Potential Options to Maintain or Replace the Structure

As part of its due diligence process, the Panel directed NYC DOT and its consultants to develop a series of potential rehabilitation and replacement options that could extend the service life of the BQE. Although the Panel ultimately decided to recommend a different approach, the review of potential concepts informed the Panel's recommendation to conduct urgent repairs until all stakeholders can finalize a corridor-wide solution. The panel's recommendation, as well as the other potential options it reviewed, are described in more detail below.

Panel Recommendation: Conduct Urgent Repairs With Extended Closures

Based on current conditions along the BQE, NYC DOT will need to address the following conditions within the next ten years:

- The retaining wall of the BQE extending from the vicinity of Willow Street to Hicks Street has large portions of exposed and corroding rebar, as well as spalled concrete.
- The abutment at Joralemon Street has exposed piles with deteriorated concrete and corroded rebar that will require stabilization.
- Several expansion joints have large portions of spalled concrete and exposed rebar and have been covered with a mesh to prevent concrete from falling on traffic below.
- A minimum of two Queens-bound cantilever decks and 12 Staten Island-bound cantilever decks have reduced load carrying capacity and are expected to require strengthening.
- Three bridges – the Columbia Heights Bridge, Joralemon Bridge, and Old Fulton/Cadman Plaza Bridge – need to be replaced regardless of deck construction method.
- The structure above the Clark Street transit facility has substantial steel corrosion and concrete degradation. This area has been flagged by NYSDOT in its annual inspections.
- Areas of undermining and cracks in the substructure may result in additional repairs.

As the monitoring program continues, additional areas of concern may arise and could be included in the repair plan. This repair work will not be easy; in order to maintain traffic operations, NYC DOT can only rehabilitate sections of the road deck in 5' strips along the length of the corridor. This method is necessary to maintain the stability of the entire structure during construction.

The length of time that NYC DOT is able to close the BQE fully to traffic will have a substantial effect on the cost and quality of the repairs. The strength of concrete, in particular, is dependent on its curing time. The NYC DOT team is exploring High Performance Concrete (HPC) and Ultra-High Performance Concrete (UHPC) for this work, both of which require special curing techniques for optimal results. These techniques require a curing time of at least seven days before the reintroduction of traffic and could extend the life of the repaired decks by 8 to 10 years. If NYC DOT cannot undertake multiple closures of the BQE of up to a week or more at a time, the agency will need to undertake nearly continuous nighttime construction for several years.

NYC DOT is traditionally conservative in its allowable hours to avoid closures during rush hours, ensuring that the city's characteristically large traffic volumes are not forced to spill over to neighboring local streets and truck routes. The impacts of such a closure or closures will be dramatic and require a plan that carefully considers all possible detours, while acknowledging that diversions through neighboring streets are inevitable.

Extended closures also pose the benefit of cost and time savings associated with minimizing the need for time-intensive activities relating to mobilization and breakdown of equipment and materials, as well as protecting the concrete before the roadway reopens to traffic. Extended closures could also be used to facilitate and provide additional flexibility toward additional repairs identified through its monitoring program.

This potential option is referred to as M1 – Urgent repairs.

Potential Maintenance Concepts that Retain the Cantilever

The Panel's recommendation to conduct urgent repairs grew out of a review of potential options to maintain or rehabilitate the BQE in an effort to extend its service life. All of these potential options retain the characteristic cantilever structure, so any future work would encounter similar construction method and staging issues to what NYC DOT currently faces. These potential options also leave a number of project benefits on the table, such as mitigating vibrations, because they do not make substantial changes to the underlying structure. The primary difference among these potential maintenance options is how NYC DOT will repair the decks of the BQE – fixes to retaining walls and other structural supports are similar across the options and would need to include the urgent repairs described previously.

Option M2 - Cathodic protection. Passive cathodic protection involves installing sacrificial pieces of metal into the structure so that those pieces corrode instead of the supporting rebar. This technique requires the removal of any loose and deteriorated concrete and does not address existing corrosion in the structure. The potential issue with this method is NYC DOT will find more deterioration than expected during the repair work, thereby requiring additional repairs. Large-scale use of cathodic protection could provide an extra 20 years of service life to the BQE, but it carries a high risk of unanticipated maintenance and slows rather than stops corrosion. Construction would take 5-6 years and cost upwards of $1 billion.

Option M3 - Partial depth deck replacement. This method involves replacing deteriorating sections of the deck of the structure. The process is similar to fixing a cavity in a tooth; workers remove and replace damaged portions of concrete until they reach concrete that is in good condition. The problem with this method is that the unrepaired sections of the structure will continue to decay at an unknown rate, and there is always a chance that more of the concrete is damaged than initially forecast. As a result, this potential concept has the shortest service life extension, giving the structure an extra 10 to 15 years of service life after 7 to 8 years of construction and more than $1 billion in construction costs.

Option M4 - Complete deck replacement. In this method, the deck of the structure is completely replaced, leaving only the original foundations and retaining walls. The work could be accomplished either by building a temporary bypass structure over Furman Street or by creating

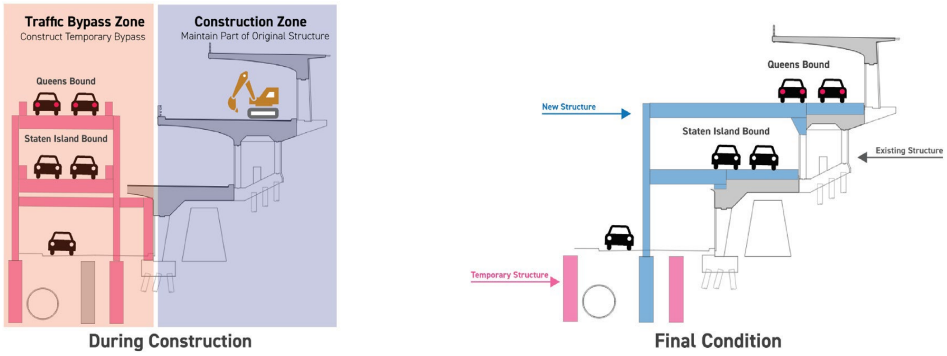
a series of on-street detours through downtown Brooklyn. While this potential concept extends the life of the structure by 40 years, the final condition is still a cantilever, leaving the next generation of New Yorkers with the same constraints facing the city today.

Potential Replacement Concepts that Create a Framed Structure

Due to the constraints of a cantilever structure, the panel also explored ways to either partially or fully replace the BQE in a way that frames the structure in a more traditional way. By adding columns along the western edge of the structure, it is possible to minimize vibrations. Another benefit of a framed structure is that future maintenance and repair activities can be conducted more easily. While the cantilever's current construction requires any work to occur across all travel lanes of a deck, a framed structure allows for the type of lane-by-lane work that is done on most bridge structures.

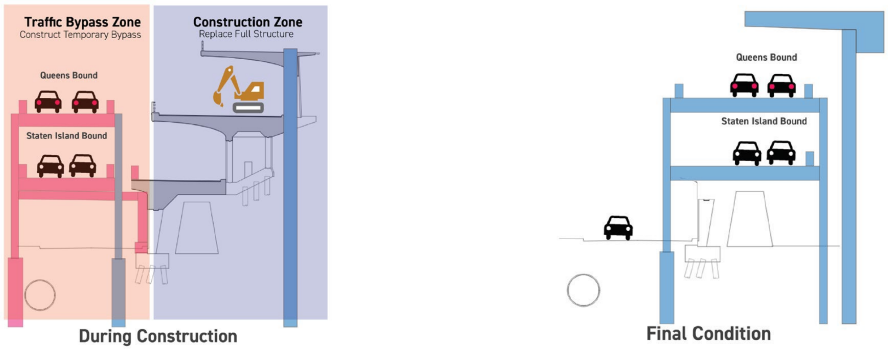
The panel explored multiple potential concepts that modify the BQE into a framed structure instead of a cantilever structure. The initial concepts had conflicts with existing infrastructure; they had a final condition that made it difficult to work on the DEP sewer interceptor and left the structure very close to 360 Furman Street. For these reasons, the panel explored additional potential options that are more complicated from a construction staging perspective but provide a better final condition. These potential concepts rely on a temporary structure to handle traffic during construction. In the final condition, they address the access issues to the interceptor and distance concerns for 360 Furman Street.

Option R1 - Partial structure replacement. In this method, construction occurs in phases so that lanes can be shifted to a two-level temporary roadway over Furman Street. New foundations to support the final structure would be built approximately along the Furman Street center line. The deck of the existing structure at all three levels (including the promenade) is replaced in sections along with repairs to the retaining walls.



Option R2 – Complete replacement with temporary bypass. This method is very similar to the partial structure replacement method. The major difference is that, instead of using the existing retaining wall, this potential option completely separates the BQE structure on a foundation that is distinct from a new retaining wall that holds up the promenade and Brooklyn Heights. With this separation, any vibrations to the surrounding buildings are minimized. Compared to the partial structure replacement method, there is a larger space left underneath the Staten Island-

bound lanes of the structure, allowing for additional open space opportunities everywhere except for at the Clark Street vent facility. It also allows for re-envisioning the roadway at a later point without affecting Brooklyn Heights or the promenade.



Both R1 and R2 are based on the assumption that the City's state and federal partners approve and implement traffic demand strategies that allow the temporary structure to carry two through lanes of traffic. The final configuration of the roadway would allow for two through lanes plus a shoulder/acceleration/deceleration lane in both directions. One thing to note is that both potential options address the staging along Furman Street only up to Columbia Avenue. The replacement of Columbia Heights Bridge along with rehabilitation of the BQE structure under Columbia Heights and farther north would still need to be accomplished using numerous weekend and overnight construction windows.

These potential options also provide opportunities for improved pedestrian and bicycle connections and new public spaces that can be developed further in the design process. Examples include:

- Incorporating greenery or open space on the Queens-bound portion of the new structure;
- Creating additional connections from the promenade to Brooklyn Bridge Park, potentially through an adaptive reuse of the temporary bypass structure; and
- Adding improvements in the open space that is created adjacent to Furman Street, particularly in the complete replacement option.

In addition, for the section of the BQE further north, there may be potential improvements to adjacent open spaces that could be explored more during planning.