GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

EVALUATION OF CROSSING SCENARIOS

MARCH 2014

Prepared for:
BC Ministry of Transportation and Infrastructure

Prepared by:
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1. Introduction and Summary

This paper evaluates five potential crossing scenarios for the George Massey Tunnel Replacement Project, as identified in the Ministry of Transportation and Infrastructure’s Consultation Discussion Guide: Planning for the Future – Phase 2: Exploring the Options (March-April 2013).

This report has been prepared by MMK Consulting (MMK) for the BC Ministry of Transportation and Infrastructure, based on research and analysis undertaken by the Ministry’s planning team. The draft report was initially completed by MMK in February 2014, with subsequent planning team review and input.

Background

Project goals

The 2013 Phase 2 Consultation Discussion Guide identified six draft project goals, including:

- **Relieve congestion** – Reduce congestion and travel times for all users.
- **Improve safety** – Improve traffic and seismic safety, as well as emergency response capabilities.
- **Support trade and commerce** – Improve access to local businesses and gateways.
- **Support objectives for regional people movement** – Increase transit ridership and protect the Highway 99 corridor for future rapid transit and provide cyclist and pedestrian access.
- **Protect the existing land base** – Minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts.
- **Involve community** – Involve communities, businesses and stakeholders in the project.

Crossing scenarios considered

The Phase 2 Consultation Discussion Guide identified five potential crossing scenarios:

- **Scenario 1 – Maintain existing Tunnel (“Maintain Tunnel”).** Scenario 1 would rehabilitate the existing Tunnel’s mechanical systems, improve its ability to withstand future earthquakes (although not to new-construction standards), and make improvements to the existing interchanges at Steveston (to the north) and Highway 17A (to the south). It would not increase the existing Tunnel’s capacity.

- **Scenario 2 – Replace existing Tunnel with new bridge (“Replacement Bridge”).** Scenario 2 would construct a new bridge along the existing right-of-way, after which the existing Tunnel would be decommissioned.
Scenario 3 – Replace existing Tunnel with new tunnel (“Replacement Tunnel”). Scenario 3 would construct a replacement tunnel along the existing right-of-way, likely upstream from the existing Tunnel, after which the existing Tunnel would be decommissioned.

Scenario 4 – Maintain existing Tunnel and build new crossing along existing Highway 99 Corridor (“Maintain Tunnel, Add In-Corridor Crossing”). The new crossing could be either a bridge (Option 4a) or tunnel (Option 4b), to provide a similar increase in capacity as Scenarios 2 and 3.

Scenario 5 – Maintain existing Tunnel and build new crossing in a new corridor (“Maintain Tunnel, Add New-Corridor Crossing”). The new crossing would be a bridge located in the Tilbury Area, between the existing Tunnel and the Alex Fraser Bridge, and accessed via the South Fraser Perimeter Road on the south side and via a newly constructed connection to Highway 91 on the north side.

Evaluation areas

The Phase 2 Consultation Discussion Guide identified 19 draft criteria, in six categories, for evaluating potential crossing scenarios:

- Efficient transportation for all users – including traffic congestion; transit capability; travel time reliability; and pedestrian and cycling accessibility.
- Safety – including incident response capability; earthquake protection; and traffic safety.
- Agriculture – including agricultural land effects; and access to/from agricultural areas.
- Environment – including local and regional air quality; wildlife and terrestrial habitat; and marine life and habitat.
- Jobs and the economy – including access to gateways and trade corridors; access to business and industrial land; and marine access for goods movement.
- Social and community considerations – including community access (including across the highway within communities); private property effects; noise effects; and visual effects.

The results of the Phase 1 and Phase 2 public consultation programs are detailed in the Consultation Summary Report, posted on the Ministry’s George Massey Tunnel Replacement Project website.

Evaluation of Scenarios

Basis for evaluations

The following evaluation of scenarios addresses all of the evaluation criteria identified in the Phase 2 Consultation Discussion Guide. In addition, capital costs and risks are important factors in comparing scenarios, and thus have also been considered in the following evaluation. A few additional technical criteria (e.g. risks of disturbing contaminated sites) have also been added to the analysis. In total, 28 individual criteria have been evaluated, within seven major categories.
Most of the evaluations have been performed on a four-point scale, based on the degree to which each scenario is assessed as potentially achieving the relevant project goals, relative to the other scenarios. Capital costs and operating and maintenance (O&M) costs have been compared on a three-point scale, since the scenarios are high-level concepts for which detailed cost information is not yet available. Further details of the basis for each of the individual ratings are contained in the following chapters.

Unless otherwise indicated, the individual assessments, and the overall comparison of scenarios, represent the combined results of (1) the preliminary planning and technical work undertaken by the Ministry and its engineering, environmental, and economic/financial advisors and (2) the public feedback and input received through the Phase 1 and Phase 2 consultation and review processes.

**Evaluation of scenarios**

The five scenarios have been compared according to 28 individual criteria within seven evaluation areas, as summarized in the table below and detailed in the balance of this report.

### Summary comparison of scenarios

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<tr>
<td>Transportation efficiency</td>
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<td>Safety</td>
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<td><strong>Overall evaluation</strong></td>
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<td><strong>Preferred</strong></td>
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Legend: ✔️ very high achievement of goals; ✔ relatively high achievement of goals; ★ relatively limited achievement of goals; ★★ low/no achievement of goals.

### Preferred scenario

Scenario 2 (Replacement Bridge) is the preferred scenario. Its overall rating is similar to or preferred to the four other scenarios in each evaluation area.

Scenario 2’s comparative ratings, for each evaluation area, are as follows:

- **Transportation efficiency** – Scenario 2’s benefits in terms of congestion relief, transit capability, and travel time reliability are similar to those of Scenarios 3 and 4, greater than those of Scenario 5, and much greater than those of Scenario 1. Scenario 2 is also preferable (along with the Scenario 4 bridge option) in terms of the potential to improve pedestrian and cyclist accessibility.

- **Safety** – Scenarios 2 and 3 are preferable in terms of both traffic safety and seismic (earthquake) safety. An all-new crossing would be designed to significantly higher standards than what is achievable through maintaining the existing Tunnel.
Agriculture – Scenario 2 is preferable to all other scenarios in improving the connectivity between agricultural areas on either side of the corridor, because of the ability to provide access underneath the bridge for agricultural traffic. Scenario 2 would require more properties to be acquired than Scenario 1, where acquisition requirements would be minimal.

Environment – Scenario 2 is preferable or similar to all other scenarios in terms of marine life, wildlife, shorelines, habitat, and regional air quality. Under Scenario 2, bridge piers can be situated outside of the river, while all other scenarios would involve significant in-river disturbance. Scenario 2 is also preferable to all other scenarios in terms of local air quality, because particulates can naturally disperse in the open air, minimizing local concentrations.

Jobs and the economy – Scenario 2’s longer-term effect on jobs and the economy is preferable to Scenario 1, and is similar to or higher than every other scenario. Scenario 2 would have the least effect on marine traffic during construction, and would make it possible to lower the water draft at the existing Tunnel.

Social and community considerations – Scenario 2 has the greatest ability to improve access across the highway between communities, because of the potential for local road connections underneath the bridge abutments on either side of the crossing. Scenario 2 also provides the capacity to serve the existing and future transportation needs of the population targets for the adjacent communities (Richmond, Delta, Tsawwassen, Surrey, White Rock) established by the Regional Growth Strategy. Scenario 2 would introduce new above-ground visual and noise effects at the existing crossing that would require mitigation.

Financial costs and risks – Based on discussions with international tunnel and bridge construction experts, Scenario 2’s capital costs are expected to be similar to those of Scenarios 3 and 4, and to be significantly lower than those of Scenario 5. While capital costs are much higher for Scenario 2 than Scenario 1, Scenario 1 does not achieve the project’s key safety and congestion relief goals, and is only a medium term option due to the existing Tunnel’s age and condition.

With regard to risks, Scenario 2 is assessed as having lower risks during both construction and operation than any other scenario, due to (1) avoiding the need to undertake seismic improvements to the existing Tunnel that would be required under Scenarios 1, 4 and 5, and (2) avoiding the significant in-river work that would be required under Scenario 3.

Further details on the comparative evaluations of individual criteria are contained in the balance of this report.
2. Transportation Efficiency

Traffic congestion

 Relevant Goal – Relieve congestion: reduce congestion and travel times for all users

The relative ability of each scenario to address current and future traffic congestion is assessed as follows:

- Scenario 1 (Maintain Tunnel) – would improve the Highway 17A and Steveston interchanges, but would not increase the current Tunnel capacity, which is the main source of congestion.

  Scenario 1 not only fails to address the traffic congestion associated with current volumes, but also raises the probability of significantly increased future congestion costs as throughput capacity falls further behind population growth. Rating: ✗✗

- Scenarios 2 (Replacement Bridge), 3 (Replacement Tunnel) and 4 (Maintain Tunnel, Add In-Corridor Crossing) – would address the current congestion levels through the existing Tunnel, by increasing the throughput capacity of the existing corridor. The new crossing could be designed (number of lanes, HOV/transit priorities, etc.) to handle future traffic demand for decades to come. Initial traffic studies estimate that under Scenarios 2 through 4, peak-hour traffic levels would be able to increase significantly more than under Scenario 1. Rating: ✗ ✓

- Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing) – would not increase capacity through the existing Tunnel, but would attract some traffic from the existing Tunnel to the new crossing. Scenario 5 would achieve most of the benefits of Scenarios 2 through 4, but to a somewhat lesser extent because of the more circuitous routing for through traffic. Rating: ✓

Summary assessment

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<tbody>
<tr>
<td>Traffic congestion</td>
<td>✗✗</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
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Legend: ✓ ✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.

1 The Highway 17 interchange became the Highway 17A interchange in December 2013, following opening of the South Fraser Perimeter Road.
2 The Regional Growth Strategy envisages population growth of 64% (1.4% annually) in adjacent communities for 2006-2041.
3 Comparisons of Scenarios 2 through 5 are based on similar levels of vehicle, transit, and pedestrian/cyclist capacity.
Transit capability

**Relevant Goals** – Regional people movement, support commerce, relieve congestion, improve safety

The relative ability of each scenario to provide transit capability is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would enable minor improvements in transit service capability, to the extent that upgrades to the Steveston and Highway 17A interchanges are able to improve transit’s priority access to the Tunnel. However, transit buses would still be required to travel on non-designated lanes through the Tunnel, merging with general traffic. As traffic grows, the benefit of existing HOV queue-jumper lanes will be diminished, increasing transit times and reducing transit’s travel time reliability relative to the automobile. Rating: ✗

- **Scenarios 2 (Replacement Bridge), 3 (Replacement Tunnel) and 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would result in the greatest improvement in transit capability. Initial conceptual work on Scenarios 2, 3 and 4 contemplates having one lane in each direction dedicated for transit/HOV use – not only for the new crossing, but also on other portions of the Highway 99 corridor. Rating: ✔️ ✔️ ✔️ ✔️ ✔️ ✔️

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would also enable improvements in transit capability along Highway 99, by diverting some passenger vehicles to the new-corridor crossing. However, dedicated transit/HOV lanes would be not be possible at the existing Tunnel, so the benefit to transit capability would be lower than for Scenarios 2 through 4. Scenario 5 would also require significant planning by TransLink to integrate the new-Corridor crossing within its existing transit service network. Rating: ✔️

**Summary assessment**

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<tbody>
<tr>
<td>Transit capability</td>
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<td>✔️ ✔️</td>
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Legend: ✔️ ✔️ very high achievement of goals; ✔️ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗ ✗ low/no achievement of goals.
Travel time reliability

**Relevant Goals** – Regional people movement, support commerce, relieve congestion

Travel time reliability is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would involve limited improvements to the Highway 17A and Steveston interchanges, resulting in some travel time reliability improvements, particularly for local traffic that is not travelling through the Tunnel. However, the variability of waiting times to access the Tunnel would not be significantly reduced. Rating: ✗✗

- **Scenarios 2 (Replacement Bridge), 3 (Replacement Tunnel) and 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would result in the greatest improvement in travel time reliability, because of the congestion relief achieved at the crossing and along the Highway 99 corridor. Rating: ✓✓

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would also result in significant improvements in travel time reliability, especially for drivers whose origins/destinations would make it more convenient to use the new corridor as an alternative to the Highway 91 and/or Highway 99 corridors. Rating: ✓✓

**Summary assessment**

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<tr>
<td>Travel time reliability</td>
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<td>✓✓</td>
<td>✓✓</td>
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<td>✓✓</td>
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</table>

Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Pedestrian and cyclist accessibility

Relevant Goal – Regional people movement

Pedestrian and cyclist accessibility is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would require continuation of the existing shuttle service through the existing Tunnel. Scenario 1 would not address the expectation of many members of the public of pedestrian/cyclist access being introduced on the existing corridor. Rating: ✗✗

- **Scenario 2 (Replacement Bridge)** – would provide above-ground pedestrian and/or cycling paths on the replacement bridge. The grade would be similar to the Alex Fraser Bridge, and the walking/cycling experience would be preferable to Scenario 3. Rating: ✓✓

- **Scenario 3 (Replacement Tunnel)** – would provide below-ground pedestrian and/or cycling paths, as part of the new tunnel. The below-ground pedestrian/cyclist tunnel route would provide a less desirable walking/cycling experience (noise, visual, air quality, etc.) than above-ground facilities because of the confined environment. Rating: ✓

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would provide new pedestrian and/or cycling paths on the new crossing. Option 4a (bridge) is assessed as for Scenario 2, while Option 4b (tunnel) is assessed as for Scenario 3. Rating (bridge option): ✓✓

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would provide a new pedestrian and/or cyclist crossing along the new corridor, a more circuitous route for most pedestrian/bicycle traffic. If the current shuttle service in the existing Tunnel was discontinued upon opening of the new crossing, some current shuttle service users would be negatively affected; and even if the current shuttle service was maintained, some stakeholders’ expectations of pedestrian/cyclist access through the existing Tunnel would not be realized. Rating: ✗

**Summary assessment**

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<th>Pedestrian and cyclist accessibility</th>
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<td>✗✗</td>
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<td>✗</td>
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Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
3. Safety

Incident response capability

Relevant Goal – Improve safety

Incident response capability is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would enable limited improvements to same-side incident response capability, through the upgrading of the Steveston and Highway 17A interchanges for emergency vehicle access. These upgrades could also incorporate some improvements in emergency vehicles’ priority access to the Tunnel. However, these gains would be minor relative to those associated with Scenarios 2 through 5. Rating: ✻ ✻

- **Scenario 2 (Replacement Bridge)** – would achieve much greater gains in incident response capability, by improving emergency vehicle access in emergency situations (congestion relief, additional lanes, emergency vehicle turnarounds, etc.). Scenario 2 was strongly preferred by the emergency responders participating in the Phase 2 consultation process. Rating: ✚ ✚

- **Scenarios 3 (Replacement Tunnel) and 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would be similar to Scenario 2 in terms of incident response capability on either side of the crossing. For incidents occurring on the crossing (e.g., car fires), the tunnel-based operations associated with Scenarios 3 and 4 would generally involve greater incident response challenges than Scenario 2. Rating: ✚

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would be less effective than Scenarios 2 through 4 in increasing incident response capability along the existing corridor, because of the inability to improve emergency vehicle access through the existing Tunnel. However, Scenario 5 would provide a new alternate routing for emergency vehicles, which would be a significant improvement over Scenario 1 in responding to many types of incidents. Rating: ✚

### Summary assessment

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<tr>
<td>Incident response capability</td>
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<td>✚ ✚</td>
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Legend: ✚ ✚ very high achievement of goals; ✚ relatively high achievement of goals; ✻ relatively limited achievement of goals; ✻ ✻ low/no achievement of goals.
Earthquake protection

*Relevant Goal – Improve safety*

Earthquake protection is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would involve a significant capital program to upgrade the geotechnical stability of the existing Tunnel during seismic events. (The Tunnel’s structural stability has been upgraded in previous work undertaken in 2006, but not to the same standard as for new construction.)

  Geotechnical studies have identified risks in attempting to improve the existing Tunnel’s geotechnical stability, including risk of destabilizing the existing tunnel-bed. In addition, quantifying the gains in earthquake risk reduction would be difficult to estimate with confidence.

  Based on discussions with engineering experts, the best-case scenario is that the earthquake risk could be reduced from the current 1-in-275-years⁴, to about 1-in-475-years. (This would still fall far short of the engineering standard for new construction, which is 1-in-2,475-years.) Rating: ✹✹

- **Scenarios 2 (Replacement Bridge) and 3 (Replacement Tunnel)** – would be preferable to Scenario 1 in terms of earthquake protection levels, since the new infrastructure would be engineered to current standards.

  There would also be some risk of destabilizing the existing Tunnel during construction – especially for Scenario 3, where a new tunnel would be built into the riverbed, likely just upstream from the existing Tunnel.

  While Scenarios 2 and 3 would be engineered to equally high levels of earthquake resistance, the Phase 2 public consultation process found that the perceived earthquake risk for some members of the public is lower for Scenario 2 than for Scenario 3. Rating: ✹✹

- **Scenarios 4 (Maintain Tunnel, Add In-Corridor Crossing) and 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would have higher levels of earthquake risk reduction for the new crossing (1-in-2,475-years), and would provide an alternate routing in the case of failure of the existing Tunnel. However, even in the best-case scenario, Scenarios 4 and 5 would not be capable of improving the existing Tunnel’s earthquake risk beyond 1-in-475-years. Rating: ✹

**Summary assessment**

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<td>Earthquake protection</td>
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Legend: ✹✹ very high achievement of goals; ✹ relatively high achievement of goals; ✹ low/no achievement of goals.

⁴ A 1-in-275-year risk, for example, means that in any given year there is 1 chance in 275 that an earthquake will occur that is of sufficient intensity and proximity to cause major damage to the Tunnel.
Traffic safety

Relevant Goal – Improve safety

Traffic safety is assessed as follows:

► Scenario 1 (Maintain Tunnel) – would have the lowest level of traffic safety. While improvements would be made, particularly at the Highway 17A and Steveston interchanges, the Tunnel portion of the corridor would still reflect the lower design standards (clearances, lane widths, etc.) of the 1950s. In addition, a review of traffic accident data indicates that rear-end collisions are particularly frequent for northbound traffic approaching the Tunnel, due in part to drivers encountering Tunnel-related traffic congestion after having driven several kilometers at freeway speeds. Rating: ✗✗

► Scenarios 2 (Replacement Bridge) and 3 (Replacement Tunnel) – would be designed to modern-day traffic safety standards, and would address the current safety issues associated with current congestion levels at the existing Tunnel. Rating: ✓✓

► Scenarios 4 (Maintain Tunnel, Add In-Corridor Crossing) and 5 (Maintain Tunnel, Add New-Corridor Crossing) – would be designed to modern-day traffic safety standards for the newly constructed portion of the crossing. However, safety improvements to the existing Tunnel would continue to be limited by the lower construction and clearance standards of the 1950s. For Scenario 4, safety levels on the new portion of construction could also be affected by the need to integrate portions of the new infrastructure with the existing infrastructure. Rating: ✓

Summary assessment

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<tbody>
<tr>
<td>Traffic safety</td>
<td>✗✗</td>
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<td>✓✓</td>
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Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Agricultural land effects

**Relevant Goal** – *Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts*

Agricultural land effects are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would have the smallest effect on agricultural land. Based on a preliminary analysis, the limited improvements to the north and south end interchanges would require little or no additional use of agricultural land. Rating: ✔ ✔

- **Scenario 2 (Replacement Bridge)** – would be constructed on the existing right-of-way. Based on preliminary analysis, the expected agricultural land requirements would be somewhat higher than for Scenario 1, with most of the effects at the adjacent interchanges. Rating: ✔

- **Scenario 3 (Replacement Tunnel)** – would be constructed mainly along the existing right-of-way, likely upstream from the existing Tunnel. Agricultural land requirements could be slightly higher for Scenario 3 than for Scenario 2, because of the required separation from the current alignment to avoid damaging the existing Tunnel during construction, and also because of the extensive approach cuts that would be required. Rating: ✗

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would likely have higher agricultural land requirements than Scenario 2, because of the challenges in routing traffic using two separate crossing facilities. Based on a preliminary analysis, the expected net effect is similar to Scenario 3. Rating: ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would have much higher agricultural land requirements than any of the other scenarios, because of the need to create a new crossing corridor. Based on a preliminary analysis, Scenario 5 would have the greatest expected use of agricultural land. Rating: ✗✗

**Summary assessment**

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<tbody>
<tr>
<td>Agricultural land effects</td>
<td>✔ ✔</td>
<td>✔</td>
<td>✗</td>
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<td>✗✗</td>
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</table>

Legend: ✔ ✔ very high achievement of goals; ✔ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Access to and from agricultural areas

*Relevant Goal* – Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts

Access to and from agricultural areas is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would not significantly improve access to and from agricultural areas, since it would only involve limited improvements to the Steveston and Highway 17A interchanges. Rating: ✗

- **Scenario 2 (Replacement Bridge)** – would potentially achieve the greatest improvements in linking agricultural areas on either side of the corridor, since the bridge clearances on either side of the crossing and at the upgraded interchanges would facilitate the provision of local connector roads between agricultural areas. Rating: ✓

- **Scenarios 3 (Replacement Tunnel) and 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would not be able to achieve Scenario 2’s improvements in accessibility, because of the continued existence of a new or replacement tunnel. However, either scenario would achieve some accessibility improvements through interchange improvements. Rating: ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would introduce a new set of local barriers associated with the construction of a new corridor, and would not significantly improve agricultural access along the existing corridor. Rating: ✗✗

**Summary assessment**

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<tbody>
<tr>
<td>Access to and from agricultural areas</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
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</table>

Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
5. Environment

Local air quality

*Relevant Goal* – *Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts*

The comparative assessment of local air quality, relating primarily to air particulates, is summarized as follows:

- **Scenario 1 (Maintain Tunnel)** – would involve substantial replacement of existing mechanical ventilation systems to manage the particulates generated by vehicle traffic. However, local air quality in the Tunnel would still not be as good as on an above-ground bridge. Air particulates would also be particularly concentrated in areas adjacent to tunnel venting outlets. Rating: ✗

- **Scenario 2 (Replacement Bridge)** – would have much better natural dispersion of air particulates for travellers than any of the tunnel-based scenarios. In addition to providing better air quality for travellers, Scenario 2 would also result in greater dispersion of air particulates for developments in adjacent areas, because of the height of the bridge. Rating: ✓

- **Scenario 3 (Replacement Tunnel)** – would require substantial investment in new mechanical ventilation systems, and would not achieve the same levels of local air quality achieved by Scenario 2, both for travellers and for adjacent developments. Rating: ✗

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing) and Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would be similar to Scenario 1 in terms of requiring substantial replacement of mechanical ventilation systems in the existing Tunnel, and would not achieve the same improvements in local air quality as Scenario 2. Rating: ✗

**Summary assessment**

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<tr>
<td><strong>Local air quality</strong></td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
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</table>

Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Regional air quality

**Relevant Goal** – *Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts*

For regional air quality, the comparative analysis includes greenhouse gas emissions, which will vary with total fuel consumption. The scenarios are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – is projected as having the lowest levels of traffic, because of the dampening effect of congestion on traffic volumes. Preliminary traffic studies indicate that total peak-hour traffic demand will increase less under Scenario 1 than under other scenarios.

  Under Scenario 1, average fuel economy for peak-hour traffic through the Tunnel will worsen as congestion continues to increase. However, Scenario 1 will have less overall traffic than the other scenarios. On balance, total levels of emissions under Scenario 1 are expected to be similar to those under Scenarios 2 through 4. Rating: ✗

- **Scenarios 2 (Replacement Bridge), Scenario 3 (Replacement Tunnel), and Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – are projected as having higher levels of traffic growth than Scenario 1, but also resulting in reduced congestion and improved per-trip fuel economy. On balance, total emissions are expected to be similar to those for Scenario 1. Rating: ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – is projected to have similar levels of traffic growth as Scenarios 2 through 4, and to achieve similar improvements in per-kilometre fuel consumption, but also to lead to some travellers taking more circuitous routings, with longer trip lengths. Rating: ✗✗

**Summary assessment**

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<tr>
<td>Regional air quality</td>
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</table>

Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Wildlife and terrestrial habitat

**Relevant Goal** – Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts

Wildlife and terrestrial habitat are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would not result in new interaction with natural areas and wildlife, but would not provide benefits in terms of reconnecting or restoring terrestrial and wildlife habitat. Rating: ✓

- **Scenario 2 (Replacement Bridge)** – would allow for re-connection of the two portions of Deas Island Park that are currently separated by the Tunnel portal. Scenario 2 would not result in new interactions with protected areas, although the construction program and new infrastructure could introduce some potential for increased interaction with wildlife. Rating: ✓

- **Scenario 3 (Replacement Tunnel)** – would result in riparian area disturbances on both sides of Deas Slough, within the existing right-of-way, with limited opportunity to repatriate habitat or to provide compensation by reconnecting currently separated natural areas. No interaction would be expected with protected areas, although the works would be close to Deas Island Park. The construction program and new infrastructure could introduce some potential for increased interaction with wildlife. Rating: ✗

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would not achieve the Tunnel decommissioning reconnection/reclamation benefits associated with Scenario 2. Otherwise, Scenario 4 would have similar impacts as Scenario 2 (if an additional bridge) or Scenario 3 (if an additional tunnel). Rating: ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would result in disturbances to riparian areas on both sides of the River in the new corridor – in particular the natural shoreline on the north side. Construction activity and the resulting infrastructure could also result in interaction with protected areas on the south side at the east end of Tilbury Island. Rating: ✗✗

**Summary assessment**

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<tr>
<td>Wildlife and terrestrial habitat</td>
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<td>✗</td>
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<td>✗✗</td>
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Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Marine life and habitat

Relevant Goal – Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts

Marine life and habitat are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would not change the overlap with productive shoreline habitats. However, the geotechnical upgrading of the existing Tunnel would require in-stream work around the existing four-lane structure, with the opportunity to limit activity to the least-risk work window from a seasonal perspective. Rating: ✗

- **Scenario 2 (Replacement Bridge)** – would not overlap with productive shoreline habitats at the new bridge, and there would be a potential net gain in productive shoreline habitat at Deas Slough because of restoration of marsh habitat. The in-stream work to decommission the existing Tunnel would be less invasive than the in-stream geotechnical upgrade under Scenario 1, with the opportunity to limit activity to the least-risk work window. Rating: ✓

- **Scenario 3 (Replacement Tunnel)** – would change the overlap with productive shoreline habitats, and would have effects on existing riparian vegetation near the existing corridor. There would be extensive in-stream work, for both the construction of the replacement tunnel and the decommissioning of the existing Tunnel. The duration of the work would be longer than for Scenario 1 or 2, with the opportunity to limit activity to the least-risk work window. Rating: ✗ ✗

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would not overlap with productive shoreline habitats, but would have the potential for riparian effects near the existing corridor. The in-stream work would be for geotechnical upgrading of the existing Tunnel, plus possibly the addition of a new tunnel. The duration of in-stream work would be longer than for Scenario 1 or 2, with the opportunity to limit activity to the least-risk work window. Rating (tunnel option): ✗ ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would have a high potential for effects on red-coded habitat, assuming that a new-corridor bridge crosses the southern shoreline of the Fraser River at or near Tilbury Slough. In-stream work would also be required for geotechnical upgrading of the existing Tunnel, with the opportunity to limit activity to the least-risk work window. Rating: ✗ ✗

**Summary assessment**

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<tbody>
<tr>
<td>Marine life and habitat</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
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Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗ ✗ low/no achievement of goals.
Contaminated sites

Relevant Goal – Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts

Contaminated sites are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would have the least potential to disrupt any contaminated sites, with the risks being limited to any currently-unknown contaminated sites that were discovered during future seismic upgrading programs. Rating: ✔️

- **Scenario 2 (Replacement Bridge)** – would have a somewhat higher potential of disrupting any currently-unknown contaminated sites that might be discovered within the existing right-of-way. These risks would be associated both with the construction of the new bridge, and with the decommissioning of the existing Tunnel. Scenario 2 would have little or no risk of disrupting contaminated sites located outside the existing right-of-way. Rating: ✗

- **Scenario 3 (Replacement Tunnel)** – would have significantly higher risks of disruption to contaminated sites, because of the significant excavations required at both ends of the new Tunnel and in the Fraser River. Rating: ✗ ✗

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would also have a relatively high risk of disrupting contaminated sites, especially if the additional crossing is a tunnel. Rating (tunnel option): ✗ ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would introduce additional risks associated with the possible disruption of contaminated sites outside of the existing right-of-way. There are numerous potentially contaminated sites near the proposed new-corridor crossing, as well as along the new corridor route as it passes through existing industrial neighbourhoods. Rating: ✗ ✗

**Summary assessment**

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<tr>
<td>Contaminated sites</td>
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Legend: ✔️ ✔️ very high achievement of goals; ✔️ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗ ✗ low/no achievement of goals.
6. Jobs and the Economy

Economic and employment impacts

Relevant Goal – Support trade and commerce: improve access to local businesses and gateways

Construction employment and longer-term economic/employment growth is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would not provide any additional capacity, extending the current congestion-related impediment to economic growth. As the population and economic base grow over time, so will the size of the impediment represented by the increasing levels of congestion-related traffic delays, for both commuter traffic and commercial goods movements. Rating: **xx**

- **Scenarios 2 (Replacement Bridge), 3 (Replacement Tunnel) and 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would address the current congestion-related impediments to economic growth (e.g., access to workplaces, commercial goods movements), leading to faster rates of economic growth and job creation than Scenario 1.

  Scenarios 2 through 4 would generate much greater levels of construction employment than Scenario 1. Rating: ✔️

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would also overcome the current congestion-related impediments to economic growth, and would have similar longer-run economic impacts as Scenarios 2 through 4.

  Scenario 5 would generate the most construction employment, because of the need to create an entire new corridor. Rating: ✔️

Summary assessment

<table>
<thead>
<tr>
<th>Economic and employment impacts</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
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Legend: ✔️ ✔️ very high achievement of goals; ✔️ relatively high achievement of goals; ✫ relatively limited achievement of goals; ✫ ✫ low/no achievement of goals.
Marine traffic effects during construction

Relevant Goal – Support trade and commerce: improve access to local businesses and gateways

Marine traffic effects during construction are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would have some effects on marine traffic during a future geotechnical strengthening program. These effects would likely be more significant than the marine traffic effects associated with decommissioning the existing Tunnel. Rating: ✗

- **Scenario 2 (Replacement Bridge)** – would have the least effect on marine traffic during construction, since the new bridge could be constructed from each bank of the River with limited work in the River itself. Decommissioning the existing Tunnel would require some marine traffic interruptions, but to a lesser extent than the geotechnical strengthening program associated with Scenarios 1, 4 and 5. Rating: ✓

- **Scenario 3 (Replacement Tunnel)** – would have very significant negative effects on marine traffic during the construction of the new tunnel, as well as having additional negative effects during decommissioning of the existing Tunnel. Rating: ✗✗

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would have relatively moderate effects (as for Scenario 1) if the additional crossing was a bridge, but would have very significant effects (as for Scenario 3) if the additional crossing was a tunnel. Rating (bridge option): ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would have relatively moderate effects on marine traffic during construction, similar to Scenario 1, since the new bridge could be constructed from both sides of the River. Rating: ✗

**Summary assessment**

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<tr>
<th>Marine traffic effects during construction</th>
<th>Scenario 1</th>
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<td>✗</td>
<td>✓</td>
<td>✗✗</td>
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Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Road access to gateways and trade corridors

**Relevant Goal** – Support trade and commerce: improve access to local businesses and gateways

Access to gateways and trade corridors is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would provide some minor improvements for local traffic using the Steveston and Highway 17A interchanges. However, Scenario 1 would not address the current congestion issues at the Tunnel, nor the long-term negative effect of congestion on local businesses and communities on either side of the Tunnel.

  Scenario 1 would also not address the current congestion issues for international goods and services in accessing the international gateways along the Highway 99 corridor – for example, Vancouver International Airport, Deltaport’s container terminal facilities, and the United States border and interstate highway network. Rating: ✴✴

- **Scenarios 2 (Replacement Bridge), 3 (Replacement Tunnel) and 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would address the current congestion issues at the Tunnel, and would significantly improve the connectivity to major international gateways. Rating: ✓✓

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would provide some traffic congestion relief at the Tunnel, attracting some international traffic to the new corridor and crossing. However, the improvement in road access to international gateways would be lower than for Scenarios 2 through 4, because of the lower congestion relief benefit and the more circuitous routing for international goods in accessing some gateways (e.g., Deltaport). Rating: ✓

### Summary assessment

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<tr>
<td>Road access to gateways and trade corridors</td>
<td>✴✴</td>
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<td>✓✓</td>
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Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✴ relatively limited achievement of goals; ✴✴ low/no achievement of goals.
Marine access to gateways and trade corridors

Relevant Goal – Support trade and commerce: improve access to local businesses and gateways

Marine access to gateways and trade corridors is assessed as follows:

- **Scenario 1 (Maintain Tunnel), Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing), and Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would not change the current water draft at the existing Tunnel. Rating: ✗

- **Scenario 2 (Replacement Bridge)** – would decommission the Tunnel, providing port and terminal operators with the flexibility to explore future opportunities for addressing other marine traffic impediments. Rating: ✓

- **Scenario 3 (Replacement Tunnel)** – would construct a new tunnel in place of the existing one, making it possible to create a deeper water draft. As for Scenario 2, a deeper replacement tunnel would provide port and marine terminal operators with the flexibility to explore future opportunities for addressing other marine traffic impediments. Rating: ✓

**Summary assessment**

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<tr>
<th>Marine access to gateways and trade corridors</th>
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Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Access to business and industrial land

Relevant Goal – Support trade and commerce: improve access to local businesses and gateways

Access to business and industrial land is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would achieve minor improvements in traffic conditions for the local businesses and industries using the Steveston and Highway 17A interchanges for same-side trips (i.e. not crossing the River). However, it would not significantly relieve the current and future congestion-related delays associated with accessing business and industrial land on both sides of the crossing. Rating: ✗

- **Scenario 2 (Replacement Bridge), Scenario 3 (Replacement Tunnel), and Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would each greatly improve access to business and industrial land, by relieving the congestion-related delays currently being experienced through the Tunnel. Rating: ✔ ✔

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would create a new access corridor to and from the Tilbury Island and Richmond/Delta industrial areas, but would be less effective than Scenarios 2 through 4 in addressing the existing corridor’s congestion-related barriers to accessing business and industrial land. Rating: ✔

### Summary assessment

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<tr>
<td>Access to business and industrial land</td>
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Legend: ✔ ✔ very high achievement of goals; ✔ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗ ✗ low/no achievement of goals.
7. Social and Community Considerations

Access across the highway, within communities

Relevant Goals – Support objectives for regional people movement

Access across the highway, within South Richmond and North Delta, is assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would continue to restrict across-the-highway access for all traffic (auto, truck, cyclist, pedestrian) on either side of the crossing. Pedestrians and cyclists would continue to be prohibited from using the Tunnel, requiring passage to continue to be made via shuttle bus. Rating: ❌❌

- **Scenario 2 (Replacement Bridge)** – would improve across-the-highway access on either side of the replacement bridge, by providing new interchanges and bridge underpasses on either side of the crossing. The new replacement bridge would improve Richmond-Delta connectivity through the dedicated cyclist/pedestrian pathway and the dedicated transit/HOV lane. Rating: ✔️✔️

- **Scenarios 3 (Replacement Tunnel) and 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would also significantly improve across-the-highway access, but to a lesser extent than Scenario 2 because of the approach cuts required and the continued existence of tunnel portals in close proximity to the shorelines. Rating: ✔️

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would be constructed with access across the Fraser River South Arm for all traffic, including cyclists and pedestrians, but only at the new-corridor crossing. Across-the-highway access would not be improved at the existing Tunnel, and cyclist and pedestrian access would continue to be prohibited. Along the new access route and crossing, new community severance would be created. Rating: ❌

Summary assessment

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<tr>
<td>Access across the highway within communities</td>
<td>❌❌</td>
<td>✔️✔️</td>
<td>✔️</td>
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Legend: ✔️✔️ very high achievement of goals; ✔️ relatively high achievement of goals; ❌ relatively limited achievement of goals; ❌❌ low/no achievement of goals.
Private-property effects

Relevant Goal – Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts

Based on preliminary analysis, private property effects may include commercial, industrial, limited mixed-use and agricultural. Private-property effects are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would have minor private-property effects, since this scenario involves only small additional amounts of land at the existing Steveston and Highway 17A interchanges, mainly within the existing right-of-way. Rating: ✔ ✔

- **Scenario 2 (Replacement Bridge) and Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would have greater private-property effects than Scenario 1. While most of the construction would be undertaken within the existing right-of-way, some private properties (especially those adjacent to the Highway 17A interchange) would be affected. Rating: ✔

- **Scenario 3 (Replacement Tunnel)** – would have greater private-property effects than Scenarios 2 or 4, particularly on the north shoreline, because of the need to maintain more separation between the existing Tunnel and the replacement tunnel during the construction period. Rating: ✗ ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would have greater private-property effects than any other scenario, since the new corridor would intersect with agricultural parcels along Number 8 Road in Richmond, industrial parcels on both sides of the Fraser River, and industrial parcels in the Tilbury area of Delta. Rating: ✗ ✗ ✗

For any acquisition or lease, the Ministry of Transportation and Infrastructure would negotiate with property owners in accordance with terms set out in the Expropriation Act, including assessment of fair market value.

### Summary assessment

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private-property effects</td>
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<td>✔</td>
<td>✗</td>
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</tbody>
</table>

Legend: ✔ ✔ very high achievement of goals; ✔ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗ ✗ low/no achievement of goals.
Compatibility with community and regional planning

*Relevant Goals* – Protect the existing land base and support trade and commerce

Community and regional planning initiatives relevant to the George Massey Tunnel include:

- **Regional Growth Strategy (RGS)** – The RGS has established a number of goals to support Metro Vancouver’s sustainability framework, including: create a compact urban area; support a sustainable economy; protect the environment and respond to climate change impacts; develop complete communities; and support sustainable transportation choices. For the Highway 99 communities of Richmond, Delta, Tsawwassen, Surrey and White Rock, the RGS projects a population increase from 714,400 in 2006 to 1,173,000 in 2041 (plus 64%).

- **Regional Transportation Strategy (RTS)** – TransLink’s RTS initiative released its Strategic Framework in 2013. The Strategic Framework’s broad targets include: (1) reducing the distances people drive by one-third, and (2) increasing the walk/bike/transit mode share to 50%. Target RTS benefits include:
  - “making travel more reliable;
  - increasing transportation options;
  - making it easier and less stressful to get to work and school;
  - giving us more time for doing the things we love;
  - ensuring businesses continue to prosper with better access to more workers and more markets;
  - making living, working and doing business in this region more affordable;
  - giving people better access to more jobs and more opportunities;
  - making our roads safer;
  - helping us live healthier and more active lives;
  - reducing the burden on the healthcare system;
  - helping us get out on the sidewalk to meet our neighbours and deter crime;
  - making the air we breathe cleaner;
  - protecting our climate by reducing our greenhouse gas emissions.”

- **Official Community Plans (OCPs)** – The land adjacent to the Tunnel falls under the City of Richmond’s OCP to the north, and under the Corporation of Delta’s OCP to the south.

Each scenario’s compatibility with community and regional plans is assessed as follows:
Scenario 1 (Maintain Tunnel) – is consistent with the RGS’ goal of creating compact and complete communities, as well as the RTS’ target of reducing distances driven in the region. However, Scenario 1 does not appear to be consistent with the future transportation needs associated with RGS’ projected 2006-41 population growth of 64 per cent, nor with most of the target benefits identified by the RTS. Scenario 1 also does not support the specific growth and maintenance goals for transportation in the Delta OCP, and is not supported by the Corporation of Delta. The Richmond OCP does not include a formal position regarding improvements at the Tunnel. Rating: ✗

Scenario 2 (Replacement Bridge) – is more consistent than Scenario 1 with RGS’ projected population growth for the local communities. Scenario 2 is also more consistent with most RTS target benefits (easier and more reliable travel to work and school, etc.). Scenario 2 is consistent with the Delta OCP, and is supported by the Corporation of Delta. While the Richmond OCP does not include a formal position on tunnel replacement/improvements, upgrades to the Steveston Highway interchange are consistent with the Richmond OCP. Rating: ✔

Scenario 3 (Replacement Tunnel) and Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing) – is similar to Scenario 2 in terms of compatibility with RGS and RTS, except that Scenarios 3 and 4 would not have the same level of benefits in terms of local air quality (air particulates).

Scenarios 3 and 4 are similar to Scenario 2 in terms of consistency with the OCPs, except that local connectivity across Highway 99 is not facilitated by these scenarios to the same extent as Scenario 2 because of the continued existence of the Tunnel and its portals in close proximity to the river shoreline. Rating: ✔

Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing) – is similar to Scenario 2 in terms of compatibility with the RGS and RTS – except that Scenario 5 would not have the same level of benefits in terms of improving walk/cycle mode share, since the improved pedestrian/cyclist access would be provided along a new corridor rather than the existing one.

Scenario 5 is not contemplated by the Delta or Richmond OCP and related plans. The Delta OCP has designated the Tilbury area for industrial use, and the Richmond portion of the new corridor (running north-south through southeast Richmond to connect with Highway 91) is not consistent with the City of Richmond’s transportation or agricultural plan. The City of Richmond has formally opposed Scenario 5. Rating: ✗

Summary assessment

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<thead>
<tr>
<th></th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
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</tbody>
</table>

Legend: ✔✔ very high achievement of goals; ✔ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
Noise effects

Relevant Goal – Protect the existing land base: minimize impacts on agricultural, park and industrial lands, and minimize environmental impacts

Noise effects are assessed as follows:

▶ **Scenario 1 (Maintain Tunnel)** – would not result in any significant change in noise levels. Rating: ✓ ✓

▶ **Scenario 2 (Replacement Bridge)** – would increase surface noise levels at the crossing. Noise reduction initiatives during design (sound barriers, bridge surface design) could mitigate noise effects to some extent. Rating: ✗

▶ **Scenario 3 (Replacement Tunnel)** – would increase current noise levels at the crossing in proportion to changes in traffic levels. Rating: ✗

▶ **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would also increase current noise levels, with the level of increase depending on whether the new crossing was a bridge or a tunnel. Rating (bridge option): ✗

▶ **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would result in additional road noise, both at the new bridge and along the new access corridor. Rating: ✗ ✗

Summary assessment

<table>
<thead>
<tr>
<th>Noise effects</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
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<tbody>
<tr>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗ ✗</td>
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</tbody>
</table>

Legend: ✓ ✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗ ✗ low/no achievement of goals.
Visual effects

Relevant Goal – Involve communities, businesses and stakeholders in the project.

Visual effects are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would not result in a significant change to the visual appearance of the existing corridor and Tunnel. Rating: ✓

- **Scenario 2 (Replacement Bridge)** – would change the appearance of the existing crossing, with the new bridge being highly visible at Deas Island, as well as at the marina and nearby residences. A viewing platform would be provided on the bridge for cyclists and pedestrians. Rating: ✗

- **Scenario 3 (Replacement Tunnel)** – would have limited visual effects, with a somewhat larger tunnel portal on either side of the crossing. Rating: ✓

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would depend on whether the additional crossing was a bridge or a tunnel. For the bridge option, visual effects would be similar to those for Scenario 2. For the tunnel option, visual effects would be similar to Scenario 3. Rating (bridge option): ✗

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would be highly visible at the new crossing from both sides of the bridge, in particular at Tilbury Island and at the industrial areas on the Richmond side of the Fraser River. Rating: ✗

**Summary assessment**

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<tr>
<th></th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
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<tr>
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</table>

Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗✗ low/no achievement of goals.
8. Financial Costs and Risks

Capital costs

Capital costs are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would have the lowest capital costs among the options, at least for the remaining life of the Tunnel. Rehabilitation and other capital expenditures would include (1) limited-scope upgrades to the Steveston and Highway 17A interchanges, (2) periodic replacement of the Tunnel’s mechanical and electrical systems (ventilation, lighting, pumping, etc.), and (3) possible geotechnical strengthening to reduce the level of geotechnical risk in case of a seismic event.\(^5\) Rating: $

- **Scenarios 2 (Replacement Bridge) and Scenario 3 (Replacement Tunnel)** – would have much higher capital costs than Scenario 1. Based on discussions with major international bridge and tunnel contractors, the capital costs of both scenarios are assessed as likely to be similar. Rating: $$

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would potentially have a somewhat lower level of new construction expenditures than Scenario 2 or 3 because of fewer number of lanes to be added, but would also require the Tunnel rehabilitation expenditures associated with Scenario 1. Scenario 4’s overall capital costs are assessed as likely to be similar to Scenarios 2 and 3. Rating: $$

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would involve additional capital costs associated with maintaining the existing Tunnel (Scenario 1), the costs of constructing a new bridge, and the additional costs of constructing new access routes from Highways 99/17 in Delta and from Highway 91 in Richmond. Scenario 5 is assessed as likely to have construction costs significantly greater than those associated with Scenarios 2, 3 and 4. Rating: $$$

**Summary assessment**

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<tr>
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<th>Scenario 1</th>
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<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 5</th>
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<tbody>
<tr>
<td>Capital costs</td>
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Legend: $$$ relatively higher cost; $$ mid-range relative cost; $ relatively lower cost.

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As previously discussed, the geotechnical strengthening program would carry risk of destabilizing the Tunnel, causing a reduction in seismic stability. A successful geotechnical strengthening program would still result in a much higher level of seismic risk for Scenarios 1, 4 and 5 than for Scenarios 2 and 3.
Capital cost risks – construction phase

Capital cost risks during the construction phase are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – the main capital cost risk during construction is associated with the geotechnical program to strengthen the riverbed. The expected cost and likelihood of success of such a program would be uncertain. There is also a possibility that the attempt to strengthen the existing riverbed could create a less stable structure. Rating: ★★★

- **Scenario 2 (Replacement Bridge)** – capital cost risks are assessed as lower than for other scenarios, because of the ability to undertake construction primarily by extending the span from the main bridge piers on either bank, reducing the need to work in the River. Rating: ✔

- **Scenario 3 (Replacement Tunnel)** – the capital cost risks for Scenario 3 relate primarily to the significant uncertainties associated with in-river tunnel construction. Rating: ★

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing)** – would have the capital cost risks associated with Scenario 1, in addition to the risks associated with Scenario 2 or 3. Rating (tunnel option): ★★★

- **Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would have the capital cost risks associated with Scenario 1, in addition to the risks associated with constructing a new crossing in an industrialized area. Rating: ★★★

**Summary assessment**

<table>
<thead>
<tr>
<th>Capital cost risks (construction)</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 5</th>
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<tbody>
<tr>
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<td>★★★</td>
<td>✔</td>
<td>★</td>
<td>★★★</td>
<td>★★★</td>
</tr>
</tbody>
</table>

Legend: ✔ ✔ very low risk; ✔ ✔ relatively low risk; ★ relatively high risk; ★★ high risk.
Capital cost risks – operations phase

Capital cost risks during the operations phase are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would somewhat reduce capital cost risks during operations, by improving the ability of the existing infrastructure to withstand an earthquake. However, the upgraded infrastructure would still have higher risks of unexpected capital costs arising during operation, relative to the all-new scenarios. Rating: ✗

- **Scenario 2 (Replacement Bridge) and Scenario 3 (Replacement Tunnel)** – would have the lowest level of exposure to future capital cost risks during operations, because of the all-new construction. Based on discussions with major bridge and tunnel construction firms, the capital cost risks during operations are assessed as similar for Scenarios 2 and 3. Rating: ✓

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing) and Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would also have higher capital cost risks during construction than for Scenarios 2 and 3, because of the requirement to continue operating the existing Tunnel as well as the new-corridor crossing. Rating: ✗

**Summary assessment**

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<tr>
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<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital cost risks (operations)</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

Legend: ✓✓ very low risk; ✓ relatively low risk; ✗ relatively high risk; ✗✗ very high risk.
Operating and maintenance (O&M) costs

Future operating and maintenance (O&M) costs are assessed as follows:

- **Scenario 1 (Maintain Tunnel)** – would have relatively low overall O&M costs. While tunnels are generally more expensive to operate and maintain than equivalent-capacity bridges, Scenario 1 would involve a smaller level of infrastructure to be operated and maintained relative to all other scenarios. Rating: $

- **Scenario 2 (Replacement Bridge)** – would have the lowest O&M costs among Scenarios 2 through 5. While bridge O&M costs are generally lower than tunnel operating costs for equivalent-capacity infrastructure, Scenario 2 would represent a significant increase in infrastructure size and capacity. Rating: $

- **Scenario 3 (Replacement Tunnel)** – would likely have significantly higher O&M costs than Scenario 2, due to the more complex and expensive mechanical systems associated with tunnel operations. Rating: $$

- **Scenario 4 (Maintain Tunnel, Add In-Corridor Crossing) and Scenario 5 (Maintain Tunnel, Add New-Corridor Crossing)** – would have significantly higher O&M costs than Scenarios 1 through 3, because of the need to operate and maintain two separate crossing infrastructures. Rating: $$$

**Summary assessment**

<table>
<thead>
<tr>
<th>Operating and maintenance costs</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
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Legend: $$$ relatively higher cost; $$ mid-range relative cost; $ relatively lower cost.
## 9. Summary of Comparative Evaluations

The following table summarizes the comparative evaluations for each of the 28 individual criteria, and illustrates the overall assessment within each of the seven major evaluation areas. A discussion of the results, for each evaluation area, is contained in Chapter 1.

<table>
<thead>
<tr>
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</tr>
<tr>
<td><strong>Overall assessment</strong></td>
<td></td>
<td>✗</td>
<td>✗</td>
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</tr>
</tbody>
</table>

Legend: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; ✗ relatively limited achievement of goals; ✗ ✗ low/no achievement of goals. $$$ relatively higher cost; $$ mid-range relative cost; $ relatively lower cost.