Section 2: Alternatives Development and Evaluation

2-1 INTRODUCTION

This section of the Scoping Information Packet describes the alternatives to be evaluated in the Environmental Impact Statement (EIS) for the Tappan Zee Hudson River Crossing Project. The development and evaluation of project alternatives is central to the National Environmental Policy Act (NEPA) process. Four alternatives (see **Figure 2-1**) have been considered for the Tappan Zee Hudson River crossing as follows:

- ***No Build Alternative.*** 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;
- ***Rehabilitation Alternative.*** The Rehabilitation Alternative would upgrade elements of the existing bridge to meet current design standards and improve the bridge's safety and mobility;
- ***Tunnel Alternative.*** The Tunnel Alternative would replace the existing Tappan Zee Bridge with a new tunnel between Rockland and Westchester Counties; and
- ***Replacement Bridge Alternative.*** The Replacement Bridge Alternative would replace the existing Tappan Zee Bridge with a new *structure or structures* near its existing location.

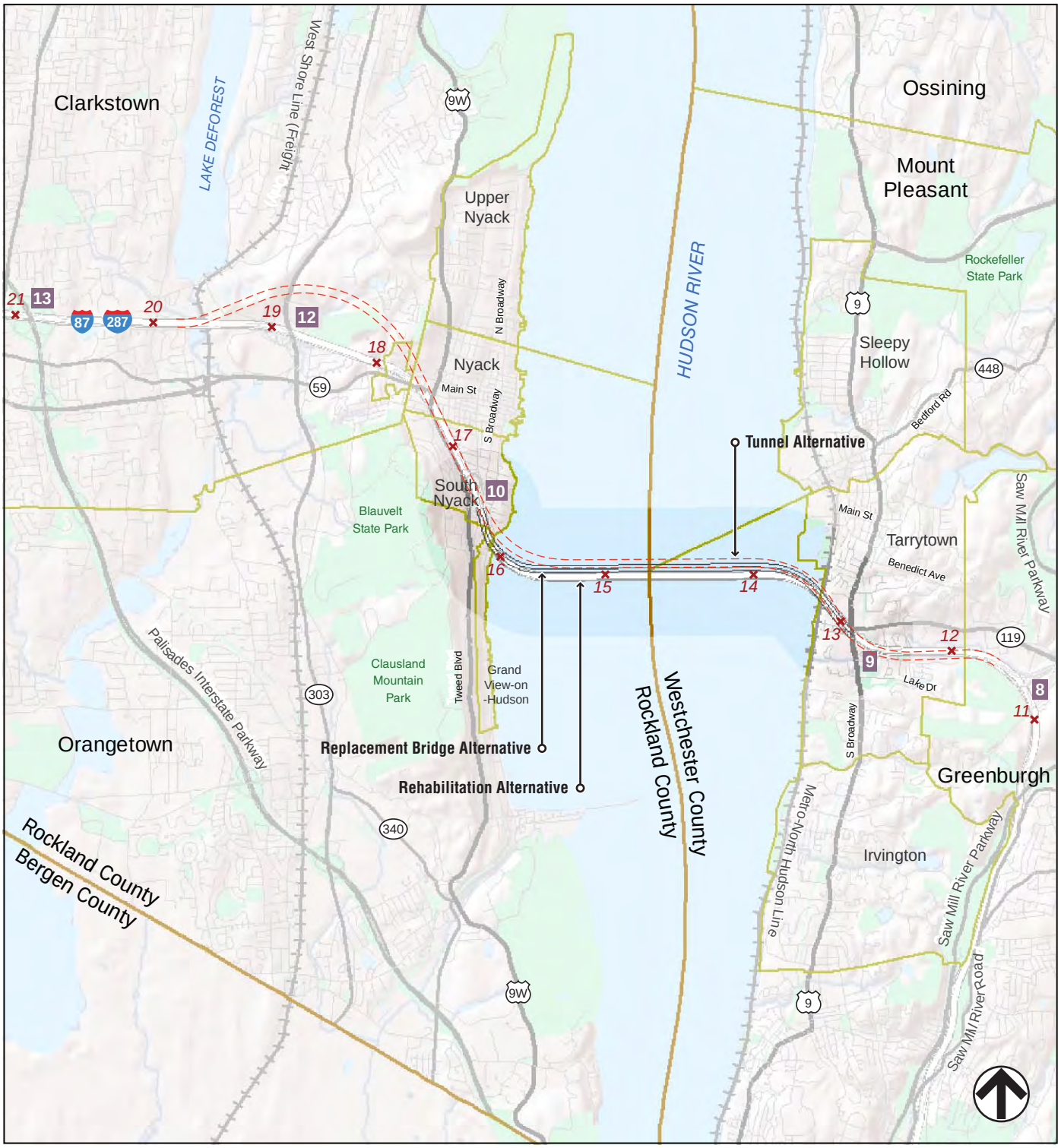
Previous studies prepared in connection with the Tappan Zee Bridge/I-287 Corridor Project concluded that the Rehabilitation and Tunnel Alternatives are not prudent because of their costs and construction risks compared to a replacement bridge. These past decisions have been reviewed in the context of the current project, and it is determined that the previous conclusions remain valid. Therefore, the EIS will not consider a Rehabilitation or Tunnel Alternative.

Previous studies identified a number of feasible options for a replacement bridge. As the Replacement Bridge Alternative is considered a viable and a prudent option, it is recommended to carry forward for detailed evaluation in the EIS. Consistent with NEPA requirements, the No Build Alternative will be carried forward to the EIS. The No Build Alternative will also serve as a baseline to evaluate the benefits and potential impacts of the Replacement Bridge Alternative.

2-2 ALTERNATIVES CONSIDERED AND ELIMINATED

2-2-1 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



TAPPAN ZEE HUDSON RIVER CROSSING
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Figure 2-1
Alignments of Project Alternatives

integrity and operation of the existing Tappan Zee Bridge. These ranged from an option that would simply upgrade the structural elements of the existing bridge with no increase in the number of lanes to options that included both upgrades to the superstructure of the bridge and construction of a new, parallel bridge that in combination with the existing bridge would address traffic operations on this river crossing.

The Alternatives Analysis for Rehabilitation and Replacement of the Tappan Zee Bridge Report (March 2009) was part of the Scoping Summary Report for the Tappan Zee Bridge/I-287 Corridor Project. It was widely distributed and the subject of intensive public and agency review and comment.

The report concluded that the Rehabilitation Alternative would not be prudent and should be eliminated from further consideration. The Rehabilitation Alternative would replace much of the existing structure—up to 80 percent of it in certain cases, and therefore, would cost nearly the same as an entirely new bridge. While the Rehabilitation Alternative would meet most current design standards, it would not achieve the same engineering performance as a replacement bridge nor would it meet all the project goals outlined in Section 1, as 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 Rehabilitation Alternative options that have a single structure would lack service redundancy. If the bridge were heavily damaged by a natural or man-made event, it could need to 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 concerns. Its closure would severely affect the traffic operations 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 in rehabilitation projects as 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 with two bridges would be more costly than an entirely new bridge and have the same deficiencies described above in terms of life cycle and vulnerabilities.

Given these considerations, the Rehabilitation Alternative would not meet the project's purpose and need, and it will not be considered in the EIS.

2-2-2 TUNNEL ALTERNATIVE

A new bored or immersed tunnel between Rockland and Westchester Counties was previously studied. The Tunnel Alternative would consist of five separate tubes with two lanes each or an immersed tunnel with two chambers. To provide for a maximum desired highway grade and to accommodate the topography of the affected area, the bored tunnel would stretch seven miles from Interchange 12 (NY 303/Palisades Center Drive) in Rockland County to east of Interchange 9 (Route 9) in Westchester County. In contrast, the immersed tunnel would be shallower and would come to surface closer to the shoreline. However, it would require extensive shoreline and in-water work.

Compared to the Rehabilitation and Replacement Alternatives, the Tunnel Alternative would take longer to construct *(estimated at up to 7 to 8 years as compared to 4½ to 5½ years)* at a higher cost *($8 billion as compared to $4.6 billion)*. The Tunnel Alternative would require acquisition of substantial right-of-way for its approach structures, portals, and ventilation structures. The tunnel's construction would impact the Talleyrand Swamp and the Rockland and Westchester County shoreline of the Hudson River where its ventilation structures would be sited. In the permanent condition, Interchanges 9 (Route 9), 10 (Route 9W), and 11 (Route 9W/NY 59) would be removed and connectivity in eastern Rockland County and western Westchester County would be considerably impaired.

The Tunnel Alternative would offer less operational flexibility than a bridge. Traffic would be separated into two or five tubes, resulting in less flexibility to maintain traffic flow through the tunnel and difficult traffic control at the portals. The tunnel would have a 3 percent grade over a long distance, making speed control difficult for trucks. The separation of highway operations into separated tubes or chambers over a long distance would make emergency response much more challenging than for a bridge. For these reasons, the Tunnel Alternative would be less effective than a bridge at meeting the project goal of "improving transportation operations and safety on the crossing."

While the Tunnel Alternative would meet some of the goals and objectives of the project, it would fail to meet the goal of "maximizing the public investment in a new Hudson River crossing" for the following reasons:

- The Tunnel Alternative would require higher construction costs and a longer duration of construction activities than a replacement bridge. As such, this alternative would not be cost-effective or yield maximum benefit in relation to its financial investment.
- The Tunnel Alternative would result in greater disruption to surrounding land uses than a replacement bridge, as extensive construction would be required outside of the existing New York State Thruway right-of-way, thereby requiring greater land acquisition.
- The Tunnel Alternative would not provide an opportunity to implement a shared-use pathway for cyclists and pedestrians.

Given these considerations, the Tunnel Alternative would not meet the project's goal to maximize the public investment in this Hudson River crossing. Thus, the Tunnel Alternative will not be considered in the EIS.

2-3 ALTERNATIVES RECOMMENDED FOR STUDY IN THE ENVIRONMENTAL IMPACT STATEMENT

As described above, the Rehabilitation and Tunnel Alternatives are not recommended for further study in the EIS. The following describes the No Build and Replacement Bridge Alternatives, which will be studied in the EIS.

2-3-1 NO BUILD ALTERNATIVE

The No Build Alternative would retain the existing Tappan Zee Bridge in its current configuration with ongoing maintenance, as practicable, to ensure its continued safe use by the traveling public. However, given the age of the bridge and its vulnerabilities in extreme events, it is possible that the crossing could be closed altogether at some point in the future. Although the No Build Alternative does not meet the project's purpose and need, NEPA requires it be evaluated in the EIS. The No Build Alternative also serves as the baseline condition against which the potential benefits and impacts of the Replacement Bridge Alternative are evaluated.

2-3-2 REPLACEMENT BRIDGE ALTERNATIVE

The Replacement Bridge Alternative would result in a new bridge crossing of the Hudson River between Rockland and Westchester Counties. A number of design parameters have been considered to develop the location and general configuration of the Replacement Bridge Alternative to be studied in the EIS.

2-3-2-1 LOCATION

The planning for the Replacement Bridge Alternative considered a footprint that would maximize the use of existing New York State Thruway Authority (NYSTA) right-of-way while minimizing effects on existing highway infrastructure in Rockland and Westchester Counties. Replacement bridge alignments both north and south of the existing Tappan Zee Bridge were considered. It has been determined that an alignment north of the existing bridge is more prudent for the following reasons:

- There is available NYSTA right-of-way to the north of the existing highway on both sides of the Hudson River to accommodate construction of a new crossing.

Sufficient right-of-way is not available on the south side of the existing highway at the Rockland landing.

- A north alignment allows for a straight approach to the Westchester toll plaza. A south alignment would result in a conflict between the new crossing's horizontal curvature and the approach to the toll plaza, which would not meet design and safety standards.
- Construction storage and staging areas are available north of the existing bridge on both sides of the Hudson River. Staging for a southern alignment *would* require temporary or permanent acquisition of property.

Therefore, the EIS will study a Replacement Bridge Alternative located to the north of the existing Tappan Zee Bridge.

2-3-2-2 GENERAL CONFIGURATION

Section 1, "Purpose and Need," identified structural, safety, operational, and mobility deficiencies of the existing Tappan Zee Bridge. Design parameters have been developed to identify a general configuration for a Replacement Bridge Alternative that would correct the deficiencies of the existing crossing.

Redundancy

Redundancy is a key consideration for the structural integrity and operational flexibility of a replacement bridge.

Structural redundancy (member redundancy, load path redundancy, and hardening and dispersion) would provide the bridge with the strength to withstand extreme events such as earthquakes, hurricanes, vessel collision, and fires. It would be achieved through a design that would include vertical and horizontal bridge elements that complement and support each other. In this way, the bridge would maintain its structural redundancy throughout the structure even if a single member should fail. Structural redundancy would be achieved through a new bridge that meets current seismic and safety design standards.

Service redundancy would provide the bridge with the ability to maintain traffic flow during both routine maintenance and extreme events. As described in Section 1, "Purpose and Need," the Tappan Zee Hudson River crossing is a vital link between Rockland and Westchester Counties for 138,000 vehicles per day and is the only interstate crossing for a 48-mile stretch of the Hudson River. A full closure of the bridge would result in major disruption to traffic, long detours, and potentially an hour or more increase in travel time. To that end, the Replacement Bridge Alternative must include provisions to ensure that the crossing is not subject to full closure to the maximum extent feasible.

Twin bridge structures would provide superior *service* redundancy as compared to a single structure. In the event that an incident or extreme event would require the closure of one *structure*, the second *structure* could remain open to traffic. At the same time, this redundancy would provide for flexibility in bridge maintenance. With a single bridge, NYSTA must carefully plan and stage maintenance activities to avoid major disruptions to traffic. As a result, repairs often take longer, cost more, and must be more limited in scope than if a temporary closure could be implemented. With two structures, NYSTA

would have much greater flexibility in planning for the bridge's long-term maintenance as well as future contract work and therefore would ensure the structural and operational integrity of this vital link over a longer timeframe.

For these reasons, the EIS will consider a Replacement Bridge Alternative that includes two separate *structures* across the Hudson River.

Minimum Width

NYSTA would maintain traffic flow across the Hudson River to the maximum extent feasible, even if one of the two bridge *structures* must be closed. To provide adequate capacity for such short-term traffic operations, a minimum of seven highway lanes would be needed across the river. In order to accommodate this service redundancy, *the Scoping Information Packet noted that based on preliminary analysis* the road deck would need a minimum width of 82 feet to provide for seven, temporary highway lanes in the event that one structure would be inoperable. *However, as the engineering design has advanced, it was determined that a minimum of 87 feet would be required to provide adequate lane and shoulder widths to safely accommodate two-way traffic flow.* This minimum dimension would be provided on both of the new *structures* to achieve this desired feature of the new crossing.

At present, bicycles and pedestrians are prohibited on the Tappan Zee Hudson River crossing although there are existing multi-use trails near the bridge on both sides of the river. To maximize the public investment in a new crossing, the New York State Department of Transportation (NYSDOT) and NYSTA would provide a shared-use (bicycle/pedestrian) path across one of the *structures* of the replacement bridge. To meet current design standards for the path and to provide adequate separation from traffic lanes, the Replacement Bridge Alternative must provide a minimum of 12 feet of additional width for the shared-use path (including the path, barrier, and a safety buffer); however, 14 feet is currently planned.

To meet these operational requirements, the EIS will consider a Replacement Bridge Alternative with two *structures*. The *structure* that includes a shared-use path would be 96 feet wide, and the *structure* that does not include the shared-use path would be *87* feet wide.

Gap

To provide adequate clearance to inspect and maintain the superstructure of each of the two new bridge structures, a gap is needed between them. NYSDOT *prefers* a minimum 16-foot gap between parallel bridge structures.

The gap between the two structures would affect the manner in which potential future transit modes could be provided in the corridor. As described in the Section 1, "Purpose and Need," one of the project's objectives is to provide a crossing that "does not preclude future trans-Hudson transit services" in the corridor. There are three options that would not preclude future transit on this corridor:

1) *Allow for the incorporation of future transit* infrastructure on the new highway *structures* without reducing the number of general traffic lanes;

2) Provide for future transit across a third parallel bridge that would be constructed at a later date and would serve as an exclusive right-of-way; or

3) *Provide additional structural support within the new highway structures, as well as a gap between the new highway structures, to allow for future transit modes to operate on a new deck that would span the gap at a later date.*

The implementation of any of these options for future transit modes would require a separate and independent environmental review process when *and if* a proposal for transit services is *foreseeable and financing is available*.

Option 1 would allow for exclusive bus lanes within the left shoulders of the replacement bridge, but infrastructure to support the upland connections to these bus lanes would need to be constructed in Rockland and Westchester Counties.

Option 2 could provide for a new exclusive or combined bus or commuter rail bridge across the Hudson River. However, Option 2 would be costly ($2 billion to $3 billion) and would result in work in the Hudson River (i.e., dredging and pile driving) for additional foundations to support piers for the new structure, which could be avoided with implementation of either Option 1 or Option 3.

Option 3 would allow for either or both bus and commuter rail service across the Hudson River; however, additional strengthening of the new bridge would be required to support the additional loads from any potential transit service within the gap between the new structures. The additional current cost for strengthening the replacement bridge under Option 3, to allow for any future transit service within the gap between structures, would be approximately $200 to $300 million. Should implementation of transit occur in the future, an additional approximately $500 to $700 million (in 2012 dollars) would be required to implement the future transit infrastructure across the bridge. In total, the cost for transit service within the gap would be $700 million to $1 billion. In comparison, a new, exclusive transit bridge across the river (i.e., Option 2) would cost between $2 billion and $3 billion. In short, Option 3 would save between $1 billion and $2 billion as compared to Option 2.

Consistent with and in furtherance of the project's goal to "maximize the public investment in a new trans-Hudson crossing," planning for additional strengthening and a gap between the two new structures to facilitate Option 3 for transit service is considered prudent at this time. Therefore, a 40-foot gap would be provided between the highway structures at the main span towers. The gap would narrow as it approaches the Rockland County landing, but the transit structure and its connections could be provided at a lower elevation (i.e., below the highway deck) at this location.

It should be noted that any option for future transit service would require an additional funds as well as land for construction of upland transit infrastructure (i.e., right-of-way, stations, parking, and ancillary facilities). A bus rapid transit service along this corridor between Suffern and Port Chester would cost an additional $4 to $5 billion (in 2012 dollars). The additional cost of commuter rail service between Suffren and the Metro North Hudson Line in Tarrytown would cost approximately $7.5 billion (in 2012 dollars). The combined cost for both commuter rail and bus rapid transit services would

*be approximately $10.1 billion (in 2012 dollars) (see **Appendix A** for further information regarding the cost of transit options).*

Summary

The design parameters described above identify the location and general characteristics of the Replacement Bridge Alternative. In summary, the Replacement Bridge Alternative would:

- *Be located to the north of the existing Tappan Zee Bridge;*
- *Include two separate structures to provide service redundancy;*
- *Have a 96-foot-wide deck for the north structure that includes a shared-use path;*
- *Have a 87-foot-wide deck for the south structure that does not include a shared-use path;*
- *Have a gap between the two bridge structures; and*
- *Provide additional strengthening as not to preclude transit and maximize the public investment.*

These design parameters have been incorporated into the following description of the Replacement Bridge Alternative.

2-3-2-3 SHORT SPAN BRIDGE VS. LONG SPAN BRIDGE

With consideration of the general configuration as described above, there are two options for the Replacement Bridge *Alternative's approach structures* that would meet the structural and operational requirements of a new crossing. These options differ in *terms of the type of structure, as well as the number of and distance between bridge piers*. These options—Short Span and Long Span—are described below.

- The Replacement Bridge Alternative—Short Span Option would be two single-level structures separated by a *40*-foot gap at their main spans. Under typical operation, each structure would have four traffic lanes, *extra-wide inside shoulders to facilitate emergency vehicle access, and an outside shoulder*. The north bridge structure would serve westbound traffic, and the south bridge structure would serve eastbound traffic. A bicycle/pedestrian path would be provided on the north bridge structure. The north bridge structure would be *96* feet wide and the south bridge structure would be *87* feet wide.

  The Short Span option would not preclude future transit service across the Tappan Zee Hudson River crossing.

- The Replacement Bridge Alternative—Long Span Option would be two new truss bridges with two levels each. The dual structures would be separated by a minimum gap of approximately *40* feet at the main span. The northernmost structure would be 96 feet wide. Under normal operations, it would support four westbound lanes and a shared-use (bicycle and pedestrian) path on the upper level. The southernmost structure would be *87* feet wide, and under normal operations, it would support four

eastbound lanes. Both structures would include *an extra-wide inside shoulder* to facilitate emergency access *as well as an outside shoulder*.

The Long Span option would not preclude future transit service across the Tappan Zee Hudson River crossing.

The Short Span and Long Span options each have advantages and disadvantages in terms of engineering, cost, and environmental considerations. The Short Span option is less expensive than the Long Span option. However, it results in more piers in the Hudson River, and therefore, has greater potential for adverse effects on the river. While both options would achieve the desired structural and *service* redundancies, the Long Span option would have greater structural strength since it is a dual level bridge. In order to carefully consider their relative advantages and disadvantages of the Short Span and Long Span bridge designs, the EIS will consider both of these options for the Replacement Bridge Alternative.

Main Spans

The main spans, which are the portions of the bridge that cross the navigable channel of the Hudson River, would provide adequate vertical and horizontal clearance for marine transport.

- *The horizontal clearance affects the width of the Hudson River's navigable channel for water craft and must be clear of bridge piers and other bridge infrastructure. The U.S. Coast Guard requires a minimum horizontal clearance of 600 feet through the Tappan Zee crossing. However, a clearance of 1,042 feet is preferred to provide a safety buffer for maritime navigation through the channel.*
- *The vertical clearance affects the height of the bridge as well as the hull-to-mast height of marine vessels that navigate under the bridge. The Replacement Bridge Alternative would provide for a minimum vertical clearance of 139 feet at mean high water to maintain the existing maximum hull-to-mast height of vessels that travel beneath the Tappan Zee crossing.*

This EIS will consides 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 1,042 feet and a vertical clearance of at least 139 feet over the navigable channel at mean high water. Neither main span option would preclude future transit service across the Tappan Zee Hudson River Crossing.

2-3-2-4 CONCLUSION

The EIS will consider two options for the Replacement Bridge Alternative's approach spans—Short Span and Long Span—and two options for the Replacement Bridge Alternative's main spans—Arch and Cable-stayed.