vegetation and high levels of anthropogenic activities. During construction of the project, this facility would continue to operate as a staging area. Therefore, the project would not result in adverse impacts to terrestrial plant resources.

West Nyack Inland Staging Area

The disturbed/developed portions of this potential staging area contain industrial uses (e.g., an existing concrete batch plant). The ecological communities within these portions of the WNSA site would be characterized as unpaved and paved areas and urban vacant lot habitat following Edinger et al. (2002) and have limited vegetation coverage with invasive and pioneer species. Plants observed around buildings and at the edges of the site are common urban-adapted species. The habitat value of these communities is low due to low species diversity, high level of anthropogenic activities, and dominance of non native, invasive vegetation and the loss of these communities as a result of the construction of the project would not result in adverse impacts to terrestrial plant resources. The potential impacts to late flowering boneset (*Eupatorium serotinum*) individuals, a state-listed endangered species, observed on the WNSA is discussed below under *Threatened, Endangered, and Special Concern Species*.

As described above under *Freshwater Wetlands*, there is a potential for palustrine forested wetlands mapped by the NWI to be present on the WNSA (see **Figure 18-20**).

As discussed previously, if this site is used for construction staging, the contractor would be required to operate in compliance with all applicable federal, state and local laws and regulations and obtain all licenses and permits necessitated by their operations. As such, they would be required to avoid, minimize or mitigate any potential impacts on terrestrial resources on the WNSA site.

Tilcon Quarry Staging Area

The ecological community of this site would be characterized as a rock quarry terrestrial community following Edinger et al. (2002) and is an active excavation site. The site is nearly devoid of vegetation with limited vegetation coverage along the perimeters of the site. This site has low habitat value due to lack of vegetation, low species diversity, high level of anthropogenic activities, and dominance of non native, invasive vegetation.

As described above if this site is used by the contractor they would be required to obtain all licenses and permits and conduct their operations in compliance with all applicable federal, state and local laws and regulations. As such, the contractor would be required to avoid, minimize or mitigate any potential impacts on the terrestrial resources of the TQSA.

Westchester Inland Staging Area

The terrestrial communities present within the WISA would be characterized paved road/path, mowed lawn, and mowed lawn with and a successional southern hardwoods community following Edinger et al. (2002). The habitat value of these communities is low due to low species diversity, high level of anthropogenic activities, and dominance of non native, invasive vegetation and the loss of these communities as a result of the construction of the project would not result in adverse impacts to these habitat types within the region.

Terrestrial Wildlife

Bridge Study Area

As described in detail in Chapter 16, “Ecology,” the terrestrial wildlife communities in the bridge study area are largely composed of disturbance-tolerant, species that are associated with fragmented habitats and forest edges and can co-exist with anthropogenic activities in highly disturbed areas. The loss of the vegetation communities described above under *Terrestrial Vegetation* for construction of the project within the bridge landings and access roads to the Bridge Landing Areas, which comprise primarily poor quality wildlife habitat, would not result in adverse impacts to wildlife resources of the region.

Wildlife using habitats within the Bridge Study Area that would not be affected by construction of the project would have the potential to be affected by noise and increased human activity resulting from the construction of the project. Human activity levels influence wildlife community composition, as disturbance tolerance varies greatly among different species (Bowles 1995, Bayne et al. 2008, Francis et al. 2009). Because the study area around the bridge has been developed and under its present land use for many years, local wildlife communities have been shaped in part by its high existing

levels of noise and other human disturbances. These communities are primarily composed of urban-adapted, disturbance-tolerant species. Highly sensitive species are unlikely to occur in the study area due to its high levels of human activity and lack of undisturbed habitat. However, construction of the project and demolition of the existing bridge would elevate noise and human activity levels above background levels in the area, and thus there is the potential to temporarily displace or otherwise adversely affect wildlife that is habituated to lower levels of disturbance.

The species most likely to be affected are those that would occur in closest proximity to the areas of construction, such as peregrine falcons that nest on the bridge, and waterbirds that forage in the Hudson River, primarily during winter. However, there has been significant maintenance work on the bridge on recent years, and many of these species are expected to be habituated to elevated noise and anthropogenic activity. As discussed below, peregrine falcons have become increasingly common in urban areas and highly tolerant of human disturbance (Cade et al. 1996, White et al. 2002).

Reactions of wildlife to loud, unfamiliar noises and other human disruptions usually include a rise in heart rate and acute stress level, and/or departure from the source of the disturbance (Bowles 1995). Waterbirds that forage in the Hudson River would in most cases be expected to temporarily avoid the areas of construction activity and instead utilize other sections of the river slightly up- or down-stream. The loss of this small section of the river to birds for habitat would not result in adverse impacts to regional bird populations. Additionally, nearby expanses of open river would remain accessible and free of disturbances throughout the project's construction.

On land, the terrestrial species expected to occur within the vicinity of the bridge landings and WISA would take place are limited to urban-adapted birds and mammals, due to the high existing levels of noise and limited habitat availability in the area. Noise and human activity associated with construction in these areas would not adversely affect regional wildlife populations.

Rockland Inland Staging Areas

The WNSA and TQSA are within a heavily developed landscape with minimal undisturbed habitat available to wildlife. Similar to the bridge study area, the wildlife expected to occur around the Rockland potential staging areas is largely limited to urban-adapted, disturbance-tolerant species that inhabit degraded habitats. The pond and forested wetland areas to the east and west of the WNSA and forested wetland area within the central portion of the WNSA may support relatively diverse assemblages of wildlife species, particularly reptiles and amphibians. However, the WNSA site is located in a highly commercial area, along a busy road adjacent to a waste transfer station. In addition, the WNSA site already has a concrete batching plant and other industrial activities. Similarly, the TQSA is an active quarry. Birds and wildlife that use this site would be acclimated to the use of noisy heavy equipment. Overall, the current commercial and industrial usages of the proposed staging areas and birds and wildlife using these sites are already adapted to high levels of anthropogenic activity. During project construction, the habitats within and around the potential staging sites would continue to support urban-adapted wildlife.

18-4-13-3 AQUATIC RESOURCES

Construction of the project has the potential to affect benthic macroinvertebrates and fish due to loss of habitat from dredging, pier installation (e.g., pile driving, installation of cofferdams and fendering), the temporary change in bottom habitat resulting from dredging and subsequent placement of armoring, temporary increases in suspended sediment due to dredging and other sediment disturbing construction activities, and hydroacoustic effects on fish and benthic macroinvertebrates, as discussed in detail below.

Benthic Macroinvertebrates

Tables 18-26 and 18-27 indicate permanent and temporary impacts to benthic macroinvertebrates due to dredging and armoring. Temporary increases in suspended sediment and changes to the hydroacoustic environment have the potential to affect benthic macroinvertebrate resources.

Dredging

The primary impact to benthic macroinvertebrates from dredging is the loss of the habitat and animals associated with the dredged material (Hirsch et al. 1978). Dredging can also cause the conversion of shallow subtidal habitat to deeper subtidal habitat and can result in temporary increases of suspended sediment due to resuspension of bottom sediment. This section addresses the potential impacts to benthic macroinvertebrates from the loss of habitat and individuals. Potential impacts associated with increased suspended sediment are evaluated under *In-water Construction Activities*. The frequency of dredging or disturbance of an area affects the invertebrate community and its ability to recover following each dredging event. Benthic communities found in environments with a great deal of variability such as estuaries have higher rates of recovery from disturbance. Recovery rates of benthic macroinvertebrate communities following dredging range from only a few weeks or months to a few years, depending upon the type of project, the type of bottom material, the physical characteristics of the environment and the timing of disturbance (Hirsch et al. 1978, LaSalle et al. 1991). In a two year study in the lower Hudson River, Bain et al. (2006) reported that within a few months following dredging, the fish and benthic communities at a dredged location were no different from seven nearby sites that had not been dredged. The results of monitoring did not indicate a lasting effect at the dredged site.

Dredging activities for the project have the potential to remove benthic macroinvertebrates, including oyster beds, and the food resources they provide to other aquatic resources. Approximately 165 to 175 acres of bottom habitat—including about 5.3 acres of NYSDEC regulated littoral zone tidal wetland described above under *Tidal Wetlands* and 160-170 acres of open water benthic habitat—would be dredged during three 3-month phases over a four year period (see **Figure 18-5**). The dredging period of August 1 to November 1 would avoid periods of anadromous fish spawning migrations and peak biological activity. In addition, the trench would be armored following dredging and the benthic habitat within the dredge zone which was primarily soft sediment would be changed to a substrate of sand and gravel. Since armoring would occur up to 20 feet of the side slope, total acreage of hard bottom would be approximately 155 to 165 acres. The materials would not be removed after the project completion, since they

would become fully buried by the gradual deposition of river sediments over time once construction was completed.

While the dredging would result in the loss of individual macroinvertebrates, it is not expected to result in adverse impacts to these species at the population level within the Hudson River(defined as the 154 mile stretch between the Troy Dam and the Battery). The majority of the bottom habitat and associated benthic macroinvertebrates within the area impacted is the soft sediment community which dominates the Upper New York Harbor and Hudson River. Calculations suggest that deposition within the dredged channel will occur at a rate of about one foot per year (see **Appendix E**). Recolonization by benthic organisms adapted to softer sediments could be expected to begin within a few months after completion of construction in any given area.

Prior to the deposition of sufficient sediment to support a soft substrate benthic invertebrate community, some recolonization of the gravel armor material would be expected to occur. Organisms within the nearby gravel substrate located within the main channel (NYSDEC benthic mapper (http://www.dec.ny.gov/lands/33596.html), and Nitsche et al. 2007) would serve as a source of organisms to colonize the gravel capping material until the soft sediment is of a sufficient depth to be colonized by soft substrate organisms. Although the area affected by dredging is substantial, the effects to the soft sediment habitat, which is the dominant sediment type in the lower estuary, should be viewed as temporary and not indicative of a long-term adverse impact.

Oyster beds

Oyster beds were mapped using side scan sonar imagery approximately two miles north and south of the existing bridge from depths of 8 to 30 feet. Seven potential oyster beds were identified south of the bridge and six potential beds to the north (see **Appendix F-1** for a description of each of the beds). During the subsequent grab sample program, all identified oyster beds except one were confirmed to contain at least some live organisms with beds exhibiting differences in terms of oyster density, amount of shell hash, gravel, or sandstone fragments, etc. Dredging would remove about 13 acres of oyster beds, some or all of which may be permanently lost due to dredging and armoring of the bottom. A permanent loss of these oyster beds would result in an unavoidable adverse impact. Potential for implementation of oyster enhancement, relocation, or restoration projects will be explored and other mitigation strategies will be developed through consultation with the NYSDEC, USACE, USFWS, and NMFS.

In-Water Construction Activities

In-water construction activities have the potential to result in temporary and permanent habitat loss, habitat modification, and temporary increases in suspended sediment due to resuspension of bottom sediment as described below.

Pier Construction

During construction, a total of approximately 8 acres and 6.5 acres of open water benthic habitat would be permanently lost within the footprint pilecaps and fendering for the Short Span and Long Span Options, respectively. However, after demolition of the existing bridge, there would be a net loss of open water benthic habitat under the Short Span Option of 0.9 acres and a net gain of 0.6 acres of open water benthic habitat

under the Long Span Option. Therefore, pier construction would not result in an adverse impact to benthic habitat.

Temporary Platforms within Bridge Staging Areas

Impacts to benthic habitat would also occur due to the construction of two temporary work platforms north of the existing bridge. Temporary platforms would be constructed on the east and west sides of the river. Since the work platforms for the two bridge replacement options would be the same, approximately 9 acres of open water benthic habitat would be temporarily affected due to overwater coverage, and about 0.4 acres of open water benthic habitat would be temporarily lost within the footprint of the piles supporting the temporary platforms. After construction, these temporary platforms would be removed and the supporting piles cut at the mudline Areas that were shaded by platform coverage would remain as benthic habitat during construction, although the value of such habitat would be diminished for some organisms for the 4½ to 5½ year construction period. After construction, these areas would be re-exposed to sunlight and light-dependent organisms (e.g., algae, epifaunal benthic macroinvertebrates, fish) would be expected to quickly re-colonize the area. After pilings are removed, the natural sedimentation process of the river would occur and the areas occupied by pilings would be restored.

Permanent Platform Within the Rockland Bridge Staging Area

As discussed above a permanent work platform would also be constructed within the Rockland Bridge Staging Area. In order to support the platform, the existing bulkhead would be extended waterward and about 0.2 acres of open water benthic habitat would be filled. An additional 0.09 acres of open water benthic habitat would be lost within the footprint of the piles supporting the overwater portion of the work platform. The permanent work platform would result in about 2 acres of overwater coverage. The permanent loss of about 0.3 acres of open water benthic habitat and permanent coverage of approximately 2 acres of open water benthic habitat would be expected to result in a loss of benthic habitat for individual organisms within the footprint of the platform, but would not result in adverse impacts to regional benthic macroinvertebrate resources.

Temporary Increases in Suspended Sediment from Construction Activities

Construction activities that are expected to contribute to sediment resuspension include dredging, vessel movements, cofferdam construction, pile driving and demolition of the existing bridge. The principal Hudson River resources that can potentially be impacted by resuspended sediments are water quality (addressed in Section 18-4-12 Water Resources) and aquatic biota, including benthic macroinvertebrates.

A wide array of benthic macroinvertebrates occurs near the bridge; they vary from motile to sessile benthic organisms and include mollusks (e.g., oysters and clams), annelids (i.e., worms), and arthropod crustaceans such as mysid shrimp, amphipods, isopods, crabs, and other species. Although estuarine benthos have developed behavioral and physiological mechanisms for dealing with variable concentrations of suspended sediment and are well adapted to changes in sedimentation and resuspension processes, certain organisms could be impacted by high levels of water column TSS interfering with their methods of feeding (e.g., filter feeders) and/or causing

possible habitat impairment. Since the location of the sediment plume from dredging would move with the dredge, this would limit the time that a particular area would be exposed to resuspended sediment. With respect to shellfish, negative impacts to oyster egg development have been observed at TSS concentrations of 188 mg/L and impacts to clam egg development at 1,000 mg/L (Clarke and Wilber 2000). EPA has identified 390 mg/L (EPA 1986) as a concentration below which adverse impacts to benthos are not anticipated. In studies of the tolerance of crustaceans to suspended sediments that lasted up to two weeks, nearly all mortality was caused by extremely high suspended sediment concentrations (greater than 10,000 mg/L) (Clarke and Wilber 2000), levels which would not occur from the in-water work associated with the proposed project.

Background concentrations of TSS in the bridge vicinity generally vary between 15 mg/L and 50 mg/L throughout the year. The increase in TSS levels predicted to occur as a result sediment-disturbing activities would range from 50-100 mg/L in the immediate vicinity of the dredging to 5 mg/L to 10 mg/L over a relatively limited river area near the replacement bridge construction site (Section 18-4-12-2). Such increases in water column solids loads would be within the normal variation occurring in the Hudson River and well below levels that would be expected to affect normal life functions of benthic invertebrates. As discussed above, many benthic organisms are tolerant to increases in suspended sediment and the increase in sediment is expected to be within their tolerance levels. Thus, impacts to benthic invertebrates due to increased water column suspended sediments from construction activities are expected to be minimal and would not result in adverse impacts to benthic communities in the region.

Bridge Demolition

As discussed above under Section 18-4-12, “Water Resources,” and in *Temporary Increases in Suspended Sediment from Construction Activities*, demolition of the bridge could cause turbidity and the potential resuspension of contaminated sediments. Turbidity curtains would be used during removal of the columns and footings and cutting of the timber piles. The curtains would minimize the potential for sediment resuspension during bridge removal activities to affect benthic macroinvertebrates and other aquatic biota. Since the benthic sampling program for the project indicated similar benthic community structure in bottom sediments at both existing and proposed bridge location, and because the demolition is not expected to substantially alter sediment characteristics, the benthic community recolonizing the restored bottom habitat following bridge demolition would be expected to be similar to that lost as a result of dredging. Demolition of the existing bridge would also remove the benthic invertebrates and algae that are attached to the bridge, which provide forage and structural habitat for fish. However, the new bridge would offset much of these losses by providing similar material and thereby structural habitat for these species. Impacts to benthic invertebrates due to increased water column suspended sediments from bridge deomolition activities are expected to be minimal and would not result in adverse impacts to benthic communities.

Hydroacoustic Effects

Limited information is available on how benthic macroinvertebrates may use sound (e.g., Popper et al. 2003) and there is little information indicating whether sounds from

construction would have any impact on invertebrate behavior. The one available study on effects of seismic exploration on shrimp suggests no behavioral effects at sound levels, with a source level of about 196 dB re 1 µPa rms at 1 meter (Andriguetto-Filho et al. 2005).

There is also no substantive evidence on whether the high sound levels from pile driving or any anthropogenic sound would have physiological effects on benthic invertebrates. The only potentially relevant data are from an unpublished study on the effects of seismic exploration on snow crabs on the east coast of Canada (Boudreau et al. 2009). The preponderance of evidence from this study showed no short- or long-term effects of seismic exposure in adult or juvenile animals, or on eggs.

The lack of any air bubbles (such as those of the fish swim bladder) that would be set in motion by high intensity sounds would suggest that there would be little impact on benthic invertebrates. However, like fish, if the benthic invertebrates are very close to the source, the shock wave from the source might have an impact on survival.

Impacts to benthic invertebrates due to increased water column suspended sediments from hydroacoustic effects associated with pile driving activities are expected to be minimal and would not result in adverse impacts to benthic communities.

Summary

In summary, for the reasons presented above, the cumulative permanent loss of benthic habitat due to pier construction and the construction of the permanent platform for the Rockland Bridge Staging Area would result in a net loss of 1.2 acres for the Short Span Option and a net gain of 0.28 acres for the Long Span Option. In addition, the temporary loss of approximately 0.3 acres of benthic habitat within the footprint of the piles for the temporary platforms within the Bridge Staging Areas would not result in an adverse impact to benthic habitat.

While the dredging of between 165 and 175 acres of bottom habitat followed by placement of approximately 155 to 165 acres of armoring material would result in the loss of individual benthic invertebrates, it is not expected to result in adverse impacts at the population level within the lower Hudson River estuary. However, the loss of 13 acres of oyster beds would result in an unavoidable adverse impact. Mitigation for the loss of oyster beds, including enhancement, relocation, and/or restoration will be developed in consultation with applicable resource and regulatory agencies.

Submerged Aquatic Vegetation (SAV)

The nearest SAV beds to the replacement bridge construction site are small and located north of the project area (see **Figure 16-3**). Therefore, dredging and temporary platform construction for the project would not directly impact SAV, but would have the potential to result in indirect impacts due to potential temporary increases in suspended sediment levels and sedimentation rates within these beds. However, dredging operations would occur after the SAV growing season, minimizing potential adverse impacts to this resource. Additionally, as discussed above under “Water Resources,” cumulative increases in suspended sediment due to dredging and other in-water construction activities are projected to be within the range of normal variation in SSC within this portion of the Hudson River. Therefore, construction of the project would not result in adverse environmental impacts to SAV within the Hudson River.

Fish

Dredging

Where access channels are dredged, there would be a temporary loss of habitat that could impact fish that use the dredged area. These impacts would occur, in part, as a result of a localized reduction in benthic fauna. However, the dredging footprint represents a very small percentage of the Hudson River Estuary. Additionally, dredging would occur from August 1 to November 1, a period that would minimize the potential for impacts to anadromous fish spawning migration. and outside the peak period of biological activity within this portion of the Hudson River. Thus, the temporary reduction of benthic fauna within the dredged area would not substantially reduce foraging opportunities for the river's fish populations. Once construction is completed, the dredged channels would be restored over time to their original elevations by action of natural sedimentation, and the river's benthic community would recolonize those areas as well. The rate of this transformation would begin at approximately 1 foot per year, likely decreasing as the bed nears it natural pre-dredged elevation.

Temporary and Permanent Platforms Within the Bridge Staging Areas

Approximately 8 acres of temporary platforms would be erected within the Bridge Staging Areas in the Hudson River to facilitate bridge construction. These platforms would be supported by an array of small piles driven into the river substrate. The piles would occupy approximately 0.4 acres of benthic habitat representing a minor reduction of foraging opportunities for fish near the construction site. An approximately 2-acre permanent platform would result in the permanent loss of approximately 0.3 acres of benthic habitat due to bulkhead construction and pile driving. The supporting piles for the platforms would provide a substrate for encrusting organisms which would provide some additional foraging opportunities for fish. Moreover, fish are widely known to seek structures for shelter and the temporary and permanent platforms could represent a favorable diversity in habitat that currently is a large flat, silty bottom. Therefore, the minimal loss of foraging habitat, and the temporary and permanent coverage of aquatic habitat by overwater structures would not result in adverse impacts to fish within the Lower Hudson River Estuary.

Temporary Increases in Suspended Sediment from Construction Activities

As described above under *Benthic Macroinvertebrates*, construction activities expected to contribute to sediment resupsension include dredging, vessel movements, cofferdam construction, pile driving and demolition of the existing bridge.

Resuspension of sediments can have a range of impacts to fish depending on the species and life stages being considered. Lethal levels of TSS vary widely among species; one study, which included a variety of fish species common to the proposed construction site and representative of tolerant and sensitive species (white perch (*Morone americana*), spot (*Leiostomus xanthurus*), silversides (Atherinidae), bay anchovies (*Anchoa mitchilli*) and menhaden (*Brevoortia* spp.)) found that the tolerance of adult fish for suspended solids ranged from 580 mg/L to 24,500 mg/L (Sherk et al. 1975 as cited in NMFS 2003). Common impacts to fishes can be classified as biological/physiological or behavioral. Among the biological/physiological impacts are: abrasion of gill membranes resulting in a reduction in the ability to absorb oxygen,

decrease in dissolved oxygen concentrations in the surrounding waters and effects on growth rate. Behavioral responses by fishes to increased suspended sediment concentrations include impairment of feeding, impaired ability to locate predators and reduced breeding activity. Increased TSS can inhibit migratory movements as well. A study conducted by NOAA concluded that TSS concentrations as low as 350 mg/L could interfere with upstream migrations of various species (NOAA 2001). At high suspended sediment concentrations, mortality has also been documented. Fish, however, are mobile and generally avoid unsuitable conditions in the field, such as large increases in suspended sediment and noise (Clarke and Wilber 2000). The effects of habitat avoidance are not expected to have widespread consequences for the ecology of the fish community based on their ability to move from the impacted area and because the spatial distribution of the community is considerably greater than the predicted extent of increased suspended sediment concentrations and the dredge footprint.

Lethal and sublethal effects of suspended sediments on fish species common to the study area have been observed at concentrations above those expected during project construction. In terms of sublethal effects, a stress response (e.g., elevated corticosterol levels) was reported for striped bass (1,500 mg/L), white perch (650 mg/L) and hogchoker (1,240 mg/L) well above expected concentrations (Wilber and Clarke 2001). Striped bass did not avoid concentrations of 954 to 1,920 mg/L to reach spawning sites (Summerfelt and Mosier 1976; Burton 1993) which are well above the levels likely to be encountered during dredging operations. Burton (1993) indicated that concentrations of suspended solids can reach thousands of milligrams per liter before an acute reaction is observed. Lethal effects were demonstrated between concentrations of 580 mg/L for sensitive species and 700,000 mg/L for more tolerant species. Lethal effects were not observed until suspended sediment concentrations exceeded 750 mg/L, at which point 100% mortality was observed for bluefish, Atlantic menhaden and white perch. More tolerant species exhibited 50% mortality at concentrations above 2,500 mg/L, including silversides (2,500 mg/L), spot (20,340 mg/L), cunner (28,000 mg/L) and mummichog (39,000 mg/L).

Sublethal effects on fish eggs and larvae have been reported in terms of slowed development, delayed hatching or reduced hatching success. Wilbur and Clarke (2001) in a literature summary of available data indicated that hatching is delayed for striped bass and white perch at concentrations of 800 mg/L and 100 mg/L, respectively, however, reduced hatching success (i.e., egg mortality) was not observed until concentrations reached 800-1,000 mg/L for these species. For eggs of Atlantic herring, there were no sublethal effects observed at suspended sediment concentrations of 300-500 mg/L (Wilber and Clarke 2001), while eggs of blueback herring and Atlantic menhaden exhibited no change in hatching or development at a concentration of 1,000 mg/L (Wilber and Clarke 2001).

As discussed earlier (Section 18-4-12-2), modeling results indicated that on flood and ebb tides, concentrations of 10 mg/L above ambient conditions may extend in a relatively thin band approximately 1,000 to 2,000 feet from the dredges, while concentrations of 5 mg/L may extend a greater distance. These changes are considered well within natural variation that has been observed within the Hudson River. For example, during the sampling conducted for the project TSS concentrations

ranged from 13 to 111 mg/L. Data recorded at Poughkeepsie (See Chapter 15) indicated that during higher freshwater flow periods the difference between suspended sediment concentrations can vary by 20 to 40 mg/L. Therefore, the TSS projected to occur as a result of the project's construction would be expected to be below the physiological impact thresholds of adult and larval fish and also below concentrations that would be expected to impact migration. Furthermore, anadromous fish such as American shad, blueback herring, and alewife spawn well upriver and their most vulnerable early life stages such as eggs and yolk-sac larvae would not be expected to occur in the Tappan Zee vicinity. Impacts due to increased water column suspended sediments are expected to be minimal and would not result in adverse impacts to fish within the Lower Hudson River estuary.

Hydroacoustic Effects

Effects on fish associated with noise from pile driving include damage to body tissue that can potentially result in death, sub-lethal effects that could result in temporary decreases in fitness, or to temporary or long-term changes in behavior. The extent and type of effects depends on many factors including sound intensity, sound duration, fish species, and numerous other variables, The type and intensity of pile driving sounds that may result in effects vary with factors such as the type and size of the pile, firmness of the substrate, depth of water, and the type and size of the pile driver. Larger piles and firmer substrate require greater energy to drive the pile resulting in higher sound pressure levels (SPL). Hollow steel piles appear to produce higher SPLs than similarly sized wood or concrete piles (Hanson et al. 2003). Some fish have been observed exhibiting an initial startle response to the first few strikes of an impact hammer, after which they may remain in an area with potentially harmful sound levels (Dolat 1997, NMFS 2001 in Hanson et al. 2003), or they may leave the area. Fish with swim bladders and smaller fish have been shown to be most vulnerable (Hanson et al. 2003). The degree of damage to fish and their hearing organs from pile driving is related to the received level and duration of the sound exposure.

Popper and Hastings (2009) indicated that the limited data from other projects suggests that immediate fish mortality may occur in limited circumstances during driving of very large piles (e.g., 8 ft diameter) and that generally only fish that are very close (up to 33 ft) to the pile driving would potentially be impacted. California Department of Transportation (Caltrans 2001) showed some mortality for several different species of wild fish exposed to driving of 8 ft diameter steel pipes, whereas Ruggerone et al. (2008) found no mortality to caged yearling coho salmon (*Oncorhynchus kisutch*) placed as close as 5.9 ft from a 1.7 ft diameter pile and exposed to over 1,600 strikes. During construction of the Woodrow Wilson Bridge, driving of piles larger than 5 ½ ft in diameter near the navigation channel resulted in kills of certain species including catfish, gizzard shad, alewife, and white perch. Implementation of bubble curtain technology at the Woodrow Wilson Bridge attenuated pressure waves to below the threshold for fish mortality (FHWA 2003). The Woodrow Wilson report also indicated that "pile tapping" which involves a series of less intensive strikes at the beginning of pile driving to startle fish, was at times an effective method for reducing fish mortality.

Sound is measured in many ways with the most common approach being the "root mean square" (rms) which is the average sound signal over a specific time period (Popper and Hastings 2009). "Peak" sound, which is the highest level of sound within a

signal, may also be measured. Because neither peak nor rms measures provide a true characterization of the extent of energy that can potentially impact an organism, scientists developed the concept of Sound Exposure Level (SEL) (See Popper and Hastings 2009). SEL is the integration over time of the square of the acoustic pressure in the signal and is an indication of the total acoustic energy the organism is exposed to (see Popper and Hastings 2009). SEL is generally expressed as the total energy in a signal over one second. There are two ways of looking at SEL that are relevant to pile driving. The single strike SEL (SEL_{ss}) is the amount of energy in one strike of the pile while the cumulative SEL (SEL_{cum}) represents the summed energy in all strikes received by a fish or other animal over a unit of time. SEL_{cum} is particularly useful since it indicates the full energy to which an organism is exposed to during any kind of signal. Halvorsen et al. (2011), based on extensive experimental studies, concluded that at least three metrics should be considered when evaluating or predicting the onset of physiological effects, namely, SEL_{cum}, SEL_{ss}, and the total number of strikes. These authors do indicate, however, that SEL_{cum} is applicable as a conservative measure for estimating the onset of physiologival effects. A more detailed discussion of the characteristics of sound, how it is measured and propagated in water, and the potential for noise from project activities to impact fish species is presented in the Popper and Hastings (2009) and the Biological Assessment (BA) Report (**Appendix F-4**).

Current Interim Physiological Criteria

The current interim criteria for onset of physiological effects on fish were developed on the U.S. West Coast. These interim criteria arose from discussions between the members of the Fisheries Hydroacoustic Working Group (FHWG), a group consisting of West Coast state agencies, NMFS, USFWS, and FHWA. In June 2008, these discussions resulted in the FHWG establishing interim injury onset criteria for projects in California, Oregon, and Washington (reviewed in Woodbury and Stadler, 2008; Stadler and Woodbury, 2009). These West Coast interim criteria (FHWG, 2008) are:

- Peak SPL: 206 dB re 1 µPa
- SEL_{cum}: 187 dB re 1µPa^2-s for fishes above 2 grams (0.07 ounces)
- SEL_{cum}: 183 dB re 1µPa^2-s for fishes below 2 grams (0.07 ounces)

The 2008 agency agreement specifically designated the criteria as interim, and the agencies committed to “review the science periodically and revise the threshold and cumulative levels as needed to reflect current information” (FHWG, 2008). These criteria are intended to reflect the onset of physiological effects (Stadler and Woodbury 2009) and not levels at which fish are mortally damaged. The onset of physiological effects may be minimal changes in fish tissues that have no biological consequence (Halvorsen et al. 2011).

Recent studies provide additional important data that indicate that the onset of physiological effects occur at levels considerably greater than 187 SEL_{cum} re 1µPa^2-s (Popper et al. 2006; Carlson et al. 2007; Popper and Hastings 2009).These views have been strongly supported in a recent peer-reviewed study from the Transportation Research Board (TRB) of the National Research Council of the National Academies of Science that describes the first carefully controlled experimental study of the effects of pile driving sounds on fish (Halvorsen et al. 2011). This investigation was funded by

National Cooperative Highway Research Program (NCHRP) of the TRB, Caltrans, and the Bureau of Ocean Energy Management (BOEM), as well as by the Canadian Department of Fisheries and Oceans (DFO) and was developed and overseen by individuals from highway programs throughout the United States. The study was the first to document effects of pile driving sounds (recorded by actual pile driving operations) under simulated free-field acoustic conditions where fish could be exposed to signals that were precisely controlled in terms of number of strikes, strike intensity, and other parameters. The acoustic field simulated one that would take place beyond about 10 m from a source. Subsequent to treatment, animals were subjected to extensive necropsy (autopsy) to determine the types of physiological effects and the sound exposure levels at which these effects would show up.

The study was conducted on Chinook salmon (*Oncorhynchus tshawytscha*), an endangered species on the U.S. West Coast. The study considered the onset of a wide variety of potential physiological effects that ranged from small amounts of hemorrhage at the base of fins to severe hemorrhage or rupture of the swim bladder and surrounding body tissues (kidney, liver, spleen, etc.). It was determined that effects, such as small hemorrhages at the base of fins are not life threatening nor would they have any short or long-term effect on fish, while damage such as swim bladder rupture would result in mortality. Based on a statistical analysis of results, with extensive controls, it was determined that onset of physiological effects that have the potential of reduced fitness, and thus a potential impact on survival, started to appear when sounds were above 210 dB re 1 $\mu Pa^2 \cdot s$ SEL_{cum}, a level that is about 23 dB above the current West Coast interim onset criteria. The peak level for effects is about the same as the current West Coast level.[1]

Subsequent work, using the identical methodology, has demonstrated that there is complete recovery from effects on Chinook salmon exposed to sounds as high as 216 dB 1 $\mu Pa^2 \cdot s$ SEL_{cum} (higher levels could not be used), and similar results have been found for striped bass (Casper et al., in prep.). In addition, other studies have shown that similar results to those reported for Chinook salmon were also found in several other species, including lake sturgeon (*Acipenser fulvescens*). There was small variation in the onset SEL_{cum} level for physiological effects, but all were well above 200 dB 1 $\mu Pa^2 \cdot s$ (Halvorsen et al., in prep; Casper et al., in prep), or levels well above the West Coast interim criteria.

Pile driving also has the potential to affect fish behavior. However, the generated sound must be behaviorally relevant to the fish, it must be detected, and be sufficiently above a threshold level so that the fish responds to it. While NMFS has considered 150 dB re 1 µPa as a conservative indication of when behavioral effects could occur, the scientific basis for a behavioral threshold has not been determined, and there is a substantial question as to even the origin of the 150 dB re 1 µPa rms level (Hastings et al. 2008).

[1] The authors also point out that there is a criterion single strike level that is determined by the number of strikes to which fish will be exposed. Thus, a fish exposed to 960 strikes, could be exposed to $SEL_{ss}$of about 181 dB 1 $\mu Pa^2 \cdot s$ whereas if the fish will be exposed to 1920 strikes the maximum single strike level to which the fish should be exposed is about 177 dB 1 $\mu Pa^2 \cdot s$.

Furthermore, fish would not be expected to remain in an area at which noise (from pile driving or any other source) would cause discomfort.

The BA (**Appendix F-4**) provides a comprehensive review of the literature and discussion on effects of sound from different sources including pile driving on fish behavior. The vast majority of the (albeit limited) behavioral studies to date, as described in the BA, suggest that there is not likely to be any adverse behavioral response from any fish species, at sound levels as low as 150 dB re 1 µPa rms. However, in order to ensure that there is limited effect at this level, or even at higher sound levels, the project will maintain a corridor where ensonification due to pile driving is below the 150dB rms SPL behavioral guidance level suggested by NMFS. Therefore, the project would minimize the potential for the project to impede movement of fish in the Hudson River. Moreover, and perhaps of even greater significance in ensuring a minimal or no behavioral impacts on fish is the fact that the duration of pile driving during bridge construction will be a very small percent of the total project duration equating to approximately 7% of the construction period. Combining this with the efforts to ensure a corridor where sounds will be below 150 dB re 1 µPa (rms) during pile driving should minimize any chance of behavioral impacts on fish.

Hydroacoustic Modeling

In order to analyze the potential impacts of the project's pile driving on Hudson River aquatic resources, the likely hydroacoustic scale of pile driving was modeled (JASCO 2011a, **Appendix F-5a, 5b**). The extent of the sound pattern generated by pile driving for the replacement bridge was determined by application of three different sound propagation modeling approaches (i.e., MONM, VSTACK, and FWRAM). The models account for the frequency composition of the source signal and the physics of acoustic propagation in the Hudson River and underlying geological substrates. This type of modeling differs from generalized and empirical acoustic models, such as "practical spreading loss" models (Caltrans, 2009), that do not take into full account the source characteristics or the many site-specific factors that could influence the rate of noise transmission such as water depth and substrate transmission characteristics.

Various pile driving scenarios were used to generate the cumulative sound exposure level (SEL_{cum}) for each day over the construction period. Maximum and typical pile driving scenarios were analyzed. In addition, the application of Best Management Practices (BMPs) that provided a 10 dB reduction in sound was incorporated into the acoustic modeling effort. These practices represent various methods to reduce the extent to which a waterbody would be ensonified by pile driving operations. Various BMPs have been employed on pile driving operations around the country, including air bubble curtains of various forms, isolation casings, Gunderbooms, and dewatered cofferdams. This 10 dB estimate of sound attenuation was considered reasonable and conservative, as Caltrans (2009) indicated that bubble curtains can achieve a reduction of 20 dB for piles greater than 4 ft in diameter. The Tappan Zee Hudson River Crossing Project is committed to the use of BMPs to attenuate the potential impacts of sound associated with pile driving.

Figure 18-22 presents the peak SPL, with BMPs in place, for 4-, 6-, 8-, and 10-ft piles being driven at representative locations along the alignment of the replacement bridge. The figure documents the transmission loss that would occur as distance from the pile

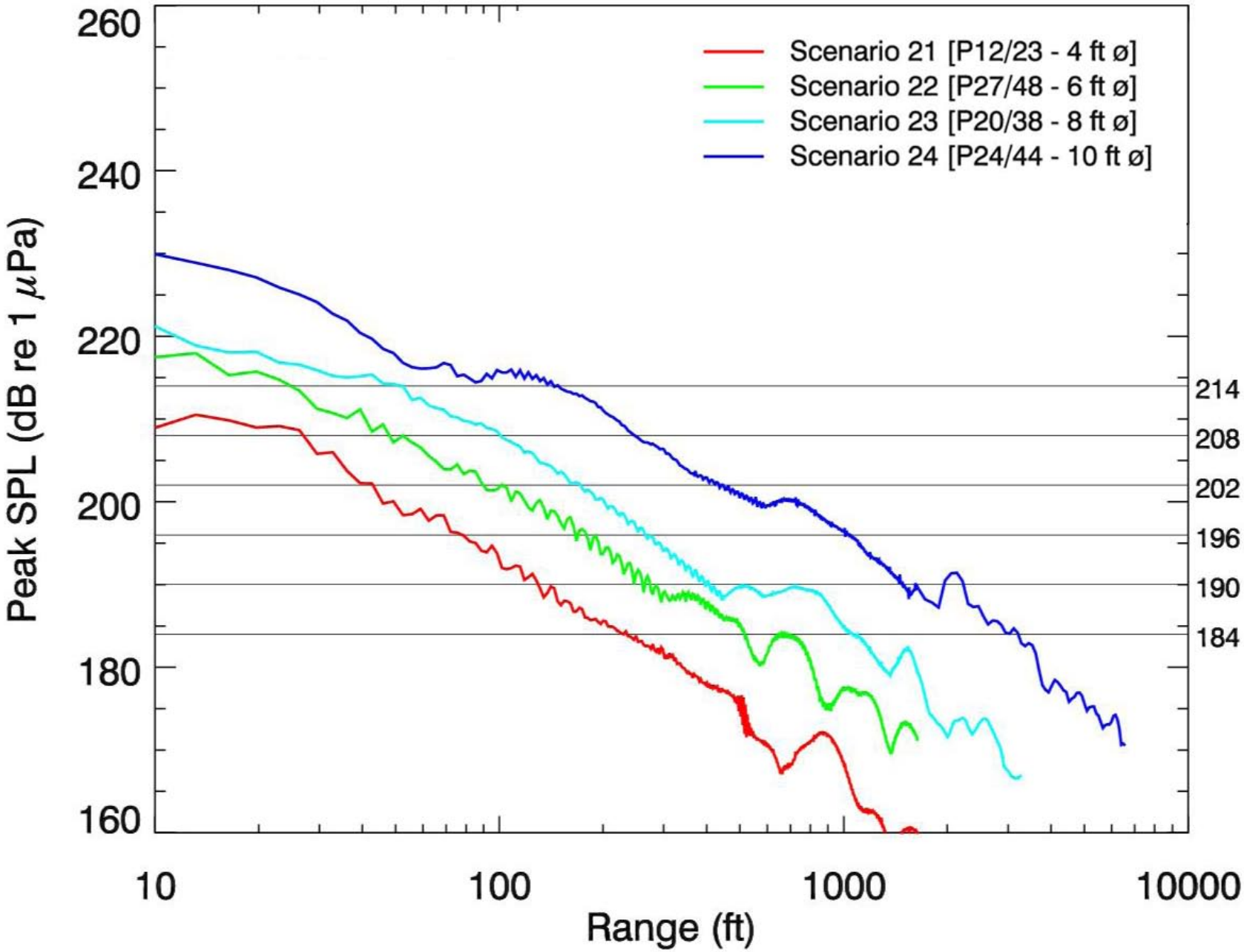


Figure 18-22

Impact Hammering of 4, 6, 8 and 10 Feet Diameter Piles with BMPs

driving site increases. Transmission loss is not uniform across the different size piles since the piles would be driven at locations where water depth and other environmental factors vary. For the 4-ft piles, sound above the interim 206 dB threshold encompasses a distance of about 30 ft; for the 10-ft piles the 206 dB peak SPL the distance increases to approximately 300 ft.

Figure 18-23 presents the SEL_{cum} metric for installing two pairs of 10-ft piles at the replacement bridge main span over the number of strikes that are predicted to be needed to fully seat the piles. The concurrent placement of two pairs of 10-ft piles is considered a representative worst case for driving of 10 ft piles, and would be the same for both the Short and Long Span Options. Transmission loss is not the same in all directions, since the factors that affect transmission such as water depth, substrate composition, etc, vary in different directions around a pile.

In order to minimize potential effects to anadromous fish, during the period from April 1 to August 1, only five hours of pile driving for 8 and 10 ft piles will be driven per day. The concentric "circles" (or isopleths) of different colors represent distances from the pile driving activity at which various SEL_{cum} levels would be attained during the driving of the two piles. For example, the 187 dB isopleths extends over a mile in each direction north and south of the point of pile driving and 49% of the cross sectional width of the river. This can be contrasted with the 187 dB 1 $\mu Pa^2 \cdot s$ isopleth profile for installing four 4-ft piles at the replacement bridge main span in one day, which does not extend substantial distances in any direction (see **Figure 18-24**). These two figures represent the accumulated energy over the whole driving time and does *not* represent the energy from a single strike or the instantaneous level of sound at any one moment in time. Moreover, this represents the received energy for an animal *only* if the animal stays in the same location for the duration of the pile driving activity. two pairs of 10-ft piles.

Figure 18-25 indicates the cross sectional area of the river that would be ensonified by the 187 dB re 1μPa^2-s isopleths over the duration of the construction period for the Short Span Option, and assumes a BMP reduction of 10 dB. During the period of driving the 10 foot piles, 49% of the river cross sectional width would be occupied within the 187dB re 1μPa^2-s isopleth. This ensonified area would be between 43 and 61% during the four-month period when 4, 6, and 8 ft piles are all being driven, sometimes simultaneously. The figure indicates that driving of the 10 and 8 ft piles would take place in the first few months of the first year of construction, limiting the period of time of greatest potential impact, During the remaining years of the construction period, the affected cross section of the river is considerably less, on the order of 14 to 38%. Given that the river is approximately 3 miles wide, there would always be a considerable portion of the river that remains below the threshold noise criteria, thereby insuring adequate corridors for migration and movement of fish through the region. **Figure 18-26** indicates the cross sectional area of the river that would be ensonified by the 187 dB re 1μPa^2-s isopleths over the duration of the construction period for the Long Span Option.

For most of the pile driving scenarios modeled, including those in which the maximum number of simultaneous piles are being driven and/or for the largest piles, a substantial portion of the Hudson River's width never reaches the SEL_{cum} criterion established for onset of physiological injury. Furthermore, even within a single day of operations (assuming an 8 to 12 hour day), there is likely to be no pile driving activity for a

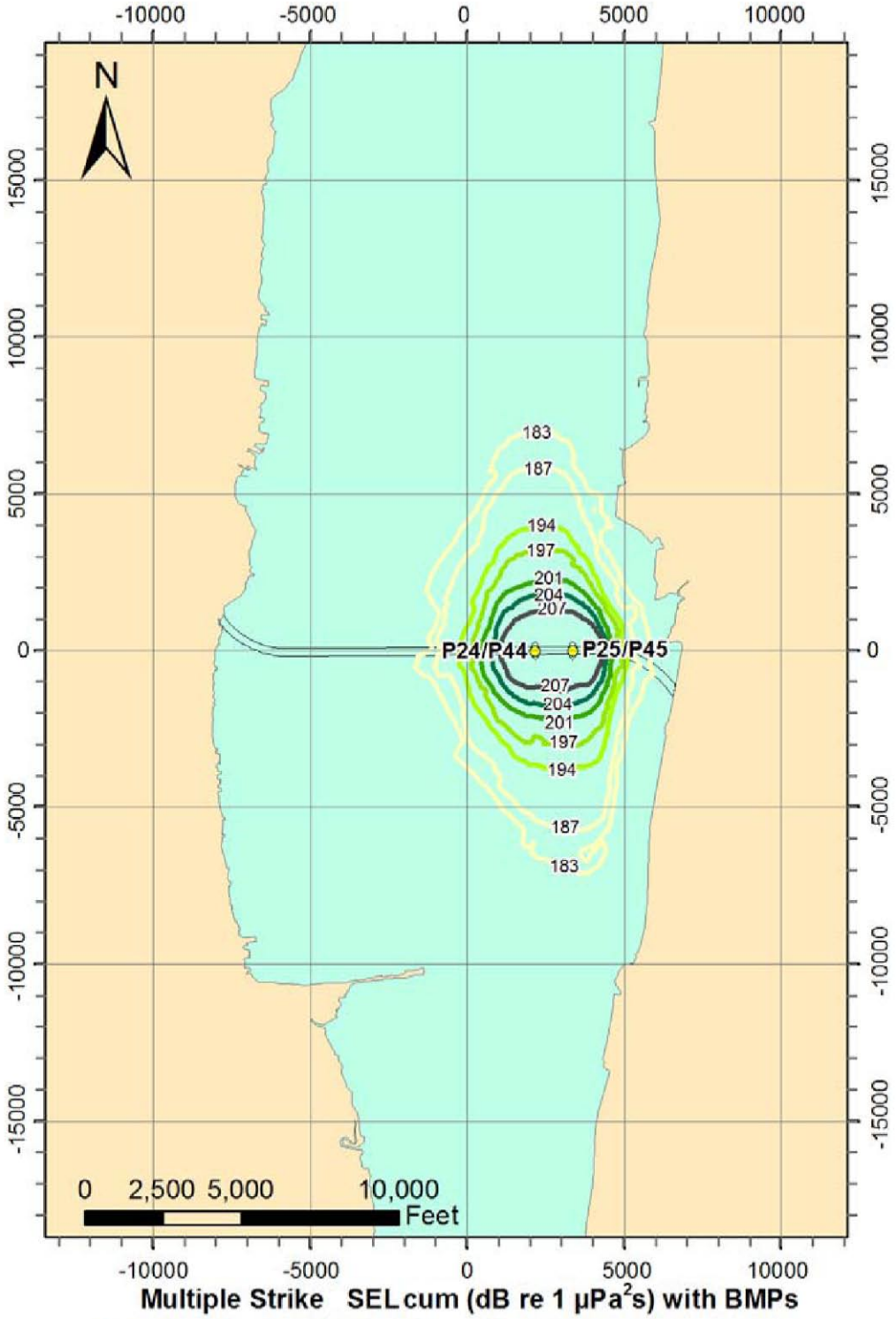


Figure 18-23

Isopleths for Short and Long Span Options - Driving of Two 10 Foot Piles at Piers 24, 25, 44 & 45

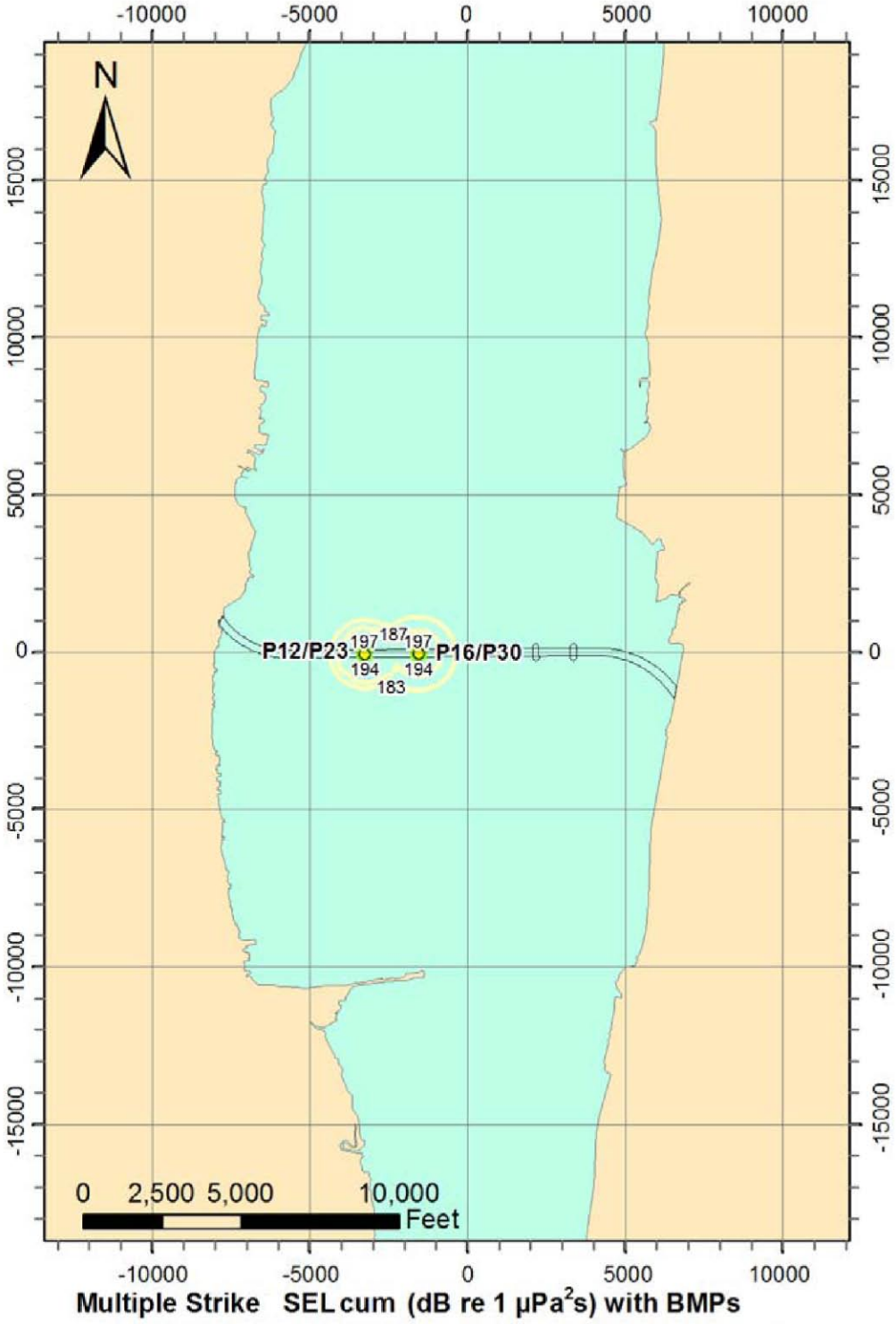


Figure 18-24

Isopleths for Short and Long Span Options - Driving of Four 4 Foot Piles at Piers 12, 16, 23 & 30

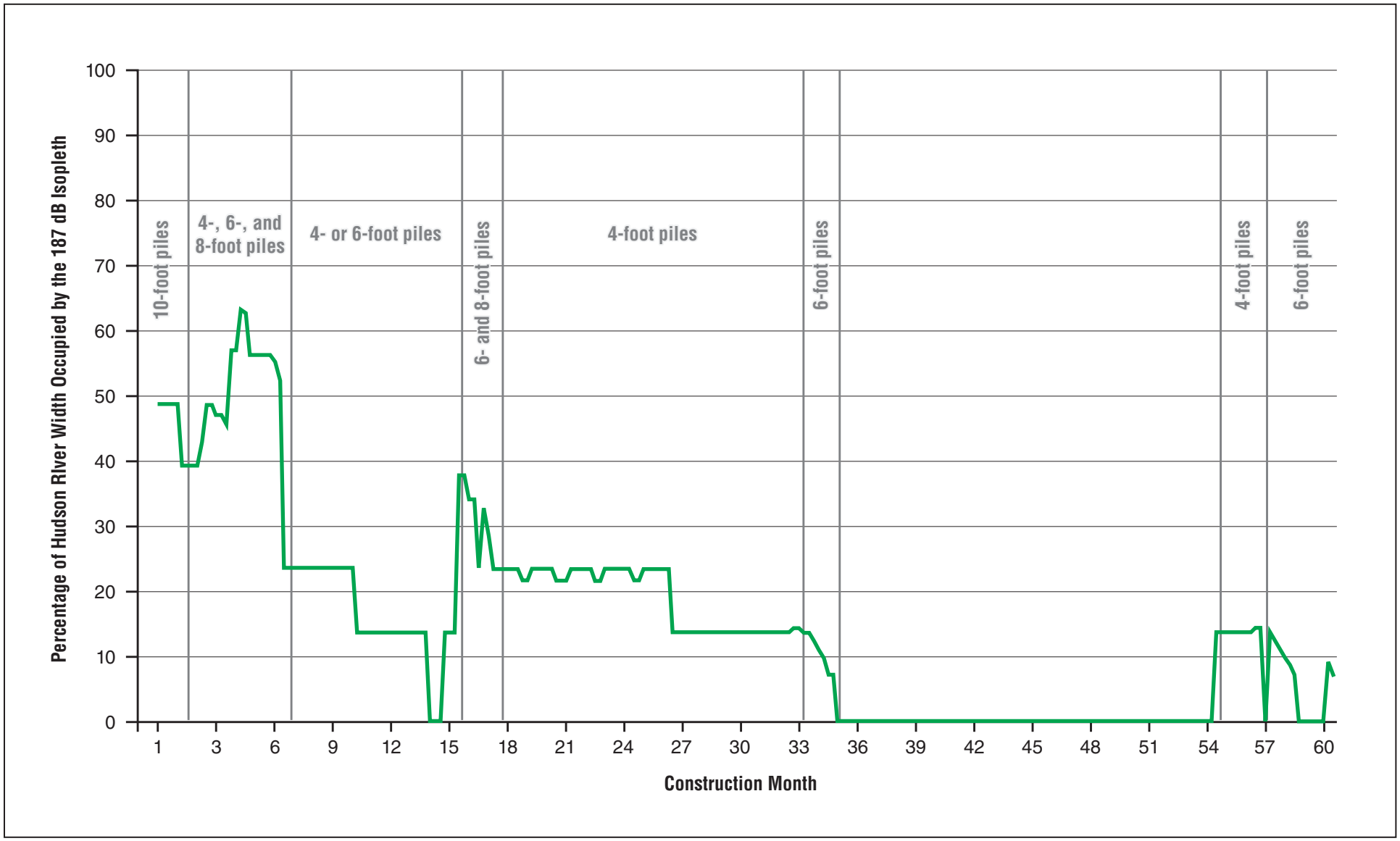


Figure 18-25

Percent of the Hudson River Width Occupied by the 187dB Isopleth During Pile Driving at the Proposed Tappan Zee Crossing Short Span Option

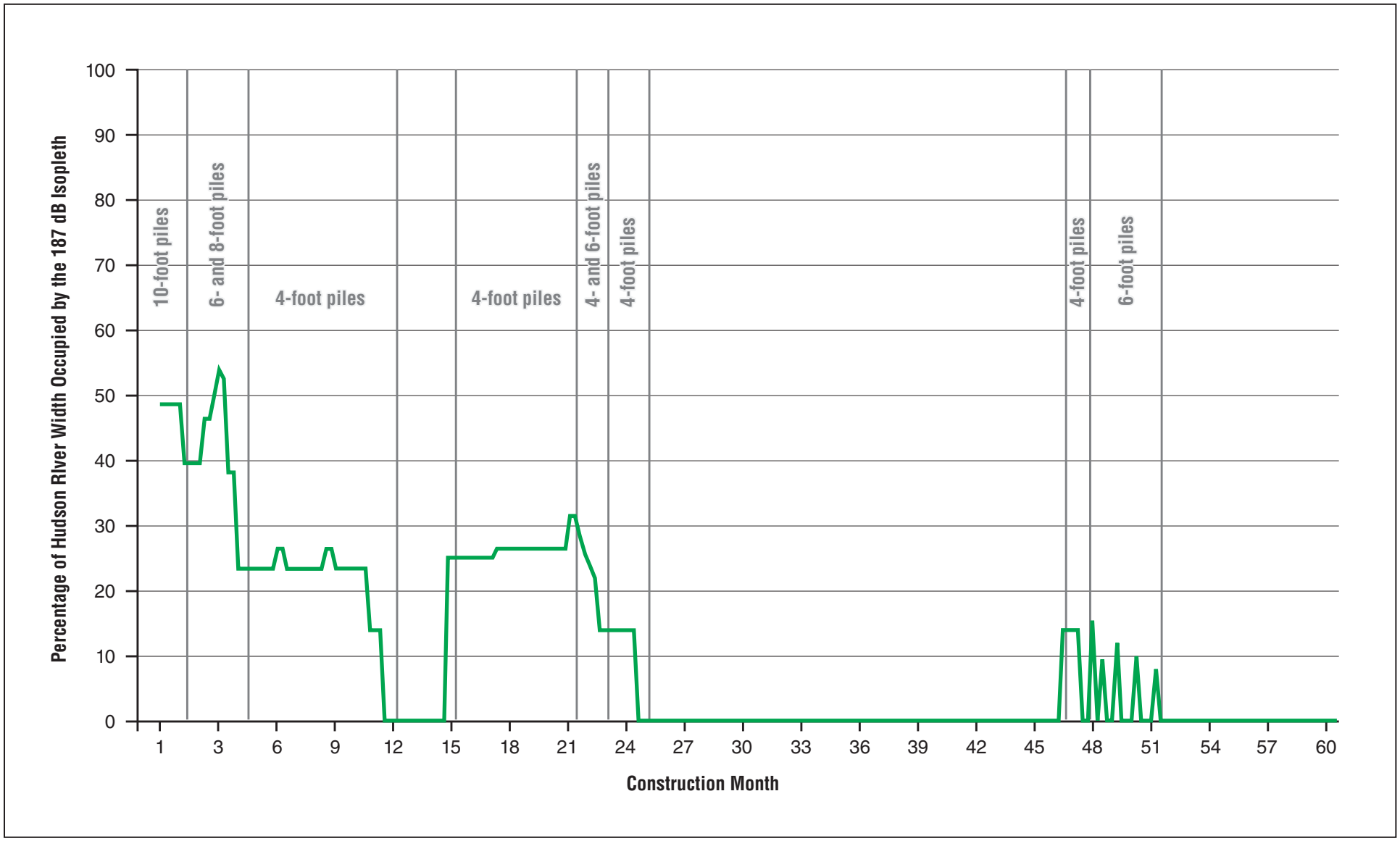


Figure 18-26

Percent of the Hudson River Width Occupied by the 187dB Isopleth During Pile Driving at the Proposed Tappan Zee Crossing Long Span Option

substantial amount of time, such as when piles are put in place, being welded, or when the pile driving machinery is relocated. Thus, fish in much of the river will not be exposed to pile driving sounds for significant periods, and the likelihood of accumulating sufficient energy (SEL_{cum}) to result in onset of physiological effects is low. Finally, fish would not be expected to remain in an area at which noise (from pile driving or other source) would cause discomfort.

Impacts to Fish

As a means to quantitatively assess potential impacts of pile driving to Hudson River fish resources, the isopleths that were generated by the JASCO hydroacoustic model (JASCO 2011a; See **Appendix F-5a, 5b**) were used to delineate the spatial extent of the SEL_{cum} of 187 dB re 1µPa^2-s noise isopleths generated during pile driving. Noise isopleths were superimposed on bathymetric data of the project area to estimate water volumes contained by the 187 dB re 1µPa^2-s isopleths during driving of 4, 6, 8 and 10-foot diameter piles. To account for depth-related differences in habitat use by various fish species, the three-dimensional volume was partitioned into habitats that corresponded to those recognized by the Hudson River Utilities Monitoring Program. These habitats included:

- Shoal (0-20-ft depth),
- Bottom (0-10-ft from the bottom where water is >20-ft deep), and
- Channel (water column above the bottom where water is >20-ft deep).

Fish community data collected as part of the Hudson River Utilities Fall Shoals monitoring program over a recent 10-year period (1998-2007) were used to estimate the number of fish by habitat within the 187 dB re 1µPa^2-s isopleths. To do this, mean fish densities in the Tappan Zee region (RM 24-33) were first calculated by habitat and sampling event for each of the sampling events that typically occurred every other week from July through November. Using the actual observed densities, interpolated densities for “off” weeks were calculated during the survey year (July through November) when samples were not collected, as well as for weeks between survey years (December through June). Details of the interpolation and the other analysis methods are presented in **Appendix F-6**. The resulting dataset included an estimate of the mean density of fishes by habitat in the Tappan Zee region for each of the 52 weeks during the calendar year.

Mean weekly fish abundances were calculated within the boundaries of the187 dB re 1µPa^2-s noise isopleths during each week of the proposed construction schedule to estimate the total number of fish expected to be potentially impacted by pile-driving activities on a weekly basis over the course of bridge construction. Impacted volumes were determined following the preliminary proposed construction schedule, which outlines the month, week and year during which specific piles are to be driven and allows fish-density estimates to be linked to the habitat and volume impacted by pile driving over the course of construction. This approach accounted for the various combinations of pile sizes that will be driven simultaneously (which includes worst case modeled scenarios), and their location along the span and their depth within the River. Fish numbers were expressed in terms of the Hudson River standing crop. Upper and lower bounds were calculated by assuming that individual fish could either be affected

only once (i.e., fish are highly mobile and all fish leave the ensonfied area after each week, and are replaced by new fish) or multiple times (i.e., fish are less mobile and limited in their range to habitats within the project area). The details of the methodology used for setting ranges for estimating fish encounters within the ensonified area are also presented in **Appendix F-6**.

For the Short Span Option, the number of fish that would be contained within the boundaries of a SEL_{cum} level of 187 dB re 1µPa^2-s and be potentially affected would range from 0.4% (lower bound) to 2.0% (upper bound) of the estimated annual riverwide standing stock of approximately 346.3 million fish. (**Appendix F-6**, Table 1). For the Long Span Option the number of fish that would be potentially affected by 187 dB 1 µPa^2·s ispoleth would range from approximately 0.4% to 2.3% of the riverwide standing stock. It is not considered likely, however, that the affected number of fish would approach either extreme of the range.

Appendix F-6, Table 1 presents results for the seven most abundant species. Three of these species (bay anchovy, striped bass and weakfish) made up about 94% of the standing stock abundance. Species composition of the fish community is largely dominated by bay anchovy (*Anchoa mitchilli*), which represented 283.8 million, or 82% of the riverwide standing stock of 346.3 million fish. In the Tappan Zee region bay anchovy was the dominant fish in all habitats but particularly in the channel habitat where it made up 99% of all individuals collected. In the shoal habitat bay anchovy comprised over 85% of all individuals collected and comprised 48% of fish in the bottom habitat.. For the Short Span Option, the number of bay anchovy encounters within the boundaries of a SEL_{cum} level of 187 dB re 1µPa^2-s and be potentially affected would range from 0.5% (lower bound) to 1.8% (upper bound) of their standing stock. For the Long Span Option the number of fish encounters within the 187 dB re 1µPa^2-s ispoleth would range from approximately 0.5% to 2.1% of the bay anchovy standing stock. Potential bay anchovy losses that might occur due to pile driving are a very small portion of the large coastal population that is the source of the bay anchovy that enter the Hudson, and the potential losses of individuals of this forage species would not be expected to result in adverse impacts on the Hudson River or coastal population of this species.

Striped bass, the second most abundant species with 21.2 million fish, comprised about 6% of the riverwide standing stock of 346.3 million fish. For the Short Span Option, the number of striped bass encounters within the boundaries of a SEL_{cum} level of 187 dB re 1µPa^2-s would range from 0.08% (lower bound) to 0.7% (upper bound) of their standing stock. For the Long Span Option the number of fish encounters within by 187 dB re 1µPa^2-s ispoleth would range from approximately 0.06 percent to 0.7 percent of the striped bass standing stock.

Weakfish, the third most abundant species with 9.2 million fish, comprised just under 3% of the riverwide standing stock of 346.3 million fish. For the Short Span Option, the number of weakfish encounters within the boundaries of a SEL_{cum} level of 187 dB re 1µPa^2-s would range from 0.07% (lower bound) to 0.7% (upper bound) of their standing stock. For the Long Span Option the number of weakfish encounters within the 187 dB re 1µPa^2-s ispoleth would range from approximately 0.09% to 0.7% of the weakfish standing stock.

The number of fish at risk would be expected to be lower than the encounter estimates presented above and in **Appendix F-6**, Table 1 for a number of reasons:

- Since the calculations do not take into consideration the normal behaviors of the fish in response to a noxious stimulus, it is reasonable to assume that sturgeon, on hearing the pile driving sound, would either not approach the source or move around it. Since the pile driving sounds are very loud, it is also very likely that many of the fish will hear the sound, and respond behaviorally, well before they reached a point at which the sound levels exceeded even the interim SEL_{cum} criterion of 187 dB 1 µPa2·s. Thus, the likely behavioral response of the fish would be to alter the path through which they were traveling to avoid the sounds that were too loud and then resume their regular path once the highest sound levels were skirted.
- Based on the most recent scientific studies (e.g., Halvorsen et al. 2011), the 187 dB re 1µPa^2-s SEL_{cum} threshold is overly conservative, and far lower than cumulative sound levels that actually result in onset of physiological effects (e.g. greater than SEL_{cum} of 203 dB). If a higher threshold for onset, such as those proposed by Halvorsen et al. (2011), were to be used to evaluate the onset of injury to sturgeon, the size of the ensonified area that could potentially cause onset of physiological effects would be considerably reduced, as would the number of potentially affected fish.
- The analysis was conducted using a 10 dB reduction associated with implementation of BMPs, which may underestimate the level of noise attenuation that can be achieved by bubble curtains or other technologies (i.e., 20 dB; Caltrans 2009)

Replacement Bridge AlternativeSummary

For all of the reasons stated above, construction of either the Short or Long Span Options would not be expected to result in adverse impacts to populations of fish species in the Hudson River.

18-4-13-4 THREATENED, ENDANGERED, AND SPECIAL CONCERN SPECIES

Terrestrial Species

Threatened or endangered terrestrial species were evaluated for a distance of ½ mile north and south of the Interstate 87/287 (New York State Thruway) right-of-way generally between Interchange 10 (Route 9W) in Rockland County and Interchange 9 (Route 9) in Westchester County, including the Hudson River, and within a ½ mile radius of the WNSA and TQSA sites.

Bridge Study Area

As discussed in Chapter 16, “Ecology,” due to lack of appropriate habitat in the study area, the project would have no effect on federally-listed threatened or endangered terrestrial wildlife species, including the bog turtle (*Clemmys* [*Glyptemys*] *muhlenbergii*), New England cottontail (*Sylvilagus transitionalis*), or Indiana bat (*Myotis sodalis*). All of the terrestrial threatened, endangered, and special concern wildlife species that are considered to occur within the study area are birds. State-listed species considered to have the potential to occur in the bridge study area include bald eagle (also protected under the federal Bald and Golden Eagle Protection Act), peregrine falcon *(Falco*

peregrinus), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*A. cooperii*), red-shouldered hawk (*Buteo lineatus*), osprey (*Pandion haliaetus*), common loon (*Gavia immer*), and pied-billed grebe (*Podilymbus podiceps*). These species are also protected under the federal Migratory Bird Treaty Act. Of these state-listed species, the occurrence of sharp-shinned hawk, Cooper's hawk, red-shouldered hawk, and osprey would likely be limited to passage overhead during migration and possibly brief stopovers. In these cases, project construction would not have any impact on individuals or populations of these species. Sharp-shinned hawk, Cooper's hawk, and red-shouldered hawk have the potential to overwinter in the area, but suitable wintering habitat for these species is limited to the study area's periphery, such as the forest fragment on the Lyndhurst Museum property, where they would not experience any disturbance as a result of project construction.

Bald eagles would have the potential to occur within the study area during the winter, during which time individuals would usually be found sitting on ice flows within areas of open water. Bald eagles are easily disturbed by human activities, even outside of the breeding season (Stalmaster and Newman 1978, Stalmaster and Kaiser 1997). During winter construction, bald eagles would be expected to avoid the section of river within the bridge study area and instead forage elsewhere up- or down-stream where disturbance levels are lower. Based on federal guidelines for minimizing disturbances to bald eagles, which recommend a maximum buffer distance of 0.5 miles between bald eagles and extremely loud noises (USFWS 2007), it can be conservatively estimated that bald eagles would avoid a maximum of 0.5 miles of river in each direction from the bridge during construction. Displacement of eagles from this area would represent a highly negligible and temporary reduction in the amount of foraging habitat available on the lower Hudson River estuary. In turn, it is unlikely that the exclusion of wintering bald eagles from this small section of river would significantly reduce food availability or otherwise affect their energetic condition. Overall, project construction would not be expected to impact bald eagles meaningful at either the individual or population level.

Common loons and pied-billed grebe would have the potential to occur within the study area during the fall and winter and winter and spring, respectively (DeOrsey and Butler 2006). Individuals of both species would be expected to avoid the bridge study area during construction of the project and use other portions of the river with less human disturbance for foraging habitat. This minimal loss of foraging habitat for these two species would not result in adverse impacts to regional populations of these two species.

Peregrine falcons have consistently nested in artificial nest boxes on the Tappan Zee Bridge since the 1980's (Mildner 1988, Frank 1994, USFWS 1997) and they remain in the area year-round. Peregrine falcons have become increasingly common in urban areas, demonstrating a tolerance of human disturbance and an ability to exploit resources in human-modified environments (Cade et al. 1996, White et al. 2002). It has been posited that peregrine falcons will tolerate almost any level of human activity taking place below their nest, provided that the nest is inaccessible (Ratcliffe 1972). Breeding peregrine falcons are more easily disturbed by activities from above, although pairs nesting in interior Alaska were found to even tolerate overhead jet flights as close as 150 meters (approximately 500 feet) to the nest (Palmer et al. 2003). Urban

peregrine falcons appear to have particularly high tolerance thresholds compared to those in more remote areas (White et al. 2002).

In New York City, peregrine falcons nest on numerous bridges and high-rise buildings amongst high levels of noise and human activity associated with the urban environment (Frank 1994, Cade et al. 1996). Peregrine falcons also nest on church towers, such as Manhattan's Riverside Church (Frank 1994, Cade et al. 1996, Fowle and Kerlinger 2001). Riverside Church's tower contains the largest and heaviest bell in the world, which is sounded for an hour and a half each Sunday and intermittently for other occasions (The Riverside Church, undated). Peregrine falcons have successfully nested within feet of the bell since 1989 (Frank 1994), undeterred by its use.

The pair of falcons currently occupying the Tappan Zee Bridge is expected to habituate to and tolerate the increased levels of noise and human activity that would occur during project construction, and continue to utilize the current nest site based on their successful nesting amidst construction and maintenance work on the bridge in past years (Loucks and Nadareski 2005, Loucks 2008).During previous maintenance and construction activities on the bridge, NYSTA developed contractor protocols, in conjunction with NYSDEC and NYCDEP, for avoiding disturbance to nesting peregrine falcons. Similar protocols would be followed for this project (see Mitigation below).

Nest site abandonment in urban peregrine falcons is extremely rare when successful nesting has occurred in prior years (Cade et al. 1996). Nesting in an urban environment inherently involves frequent introduction of new and unfamiliar sources of disturbance, and this strong nest site fidelity of peregrine falcons in cities is further testament to their tolerance of noisy and unpredictable conditions. In California, peregrine falcons successfully nested on the Bay Bridge with no evidence of disturbance throughout the bridge's earthquake retrofitting project in the early 2000's. Similarly, current construction to replace the Bay Bridge has had no observable impact on the peregrine falcon pair nesting on the existing bridge. The pair has continued nesting throughout construction of the new bridge, with workers sometimes as close as 100 feet away from the nest. (Stewart 2011). Given these observations in California, along with the species' demonstrated tolerance of various forms and levels of disturbance that are experienced in an urban environment, peregrine falcons nesting on the Tappan Zee Bridge are not expected to experience adverse impacts from construction of the replacement bridge.

Upon completion of the replacement bridge, and prior to demolition of the existing bridge, it is possible that nest boxes would be moved to the replacement bridge to provide an alternative nest site for the resident pair of peregrine falcons to utilize in future breeding seasons. This passive form of nest relocation, as well as active nest relocation, have been successful with raptors (Postovit and Grier 1982, Trulio 1995, Smith and Belthoff 2001), including the closely-related prairie falcon (Postovit and Postovit 1987 in Roppe et al. 1989). Raptor species with high nest-site fidelity and territoriality, such as the peregrine falcon (Cade et al. 1996, White et al. 2002), are particularly strong candidates for successful passive relocation of a former nest (Trulio 1995). As such, and considering both the long history of the nest site on the existing bridge and the close proximity of the replacement bridge, it is expected that the peregrine falcons will readily transition to their former nest boxes if affixed to the nearby replacement bridge.

Depending on the timing of completion and demolition of the bridges, the pair may lose an opportunity to reproduce for one breeding season. Productivity of peregrine falcons nesting on bridges, including the Tappan Zee Bridge, has been notoriously low due to the dangerous conditions surrounding bridge nests (Cade and Bird 1990, Frank 1994, Bell et al. 1996, USFWS 1997, White et al. 2002, Stewart 2008). With nowhere safe to land nearby, offspring often drown in the water below or fledge to the bridge's road deck where they are hit by a vehicle. Extensive human intervention, such as rescue and rehabilitation of fledglings that fall onto the road deck or into water, is often needed for bridge-nesting peregrines to achieve reproductive success rates that are comparable to those of peregrine falcons that nest elsewhere (Cade and Bird 1990, Frank 1994, Bell et al. 1996, Stewart 2008). At the Tappan Zee Bridge nest site, data reported by Frank (1994) for the six breeding seasons between 1988 and 1993 show that a total of only four offspring survived to dispersal. At either this success rate, or a more traditional success rate for the species, the loss of one breeding opportunity that may occur between completion and demolition of the bridges would have a negligible effect on the size and viability of state and local populations.

Although urban peregrine falcons exhibit high tolerance of human disturbances and strong nest site fidelity (Cade et al. 1996), a worst case scenario remains possible in which the pair residing on the existing bridge would abandon their territory and seek a new breeding territory elsewhere. Emigration of these adults outside of the lower Hudson Valley/New York City area would measurably reduce the size of the local breeding population, which usually totals approximately ten to twelve pairs (Frank 1994, Loucks and Nadareski 2005), but would be unlikely to significantly reduce its viability. Similarly, emigration of these adults outside of New York State would have no adverse impact on the size or viability of the state's breeding population, which as of 2006, stood at 52 pairs and rising (Loucks 2008).

Measures to Minimize Impacts to Peregrine Falcons

Construction activities would be distanced as far from the peregrine falcon nest on the existing bridge as possible. Protocols developed by NYSTA, NYSDEC, and NYCDEP for minimizing disturbance to bridge-nesting peregrine falcons during maintenance and construction on the city's bridges have been successful (Loucks and Nadareski 2005, Loucks 2008), and would also be followed to the greatest extent possible during the February through August nesting period. These may include prohibiting construction activities, where practicable, at heights greater than 26 feet above the roadway or within 100 feet of the piers over which the nest boxes are located, and marking the tops of heavy equipment (e.g., cranes) and any tall exhaust pipes of such equipment with flagging to deter peregrine falcons from landing on them.

As discussed above, it is possible, upon completion of the replacement bridge, and prior to demolition of the existing bridge, nest boxes would be moved to the replacement bridge to provide an alternative nest site for the resident pair of peregrine falcons to utilize in future breeding seasons. The timing of nest box relocation and the siting of the boxes on the replacement bridge would be performed in consultation with NYSDEC and NYCDEP wildlife biologists to help ensure a successful transition.

Inland Staging Areas

The limited habitat available within the Inland Staging Areas would not be expected to provide habitat for threatened or endangered wildlife. Therefore, use of these sites for construction staging activities would not have any adverse impact on threatened, endangered, or special concern wildlife species.

The state-listed endangered late flowering boneset was observed within portions of the successional southern hardwoods community within the WNSA. Currently, this species is on the New York Natural Heritage Program's (NYNHP) "2010 Rare Plant Status List - Native Pioneer Plant Watch List." This list contains species that are under review for potential delisting by the state because they are considered pioneer species, or weedy in nature, and predicted to increase in numbers over time. These species are usually recent additions to the state and are actively colonizing disturbed sites. With respect to late flowering boneset, there is a debate among botanists over the native versus non-native status of this species within New York State (Lamont and Young 2001). Despite this debate, it has been determined that late flowering boneset is considered to be a native weedy species in states south and west of New York State, and the species is expected to continue to spread northward (Lamont and Young 2001).

Should late flowering boneset be delisted by the state prior to project construction, then it would be assumed that populations of this plant are secure and that the construction of the project would not result in an adverse impact on populations of this species within the region. However, if late flowering boneset remains listed by the state when construction is scheduled to commence, then coordination with NYNHP to develop a conservation strategy (e.g., the implementation of protection measures during construction or relocation of plants) to protect individuals of this species would occur. With this conservation strategy in place, the construction of the project would not result in adverse impacts on late flowering boneset populations within the region.

Aquatic Species

Only one federally endangered fish species, the shortnose sturgeon (*Acipenser brevirostrum) is* known to occur within the study area. Because shortnose sturgeon are anadromous, this species falls under the jurisdiction of NMFS under the ESA. Shortnose sturgeon are also currently listed for protection by the State of New York as an endangered species. Atlantic sturgeon (*Acipenser oxyrhynchus*) are also known to occur in the study area, and although they are not currently federally listed as threatened or endangered, five DPSs of Atlantic sturgeon have been proposed for listing as either threatened or endangered under the ESA. There is no federally designated critical habitat for either shortnose or Atlantic sturgeon in the Hudson River. However, NYSDOS has identified several areas in the Hudson River essential to shortnose sturgeon reproduction and survival. These fish spawn, develop, and most overwinter in the mid-Hudson River north of the project area.

As described in Chapter 16, "Ecology," a Biological Assessment (BA) has been prepared as part of a formal consultation process under Section 7 of the Endangered Species Act (ESA) (see Biological Assessment, **Appendix F-4).** Under Section 7 of the Endangered Species Act (ESA), the FHWA is required to consult with the USFWS and National Oceanic and Atmospheric Administration (NOAA) Fisheries to determine whether any federally listed species or species proposed for listing as endangered or

threatened species, or their designated critical habitats, occur in the vicinity of a proposed project. In the event that a federally listed or proposed endangered or threatened species or its designated critical habitat occurs in the vicinity of a "major construction activity," a Biological Assessment (BA) may need to be prepared to determine whether the proposed federal action would affect that species. The regulations promulgated pursuant to the ESA require every federal agency to ". . .[e]nsure that any action it authorizes, funds, or carries out, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat" (50 CFR Section 402.01).

The BA (Appendix F-4) provides extensive information on the spawning, abundance, distribution and movement patterns of shortnose and Atlantic sturgeon in the Hudson River. The BA concludes that while the loss of habitat associated with construction of the project may affect individual shortnose and Atlantic sturgeon, it would not be expected to adversely impact the Hudson River population of either species. The project site is neither a shortnose nor Atlantic sturgeon spawning area, or designated as critical habitat. Both of these species spawn well north of the bridge, with the principal spawning area for the shortnose as far north as Albany. Early life stages such as eggs and larvae of either species would not occur in the vicinity of the project. Dovel et al. (1992) indicated that the spawning grounds for shortnose sturgeon extends from just below the Troy Dam to river kilometer 212 (RM 131) and eggs and larvae can be expected to remain in this region for approximately four weeks post spawning.

The dredged access channels would represent an area of reduced foraging opportunities for both sturgeon species. As discussed above, over time deposition processes would allow benthic habitat to return to its pre-construction state. The temporary loss of the access channel area would represent a minor fraction of similar available habitat throughout the Tappan Zee region (1.2%) as defined by the Hudson River Utilities (RM 24-33), and an even smaller percentage of the riverwide benthic area (0.2%). The BA (**Appendix F-4**) concluded that while construction activities such as dredging and pile driving could affect individual fish, these activities would have minimal effects to shortnose and Atlantic sturgeon populations. Therefore, the construction of the project would not result in adverse impacts to populations of either species.

Analyses were conducted to estimate the number of shortnose sturgeon that may be affected by pile driving activities. The analysis methodology and results are more fully described in the attached appendix document (**Appendix F-6**).

Using fish abundance estimates from a 1-year comprehensive bimonthly gill-net sampling study (**Appendix F-1**), the encounter rate of shortnose sturgeon in the project area was estimated as the number of shortnose sturgeon collected per gill net per hour. From June 2007–May 2008, 476 gill nets were deployed just upstream of the existing Tappan Zee Bridge for a total sampling time of 679 hours. During this time, 12 shortnose sturgeon were collected: 7 in September and October, 4 in May and June, and 1 in August. Based on the observed number of sturgeon collected over 679 gill-net hours, the encounter rate for shortnose sturgeon in the project area was calculated as 0.02 sturgeon encountered per hour of sampling.

To estimate the potential number of shortnose sturgeon affected by pile driving activities, it was necessary to scale gill-net encounter rates from a single gill-net sample to the area encompassed by the isopleth bounding the SEL_{cum} of 187 dB re 1µPa^2-s (JASCO 2011a, **Appendices F-5a, 5b**). The SEL_{cum} of 187 dB re 1µPa^2-s, which is a an interim threshold measure (agreed to by a group consisting of West Coast state agencies, NMFS, USFWS, and FHWA for onset of physical injury to fish was used to determine the number of shortnose sturgeon that would have been collected if multiple gill nets were deployed side-by-side across the width of the 187 dB re 1µPa^2-s isopleth. The length of the gill net is 125-ft. For the Short Span Option the width of the 187 dB isopleth for the pile sizes ranges from 1,020 ft to 9,324 ft, depending on the size of the pile, or combination of pile sizes being driven (**Appendix F-6**, Table 2) . However, for about 80% of the weeks that construction will be ongoing, the width of the isopleths will be 3,500 ft or less. For the Long Span Option the width of the 187 dB isopleth for the pile sizes ranges from 1,178 ft to 7,965 ft, depending on the size of the pile, or combination of pile sizes being driven (**Appendix F-6**, Table 3). For 80% of the weeks that construction will be ongoing for the Long Span Option, the width of the isopleths will be 3,910 ft or less.

Movement by shortnose sturgeon has been shown to be strongly oriented into or with river currents (McCleave et al. 1977; Richmond and Kinard 1995). This is supported by data collected during the 2007-2008 gill net study, in which shortnose sturgeon were collected with greater frequency in gill nets deployed across the river current vs. with the current. Based on these results, it was assumed that sturgeon moved in an upstream or downstream direction through the project area and at a constant rate and would thus be intercepted by gill nets spanning the width of the noise isopleth. It was also assumed that catch rates are proportional to shortnose sturgeon abundance, which is a central assumption of most fish-sampling gears, and that sturgeon were uniformly distributed throughout the Tappan Zee region. Under these assumptions, each gill net would encounter shortnose sturgeon at the same rate allowing the estimates of sturgeon number to be scaled to the width of the isopleth.

Appendix F-6, Tables 2 and 3 provide a summary of the number of shortnose sturgeon potentially affected by the pile driving at various locations with 10 dB BMPs for each week of the construction period. Based on the analytical approach, the Short Span Option has the potential to affect 482 shortnose sturgeon and the Long Span Option has the potential to affect 365 fish, in total, for the project. Assuming 60,000 as a valid, current standing stock estimate for shortnose sturgeon in the Hudson River and assuming that this number remains static for the duration of the project, the Short Span Option has the potential to affect 0.80% of the population and the Long Span has the potential to affect 0.61% of the population. These estimates can be viewed as a conservative maximum because they represent the encounter rate within the isopleths over several years, and one should assume that some fraction of that total number would be encountered more than once. This approach also overestimates the numbers affected because is neglects any behavioral effects, such as moving away from the sounds at the onset of ensonification.

Because Atlantic sturgeon were not collected in the gill net sampling program no estimate of the number of fish within the ensonifed zone was calculated. However, because the Hudson River population size is considerably less than that for the

shortnose, the number would be expected to be less than 482 and 365 fish for the Short Span and Long Span Options, respectively.

As part of the ongoing Endangered Species Act listing for Atlantic sturgeon, the National Marine Fisheries Service (NMFS) is considering each of the five Distinct Population Segments (DPS) as an individual species. Because Atlantic sturgeon are thought to range widely along the Atlantic coast and have been shown to move among DPS (Erickson et al. 2011), there is a possibility that individuals from all five DPS could occur in the New York Bight DPS and may potentially pass through the Tappan Zee study area. As a result, Atlantic sturgeon from any of the five DPS could be affected by project activities associated with construction of the new Tappan Zee Bridge. For this reason, the BA (Appendix F-4) evaluated the potential for project effects on each of the five DPS.

Despite the fact that some individuals may migrate over large distances, their movement, in general, appears to be more localized to the coastal waters of the DPS of their origin (Erickson et al. 2011). For example, movement of Hudson River sturgeon has been shown to be largely limited to coastal waters from Long Island to the Chesapeake Bay, suggesting that the potential impact of bridge construction on Atlantic sturgeon may be greatest for individuals from the New York Bight DPS and possibly individuals from the adjacent Chesapeake DPS and much less for sturgeon from non-contiguous DPS. Studies from the Carolina DPS indicate that Atlantic sturgeon from the two southern DPS have more restricted geographic distributions and move shorter distances than sturgeon from northern DPS, with all the recaptures in those areas coming from the Carolina or South Atlantic DPS. These studies suggest that the majority of Atlantic sturgeon remain in coastal waters within their DPS or in adjacent DPS. The BA concluded that based on the best available information, the potential impacts of bridge construction on Atlantic sturgeon are greatest for individuals from the New York Bight DPS and much less likely for individuals from the four other DPS, despite the potential for Atlantic sturgeon to disperse widely among Atlantic coastal habitats and throughout DPS.

The attached BA (**Appendix F-4**) concluded that while pile driving can potentially injure sturgeon in the immediate vicinity of the activity, it will not jeopardize the continued existence of shortnose or Atlantic sturgeon in the Hudson River. Both shortnose and Atlantic sturgeon are subject to the same risks associated with pile driving as are other fish species inhabiting or migrating through the Tappan Zee region. However, their relatively small swim bladder would suggest that the physiological impacts of pile driving on sturgeon may not be as great as for other species with larger swim bladders. Furthermore, NMFS has commented (FHWA 2003) that fish like shad and alewife are more susceptible to pressure waves due to their laterally compressed body shape, in comparison to the shortnose sturgeon's fusiform shape. There is no critical habitat for shortnose or Atlantic sturgeon in the Hudson River.

While pile driving impacts resulting from constructing either Short or Long Span Options may impact some individuals of these two species either behaviorally or physiologically, the activity would not adversely impact their overall populations.

Candidate Species

Alewife and blueback herring were designated as candidate species on November 2, 2011. These species are being considered for listing as endangered or threatened under the ESA. Candidate status does not carry any procedural or substantive protections under the ESA. Impact analyses for blueback herring and alewife are included in this document with the general fish discussions.

Impacts to Marine Mammals from Pile Driving

Dolphins, harbor porpoises, and seals make occasional use of the Tappan Zee region of the Hudson River. These species are marine, and only occur in the tidal Hudson River as transients. The impact of sound on marine mammals is addressed in the attached Biological Assessment (**Appendix F-4**). The BA concludes that given the scarcity of marine mammals in the project area, it is not possible to reliably estimate the number of animals that may be affected by pile driving sounds (or noises associated with other construction activities). Based on the few anecdotal observations cited in the BA, the presence these species in the vicinity of the project is rare and is likely attributable to either previously stressed/injured animals or healthy, but transient, individuals. In the case of the former, if the animals don't or can't avoid the ensonified area, the pile driving sounds could exacerbate existing stressors and result in either sub-lethal or lethal effects, while in the case of the latter, healthy animals would be expected to retreat from the source of any sounds that produce discomfort. Nevertheless, because this portion of the Hudson River doesn't provide areas for spawning, nursery, or overwintering, or migratory pathways for these species, any anthropogenic sound in the river is not expected to result in adverse effects to the movement, reproduction, feeding, or sustained population of these species.

Historic Area Remediation Site

The Historic Area Remediation Site (HARS) will be used for disposal the project's dredge material that qualifies as Category I sediment, i.e. material judged suitable for remediation purposes. Consultations pursuant to Section 7 of the Endangered Species Act (ESA) have taken place for the area of the HARS during preparation of the SEIS. The USEPA prepared a biological assessment that concluded that the closure of the Mud Dump Site and designation of the HARS would not be likely to adversely affect loggerhead and kemps ridley sea turtles and humpback and fin whales (USEPA 1997). Special conditions are included in USACE Section 103 permits for placement of Remediation Material at HARS that requires the presence of NMFS approved Endangered Species Observer(s) on disposal scows during their trips to the HARS. The role of these observers is to prevent adverse impacts to endangered or threatened species transiting the area between the proposed dredge site and the HARS. With the implementation of these conditions placement of Remediation Material at the HARS would not result in adverse impacts to threatened or endangered species, also including marine mammals.

Project Measures to Minimize Hydroacoustic Effects

A number of measures are being implemented by the bridge replacement project to reduce the potential for pile driving associated injury to sturgeon and other aquatic species. These include:

- Driving the largest [3 and 2.4 m (10 and 8 ft)] diameter piles within the first few months of the project thereby limiting the time period of greatest potential impact.
- Using a vibratory pile driver to the extent feasible (i.e., all piles will be vibrated at least to 36.6 m (120 ft) depth or to vibration refusal) particularly for the initial pile segment.
- Using bubble curtain, cofferdams, isolation casings, Gunderboom, or other technologies to achieve a reduction of at least 10 dB of noise attenuation.
- Using the results of the Hudson River site specific Pile Installation Demonstration Project (PIDP) to inform the project on the effectiveness of BMP technologies for reducing sound levels, and implementing BMPs to achieve maximum sound reduction.
- Limiting the periods of pile driving to no more than 12-hours/day.
- Limiting driving of 8- and 10 ft diameter piles with an impact hammer within Zone C [water depths 5.5-13.7 m (18-45 feet)] to 5 hours per day during the period of spawning migration for shortnose, Atlantic sturgeon, and other anadromous fish species (April 1 to August 1).
- Maintaining a corridor where the sound level is below the West Coast threshold for onset of behavioral effects to fish totaling at least 5000 feet at all times during impact hammer pile driving. This corridor shall be continuous to the maximum extent possible but at no point shall any contributing section be smaller than 1500 ft.
- Pile tapping (i.e. a series of minimal energy strikes) for an initial period to frighten fish so that they move from the immediate area.
- Development of a comprehensive monitoring plan. Elements would include:
  - Monitoring locations to characterize the hydroacoustic field surrounding pile driving operations to evaluate the performance of underwater noise attenuation systems that are integral to the project.
  - Monitoring water quality parameters such as temperature, salinity, and suspended sediment concentrations in the vicinity of the pile driving.
  - Monitoring fish mortality and inspection of fish for types of injury.
  - Monitoring predation levels by gulls and other piscivorous birds, which would indicate that they are finding an increased number of dead or dying fish at the surface.
  - Developing criteria for re-initiating consultation with NMFS should specific numbers of shortnose or Atlantic sturgeon come to the surface injured or dead.
  - Preparing a Standard Operating Procedures Manual outlining the monitoring and reporting methods to be implemented during the program.

18-4-13-5 SIGNIFICANT HABITATS

Significant Coastal Fish and Wildlife Habitats

Neither the area to be dredged for access channels nor the area over which temporary platforms would be constructed, would directly impact Significant Coastal Fish and Wildlife Habitat. The closest Significant Coastal Fish and Wildlife Habitat is the Piermont Marsh, which is located two miles south of the bridge, far outside the projected plumes of increased suspended sediment for the worst-case in-water construction scenarios discussed above. Therefore, construction of the project would not result in adverse impacts to the resources of Piermont Marsh.

USFWS Significant Habitats

For reasons discussed above under “Fish,” and in Sections 18-4-13-3, “Suspended Sediment,” and 18-4-13-4, “Hydroacoustic Effects,” construction of the project would not result in adverse impacts to aquatic habitat or biota and would not affect the inclusion of this portion of the Hudson River within the USFWS Lower Hudson River Estuary Significant Habitat of the New York Bight.

There are a number of measures that the project would employ during construction to avoid or minimize adverse effects on the significant habitat. Measures to protect aquatic life and aquatic habitat during construction of the bridge in the Hudson River would include the use of turbidity curtains and cofferdams to minimize the potential for sediment resuspended during the bridge installation and removal activities to adversely affect water quality. Dredging would only be conducted during a three-month period from August 1 to November 1 for the three years of the construction period in which dredging would occur, in order to minimize the potential for impacts to sturgeon migration, as well as migration by other fish species. Other measures to minimize impacts to aquatic biota are described below under section 18-4-13, “Measures to Minimize Hydroacoustic Effects.”

As discussed above, the cumulative permanent loss of benthic habitat due to pier construction and the construction of the permanent platform for the Rockland Bridge Staging Area would result in a net loss of 1.2 acres for the Short Span Option and a net gain of 0.28 acres for the Long Span Option. In addition, the temporary loss of approximately 0.3 acres of benthic habitat within the footprint of the piles for the temporary platforms within the Bridge Staging Areas would not result in an adverse impact to the Hudson River Estuary Significant Habitat.

While the dredging of between 165 and 175 acres of bottom habitat followed by placement of approximately 155 to 165 acres of armoring material would result in the loss of individual benthic invertebrates, it is not expected to result in adverse impacts at the population level within the lower Hudson River estuary. However, the loss of 13 acres of oyster beds would result in an unavoidable adverse impact. Mitigation for the loss of oyster beds, including enhancement, relocation, and/or restoration will be developed in consultation with applicable resource and regulatory agencies.

Essential Fish Habitat

An EFH evaluation has been prepared as part of a formal consultation process under the Magnuson-Stevens Fishery Conservation and Management Act (see **Appendix F-3**).

Bridge Study Area

The primary potential direct impact to EFH species from the project is the physical disturbance to adults and juveniles as a result of pile driving, increased vessel traffic, and dredging. In the winter, few, if any, of the EFH species are likely to be in the study area because the salinity of the Hudson River within this area would be far below the preferred salinity range. However, in the warmer months of the year several EFH species do frequent the Tappan Zee Region. These species would include certain life stages of red hake, winter flounder, windowpane, bluefish, summer flounder and scup. In years when the salt wedge extends upriver, the study area would also provide EFH for Atlantic butterfish, black sea bass, king mackerel and possibly Atlantic mackerel, Spanish mackerel and cobia. Sounds from pile driving and other in-water construction activities would be temporary, and would not be expected to represent a barrier to movement of individuals within the Hudson River. Potential hydroacoustic impacts to fish using the deep water portions of the Hudson River due to pile driving with an impact hammer would only occur during the initial few months of in-water construction activities, and from April 1 to August 1 would be restricted to 5 hours per day for the installation of the 8- or 10-foot diameter piles within waters 18 feet or deeper at MLLW (i.e., Zone C). Pile driving would not generally occur at night and would not be continuous during the day (i.e., when piles are being put in place or being welded, or when the pile driver is being relocated). For most of the pile driving scenarios modeled, including those in which the maximum number of simultaneous piles are being driven and/or for the largest piles, a substantial portion of the Hudson River's width would never reach the SEL_{cum} criterion established for onset of physiological injury, and portions of the river would also be below the 150 dB RMS guidance for behavioral effect. Fish would not be expected to remain in an area at which noise would cause discomfort.

Therefore, the hydroacoustic environment resulting from pile driving with an impact hammer would result in a temporary loss of a small area of EFH and would not be expected to affect movement of EFH species within the river. The species identified as having EFH within the study area are common throughout the waters of the Lower Hudson Estuary and it is anticipated that only a small percentage of the fish stock in the region would be potentially exposed to potential impact. None of the EFH species utilize the project area or the Tappan Zee Region as their sole spawning grounds and/or critical habitat. The majority of the EFH spawn in the coastal and offshore waters of the Atlantic Ocean, the Hudson River within the study area would not provide spawning habitat for most EFH species. No eggs were collected in the Tappan Zee region (RM 24-33) for the Utilities Studies for 11 of the 13 EFH species. Eggs of Atlantic mackerel and windowpane have been reported within the study area. Atlantic mackerel have been reported but only rarely and in very low densities, based on utilities fish surveys. The primary spawning habitat for this species is located over the continental shelf within the Mid-Atlantic Bight, with very little evidence for spawning in tidal rivers or estuaries. The primary spawning habitat for windowpane is located in the nearshore coastal

waters of the Mid-Atlantic Bight; however, spawning is also known to occur in the saline portions of the lower Hudson River at salinities greater than 25 ppt. Windowpane eggs have been collected in low relative abundance during utilities fish surveys in the Tappan Zee region. The majority of windowpane eggs are reported from the lower 23 miles between the Battery and Yonkers. On the basis of the range of preferred spawning salinities for windowpane and the relatively low abundance of eggs in the Tappan Zee region, it is likely that eggs spawned downstream of the Tappan Zee study area are transported upstream on flood tides, rather than being spawned in the study area. Therefore, pile driving with an impact hammer would not be expected to result in adverse impacts to EFH or the species identified as having EFH within the study area.

The potential direct effects associated with increases in vessel traffic within the dredged construction channel include potential collision with vessels and disturbance of foraging and migratory adults and juveniles associated with an increase in surface activity and noise. For the fish species for which EFH has been designated in the Hudson River, the effects of vessel strikes is likely a function of fish size and location within the water column; however, impacts to these (smaller) species from increased vessel traffic is more likely to occur in the form of propeller entrainment. However, the increased surface activity and associated noise would have the potential to displace/disrupt adults and juveniles during foraging and migratory activities within the vicinity of the in-water activities on a given day, which would minimize the potential for losses due to contact with vessels.

The frequency of dredging or disturbance of an area affects the invertebrate community and its ability to recover following each dredging event. For EFH that feed on benthos, dredging would result in a sizable loss of bottom habitat and temporary alteration of this habitat that could affect foraging opportunities. However, benthic communities found in environments with a great deal of variability such as estuaries generally have high rates of recovery from disturbance, because they are adapted to disturbance. Recovery of the benthic macroinvertebrate community within the dredged and armored areas is expected to start upon cessation of bottom disturbing construction activities in a particular portion of the dredged construction channel. Therefore, while the dredging would result in the loss of individual macroinvertebrates, it is not expected to result in adverse impacts of these species at the population level within the Hudson River Estuary. The majority of the bottom habitat and associated benthic macroinvertebrates within the area impacted is the soft sediment community which dominates the Upper New York Harbor and Hudson River. Deposition of sediment into the dredged channel is projected to occur at a rate of one foot per year. Recolonization by benthic organisms adapted to softer sediments could be expected to begin within a few months after completion of in-water activities in any given area. Prior to the deposition of sufficient sediment to support a soft substrate benthic invertebrate community, some recolonization of the gravel armor material would be expected occur.

The primary potential indirect impact to EFH species from the project is the physical disturbance as a result of loss of habitat change, changes in interpier water velocities, total suspended solids (TSS), and re-deposition of sediments from dredging activities. Loss of bottom habitat due to the placement of the piles and other structures (including armoring of the dredged channel) would be minimal and would not be expected to result in significant reductions in fish habitat or prey availability. Furthermore, the loss of these

habitats will be fully or nearly fully offset by the removal of the existing bridge and associated piles to below the mud line. Therefore, habitat changes resulting from the project would not adversely affect EFH.

Water quality changes resulting from resuspension of bottom sediment during dredging and other sediment disturbing construction activities would be minimal and temporary, limited to the immediate area of the activity, and within the range of suspended sediment concentration reported for this portion of the Hudson River. Therefore increases in suspended sediment resulting from dredging and other sediment disturbing construction activities would not adversely affect EFH.

Harbor Area Remediation Site

Potential Direct Impacts

The Historic Area Remediation Site (HARS) will be used for disposal the project's dredge material that qualifies as Category I sediment, i.e., material judged suitable for remediation purposes. As described in the programmatic EFH for the HARS, direct impacts to EFH resulting from the placement of dredged material from the project at the HARS as Remediation Material would be the burial of benthic invertebrates within the cells receiving the material. While the loss of benthic invertebrates within the placement cells would be immediate, there would be sufficient foraging area available outside each approximately 250 foot by 500 foot cell such that fish species that forage on benthic invertebrates would not be adversely affected. Individual EFH would be expected to leave the area of the cells receiving dredged material from the project and would not be directly impacted due to the placement of the material due to burial or contact with the barge. Water quality impacts resulting from placement of the dredged material such as increased turbidity and contaminant concentrations would be expected to be temporary (less than an hour) and would not result in adverse impacts to EFH. Because the dredged material placed at the HARS from the project would be similar to the existing sediment at the HARS recolonization of the cell(s) receiving this material by benthic invertebrates would be expected to occur rapidly.

Potential Indirect Impacts

Benthic invertebrates contained in the dredged material from the project would have the potential to provide additional prey for EFH species using the habitats in the vicinity of the cells receiving placement of the Remediation Material. While minor changes to bathymetry may occur as a result in the placement, it would never be more than approximately 3 feet, which would not be expected to adversely affect the suitability of the sediment for benthic invertebrates on the basis of depth or light penetration.

Potential Cumulative Impacts

The primary cumulative impact from the placement of the dredged material from the project at the HARS would be the eventual remediation of the HARS which would result in an improved benthic community and improved habitat for fish and shellfish. The placement of the dredged material from the project at the HARS in three stages would minimize the area of disturbance within the cells designated for the project by the USACE during each dredging season for the project. Because changes to water quality during placement of Remediation Material would be expected to be limited temporally

and spatially, placement of the dredged material with material from other projects would not be expected to result in adverse impacts to water quality or EFH. Given the large area of the HARS yet to be remediated, placement of the dredged material from the project concurrent with placement of material from other projects, sufficient EFH would still be available within the HARS that placement of the dredged material concurrent with placement of Remediation Material from other projects would not be expected to result in adverse impacts to EFH.

18-4-14 HAZARDOUS AND CONTAMINATED MATERIALS

Construction of the Replacement Bridge Alternative would not result in any adverse impacts to workers or the surrounding communities because a variety of procedures would be implemented to manage hazardous materials[1] (e.g., asbestos and lead-based paint) both in the existing bridge structure and in other structures that would be demolished/renovated as well as any potential hazardous materials in the subsurface, i.e., soil and groundwater, in the upland areas that would be disturbed.

To evaluate the potential presence of hazardous materials, a Phase I Environmental Site Assessment (ESA) was performed. This non-ground-intrusive study included site reconnaissance, research on current/historical use, and review of federal and state regulatory listings for both the project site itself and for its neighboring properties within certain specified distances. Where a Phase I ESA finds evidence of known or potential concerns, a subsurface (also known as a Phase II) investigation is generally recommended. Unlike a Phase I ESA, a Phase II investigation typically includes laboratory analysis of soil and groundwater samples in the areas of potential disturbance. Both Phase I and Phase II studies also frequently include evaluation of non-subsurface issues typically associated with structures, e.g., asbestos-containing materials (ACM) or lead-based paint. Hazardous materials associated with existing structures must be addressed in accordance with established regulatory requirements, especially when being renovated or demolished.

Phase I ESAs found evidence of “recognized environmental conditions” (RECs) as well as non-REC issues, such as ACM and lead-based paint, and recommended that subsurface investigations be done to understand the nature of potential contaminants.

Phase II investigations would be used to refine the measures to be implemented during construction to properly manage hazardous materials in the existing bridge structure, in other structures that would be disturbed, and in the subsurface, i.e., soil and groundwater. In this way, adverse impacts to workers, the surrounding communities and the environment would be avoided. To avoid the potential for adverse impacts, the project would be conducted in accordance with the following:

- Once the exact areas where soil disturbance are identified (and prior to the soil disturbance activities), subsurface (Phase II) investigations of the areas to be disturbed would be conducted. The investigations would involve the collection of

[1] For the purposes of this chapter the terms “hazardous material” and “contaminated material” are used interchangeably and to mean any substance that poses a threat to human health or the environment. “Hazardous waste” is a specific regulatory term meaning a subset of solid wastes in the federal (40 CFR Part 261) or State (6 NYCRR Part 371) regulations that are either specifically listed or possess the characteristic of ignitability, reactivity, corrosivity or toxicity.

subsurface soil and groundwater samples for laboratory analysis. Should additional project areas (e.g., construction staging) be identified that were not within the limits of the existing Phase I ESA, additional Phase I ESAs and, if warranted by Phase I ESA findings, subsurface investigations, would be conducted prior to soil disturbance in those areas.

- Based on the findings of the subsurface investigations, site-specific Remedial Action Plans (RAPs) and Construction Health and Safety Plan (CHASP) would be prepared and implemented during construction. These plans would provide the appropriate clean fill importation criteria and criteria for allowable reuse of excavated site soils (whether in the uppermost layer of unpaved areas or elsewhere), handling, stockpiling, testing, transportation, and disposal of excavated materials, including any unexpectedly encountered contaminated soil and petroleum storage tanks, in accordance with applicable regulatory requirements. The RAP would include requirements that all excavated soil and/or fill be handled and disposed of in accordance with regulatory requirements and standard NYSDOT procedures. Where dewatering is required, it would be conducted under a NYSDEC State Pollutant Discharge Elimination System (SPDES) permit and in accordance with standard NYSDOT procedures. The CHASP would ensure that subsurface disturbance is performed in a manner protective of workers, the community, and the environment.
- Any petroleum storage tanks within the project limits that would not be used following the proposed action would be properly closed and removed, along with any contaminated soil, prior to disturbance in accordance with NYSDEC requirements and NYSDOT procedures. Any remaining tanks, as well as any new tanks, would be maintained in accordance with regulatory requirements and standard NYSDOT procedures as discussed in Chapter 17, Hazardous and Contaminated Materials.
- Any chemicals requiring disposal would be properly disposed of in accordance with regulatory requirements and standard NYSDOT procedures. Any chemicals used for maintenance following the proposed action, as well as any accident-related chemicals requiring clean-up, would be handled and disposed of in accordance with regulatory requirements and standard NYSDOT procedures as discussed in Chapter 17, Hazardous and Contaminated Materials.

18-5 MITIGATION

18-5-1 ECOLOGY

In addition to the environmental monitoring, minimization measures, and EPCs-including conditions of various state and federal permits, potential l measures to mitigate effects on ecological resources are identified below.

- Oyster Reefs: Opportunities for oyster bed enhancement, relocation, and/or restoration would be evaluated under consideration with NYSDEC, USACE, USFWS, and NMFS as possible mitigation for loss of oyster reefs.
- Wetland Enhancement: Wetland enhancement and/or creation can be implemented to offset impacts to wetlands at the Westchester Bridge Staging Area access road

and at the WNSA, should this staging site be selected during the design build process and there are unavoidable impacts to the forested wetland habitat. Mitigation would be coordinated with USACE for the loss of wetlands at this site.

Chapter 19: Environmental Justice

19-1 INTRODUCTION

This chapter analyzes the Tappan Zee Hudson River Crossing Project's potential effects on minority and low-income populations, to determine whether the project would result in disproportionately high and adverse impacts on those populations. The analysis of potential environmental justice impacts of the Tappan Zee Hudson River Crossing Project is based on the impact assessments included in the other chapters of this Environmental Impact Statement (EIS), and takes into account mitigation measures and any offsetting benefits to the affected populations.

In summary, the project would not result in any disproportionately high and adverse effects on minority and low-income populations. Therefore, no environmental justice impacts are anticipated.

19-2 REGULATORY CONTEXT

To satisfy Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (February 11, 1994), this analysis has been prepared to identify and address any disproportionately high and adverse impacts on minority or low-income populations that could result from the project. Executive Order 12898 also requires federal agencies to work to ensure greater public participation in the decision-making process. This environmental justice analysis will also serve to assist the New York State Department of Environmental Conservation (NYSDEC) in its environmental permit review process associated with the proposed permit actions and its application of the State Environmental Quality Review Act (SEQRA), and is consistent with the intent of CP-29, "Environmental Justice and Permitting," which is the NYSDEC's policy on environmental justice.

The environmental justice analysis for the project follows the guidance and methodologies recommended by the federal Council on Environmental Quality (CEQ) in *Environmental Justice Guidance under the National Environmental Policy Act* (December 1997), the U.S. Department of Transportation (USDOT) in the *US Department of Transportation Order on Environmental Justice* (April 1997), and the Federal Highway Administration (FHWA) in *FHWA Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (December 1998). These orders establish policies and procedures for the agencies to use in complying with Executive Order 12898. The Executive, USDOT, and FHWA orders on environmental justice reaffirm the principles of Title VI of the Civil Rights Act of 1964 (Title VI) and the National Environmental Policy Act (NEPA), emphasizing the importance of those provisions in the environmental and transportation-related decision-making process. On December 16, 2011, FHWA issued supplemental guidance on environmental justice and NEPA, which was also consulted in preparing this environmental justice analysis.

19-3 METHODOLOGY

The assessment of environmental justice for the project was based on the CEQ, USDOT, and FHWA documents identified above. It involved five basic steps:

1. Identify the areas where the project may cause adverse impacts either during construction or operation (i.e., the study areas);
2. Compile minority and low-income data for the census block groups within the study areas and identify minority and low-income populations;
3. Identify the project's potential adverse impacts on minority and low-income populations; and
4. Evaluate the project's potential adverse effects on minority and low-income populations relative to its overall effects to determine whether any potential adverse impacts on those communities would be significant and disproportionately high.
5. Discuss mitigation measures for any identified disproportionate adverse impacts and describe the public outreach and participation process for effectively engaging minority and low-income populations in the decision-making process.

19-3-1 DELINEATION OF STUDY AREA

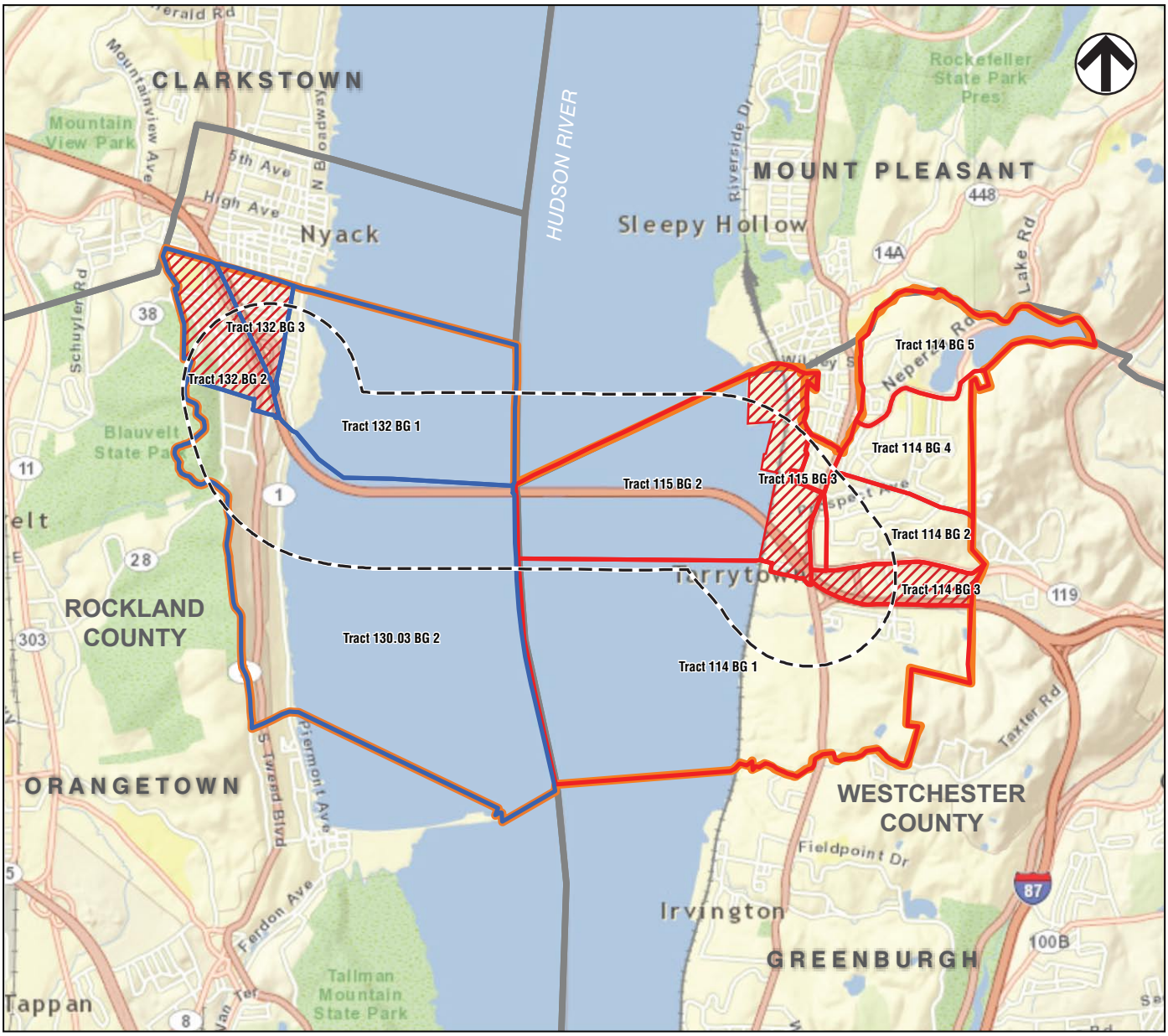
The study area for environmental justice encompasses the area most likely to be affected by the project and accounts for the potential impacts resulting from operation (see **Figures 19-1** and **19-2**). For the evaluation of environmental justice for the project, the environmental justice study area generally approximates the socioeconomic study area (see Chapter 8, "Socioeconomic Conditions"). The environmental justice study area generally includes the census block groups that overlap with the ½-mile perimeter around the project site. Census block groups were chosen as the geographic unit most appropriate for this analysis so as not to artificially dilute or inflate the affected populations, consistent with the federal guidance on environmental justice. Some census block group boundaries have changed between the 2000 Census and the 2010 Census. In order to have a consistent study area (in terms of land area covered) between the minority analysis (which relies on 2010 Census race and ethnicity data for 2010 Census block groups) and the low-income analysis (which relies on 2005-2009 American Community Survey poverty status data for 2000 Census block groups), additional block groups beyond the ½-mile perimeter were included in the Westchester County portion of the study area.[1]

The environmental justice study area for operational impacts spans a portion of the Hudson River in the area of the Tappan Zee Bridge and extends into Westchester County on the east and Rockland County on the west. The study area includes the replacement bridge and proposed landing locations.

The study area for construction effects includes the area where construction would take place along the Interstate 87/287 right-of-way (see **Figures 19-3** and **19-4**). In addition, the study area includes three potential construction staging areas outside the NYSTA

[1] It is anticipated that between publication of the Draft EIS and Final EIS, 2006-2010 American Community Survey data will be released based on 2010 Census block groups, so that one set of common block groups may be analyzed for both the minority and low-income analysis.

11.29.11



0 0.5 1 MILES
SCALE

1/2-Mile Perimeter

Environmental Justice Study Area

2010 Census Block Groups in Westchester County

2010 Census Block Groups in Rockland County

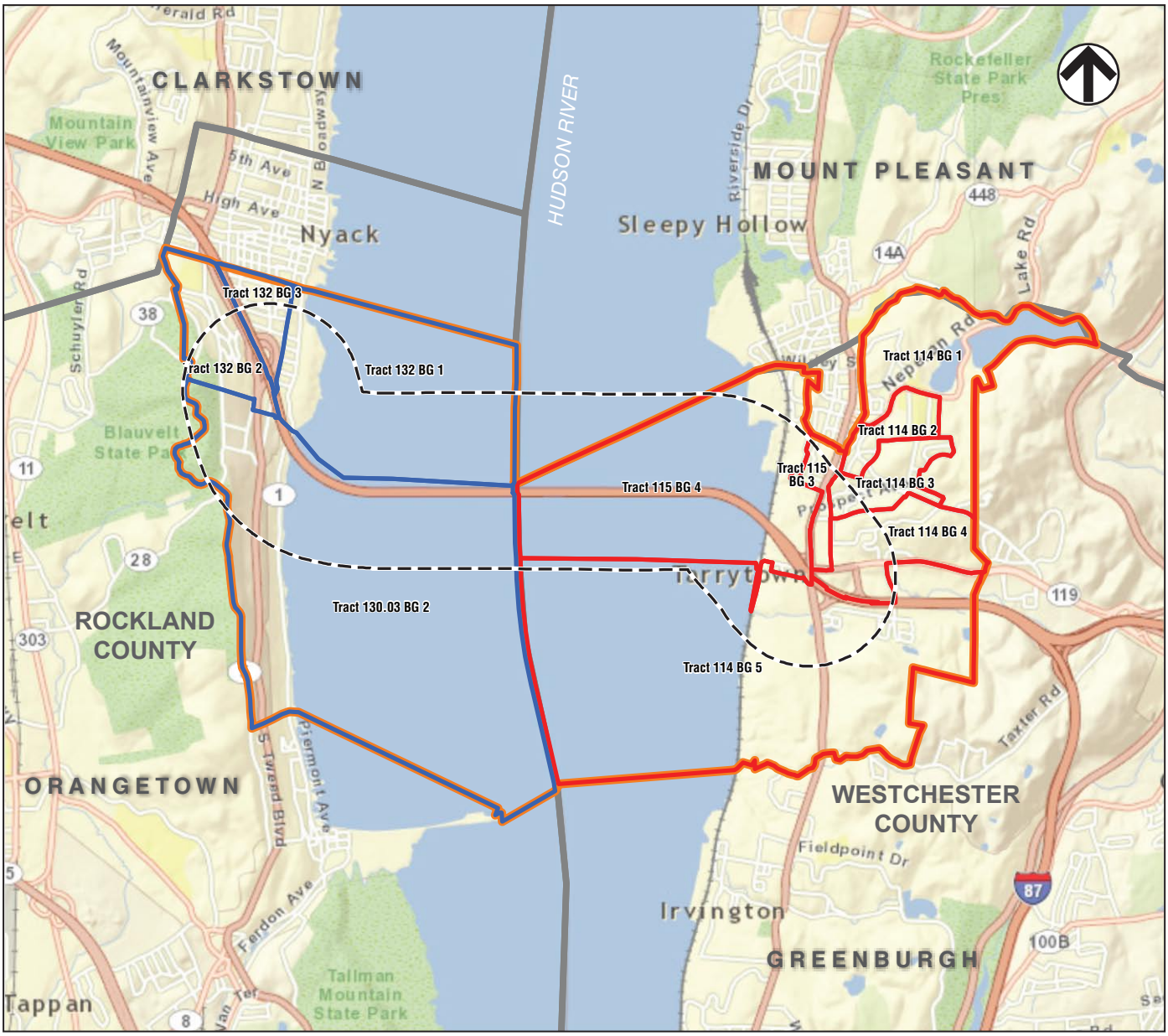
County Subdivision

Minority Area

Figure 19-1

Environmental Justice Study Area: Minority Analysis

11.29.11



0 0.5 1 MILES
SCALE

1/2-Mile Perimeter

Environmental Justice Study Area

2000 Census Block Groups in Westchester County

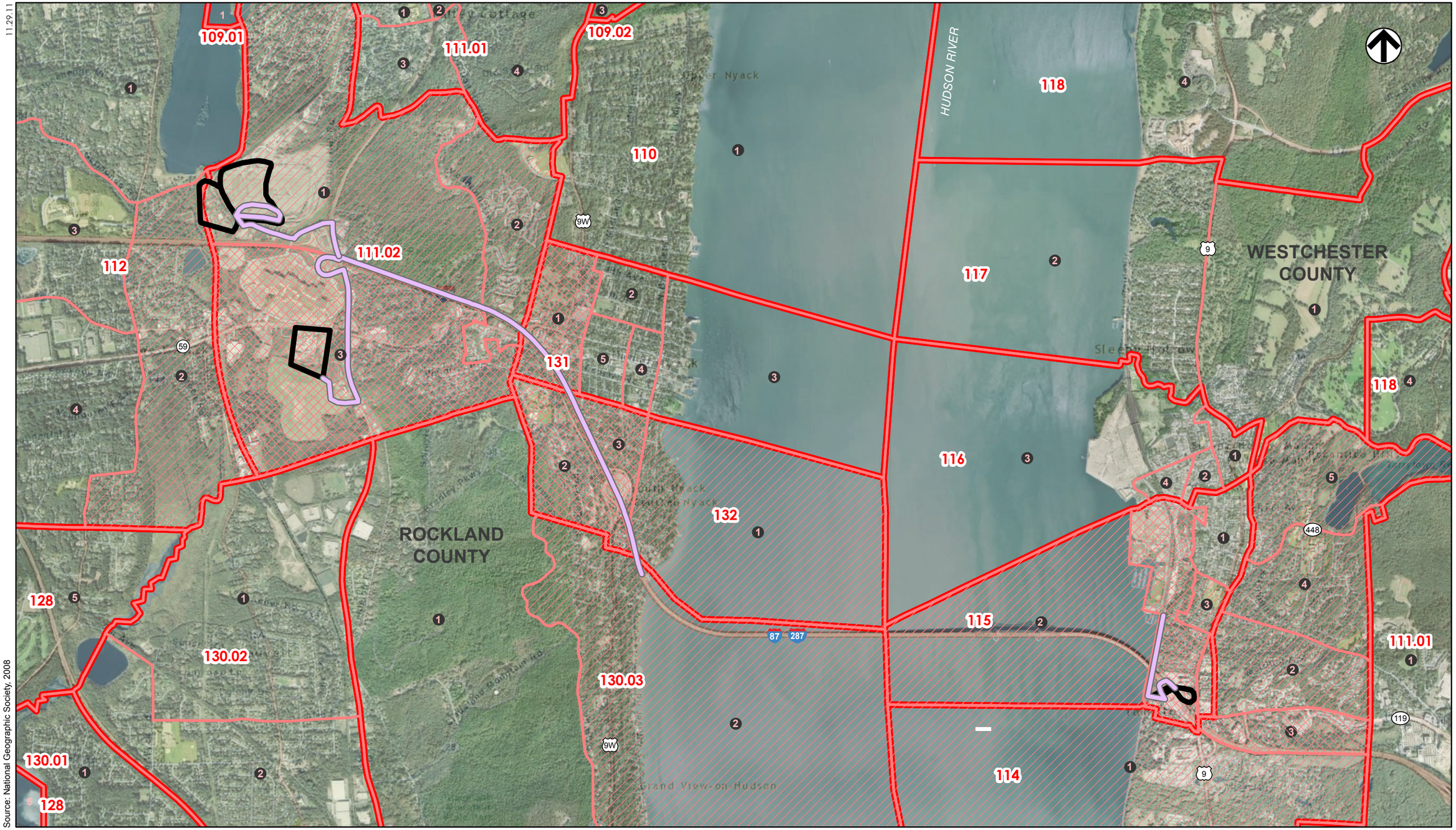
2000 Census Block Groups in Rockland County

County Subdivision

Figure 19-2

Environmental Justice Study Area: Low-Income Analysis

11.29.11



Source: National Geographic Society, 2008

Construction Truck Routes

Potential Temporary Staging Areas

Minority Areas in Study Area

2010 Block Groups in Study Area

2010 Block Groups

2010 Census Tracts

0 1/2 MILE

SCALE

Figure 19-3

Construction Study Area for Environmental Justice - Minority Analysis

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

11.29.11

Construction Truck Routes

Potential Temporary Staging Areas

Low-Income Area in Study Area

2000 Block Groups in Study Area

2000 Block Groups

2000 Census Tracts

0 1/2 MILE

SCALE

Figure 19-4

Construction Study Area for Environmental Justice - Low Income Analysis

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

right-of-way: the Tilcon Quarry Inland Staging Area and the West Nyack Inland Staging Area in Rockland County on the west side of the Hudson River and the Tarrytown Inland Staging Area in Westchester County on the east side of the Hudson River.

19-3-2 IDENTIFICATION OF ENVIRONMENTAL JUSTICE POPULATIONS

Data were gathered from the U.S. Census Bureau's *Census 2010* and 2*005–2009 American Community Survey* for all census block groups within the study areas. For comparison purposes, data were aggregated for the study areas as a whole, and compiled for Rockland and Westchester Counties since the study areas include portions of both. Minority and low-income populations were identified as follows:

- *Minority Populations.* The guidance documents define minorities to include American Indians or Alaskan Natives, Asians and Pacific Islanders, Black or African American persons, and Hispanic persons. This environmental justice analysis also considers minority populations to include persons who identified themselves as being either "some other race" or "two or more races" in the *Census 2010*. Following CEQ guidance, minority populations were identified where either: (1) the minority population of the affected area exceeds 50 percent; or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. For this analysis, Rockland County was used as the project's primary statistical reference area for the census block groups located in Rockland County. In Rockland County, the minority population in 2010 was 34.7 percent. Westchester County was used as the reference area for the study area's census block groups located in Westchester County. In Westchester County, the minority population in 2010 was 42.6 percent. For this environmental justice analysis, census block groups having total minority populations greater than in the respective county reference areas were identified as minority areas.

- *Low-Income Populations.* The percent of individuals below poverty level in each census block group (based on the 2000 Census), available in the U.S. Census Bureau's *2005–2009 American Community Survey,* was used to identify low-income populations. Since the federal guidance documents do not specify thresholds to identify low-income areas, this analysis considers any census block group with a percentage of individuals below poverty level that is greater than its respective reference area (i.e., Rockland or Westchester County) to be a low-income. In Rockland County, approximately 11 percent of individuals live below the federal poverty threshold; therefore, any census block group located in Rockland County with more than 11 percent of its individuals living below the poverty level is considered to be low-income area. Similarly, any census block group in Westchester County having a low-income population greater than the percentage of individuals living below poverty in Westchester County (8 percent) is considered to be a low-income area.

19-4 AFFECTED ENVIRONMENT

19-4-1 MINORITY STATUS ANALYSIS

19-4-1-1 OPERATIONAL STUDY AREA

Of the study area's 11 census block groups, four (4) are considered minority areas or communities of concern for environmental justice (see **Figure 19-1** and **Table 19-1**). The identified minority populations include two in Rockland County (Tract 132 Block Groups 2 and 3) and two in Westchester County (Tract 114 BG 3 and Tract 115 BG 2). These communities have minority population percentages ranging from 44.1 to 50.0 percent. While these percentages are at or below CEQ's 50 percent threshold for identifying minority populations, they are considered meaningfully greater than in their respective references areas (34.7 percent in Rockland County and 42.6 percent in Westchester County). Of the minority populations in the study area, the Hispanic population accounts for the greatest proportion of the total population in the study area (13.3 percent), followed by Black or African American populations (9.3 percent) and by Asian populations (7.8 percent) and "Other" minority populations (2.5 percent).

Table 19-1
Operational Study Area Race and Ethnicity

Census Block Groups	2010 Census											
	2010 Total	Race and Ethnicity*										Total Minority (%)
		White	%	Black	%	Asian	%	Other	%	Hispanic	%	
Westchester County Block Groups												
Tract 114, BG 1	1,331	1032	77.5	11	0.8	166	12.5	48	3.6	74	5.6	22.5
Tract 114, BG 2	2,004	1,333	66.5	192	9.6	209	10.4	27	1.3	243	12.1	33.5
Tract 114, BG 3	***575***	***291***	***50.6***	***69***	***12.0***	***103***	***17.9***	***19***	***3.3***	***93***	***16.2***	***49.4***
Tract 114, BG 4	1,808	1217	67.3	129	7.1	215	11.9	54	3.0	193	10.7	32.7
Tract 114, BG 5	650	567	87.2	11	1.7	21	3.2	3	0.5	48	7.4	12.8
Tract 115, BG 2	***1,478***	***783***	***53.0***	***135***	***9.1***	***53***	***3.6***	***27***	***1.8***	***480***	***32.5***	***47.0***
Tract 115, BG 3	862	617	71.6	44	5.1	36	4.2	25	2.9	140	16.2	28.4
Rockland County Block Groups												
Tract 130.03, BG 2	912	774	84.9	54	5.9	37	4.1	9	1.0	38	4.2	15.1
Tract 132, BG 1	1,014	874	86.2	45	4.4	42	4.1	19	1.9	34	3.4	13.8
Tract 132, BG 2	***1,333***	***745***	***55.9***	***209***	***15.7***	***123***	***9.2***	***64***	***4.8***	***192***	***14.4***	***44.1***
Tract 132, BG 3	***1,163***	***581***	***50.0***	***322***	***27.7***	***25***	***2.1***	***29***	***2.5***	***206***	***17.7***	***50.0***
Total Study Area	13,130	8,814	67.1	1,221	9.3	1,030	7.8	324	2.5	1,741	13.3	32.9
Westchester County	949,113	544,563	57.4	126,585	13.3	51,123	5.4	19,810	2.1	207,032	21.8	42.6
Rockland County	311,687	203,670	65.3	34,623	11.1	19,099	6.1	5,512	1.8	48,783	15.7	34.7

Notes:
Bold italic denotes environmental justice area.
* The racial and ethnic categories provided are further defined as: White (White alone, not Hispanic or Latino); Black (Black or African American alone, not Hispanic or Latino); Asian (Asian alone, not Hispanic or Latino); Other (American Indian and Alaska Native alone, not Hispanic or Latino; Native Hawaiian and Other Pacific Islander alone, not Hispanic or Latino; Some other race alone, not Hispanic or Latino; Two or more races, not Hispanic or Latino); Hispanic (Hispanic or Latino; Persons of Hispanic origin may be of any race).
Sources: U.S. Census Bureau, *Census 2010*.

19-4-1-2 CONSTRUCTION STUDY AREA

As shown on **Figure 19-3** and in **Table 19-2**, there are minority areas, as well as non-minority areas, located within the construction study area. Of the construction study area's 16 2010 Census block groups, 6 are considered minority areas and the remaining 10 block groups are considered non-minority areas.

Table 19-2
Construction Study Area Race and Ethnicity

Census Block Groups	2010 Census											
	2010 Total	Race and Ethnicity*										Total Minority (%)
		White	%	Black	%	Asian	%	Other	%	Hispanic	%	
Westchester County Block Groups												
Tract 114, BG 1***	1,331	1032	77.5	11	0.8	166	12.5	48	3.6	74	5.6	22.5
Tract 114, BG 2***	2,004	1,333	66.5	192	9.6	209	10.4	27	1.3	243	12.1	33.5
Tract 114, BG 3*	***575***	***291***	***50.6***	***69***	***12.0***	***103***	***17.9***	***19***	***3.3***	***93***	***16.2***	***49.4***
Tract 114, BG 4***	1,808	1217	67.3	129	7.1	215	11.9	54	3.0	193	10.7	32.7
Tract 114, BG 5***	650	567	87.2	11	1.7	21	3.2	3	0.5	48	7.4	12.8
Tract 115, BG 2*	***1,478***	***783***	***53.0***	***135***	***9.1***	***53***	***3.6***	***27***	***1.8***	***480***	***32.5***	***47.0***
Tract 115, BG 3***	862	617	71.6	44	5.1	36	4.2	25	2.9	140	16.2	28.4
Rockland County Block Groups												
Tract 111.02 BG 1	1,844	1350	73.2	109	5.9	188	10.2	35	1.9	162	8.8	26.8
Tract 111.02 BG 2	2,103	1380	65.6	396	18.8	120	5.7	35	1.7	172	8.2	34.4
Tract 111.02 BG 3	***1,948***	***658***	***33.8***	***639***	***32.8***	***182***	***9.3***	***68***	***3.5***	***401***	***20.6***	***66.2***
Tract 112 BG 2	1,281	902	70.4	30	2.3	171	13.3	11	0.9	167	13.0	29.6
Tract 130.03, BG 2***	912	774	84.9	54	5.9	37	4.1	9	1.0	38	4.2	15.1
Tract 131 BG 1*	***1,331***	***669***	***50.3***	***295***	***22.2***	***86***	***6.5***	***33***	***2.5***	***248***	***18.6***	***49.7***
Tract 132, BG 1***	1,014	874	86.2	45	4.4	42	4.1	19	1.9	34	3.4	13.8
Tract 132, BG 2*	***1,333***	***745***	***55.9***	***209***	***15.7***	***123***	***9.2***	***64***	***4.8***	***192***	***14.4***	***44.1***
Tract 132, BG 3*	***1,163***	***581***	***50.0***	***322***	***27.7***	***25***	***2.1***	***29***	***2.5***	***206***	***17.7***	***50.0***
Total Study Area	21,637	13,773	63.7	2,690	12.4	1,777	8.2	506	2.3	2,891	13.4	36.3
Westchester County	949,113	544,563	57.4	126,585	13.3	51,123	5.4	19,810	2.1	207,032	21.8	42.6
Rockland County	311,687	203,670	65.3	34,623	11.1	19,099	6.1	5,512	1.8	48,783	15.7	34.7

Notes:
Bold italic denotes environmental justice area.
* The racial and ethnic categories provided are further defined as: White (White alone, not Hispanic or Latino); Black (Black or African American alone, not Hispanic or Latino); Asian (Asian alone, not Hispanic or Latino); Other (American Indian and Alaska Native alone, not Hispanic or Latino; Native Hawaiian and Other Pacific Islander alone, not Hispanic or Latino; Some other race alone, not Hispanic or Latino; Two or more races, not Hispanic or Latino); Hispanic (Hispanic or Latino; Persons of Hispanic origin may be of any race).
Tract 131, BG 1 as defined by the 2010 Census covers the same land area as Tract 131, Block Groups 4 and 5 as identified in the 2000 Census (see **Table 19-4, below)
***These block groups are also in the operational study area.
Sources: U.S. Census Bureau, *Census 2010*.

Both minority and non-minority areas are located along the right-of-way. There is no alternative to construction of the Tappan Zee Hudson River Crossing taking place within the Interstate 87/287 right-of-way. Outside of the right-of-way, two of the potential construction staging areas (the West Nyack Inland Staging Area in Rockland County and the Tarrytown Inland Staging Area in Westchester County) are located in minority areas as identified according to the applicable federal guidance on environmental justice, and one of the potential staging areas—the Tilcon Quarry Inland Staging Area in Rockland County—is located in a non-minority and non-low-income area. Of the two

staging areas located in minority areas, the one in West Nyack, Town of Clarkstown, is composed of vacant land or commercial and industrial uses, including auto-related uses, storage and manufacturing, a fast food establishment, and a waste disposal facility, and does not contain any residents.[1] The Tarrytown Inland Staging Area, which is also located in a minority area, is owned by the New York State Thruway Authority (NYSTA).

19-4-2 POVERTY STATUS ANALYSIS

19-4-2-1 OPERATIONAL STUDY AREA

Data on poverty status were collected for the 2000 Census block groups in the study area to determine whether any low-income areas are present in the study area. As shown in **Table 19-3**, none of the study area's block groups have low-income populations that exceed the percentage of the overall low income in Rockland County (11 percent) or Westchester County (8 percent). Rather, the study area's 11 block groups have low-income population percentages ranging from less than 1 percent to approximately 6 percent. The study area as a whole has a low-income population of approximately 3 percent of the total study area population. Therefore, none of the study area's block groups are considered potential environmental justice areas based on the income characteristics.

Table 19-3
Operational Study Area Poverty Status

2000 Census Block Groups	ACS 2005-2009 Individuals Below Poverty Level (%)*
Westchester County Block Groups	
Tract 114, BG 1	2
Tract 114, BG 2	0
Tract 114, BG 3	0
Tract 114, BG 4	3
Tract 114, BG 5	3
Tract 115, BG 1	1
Tract 115, BG 2	5
Rockland County Block Groups	
Tract 130.03, BG 2	5
Tract 132, BG 1	4
Tract 132, BG 2	6
Tract 132, BG 3	4
Study Area	3
Rockland County	11
Westchester County	8

Notes:
** Percent of individuals with incomes below poverty level, as established by the U.S. Census Bureau.
Sources: U.S. Census Bureau, 2005-2009 American Community Survey.

19-4-2-2 CONSTRUCTION STUDY AREA

In terms of low-income areas, of the 17 2000 Census block groups located in the construction study area for environmental justice, only 1—Tract 131 BG 5—was

[1] Uses based on 2011 Tax Bills from the Town of Clarkstown, Receiver of Taxes.

identified as a low-income area according to the applicable federal guidance on environmental justice (see **Table 19-4** and **Figure 19-4**). Interstate 87/287 runs along a small portion of this block group's southwestern boundary.

Table 19-4
Construction Study Area Poverty Status

2000 Census Block Groups	ACS 2005-2009 Individuals Below Poverty Level (%)*
Westchester County Block Groups	
Tract 114, BG 1***	2
Tract 114, BG 2***	0
Tract 114, BG 3***	0
Tract 114, BG 4***	3
Tract 114, BG 5***	3
Tract 115, BG 1***	1
Tract 115, BG 2***	5
Rockland County Block Groups	
Tract 111.02, BG 1	1
Tract 111.02, BG 2	9
Tract 111.02, BG 3	5
Tract 112, BG 2	5
Tract 130.03, BG 2***	5
Tract 131, BG 4**	7
Tract 131, BG 5 ***	***16***
Tract 132, BG 1***	4
Tract 132, BG 2***	6
Tract 132, BG 3***	4
Study Area	3
Rockland County	11
Westchester County	8

Notes:
Bold italic denotes potential environmental justice area.
*Percent of individuals with incomes below poverty level, as established by the U.S. Census Bureau.
Tract 131, Block Groups 4 and 5 as defined by the 2000 Census covers the same land area as Tract 131, BG 1 as identified in the 2010 Census (see **Table 19-2, above).
***These block groups are also located in the operational study area for poverty status.
Sources: U.S. Census Bureau, 2005-2009 American Community Survey.

19-5 ENVIRONMENTAL EFFECTS

19-5-1 SUMMARY OF ADVERSE EFFECTS

As discussed throughout this EIS, the Replacement Bridge Alternative would result in certain adverse impacts. Those impacts are described below. An analysis of the project's potential for disproportionately high and adverse impacts on environmental justice populations is provided in the next section.

- ***Land Acquisition, Displacement, and Relocation.*** The Replacement Bridge Alternative would result in the displacement of approximately nine households in Rockland County. Three of these are two-family homes and three are one-family homes. The displacement would be undertaken pursuant to the federal *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970* and the

New York State Eminent Domain Procedure Law (EDPL), which protect the rights of property owners and tenants.

- ***Visual and Aesthetic Resources.*** The Replacement Bridge Alternative would adversely impact views from a limited number of residences on Ferris Lane, Bight Lane, and River Road.
- ***Historic and Cultural Resources.*** The existing Tappan Zee Bridge would be removed and replaced as a result of this project. This would constitute an adverse effect on historic properties. Proposed measures to mitigate the adverse effect of the project on the Tappan Zee Bridge are outlined in a Draft Section 106 Memorandum of Agreement (MOA) for this project, included as **Appendix C** of this document, and are discussed in Chapter 10, "Historic and Cultural Resources."

  The Replacement Bridge Alternative would adversely affect two architectural resources—Tappan Zee Bridge and South Nyack Historic District. Proposed measures to mitigate these adverse effects on the Tappan Zee Bridge and the South Nyack Historic District (including the removal of two historic residences) are outlined in the Draft Section 106 MOA and are discussed in Chapter 10, "Historic and Cultural Resources."
- ***Noise and Vibration.*** The Replacement Bridge Alternative would exceed the FHWA Noise Abatement Criteria (NAC) resulting in noise impacts at up to 79 properties in Rockland County and 8 properties in Westchester County. The majority of these impacts would be attributed to increases in traffic independent of the Replacement Bridge Alternative. As addressed in Chapter 12, "Noise and Vibration," where feasible and reasonable, noise impacts would be mitigated through the use of noise walls pursuant to federal regulations and state policy.
- ***Construction Impacts.*** Potential construction impacts related to traffic, air quality, noise, water quality, and ecology would occur along the right-of-way. Construction activities would incorporate measures to minimize these impacts to the extent feasible (see Chapter 18, "Construction Impacts").

19-5-2 ANALYSIS OF THE POTENTIAL FOR DISPROPORTIONATELY HIGH AND ADVERSE IMPACTS

The FHWA environmental justice guidance document states that when determining whether an action would have a disproportionately high and adverse effect on minority and low-income populations, mitigation measures for any potential adverse effects from the project and potential offsetting benefits to the affected minority and low-income populations should be taken into account. The project would maintain a vital link in the regional and national transportation network by providing an improved Hudson River crossing between Rockland and Westchester Counties. While safe to the traveling public, the bridge does not meet current standards for its design or traffic operations. The project would correct structural, operational, mobility, safety, and security features of the existing Tappan Zee Bridge, including providing for trans-Hudson access for cyclists and pedestrians and study area residents. The project would result in improvements in transportation mobility and safety and would not affect existing bus service nor would it preclude transit operations.

In addition, the Replacement Bridge Alternative would include a shared-use path for pedestrians and bicyclists to cross the Hudson River. This shared-use path would increase the public's access to trail systems and bicycle routes on both sides of the Hudson River. The addition of the shared-use path would also mitigate the 0.01 acre loss of the green space in Rockland County as a result of the bridge replacement and would also benefit area residents with no access to a car or other vehicle transport.

The Replacement Bridge Alternative would not result in any disproportionately high and adverse impacts on environmental justice populations. Of the households that would be displaced with the Replacement Bridge Alternative, three (one one-family and one two-family homes) are located in Tract 132 BG 1—a non-minority area—and six (two one-family and two two-family homes) are located in Tract 132 BG 2—a minority area or community of concern for environmental justice. Neither of these communities are considered low-income areas of concern for environmental justice. Thus, displacement impacts would affect both minority and non-minority areas. Assuming the 2010 Rockland County socioeconomic study area average household size of 2.39 (see Chapter 8, "Socioeconomic Conditions"), approximately 7 persons in Tract 132 BG 1 (or approximately 1 percent of the 2010 total population in that community) and 14 persons in Tract 132 BG 2 (also approximately 1 percent of the 2010 total population in that particular community) would be displaced. Therefore, while the displacement is higher for the community of concern (six families compared to three families), displacement impacts on the block group populations are not considered disproportionately high and adverse since the percentage change in population is the same in both communities (1 percent), such that the overall effect of displacement would not be predominantly borne by the minority community.[1] The numbers of persons or households to be displaced relative the entire community in either block group is not significant and the displaced residents would be expected to be relocated in close proximity to their existing residences, such that there would not be a destruction or disruption of community cohesion or a community's economic vitality, and there would not be an exclusion or separation of minority individuals from the broader community, and socioeconomic or community character impacts are expected (see also Chapter 6, "Land Acquisition, Relocation, and Displacement" and Chapter 8, "Socioeconomic Conditions").As discussed elsewhere, the project would also result in transportation safety and mobility benefits for all study area residents, and the displaced residents would be appropriately compensated for the acquisition and relocated.

Moreover, the approximately 14 persons to be displaced in the minority community represent just 2 percent of the total minority population in that block group. Based on property records and public meetings, not all residents of these displaced households are minority (FHWA guidance on relocation impacts when there are only a small

[1] *FHWA Actions to Address Environmental Justice* (6640.23) defines a disproportionately high and adverse effect as "an adverse effect that is predominantly borne by a minority population and/or low-income population or will be suffered by the minority population and/or low-income population and is appreciably more sever or greater in magnitude than the adverse effect that will be suffered by the nonminority population and/or non-low-income population. The guidance also states that "when determining whether a particular program, policy, or activity will have disproportionately high and adverse effects on minority and low-income populations, FHWA managers and staff should take into account mitigation and enhancement measures and potential offsetting benefits to the affected minority or low-income populations. Other factors that may be taken into account include design, comparative impacts, and the relevant number of similar existing system elements in non-minority and non-low-income areas."

number of displacements, specifically advises that information on race, ethnicity and income level should not be included to protect the privacy of those affected). Therefore, the percentage of minority persons that would be displaced would likely be even smaller. In all cases, displacement would be accommodated pursuant to the *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970,* which ensures that a relocation assistance program is provided to displaced occupants.

As discussed in more detail in Chapter 8, "Socioeconomic Conditions," the Replacement Bridge Alternative would not adversely affect the population characteristics of the study area. As identified in Chapter 6, "Land Acquisition, Displacement, and Relocation," the small loss of property tax revenue associated with the parcels to be acquired would not affect the overall social or economic base of the community, representing less than a 1 percent loss in assessment base. Furthermore, based on the implementation of a relocation assistance program for displaced residents, it is anticipated that displaced households would be able to remain in the study area or, at a minimum, in the larger Town and County area. As a result, there is unlikely to be any net reduction of population or workforce as a result of the Replacement Bridge Alternative. Given the small changes to the local study area, and the lack of overall changes to demographic characteristics generated by the Replacement Bridge Alternative, there would be no expected socioeconomic impact on specific populations of the elderly, disabled, or low-income and minority populations, and the cohesiveness of the affected communities would remain intact. On the other hand, the Replacement Bridge Alternative would provide benefits to local and regional populations in terms of improved operational mobility and safety. Displaced households would also be compensated for the displacement and would be relocated. In addition, the land area that would be acquired would become part of the Thruway right-of-way thereby providing an added buffer between the roadway and the surrounding communities such that the adjacent minority and non-minority areas would also experience an overall quality of life benefit.

The project's potential impacts on historic resources would occur mainly in a non-minority area and would not constitute a disproportionately high or adverse impact on environmental justice populations. The affected historic districts and the resource at 10 Ferris Lane are located in non-minority and non-low-income areas. The Tappan Zee Bridge is located in both minority and non-minority areas. The historic residences that would be removed contribute to the overall South Nyack Historic District which is beneficial to the entire Village, including both minority and non-minority populations. The potential impacts associated with the removal of the historic residences in the South Nyack Historic District (which are both located in non-minority and non-low-income areas) would be mitigated as outlined in the Draft MOA (see **Appendix C**) and would be undertaken pursuant to the federal *Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970* and the New York State Eminent Domain Procedure Law, as described in Chapter 6, "Land Acquisition, Displacement, and Relocation."

The expected visual impacts would also occur in non-minority and non-low-income areas such that no disproportionately high or adverse impacts on environmental justice populations would occur from the project's visual effects.

The expected noise impacts as a result of the project would occur on either side of Interstate 87/287 in both minority and non-minority areas, in close proximity to the area of the proposed bridge realignment. In Rockland County, noise impacts would occur in CT 132 Block Groups 2 and 3, which are minority areas, in addition to in non-minority areas (CT 130.03 BG 2 and CT 132 BG 1). In Westchester County, noise impacts would occur in both minority (CT 115 BG 2) and non-minority (CT 114 Block Groups 1 and 3) areas. Where feasible and reasonable, noise impacts would be mitigated through the use of noise walls. Unmitigated noise impacts would primarily occur in non-minority areas of Rockland County (CT 132 BG 1 in both the Short and Long Span Options) and in CT 130.03 BG 2 (Long Span Option only). In Westchester County, unmitigated noise impacts would occur in minority (CT 115 BG 2) and non-minority (CT 114 BG 1) areas in both the Short and Long Span Options.

In summary, there is no alternative to construction of the Tappan Zee Hudson River Crossing taking place within the Interstate 87/287 right-of-way along which both minority and non-minority areas are located. Based on a review of the likely potential impacts of the project, minority and low-income areas would not bear a disproportionately high or adverse share of construction impacts resulting from the project. Construction-related effects of the project would be borne by minority and low-income areas as well as non-minority and non-low-income areas including at the staging areas where potential construction effects would be mitigated.

19-6 PUBLIC PARTICIPATION

FHWA, the New York State Department of Transportation (NYSDOT) and NYSTA have engaged in a robust public outreach effort. The project sponsors have compiled a mailing list, comprising more than 5,000 interested individuals and organizations, which is used to distribute meeting announcements and information about the project. Included within the list are organizations, media, and individuals that have relevance and connections with environmental justice communities in the study area.

Advertisements announcing public hearings were and will continue to be placed in five newspapers, including two newspapers serving environmental justice communities. A public notice inviting interested members of the public to participate in the Section 106 consultation process also was published in English and Spanish in newspapers, and Spanish translation services were available at the scoping briefings (held on October 25, 2011 in Westchester County and on October 27, 2011 in Rockland County) and will be available at future public hearings. A project website is updated regularly to provide notification of meetings and other project-related information.

The Tappan Zee Bridge Hudson River Crossing Project's public outreach program, including outreach to the affected communities of concern, will be ongoing throughout the environmental review process in accordance with applicable regulations.

19-7 MITIGATION FOR DISPROPRIONATELY HIGH AND ADVERSE EFFECTS

The Replacement Bridge Alternative would not result in any disproportionately high and adverse effects on minority and low-income populations during operation or construction and therefore no mitigation would be required.

Chapter 20: Coastal Area Management

20-1 INTRODUCTION

The project would be located in the Coastal Area as designated by the New York State Waterfront Revitalization of Coastal Areas and Inland Waterways Act. This act implements New York State's Coastal Management Program (CMP). In addition, the project requires approvals from federal and state agencies and is therefore subject to consistency review in accordance with the policies set forth to implement the CMP. This chapter examines the compliance of the project with those policies.

20-2 REGULATORY CONTEXT

The federal Coastal Zone Management Act (CZMA) of 1972 was established to encourage coastal states to manage development within their designated coastal areas, and to balance conflicts between coastal development and protection of resources within the coastal zone. CZMA requires that federal actions within a state's coastal zone be consistent with that state's coastal zone management program (CMP). The New York State Department of State (NYSDOS) administers this program in New York.

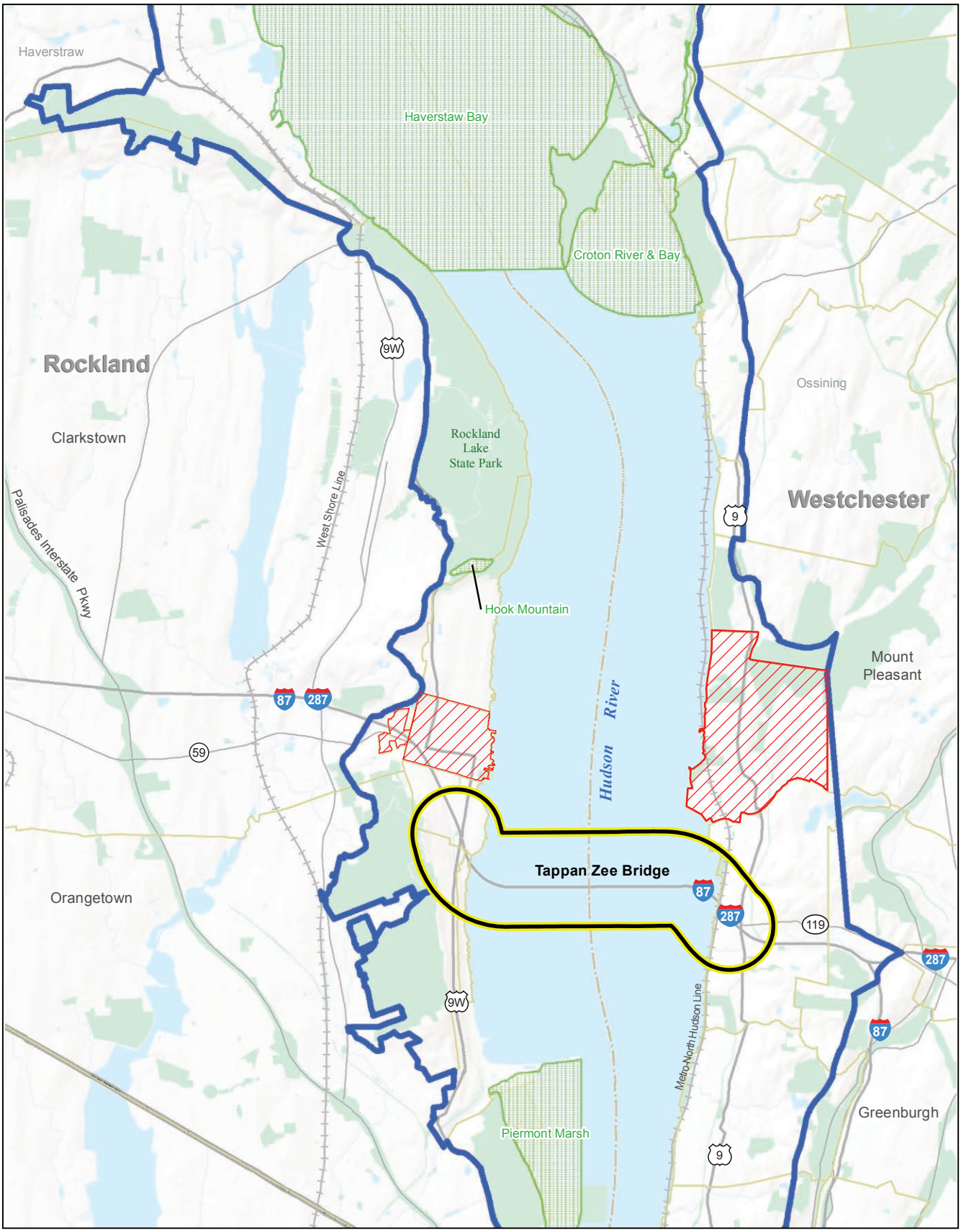
The state's CMP encourages coordination among all levels of government to promote sound waterfront planning and requires consideration of the program's goals in making land use decisions. Thus, the state permits a local government that has any portion of its jurisdiction contiguous to the state's coastal waters to submit a Local Waterfront Revitalization Program (LWRP) to NYSDOS for approval. Municipalities that have adopted LWRPs make a determination of an action's consistency with their LWRP policies and then send their determinations to NYSDOS. In regions without an LWRP, the state policies apply and projects are reviewed by NYSDOS.

The Village of South Nyack, the Village of Grand View-On-Hudson, and the Village of Tarrytown have not adopted local waterfront revitalization plans (LWRPs). Therefore, coastal zone consistency for the project is determined by the NYSDOS using the New York State's Coastal Consistency policies. The Villages of Nyack and Sleepy Hollow have approved LWRPs. **Figure 20-1** shows the boundaries of these two municipalities' LWRPs, which are ½ mile or more from the limits of the Replacement Bridge Alternative. While the municipalities' authority to implement their LWRPs is confined to the area within their corporate limits, this chapter addresses those local LWRP policies that may apply to the proposed project.

As outlined in the NYSDOT Environmental Manual (TEM), the process for obtaining CMP concurrence from the NYSDOS includes the following, each of which must be documented in the Design Report/Environmental Assessment:

- As a partially federally funded project, a Federal Aid Notification (FAN) letter must be sent to NYSDOS.

11.8.11



Study Area Boundary

New York State Coastal Zone Boundary

Local Waterfront Revitalization Plan (LWRP)

Significant Coastal Fish and Wildlife Habitats

0 1 2 MILES

SCALE

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 20-1
Coastal Zone

- A State Coastal Assessment Form (CAF) must be completed and sent to NYSDOS.
- Because the project will require federal permits, the Federal Consistency Assessment Form (FCAF) and relevant permits must be sent to NYSDOS.

20-3 METHODOLOGY

This chapter reviews the project to determine its compliance with the state's 44 coastal policies based on the analyses presented in the relevant chapters of this Environmental Impact Statement (EIS). The project's primary areas of potential impact to the coastal resources that are the subject of the CZMA include: ecology; water quality; historic and cultural resources; visual resources; marine transportation; recreational boating; and ambient noise.

20-4 AFFECTED ENVIRONMENT

As shown in **Figure 20-1**, the footprint of the project, comprised of Interstate 87/287 from Interchange 9 (Route 9) to Interchange 10 (Route 9W), including the Tappan Zee Bridge, is within the New York State's Coastal Area Boundary. In addition, as part of the project, a new maintenance facility would be constructed at approximately the same location as the existing NYSTA maintenance facility on the north side of Interstate 87/287 at Interchange 9. This facility would also be within the Coastal Area Boundary.

20-5 COASTAL ZONE POLICY ANALYSIS

20-5-1 NO BUILD ALTERNATIVE

The No Build Alternative would not have any adverse impacts on coastal resources. However, continued maintenance of the bridge over the next decade would not correct the structural, operational, safety, and mobility needs of the Hudson River crossing.

20-5-2 REPLACEMENT BRIDGE ALTERNATIVE

The studies and analyses undertaken for the project and described in this EIS are the primary foundation for evaluating consistency with the applicable CMP policies. Each policy is listed below, followed by a narrative response describing the consistency with applicable policies or the non-applicability of the policy to the project. Only those components to which a particular CMP policy is potentially applicable are evaluated in the following discussions.

There are two options for the approach spans, the sections of the bridge that link the landings with the main spans over the navigable channel. These options—Short Span and Long Span—differ in terms of the type of structure as well as the number of and distance between bridge piers. In addition, there are two options for the bridge's main spans over the navigable channel—Cable-stayed and Arch. Both options would result in a horizontal clearance of at least 1,000 feet and a vertical clearance of 139 feet over the navigable channel at mean high water. Where there are differences between options with respect to the coastal policies, these are discussed below.

20-5-2-1 COASTAL ZONE POLICIES

Policy 1: *Restore, revitalize, and redevelop deteriorated and underutilized waterfront areas for commercial, industrial, cultural, recreational, and other compatible uses.*

As discussed in Chapter 5, "Community Character," the project is not intended to directly revitalize and restore underutilized waterfront areas. However, the replacement bridge would not be a detriment to such revitalization efforts because it would not use any waterfront lands that have the potential for redevelopment as part of a larger economic development initiative. By replacing the existing bridge, the project would ensure that the potential for economic revitalization of the waterfront continues unimpeded by avoiding potential closure of the bridge and detrimental effects to local and regional transportation patterns. A closed bridge, or one with reduced capacity, would have the potential to limit private and public investment in the area and along the waterfront.

As discussed in Chapter 7, "Parklands and Recreational Resources," and Chapter 8, "Socioeconomic Conditions," no adverse impacts would occur to the commercial and recreational uses adjacent to the bridge in Tarrytown, South Nyack, and neighboring municipalities. The federal channel which conveys shipping north/south beneath the Tappan Zee Bridge would remain unimpeded during construction. In addition, waterfront parks, marinas, mooring fields, and commercial/industrial businesses that currently operate in the study area would remain largely unaffected by the proposed bridge. Therefore, the project is consistent with Policy 1.

Policy 2: *Facilitate the siting of water-dependent uses and facilities on or adjacent to coastal waters.*

Nyack Policy 2A: *Preserve and retain existing water dependent uses in the coastal area.*

The purpose of the project is to maintain a vital link in the regional and national transportation network. This will improve traffic congestion on the bridge and address the structural, safety, and security needs of the Hudson River crossing. The project is not related to the siting of water-dependent uses. Therefore, Policy 2 is not applicable to the project.

Water dependent uses in the Village of Nyack, including the Memorial Park boat launch and additional marinas and boat facilities listed in the Village's LWRP, are located ½ mile or more from the project and would not be adversely affected during or after construction. Therefore, the project is consistent with Nyack Policy 2A.

Policy 3: *Further develop the state's major ports of Albany, Buffalo, New York, Ogdensburg, and Oswego as centers of commerce and industry, and encourage the siting, in these port areas, including those under the jurisdiction of state public authorities, of land use and development which is essential to or in support of the waterborne transportation of cargo and people.*

The project is not located near any of the state's major ports and would not affect the waterborne transportation of cargo and people to or from the port of Albany, Buffalo, New York, Ogdensburg, or Oswego. Therefore, the policy is not applicable to the proposed project.

Policy 4: *Strengthen the economic base of smaller harbor areas by encouraging the development and enhancement of those traditional uses and activities which have provided such areas with their unique maritime identity.*

This policy recognizes that the traditional activities occurring in and around many smaller harbors throughout the state's coastal area contribute to the economic strength and attractiveness of these harbor communities, and seeks to promote activities that make small harbors appealing as tourist destinations and as commercial and residential areas (e.g., recreational and commercial fishing, ferry services, marinas, historic preservation, cultural pursuits, and other compatible activities). The project is not related to, and would have no impact upon, traditional uses and activities of small harbors. Therefore, Policy 4 is not applicable to the proposed project.

Policy 5: *Encourage the location of development in areas where public services and facilities essential to such development are adequate.*

Sleepy Hollow Policy 5A: *Discourage the development of uses which, by reason of their demand for new community services and facilities or their imposition of burdens on existing services and facilities, would require disproportionate public cost in comparison to public benefits.*

The project would not extend new services into unserved areas, nor would it introduce any new residents or permanent workers to the surrounding area. Instead, it would provide benefits to local and regional populations and workforce in the form of improved operational mobility and safety. As such, the project is not related to the encouragement of development in the coastal area. Therefore, neither Policy 5 nor Sleepy Hollow Policy 5A is applicable to the proposed project.

Policy 6: *Expedite permit procedures in order to facilitate the siting of development activities at suitable locations*.

The responsibility for implementing Policy 6 rests with the various agencies issuing the requisite permits and/or approvals. Therefore, Policy 6 is not applicable to the proposed project.

20-5-2-2 FISH AND WILDLIFE POLICIES

Policy 7: *Significant coastal fish and wildlife habitats will be protected, preserved, and, where practical, restored so as to maintain their viability as habitats.*

Nyack Policy 7A: *Protect the physical characteristics of the Hudson River along Nyack that support the varied fish populations found there.*

Sleepy Hollow Policy 7D: *The Hudson River immediately adjacent and within 1,000 feet of the Village's shoreline shall be protected, preserved, and where practical, restored so as to maintain its viability as a locally significant habitat.*

As discussed in Chapter 16, "Ecology," the project is not located in close proximity to any Significant Coastal Fish and Wildlife Habitats and would not result in adverse impacts to Significant Coastal Fish and Wildlife Habitats designated by the NYSDOS.

Sediment plume modeling was performed, and as discussed in Chapter 15, "Water Resources," the plumes do not enter NYSDOS-designated SFWHs. In addition, hydroacoustic modeling was performed, and as described in Chapter 18, "Construction

Impacts," the 187 dB isopleth (impact criteria for physical effects to fish), using Best Management Practices, does not enter SFWHs north or south of the project area.

Therefore, the project is consistent with Policy 7, Nyack Policy 7A, and Sleepy Hollow Policy 7D.

Policy 8: *Protect fish and wildlife resources in the coastal area from the introduction of hazardous wastes and other pollutants which bioaccumulate in the food chain or which cause significant sublethal or lethal effects on those resources.*

As discussed in Chapter 15, "Water Resources," with the implementation of stormwater management practices to treat stormwater, the discharge of stormwater runoff from the Replacement Bridge Alternative would not result in a net increase in pollutant loading to the Hudson River. Therefore, the project would be consistent with Policy 8.

Policy 9: *Expand recreational use of fish and wildlife resources in coastal areas by increasing access to existing resources, supplementing existing stocks, and developing new resources*.

Increasing access to recreational fish and wildlife resources; increasing existing stocks; or developing new resources are not components of this project.

The ability for boats to travel along the Hudson River would be maintained throughout the construction period. Signage and channel markers would be utilized to advise recreational boaters of preferred routes and potential dangers within the construction zone. While some boaters, due to water craft size or power source, may experience difficulty navigating through the construction zone during this time period, this temporary disruption is not considered an adverse impact.

Therefore, the project is consistent with Policy 9.

Policy 10: *Further develop commercial finfish, shellfish and crustacean resources in the coastal area by: (i) encouraging the construction of new, or improvement of existing on shore commercial fishing facilities; (ii) increasing marketing of the state's seafood products; and (iii) maintaining adequate stocks and expanding aquaculture facilities.*

Development, maintenance, or marketing of commercial fisheries are not components of the project. The loss of oyster beds is identified as an adverse impact in this DEIS. However, these are not part of a commercial fishery. Mitigation for the loss of oyster beds will be coordinated with NYSDEC. It should be noted that the U.S. Food and Drug Administration shut down New Jersey's oyster restoration program in summer 2010 due to fears that the public may consume the oysters, which are not suitable for human consumption.

Therefore, the project would be consistent with Policy 10.

20-5-2-3 FLOODING AND EROSION POLICIES

Policy 11: *Buildings and other structures will be sited in the coastal area so as to minimize damage to property and the endangering of human lives caused by flooding and erosion.*

As discussed in Chapter 15, "Water Resources," for the Short Span and Long Span Options, approximately 0.3 acres of the replacement bridge landing in Rockland County

would be located within 100-year floodplain. No portion of the replacement bridge would be located within the 100-year floodplain within Westchester County.

Use of a portion of the 100-year floodplain within Rockland County would not result in adverse impacts to floodplain resources or result in increased flooding of adjacent areas. The Hudson River within the general study area is tidal and as such is affected by coastal flooding, which is influenced by astronomic tide and meteorological forces. Therefore, the project would not have any adverse effects to flooding despite some development in the 100-year floodplain.

A Stormwater Pollution Prevention Plan (SWPPP) would be developed to minimize the potential for adverse impacts to water quality of the Hudson River.

Therefore, the project would be consistent with Policy 11.

Policy 12: *Activities or development in the coastal area will be undertaken so as to minimize damage to natural resources and property from flooding and erosion by protecting natural protective features including beaches, dunes, barrier islands and bluffs.*

The project would be constructed on land areas that do not include natural protective features such as beaches, dunes, barrier islands, and bluffs. Therefore Policy 12 is not applicable.

Policy 13: *The construction or reconstruction of erosion protection structures shall be undertaken only if they have a reasonable probability of controlling erosion for at least 30 years as demonstrated in design and construction standards and/or assured maintenance or replacement programs.*

This policy is not applicable.

Policy 14: *Activities and development including the construction or reconstruction of erosion protection structures, shall be undertaken so that there will be no measurable increase in erosion or flooding at the site of such activities or development, or at other locations.*

This policy is not applicable.

Policy 15: *Mining, excavation, or dredging in coastal waters shall not significantly interfere with the natural coastal processes which supply beach materials to land adjacent to such waters and shall be undertaken in a manner which will not cause an increase in erosion of such lands.*

Dredging activities for the project would not interfere with natural coastal processes and are not anticipated to increase erosion of coastal land. Therefore, the project would be consistent with Policy 15.

Policy 16: *Public funds shall only be used for erosion protective structures where necessary to protect human life, and new development which requires a location within or adjacent to an erosion hazard area to be able to function, or existing development; and only where the public benefits outweigh the long-term monetary and other costs including the potential for increasing erosion and adverse effects on natural protective features.*

Coastal erosion protective structures are not a component of the project. Therefore, Policy 16 is not applicable.

Policy 17: *Non-structural measures to minimize damage to natural resources and property from flooding and erosion shall be used whenever possible.*

The project would require retaining walls for support and erosion control. Non-structural measures, such as the set-back of buildings, use of vegetation, etc. are not applicable to the project. As discussed in Chapters 15, "Water Resources," and 16, "Ecology," the replacement bridge would not cause shoreline erosion or increases in area flooding. Therefore, the project would be consistent with Policy 17.

20-5-2-4 GENERAL SAFEGUARDS POLICY

Policy 18: *To safeguard the vital economic, social and environmental interests of the state and its citizens, proposed major actions in the coastal area must give full consideration to those interests, and to the safeguards which the state has established to protect valuable coastal resource areas.*

Sleepy Hollow Policy 18A: *Protect the vital economic, social, cultural, and environmental interests of the Village in the Evaluation of any proposal for new roads, road widening or infrastructure.*

As discussed in Chapter 1, "Purpose and Need," the project would ensure that there is a reliable transportation corridor across the Hudson River linking I-287 and I-87 which would support both the economic and social interests of the state, the region, and adjacent communities. By maintaining this vital transportation link, the project would safeguard and promote New York State's, economic, social, and environmental interests. Regarding Sleepy Hollow Policy 18A, the project would not interrupt traffic patterns in the Village nor adversely impact established residential or commercial character with new roadways or infrastructure. Therefore, the project would be consistent with Policy 18 and Sleepy Hollow Policy 18A.

20-5-2-5 PUBLIC ACCESS POLICIES

Policy 19: *Protect, maintain, and increase the level and types of access to public water-related recreation resources and facilities.*

The Hudson River is used by sail boaters, power boaters, and other personal water craft users for recreational purposes. Temporary disruptions to recreational boating through the study area can be expected during the construction period for the Replacement Bridge Alternative, and sail boaters may be precluded from using sails while traversing through the construction zone. However, no long-term impacts to recreational boating on the Hudson River are anticipated once the Replacement Bridge Alternative is operational. The ability for boats to travel along the Hudson River would be maintained throughout the construction period. Signage and channel markers would be utilized to advise recreational boaters of preferred routes and potential dangers within the construction zone. This would be done in coordination with the U.S. Coast Guard.

The replacement bridge would include a shared-use bike and pedestrian path, thereby improving the connectivity between trailways and recreational resources on either side

of the Hudson River. The project would have no detrimental effect on any existing waterfront park or recreational resource.

Therefore, the project would be consistent with Policy 19.

Policy 20: *Access to publicly owned foreshore and to lands immediately adjacent to the foreshore or the water's edge that are publicly owned shall be provided, and it should be provided in a manner compatible with adjoining uses.*

The project would provide public access on the replacement bridge by means of a bicycle/pedestrian path that would connect to existing trails and walkways along the waterfront in both counties. This path would consist of a 4-acre, shared-use public space for pedestrians and bicyclists to cross the Hudson River. This shared-use path would increase the public's access to trail systems and bicycle routes on both sides of the Hudson River, offering new direct and on-street connections to existing systems.

New access points to the foreshore are not provided by the project, nor are they precluded from occurring in the future.

Therefore, the project would be consistent with Policy 20.

20-5-2-6 RECREATION POLICIES

Policy 21: *Water dependent and water enhanced recreation will be encouraged and facilitated, and will be given priority over non-water related uses along the coast.*

The project is consistent with the preservation and enhancement of other coastal resources because it would allow for the continued use of existing recreational facilities in the area. It would not diminish any existing water-dependent use or water-enhanced recreational use of the Hudson River.

The proposed extension of RiverWalk, the shared-use path along the eastern shore of the Hudson River, would not be adversely affected by the project. Future connections of RiverWalk beneath the bridge to segments north and south would not be precluded. The replacement bridge would also include a shared-use (bicycle and pedestrian) path across its north bridge span which would connect the Esposito Trail in Rockland County with Route 9 in Westchester County. This shared-use path would be approximately 4 acres in footprint. Therefore, the project would be consistent with Policy 21.

Policy 22: *Development, when located adjacent to the shore, will provide for water-related recreation whenever such use is compatible with reasonably anticipated demand for such activities, and is compatible with the primary purpose of the development.*

The project would not generate new demand for water related recreation as might be the case for a residential or commercial development. Therefore, Policy 22 is not applicable to the proposed project.

20-5-2-7 HISTORIC RESOURCES AND VISUAL QUALITY POLICIES

Policy 23: *Protect, enhance, and restore structures, districts, areas or sites that are of significance in the history, architecture, archeology or culture of the state, its communities, or the nation.*

The Replacement Bridge Alternative would result in adverse effects on historic and archaeological resources due to the removal of the existing Tappan Zee Bridge, two historic residences, and potential impacts to submerged archaeological resources. As discussed in Chapter 10, "Historic and Cultural Resources," there is no alternative to avoid the impact on these resources. Through the requirements of Section 106 of the National Historic Preservation Act, efforts to avoid, minimize, or reduce potential adverse impacts were evaluated and appropriate mitigation measures and strategies are being developed to offset unavoidable adverse effects. Although not consistent with Policy 23, the compelling need to maintain a regionally important transportation link necessitates impacts to historic structures.

Policy 24: *Prevent impairment of scenic resources of statewide significance.*

The project is not within a NYSDOS-mapped Scenic Area of Statewide Significance (SASS) and no designated scenic resources of statewide significance would be impaired by the project. The closest SASS to the project site is the Hudson Highlands SASS, which encompasses a 20-mile stretch of the Hudson River and its eastern (Westchester, Putnam, and Dutchess Counties) and western (Rockland County) shore lands. The project would be approximately 15 miles from the southernmost boundary of the Hudson Highlands SASS. Therefore, views of the project site would be not limited from locations within the SASS.

Therefore, the project would be consistent with Policy 24.

Policy 25: *Protect, restore, or enhance natural and manmade resources which are not identified as being of statewide significance, but which contribute to the overall scenic quality of the coastal area.*

Nyack policy 25A: *Protect and enhance views from Route 9W, Tallman Place, Fourth Avenue, Second Avenue, First Avenue and Memorial Park.*

Sleepy Hollow policy 25A: *Protect or enhance views of the Hudson River, the Hudson River valley, and the opposite shore from the immediate riverfront as viewed from publically owned properties.*

As discussed in detail in Chapter 9, "Visual and Aesthetic Resources," the replacement bridge would result in changes to individual views from the shore and from the water. The project consists of two approach span options – Long Span and Short Span – and two main span options – Cable Stayed and Arch. All options would result in a bridge structure that is wider and taller than the existing Tappan Zee Bridge. This would affect the scenic view of a limited number of residents living in proximity to the bridge in Rockland County. However, the replacement bridge would not affect the overall scenic quality of the Tappan Zee region or the surrounding Hudson River communities.

Therefore, the project would be consistent with Policy 25, Nyack Policy 25A, and Sleepy Hollow Policy 25A.

20-5-2-8 AGRICULTURAL LANDS POLICY

Policy 26: *Conserve and protect agricultural lands in the state's coastal area.*

The project site is not located on or adjacent to lands meeting NYSDOS criteria for important agricultural lands. Therefore, Policy 26 is not applicable.

20-5-2-9 ENERGY AND ICE MANAGEMENT POLICIES

Policy 27: *Decisions on the siting and construction of major energy facilities in the coastal area will be based on public energy needs, compatibility of such facilities with the environment, and the facility's need for a shorefront location.*

This policy is not applicable.

Policy 28: *Ice management practices shall not interfere with production of hydroelectric power, damage significant fish and wildlife and their habitats, or increase shoreline erosion or flooding.*

This policy is not applicable.

Policy 29: *Encourage the development of energy resources on the Outer Continental Shelf, in Lake Erie and in other water bodies, and ensure the environmental safety of such activities.*

This policy is not applicable.

20-5-2-10 WATER AND AIR RESOURCES POLICIES

Policy 30: *Municipal, industrial, and commercial discharge of pollutants, including, but not limited to, toxic and hazardous substances, into coastal waters will conform to state and national water quality standards.*

No municipal, industrial, or commercial discharges of pollutants or hazardous substances would occur as part of the project. Regarding non-point source pollution, as discussed in Chapter 15, “Water Resources,” the project would conform to New York State stormwater management measures such that no adverse impacts to the water quality of the Hudson River would result. Therefore, the project would be consistent with Policy 30.

Policy 31: *State coastal area policies and management objectives of approved Local Waterfront Revitalization Programs will be considered while reviewing coastal water classifications and while modifying water quality standards; however, those waters already over-burdened with contaminants will be recognized as being a development constraint.*

Policy 31 requires that NYSDEC consider the CMP and the purposes of any approved LWRP when reviewing coastal water classifications and while modifying surface water quality standards. Policy 31 is not applicable to the project.

Policy 32: *Encourage the use of alternative or innovative sanitary waste systems in small communities where the costs of conventional facilities are unreasonably high, given the size of the existing tax base of these communities.*

This policy is not applicable.

Policy 33: *Best management practices will be used to ensure the control of storm water runoff and combined sewer overflows draining into coastal waters.*

With the implementation of stormwater management practices to treat stormwater quality for the landing areas for the Replacement Bridge Alternative designed and constructed in accordance with the New York State Department of Environmental

Conservation's (NYSDEC's) Stormwater Management Design Manual, New York State Department of Transportation's Highway Design Manual and Environmental Procedures Manual, and New York State Thruway Authority engineering guidance, the discharge of stormwater runoff from the Replacement Bridge Alternative would not result in a net increase in pollutant loading to the Hudson River for Total Suspended Sediments and would result in just a small increase in pollutant loading for total phosphorus, minimizing the potential for adverse changes to Hudson River water quality from the discharge of stormwater from the Replacement Bridge Alternative. Therefore, the project would be consistent with Policy 33.

Policy 34: *Discharge of waste materials into coastal waters from vessels will be limited so as to protect significant fish and wildlife habitats, recreational areas and water supply areas.*

The project would not involve the operation or vessels or the discharge of waste materials. Wastewater from sanitary facilities and from vessels used during construction would be disposed in accordance with all applicable health regulations. Therefore, the project would be consistent with Policy 34.

Policy 35: *Dredging and dredge spoil disposal in coastal waters will be undertaken in a manner that meets existing state dredging permit requirements, and protects significant fish and wildlife habitats, scenic resources, natural protective features, important agricultural lands, and wetlands*.

Sleepy Hollow policy 35A: *Dredging shall not occur during fish spawning seasons and must be authorized by an appropriate permit from the NYSDEC and USACE.*

Dredging would be undertaken outside the spawning season and in accordance with permits to be issued by USACE and NYSDEC. Any disposal of dredging material in ocean waters would be undertaken in accordance with a Section 303 permit pursuant to the Marine Protection, Research and Sanctuaries Act (16 USC §§ 1431, et seq., and 33 USC §§ 1401, et seq.).

The project sponsors are coordinating dredging windows with the state and federal resource agencies, including the National Marine Fisheries Service due per EFH and ESA consultations. As discussed in Chapter 18, "Construction Impacts," dredging would be initiated from August 1 to November 1 to avoid peak periods of anadromous fish spawning migrations and peak biological activity.

Therefore, the project would be consistent with Policy 35 and Sleepy Hollow Policy 35A.

Policy 36: *Activities related to the shipment and storage of petroleum and other hazardous materials will be conducted in a manner that will prevent or at least minimize spills into coastal waters; all practicable efforts will be undertaken to expedite the cleanup of such discharges; and restitution for damages will be required when these spills occur.*

As discussed in Chapter 17, "Hazardous Waste and Contaminated Materials," cleanup of hazardous spills and accidents and management of solvents, road salt, etc., would be performed in accordance with applicable laws and regulations and existing standard NYSTA procedures. Signage and channel markers would be established during

construction to guide vessels, including those transporting fuel and any other hazardous materials, through or around the construction zone.

Therefore, the project would be consistent with Policy 36.

Policy 37: *Best management practices will be utilized to minimize the non-point discharge of excess nutrients, organics and eroded soils into coastal waters.*

As discussed in Chapter 15, "Water Resources," the project would conform to the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity. The Replacement Bridge Alternative would include treatment of stormwater and would not result in a net increase in total suspended sediments (see response to Policy 33). Therefore, the project would be consistent with Policy 37.

Policy 38: *The quality and quantity of surface water and groundwater supplies will be conserved and protected, particularly where such waters constitute the primary or sole source of water supply.*

As discussed in Chapter 15, "Water Resources," the project would not impact the quality and quantity of surface water or groundwater supplies. With the implementation of stormwater management practices to treat stormwater quality for the landing areas for the Replacement Bridge Alternative, the discharge of stormwater would not result in a net increase in pollutant loading to the Hudson River for Total Suspended Sediments and would result in just a small increase in pollutant loading for total phosphorus, minimizing the potential for adverse changes to Hudson River water quality from the discharge of stormwater from the Replacement Bridge Alternative. Therefore, the project would be consistent with Policy 38.

Policy 39: *The transport, storage, treatment and disposal of solid wastes, particularly hazardous wastes, within coastal areas will be conducted in such a manner so as to protect groundwater and surface water supplies, significant fish and wildlife habitats, recreation areas, important agricultural lands and scenic resources.*

See response to Policy 35, above. Any disposal to upland sites would be the responsibility of the contractor and would comply with relevant laws and regulations. During construction, signage and channel markers would be established to guide all vessels, including those carrying any hazardous materials, through and/or around the construction zone. Marine transport would be monitored by and coordinated with the U.S. Coast Guard to ensure safe passage of all vessels traveling in this area.

Policy 40: *Effluent discharged from major steam electric generating and industrial facilities into coastal waters will not be unduly injurious to fish and wildlife and shall conform to state water quality standards.*

This policy is not applicable.

Policy 41: *Land use or development in the coastal area will not cause national or state air quality standards to be violated.*

The proposed project is not a land use or development project. Therefore, Policy 41 does not apply.

Policy 42: *Coastal management policies will be considered if the state reclassifies land areas pursuant to the prevention of significant deterioration regulations of the Federal Clean Air Act.*

Policy 42 relates to NYSDEC's obligations under the federal Clean Air Act's prevention of significant deterioration program and, therefore, is not applicable to the project.

Policy 43: *Land use or development in the coastal area must not cause the generation of significant amounts of the acid rain precursors: nitrates and sulfates.*

As described in Chapter 11, "Air Quality," the project would not generate significant amounts of acid rain precursors (NO_x, SO_2). Therefore, the project would be consistent with Policy 43.

20-5-2-11 WETLANDS POLICY

Policy 44: *Preserve and protect tidal and freshwater wetlands and preserve the benefits derived from these areas.*

As described in Chapter 16, "Ecology," and Chapter 18, "Construction Impacts," upland construction of the access road within the Westchester Inland Staging Area to the temporary platform within the Westchester Bridge Staging Area would deck over approximately 0.15 acres of a 0.63-acre small stream and forested wetland corridor on the east bank of the river. Trees would be removed and pilings placed every 200 feet to support the roadway. As the roadway would consist of a platform over the wetland areas, it is not expected that wetland hydrology would be altered or indirectly effect wetlands downstream. Once engineering design has sufficiently progressed and the permitting phase of the project has begun, this freshwater wetland would be evaluated and the boundary delineated in accordance with the USACE Wetlands Delineation Manual. After construction is complete, the area would be restored as forested wetland habitat with equal or greater value and re-planted with native wetland vegetation in accordance with a wetland mitigation plan to be developed in coordination with the USACE.

There is no feasible or practicable alternative to construction within this potential wetland area. However, measures have been taken to minimize impacts. Instead of filling the wetland for the roadway, the roadway will be a pile-supported platform that will deck over the wetlands. Although plants will be removed for this effort, wetland hydrology will be maintained. The roadway was designed with the smallest footprint feasible to keep with the project goals of providing access to the Westchester Bridge Staging Area, while accommodating the width required for construction equipment and emergency vehicles.

Implementation of erosion and sediment control measures (e.g., silt fences and straw bale dikes) and stormwater management measures implanted through the development of a stormwater pollution prevention plan (SWPPP) would minimize the potential for stormwater runoff from construction of the access road to affect the forested corridor (0.63 acres) at the Westchester Bridge Staging Area and small potential wetland (approximately 0.11 acres) at the Rockland Bridge Staging Area.

With these avoidance, minimization, and mitigation measures to be developed and adhered to, the project would be consistent with Policy 44.

Chapter 21: Indirect and Cumulative Effects

21-1 INTRODUCTION

The federal Council on Environmental Quality's (CEQ) regulations implementing the procedural provisions of the National Environmental Policy Act (NEPA), set forth in 40 C.F.R. §§ 1500 et seq., requires federal agencies to also consider the potential for indirect and cumulative effects from a proposed project. In addition, SEQRA regulations identify that the contents of an environmental impact statement (EIS) include an evaluation of both cumulative impacts and the growth-inducing aspects of a proposed action [6 NYCRR § 617.9 (b)(5)(iii) (a) and (d)]. As discussed in Chapter 1, "Purpose and Need," the project is a replacement bridge for the existing Tappan Zee crossing. As discussed below, the project would not increase highway capacity or alter regional access and would not result in indirect impacts generated by induced or secondary growth. In consideration of the range of technical analyses presented in this EIS, the project also has little or no potential to result in localized or regional cumulative effects.

21-2 INDIRECT EFFECTS

Potential indirect effects are generally defined as those induced or "caused by an action and are later in time or farther removed in distance, but are still reasonably foreseeable" (40 CFR §§ 1500-1508). Comprehensive guidance literature on assessing indirect impacts is found in the National Cooperative Highway Research Program (NCHRP)-initiated Project 25-10, the results of which were published as Report 403, "Guidance for Estimating the Indirect Effects of Proposed Transportation Projects," and Report 466, "Desk Reference for Estimating the Indirect Effects of Proposed Transportation Projects." These reports identify and provide examples for the types of transportation projects more likely to result in induced or indirect growth. Unlike the proposed bridge replacement, such projects need to greatly influence changes in regional access and mobility so as to induce changes in development and land use patterns. Such secondary effects could result in indirect impacts to the social and human environment as well to natural resources affected by new development patterns.

As identified in Report 466, Course Module 1, Figure 1-3, these types of projects include construction of a new highway, highway extensions, bridges to currently undeveloped areas, new highway bypasses around congested downtowns, new or expanded airports and harbors, new rail transit, new interstate highways, or new interchanges in undeveloped or rural locations. Course Module 7 summarizes such projects as falling into three overall categories: (1) projects planned to serve specific land development, (2) projects likely to stimulate complementary development, and (3) projects likely to influence interregional locational decisions. Since the proposed bridge replacement is not expected to alter regional mobility or capacity, and is in an area with well-established land use patterns, it is not expected to result in new induced or indirect effects. The Replacement Bridge Alternative would replace an existing Hudson River

crossing in a similar alignment with similar landing points and would not include any new access points. As such, this project would not result in induced or indirect effects typical of transportation projects listed above. Additionally, as described further in Chapter 5, "Community Character," the project would be consistent with local and regional comprehensive planning documents by maintaining this important transportation infrastructure, which is vital to the economy of the region. While many of these comprehensive plans call for improvements to certain parklands or trails and for the implementation of expanded transit opportunities, this project would not preclude these initiatives in the future.

21-3 CUMULATIVE EFFECTS

21-3-1 OPERATIONAL EFFECTS

Potential cumulative effects may result from the incremental consequences of an action when added to other past and reasonably foreseeable future actions (40 C.F.R. § 1508.7). The direct effects of an individual action may be negligible, but may contribute to a measurable environmental impact when considered cumulatively with indirect effects and with other past and/or future projects. Report 466, Course Module 1 provides an overview of the relationship of indirect and cumulative impact, identifies the types of large-scale linkages that can lead to noticeable cumulative impacts, and provides examples major transportation improvements combined with: other transportation projects (i.e., a new highway in combination with a new/expanded airport resulting in new locations for commercial and industrial development); new major development projects (i.e., a new interchange and a new shopping mall that could change local and regional traffic patterns); and regional shifts in development patterns (i.e., a new highway in combination with new suburban development creating increased traffic volumes and congestion). Since the proposed replacement bridge has been determined to have no direct or indirect effect on regional traffic capacity or vehicle miles traveled (VMT), it would have no cumulative effect in combination with other projects. Potential adverse effects, as detailed throughout the EIS, and the potential for cumulative effects are summarized in **Table 21-1**.

21-3-2 CONSTRUCTION EFFECTS

Chapter 18, "Construction Impacts," identifies several potential adverse impacts that would result from direct construction activities associated with the proposed replacement bridge and the demolition of the existing Tappan Zee Bridge. As identified in that chapter, the terrestrial construction-related impacts are specific to localized effects at staging sites and along the existing highway. Since no other major construction projects (public or private) were identified within these areas, there is no cumulative effect. The greatest potential for cumulative impacts would result from proposed in-water construction activities associated with dredging, bottom stabilization, demolition, and pile-driving activities.

Table 21-1
Summary of Potential Cumulative Effects

Resources	Potential Adverse Effects[1]	Potential Cumulative Effects
Transportation	No Adverse Impacts	No Cumulative Effects
Community Character	No Adverse Impacts	No Cumulative Effects
Land Acquisition, Displacement, and Relocation	Full acquisition of 6 residential properties and 1 vacant property in Village of South Nyack (Rockland County) Partial acquisition on 3 residential properties and 1 green space area in Village of South Nyack (Rockland County) Permanent aerial easement on small section of 1 residential property in Village of Tarrytown (Westchester County)	No Cumulative Effects No known additional public or private actions are proposed that would add to proposed property acquisition
Parklands and Recreational Resources	No Adverse Impacts	No Cumulative Effects
Socioeconomics	No Adverse Impacts	No Cumulative Effects
Visual and Aesthetic Resources	Obstruction of existing scenic Hudson River views from residences on Bight Lane	No Cumulative Effects No other known projects are planned that would alter the existing viewscape in the study area
Historic and Cultural Resources	Removal of S/NR-eligible Tappan Zee Bridge Acquisition of two contributing properties in the South Nyack Historic District Potential disturbance of submerged archaeological resources, pending further investigation	No Cumulative Effects No known additional public or private actions are proposed that would affect historic and cultural resources in the study area
Air Quality	No Adverse Impacts	No Cumulative Effects
Noise	The project would result in NAC exceedances at several properties.[2] Mitigation measures (such as noise barriers) would be implemented to the extent feasible and practicable to minimize any adverse impacts.	No Cumulative Effects
Energy and Climate Change	No Adverse Impacts	No [Adverse] Cumulative Effects The project would improve mobility and reduce congestion, thereby reducing GHG emissions and helping work toward regional, state, and federal air quality improvement initiatives
Topography, Geology, Soils	No Adverse Impacts	No Cumulative Effects
Water Resources	No Adverse Impacts	No Cumulative Effects
Ecology	Loss of 13 acres of oyster beds	No Cumulative Effects No other known projects are planned that would result in loss of oyster habitat in the study area
Hazardous Materials	No Adverse Impacts	No Cumulative Effects
Environmental Justice	No Adverse Impacts	No Cumulative Effects
Coastal Zone Management	No Adverse Impacts	No Cumulative Effects

Notes: [1]Technical analyses and potential adverse effects are presented in greater detail in each of the EIS chapters.
[2]Some properties may have multiple dwellings and therefore multiple receptors.

21-3-2-1 AQUATIC ECOLOGY

As discussed in Chapter 18, "Construction Impacts," these activities can be expected to result in direct effects from the suspension and deposition of bottom sediments, loss of aquatic vegetation and habitat areas, and hydroacoustic impacts on fish populations. That chapter indicates that these impacts are limited to the specific area of disturbance or a short distance beyond the area of disturbance.

The Champlain-Hudson Power Express (CHPE) project would lay cable at an estimated depth of 6 to 15 feet below the river bottom and the project would extend from Lake Champlain south under the Hudson River and into New York Harbor. Project sponsors indicate that the project may be active in the area of the Tappan Zee in 2014 or 2015, and therefore, construction activities for the CHPE project would potentially be undertaken at the same time as the bridge's construction. The construction technique for the laying of cable is a "jet-plow" operation that would temporarily plow a trench for the cable that would then immediately be filled in in a continuous process that the CHPE project sponsor estimates would lay cable at a rate of approximately one mile per day, creating a disturbance of about 15 feet across and the required depth below the sediment surface at river bottom. Like the analyses for the Tappan Zee, the temporary disturbance and suspension of bottom sediments has been modeled showing that the suspension and deposition of sediments is limited to a short distance from the disturbance. In summary, the CHPE could be expected to be active in the immediate area of the Tappan Zee construction area for less than one week and would be active in a narrow band immediately west of the navigation channel which, as described in Chapter 18 "Construction Impacts," is outside the area of armoring. Therefore, other than coordination of activities (which has already been initiated) to ensure no direct disruption to either project, the cumulative effect of the projects would be minimal. Other regional projects up- or down-stream of the Tappan Zee Hudson River crossing would have no cumulative effect on activities at the project site. At the same time, with no noticeable changes beyond a limited area around the construction site, the project would not create any foreseeable changes at other project locations.

It is noted in Chapter 18, "Construction Impacts," that habitat losses resulting from bridge construction are expected to be localized and would not extend beyond the defined areas of impact. Therefore, any temporary or permanent changes to aquatic habitats would not affect the larger habitat value of the Hudson River and no cumulative habitat fragmentation would be expected. Similarly, the analysis of potential impacts on benthic and fish populations affected by the pile driving would potentially affect a small proportion of any given species and would not cumulatively affect overall populations. It is noted that the CPHE project has been delineated to avoid important habitat locations and such conditions have been established in the New York State Department of State's Conditional Concurrence with the CPHE Coastal Zone Consistency Certification.

21-3-2-2 DREDGING

As set forth in Chapter 18, "Construction Impacts," the vast majority of the dredging activity for the Replacement Bridge Alternative occurs in Stage 1 of the first construction year, when up to 1.12 million cubic yards of materials may be removed. In the second year, this is reduced to 0.43 million cubic yards and by the third stage of dredging in

year four, the estimated amount of dredged material is 0.19 million cubic yards. There is little or no other dredging proposed for the Hudson River navigation channel in the vicinity of the Tappan Zee Bridge so this would not be expected to result in any cumulative impacts in combination with the project.

Localized and periodic dredging of ship channels and berths may occur occasionally for maritime activities within the general area of the Tappan Zee These activities tend to be smaller and localized (the last analysis of dredging permits involving testing for HARS disposal was for 0.1 million cubic yards at US Gypsum in 2000 and 0.06 million cubic yards for American Sugar in a 1998 application).

In terms of potential cumulative effects in the use of HARS disposal, the permitting of disposal is controlled by the U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (USEPA) and subject to the Site Management and Monitoring Plan (SMMP). Materials that are tested and found to be suitable for disposal are considered to have a beneficial effect in creating new cover over prior disposal sites of more contaminated materials. The 2009 SMMP and information available from the USACE New York District website (http://www.nan.usace.army.mil), indicates that the as of 2008 the HARS had mostly completed remediation of the first three priority cells and that cells 4 through 9 would continue to accept new cover for many decades. The total material dredged as part of the Tappan Zee project (up to an estimated 1.74 million cubic yards), should it be deemed eligible for HARS disposal, would be a small proportion of the overall fill necessary to remediate the site and would only be disposed within the HARS based on the characteristics of the dredged material following extensive testing. Therefore, there would be no cumulative adverse effects from the disposal of the project-generated dredge material.

Chapter 22: Other NEPA and SEQRA Considerations

22-1 INTRODUCTION

Consistent with NEPA and SEQRA guidance, this chapter evaluates the following subject areas:

- **Irreversible and Irretrievable Commitment of Resources:** This section discusses natural and man-made resources expended during construction or operation of the project that would become unavailable for future use.
- **Relationship between Short-term Uses of the Environment and Long-term Productivity:** This section summarizes those instances where short-term impacts to the environment are necessary in order to maintain and enhance the long-term effectiveness of the transportation system in the corridor.
- **Unavoidable Impacts:** This section discusses adverse impacts of the project that cannot be avoided. Unavoidable impacts may occur if there are no reasonably practicable mitigation measures to eliminate the impacts; and if there are no reasonable alternatives to the project that would meet the purpose and need of the action, eliminate the impact, and not cause other or similar adverse impacts.
- **New York State Smart Growth Public Infrastructure Policy Act:** This section evaluates the project's consistency with the New York State Smart Growth Public Infrastructure Policy Act, which was established to promote the principles of smart growth in public infrastructure projects.

22-2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversibly and irretrievably committed resources for a project primarily include land, energy, construction materials, and human effort (i.e., time and labor). Some of these resources are typically irreversible during the life of the project, such as land and building materials. Others are irretrievable beyond the project lifespan, such as energy and human effort.

22-2-1 NO BUILD ALTERNATIVE

Under the No Build Alternative, the Tappan Zee Bridge would continue to operate under existing conditions. While this alternative would not require land typical of a construction project, it would require an irretrievable and irreversible commitment of human effort, materials, energy, and financial resources. The New York State Thruway Authority (NYSTA) estimates that it would spend $1.3 billion to maintain and repair the bridge over the next decade. Major work activities will include seismic upgrades to portions of the bridge, navigational safety improvements, steel and concrete repairs and other

miscellaneous work to continue to keep the bridge safe for the traveling public. However, the No Build Alternative does not offer increased potential for safety and reliability in case of extreme event.

22-2-2 REPLACEMENT BRIDGE ALTERNATIVE

The Replacement Bridge Alternative would result in the irreversible and irretrievable commitment of a number of resources. Land and money are the most basic resources that would be irretrievably committed. The alignment of the Replacement Bridge Alternative would follow the existing highway alignment on land to the extent practicable, but would require some development of currently undeveloped land. The allocation of $4.64 billion (in 2012 dollars) for construction of a replacement bridge would ensure the long term vitality of the Tappan Zee Hudson River Crossing.

Building materials (e.g., concrete, steel, etc.) and energy resources (e.g., fuel and electricity) used or consumed during construction and operation of the project would be irretrievably and irreversibly committed to the project. Labor expended to construct the Replacement Bridge Alternative would also be irretrievable.

None of the resources described above are expected to be in short supply. In addition, the improved mobility of and emergency access on the Tappan Zee Hudson River Crossing would reduce wasteful energy consumption associated with traffic congestion. For these reasons the project is not expected to have any adverse impacts related to irreversible and irretrievable commitment of resources.

22-3 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Short-term impacts are often a necessary component of construction projects in order to achieve the long-term goals and productivity of the project. Typically, the most notable areas of short-term impacts are related to traffic, noise, and air quality, but may also relate to natural resources and other environmental and social considerations.

22-3-1 NO BUILD ALTERNATIVE

Under the No Build Alternative, operation of the Tappan Zee Bridge would continue similar to existing conditions. This alternative would not result in any short-term impacts, but it would also forego the substantial benefits of the Replacement Bridge Alternative. The No Build Alternative would continue to require substantial financial commitments to maintain the existing structure, and the existing bridge would continue to operate under nonstandard seismic and highway design conditions.

22-3-2 REPLACEMENT BRIDGE ALTERNATIVE

All areas of potential short-term impacts related to construction of the Replacement Bridge Alternative are detailed in Chapter 18, “Construction Impacts.” Best management practices and other mitigation measures would be implemented to minimize adverse effects.

Potential short-term impacts of the Replacement Bridge Alternative would include increased traffic from construction vehicles and potential congestion associated with temporary modification of circulation patterns; effects on community character, visual

quality, and cultural resources in the study area due to ground disturbance, increased noise, and other temporary alterations of the existing setting; potential air quality impacts related to fugitive dust and exhaust from construction vehicles and equipment; temporary easement of a small portion of Elizabeth Place Park and an adjacent green space, both in the Village of South Nyack; and impacts to aquatic biota and vegetation through habitat disturbance, sediments from dredging, and hydroacoustic impacts from pile driving. Measures to avoid short-term construction impacts would be conducted to the extent possible, but where avoidance is not prudent or feasible, measures to minimize impacts would be implemented. Such measures would include limiting the duration of construction activities to the extent feasible and employing modern methods of construction that would minimize adverse effects on ecological resources and the surrounding community.

Short-term impacts are necessary to realize the long-term local and regional benefits of the Replacement Bridge Alternative. The Replacement Bridge Alternative would enhance safety, emergency response, travel time, energy efficiency, and reduce emissions; it would address existing nonstandard structural and seismic designs; and it would provide a shared-use bike and pedestrian path, linking trailways in Westchester and Rockland Counties and providing greater opportunities for non-motorized transport. The proposed facility would foster future economic development, which in turn would serve to create jobs and generate increases in property tax revenues. The beneficial long-term effects of implementing the project would offset the localized short-term impacts associated with construction.

22-4 UNAVOIDABLE IMPACTS

22-4-1 NO BUILD ALTERNATIVE

Under the No Build Alternative, the existing Tappan Zee Bridge would continue to operate similar to existing conditions. While this alternative would not directly result in any unavoidable impacts, it would sustain many of the existing deficiencies of the bridge. The No Build Alternative would remain vulnerable to high accident rates and would be susceptible to severe traffic congestion as a result of accidents and vehicular breakdowns. In addition, with narrow land widths and without shoulders, emergency response on the bridge would continue to be hindered. Further, maintenance of the existing Tappan Zee Bridge would require large expenditures of taxpayer dollars without providing the long-term benefits of the Replacement Bridge Alternative.

22-4-2 REPLACEMENT BRIDGE ALTERNATIVE

Because the Replacement Bridge Alternative would replace an existing use in a similar location, long-term adverse impacts from operation of the project would be minimized. However, this alternative would result in several unavoidable adverse impacts, described below. The majority of adverse impacts would be associated with construction, as discussed in Chapter 18, “Construction Impacts.” Where feasible, mitigation measures would be implemented to minimize or avoid adverse impacts. However, where measures cannot fully mitigate adverse effects, unavoidable impacts would result.

Construction of the Replacement Bridge Alternative would result in short-term impacts that cannot be avoided. Traffic flow would be temporarily affected by the reconstructed connections to the new bridge structures. Temporary easements on several properties (including two parkland resources) would be required during construction. Construction activities would also result in temporary noise and air quality impacts on nearby sensitive land uses. Air quality impacts would primarily be related to fugitive dust and exhaust from diesel engines. Noise from pile driving during construction would affect both ecological and human resources. In addition, construction would result in direct disturbance to aquatic habitats and the creation of suspended sediments as a result of underwater earthwork. Sensitive habitats would be avoided to the extent possible and construction methods to minimize impacts on surrounding communities and natural resources would be employed to the extent feasible.

The Replacement Bridge Alternative would result in several long-term unavoidable adverse impacts. Potential adverse impacts would be avoided or minimized to the extent possible, but in some instances, adverse impacts cannot be avoided. These impacts would include the following:

- **Land Acquisition:** As discussed in Chapter 6, "Land Acquisition, Displacement, and Relocation," the project would require acquisition of and easements on several properties, thereby displacing existing property owners. To minimize impacts to existing landowners, any displacement would be conducted in accordance with the New York State Eminent Domain Procedure Law and the federal Uniform Relocation and Assistance and Real Property Acquisition Policies Act of 1970.
- **Visual Resources:** While the project would not have an effect on the overall visual character or scenic resources in the study area, there would be localized adverse impacts on views from several residences along Bight Lane, River Road, and Ferris Lane in Rockland County. These properties overlook the Tappan Zee Bridge causeway or Interstate 87/287. Under the Replacement Bridge Alternative, views of the Hudson River and Westchester County from these properties would be obstructed by the Replacement Bridge Alternative. While landscaping could be provided to partially mitigate these impacts, the loss of these sight-lines would be unavoidable.
- **Historic and Cultural Resources:** As described in Chapter 10, "Historic and Cultural Resources," three historic resources listed or eligible for listing on the State and National Register of Historic Places (S/NR) would be adversely affected by the project. The existing Tappan Zee Bridge is a historic resource that would be removed. In addition, the project would require acquisition and demolition of two historic structures within the South Nyack Historic District. Acquisition of these properties would be related to the reconstruction of the South Broadway overpass.

  While measures have been developed to partially mitigate the adverse effects of the Replacement Bridge Alternative, the loss or diminution of these resources would be unavoidable. Additionally, further analysis will be conducted to confirm whether there are any submerged archaeological resources within the area of potential effect (APE) to determine whether any such resources would be adversely affected by the Replacement Bridge Alternative.

- **Noise and Vibration:** As discussed in Chapter 12, "Noise and Vibration," the project would result in noise levels at several receptors that exceed FHWA/NYSDOT Noise Abatement Criteria (NACs). However, where feasible and reasonable, measures such as noise barriers, would be implemented to mitigate these impacts to the extent feasible and practicable.
- **Ecology:** As discussed above, the Replacement Bridge Alternative would result in potentially unavoidable temporary adverse impacts to aquatic biota and habitats during construction. Temporary conditions during construction (such as hydroacoustic effects and suspended sediments) may result in permanent loss of individuals and habitats, but would not be expected to substantially affect populations. Unavoidable adverse impacts to soft bottom habitat would occur as a result of dredging and armoring, but this impact is considered temporary, as deposition processes would cause the bottom habitat to return to its natural state over time once construction is completed. Oyster habitat in the project vicinity would likely be lost as an unavoidable impact during construction activities. Where the existing Tappan Zee Bridge would be removed, there would be an opportunity for habitats to redevelop. Affected aquatic biota and vegetative species would be expected to recover post-construction.

22-5 NEW YORK STATE SMART GROWTH PUBLIC INFRASTRUCTURE POLICY ACT

Under the New York State Smart Growth Public Infrastructure Policy Act, no state infrastructure agency shall approve, undertake, support, or finance a public infrastructure project, unless, to the extent practicable, the public infrastructure project is consistent with its ten smart growth infrastructure criteria. The New York State Department of Transportation (NYSDOT) and the New York State Thruway Authority (NYSTA) have developed policies to ensure projects comply with this act.

22-5-1 NO BUILD ALTERNATIVE

Under the No Build Alternative, no state infrastructure development initiative related to the Tappan Zee Hudson River Crossing, other than routine maintenance and repairs would occur. Therefore, the New York State Smart Growth Public Infrastructure Policy Act would not be relevant to this alternative.

22-5-2 REPLACEMENT BRIDGE ALTERNATIVE

The ten New York State Smart Growth Public Infrastructure Policy Act criteria and the Replacement Bridge Alternative's consistency with these criteria are presented in **Table 22-1**. The Replacement Bridge Alternative would be consistent with all applicable criteria and would be conducted in accordance with NYSDOT and NYSTA smart growth policies, which are based on these criteria.

Table 22-1
Replacement Bridge Alternative's Consistency with New York State Smart Growth Public Infrastructure Policy Act

Criterion 1: To advance projects for the use, maintenance or improvement of existing infrastructure.
Consistent. The Replacement Bridge Alternative would replace and improve existing transportation infrastructure so that it can better meet existing and future travel needs in the Interstate 87/287 corridor.
Criterion 2: To advance projects located in municipal centers.
Not Applicable. The Replacement Bridge Alternative would be a transportation infrastructure initiative that would maintain a vital Hudson River crossing in a major transportation network.
Criterion 3: To advance projects in developed areas or areas designated for concentrated infill development in a municipally-approved comprehensive land use plan, local waterfront revitalization plan and/or brownfield opportunity area plan.
Consistent. The Replacement Bridge Alternative would be constructed within the existing New York State Thruway right-of-way to the extent practicable and would realign with existing upland portions of Interstate 87/287 in order to minimize disturbance of currently undisturbed land.
Criterion 4: To protect, preserve and enhance the state's resources, including agricultural land, forests, surface and groundwater, air quality, recreation and open space, scenic areas, and significant historic and archeological resources.
Consistent. The Replacement Bridge Alternative would be constructed within existing New York State Thruway right-of-way to the extent possible and the alignment of the Replacement Bridge Alternative would follow the existing highway alignment on land to the extent practicable, thereby minimizing disturbance to preserved habitats and environmental resources. By reducing the frequency of accident and incident delays on the bridge, traffic flow would be improved and air quality emissions reduced. While the Replacement Bridge Alternative would require unavoidable adverse effects on several historic and recreational resources, the project has been designed to minimize impacts to these resources to the extent possible. In addition, the project would enhance the lower Hudson Valley region's recreational resources by providing a shared-use bike and pedestrian pathway, thereby providing a link to trailways on either side of the Hudson River. The project would also provide stormwater treatment facilities at the bridge landings. This would provide a substantial benefit to water quality, as stormwater runoff is currently untreated.
Criterion 5: To foster mixed land uses and compact development, downtown revitalization, brownfield redevelopment, the enhancement of beauty in public spaces, the diversity and affordability of housing in proximity to places of employment, recreation and commercial development and the integration of all income and age groups.
Not Applicable. The Replacement Bridge Alternative would be a transportation infrastructure improvement project. The project would maintain the region's quality of life by preserving an important transportation link, but would not directly affect community development.
Criterion 6: To provide mobility through transportation choices including improved public transportation and reduced automobile dependency.
Consistent. The Replacement Bridge Alternative would improve mobility and efficiency along this section of Interstate 87/287. In addition, the bridge would be designed not to preclude transit.
Criterion 7: To coordinate between state and local government and inter-municipal and regional planning.
Consistent. While the project does not require any discretionary approvals by local municipalities, the project sponsors recognize the potential effects of the project on these communities. As such, coordination with local and regional agencies will continue as the project develops. In addition, the project considers and incorporates features consistent with local planning initiatives where appropriate, such as providing a shared-use bike and pedestrian pathway.
Criterion 8: To participate in community-based planning and collaboration.
Not Applicable. This project is a large-scale regional transportation initiative being coordinated with the New York State Department of Transportation (NYSDOT), the New York State Thruway Authority (NYSTA), and the Federal Highway Administration (FHWA).

Table 22-1 (Continued)
Replacement Bridge Alternative's Consistency with New York State Smart Growth Public Infrastructure Policy Act

Criterion 9: To ensure predictability in building and land use codes.
Not Applicable.
Criterion 10: To promote sustainability by strengthening existing and creating new communities which reduce greenhouse gas emissions and do not compromise the needs of future generations, by among other means encouraging broad based public involvement in developing and implementing a community plan and ensuring the governance structure is adequate to sustain its implementation.
Not Applicable. Although this criterion is not applicable to the project, the Replacement Bridge Alternative would support objectives of this criterion. By improving roadway safety features and improving emergency access on the bridge, the project would foster a reduction in accidents and congestion, thereby reducing greenhouse gas emissions. The project would further reduce emissions by eliminating the need to move the median barrier twice daily, currently accomplished using a diesel-powered engine.

23-1 INTRODUCTION

This chapter addresses the requirements of Section 4(f) of the U.S. Department of Transportation (USDOT) Act of 1966.[1] The Tappan Zee Hudson River Crossing Project would use three Section 4(f) Properties—Tappan Zee Bridge, Elizabeth Place Park, and the South Nyack Historic District. The use of Elizabeth Place Park is considered *de minimis*. The use of the Tappan Zee Bridge and South Nyack Historic District cannot be avoided, and therefore, the Federal Highway Administration (FHWA) has identified measures to minimize harm to these properties.

23-2 REGULATORY CONTEXT

Section 4(f) of the USDOT Act of 1966 (49 USC § 303; 23 CFR §774) prohibits the Secretary of Transportation from approving any program or project that requires the "use" of (1) any publicly owned parkland, recreation area, or wildlife and waterfowl refuge of national, state, or local significance; or (2) any land from a historic site of national, state, or local significance (collectively, "Section 4(f) properties"), unless there is no feasible and prudent alternative to the use of such land and such program or project includes all possible planning to minimize harm to the park, recreation area, wildlife refuge, or historic site. A historic site is considered to be a property that is listed on, or eligible for listing on, the National Registers of Historic Places ("NR-listed" and "NR-eligible").

A project uses a Section 4(f) property when:

- It permanently incorporates land from the property into a transportation facility;
- It temporarily but adversely occupies land that is part of the property; or
- It "constructively" uses the property, which occurs "when the transportation project does not incorporate land from a Section 4(f) property, but the proximity impacts are so severe that the protected activities, features, or attributes that qualify property for protection under Section 4(f) are substantially impaired."

Whenever a Section 4(f) property would be used for a transportation project, documentation must be prepared to demonstrate that:

- No feasible and prudent alternative exists to the use of the 4(f) property; and
- The project includes all possible planning to minimize harm to the property.

[1] In 1983, Section 4(f) of the USDOT Act was codified as 49 USC §303(c), but this law is still commonly referred to as Section 4(f).

As described in 23 CFR § 774.17, an alternative is not feasible if it cannot be built as a matter of sound engineering judgment. An alternative is not prudent if:

- It compromises the project to a degree that it is unreasonable to proceed with the project in light of its stated purpose and need;
- It results in unacceptable safety or operational problems;
- After reasonable mitigation, it still causes:
  - Severe social, economic, or environmental impacts;
  - Severe disruption to established communities;
  - Severe disproportionate impacts to minority or low income populations; or
  - Severe impacts to environmental resources protected under other Federal statutes;
- It results in additional construction, maintenance, or operational costs of an extraordinary magnitude;
- It causes other unique problems or unusual factors; or
- It involves multiple factors of the above, that while individually minor, cumulatively cause unique problems or impacts of extraordinary magnitude.

If there is no feasible and prudent avoidance alternative, FHWA may approve only the alternative that causes the least overall harm in light of Section 4(f)'s preservation purpose. As stated in 23 CFR § 774.3 The "least overall harm" is determined by balancing the following list of factors:

- The ability to mitigate adverse impacts to each Section 4(f) property (including any measures that result in benefits to the property);
- The relative severity of the remaining harm, after mitigation, to the protected activities, attributes, or features that qualify each Section 4(f) property for protection;
- The relative significance of each Section 4(f) property;
- The views of the official(s) with jurisdiction over each Section 4(f) property;
- The degree to which each alternative meets the purpose and need for the project;
- After reasonable mitigation, the magnitude of any adverse impacts to resources not protected by Section 4(f); and
- Substantial differences in costs among the alternatives.

23-2-1 *DE MINIMIS* IMPACTS

Section 6009(a) of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU amended the Section 4(f) legislation to simplify the approval of projects that have only *de minimis* impacts on lands protected by Section 4(f). *De minimis* impacts related to historic sites are defined as the determination of either "no adverse effect" or "no historic properties affected" in compliance with Section 106 of the National Historic Preservation Act (NHPA; 16 USC § 470 et seq.; 36 CFR

Part 800). *De minimis* impacts on publicly owned parks, recreation areas, and wildlife and waterfowl refuges are defined as those that do not “adversely affect the activities, features, and attributes” of the Section 4(f) property.

A finding of a *de minimis* impact on a historic site may be made when:

- The process required by Section 106 of the NHPA results in the determination of "no adverse effect" or "no historic properties affected" with the concurrence of the State Historic Preservation Officer (SHPO) and/or Tribal Historic Preservation Officer (THPO), if applicable, and the Advisory Council on Historic Preservation, if participating in the Section 106 consultation process;
- The SHPO and/or THPO, and ACHP, if participating, is informed of FHWA's intent to make a *de minimis* impact finding based on their written concurrence in the Section 106 determination; and
- The FHWA has considered the views of any consulting parties participating in the Section 106 consultation.

The impacts of a transportation project on a park, recreation area, or wildlife and waterfowl refuge may be determined to be *de minimis* if:

- The transportation use of the Section 4(f) property, together with any impact avoidance, minimization, and mitigation or enhancement measures incorporated into the project, does not adversely affect the activities, features, and attributes that qualify the property for protection under Section 4(f);
- The official(s) with jurisdiction over the property are informed of FHWA's intent to make the *de minimis* impact finding based on their written concurrence that the project will not adversely affect the activities, features, and attributes that qualify the property for protection under Section 4(f); and
- The public has been afforded an opportunity to review and comment on the effects of the project on the protected activities, features, and attributes of the Section 4(f) property.

Once FHWA determines that a transportation use of Section 4(f) property results in a *de minimis* impact, analysis of avoidance alternatives are not required and the Section 4(f) evaluation process is complete.

23-2-2 PROGRAMMATIC SECTION 4(f) EVALUATION FOR HISTORIC BRIDGES

In July 1983, FHWA issued through the *Federal Register* a programmatic Section 4(f) approval for historic bridges that are part of the interstate highway system or a state or local highway system. Programmatic Section 4(f) evaluations streamline the amount of documentation, approval, and interagency coordination that is required. If a project meets the criteria of the Programmatic Section 4(f) evaluation, it is deemed to meet the regulations of Section 4(f). For Programmatic Section 4(f) evaluations, interagency coordination is required with the official(s) with jurisdiction over the resource but not with the U.S. Department of Interior (DOI).

In its programmatic evaluation for historic bridges, FHWA states that:

> Even though these structures are on or eligible for inclusion on the National Register of Historic Places, they must perform as an integral part of a modern transportation system. When they do not or cannot, they must be rehabilitated or replaced in order to assure public safety while maintaining system continuity and integrity.

FHWA can apply the programmatic Section 4(f) evaluation for historic bridges if a project that meet the following criteria:

- The bridge is to be replaced or rehabilitated with federal funds.
- The project will require the use of a historic bridge structure which is on or is eligible for listing on the National Register of Historic Places.
- The bridge is not a National Historic Landmark.
- The FHWA Division Administrator determines that the facts of the project match those set forth in the sections of the programmatic Section 4(f) evaluation.
- Agreement among the FHWA, SHPO, and ACHP has been reached through procedures pursuant to Section 106 of the NHPA.

The programmatic Section 4(f) evaluation and approval may be used only for projects where the FHWA Division Administrator, in accordance with the project's Section 4(f) evaluation, ensures that the project includes all possible planning to minimize harm. For bridges that are to be replaced, this is considered to occur when: 1) the existing bridge is made available for an alternative use, provided a responsible party agrees to maintain and preserve the bridge; and 2) agreement among the SHPO, ACHP, and FHWA is reached on measures to minimize harm through the Section 106 process of the NHPA, and such measures are incorporated into the project.

23-2-3 SECTION 4(f) REVIEW PROCESS

After public comments on this draft Section 4(f) statement are received, a final Section 4(f) evaluation will be prepared. The final Section 4(f) evaluation will contain the conclusions of the Section 4(f) evaluation, encompassing:

- A description of the basis for concluding that there are no prudent and feasible alternatives to the use of the Section 4(f) property, including a demonstration that there are unique problems or unusual factors involved in the use of alternatives that avoid these properties, or that the cost, social, economic, and environmental impacts or community disruption resulting from the alternatives reach extraordinary magnitudes;
- A description of the basis for concluding that the proposed action includes all possible planning to minimize harm; and
- A summary of appropriate formal coordination with the U.S. Department of the Interior (DOI).

FWHA, acting as the lead federal agency, will make its final Section 4(f) finding when it issues the Final Environmental Impact Statement (FEIS) for the Tappan Zee Hudson River Crossing Project.

23-3 APPLICABILITY OF SECTION 4(f) TO THE PROJECT

Three Section 4(f) properties would be temporarily and/or permanently used by the Replacement Bridge Alternative. These effects of the Short Span and Long Span Options for the Replacement Bridge Alternative would be the same with respect to these Section 4(f) properties. The location of these Section 4(f) properties is shown in **Figure 23-1**.

- The Replacement Bridge Alternative would remove the existing Tappan Zee Bridge, which is S/NR-eligible;
- The Replacement Bridge Alternative would require a temporary easement of 0.03 acres of Elizabeth Place Park in South Nyack, Rockland County for three years during construction; and
- The Replacement Bridge Alternative would require the permanent acquisition and demolition of the houses at 21 Cornelison Avenue and 78 Smith Avenue, South Nyack, Rockland County, both of which are contributing resources to the NR-eligible South Nyack Historic District.

As stated in 23 CFR § 77.11 and 23 CFR § 77.13, Section 4(f) applies to all archeological sites on or eligible for inclusion on the National Register, including those discovered during construction, except when:

- The Administration concludes that the archeological resource is important chiefly because of what can be learned by data recovery and has minimal value for preservation in place. This exception applies both to situations where data recovery is undertaken and where the Administration decides, with agreement of the official(s) with jurisdiction, not to recover the resource; and
- The official(s) with jurisdiction over the Section 4(f) resource have been consulted and have not objected to the Administration finding.

The potential archaeological resources identified for the Tappan Zee Hudson River Crossing Project and described in Chapter 10, “Historic and Cultural Resources,” would be important for the information they might yield and not for preservation in place. Therefore, at this time, these resources are not considered as Section 4(f) properties. However, if based on further study and onsultation with the State Historic Preservation Officer (SHPO) of the New York State Offices of Parks, Recreation, and Historic Preservation (OPRHP), it is determined that these resources are important for preservation in place, this Section 4(f) evaluation would be supplemented to address these properties.

As described above, a “constructive” use occurs “when the transportation project does not incorporate land from a Section 4(f) property, but the proximity impacts are so severe that the protected activities, features, or attributes that qualify a property for protection under Section 4(f) are substantially impaired.” The Replacement Bridge Alternative would construct a new bridge north of the existing location of the Tappan Zee Bridge with realignment and regrading of Interstate 87/287 in Rockland and Westchester Counties to meet the new bridge abutments. The realignment of the highway would result in its closer proximity to Section 4(f) properties on the north side

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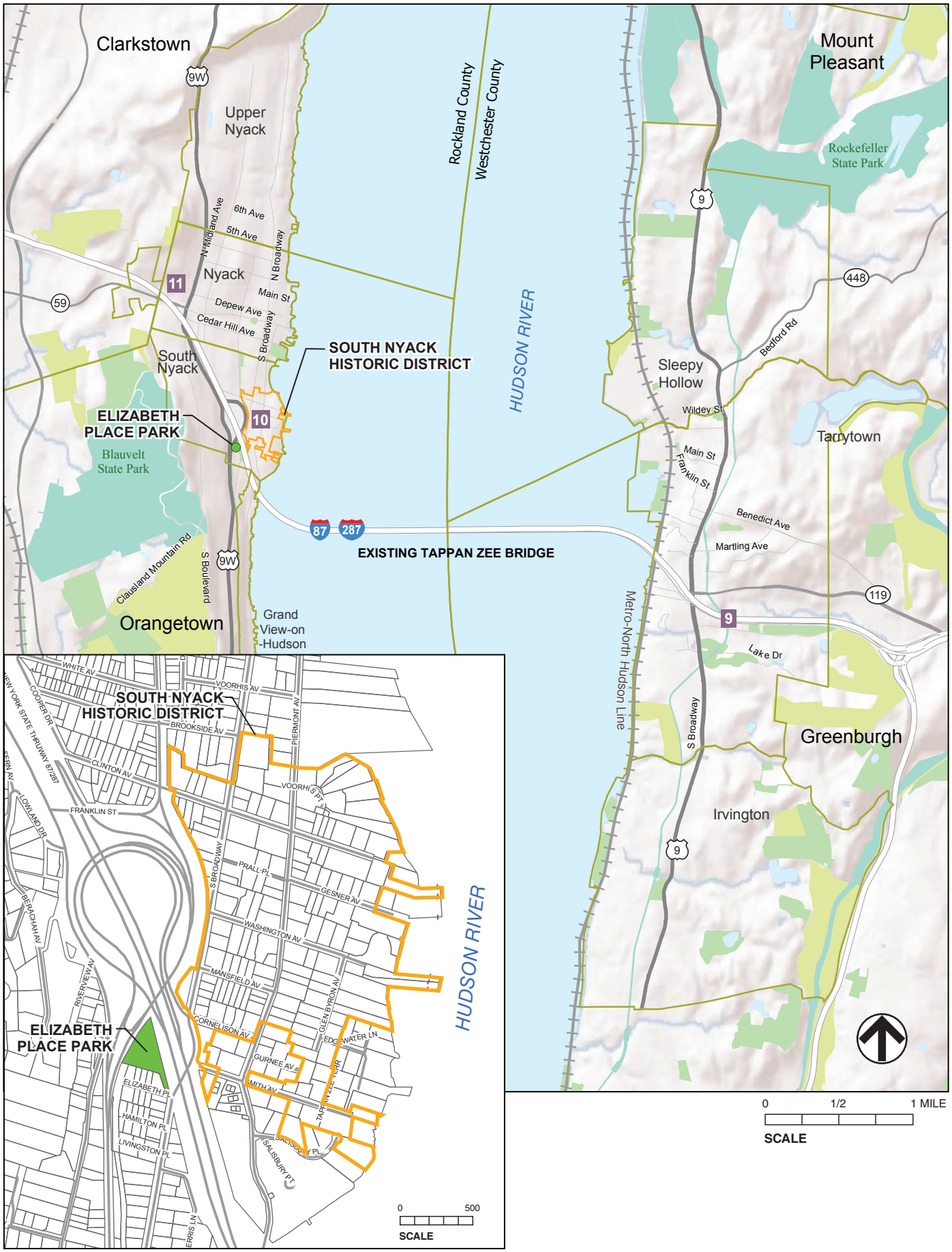

TAPPAN ZEE HUDSON RIVER CROSSING
Environmental Impact Statement

Figure 23-1
Section 4(f) Properties

of the existing right-of-way, and the higher elevation of the highway would be more visible from Section 4(f) properties on the south side of the right-of-way.

While this shift may increase noise levels and vehicle emissions at some discrete locations, it would not substantially alter the existing character of these properties, as they already exist very near Interstate 87/287. New noise walls and the highway grade may block views of and from certain historic properties, but the viewshed is not considered a character defining feature. Therefore, the Replacement Bridge Alternative, including the shift of the Interstate 87/287 right-of-way to the north, would not constitute a constructive use on Section 4(f) properties.

23-4 SECTION 4(f) EVALUATION

Below is an evaluation of the use of each of the Section 4(f) properties identified above to determine whether there are any feasible and prudent alternatives to its use. If multiple adverse factors, such as environmental impacts, increased costs, and impaired traffic operations, taken together create unique problems, these resulting problems can mean an alternative is not prudent. An alternative that would not meet the project's purpose and need also is not prudent. An alternative is not feasible if it cannot be built as a matter of sound engineering practice. Where prudent and feasible alternatives to avoid the use of a Section 4(f) property cannot be identified, this section describes the measures that would be implemented to minimize harm to the property.

23-4-1 TAPPAN ZEE BRIDGE

Section 6007 of SAFETEA-LU exempts the Interstate Highway System from being considered as a Section 4(f) property. This exemption applies to the entire Interstate System, except for specific facilities designated by FHWA as having national and/or exceptional significance. Although it is part of the Interstate Highway System, the requirements of Section 4(f) apply to the Tappan Zee Bridge as it is designated as having exception significance in engineering history for its use of prefabricated buoyant caissons supports.

The Tappan Zee Bridge was constructed between 1952 and 1955. Captain Emil H. Praeger, U.S. Navy Retired (1882–1973), served as chief engineer for Madigan-Hyland, the designers of the bridge. The bridge is 3.1-mile-long structure supported by a substructure consisting of abutments and 198 piers. It is the longest bridge in the state and one of the longest in the country. It also has the world's ninth longest cantilever span, at 1,212 feet. It has been determined eligible for National Register listing for its significance in the areas of transportation and engineering. The Tappan Zee Bridge is not designated as a National Historic Landmark.

23-4-1-1 DESCRIPTION OF THE USE OF THE SECTION 4(F) PROPERTY

The Replacement Bridge Alternative would incorporate portions of the existing Rockland and Westchester Counties' landings of the Tappan Zee Bridge into the new structure and would demolish the existing bridge, causeway, and approach spans.

23-4-1-2 ALTERNATIVES TO AVOID THE USE OF THE SECTION 4(F) PROPERTY

FHWA's programmatic Section 4(f) Evaluation identifies three alternatives to the use of a historic bridge: 1) Implement the No Build Alternative ("Do Nothing Alternative"); 2)

Build a new structure at a different location without affecting the historic integrity of the old bridge, as determined by procedures implementing the NHPA; and 3) Rehabilitate the historic bridge without affecting the historic integrity of the structure, as determined by procedures implementing the NHPA.

No Build Alternative

The No Build Alternative ("Do Nothing" Alternative") would not result in the demolition of the Tappan Zee Bridge. Ongoing maintenance and capital projects would ensure that the Tappan Zee Bridge would remain safe to the traveling public, but these projects would not correct the structural, operational, safety, or mobility needs of the bridge. The New York State Thruway Authority (NYSTA) estimates that it would spend $1.3 billion to maintain and repair the bridge over the next decade. Major work activities will include seismic upgrades to portions of the bridge, navigational safety improvements, steel and concrete repairs, and other miscellaneous improvements to continue to keep the bridge safe for traveling public. Despite this considerable expenditure, the structural, operational, safety, and mobility needs of the Tappan Zee Hudson River crossing would not be fully corrected.

Given the age of the bridge and the vulnerabilities in extreme events, it is possible that the crossing could be closed altogether at some point in the future. If the bridge were closed, the vital link between the population and employment centers of Rockland and Westchester Counties would be removed, causing a break in the regional and national transportation network. As a result, the local and regional population and workforce could be adversely affected by the No Build Alternative.

While the No Build Alternative would be feasible, it is not prudent, as it would not meet the project's purpose and need and could result in severe social, economic, and environmental impacts.

Build at a New Location Alternative

Construction of a new bridge on another alignment and retention of the existing bridge in a manner that would preserve its historic integrity would avoid a use of the Tappan Zee Bridge. Two potential alignments for a new bridge were evaluated—Remote Northern Route and Remote Southern Route (see **Figure 23-2**).

- ***Remote Northern Route.*** A Remote Northern Route was identified 3 miles north of the existing bridge that would generally avoid terrain obstacles. This route would require a new, 2-mile corridor in Rockland County, diverging from Interstate 87/287 near Interchange 12 (Palisades Interstate Parkway). In Westchester County, the alignment would require a new ½-mile long roadway from the Hudson River to Route 117 at its interchange with Route 9. At this point, the Remote Northern Route would rejoin the existing Interstate 87/287 right-of-way.
- ***Remote Southern Route.*** A Remote Southern Route was identified in the vicinity of Snedens Landing in Rockland County and Dobbs Ferry or Hastings on Hudson in Westchester County, approximately 4 miles south of the existing bridge. This route would diverge from the existing right-of-way at the Palisades Interstate Parkway (Interchange 13) in Rockland County and would rejoin Interstate 87 at south of Interchange 7 (Interstate 287) in Westchester County. It would require acquisition of about two miles of new right-of-way in Rockland County and about two to three

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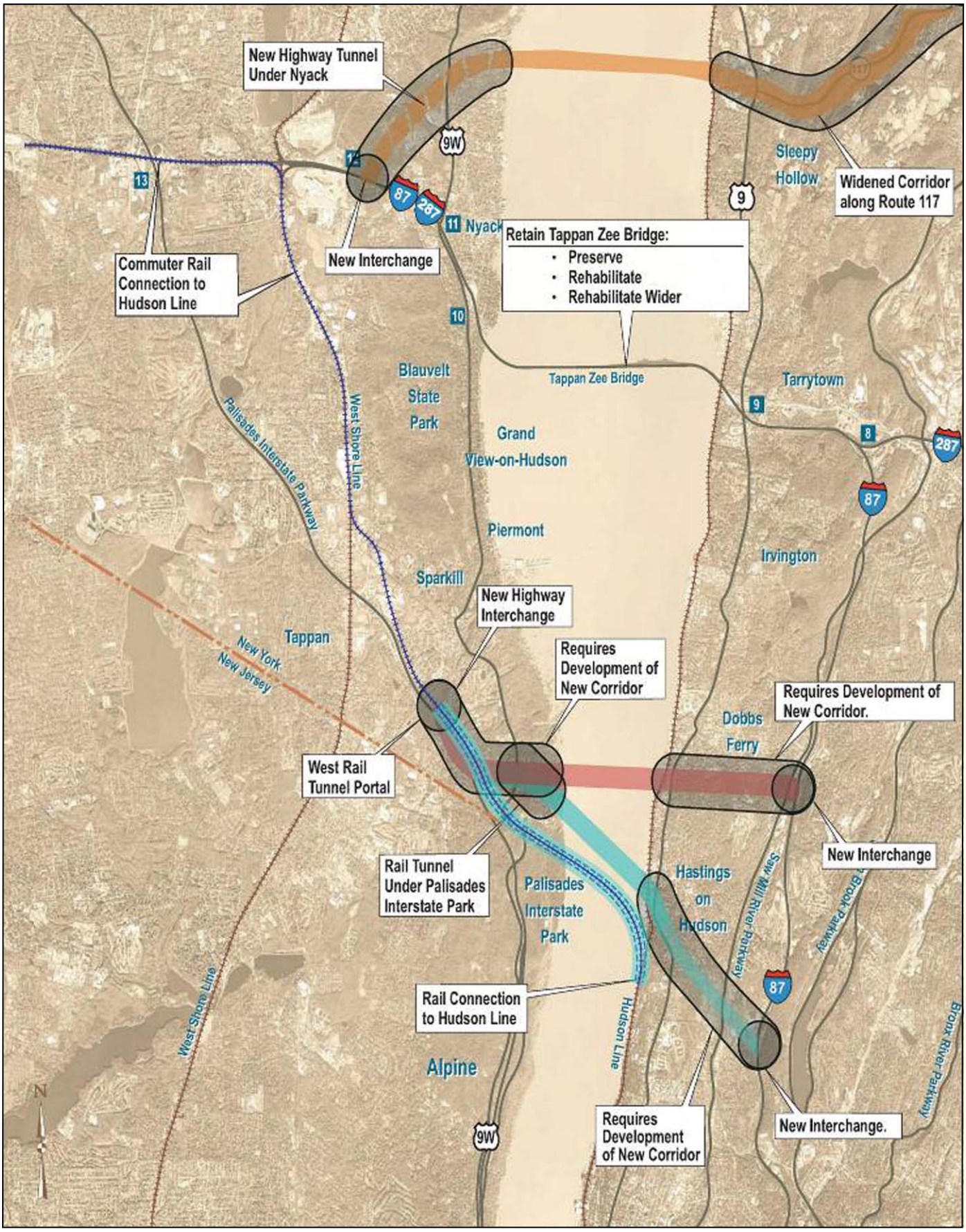

Figure 23-2

Avoidance Alternatives: Build at a New Location Alternative

miles of new right-of-way in Westchester County. The Remote Southern Route would also require extensive modifications to the Palisades Interstate Parkway to meet design requirements for interstate highways.

The Remote Northern and Remote Southern Routes would require acquisition of more than 40 acres of property in a heavily populated area, resulting in a substantial number of residential and commercial relocations. Furthermore, the Remote Northern and Southern Routes would require reconstruction of portions of the Palisades Interstate Parkway to provide new interchanges and allow for truck access. The construction and reconstruction of the highway would impact a number of built and natural features in both Rockland and Westchester Counties. Thus, the Remote Northern and Remote Southern Routes are not considered prudent.

Rehabilitation Alternative

The Alternatives Analysis for Rehabilitation and Replacement of the Tappan Zee Bridge Report (March 2009) identified four rehabilitation options to enhance the structural integrity and operation of the existing Tappan Zee Bridge. Four rehabilitation options were considered:

1) Replacement Causeway and Rehabilitated Main Span;

2) Replacement Causeway and Widened Main Span;

3) Replacement Causeway, Rehabilitated Main Span, and Single Level Supplemental Bridge; and

4) Replacement Causeway, Rehabilitated Main Span, and Dual Level Supplemental Bridge.

The findings of this report were reviewed in the context of the goals and objects for the current project (see Chapter 1, “Purpose and Need”). This review concluded that the Rehabilitation Alternative is not considered prudent for the reasons described below.

The Rehabilitation Alternative would fail to meet the project goal of “ensuring the long-term vitality of this Hudson River crossing” for the following reasons:

- The Rehabilitation Alternative would be designed to comply with seismic criteria, which are based on strength. However, the Rehabilitation Alternative would lack ductility, which allows bridge members to endure changes in shape without breaking. Therefore, the Rehabilitation Alternative would be vulnerable during an extremely long or intensive earthquake.
- The Replacement Bridge Alternative would consist of two structures to provide for service redundancy in the event that one structure is closed for damage, maintenance, and/or repair. The Rehabilitation Alternative options that have a single structure would lack this service redundancy. If the bridge were heavily damaged by a natural or man-made event, it would be closed for repairs. If the bridge were closed, there would be no alternative routing for traffic at this location along the Hudson River.

The Rehabilitation Alternative would fail to meet the project goal of “improving transportation operations and safety on the crossing” for the following reasons:

- The Rehabilitation Alternative would lack alternative load path redundancy (i.e., the ability of bridge members to be supported by multiple means such as a deck supported both by a deck truss and by a bridge cable). As such, the Rehabilitation Alternative would not adequately address security or operational concerns. Its closure would severely affect traffic operations, freight movement, and economic conditions across the region.

The Rehabilitation Alternative would fail to meet the project goal of "maximizing the public investment in a new Hudson River crossing" for the following reasons:

- The life span of bridge components retained in the Rehabilitation Alternative would be shorter than those of a new bridge. To maximize the public investment in a new Tappan Zee Hudson River crossing, the desired life span of the new structure is at least 100 years before major maintenance or rehabilitation is needed. However, components of the Rehabilitation Alternative would need major maintenance or replacement in as few as 50 years.
- The construction duration for the Rehabilitation Alternative would be one year longer than for a replacement bridge.
- There is much uncertainty associated with rehabilitation projects in that the extent of damage to certain bridge components may not be fully known until they are actually replaced. This uncertainty would have the potential to substantially increase the construction cost and duration of the Rehabilitation Alternative.
- The Rehabilitation Alternative would involve both upland and in-water construction activities and would be expected to result in many of the same environmental impacts of a replacement bridge.
- The Rehabilitation Alternative with two bridges would cost $2.5 to $2.7 billion more than the Replacement Bridge Alternative. It would also result in more in-water work and would have the same deficiencies described above in terms of life cycle and vulnerabilities.

In addition, the Rehabilitation Alternative would remove historic features of the Tappan Zee Bridge and many other impacts of its construction and operation would be materially the same or potential worse than the Replacement Bridge Alternative. Given these considerations, the Rehabilitation Alternative would not meet the project's purpose and need. While feasible, the Rehabilitation Alternative is not prudent. Rehabilitation without adversely affecting the historic integrity of the Tappan Zee Bridge also appears to not be feasible.

Reuse Alternative

The reuse of the existing Tappan Zee Bridge in tandem with the Replacement Bridge Alternative would partially avoid a use of this Section 4(f) property. Under the Reuse Alternative, FHWA, New York State Department of Transportation (NYSDOT), and NYSTA would seek a new owner for the existing Tappan Zee Bridge once the Replacement Bridge Alternative is operational. The new owner would be responsible for the future use of the bridge in accordance with federal, state, and local laws, permits, and approvals and would be responsible for the maintenance of the structure.

The Reuse Alternative is not prudent for the following reasons:

- Consistent with the project's objectives to "minimize effects on existing highways" and "maximize the use of existing right-of-way," the Replacement Bridge Alternative would incorporate as much of the existing bridge landings as possible into the new structures. In Rockland County, the landings would shift slightly north; however, in Westchester County, the new landings would fully incorporate right-of-way for the existing landings. Therefore, under the Reuse Alternative, access to the existing Tappan Zee Bridge would be precluded without an alternative upland right-of-way. Upland right-of-way would be need for pathways to get onto the bridge and possibly for parking or uses related to the bridge's conversion to public space.
- The reuse of the existing bridge in combination with the Replacement Bridge Alternative would result in three structures over a 500-foot corridor of the navigable channel. Based on conversations with the U.S. Coast Guard, retention of the existing bridge would be considered an obstruction to navigation.
- The cost to rehabilitate the existing structure for alternative use and to maintain its ongoing structural integrity would be very high. The estimated cost for full rehabilitation of the existing bridge is $3.5 billion, including replacement of the causeway and seismic upgrades. The costs to maintain the bridge would be about $50 million per year.
- The reuse of the existing structure would require demolition, alteration, or removal of bridge features. These efforts would adversely affect the historic integrity of the Tappan Zee Bridge.

23-4-1-3 MEASURES TO MINIMIZE HARM

As described above, the reuse of the existing Tappan Zee Bridge in place is not considered prudent or feasible. The Tappan Zee Bridge is more than 3.1 miles long with 198 piers, and the removal and relocation of the bridge in tact would be infeasible. Disassembly and reassembly of the structure would also be extremely difficult given the location, length, and age of the Tappan Zee Bridge. Furthermore, the removal of the bridge would likely alter or demolish its causeway foundations, buoyant foundations, and cofferdams, which are contributing elements to the historic integrity of the bridge.

Since preservation in place or relocation is not a viable option, FHWA, NYSDOT, and NYSTA, in consultation with SHPO, have explored measures to mitigate the adverse effect on the Tappan Zee Bridge. These measures, which are identified in the draft Section 106 Memorandum of Agreement (see **Appendix C**), are as follows:

- American Engineering Record (HAER) documentation of the Tappan Zee Bridge would include at a minimum large-format black-and-white archival photographs, measured drawings, and a historic report meeting the current HAER guidelines established by the Heritage Documentation Program of the National Park Service. Copies of the HAER Report would be distributed to the Library of Congress and other appropriate repositories identified in consultation with SHPOSelect Existing Drawings: Drawings of historic buildings, sites, structures or objects, whether original construction or later alteration drawings that portray or depict the historic value or significance.
- Educational materials documenting the history and construction of the bridge.

23-4-2 ELIZABETH PLACE PARK

Elizabeth Place Park is a public park in the Village of South Nyack. The park is owned and maintained by the Village of South Nyack. It is situated on an approximately 0.81-acre triangular parcel located on the southwest side of Interstate 87/287, north of Elizabeth Place, and east of the Raymond G. Esposito Memorial Trail and Route 9W. The park features active recreation opportunities, including a basketball court, play area, open space, picnic areas, and a dog park.

The South Broadway Bridge over Interstate 87/287 must be lengthened to allow for a northward shift in the highway alignment to meet the new abutments of the Replacement Bridge Alternative. To construct the new South Broadway Bridge, NYSDOT and NYSTA would seek a temporary, 3-year easement for 0.03 acres of Elizabeth Place Park. The easement would consist of a sloped area at the western edge of the park adjacent to South Broadway. This area is vegetated, and its steep slope results in its limited use by park patrons. The easement would allow for staging to reconstruct and realign the South Broadway Bridge over Interstate 87/287. During that time, this portion of the park would be inaccessible to the public. Upon completion of construction, the temporary easement would expire and the 0.03 acres would be returned to parkland. This area would be regraded and flattened such that it would better serve for recreational use.

FHWA proposes a *de minimis* impact finding for the use of Elizabeth Place Park. The use of this property would be temporary and would impact less than 5 percent of the park's area. The use would involve areas of the park with limited public utility and would not affect the other attributes of the park. Furthermore, upon completion of construction, the 0.03 acres would be regraded to better serve park users. FHWA will seek the concurrence with the Village of South Nyack for its proposed *de minimis* impact finding.

23-4-3 SOUTH NYACK HISTORIC DISTRICT

The South Nyack Historic District (determined S/NR-eligible as part of this project) is located within the Village of South Nyack. The southwestern portion of the historic district abuts Interchange 10 (Route 9W) of Interstate 87/287. The proposed historic district is characterized by large, Second Empire estates, Queen Anne-style residences, and modest residences built in the Tudor, Colonial Revival, and Craftsman styles. The district encompasses residences on Piermont, Clinton, Cornelison, Gesner, Glen Byron, Mansfield, Smith, and Washington Avenues; Gurnee and Prall Places; South Broadway; Tappan Zee Terrace; and Voorhis Point. The proposed district includes 130 contributing resources and 34 noncontributing resources. The proposed district was determined eligible for NR listing because it is a cohesive assembly of predominantly residential structures that visually communicate the history of South Nyack's affluent and middle-class neighborhoods over time.

The residences at 21 Cornelison and 78 Smith Avenues are contributing resources to the South Nyack Historic District. The residence at 21 Cornelison is a four-square, hip-roofed structure built in the early 20th century. 78 Smith Avenue consists of a two-story, three-bay residence constructed ca, 1910. Its surrounding landscape features include concrete-paved paths, mature trees, and shrubs. 78 Smith Avenue was designed in an interpretation of the Colonial Revival style that references the Greek Revival style.

23-4-3-1 DESCRIPTION OF THE USE OF THE SECTION 4(F) PROPERTY

The 21 Cornelison Avenue and 78 Smith Avenue properties would be acquired. Structures would be removed, and the properties would be permanently incorporated into the Interstate 87/287 and future South Broadway right-of-way. In order to reconstruct the South Broadway Bridge and avoid disruption to traffic over Interstate 87/287, the bridge alignment would be shifted slightly east. The property at 21 Cornelison Avenue would be the future location of the shared-use path, the realigned South Broadway Bridge, and landscaped buffer space. The property at 78 Smith Avenue would be the future location of the Replacement Bridge Alternative's shared-use path, a retaining wall, and landscaped buffer space.

23-4-3-2 AVOIDANCE ALTERNATIVES

No Build Alternative

The No Build Alternative would not replace the Tappan Zee Bridge, reconstruct the South Broadway Bridge, or construct a shared-use path adjacent to the westbound lanes of Interstate 87/287. The No Build Alternative would avoid the use of the South Nyack Historic District. However, as described above, the No Build Alternative is not prudent as it would not meet the project's purpose and need and could result in severe social and economic impacts.

Southerly Alignment in Rockland County Alternative (Replace Tappan Zee Bridge but No South Broadway Bridge Replacement)

The Southerly Alignment in Rockland County Alternative would involve construction of a replacement Tappan Zee Bridge and landings in Rockland and Westchester Counties. However, it would not replace the South Broadway Bridge. Instead, Interstate 87/287 would maintain its existing alignment west of and beneath the South Broadway Bridge and would then shift northward to meet the replacement bridge abutments. The Southerly Alignment in Rockland County Alternative would avoid a use of the South Nyack Historic District.

The Southerly Alignment in Rockland County Alternative would result in non-standard roadway features between the South Broadway Bridge and the replacement bridge's abutment. With less horizontal distance to shift the highway alignment northward, the design would call for non-standard, highway curves. To ensure safe travel through this curve, NYSTA would likely reduce the speed limit to 45 miles per hour on this section of Interstate 87/287. There would also not be sufficient spaces for the shared-use path to travel beneath the bridge and connect to the Raymond G. Esposito Memorial Trail. Since the Southerly Alignment in Rockland County Alternative would result in substandard roadway features, permanent speed restrictions on Interstate 87/287, and poor connectivity to the shared-use path, it is not considered a prudent alternative.

Replacement of the South Broadway Bridge at the Same Location Alternative

The South Broadway Bridge over Interstate 87/287 must be lengthened to allow for a northward shift in the highway alignment to meet the new abutments of the Replacement Bridge Alternative as well as to provide for the new shared-use path immediately north of the highway lanes.

The Replacement Bridge Alternative would reconstruct the South Broadway Bridge by first building the structure on adjacent land and then installing it when complete. NYSDOT and NYSTA would acquire property east of South Broadway to stage the bridge's construction. Once completed, the new South Broadway Bridge would be lifted in place. In this manner, NYSDOT and NYSTA could avoid an 18- to 24-month closure of South Broadway.

The Replacement of the South Broadway Bridge at the Same Location Alternative would avoid use of the 21 Cornelison Avenue property. However, the northward shift of the Interstate 87/287 right-of-way, including the shared-use path and a noise wall, would move the transportation infrastructure much closer to the house on this property and would violate legal light and air requirements for residential structures. NYSDOT and NYSTA could acquire the property and maintain the structure, but it could not be legally inhabited upon completion of the project.

Furthermore, the Replacement of the South Broadway Bridge at the Same Location Alternative would lengthen the South Broadway Bridge at its current location within its existing right-of-way. During the 12-month or longer reconstruction of South Broadway, the bridge would be closed to traffic over Interstate 87/287, and vehicles would be diverted to either Route 9W or Piermont and River Roads. The modified grade of the new South Broadway Bridge would also require a new 10-foot-tall retaining wall in front of the South Nyack Village Hall.

The Replacement of the South Broadway Bridge at the Same Location Alternative is feasible but is not prudent. The closure of South Broadway longer than a year would substantially impair travel in South Nyack, as it would divert to either Route 9W or River Road to traverse above or below Interstate 87/287. This diversion would inconvenience motorists and increase travel times, vehicle emissions, and noise. It would also substantially impair emergency response for the Village of South Nyack. Upon completion, the bridge's retaining wall would block the South Nyack Village Hall, which fronts South Broadway, and the residence at 21 Cornelison Avenue may not be legally inhabitable due to light and air considerations. All of these adverse impacts would be avoided with the Replacement Bridge Alternative. Therefore, the replacement of the South Broadway Bridge at the Same Location Alternative would result in severe social, economic, and environmental impacts and is not prudent.

23-4-3-3 LEAST HARM ALTERNATIVES

The No Build Alternative, Southerly Alignment in Rockland County, and Replacement of the South Broadway Bridge at the Same Location Alternatives would avoid a use of the South Nyack Historic District, but these alternatives are not prudent. This section identifies an alternative that would not fully avoid the use of Section 4(f) properties but may result in less harm to the South Nyack Historic District.

Reconstruct South Broadway Bridge to the West Alternative

Reconstruction of the South Broadway Bridge to the west would avoid use of the 21 Cornelison Avenue property. However, the property at 78 Smith Avenue would still be incorporated into NYSTA right-of-way.

The Reconstruct South Broadway Bridge to the West Alternative would require a more extensive and permanent use of Elizabeth Place Park and would not avoid a

transportation use within the South Nyack Historic District. The abutment of the new bridge would impact the eastbound ramp from South Broadway to Interstate 87/287 (Interchange 10). This ramp could be reconfigured, but this would require additional property acquisition within the South Nyack Historic District. If property could not be acquired, the ramp would be permanently closed; which would substantially inhibit traffic flow and access in eastern Rockland County.

To provide adequate clearance over Interstate 87/287, the north abutment of the new South Broadway Bridge would be taller than it currently is. The higher elevation and would require retaining walls. These walls would block views from and of properties within the South Nyack Historic District, including the South Nyack Village Hall. In addition, access to some properties would need to be modified or eliminated to accommodate the new grade of South Broadway.

The Reconstruct South Broadway Bridge to the West Alternative would require the closure of South Broadway for a year during construction, thereby diverting traffic to Route 9W or River Road. Such a diversion would increase travel time for the general public and would substantially impair emergency response for the Village of South Nyack.

While it would avoid a use of 21 Cornelison Avenue, the Reconstruct South Broadway Bridge to the West Alternative is not considered the “least harm” alternative for the following reasons:

- The Reconstruct South Broadway Bridge to the West Alternative would result in a permanent use of Elizabeth Place Park. At the same time, it would not avoid the use of 78 Smith Avenue and the existing Tappan Zee Bridge. Therefore, the Reconstruct South Broadway Bridge to the West Alternative results in the same number of impacts to Section 4(f) properties as the Replacement Bridge Alternative.
- Measures to mitigate the adverse effect of the Replacement Bridge Alternative on the South Nyack Historic District could be implemented for the Reconstruction South Broadway Bridge to the West Alternative. However, additional mitigation measures would be required for the Reconstruction South Broadway Bridge to the West Alternative’s permanent use of Elizabeth Place Park.
- The property at 21 Cornelison Avenue is one of 130 contributing resources within the South Nyack Historic District. While its loss would be adverse, the district would retain multiple other homes that contribute to its historic character. On the other hand, the permanent loss of a portion of Elizabeth Place Park would reduce open space within South Nyack, an area with limited open space resources.
- The Replacement Bridge Alternative and the Reconstruct South Broadway Bridge to the West Alternative would both address the structural, operational, safety, security and mobility needs of the existing Tappan Zee Hudson River Crossing. However, the Reconstruct South Broadway Bridge to the West Alternative may require the permanent closure of the eastbound ramp from South Broadway to Interstate 87/287 (Interchange 10)., which would be inconsistent with the Project’s objective to “minimize effects on existing highways” and would not achieve the same mobility benefits of the Replacement Bridge Alternative.

- The Reconstruct South Broadway Bridge to the West Alternative would require mitigation for the permanent loss of a portion of Elizabeth Place Park and for traffic impacts associated with the possible closure of the eastbound ramp from South Broadway to Interstate 87/287 (Interchange 10). The Reconstruct South Broadway Bridge to the West Alternative would also require all of the same measures proposed to mitigate the impacts of the Replacement Bridge Alternative. Therefore, the Reconstruct South Broadway Bridge to the West Alternative would require more extensive mitigation for its impacts than would the Replacement Bridge Alternative.

For the above reasons, the Replacement Bridge Alternative is considered the "Least Harm" Alternative for the use of the South Nyack Historic District.

23-4-3-4 MEASURES TO MINIMIZE HARM

Measures to mitigate the use of the South Nyack Historic District are described in the draft Section 106 Memorandum of Agreement (see **Appendix C**). These measures are as follows:

- Plantings along sound walls on the western edge of the district to provide screening;
- Historic American Building Survey recordation to document 21 Cornelison Avenue and 78 Smith Avenue, the two contributing resources that would be removed; and
- Creation of signage interpreting the history and architecture of the South Nyack Historic District for installation within the South Nyack Historic District or along the Replacement Bridge Alternative's shared-use path.

23-5 COORDINATION

In accordance with the Safe, Accountable, Flexible, Efficient Transportation Equity Act—A Legacy for Users (SAFETEA-LU), FHWA is identified as the lead federal agency for the federal environmental review process, and NYSDOT and NYSTA are identified as the joint lead agencies. As described in this EIS, permits would also be required from federal agencies, including the U.S. Army Corps of Engineers and the U.S. Coast Guard. The Replacement Bridge Alternative would also require permits and approvals from NYSDEC, the New York State Department of State, and SHPO.

Review of this Section 4(f) Evaluation includes FHWA, NYSDOT, NYSTA, DOI, and SHPO. As described in Chapter 3, "Process, Agency Coordination, and Public Participation," FHWA, NYSDOT, and NYSTA have initiated an extensive public outreach program. As part of these efforts, a formal consultation process under Section 106 of the NHPA was initiated. FHWA contacted Native American tribes and groups who may attach religious and cultural interest in sites within the Tappan Zee Hudson River crossing's area of potential effect. NYSDOT and NYSTA have contacted municipalities, preservation groups, and individuals with an interest in the project and the Section 106 process as well as property owners of historic sites within the area of potential effect. Through consultation with these groups, FHWA, NYSDOT, and NYSTA have developed measures to minimize harm to the Section 4(f) properties to be used for implementation of the Replacement Bridge Alternative. These measures are described above and are also contained in the project's draft Section 106 Memorandum of Agreement (see **Appendix C**).

During the public review of the Draft Section 4(f) Evaluation, FHWA, NYSDOT, and NYSTA will meet with the Village of South Nyack to discuss the project's temporary impacts on Elizabeth Place Park. FHWA will provide the Village with any public comments on the proposed use of Elizabeth Place Park and will seek the Village's concurrence with its proposed *de minimis* impact finding.