City of Richmond

Report to Committee

To:	General Purposes Committee	**Date:**	July 21, 2017
From:	Victor Wei, P. Eng. Director, Transportation	**File:**	10-6350-05-08/2017-Vol 01
Re:	**George Massey Tunnel Replacement - Alternative Crossing Improvement Options**		

Staff Recommendation

1. That a letter and copy of the report titled "George Massey Tunnel Replacement - Preliminary Assessment of Alternative Crossing Options" dated July 21, 2017, from the Director, Transportation be sent to the Premier of British Columbia requesting:

   (i) Suspension of all current work associated with the George Massey Tunnel Replacement Project, including the relocation of the BC Hydro transmission lines, pending a comprehensive review and analysis of alternative crossing improvement options;
   (ii) Consideration in a timely manner of the suggested alternative improvement crossing options for the George Massey Tunnel including estimated costs and complementary measures to improve regional transportation as described in the report; and
   (iii) Collaboration with stakeholders, including Metro Vancouver, the Mayors' Council, TransLink and the Greater Vancouver Gateway Council, to develop a preferred mutually acceptable alternative tunnel crossing concept(s) that would be presented for public consultation.

2. That copies of the letter referenced in Recommendation 1 and this report be provided to:

   (i) the Leaders of the BC Green Party and the BC Liberal Party,
   (ii) Honourable Claire Trevena, MLA – North Island, Minister of Transportation and Infrastructure,
   (iii) Honourable Selina Robinson, MLA – Coquitlam-Maillardville, Minister of Municipal Affairs and Housing,
   (iv) Bowinn Ma, MLA – North Vancouver-Lonsdale, Parliamentary Secretary for TransLink,
   (v) the Metro Vancouver Board of Directors,
   (vi) the TransLink Board of Directors,
   (vii) the Mayors' Council on Regional Transportation,
   (viii) all Richmond and Delta MPs,
   (ix) all Richmond MLAs,
   (x) Corporation of Delta Mayor and Councillors,
   (xi) Chair of BC Hydro Board of Directors,
   (xii) the Mobility Pricing Independent Commission, and
   (xiii) the Greater Vancouver Gateway Council.

3. That a communications strategy be undertaken to convey the urgent need to suspend all current work associated with the George Massey Tunnel Replacement Project, including the relocation of the BC Hydro transmission lines, and undertake a timely comprehensive review and analysis of alternative crossing improvement options.

Victor Wei, P. Eng.
Director, Transportation
(604-276-4131)

Att. 14

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**
Parks	☑	
Engineering	☑	
Policy Planning	☑	
Development Applications	☑	
Communications	☑	
Intergovernmental Relations and Protocol	☑	
REVIEWED BY STAFF REPORT / AGENDA REVIEW SUBCOMMITTEE	INITIALS: DW	**APPROVED BY CAO**

Staff Report

Origin

At its July 4, 2017 meeting, the General Purposes Committee resolved that "*staff identify and analyse options which are alternatives to a bridge for the George Massey Tunnel Replacement Project including the option to twin the Tunnel and report back.*"

Staff were also directed to:

(i) re-submit the Freedom of Information requests on the George Massey Tunnel Replacement Project for a new response, and
(ii) seek further information regarding options for the George Massey Tunnel Replacement Project from any other interested groups including but not limited to the Greater Vancouver Gateway Council.

At its July 10, 2017 meeting, Delta Municipal Council considered a report on the George Massey Tunnel Replacement Project (the Project) regarding the "public safety and economic imperative" for the Project. Delta also placed a full page notice in several newspapers that highlight statements from the report.

This report responds to the General Purposes Committee referral, offers comments on the Delta report and notice, and provides preliminary analysis of two alternative crossing options.

This report supports Council's 2014-2018 Term Goal #3 A Well-Planned Community:

> *3.3. Effective transportation and mobility networks.*

This report supports Council's 2014-2018 Term Goal #5 Partnerships and Collaboration:

> *Continue development and utilization of collaborative approaches and partnerships with intergovernmental and other agencies to help meet the needs of the Richmond community.*

Findings of Fact

The improvement and/or expansion of the George Massey Tunnel (the Tunnel) and related Highway 99 corridor enhancements has been studied for many years dating back to at least 1989. As chronicled below, the recommended improvements to the Tunnel typically involved adding a new tunnel tube adjacent to the existing tube.

- 1989: The *Freedom to Move* study by the Greater Vancouver Transportation Task Force[1] recommended widening "the George Massey Tunnel to six lanes by constructing a new two-lane tube" by 2001. The evaluation process indicated that "the addition of a third tube to the George Massey Tunnel results in a high benefit/cost ratio."
- March 1991: The *George Massey Tunnel Expansion Planning Study* (Attachment 1) prepared for the Ministry of Transportation and Highways (the Ministry) by Ward Consulting Group

[1] Task Force members included the Ministry of Transportation and Highways, BC Transit and the Greater Vancouver Regional District.

analyzed five scenarios and recommended the addition of a third two-lane tube as a short-term improvement in advance of a preferred long-term alternative to construct a new highway and two bridges that would link Highway 17 in Delta to Boundary Road-Marine Way in Vancouver.

- September 1993: *Transport 2021: A Long-Range Transportation Plan for Greater Vancouver* (Attachment 2), prepared by the Province of BC and the Greater Vancouver Regional District, states that the Ministry has identified "additional capacity over both the South Arm and North Arm of the Fraser River" and recommended that the "choke points of the bridges and tunnels across the Fraser River and across Burrard Inlet would be used to "draw the line" and limit access by the single-occupant vehicle."
- July 1995: The *Fraser River North and South Arm Crossing Study* (Attachment 3) prepared for the Ministry by Reid Crowther and Ward Consulting Group analyzed 12 options in three corridors and, for Highway 99, recommended a "new two lane tunnel tube" plus additional travel lanes between White Rock and the Oak Street Bridge.
- September 2004: The *Gateway Program: Traffic and Revenue Forecasts* study, prepared for the Ministry by Steer Davies Gleave as input to the Gateway Program planning process for a number of potential road infrastructure projects, states that Highway 99 improvements assume "a widening of both the Fraser River crossing, in this case the new bore next to the existing George Massey (Deas) Tunnel, and widening of a length of the existing highway to both the north and south of the crossing."
- January 2006: The *Gateway Program – Program Definition Report* (Attachment 4) states that a number of alternatives for addressing congestion on Highway 1 and at Fraser River crossings were analyzed including widening of the Tunnel and that to "capture sufficient benefits, twinning the tunnel would also require improvements to other crossings over the North Arm of the Fraser River, such as the Oak Street or Knight Street bridges."

In February 2006, the then Minister of Transportation and Infrastructure Kevin Falcon was reported as stating to the media that the "George Massey tunnel will be twinned and both Highway 99 approaches widened from four lanes to six once the province's more pressing transportation projects are complete" (Attachment 5).

Beyond these planning studies, the Ministry has made incremental upgrades to the Tunnel and the Highway 99 corridor to improve safety and transit priority including:

- 2004-2006: Phase 1 of a planned two-phase seismic upgrade of the Tunnel to "improve safety, avoid collapse and reduce structural damage during an earthquake" at a cost of $22.2 million. Phase 2 of the upgrade was not undertaken.
- 2008: Installation of an early warning system at the Tunnel to improve seismic safety.
- 2012: Completion of 17 km of separate shoulder bus-only lanes on Highway 99 between Surrey, Delta and Richmond was completed at a cost of $60 million, which included funding contributions from the federal government.

On September 28, 2012, then Premier Christy Clark announced the Government's intention to begin the process to replace the George Massey Tunnel in an address to the Union of B.C. Municipalities. Phase 1 public consultation (November-December 2012) solicited ideas from the public while Phase 2 public consultation (March-April 2013) presented five high-level crossing scenarios with the intent, as indicated by Project staff at an open house, that one to two preferred options would be identified for further technical work, including a business case study.

In September 2013, without further public consultation, the previous Government of BC announced the replacement of the existing Tunnel with a new 10-lane wide high level bridge over the South Arm of the Fraser River linking Delta with Richmond. The Project scope includes the widening of Highway 99, the replacement of existing interchanges and overpasses, and the decommissioning of the Tunnel at an initial estimated cost of $3.5 billion (see Attachment 6 for a rendering of the proposed bridge and scale model of the proposed Highway 99-Steveston Highway Interchange). The Project scope to decommission the Tunnel and build a new bridge is inconsistent with the past studies noted above that generally focussed on upgrading the Tunnel and adding a new tunnel tube adjacent to the existing tube.

At its June 24, 2016 meeting, the Metro Vancouver Board considered a report on the Project and resolved to send a letter to the Ministry conveying its opposition to the proposed Project due to the cumulative regional impacts and concerns regarding a lack of integration with the Regional Growth Strategy, insufficient consideration of alternatives to a 10-lane bridge and negative effects on transit ridership and affordability (Attachment 7).

A Request for Proposals was issued in October 2016 to seek potential proponents to deliver the P3 project. The Project received an Environmental Assessment Certificate from the Province of BC in February 2017. Both Metro Vancouver and the City requested that the Project be referred to a federal environmental assessment; however, the federal Minister declined to designate the Project for review.

Preliminary construction work comprising site preparation (watercourse improvements and the placement of pre-load material immediately adjacent to the existing Highway 99 on the west side) in Richmond and Delta officially commenced in April 2017 and is currently continuing.

BC Hydro is proceeding with the relocation of its transmission line from the Tunnel to an overhead crossing pending further direction from the Ministry of Transportation and Infrastructure (the Ministry). Current work is proceeding within BC Hydro or Ministry rights-of-way. Vegetation clearing work began in November 2016 and work to relocate existing "pothead" infrastructure began in January 2017. The installation of foundations to improve ground stability for the new transmission structures began in April 2017; this work is anticipated to take approximately eight months. Future work includes the relocation of the existing monopoles along Highway 99 (between the Steveston Highway and Highway 17A interchanges) between late 2017 to Summer 2018, and the construction of steel lattice towers for the overhead transmission line in 2018 and 2019. The new transmission line is planned to be in service by Fall 2019.

Analysis

Council Concerns with Current Proposed Project Scope

Richmond City Council recognizes the urgent need to address significant traffic congestion around the Tunnel, which negatively impacts the region's economy and quality of life for its residents; its concerns are related to the specific current proposal to address the congestion. Council has expressed a preference for a new or improved Tunnel (Council Resolution R16/17-6 of October 11, 2016) as opposed to the proposed 10-lane bridge and has continually re-iterated its key concerns (Attachment 8) including:

- the expansion of single occupant vehicle (SOV) capacity and lack of consistency with Metro Vancouver's Regional Growth Strategy,
- the scale of the combined infrastructure (i.e., new bridge and interchanges plus widened Highway 99) and the associated land use and agricultural impacts,
- traffic impacts on local roads and at the Oak Street Bridge, and
- the decommissioning of the Tunnel enabling potential future dredging of the Fraser River that in turn may increase industrialization of the river.

Given that the Port of Vancouver has since released a statement that "the Fraser River will be well positioned to accommodate Canada's growing trade without deepening the channel" to accommodate larger vessels (see Attachment 9 for the media release dated May 25, 2017), there is now no apparent need to remove the Tunnel.

Accordingly, based on the above concerns, any alternative options for an improved crossing relative to the current Project should:

- have little to no net adverse effects on the environment;
- minimize the scale of the infrastructure in order to lessen the environmental, land use and agricultural impacts;
- be compatible with the Regional Growth Strategy (i.e., reduce reliance on private auto use, limit increased SOV capacity, accommodate expanded and improved public transit service, and promote a mode shift to high occupancy vehicles (HOV) with three or more occupants); and
- address current traffic congestion at both ends of the Tunnel by providing better transit and effective measures to manage private auto travel demand and more efficient traffic integration with adjacent interchanges (i.e., merge and diverge traffic operations).

Delta Report and Newspaper Notice regarding Project

The Delta staff report does not contain any new information and references statements from various past technical studies to support an assertion that the proposed scope of the Project should proceed unchanged. The July 14, 2017 editions of the *Richmond News* and *Delta Optimist* each contain a full page notice (Attachment 10) placed by the Municipality of Delta that highlights statements from the Delta staff report regarding the Project that was considered by Delta Municipal Council at its July 10, 2017 meeting. The same notice was also placed in the July 15, 2017 edition of the *Vancouver Sun* and the July 16, 2017 edition of *The Province*. Delta has also placed a Changeable Message Sign on River Road that is visible to northbound motorists on Highway 99 just before entering the Tunnel that includes phrases from the newspaper notice (e.g., "weneedabridge.ca," "public safety #1").

The newspaper notice directs readers to a website (www.weneedabridge.ca) for further information; the link takes viewers to a section of the Municipality of Delta website that includes a link to the Delta staff report. Staff offer the following comments on several of the highlighted statements featured in the newspaper notice:

- Seismic Risk of Existing Tunnel: Currently, the Tunnel is estimated to be able to withstand a 1-in-275 year seismic event based on the retrofit work completed in 2006. The Delta staff report comments appear to be based on this seismic rating. However, the Tunnel is capable of undergoing further seismic upgrades to enable the structure to sustain repairable damage and remain usable following a 1-in-475 year seismic event, which would be a substantial improvement to the current condition. The upgrade to a 1-in-475 year seismic rating would render the Tunnel comparable to the current seismic ratings of other existing lifeline crossings in Greater Vancouver such as the Lions Gate Bridge, Ironworkers Memorial Bridge, Oak Street Bridge, and Queensborough Bridge following seismic upgrades undertaken by the Ministry in 2008 (Attachment 11).

- Cost of Replacement Tunnel: The quoted \$4.3 billion cost of a replacement tunnel is based on an equivalent 10-lane structure (two tubes with five lanes each) constructed to maintain a deeper draught of 14.5 m (compared to the current draught of 11.5 m for the Tunnel). Throughout the Project's lifetime including the environmental assessment process, Council and staff have repeatedly stated that the significant expansion of SOV capacity associated with a 10-lane crossing is contrary to the Regional Growth Strategy and would have associated negative impacts on environmental and social factors due to the footprint and scale of the infrastructure. The Metro Vancouver Board of Directors also expressed its opposition to the current Project scope in June 2016. In addition, as noted above, the Port of Vancouver has since stated there is no need for future deepening of the Fraser River. Therefore, an alternative crossing with fewer lanes and at a shallower draught of 11.5 m presumably could be constructed at less than or equal to the current Project cost of \$3.5 billion.

- Negative Implications of Replacement Tunnel: Again, the statement that a replacement tunnel would have more negative impacts is based on a new 10-lane structure comprised of two tubes with five lanes each placed at a greater depth than existing. The impacts would be far less based on an improved crossing on a smaller scale (e.g., upgraded Tunnel with a new two or four lane tube placed at a shallower depth). Further technical analysis would be required to determine how a narrower tunnel may reduce environmental impacts and costs.

- Replacement of Major Components of Existing Tunnel: A retrofit of the existing Tunnel that includes replacement of the electrical and mechanical systems plus seismic upgrades to achieve a rating of being able to sustain repairable damage following 1-in-475 year seismic event has an estimated cost of \$590 million. This work could be considered as a cost-effective option that gives the Tunnel the equivalent seismic rating as other key crossings in the region and optimizes the use of existing infrastructure before incurring additional costs for new infrastructure.

- Transportation Efficiency of Replacement Tunnel: The notice features statistics regarding truck and transit trips through the existing Tunnel. It is not clear why a replacement tunnel, particularly if HOV and/or transit only lanes are included, would result in reduced efficiency of the transportation system as increased investment in transit, rather than SOV capacity, is a responsible solution to address congestion in the long-term.

- Annual Collisions: The notice cites an average of over 300 crashes per year at the Tunnel and adjacent interchanges, which is based on ICBC data from the five-year period 2009 to 2013. Based on ICBC data from the five-year period 2011 to 2015, there were an average of 270 crashes per year at the Tunnel and adjacent interchanges; however, nearly 60% of those crashes occurred at the interchanges on either side of the Tunnel (including 53% at the Highway 99-Steveston Highway). Thus, the majority of crashes are unrelated to the crossing itself. As a comparison, during the same 2011 to 2015 period, Knight Street Bridge and the on- and off-ramps at the north end recorded an average of 420 crashes per year (of which 54% occurred at the north end on- and off-ramps) and Alex Fraser Bridge including the Highway 91A and Nordel Way on- and off- ramps at either end recorded an average of nearly 290 crashes per year.

Alternative Crossing Improvement Options

As described below, staff have identified two concepts, with limited detailed technical analysis, for alternative crossing options that meet the criteria described above regarding minimizing impacts to the environment, compatibility with the Regional Growth Strategy and addressing congestion at the Tunnel. Both options:

- retain and upgrade the Tunnel to the current seismic rating for existing structures to optimize the use of existing infrastructure and minimize the cost of new infrastructure;
- retain the existing BC Hydro transmission lines in the Tunnel thereby realizing cost savings from the total $76 million budget and the elimination of the visual impacts associated with a new overhead transmission line;
- include provision for cyclists and pedestrians, and separate HOV and/or transit facilities in support of policies of all levels of government to reduce greenhouse gas emissions;
- limit increased SOV capacity and improve sustainable transportation choices;
- would not exceed the current estimated Project cost of $3.5 billion; and
- can be supplemented by transportation demand management (TDM) measures to govern future travel demand, particularly for SOVs.

For both options, a new tunnel would be built to modern seismic standards for a lifeline crossing. In the event of an earthquake, a lifeline structure will:

(1) Sustain no damage and remain open to all traffic following an earthquake with a 1-in-475-year return period seismic event;
(2) Sustain minimal damage following a 1-in-975-year return period seismic event; and
(3) Sustain repairable damage resulting in limited service following a 1-in-2,475-year return period seismic event.

To address concerns regarding the safety of the existing Tunnel during a seismic event, such as those cited in the Delta report, both options include the Tunnel undergoing retrofit work to enable the structure to sustain repairable damage and remain usable following a 1-in-475 year seismic event (i.e., following the retrofit work, its seismic rating would match that of other key crossings in the Lower Mainland). Maintaining and undertaking a seismic upgrade of the Tunnel recognizes that not only is public safety critical but also that there are numerous other facilities in the region (i.e., schools and hospitals) that require seismic upgrades. Completing all of the seismic upgrades will take time and during this process, the Tunnel should not be considered in isolation.

Option 1: Retain Existing Tunnel and Add 4-Lane Tunnel (Twinning)

Option 1 would retain and upgrade the existing 4-lane tunnel and add a new 4-lane tube adjacent to the existing tunnel placed at the same depth. Of the four new lanes, two would be reserved for HOV and bus transit use only (and be readily convertible to accommodate future LRT) and two would be used by general purpose traffic for better connection with the two adjacent interchanges (i.e., Steveston Highway and Highway 17A). The resulting six lanes for general purpose traffic through the tunnels would provide greater flexibility with respect to their operation in the most efficient arrangement (e.g., could be operated as three lanes in each direction at all times or with a peak period counter-flow system with four lanes in the peak direction and two lanes in the non-peak direction).

Since the primary purpose of the two additional general purpose travel lanes is to facilitate merging/diverging at the interchanges on either side of the tunnels, particularly at the north end in the vicinity of Steveston Highway, rather than for through traffic, the two lanes would not extend north of Steveston Highway and there would be no added SOV capacity beyond the adjacent interchanges at either end of the tunnels. TDM measures could be used to manage any increase of vehicular travel demand such traffic queues at both ends of the Tunnel would be further reduced but not result in an undesirable growth of private auto use.

A technical analysis of replacement crossing options titled "George Massey Tunnel Replacement Project: Review of Replacement Options," (the Project Report[2], Attachment 12) dated July 2016 and prepared by WSP/MMM Group identifies a feasible crossing scenario that comprises the retrofit of the Tunnel and a new 6-lane tunnel (single tube with six lanes) adjacent to the existing Tunnel. As shown in Attachment 12, the evaluation of this Scenario 4(b) indicates that the option is technically feasible.

Option 2: Retain Existing Tunnel and Add 2-Lane Bus-HOV Only Tunnel

Option 2 would retain and upgrade the existing 4-lane tunnel and add a new 2-lane tunnel crossing for bus transit and HOV use only that would be readily convertible to accommodate future LRT. Again, similar to Option 1, the new tunnel would be placed at the same depth as the existing Tunnel. A future LRT line could extend from either the Bridgeport or Richmond-Brighouse Stations of the Canada Line to the existing Tunnel crossing and under the river to Delta and ultimately further south, which is consistent with TransLink's *Regional Transportation Strategy* that identifies future rapid transit along the Highway 99 corridor south of the Oak Street Bridge. Any future LRT alignment and its costing would be determined by TransLink.

The order of magnitude cost of Option 2 is estimated to be lower than Option 1 as the new tunnel would be two lanes rather than four lanes. Thus, any surplus funding from the current Project cost of $3.5 billion could be used towards improved bus service operations in the interim and an LRT line in the future.

As this option would result in no SOV capacity increase but improved transit service, TDM measures (such as mode shift through the use of mobility pricing) would manage private vehicle travel demand through the Tunnel, thereby reducing traffic queues and encouraging greater transit use.

<u>Preliminary Evaluation of Alternative Crossing Improvement Options</u>

At a very preliminary level, Table 1 summarizes the relative performance of the two options. Further detailed analysis would be required to confirm the relative impacts of each option across the multiple considerations of an environmental assessment application (e.g., land use,

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[2] "George Massey Tunnel Replacement Project: Review of Replacement Options," July 2016, prepared by WSP/MMM Group. http://engage.gov.bc.ca/app/uploads/sites/52/2017/02/GMT-Review-of-Replacement-Options-July-2016.pdf

agricultural use, geotechnical, river hydraulics, fish and fish habitat, traffic, etc). The analysis of any alternative crossing concepts should also include an inclusive and transparent public consultation process.

The order of magnitude costs presented are for the crossing only and do not include costs for improved transit operations, as in the case of the current proposed 10-lane bridge. Any surplus funding resulted from either of the two alternative options could be allocated to complementary transit investment. Further detailed analysis would be required to confirm that the option costs could fit within the existing funding envelope. For example, the estimated costs for the narrower 4- or 2-lane tunnels of Options 1 and 2 respectively are based on the proportional cost difference of a 10-lane versus 6-lane tunnel and thus there would be certain fixed costs common to any tunnel structure regardless of the number of lanes. These fixed costs have been retained in the two alternative options.

Table 1: Summary Evaluation of Options

Evaluation Criterion	Option	
	1: Upgrade Tunnel & Add 4-Lane Tube	**2: Upgrade Tunnel & Add 2-Lane Bus-HOV Tube**
Transportation: reduce congestion, improve transit	✓✓	✓✓
Land Use: compatibility with RGS, agriculture effects	✓✓	✓✓
Environment: air quality, marine and wildlife habitat	✓	✓✓
Social: noise, visual and private property impacts	✓	✓✓
Financial: order of magnitude estimated capital cost[3]		
• Existing Tunnel Upgrade[4]	$0.6B	$0.6B
• Crossing Cost[5]	$2.9B	$2.5B
• Total	$3.5B	$3.1B
• Project Savings towards Transit Improvements	-	$0.4B

The key differences between the options are their relative impacts in terms of:

- Transportation: Option 1 provides two new lanes for vehicle traffic, which would reduce current congestion at the adjacent interchanges on either side of the Tunnel and, consistent with the Regional Growth Strategy, would not increase corridor SOV capacity to other existing crossings such as the Oak Street Bridge. Option 2 provides improved transit and limits expansion of SOV lanes, which would address congestion by encouraging a mode shift to transit operating at a higher level of service (relative to the existing bus operation in general traffic lanes).

- Compatibility with Land Use Plans: Both options are considered compatible with the Regional Growth Strategy as the two additional vehicle lanes for Option 1 are to facilitate merging/diverging at the interchanges and there would be no added SOV capacity beyond those interchanges. As well, the use of TDM measures could be used to manage future

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[3] Order of magnitude estimated costs for Options 1 and 2 are derived from the costs presented for five crossing scenarios in the Project Report (Attachment 12).
[4] Estimated cost of Scenario 1 presented in the Project Report.
[5] Estimated costs of Scenario 3 (10-lane tunnel) and Scenario 4(b) (6-lane tunnel) are $4.3B and $3.4B respectively. Estimated costs of a 4-lane or 2-lane tunnel are derived from the difference of $0.9B.

vehicular travel demand to ensure that an undesirable mode shift to increased private auto use would not materialize and that traffic congestion at the both ends of the Tunnel is reduced.

- Environment/Social: The larger footprint of Option 1 (four new lanes versus two new lanes for Option 2) would have relatively greater impacts to adjacent properties and marine and wildlife habitat.

- Financial: The estimated cost of Option 2 is presumed lower than Option 1 as the new tunnel would be two lanes rather than four lanes. Any surplus funding from the current Project cost of $3.5 billion could be used towards an LRT line for Option 2.

Communications Strategy

Should Council adopt the recommendations of this report, staff plan a number of communications initiatives to publicize the report's findings and recommendations including:

- New Webpage: A new webpage, www.richmond.ca/masseytunnelproject, would be launched on the City's website that includes a summary of the report recommendations and the City's overall position, an outline of the City's concerns with the current project as proposed, a FAQ page addressing specific issues raised by proponents of the Project and links to all Council reports and other relevant City and other documents. The new webpage will also be featured on the City' website's homepage.

- Media Release: The report's findings would be publicized to the media through a media advisory, news release and other outreach activities. Based on the strong media interest generated by Council's initial referral requesting this report, it is anticipated these outreach activities would generate significant media coverage. The report would also be promoted through the City's social media channels.

- Meetings with New Provincial Government: Communications staff will also support Intergovernmental Relations, senior staff and Council in continued representations to the new Provincial government. With the appointment of the new cabinet, staff will be seeking further meetings with key cabinet and NDP and Green Party caucus members to present the City's position in relation to the renewal and improvement of the Tunnel.

Further information on communications activities will be provided to Council in a separate memorandum.

Complementary Measures

In addition to the improvement of the George Massey Tunnel crossing itself, the following additional complementary measures have been identified for consideration as part of an overall project to improve regional transportation in the corridor.

- Transportation Demand Management: TDM measures seek to improve transportation system efficiency by reducing the demand for private auto trips by influencing how trips occur (e.g., by private vehicle versus transit), when trips occur (e.g., peak versus non-peak) and how far trips are made (e.g., reduce trips by providing complete communities with amenities close to where people live). With any alternative crossing option, the use of TDM measures would help manage private SOV use and encourage a shift to HOV (three or more occupants rather than only two or more occupants) and transit use.

Mobility pricing is a potential economic tool (e.g., a higher price for peak hour travel versus a lower price for off-peak hour travel) that could be considered to supplement any option. The application of TDM measures such as mobility pricing would also help manage potential congestion at the Oak Street Bridge by discouraging SOV travel. As TransLink and the Mayors' Council recently established the Mobility Pricing Independent Commission (the Commission), staff recommend that this report be forwarded to the Commission for its consideration in developing recommendations regarding potential measures that could be applied to the region-wide road network rather than at select crossings only.

As well, a review of the existing provincial tolling "policy" is necessary as the current application of tolls at only some crossings creates undesirable travel patterns and does not optimize the use of all crossings as a cohesive, efficient and equitable transportation network (e.g., tolls encourage traffic diversion from the new Port Mann Bridge to the older non-tolled Pattullo Bridge thereby exacerbating congestion at the latter crossing and underutilizing expensive new infrastructure).

- Restriction of Truck Operations: Consider restricting or outright banning truck operations through the crossing during peak hours in order to increase capacity. As part of a mobility pricing system, consider incentives to shift truck operations to off-peak or night-time hours (e.g., commercial vehicles could be exempt from mobility pricing between 10:00 pm and 6:00 am) with the provision of 24-hour trucking and distribution operations.

- Highway 99 Widening: Minimize the widening of Highway 99 to reduce impacts to adjacent properties including agricultural land and the City's Gardens Agricultural Park (located on the west side of Highway 99 north of Steveston Highway), which could be realized with a reduced number of traffic lanes on the new crossing relative to the current Project scope.

- Steveston Highway-Highway 99 Interchange: Improve the efficiency and capacity of the interchange while maintaining its 2-level structure (e.g., twin the existing overpass and reduce the current proposed three-level interchange) and re-designing for a more user-friendly transit exchange.

- Steveston Highway-No. 5 Road Intersection: Integrate effectively with the improved Steveston Interchange and improve the traffic signal efficiency of the intersection to reduce the congestion on local roads that arises from the current configurations of the Tunnel and the Steveston Highway-Highway 99 Interchange.

Freedom of Information Requests

As directed by Council, staff originally submitted two separate Freedom of Information (FOI) requests regarding the George Massey Tunnel Replacement Project in March 2016 and February 2017 as summarized in Table 2 below.

Table 2: FOI Requests Previously Submitted

Date of FOI Request	Information Requested
March 2016	• Plan to Twin the Tunnel: reports and studies relating to the original plan to twin the Tunnel and/or provide rapid bus service that were considered during the period from 2006 to 2008.
February 2017	• Drill Tests: information relating to the measurement of the depth to bedrock beneath the site of the current Tunnel. • Stability of Proposed New Bridge: information on soil stability and liquefaction hazards, the seismic risk of the new bridge and construction costs for the seismic-related works. • Public Transit and the Project: information relating to the feasibility of bus or rail across the new bridge and transit options using the existing Tunnel versus a new LRT tube.

As no meaningful information was received in response to either request, staff have re-submitted the same Freedom of Information requests for new responses.

Request for Alternative Crossing Options from Other Groups

Letters have been sent to the following stakeholders and other interested groups requesting a description and rationale of any preferred alternative crossing options from their perspective: Greater Vancouver Gateway Council, Metro Vancouver, TransLink, Mayors' Council, BC Trucking Association, Greater Vancouver Urban Freight Council, Garden City Conservation Society, and Fraser Voices. Staff have received a preliminary response from the Garden City Conservation Society that describes a crossing option similar to Option 2 (Attachment 14).

Financial Impact

None.

Conclusion

Options 1 and 2 presented in this report are illustrative but feasible concepts intended to stimulate discussion and emphasize the need for a comprehensive, transparent and collaborative analysis of alternative crossing improvement options for the George Massey Tunnel. Any crossing options should adhere to federal, provincial, regional, and local strategies, policies and targets to reduce greenhouse gas emissions, particularly as the transportation sector is the second largest GHG emitter in Canada.

Indeed, the *Pan-Canadian Framework on Clean Growth and Climate Change*[6] (Attachment 13) signed in December 2016 by the Prime Minister and all provincial Premiers (except Saskatchewan) commits the signatories to work collaboratively to reduce GHG emissions and enable sustainable economic growth. While pricing carbon pollution is a core element of the Framework, it also identifies complementary actions related to transportation to support "the shift from higher to lower-emitting types of transportation, including through investing in infrastructure," which includes investments in public transit upgrades and expansions.

As the current scope of the George Massey Tunnel Replacement Project includes the significant expansion of SOV capacity, the Project is not compatible with the intent of the Framework and

[6] https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework.html.

should be revised to emphasize infrastructure improvements for public transit and HOV rather than private vehicles.

J Caravan

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(604-276-4035)

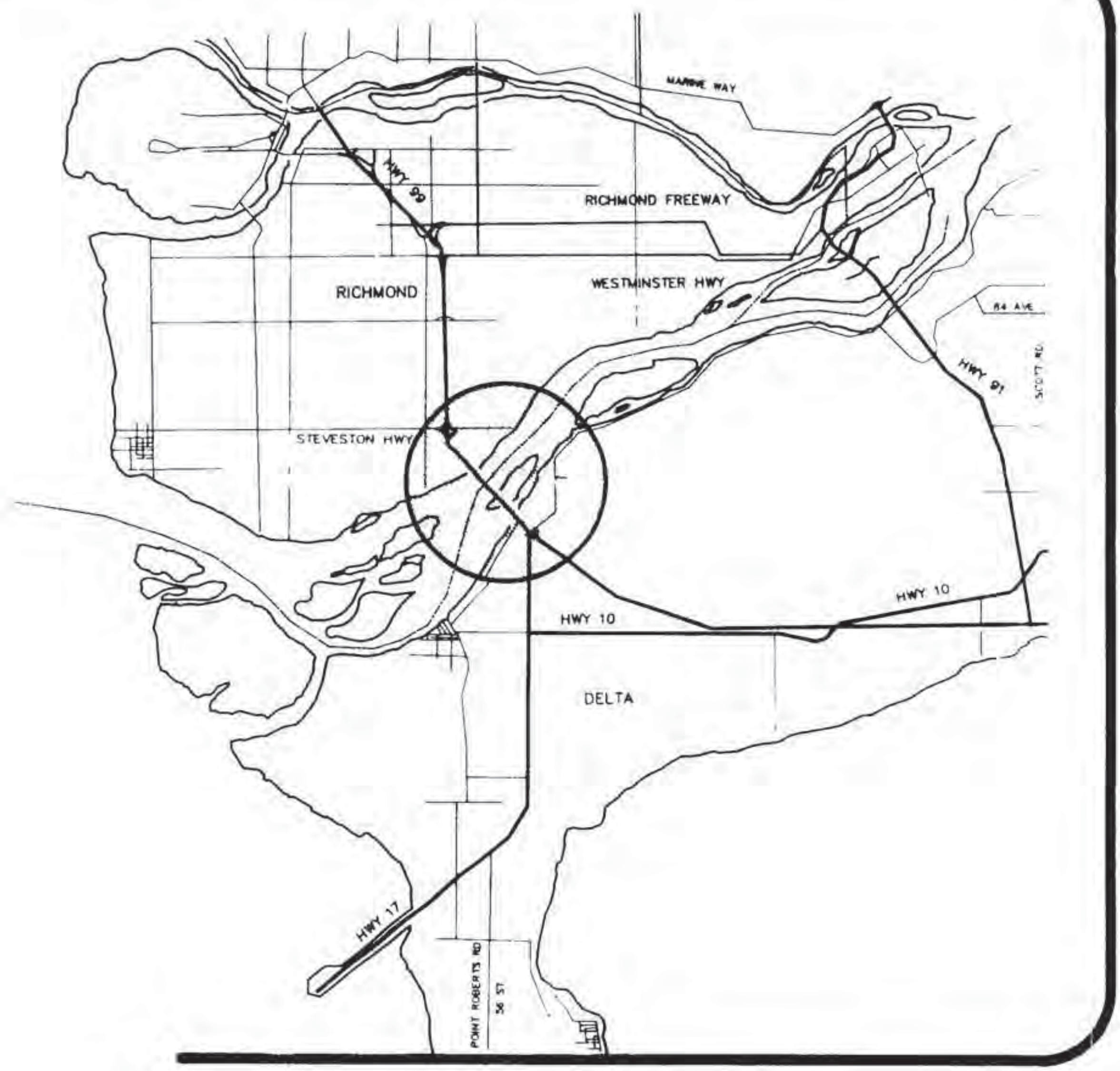
JC:jc

Att. 1: *George Massey Tunnel Expansion Planning Study*, Ward Consulting Group, March 1991.
Att. 2: *Transport 2021: A Long-Range Transportation Plan for Greater Vancouver*, Province of BC and Greater Vancouver Regional District, September 1993.
Att. 3: *Fraser River North and South Arm Crossing Study*, Reid Crowther and Ward Consulting Group, July 1995.
Att. 4: *Gateway Program – Program Definition Report*, Province of BC, January 2006.
Att. 5: "Tunnel will be twinned," *Richmond Review*, February 18, 2006.
Att. 6: Proposed Project Components: Bridge and Highway 99-Steveston Highway Interchange
Att. 7: *George Massey Tunnel Replacement Project – Analysis of Regional Impact*, Metro Vancouver, June 24, 2016.
Att. 8: Summary of Council Concerns with Current Proposed Project
Att. 9: Media Release from Port of Vancouver regarding Dredging of Fraser River
Att. 10: Newspaper Notice placed in Richmond News by Municipality of Delta
Att. 11: "Close up: Vancouver's disaster preparedness – Earthquake strategy is B.C.'s infrastructure priority," *Vancouver Sun,* December 16, 2008.
Att. 12: *George Massey Tunnel Replacement: Review of Replacement Options*, WSP/MMM Group, July 2016.
Att. 13: *Pan-Canadian Framework on Clean Growth and Climate Change*, Government of Canada, December 2016.
Att. 14: *Massey Crossing rationale*, Garden City Conservation Society.

Attachment 1

Report to

MINISTRY OF TRANSPORTATION AND HIGHWAYS



On

GEORGE MASSEY TUNNEL EXPANSION PLANNING STUDY

ward consulting group

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• Traffic Impact
• Parking
• Transportation Planning
• Traffic Operations
• Transit
• Trucking
• Modelling

4

March 26, 1991

Ministry of Transportation and Highways
South Coast Regional District
7818 Sixth Street
Burnaby, B.C.
V3N 4N8

Attention: Ms. Maria Swan, P.Eng.
Senior Transportation Planning Engineer

Dear Sir:

RE: Expansion of George Massey Tunnel -
Preliminary Planning Study

In accordance with your instructions, we have now carried out the preliminary planning study of the future expansion of the George Massey Tunnel on Highway 99. The attached report presents an overview of the study together with the resultant conclusions and recommendations.

Thank you for the opportunity to work on this project on behalf of the Ministry. I trust that this report enables your staff to continue with the next steps necessary to bring these recommendations to fruition.

Yours truly,

WARD CONSULTING GROUP

Trevor J. Ward, P.Eng., M.B.A.
Principal

145gmasy\gmt.rpt

520 - 1112 West Pender Street, Vancouver, British Columbia, Canada V6E 2S1 • Tel: (604) 688-8826 Fax: 688-9562

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1.0 INTRODUCTION

1.1 Background to Study

Greater Vancouver is divided by a number of bodies of water, one of which is the Fraser River. When this river reaches Queensborough in New Westminster, it divides into two segments, these being the North and South Arms with the main flow being along the latter. For the purpose of this study the South Arm will be taken to include the main flow east of Queensborough.

The George Massey Tunnel which passes beneath the South Arm is one of only four crossings of the main flow of the river with the others being the Alex Fraser Bridge (also across the South Arm), and the Pattullo and Port Mann Bridges. These river crossings link the municipalities of Delta, Surrey, White Rock, and Langley in the south to the remainder of Greater Vancouver. These municipalities on the south side are primarily residential whereas the region's large employment areas are located on the north side of the river. The George Massey Tunnel is therefore a very strategic component of Greater Vancouver's regional road network. Not only is this crossing a vital link between the two segments of the region but any capacity restraint on this crossing quickly affects the other crossings as well.

Over the past 10 years, the capacity across the South Arm has been increased a number of times. This has been through the introduction of the northbound contra flow lane in the tunnel during the morning peak period in 1981, the opening of the four lane Alex Fraser Bridge in 1986, the widening of this bridge to three lanes southbound as well as the introduction of the southbound contra flow lane in the tunnel during the afternoon peak period in 1989, and the extension of the Vancouver to New Westminster SkyTrain to Surrey in 1990.

Although these improvements have provided some relief to the tunnel as well as to the other river crossings, the tunnel is once again near its practical capacity in both the morning and afternoon peak periods due to the constant increase in vehicular travel, particularly as a result of the continued development of residential areas south of the Fraser River and employment opportunities north of the river. Furthermore, accidents or breakdowns often occur in the tunnel and these cause extensive delays to traffic travelling to or from work or on business during the peak periods - sometimes it requires up to 2 or 3 hours to clear the cause and get the traffic back to normal. This situation, which occurs at least once per week, has a very negative impact on tunnel users, no matter whether they are travelling by automobile, bus or truck.

The provision of the additional capacity across the Fraser River over the past few years has in itself resulted in an increase in the attractiveness of the residential developments in areas south of the river. This in turn has resulted in an accelerated growth in travel demand across the river as these residents travel to and from their places of work in the employment centres in Vancouver, Richmond and Burnaby. This growth is likely to continue into the future. Another factor influencing the growth in travel across the river is the fact that B.C. Ferries is currently in the planning stage of an expansion program that will see the capacity of their Tsawwassen Ferry Terminal almost doubled and larger ships in service.

As demand in travel across the Fraser River continues to increase year after year, the Ministry of Transportation and Highways recognised that there is a need to undertake a study to determine where, when, and how the existing capacity across the South Arm should be expanded. Once these issues have been addressed, then the real planning for the implementation of the recommended improvements can be commenced. Hence the initiation of this study.

1.2 Scope of Study

Ward Consulting Group was engaged by the Ministry to carry out a preliminary planning study to consider the need for, and the form of, any future expansion of the existing George Massey Tunnel. In undertaking this review, it was requested that the overall travel demand across the South Arm of the Fraser River during the next ten years be analyzed and that the feasibility of other alternative crossings separate from the tunnel also be examined. As a result of this analysis a planned program of improvements to the regional road network is to be determined so that the projected travel demand across the river through to the year 2001 can be accommodated in the most effective and efficient manner.

In developing the analysis, the Ministry asked the Ward Consulting Group to employ the EMME2 model in the same general manner as it was used in the 1989 "Freedom to Move" study. The approach allowed a direct comparison between alternatives since all newly constructed road capacity was assigned to general purpose traffic. The Ministry is considering the possible peak hour designation of some new road capacity for bus or combined bus and carpool traffic. In order to estimate the attractiveness of such laning and the influence on vehicle demand it would be necessary to have confident information concerning some other transportation decisions. These would include the timing, routing and technology for the Richmond to Vancouver Transit system, allocation of bus or combined bus and carpool lanes across the North Arm, the long term service policy for passenger only ferries, how the Whalley Transit extension will be integrated with the South Surrey & White Rock bus service and the general policy for Park and Ride or Park and Pool lots. With this many uncertainties it was decided that the effectiveness of special vehicle lane designations could not be determined within the scope of the study.

In developing the analysis, the Ministry asked the Ward Consulting Group to employ the EMME2 model in the same general manner as it was used in the 1989 "Freedom to Move" study. The approach allowed a direct comparison between alternatives since all newly constructed road capacity was assigned to general purpose traffic. The Ministry is considering the possible peak hour designation of some new road capacity for bus or combined bus and carpool traffic. In order to estimate the attractiveness of such laning and the influence on vehicles demand it would be necessary to have confident information concerning some other transportation decisions. These would include the timing, routing and technology for the Richmond to Vancouver Transit system, allocation of bus or combined bus and carpool lanes across the North Arm, the long term service policy for passenger only ferries, how the Whalley Transit extension will be integrated with the South Surrey & White Rock bus service and the general policy for Park and Ride or Park and Pool lots. With this many uncertainties it was decided that the effectiveness of special vehicle lane designations could not be determined within the scope of the study.

This report addresses the analyses carried out in this study and presents the resultant findings, conclusions, and recommendations.

1.3 History and Role of the George Massey Tunnel

The four-lane 2,100 foot George Massey Tunnel was constructed under the South Arm of the Fraser River at Deas Island in the early 1960's by the Ministry of Transportation and Highways as part of what was then known as Deas Tunnel Through-Way. This four-lane, 25-mile divided freeway, including the George Massey Tunnel itself (then called the Deas Tunnel), extending from the Oak Street Bridge which crosses the North Arm, to the United States border to the south was officially opened in 1962. The new tunnel provided the only direct vehicular access between the adjacent municipalities of Richmond and Delta, replacing the ferry service that had been in operation for a number of years. The only other river crossing available at that time was the Pattullo Bridge, 16.5 kilometres to the east, on the then Highway 1 linking Surrey to New Westminster.

Highway 99 is now one of two provincial highways that feed traffic into the south end of the tunnel, the other being Highway 17, which primarily serves the Delta communities of Tsawwassen and Ladner and the B.C. Ferries' Tsawwassen Ferry Terminal. Ferry services run from this point to Swartz Bay (Victoria), the Gulf Islands, and, commencing in 1990, to Nanaimo. The two highways join together approximately 1.5 km south of the tunnel. On the south side of the river, the Steveston Highway joins Highway 99 a short distance north of the tunnel. Further to the north, Westminster Highway and the Richmond Freeway both join into Highway 99. The location of the tunnel in the context of the regional road network is illustrated in Exhibit 1.1.

It is apparent that the George Massey tunnel plays an important role in the regional road network of Greater Vancouver, particularly for the population living in the southern segments of Delta, Surrey and Langley. It is also a key facility for trucks moving goods into and out of Vancouver and its international port. The 1989 "Freedom to Move" study undertaken by the Greater Vancouver Transportation Task Force looked at the road and transit networks of Greater Vancouver. A number of the resultant recommendations on improvements required through to the year 2001 related to the George Massey Tunnel and Highway 99. These were:

- provide a third tube in the tunnel;
- construct the new Blundell Road Interchange on Highway 99; and
- provide a new freeway around the east side of Ladner connecting Highway 17 at Tsawwassen to Highway 99.

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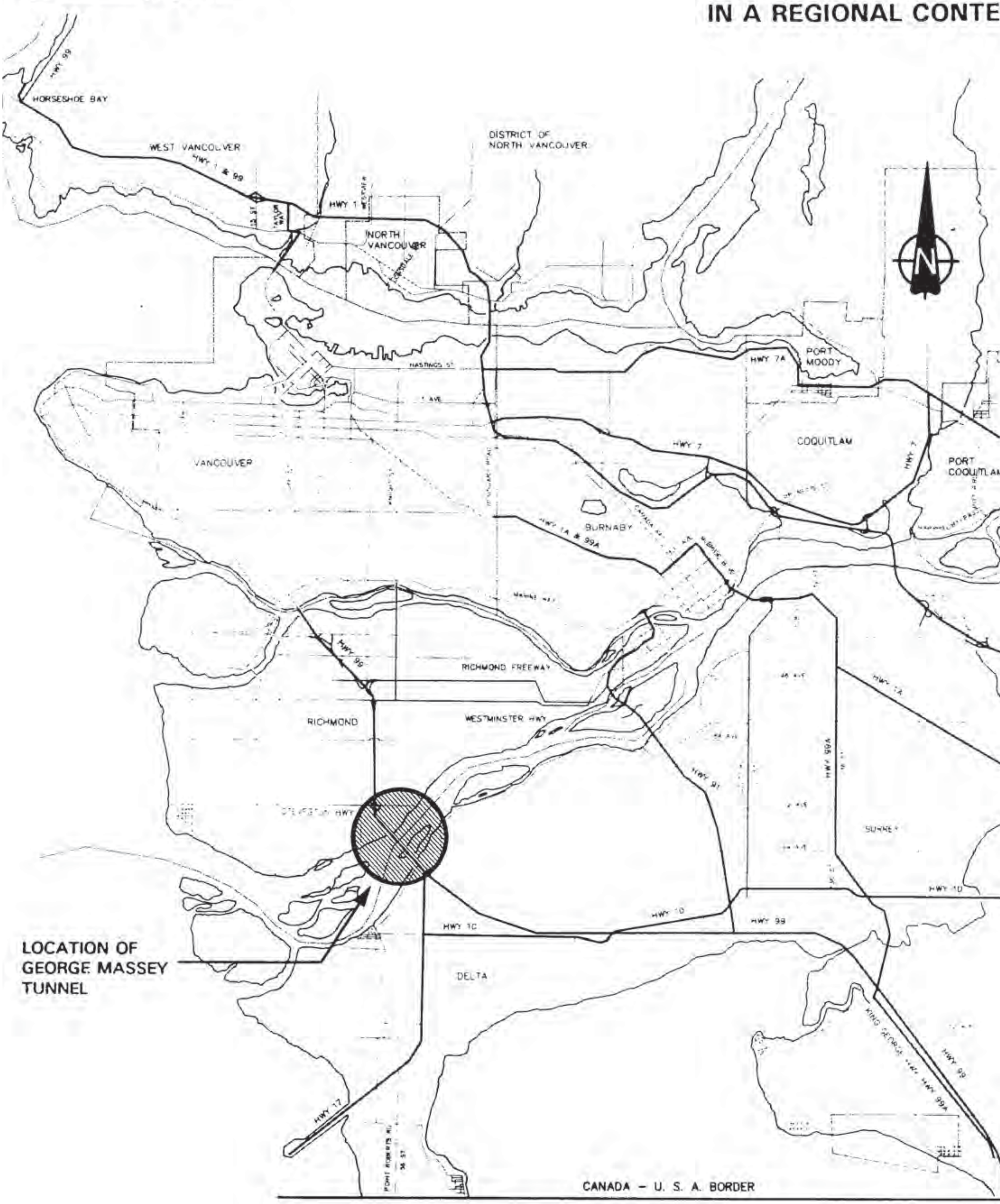
EXHIBIT **1.1**

GEORGE MASSEY TUNNEL IN A REGIONAL CONTEXT



2.0 EXISTING TRANSPORTATION SYSTEM

2.1 Regional Road Network

As already noted, the George Massey Tunnel is one of four crossings of the main flow of the Fraser River. The others are the Alex Fraser Bridge located 4.5 kms. to the east, the Pattullo Bridge, a further 3.5 kms. to the east, and the Port Mann Bridge, another 5.0 kms. east. Each of these river crossings are an integral component of a major regional highway, linking various segments of Greater Vancouver together. These crossings and their key features are presented in summary form in Table 2.1 and the location of each of these river crossings as well as others across the North Arm are shown in Exhibit 2.1. Note that although the Alex Fraser Bridge is three lanes in each direction, Highway 91 at the north end of the bridge is currently only two lanes northbound. At the present time, the only South Arm crossings that are connected to each other via a high capacity link, ie., an expressway or freeway, are the George Massey Tunnel and the Alex Fraser Bridge. These are connected via the Richmond Expressway (Highway 91) which runs along the north side of the South Arm and Highway 99. These two highways also join each other to the south of the river. The only other provincial highways of any significance in this study are Highway 17 which links the Tsawwassen Ferry Terminal to Highway 99 immediately south of the tunnel, and Highway 91A which links the Alex Fraser Bridge to the Queensborough Bridge which crosses the North Arm into New Westminster. Each of these highways are shown in Exhibit 2.2.

Table 2.1
Fraser River Crossings

River Crossing	No. of Lanes	Highway	Municipality From	Municipality To
George Massey Tunnel	4	Highway 99	Delta South Surrey White Rock U.S.A.	Richmond Vancouver
Alex Fraser Bridge	6	Highway 91	Surrey North Delta	New Westminster Richmond Burnaby Vancouver
Pattullo Bridge	4	Highway 1A	Surrey North Delta	New Westminster Burnaby
Port Mann Bridge	4	Highway 1	Surrey Langley Fraser Valley	Coquitlam Burnaby Port Coquitlam New Westminster Vancouver North Shore

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EXHIBIT **2.1**

GREATER VANCOUVER'S RIVER CROSSINGS

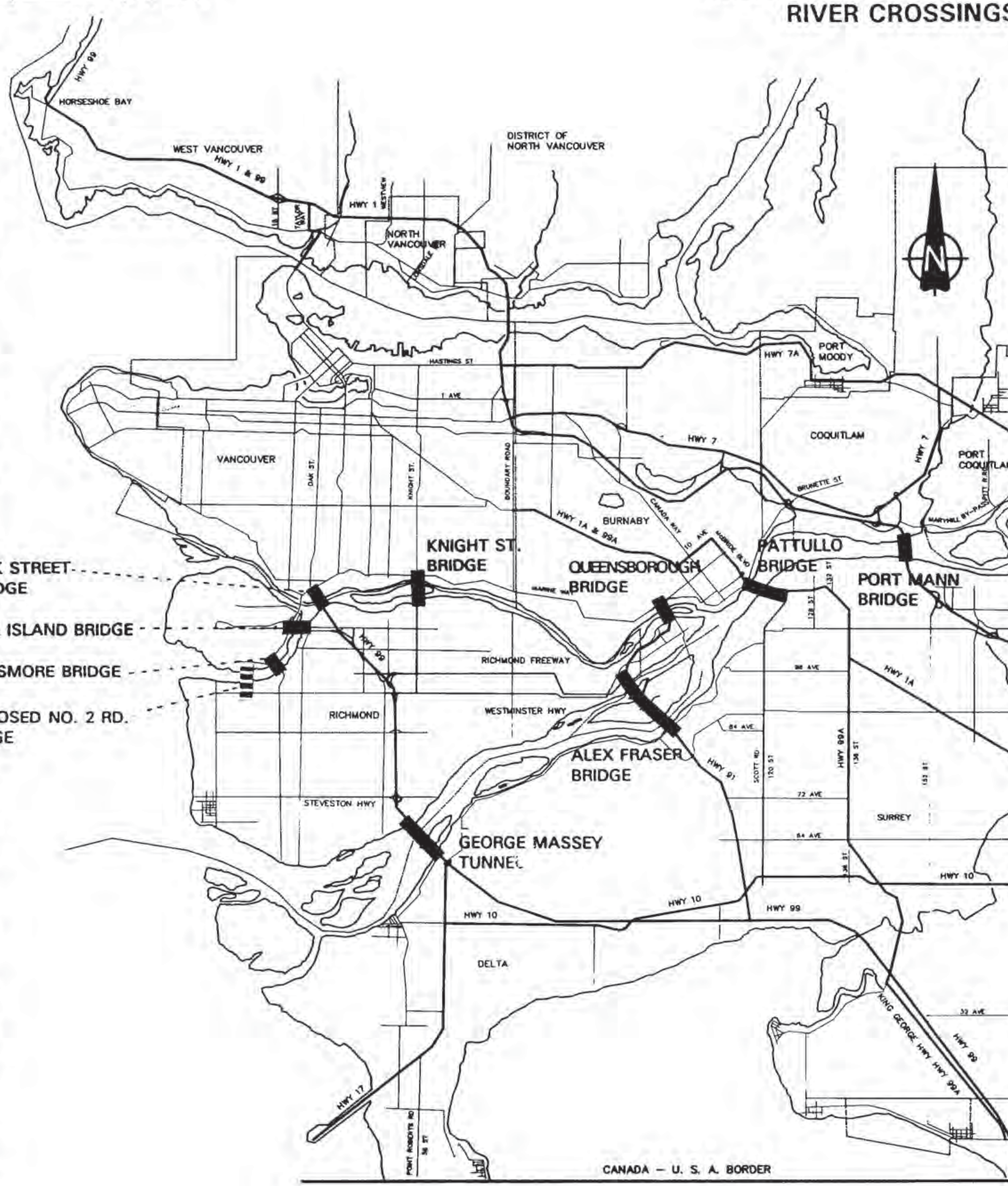
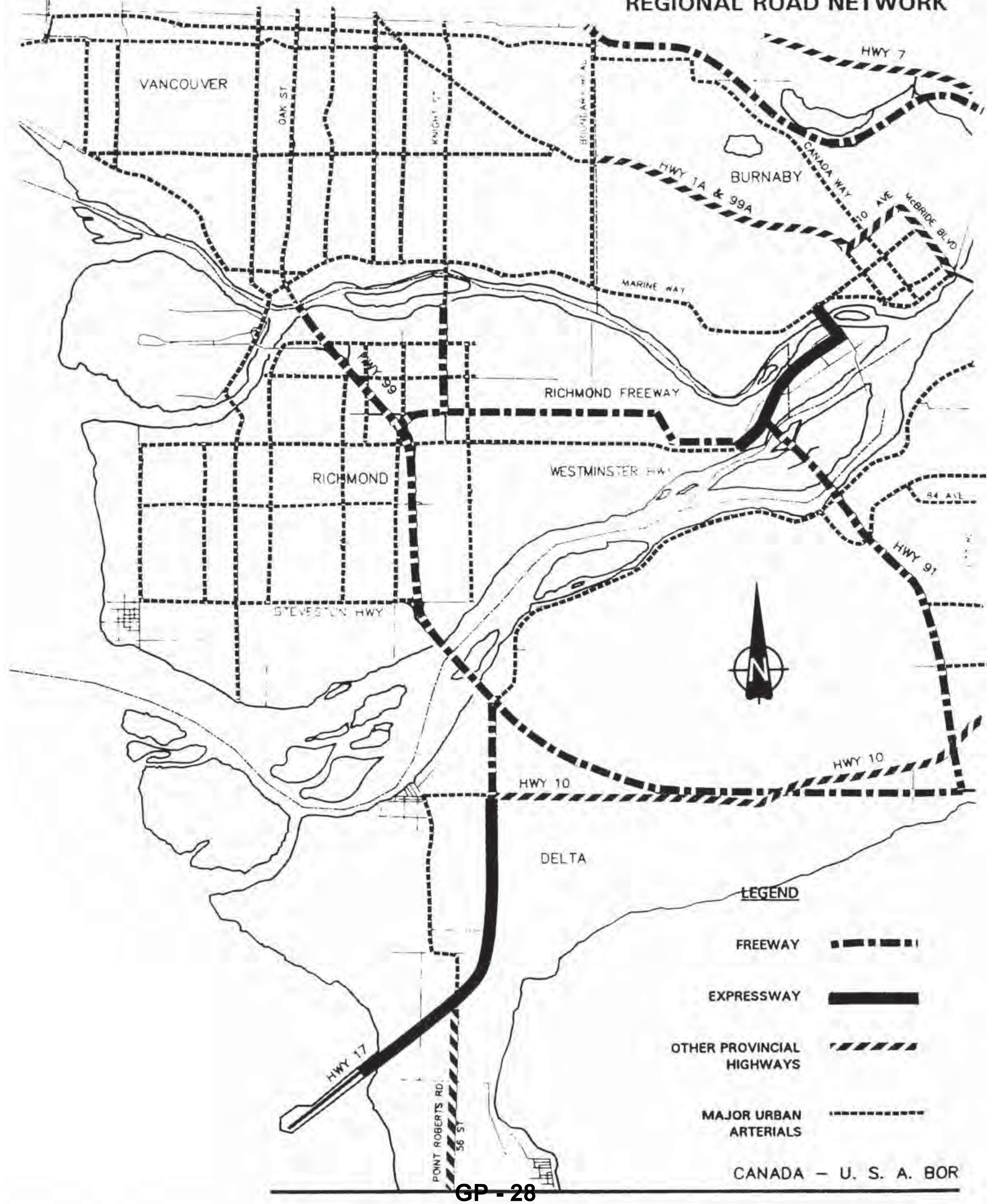


EXHIBIT 2.2

REGIONAL ROAD NETWORK



Other major municipal roads of significance in this particular George Massey Tunnel Expansion Study are:

- River Road linking Highway 17 at the Ladner Interchange on Highway 99 to the Tilbury Business Park and on to Scott Road with a connection to Highway 91 via Nordel Way;
- No. 3 Road, No. 4 Road, No. 5 Road and No. 8 Road - north south arterials extending across Richmond between the Middle and South Arms of the Fraser River;
- Steveston Road which provides a link between the south end of Richmond's north-south arterials and Highway 99 via the Steveston Interchange which is located immediately north of the tunnel;
- Ladner Trunk Road which connects the residential area of Ladner to Highway 17 and then becomes Highway 10 to the east of this point; and
- Blundell Road, another east-west arterial in Richmond which does not at present have a connection to Highway 99.

The location of these roads are also shown in Exhibit 2.2.

2.2 Current Traffic Volumes on Fraser River Crossings

Current traffic volume data for each of the river crossings was obtained from the Ministry's Planning Services Branch. The 1989 morning and afternoon peak hour volumes at each of the crossings are presented in Table 2.2. The relative magnitude of the volume of vehicles at each crossing in the morning peak hour is illustrated in Exhibit 2.3. The variation in volumes in the George Massey Tunnel and the Alex Fraser Bridge during a typical day are illustrated in Exhibit 2.4. Note that these graphs are based on data for September 1989. The reverse lane in the tunnel in the afternoon peak hour was introduced in October 1989 and therefore Exhibit 2.4 reflects three northbound lanes in the morning peak period but only two southbound lanes in the afternoon peak period. It is apparent from this exhibit that whilst both crossings exhibit the same overall pattern with high northbound peaks in the morning and high southbound peaks in the afternoon, in the George Massey Tunnel the afternoon peak hour is significantly lower than the morning peak hour, whereas on the Alex Fraser Bridge these peaks are approximately equal. This difference is no doubt due to the fact that free flow conditions exist the junction of Highway 91 and Highway 91A for southbound traffic travelling south on Highway 99 to east on the Richmond Freeway and south over the Alex Fraser Bridge in the afternoon peak hour whereas the reverse movement in the morning peak hour faces significant delays as a result of the left turn movement at this signalized intersection.

From this data, the following should be noted:

- The highest peak hour volumes are in the George Massey Tunnel with 5,850 northbound in the morning and Alex Fraser Bridge with 5,510 southbound in the afternoon - both of these facilities have three lanes in the same direction as these peak flows;
- Peak flows on the Oak Street, Knight Street, Pattullo and Port Mann Bridges are all in

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EXHIBIT 2.3

RIVER CROSSING VOLUMES IN THE MORNING PEAK HOURS

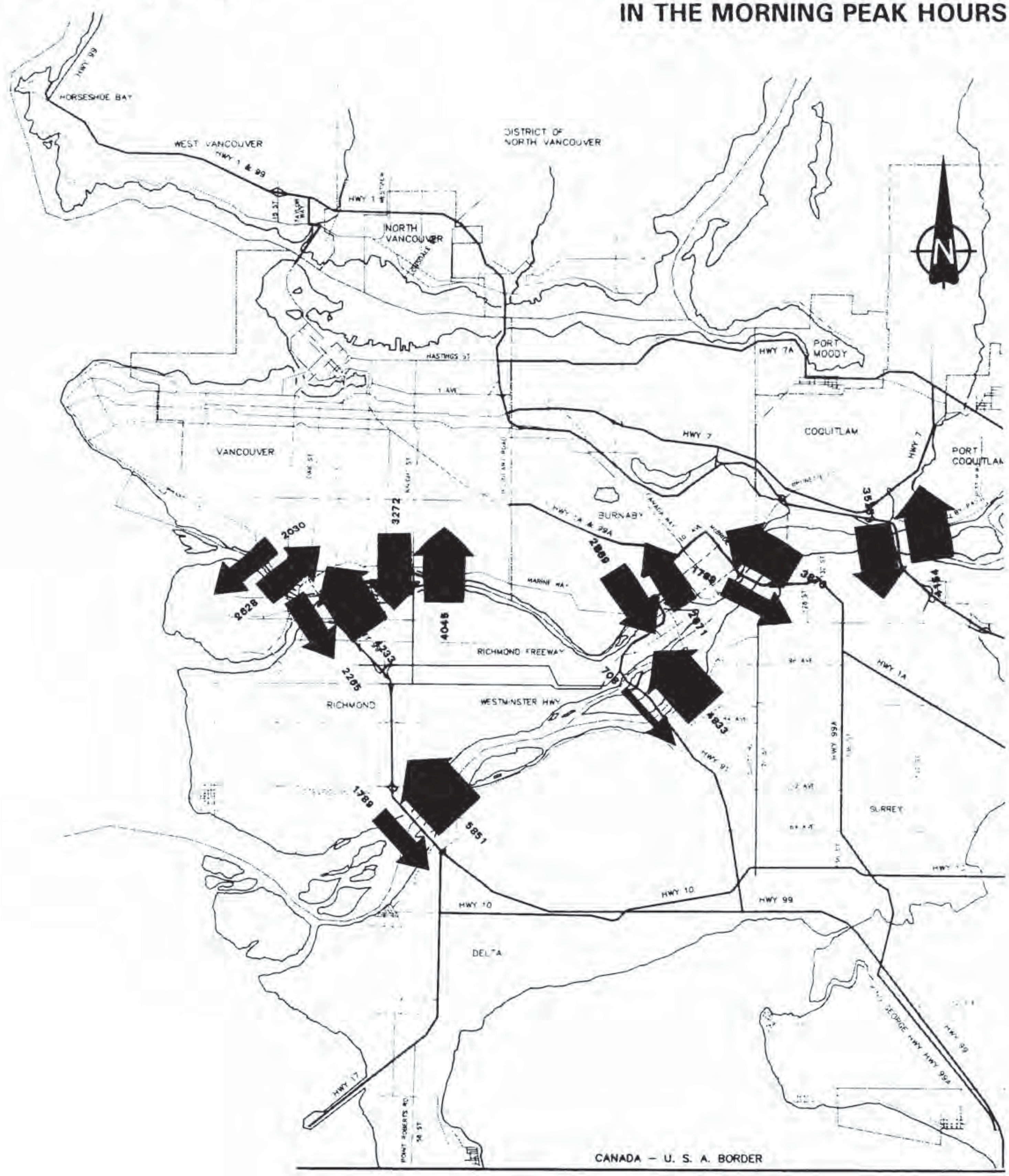

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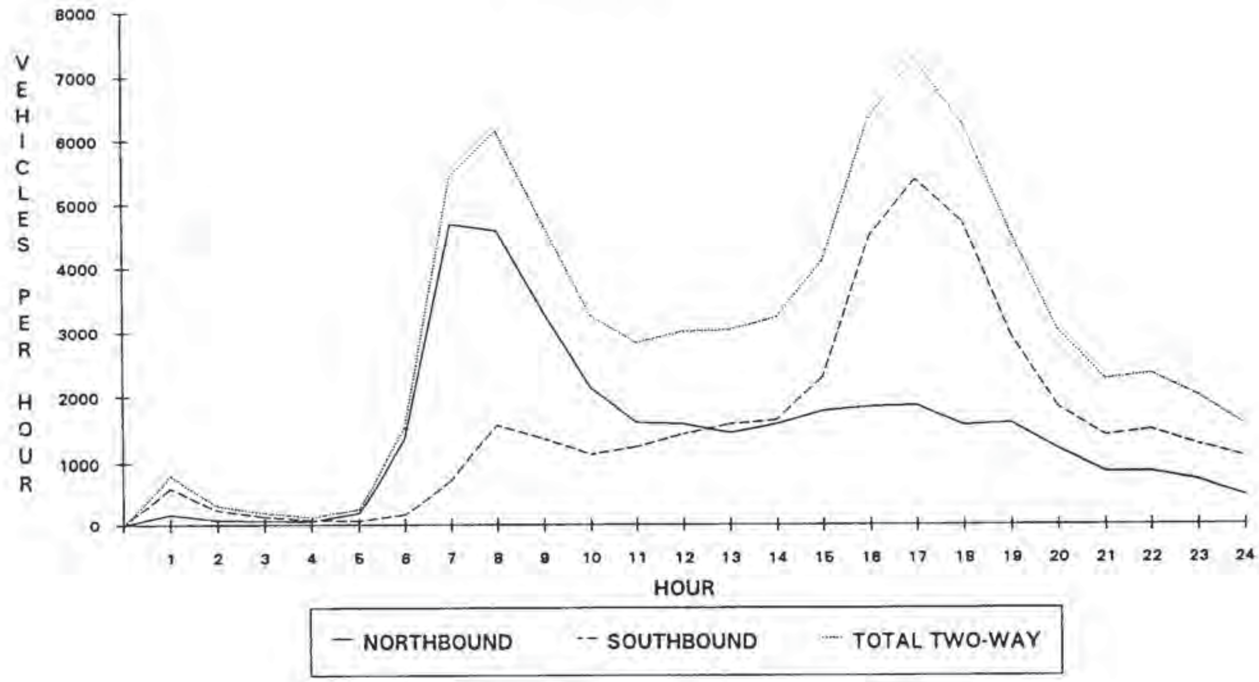
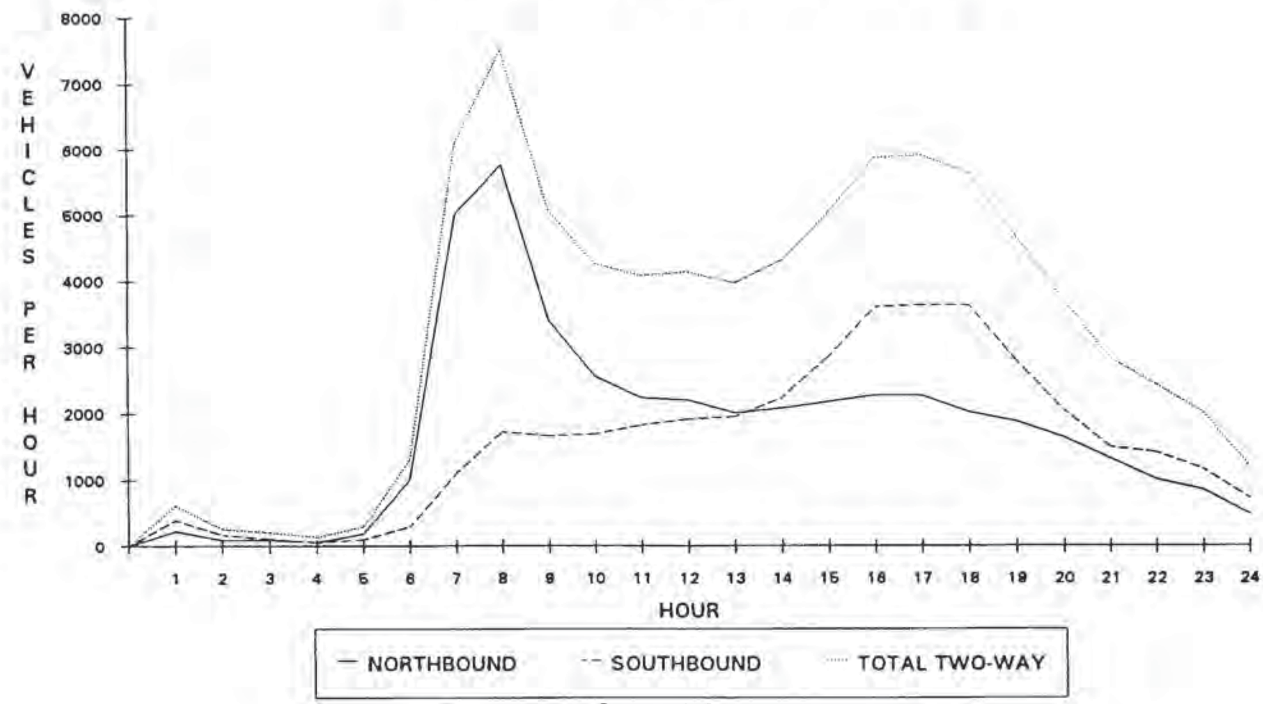
EXHIBIT 2.4

VARIATION IN HOURLY VOLUMES AT RIVER CROSSINGS

ALEX FRASER BRIDGE - SEPTEMBER 1989



GEORGE MASSEY TUNNEL - SEPTEMBER 1989



the range 3,870 to 4,230 - all of these facilities have two lanes in each direction;

- For both arms of the river, the northbound direction is the peak direction in the morning peak hour and the southbound direction is the peak direction in the afternoon peak hour - this is not a new revelation.

Table 2.2
1989 Peak Hour Traffic Volumes on Fraser River Crossings

	Morning		Direction Ratio	Afternoon		Direction Ratio
North Arm	Northbnd	Southbnd	Peak/Off-Peak	Northbnd	Southbnd	Peak/Off-Peak
Arthur Laing	2628	2032	1.29	2049	2216	1.08
Oak St. Bridge	4233	2265	1.87	2668	3939	1.48
Knight St. Bridge	4045	3272	1.24	3802	3746	1.01
Queensborough Bridge	2671	2869	1.07	2933	2729	1.07
Total North Arm	13577	10438	1.30	11452	12630	1.10
South Arm						
George Massey Tunnel	5851	1747	3.35	1485	4301	2.90
Alex Fraser Bridge	4833	708	6.83	1801	5509	3.06
Pattullo Bridge	3870	1789	2.16	1953	3564	1.82
Port Mann Bridge	4154	3525	1.18	3531	4151	1.18
Total South Arm	18708	7769	2.41	8770	17525	2.00

- The imbalance in directional volume is considerably more pronounced on the South Arm where in the morning, the peak direction is 140 % higher than the off-peak direction overall (18,710 vs. 7,770) whereas on the North Arm in the same time period it was only 30% higher (13,557 vs. 10,438) - this is because a significant number of residents living in Vancouver, Burnaby and the North Shore commute to work at places of employment in Richmond, whereas very few residents living north of the South Arm commute to work in Delta or Surrey.

- The directional imbalance is greatest on the Alex Fraser Bridge which has a very low flow in the off peak direction, especially in the morning peak hour - this is no doubt because of the lack of any significant number of job opportunities in North Delta.

- The George Massey Tunnel has the next highest directional imbalance - this is a result of the reversible counter-flow lane in the peak periods which provides three lanes in one direction and only one in the opposite.

- The 1989 southbound volume in the afternoon peak hour is slightly lower than the northbound volume in the morning peak hour confirming the often stated belief that commuters are now more inclined to spread out their times for travel when commuting home from work in the afternoon than they are to change their time of travel to work in the morning. Each of the individual crossings follow this same pattern with the exception of the Queensborough Bridge which experiences the reverse to this pattern in both peak periods.

Table 2.3
Historic Peak Hour Crossing Volumes of the Fraser River

	Actual Counts Year 1979		Actual Counts Year 1984		Actual Counts Year 1989	
(a) Morning Peak Hour	NB	SB	NB	SB	NB	SB
North Arm						
Arthur Laing	1,400	1,100	1,250	1,100	2,628	2,032
Oak St. Bridge	3,917	1,523	4,172	1,903	4,233	2,265
Knight St. Bridge	2,428	2,727	3,472	2,817	4,045	3,272
Queensborough	818	1,982	786	1,696	2,671	2,869
Total North Arm	8,563	7,331	9,680	7,516	13,577	10,438
South Arm						
George Massey	4,167	1,524	5,930	1,492	5,851	1,747
Alex Fraser	-	-	-	-	4,833	708
Pattullo	3,871	1,883	4,098	1,631	3,870	1,789
Port Mann	3,764	2,171	3,615	2,426	4,154	3,525
Total South Arm	11,802	5,578	13,643	5,549	18,708	7,769
(b) Afternoon Peak Hour						
North Arm						
Arthur Laing	1,050	1,300	850	1,550	2,049	2,216
Oak Street	2,674	3,428	2,644	3,753	2,668	3,939
Knight Street	3,047	2,892	3,048	3,313	3,802	3,746
Queensborough	1,895	1,044	1,701	754	2,933	2,729
Total North Arm	8,666	8,664	8,243	9,370	11,452	12,630
South Arm						
George Massey	1,797	3,753	1,760	3,986	1,485	4,301
Alex Fraser	-	-	-	-	1,801	5,509
Pattullo	2,062	3,582	1,796	3,814	1,953	3,564
Port Mann	2,612	3,966	2,538	4,207	3,531	4,151
Total South Arm	6,471	11,301	6,094	12,007	8,770	17,525

2.3 Historic Growth in Traffic Volumes

Traffic counts recorded at each of the crossings of the Fraser River between the years 1979 to 1989 were also obtained in order to establish the historic growth in traffic volumes across the two arms which will be treated as screen lines in the analysis carried out in this study. The results of analyzing this data are presented in Tables 2.3 and 2.4 and illustrated in Exhibits 2.5 through to 2.8. Note that all data used

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EXHIBIT **6.8**

PROPOSED CONCEPTUAL PLAN OF HIGHWAY 99 BLUNDELL TO RICHMOND FREEWAY

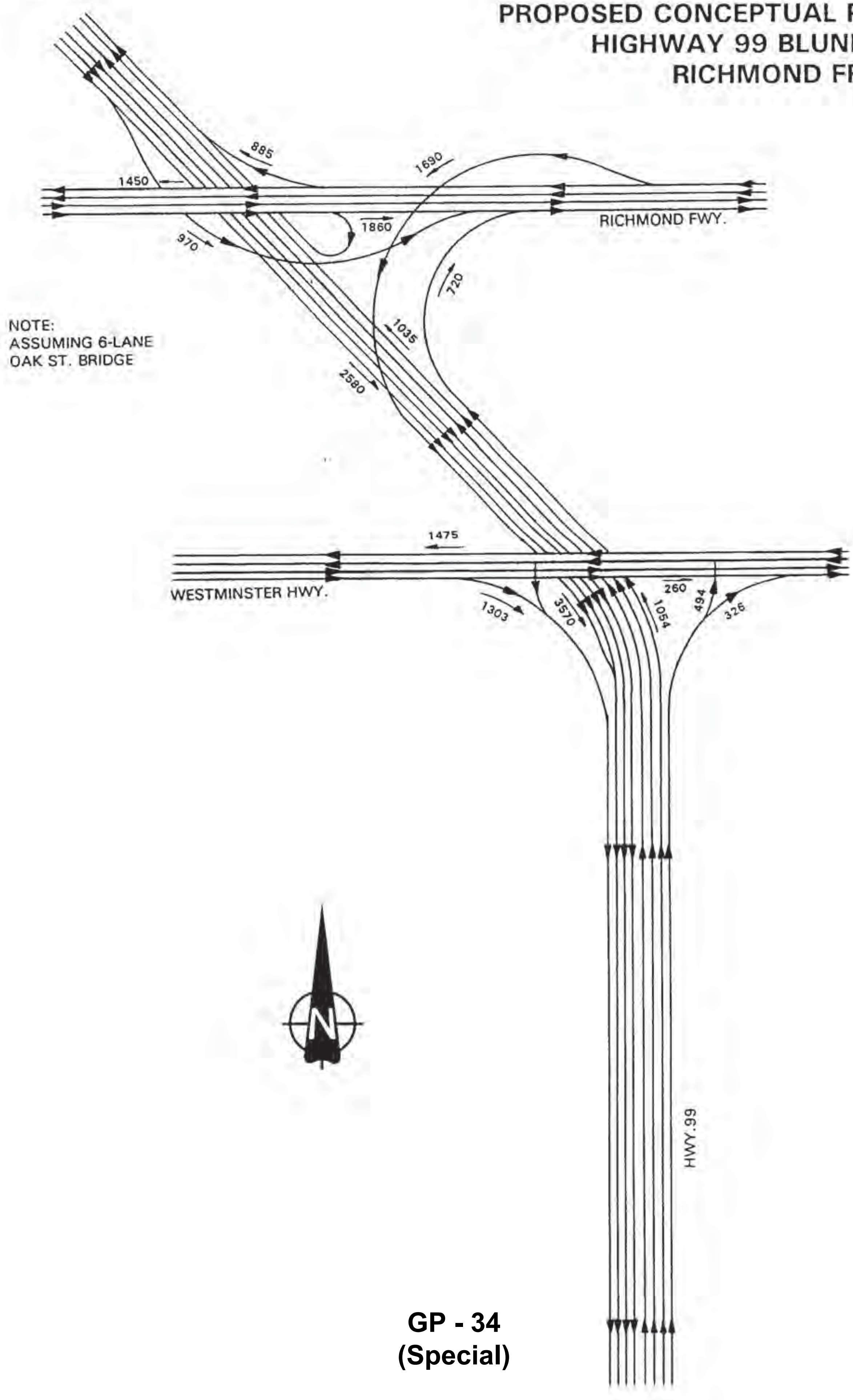

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EXHIBIT **6.9**

PROPOSED CONCEPTUAL PLAN OF NEW HIGHWAY 17 TO HIGHWAY 99 CONNECTOR IN SHORT TERM UPGRADING

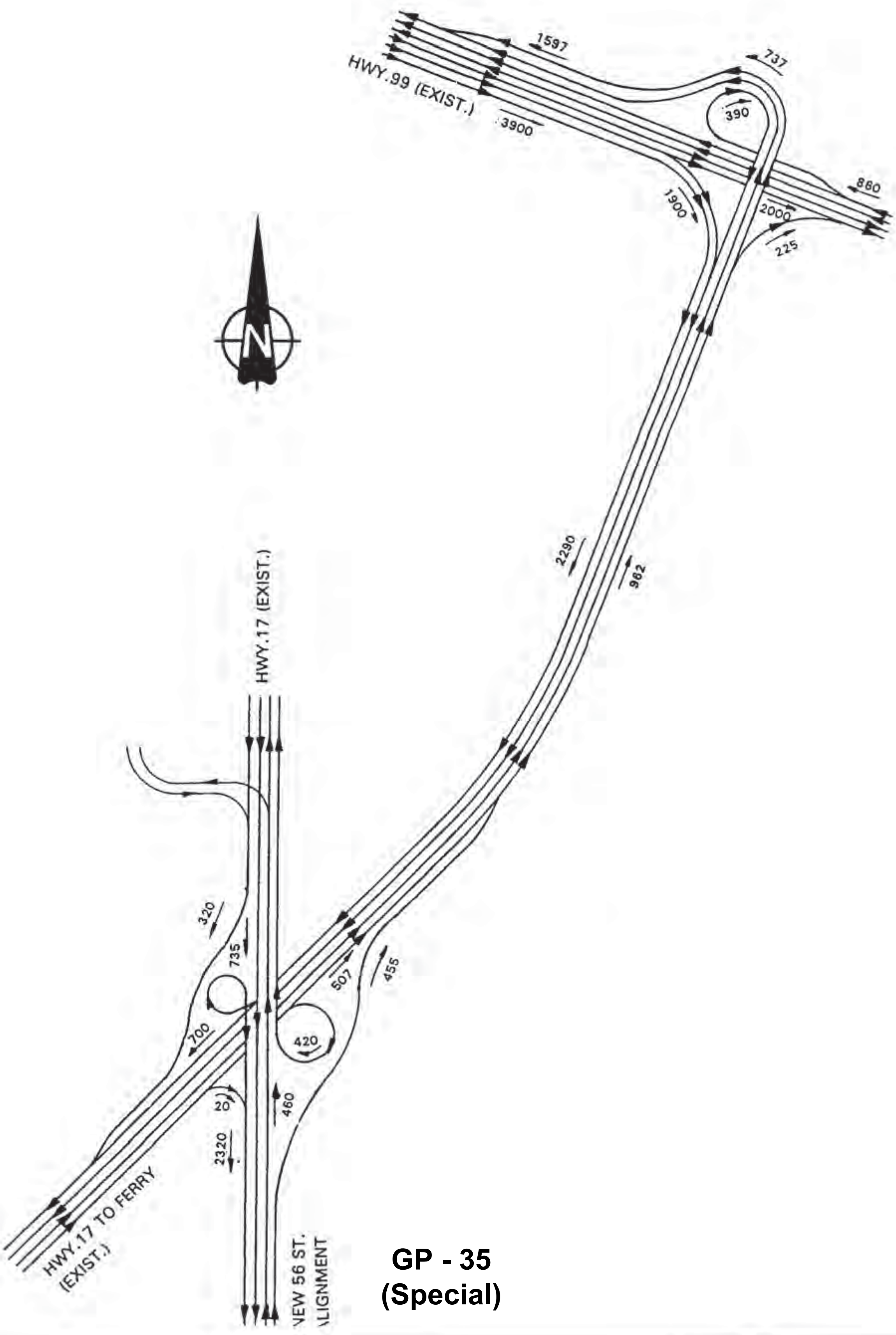

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EXHIBIT **6.10**

PROPOSED CONCEPTUAL PLAN OF HIGHWAY 17 INTERCHANGE WITH WITH TSAWWASSEN FREEWAY

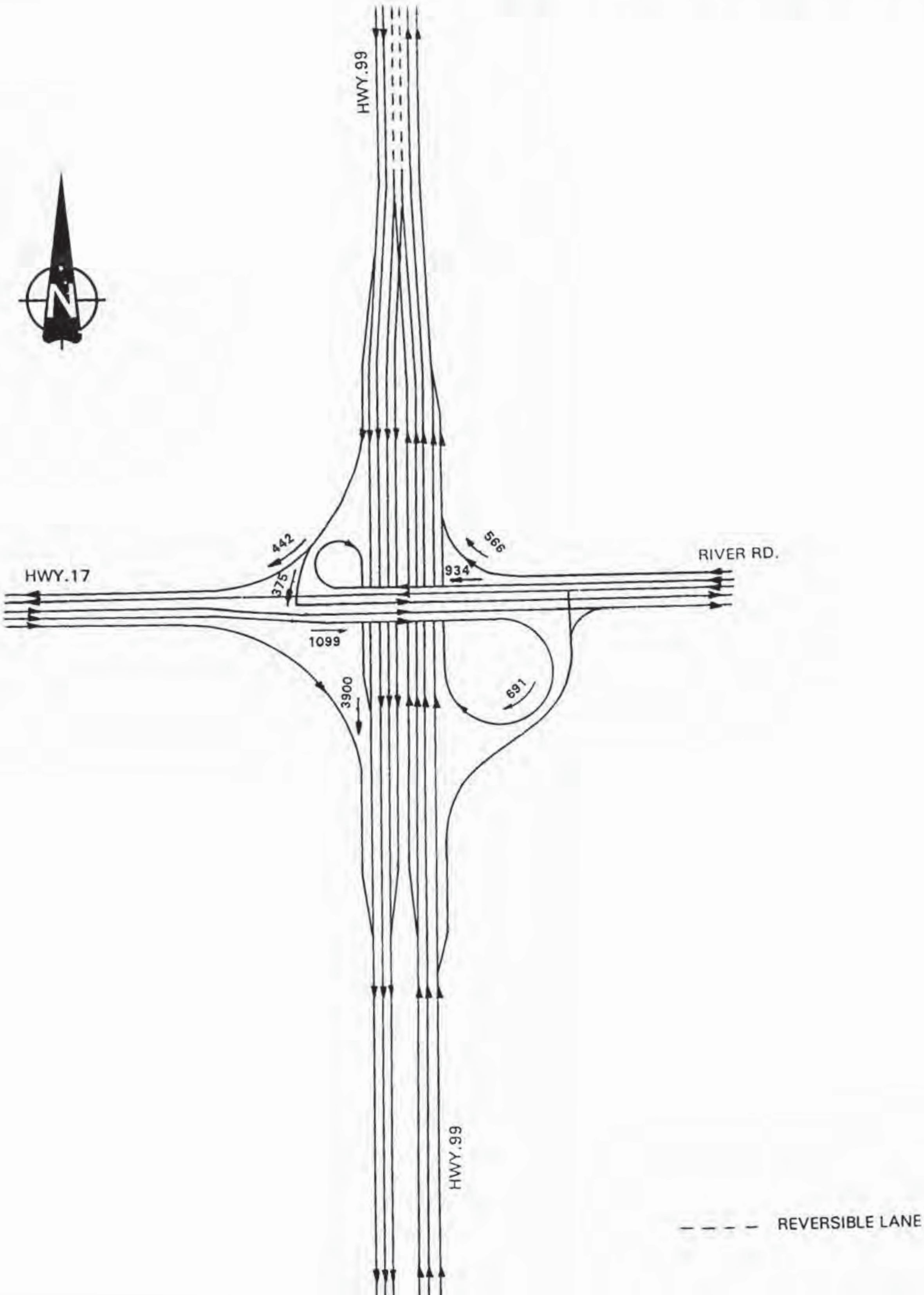

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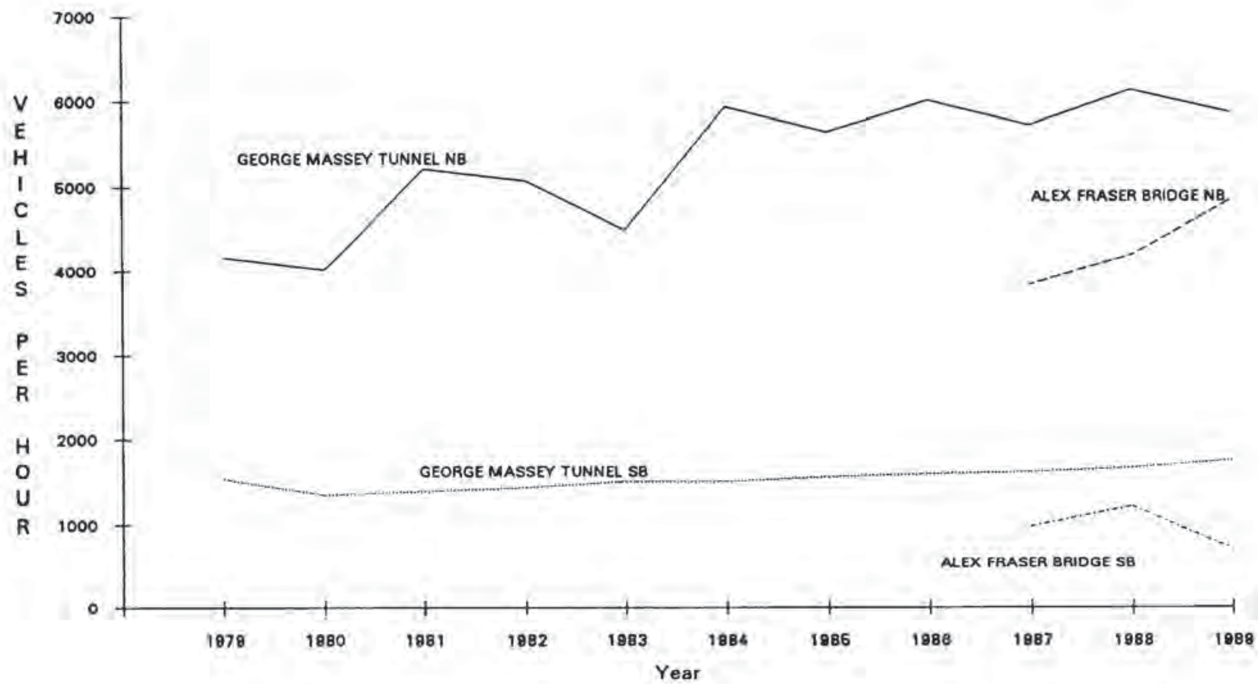
EXHIBIT **2.5**

HISTORIC TRAFFIC VOLUMES IN THE GEORGE MASSEY TUNNEL AND ALEX FRASER BRIDGE 1979-1989

MORNING



AFTERNOON

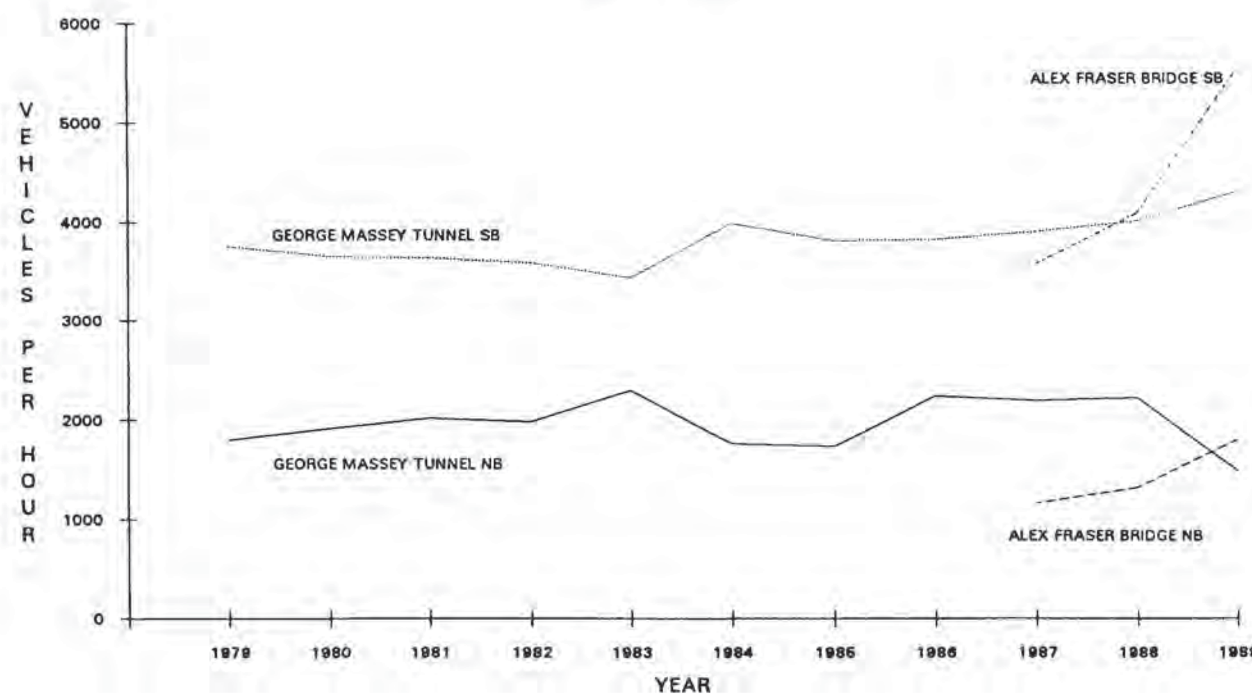


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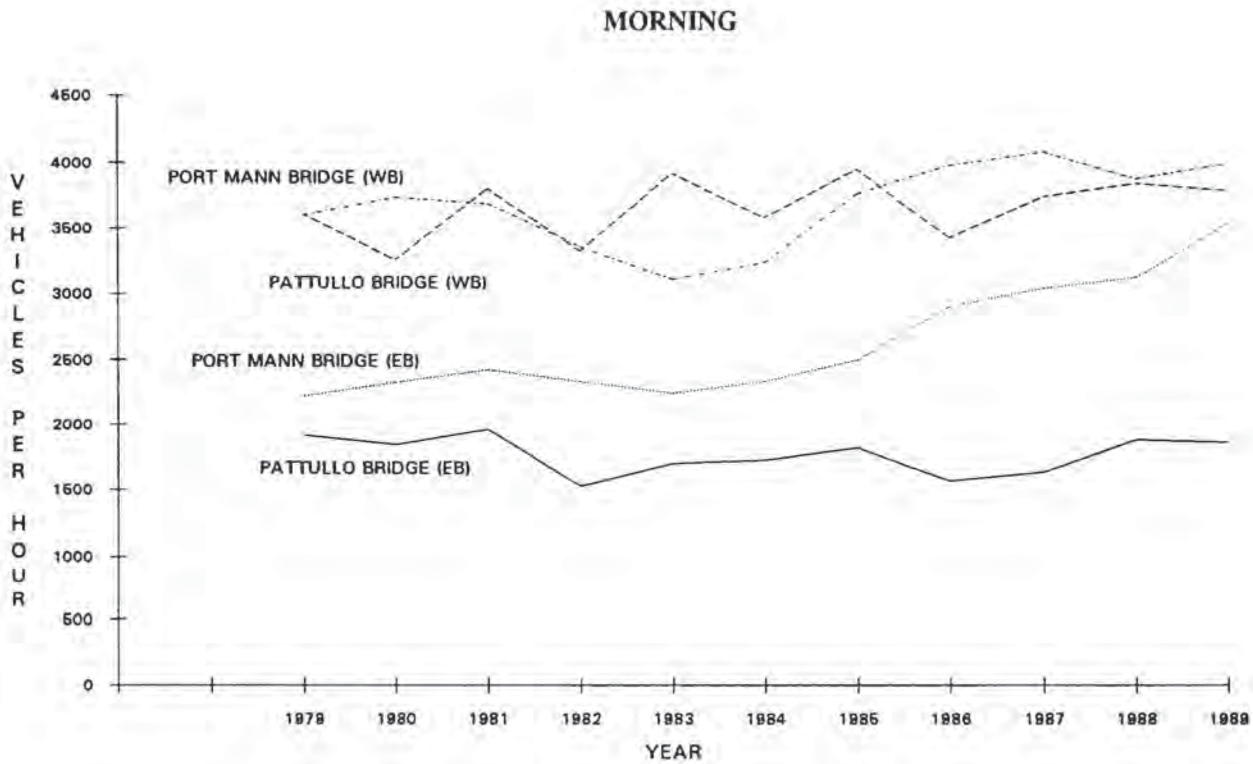
EXHIBIT **2.6**

HISTORIC TRAFFIC VOLUMES IN THE PATTULLO AND PORT MANN BRIDGES 1979-1989



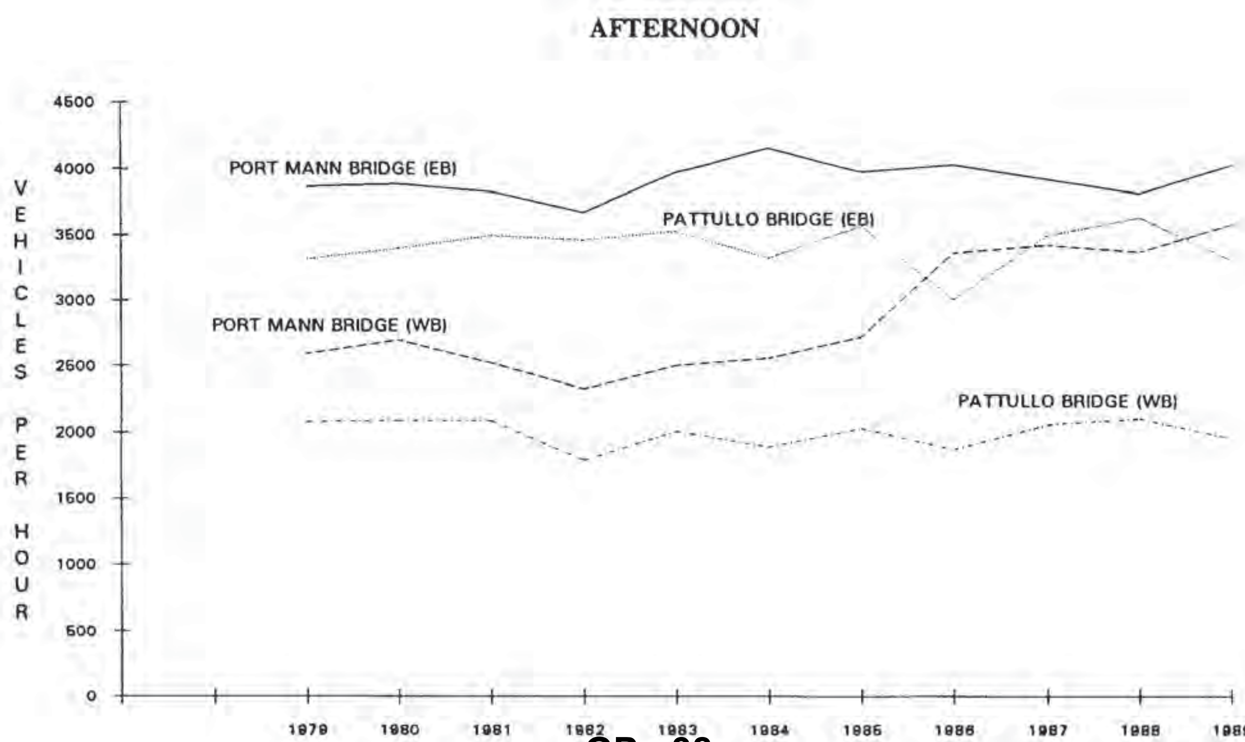
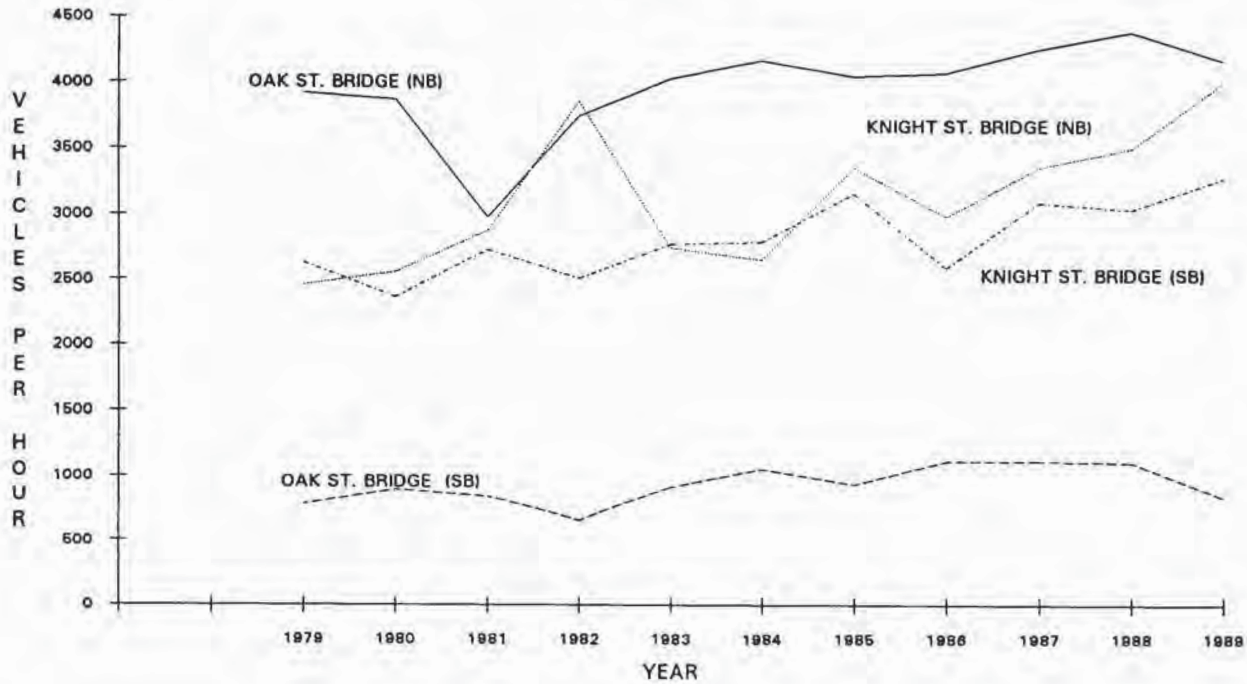


EXHIBIT **2.7**

HISTORIC TRAFFIC VOLUMES ON THE OAK ST. AND KNIGHT ST. BRIDGES 1979-1989

MORNING



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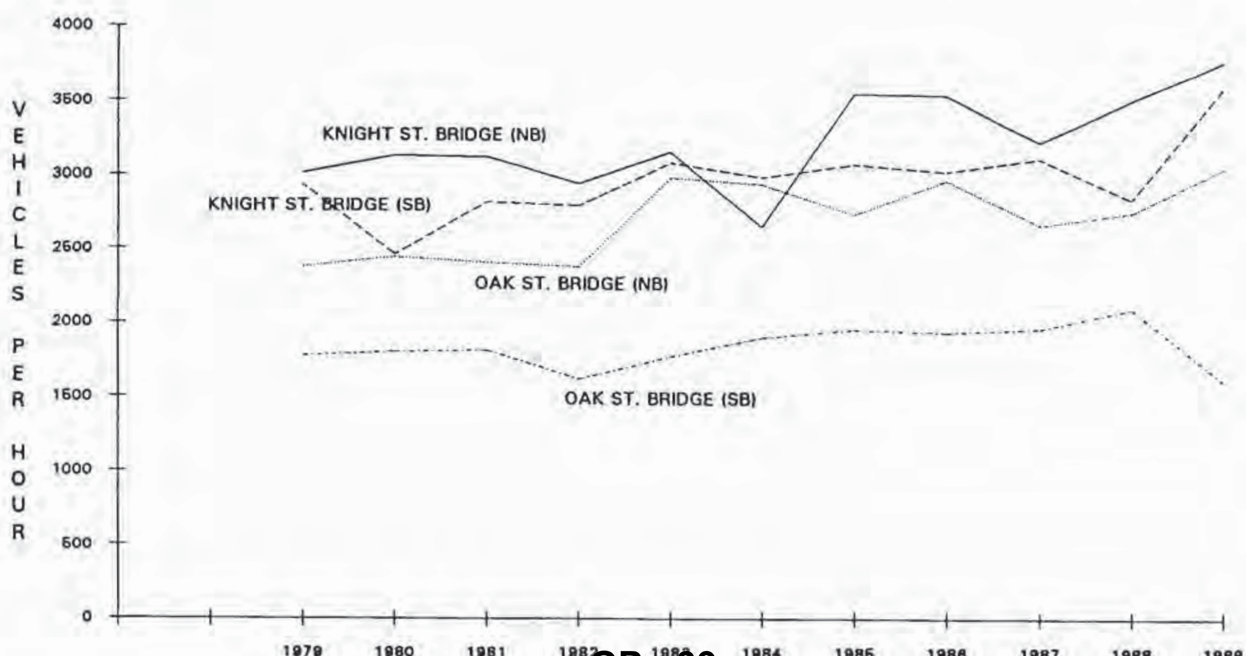
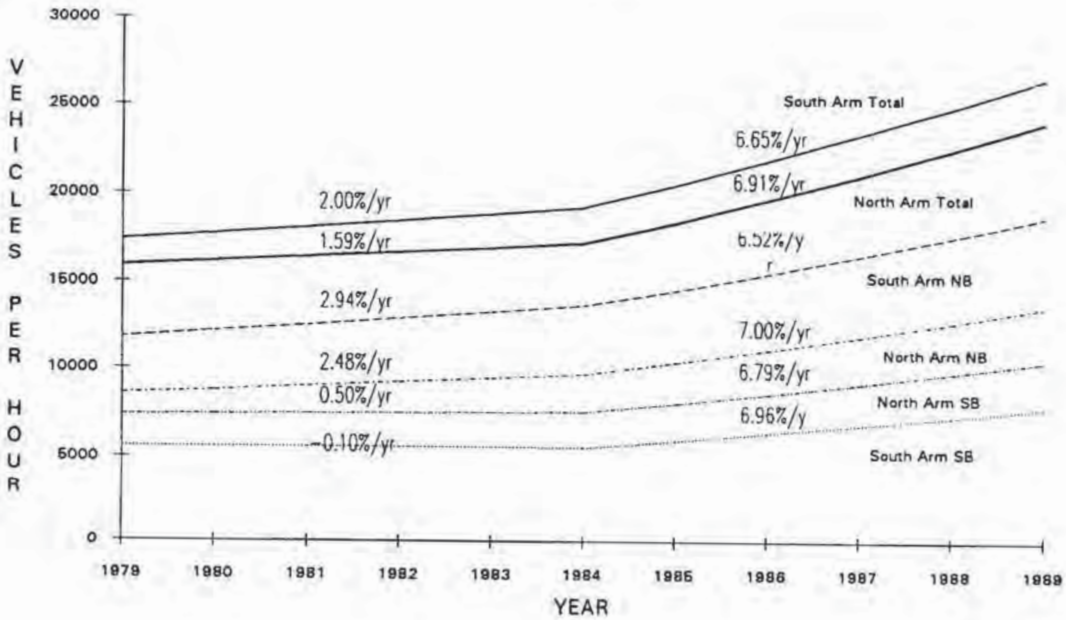


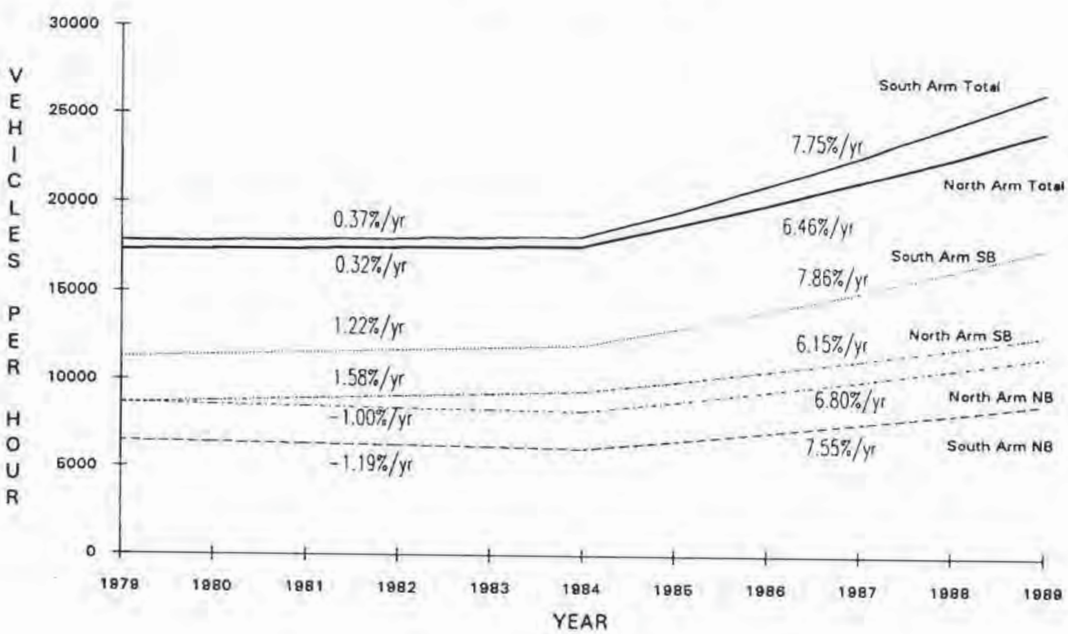
EXHIBIT **2.8**

GROWTH IN TRAFFIC VOLUMES ON THE NORTH AND SOUTH ARMS

MORNING



AFTERNOON



is for a typical Wednesday in September on each of the seven years.

Table 2.3 presents the actual traffic volumes recorded for the years 1979, 1984 and 1989 for the morning and afternoon peak periods in both directions on each crossing as well as across each arm in total. The data for each year is illustrated graphically in Exhibit 2.5 for the George Massey Tunnel and Alex Fraser Bridge, in Exhibit 2.6 for the Pattullo and Port Mann Bridges, and in Exhibit 2.7 for the Oak Street Bridges. The opening dates for the various river crossings, including any capacity improvements is discussed later in Section 2.4 and presented in Table 2.5.

The key points arising from this table and accompanying exhibits are as follows:

- Northbound traffic volumes in the George Massey Tunnel clearly increased between 1983 and 1984 due to the introduction of the reversible lane and has remained constant since then.

- The total northbound volume of vehicles across the South Arm of the Fraser River during the morning peak hour has increased by 59% over the last 10 years from 11,800 in 1979 to 18,710 in 1989. During the afternoon peak hour, the equivalent southbound volume has increased by 55% from 11,300 in 1979 to 17,525 in 1989.

- Peak direction traffic volumes in the morning peak hour on the Oak Street Bridge, the Pattullo Bridge and the Port Mann Bridge have increased only marginally over the 10 year period going from 11,552 to 12,257 or 6% in total - this is no doubt due to the capacity restraint that has been present at each of these crossings.

- Traffic volumes in the non-peak direction have increased consistently on the Port Mann Bridge from 2,171 to 3,525 in the morning and 2,612 to 3,531 in the afternoon and this movement is now approaching capacity.

- The increase in volumes in the off-peak direction, i.e. southbound in the morning peak hour and northbound in the afternoon peak hour, has been lower than that in the peak direction over this 10 year time frame at 39% and 36% respectively. This result in turn confirms the fact that it is the continual growth in population south of the Fraser River and an equivalent growth in employment opportunities north of the river that is driving the travel demand across this screenline.

Table 2.4 presents the annual percentage growth rates over the same two five year periods, viz., 1979-1984 and 1984-1989, for the two arms. The comparative volumes and growth rates for both arms are illustrated in Exhibits 2.8 and 2.9. These indicate that the highest overall growth rate has been in the northbound direction in the morning peak hour when both arms have had an average annual increase of 4.7% per annum over the ten year span. This is closely followed by the southbound flow in the afternoon peak hour across the South Arm with an average growth rate of 4.5% per annum. The lowest growth rate has been in the northbound flow in the afternoon peak hour across the South Arm with a value of 3.1% per annum. Although these annual percentage rates appear both small and similar, it must be noted that when compounded over a number of years they are significant, e.g.

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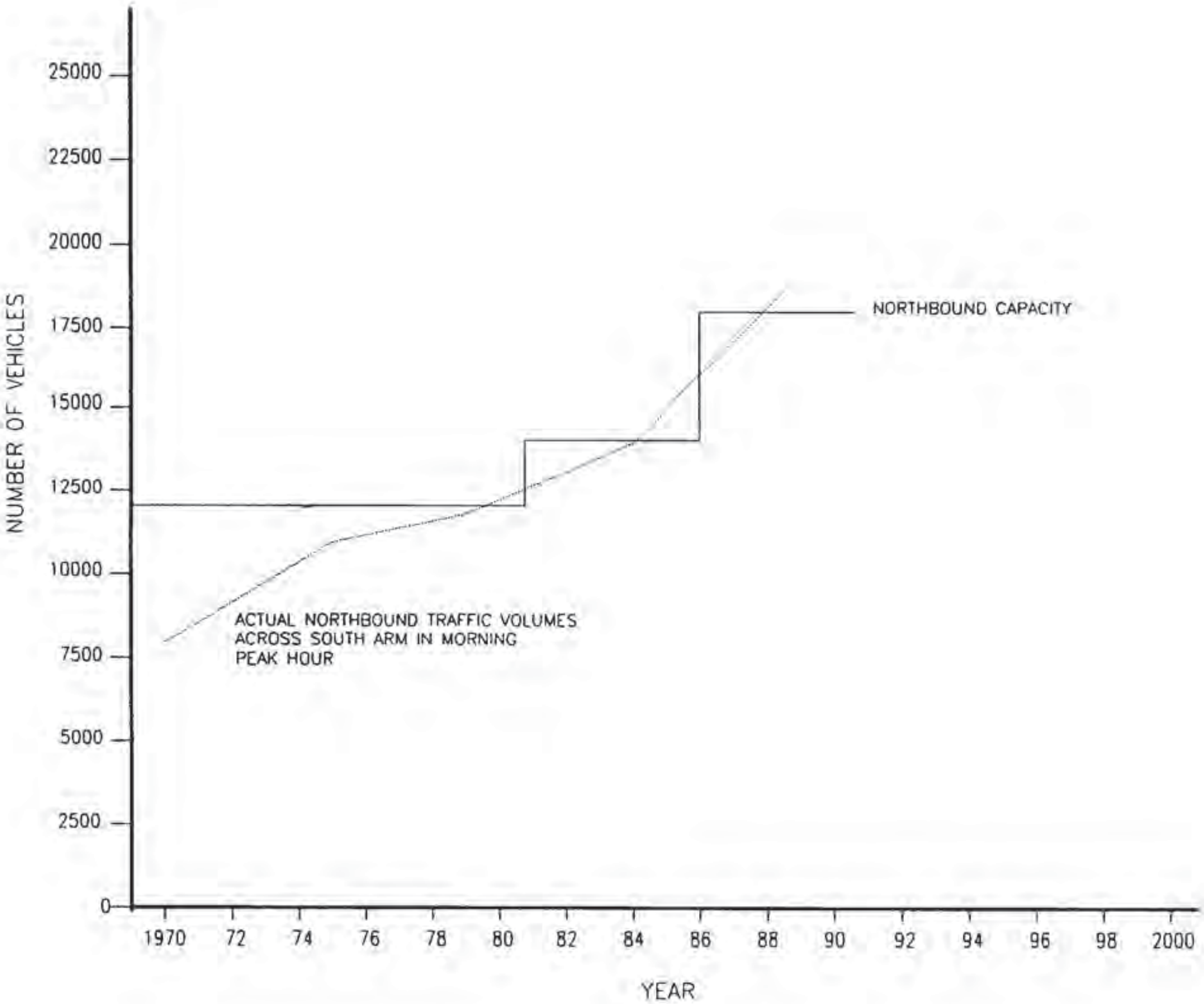
EXHIBIT **2.9**

COMPARISON OF ACTUAL VOLUMES VERSUS CAPACITY ACROSS THE SOUTH ARM 1970-1989



1981 - INTRODUCTION OF COUNTER-FLOW LANE IN TUNNEL IN MORNING PEAK PERIOD

1986 - OPENNGS OF FOUR-LANE ALEX FRASER BRIDGE

Annual Growth Rate	Total Growth Over 10 years	20 years
2%	22%	49%
3%	34%	81%
4%	48%	119%
5%	63%	165%

It will be noted in Exhibit 2.5 that the northbound traffic volume in the George Massey Tunnel in the morning increased at an average rate of 7.3% per annum between 1979 and 1984 and then showed no growth from 1984 to 1989. This increase was no doubt a result of the introduction of the counter-flow lane for northbound morning peak period traffic through the tunnel in 1981. In the afternoon, the peak direction volume (southbound) showed only a small growth of 1.2% and 1.5% per annum from 1979 to 1984 and 1984 to 1989 respectively. The opening of the counter-flow lane for southbound afternoon peak period traffic toward the end of 1989 has now provided the additional capacity for this flow and no doubt 1990 data will show a healthy increase in this volume.

Table 2.4
Annual Growth Rates In Fraser River Crossing Volumes

North Arm		1979 - 1984	1984 - 1989	1979 - 1989
a.m. Peak Hour	Northbound	2.48	7.00	4.72
	Southbound	0.50	6.79	3.60
	Total Two-Way	1.59	6.91	4.21
p.m. Peak Hour	Northbound	-1.00	6.80	2.83
	Southbound	1.58	6.15	3.84
	Total Two-Way	0.32	6.46	3.34
South Arm				
a.m. Peak Hour	Northbound	2.94	6.52	4.71
	Southbound	-0.10	6.96	3.37
	Total Two-Way	2.00	6.65	4.30
p.m. Peak Hour	Northbound	-1.19	7.55	3.09
	Southbound	1.22	7.86	4.49
	Total Two-Way	0.37	7.75	4.00

In 1979, the northbound morning peak hour volumes and the southbound afternoon peak hour volumes through the tunnel were approximately equal at 4160 and 3750 vehicles per hour respectively. Between 1984 and 1989 however, the northbound morning peak hour volume has been significantly higher than the southbound afternoon peak hour volume due, as already noted, to the 50% greater capacity in the peak direction in the morning peak period. Although there is now the same capacity in both peak directions in the two peak periods, there is still an imbalance in these volumes in that the northbound morning peak hour volumes are higher than the southbound afternoon peak hour volume. This is no doubt as a result of the Alex Fraser Bridge being a more attractive route for traffic travelling between Vancouver/Richmond and Surrey in the afternoon peak period than the reverse trip is along the same route in the morning peak period due to three factors:

- the higher capacity in the southbound direction on the Alex Fraser Bridge with 3 lanes throughout vs. only 2 lanes northbound between the Cliveden Interchange and the Highway 91/91A intersection;

- the delays at the signalized intersection at the junction of Highways 91 and 91A for northbound to westbound movements - this delay is non-existent for eastbound to southbound movements; and

- the negative impact of the two interchanges in close proximity to both ends of the George Massey Tunnel resulting in congestion directly attributable to problems associated with merging and diverging.

It must be noted that the volumes passing through the tunnel and across the bridges as presented in Table 2.3 are not a true measure of demand since once the capacity of the facility is reached, the facility itself acts as a restriction to control the amount of traffic passing through. Although the addition of the third northbound lane through the tunnel in the morning peak hour did increase the capacity, there is still congestion and delays at the south end of both the tunnel and the Alex Fraser Bridge during this time period. These vehicles that arrive during the measured peak hour and do not get across the river are also part of the total demand but are not included in any counts of actual volumes.

This also applies to the volume of traffic flowing in the opposite direction to the peak hour particularly in the afternoon peak period. At this time, the tunnel is restricted to one lane northbound. The count data indicates a flow of approximately 1,800 to 1,900 vehicles in the peak hour. On a typical week day there is an extensive queue of northbound vehicles waiting to enter the tunnel especially on Highway 17, which serves the community of Tsawwassen and the B.C. Ferry Terminal. Those arriving via River Road or Highway 99 at least have the choice of using the Alex Fraser Bridge to the east instead and this crossing is only 50% utilized in the northbound direction at this time.

Table 2.5
Annual Growth Resulting From Opening of
Alex Fraser Bridge

	Total South Arm Volume	Annual Growth
1984	13153	
1985	13349	1.5
1986	16223	21.5
1987	17049	5.1
1988	17499	2.6

This latent or hidden demand was illustrated when the Alex Fraser Bridge was opened in 1986. The total South Arm crossings from the Port Mann Bridge to the Alex Fraser Bridge for the five years between 1984 and 1988 are presented in Table 2.5. This indicates a phenomenal 26.6% increase over the two year period between 1985 and 1987, no doubt because of two factors. Firstly, the residents south of the river perceive jobs and shopping north of the river to be more accessible, and secondly, more vehicles crossed the river in the preferred peak hour rather than be inconvenienced and travel in the shoulders of the peak period.

2.4 Growth in Capacity Across the South Arm

As was noted in Section 1.2, the South Arm of the Fraser River has experienced not only an increase in travel demand across the river, but also an increase in the total capacity provided, as additional facilities and/or improvements to existing ones have been implemented. The total peak direction capacity of these crossings, as presented in Table 2.6, has increased from 12,000 in 1964 after the opening of the tunnel to 18,000 with the opening of the Alex Fraser Bridge in 1986.

For the purpose of this study, the capacity of a lane in the George Massey Tunnel was taken to be 2,000 vehicles per hour. The actual maximum volumes based on the data presented in Table 2.3 range from 1950 to 2150. An examination of hourly count data for the whole of 1988 indicated a peak volume of 5,850 through the three northbound lane, in the morning peak hour, i.e., 1950 vehicles per lane and 4,050 through the two southbound lanes in the afternoon peak hour, i.e., 2,025 vehicles per lane. This slight disparity could very easily be a result of the nervousness of some drivers with travelling in the contra-flow lane in a tunnel against opposing traffic.

The capacity of a lane on a bridge was also taken to be 2,000 vehicles per hour regardless of its grade. It is sometimes assumed that the long lengths of relatively steep grades on the Alex Fraser, Pattullo and Port Mann Bridges has the effect of reducing the capacity of these facilities. An examination of 1988 count data provided by the Ministry indicated that per lane volumes on the various crossings are as follows:

Crossing	One-Way Volume	Per Lane Volume
• Port Mann Bridge Westbound	4220	2110
• Port Mann Bridge Eastbound	4140	2070
• Alex Fraser Bridge Northbound	4044	2022
• Alex Fraser Bridge Southbound	3830	1915*
• Second Narrows Northbound	5620	1870*
• Second Narrows Southbound	5850	1950
• Knight Street Bridge Northbound	3910	1950
• Knight Street Bridge Southbound	3503	1750

* An asterisk indicates flow controlled by a signalized intersection upstream of the crossing. It is evident from the above that 2000 vehicles per lane is a reasonable capacity figure to use for any bridge. Although the Alex Fraser bridge has now been widened to six lanes, Highway 91 between the Cliveden Interchange and Highway 91A is still only two lanes northbound which is considered to be the peak direction. Hence the total peak direction capacity has been left unchanged in Table 2.5(*). This growth in capacity with the corresponding growth in crossing volumes between the years 1970 and 1989 is illustrated in Exhibit 2.9. It is evident from this exhibit that capacity and demand have increased

approximately in step with each other over the past 14 years.

Table 2.6
Capacity of South Arm Crossings

Facility	Date	Incremental Peak Direction Capacity	Total Peak Direction Capacity
Pattulo Bridge	1937	4,000	4,000
Port Mann Bridge	1958	4,000	8,000
George Massey Tunnel	1964	4,000	12,000
NB Counter Flow Lane in Tunnel	1981	2,000 (NB only)	14,000
Alex Fraser Bridge - 4 lanes	1986	4,000	18,000
SB Counter Flow Lane in Tunnel	1989	2,000 (SB also)	18,000
Alex Fraser Bridge - 6 lanes	1989	2,000	*18,000
SkyBridge for SkyTrain	1990	7,000	(25,000)

The increases in volume on any facility have not been uniform over the years since the actual volume is very much controlled by the capacity available on a particular facility or an arm as a whole. Hence the flattening off in the growth plots presented earlier whenever the capacity is reached.

2.5 Physical Constraints on Highway 99

The most apparent obstacle or constraint to widening Highway 99 is the tunnel itself. The existing tunnel was floated into the river in sections and then lowered into place. It is apparent that any increase in the capacity of the tunnel will require an additional tube to be laid alongside the existing tubes. Whether this new tube is to be upstream or downstream of the existing tubes is still to be determined.

The other possible key constraints are the existing overpasses which are an integral part of the Ladner, Steveston Highway and Westminster Highway Interchanges. The distance between adjacent columns will dictate how much widening of the existing pavement will be possible without having to rebuild or add a span to the overpass. Land immediately adjacent to the highway is in general undeveloped with the exception of Fantasy Gardens on the west side of the highway north of the Steveston Highway.

2.6 Projected Growth in Ferry Traffic

Vehicular traffic on B.C. Ferries vessels increased at a rate of 6.5% per annum on a system wide basis between 1970 and 1988. This increase in ferry traffic is the result of a combination of:

- increased demand
- increased frequency of service
- increased size of vessels

The ferries running out of the Tsawwassen Ferry Terminal have experienced a growth even higher than this increasing from 126,600 vehicles (expressed in auto equivalents or AEQ's) in 1985 to 181,140 vehicles in 1990, or an annual rate of 7.2%. B.C. Ferries expect their ridership to continue to increase over the next few years at a rate in the range of 3.7 to 5.0% per annum. There are three factors that will ensure that this growth continues at least in terms of the number of vehicles through Tsawwassen Ferry Terminal. They are:

- a number of super-ferries that can carry 470 A.E.Q.'s are now under construction - these are approximately 40% larger than the existing ferries which can carry 275 - 310 vehicles.

- 1990 saw the introduction of a new Tsawwassen to Nanaimo service which enables vehicles to avoid having to travel through Vancouver in order to get to the Horseshoe Bay terminal - this had a significant contribution to the 17% increase in the number of vehicles handled through the Tsawwassen Ferry Terminal between 1989 and 1990; and

- the Tsawwassen Ferry Terminal is currently undergoing an extensive expansion program to increase the number of vessel berths and the number of vehicles that can be handled.

2.7 Role of Transit

At the present time, there are approximately 32 buses travelling through the tunnel northbound in the morning peak hour. All but four of these are express buses carrying commuters from their residences in Surrey (4), White Rock/South Surrey (11) and Ladner/Tsawwassen (13) (Delta) south of the river, to their places of employment in downtown Vancouver. The remaining four travel between Ladner and Vancouver International Airport. Priority measures have been provided on Highway 99 for these vehicles as they approach the tunnel from both directions to ensure that they are delayed as little as possible.

For vehicles approaching from the south in the morning peak hour, the existing queue jumper lane enables buses to bypass the queues of vehicles on both Highways 99 and 17 and enter the main traffic stream just before the entrance to the tunnel. For vehicles approaching from the north in the p.m. peak hour, there is a bus only lane that extends north, from the tunnel as far as Westminster Highway.

Regular vehicular traffic is sometimes backed up for up to 3 kms. waiting to pass through the tunnel. These priority measures therefore play an important role in making travel by transit as attractive as possible in terms of comparing the travel times by auto and transit.

Any plan to upgrade the George Massey Tunnel must therefore ensure that transit is once again given priority, preferably more than it is given at present.

3.0 GROWTH IN TRAVEL DEMAND

3.1 Projected Population Trends

The future travel demand projected by any transportation planning model requires estimates of future growth of population and employment and the distribution of that growth within the study area as a basis for making any traffic projections. The Greater Vancouver Regional District has, in cooperation with each of the municipalities that make up Greater Vancouver, prepared future forecasts of household and population growth for both the region as a whole and each of the individual municipalities. These forecasts have been prepared for 1996, 2001, 2006 and 2011.

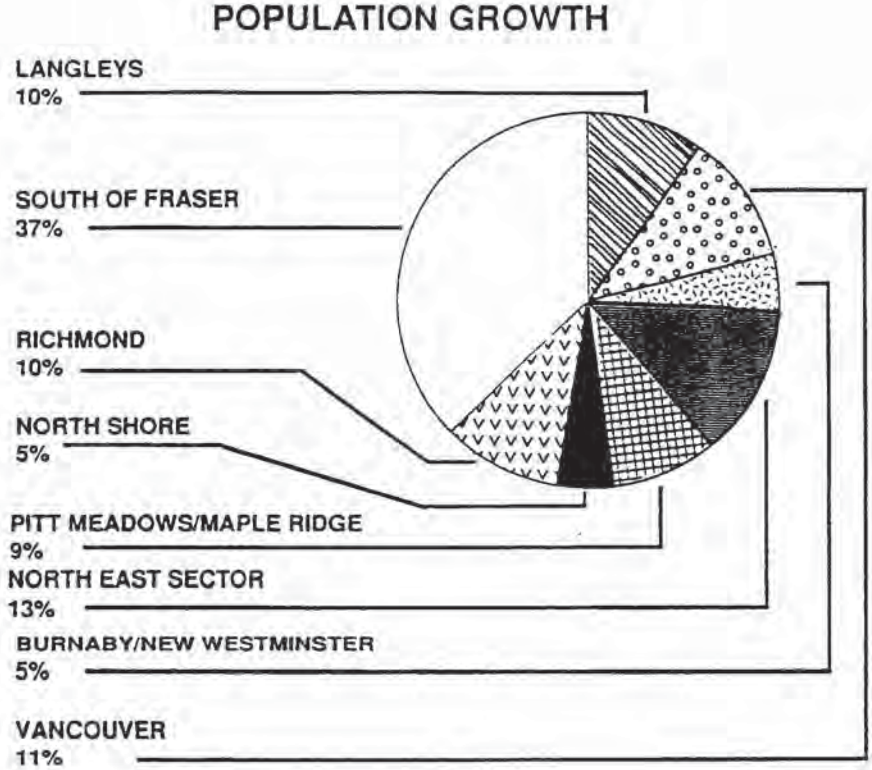
This current study sought to address the transportation needs across the Fraser River in the year 2001 and therefore the population data for this year as established by G.V.R.D., was used in the study. The future projections of population alongside the 1986 population are presented for individual municipalities in Table 3.1 and illustrated on a sector basis in Exhibit 3.1(a). The population in the region as a whole is projected to increase at an annual rate of 1.7%. The distribution of the total increase in the region to the different sectors is illustrated in Exhibit 3.1(b). It will be noted that 37% of the increase in population between 1986 and 2001 is projected to be "South of the Fraser River" which covers Delta, Surrey and White Rock with a further 10% in the two Langleys. The Delta population is forecasted to increase from 79,780 to 95,300 while the Surrey population will go from 181,680 to 302,300. At the same time, only 26% of the increase will be in Richmond, Vancouver, Burnaby and New Westminster.

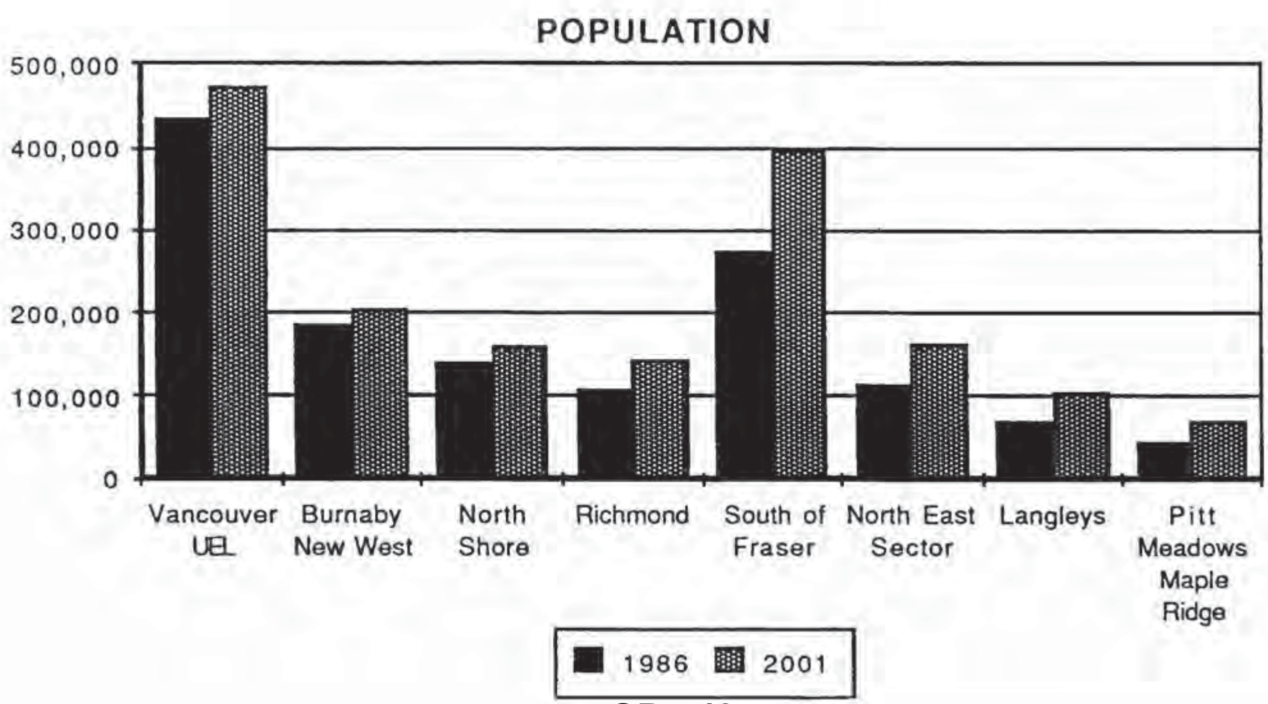
Table 3.1
Population Projections by Municipality

Municipalities	1986	1991	2001
Burnaby	145,161	153,900	163,900
Coquitlam	69,291	83,200	106,900
Delta	79,783	85,000	95,300
Langley City	16,557	18,700	22,100
Langley Township	53,900	64,900	89,800
Maple Ridge	36,035	45,800	63,600
New Westminster	39,972	42,300	45,100
North Vancouver City	35,959	37,600	39,500
North Vancouver District	68,338	74,900	86,800
Pitt Meadows	8,085	9,400	11,700
Port Coquitlam	29,115	34,900	42,100
Port Moody	15,754	17,600	20,000
Richmond	108,492	123,700	147,900
Surrey	181,683	228,800	302,300
University Endowment Lands	3,606	3,500	3,400
Vancouver	432,391	453,500	481,300
West Vancouver	37,997	38,200	39,900
White Rock	14,387	15,900	19,000
Lions Bay, Belcarra	4,223	5,200	7,000
Vancouver CMA	1,380,729	1,537,000	1,787,600

EXHIBIT **3.1**

POPULATION INCREASE AND DISTRIBUTION IN GREATER VANCOUVER





3.2 Employment Growth Trends

G.V.R.D. has also prepared similar projections for employment growth, albeit not to the same accuracy as for the population data. The 2001 projections in each sector, together with the 1986 figures are illustrated in Exhibit 3.2(a). Once again the distribution of the total increase in the region to the different sections is illustrated, this time in Exhibit 3.2(b). Employment figures for the same municipalities as specified earlier are presented in Table 3.2 and this shows that the employment opportunities will increase at a slightly faster annual rate of 2.7%. This shows that while 37% of the population increase is to be south of the Fraser River, only 24% of the employment increase is to be in this sector with a further 9% in the Langleys. Richmond, Vancouver, Burnaby and New Westminster on the other hand will account for 48% of the employment increase.

This disparity between population growth and employment growth on either side of the South Arm of the Fraser River suggests that residents of Surrey and Delta will still have to commute to their jobs in the municipalities on the north side of the river. This in turn will lead to a continued increase in demand for travel across the river.

Table 3.2
Employment Projections by Municipality

Municipalities	1986	1991	2001
Burnaby	68,756	80,500	104,800
Coquitlam	17,885	22,200	32,700
Delta	17,758	21,500	30,300
Langley City	2,303	3,000	4,400
Langley Township	22,285	28,800	43,100
Maple Ridge	9,884	12,400	18,200
New Westminster	22,508	23,100	25,700
North Vancouver City	20,614	24,000	34,500
North Vancouver District	15,124	17,300	21,800
Pitt Meadows	1,298	1,600	2,300
Port Coquitlam	8,417	10,700	15,500
Port Moody	3,843	4,400	5,500
Richmond	55,794	69,800	100,600
Surrey	52,687	69,300	105,200
University Endowment Lands	7,954	8,600	10,400
Vancouver	291,192	308,300	364,200
West Vancouver	12,700	14,000	18,800
White Rock	3,865	4,400	5,900
Lions Bay, Belcarra	391	500	800
Vancouver CMA	635,258	725,200	944,700

3.3 Projected Travel Demand

The G.V.R.D. computer based transportation planning model EMME/2 was selected for use in this George Massey Tunnel Expansion Study. In order to enable it to be an effective tool for both projecting

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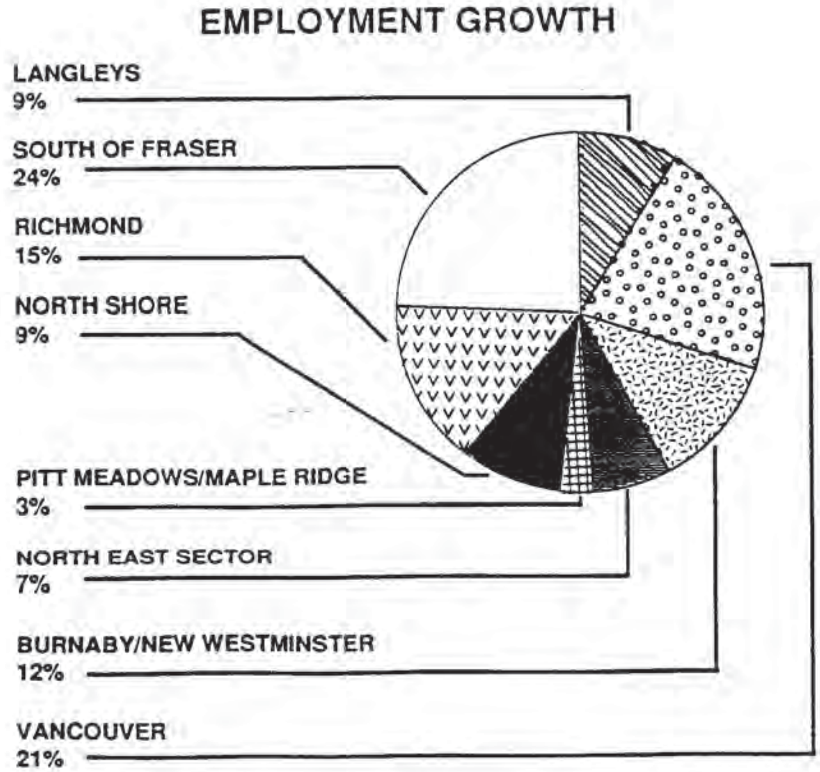
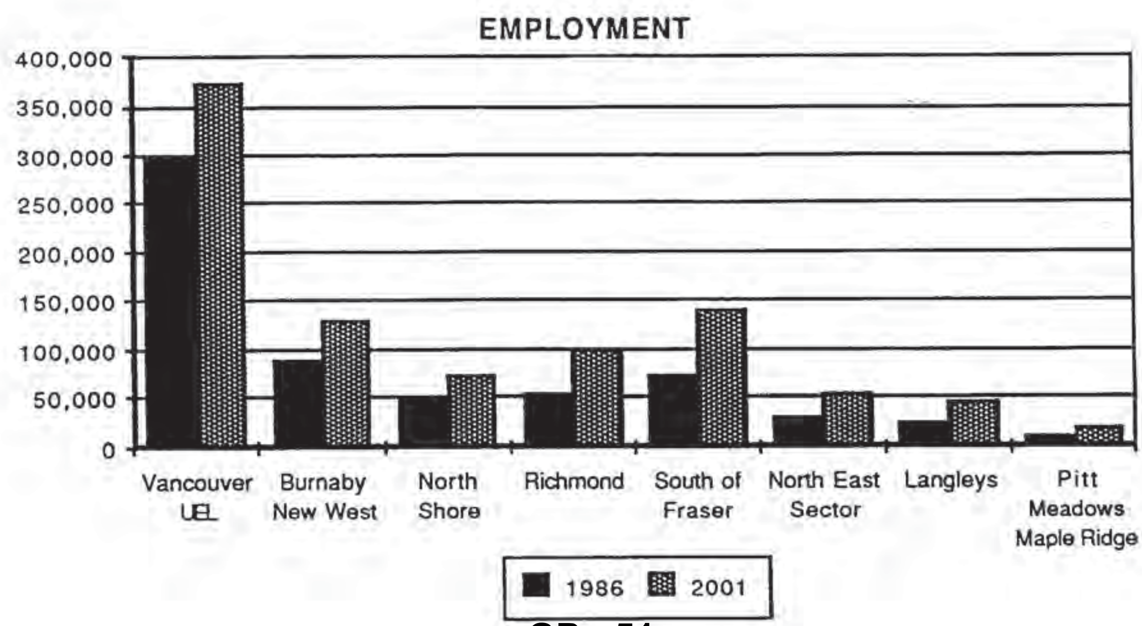
EXHIBIT **3.2**

EMPLOYMENT INCREASE AND DISTRIBUTION IN GREATER VANCOUVER





future traffic volumes and analyzing and evaluating the alternative networks, a finer zone structure was established in Richmond and Delta. This allowed more accurate or finite traffic projections to be made on the alternative networks in the vicinity of the river crossings.

Using data such as projected labour force, school enrolment, transportation costs, travel speeds, and road capacities, this model is able to predict the travel demand under future conditions on any given road and transit network. The overall travel demand, i.e. the number of trips between all origin and destination zones, as forecast by this model for the selected design year of 2001, in both the morning and afternoon peak hours, was established by the G.V.R.D. before the commencement of this study based on the 2001 land use, and road and transit networks as recommended at the end of the Greater Vancouver Transportation Task Force Study. This demand, in the form of a fixed origin-destination or trip table, was then modified to fit the finer zone structure established for use in this study.

In using this fixed 2001 trip table in this study, it was assumed that there will be no change in the overall travel demand between origin and destination zones as a result of any of the proposed changes to the road network. This means that the total number of future trips across the South Arm of the Fraser River would also remain unchanged. This assumption is in fact contrary to the usual understanding of travel behaviour as it is generally believed that as a given route between two points becomes more attractive, i.e. there is an increase in capacity and/or a decrease in congestion along a route linking the two points,

Table 3.3
Projected 2001 Travel Demand Across South Arm
Morning Peak Hour

	Destination								
Origin	North Shore	Vancouver	Bby N.West	N.E. Sector	Richmond	South Delta	N.Delta N.Surrey	W.Rock S.Surrey	Langley
North Shore	-	-	-	-	452	17	260	40	41
Vancouver	-	-	-	-	5631	422	970	69	130
Burnaby/ New Westminster	-	-	-	-	1819	91	2496	169	225
N.E. Sector	-	-	-	-	548	154	1557	72	485
Richmond	344	7206	1534	88	-	702	500	111	122
South Delta	45	1373	323	27	1918	-	-	-	-
North Delta/ North Surrey	583	3021	4695	1367	2035	-	-	-	-
White Rock/ South Surrey	29	540	734	52	793	-	-	-	-
Langleys	95	494	812	252	237	-	-	-	-

then, firstly more people will choose to take that route rather than the one they are presently using, and secondly, people will travel further to find better work opportunities. This results in longer trips in general and more of them on the improved route.

The travel demand on a sector basis for all trip table pairs that result in a crossing of either the north or south arms of the Fraser River in the morning peak hour as determined by EMME/2 for both 1987 and 2001 is presented in Tables 3.3 and 3.4 respectively. The volumes assigned to each of the river crossings by the model - both north and south arms - using the existing network for 1987 and the "do nothing" network as described in Section 4.2 for 2001 is presented in Table 3.5. Based on these results, the number of trips crossing the south arm in the morning peak hour in the peak northbound direction as projected by the model, is expected to increase from 16,400 in 1987 to 20,890 in 2001, a 27% increase.

Table 3.4
Projected 2001 Travel Demand Across South Arm
Afternoon Peak Hour

	Destination								
Origin	North Shore	Vancouver	Bby N.West	N.E. Sector	Richmond	South Delta	N.Delta N.Surrey	W.Rock S.Surrey	Langley
North Shore	-	-	-	-	156	25	334	45	44
Vancouver	-	-	-	-	6953	843	2122	341	420
Burnaby/ New Westminster	-	-	-	-	1739	247	4094	427	533
N.E. Sector	-	-	-	-	79	15	1475	45	178
Richmond	325	6253	1730	397	-	1831	1525	584	115
South Delta	6	276	100	74	1027	-	-	-	-
North Delta/ North Surrey	111	754	3275	2152	816	-	-	-	-
White Rock/ South Surrey	12	70	151	40	187	-	-	-	-
Langleys	29	108	238	554	107	-	-	-	-

3.4 Deficiencies with Modelling Process

It must be cautioned however that the EMME/2 model, as with other similar models, has difficulty accurately simulating traffic volumes passing through restrictions such as bridge and river crossings. Once a trip table is input into the model, all trips are assigned to the available links regardless of the absolute capacity restriction across a screenline. This means that all trips across the South Arm will be assigned to one of the alternative crossings even though some of the links will be beyond their capacity, e.g. Port Mann Bridge with 2,250 vehicles per lane compared with the established capacity of 2,000

Table 3.5
EMME/2 Projected 2001 Crossing Volumes
On "Do Nothing" Network

	1987		2001		Growth Rate 1987 - 2001	
(a) Morning Peak Hour	NB	SB	NB	SB	NB	SB
North Arm						
Arthur Laing	2,614	2,146	3,664	2,550	2.44	1.24
Oak Street	4,043	2,125	4,413	2,038	0.63	-0.30
Knight Street	3,428	3,743	4,804	4,085	2.44	0.63
Queensborough	3,224	1,922	4,035	2,456	1.62	1.77
Total North Arm	10,085	8,014	12,881	8,673	1.76	0.57
South Arm						
George Massey	5,078	1,586	6,067	1,746	1.28	0.69
Alex Fraser	3,628	1,115	6,149	1,950	3.84	4.07
Pattullo	3,983	1,882	4,158	2,473	0.31	1.97
Port Mann	3,714	2,553	4,515	3,467	1.40	2.21
Total South Arm	16,403	7,136	20,889	9,636	1.74	2.17
(b) Afternoon Peak Hour						
North Arm						
Arthur Laing	2,129	2,016	2,785	2,942	1.94	2.74
Oak Street	2,290	3,629	2,138	4,293	-0.71	1.21
Knight Street	3,654	3,145	4,066	4,184	0.77	2.06
Queensborough	2,331	2,783	2,870	3,460	1.50	1.57
Total North Arm	8,073	8,790	8,989	11,419	0.77	1.89
South Arm						
George Massey	1,910	3,487	2,070	4,134	0.58	1.22
Alex Fraser	1,419	3,168	2,607	4,966	4.44	3.26
Pattullo	3,237	3,259	2,920	3,141	-0.73	-0.03
Port Mann	2,779	3,449	3,800	4,093	2.26	1.23
Total South Arm	8,435	13,363	11,397	16,274	2.17	1.42

vehicles per lane. Consequently, the model does not recognize the delays to the drivers and their passengers resulting from the queue of vehicles that builds up waiting to travel across a bridge or through the tunnel. In this particular study, the primary purpose for using the model was to compare the impact of different bridge and tunnel concepts on travel patterns. As long as the results are used for comparing the alternative concepts and not for establishing absolute volumes over specific crossings, there is no problem in using this model.

A second problem with the modelling process is that it fails to take into account the surges in the volume of traffic on Highway 17 resulting from the Tsawwassen Ferry Terminal. In 1989, B.C. Ferries made 20 sailings per day from Swartz Bay to Tsawwassen Bay on their summer schedule plus two per day to the Gulf Islands. In 1990 the new "midisland" ferry service was introduced and in 1991 this will result in an additional 8 sailings arriving into Tsawwassen each day. With new super-ferries discharging larger numbers of vehicles at one time and more sailings arriving during a given hour, the surges will increase in both size and frequency. EMME/2 on the other hand has simply assumed a constant growth in ferry traffic equal to the annual growth rate in Greater Vancouver's population.

3.5 Comparison of Traffic Volume Growth Rates

In order to put the model's projections of future traffic volumes in context with historic growth trends, the growth rates of actual traffic volumes across the North and South Arms of the Fraser River as established in Chapter 2.0 of this report and presented in Tables 2.3 and 2.4 were compared to the growth rates resulting from the projections made by EMME/2 across these same screenlines between the years 1987 and 2001 as presented in Table 3.2. This comparison, once again for northbound traffic volumes in the morning peak hour, is presented in graphical form in Exhibits 3.3 and 3.4.

This analysis indicates that the growth rate of northbound traffic volumes crossing the South Arm of the Fraser River in the morning peak hour between 1987 and 2001 as projected by EMME/2 is 1.74% per year whereas the actual historic growth rate for this same screenline over the years 1979 to 1989 as observed with actual field counts is 4.72% per year. A similar difference was found in the southbound afternoon peak hour figures as the growth rate resulting from the EMME/2 projections is 1.42% per year whereas the observed traffic counts over the period 1979 to 1989 showed a growth rate of 4.54% per year.

The total South Arm traffic volumes estimated by EMME/2 for 1987 were found to be approximately the same as the actual counts for both morning and afternoon peak periods. This is to be expected since the 1987 projections by EMME/2 are the result of calibrating the model to represent actual 1987 conditions, based on an extensive origin/destination survey carried out in 1985.

The model's projected 2001 traffic volumes are clearly significantly lower than would be expected if the 10 year historic growth rate is extrapolated into the future at the same rate. Whether the model's low projections are a genuine indication of the future travel behaviour taking into account projected land use changes and travel characteristics - this implies that the growth in employment opportunities south of the Fraser River will almost keep pace with the growth in population - or simply a low estimate of real future travel characteristics is impossible to state at this time. It should be noted, however, that the EMME/2 model was calibrated based on an extensive travel characteristics survey undertaken throughout Greater Vancouver in 1985 during a time when B.C. was still suffering through a major recession. Traffic volumes were generally down during this period and it can therefore safely be assumed that trip generation rates were low. It is these same generation rates that have been implanted into the EMME/2 model for use in projecting future traffic volumes.

Based on the projected growth in population and employment and the distribution of this growth to the different sectors of the region as was illustrated in Exhibits 3.1 and 3.2, it would appear that those living south of the South Arm of the Fraser River will continue to work north of the river and thus the historic annual increase in peak hour travel across the South Arm is indeed likely to continue into the future.

Since however the model's projected 2001 traffic volumes were used only to compare the effectiveness of each alternative road network in handling the future travel demand and not to evaluate the impact of the magnitude of the actual demand on one or more crossings, these discrepancies in growth rates have little influence on the report's conclusions as long as the concept of a fixed travel demand table applied to each network alternative is taken into account. The only aspects of the recommendations that the

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EXHIBIT **3.3**

COMPARISON OF HISTORIC AND EMME/2 PROJECTED TRAFFIC VOLUMES BY RIVER ARM

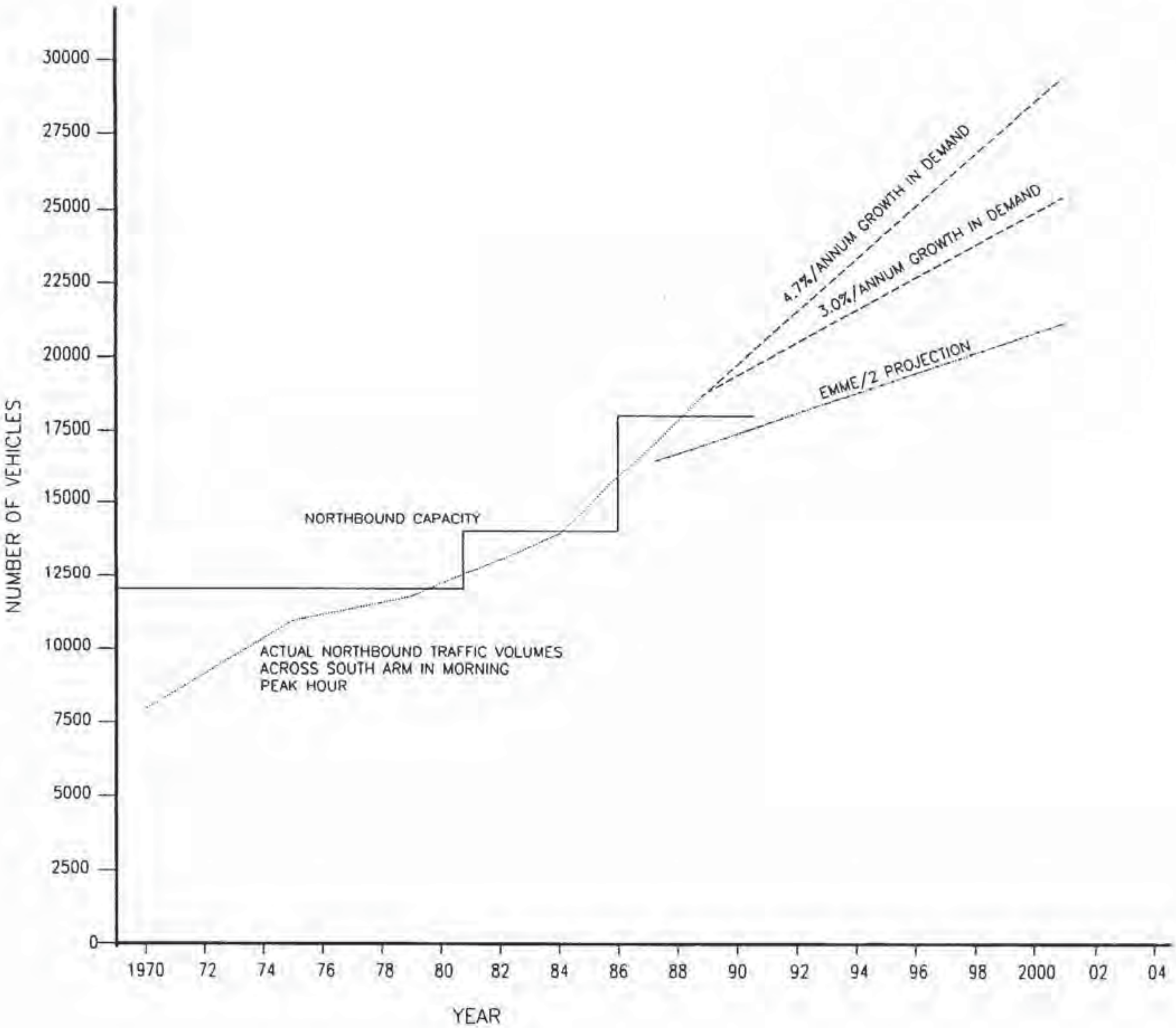

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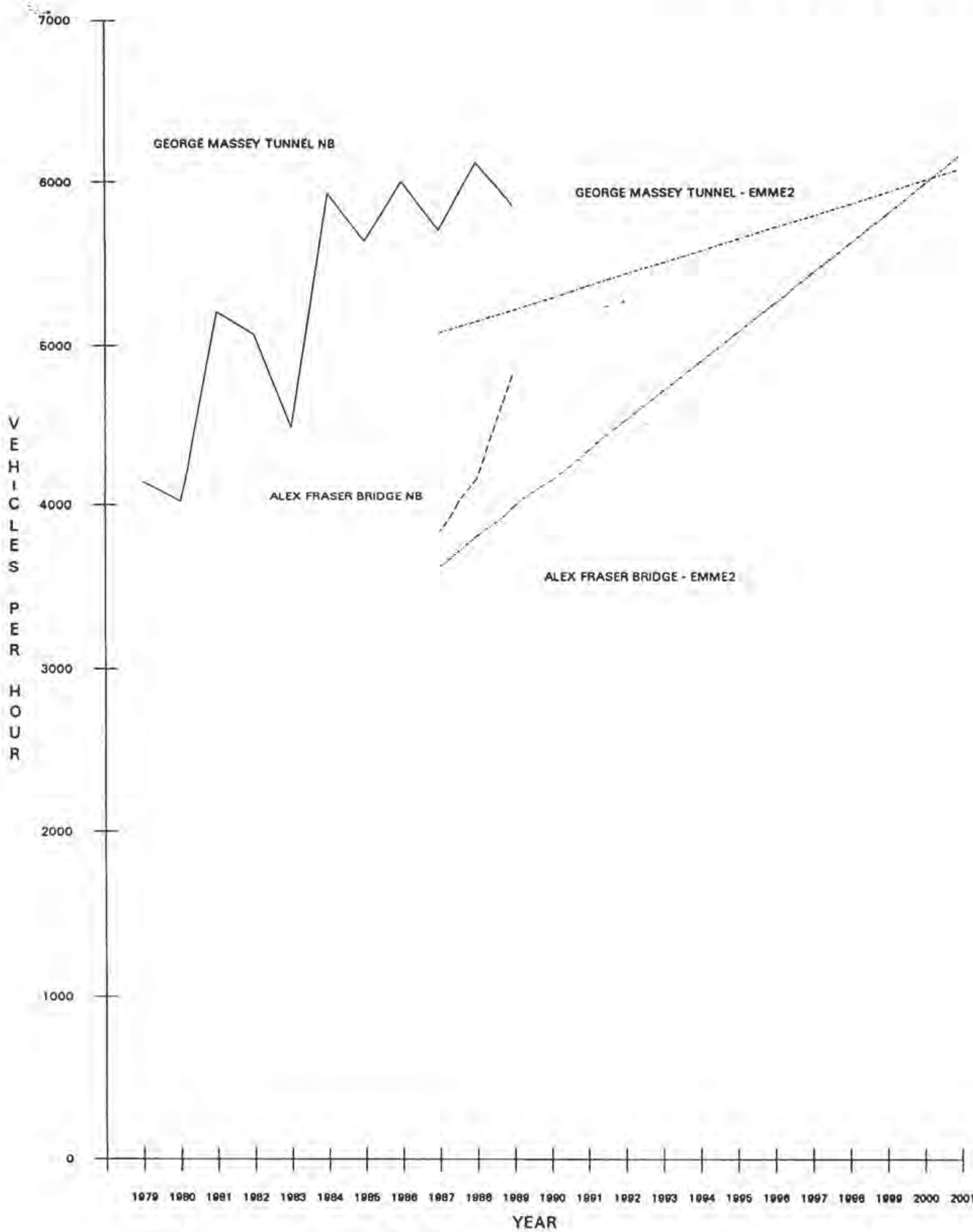
EXHIBIT **3.4**

COMPARISON OF HISTORIC AND EMME/2 PROJECTED VOLUMES FOR GEORGE MASSEY TUNNEL AND ALEX FRASER BRIDGE



growth differential will have any effect on is in terms of the configuration of any intersections and interchanges as established in Chapter 6.0 and the timing of any improvements which is addressed in the same chapter. In order to use the projected volumes and especially the intersection turning movements and ramp volumes for functional planning purposes, the EMME/2 projected volumes were increased by 19% to bring them up to levels that are considered to be comparable to an extrapolation of historic growth rates. This figure of 19% is derived by extrapolating the 1987 South Arm morning peak hour northbound crossing total of 16,400 as established by EMME/2, at a growth rate of 3.00%/annum to 2001 and comparing this projected volume of 26,800 vehicles with the EMME/2 projection of 20,900 vehicles. This 3.77% annual growth rate is 64% of the historic growth rate of northbound traffic volumes in the morning peak hour, viz., 4.71%.

4.0 ALTERNATIVE ADDITIONAL CROSSINGS

4.1 Developing Alternative Crossing

As indicated earlier, the four crossings of the South Arm of the Fraser River, viz. the George Massey Tunnel and the Alex Fraser, Pattullo and Port Mann Bridges, are presently carrying very high traffic volumes and operating at or near their capacities, resulting in undesirable delays for automobiles, buses, and commercial vehicles alike. This is especially true on the approaches to these river crossings. In order to maintain future economic growth and to keep pace with the ever increasing desire to travel between the residential areas south of the river and the employment areas north of the river, the expansion of the George Massey Tunnel and/or the addition of other new crossings of the South Arm were considered essential in order to ensure that the projected future volumes of people and goods are to be adequately accommodated.

For the purpose of developing a recommended future road network for this sector of Greater Vancouver, the target year of 2001 was selected to represent future conditions. Five alternative networks were established for analysis and evaluation in this study. They are:

- Do Nothing
- Third Tube in the George Massey Tunnel
- Third and Fourth tubes in the George Massey Tunnel
- New bridge in line with No. 5 Road in Richmond
- New bridge in line with 72nd Street in Delta and No. 8 Road in Richmond

Future volumes were then established on all links for each alternative, and these alternatives evaluated in terms of their effectiveness at distributing travel over available crossings, providing adequate capacity, overall fuel consumption, total travel time and estimated construction costs. These five alternatives are described in more detail below.

4.2 Alternative A - "Do Nothing"

In order to assess the impact of not providing any additional capacity, "do nothing" alternative was established. This alternative incorporates no improvements to any of the existing crossings. However, all other road network improvements which were recommended in the 1989 Greater Vancouver Transportation Task Force Study to be in place by the year 2001 and not related directly to the South Arm crossings were assumed to be in place. These improvements, which are illustrated in Exhibit 4.1, include:

- widening of Highway 1 to eight lanes between Second Narrows and Port Mann Bridge;
- widening of the Alex Fraser Bridge to six lanes;
- upgrading of the River Road/River Way/North Perimeter Road route to a four lane arterial standard;
- construction of interchanges on Highway 91 at 72nd Avenue, Highway 91A (Westminster Interchange) and Hamilton Street;
- widening of the Knight Street Bridge to six lanes (currently scheduled by the Ministry

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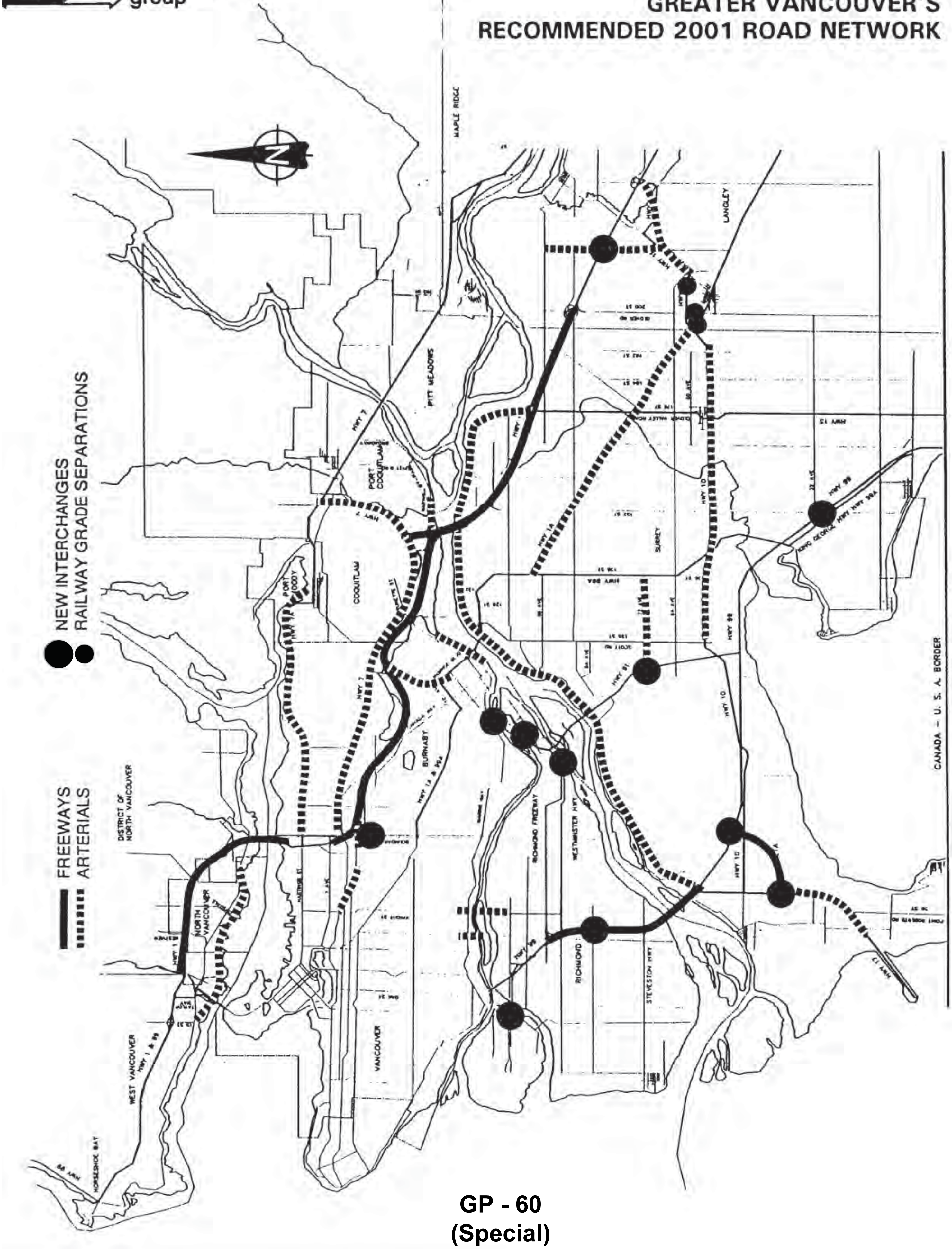
EXHIBIT **4.1**

GREATER VANCOUVER'S RECOMMENDED 2001 ROAD NETWORK



for 1998);
- construction of new interchange at the junction of the Russ Baker Way, Miller Road, and the Arthur Laing Bridge;
- construction of interchanges on Highway 91A at Boyd Street and Queensborough North Bridgehead; and
- widening of Highway 10 to four lanes.

Recommended improvements omitted from this "Do Nothing" network for the purpose of this analysis since they are included in one or more of the alternatives to be evaluated are as follows:

- construction of a new direct freeway connection between Highway 17 and Highway 99 to the east of the East Ladner Community;
- upgrading of Highway 17 to freeway standard through the elimination of all at grade intersections; and
- widening of Highway 99.

The road network developed for this alternative was therefore also considered to be the 2001 "base network" from which all other alternatives evolved.

4.3 Alternative B - Third Tube in the Tunnel

The key improvements in this alternative, over and above those included in the 2001 base network as described in the previous section, are as follows:

- the addition of a third two-lane tube adjacent to the existing tunnel beneath the Fraser River;

- the widening of Highway 99 to a minimum of six lanes, with four lanes in the peak direction, from the south end of the tunnel to south of the Highway 17/River Road interchange;

- the widening of Highway 99 to eight lanes, four in each direction, from the north end of the tunnel to the Westminster Highway interchange and six lanes to the Richmond Freeway;

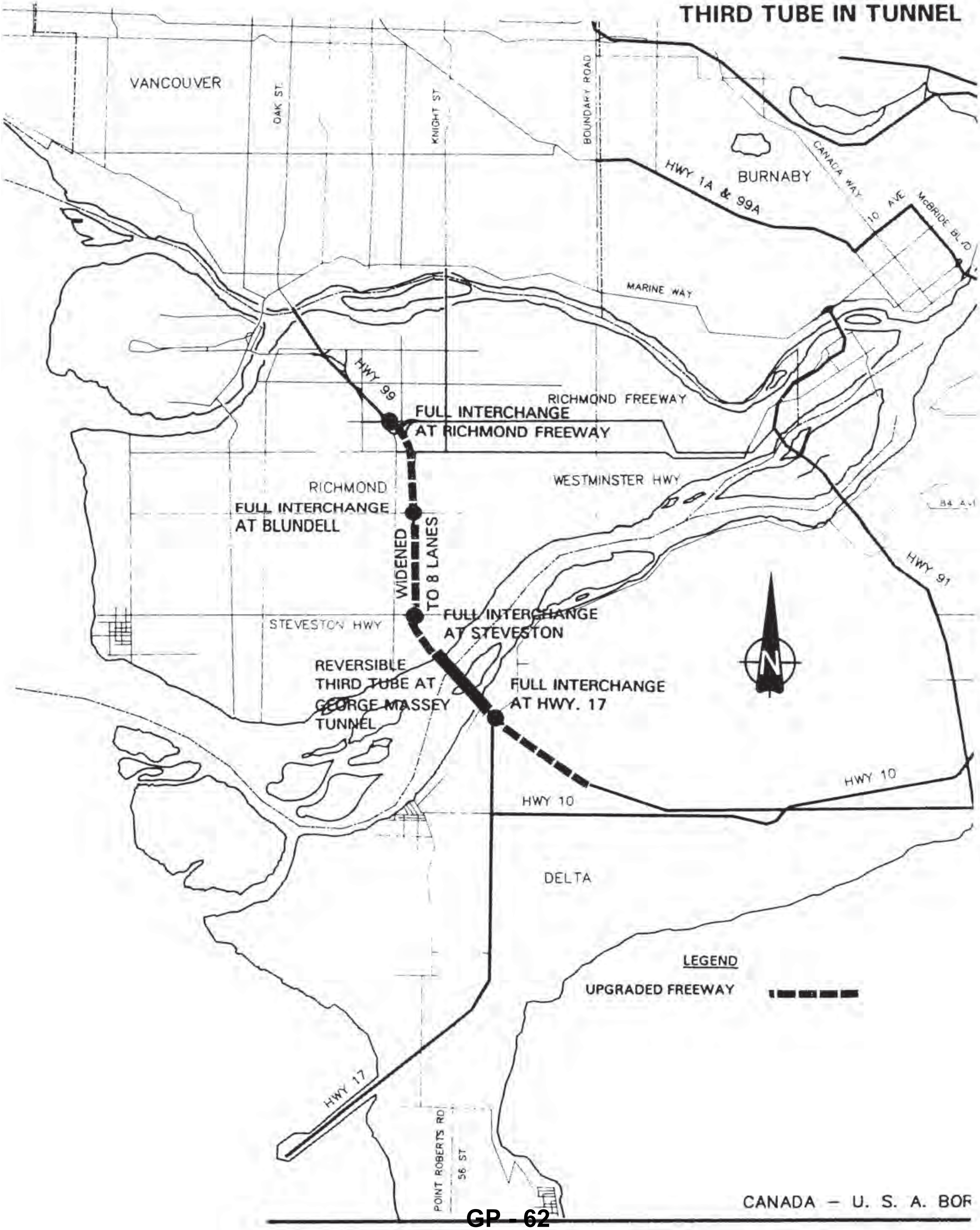
- the addition of a full all-movements interchange on Highway 99 at Blundell Road; and

- the upgrading of the existing Highway 99 interchanges at Highway 17/River Road, Steveston Highway, and the Richmond Freeway.

This alternative is illustrated conceptually in Exhibit 4.2. The laning concept within the expanded tunnel was assumed to be four lanes northbound and two lanes southbound during the morning peak period, and the reverse during the afternoon peak period. Off-peak traffic flows would be handled with three lanes in each direction. This means an increase of one lane in each direction, i.e. 2,000 vehicles per hour, over the present lane configurations in all three time periods for a total peak direction capacity of 8,000 vehicles per hour.

EXHIBIT **4.2**

ALTERNATIVE B - THIRD TUBE IN TUNNEL



4.4 Alternative C - Third and Fourth Tubes in the Tunnel

The key improvements in this alternative are similar to those described for the Third Tube alternative, except that there are two and not just one additional two-lane tubes. This results in one more lane in each direction within the tunnel in each time period, i.e. five lanes northbound and three lanes southbound during the morning peak period, with the reverse during the afternoon peak period for a total peak direction capacity of 10,000 vehicles per hour. At all other times of the day there would be four lanes in each direction. The additional lane in each direction was assumed to terminate at the Highway 17/River Road interchange in the south and at the Steveston Highway interchange in the north, thereby effectively providing a direct lane through the tunnel linking Steveston Highway to Highway 17. In general, this alternative was assumed to necessitate further widening of Highway 99 between Steveston Highway and Highway 17 above the eight lanes to the north and six lanes to the south as included in Alternative B.

The primary reason for including this alternative was to provide a tunnel concept that included the same number of additional lanes across the South Arm, as would be provided in any of the other new bridge crossing alternatives, ie. an increase of two lanes in the peak directions. Any of the new bridges included in Alternatives D or E were assumed to be four lanes with two in each direction. It is therefore necessary to add two tubes in order to provide this same increase in capacity. This alternative was also used to evaluate the ultimate demand for capacity through the tunnel assuming no capacity restrictions and given the 2001 land-use scenario assumptions used by the G.V.R.D. in establishing the trip table.

4.5 Alternative D - No. 5 Road Bridge

Another alternative that was included in this investigation was the upgrading of No. 5 Road and the introduction of a new bridge or tunnel linking the south end of No. 5 Road in Richmond with Highway 17 in Ladner. The south end of this new connection was assumed to be located on Highway 17 at some point between Highway 99 and Highway 10/Ladner Trunk Road. The primary function of this new route was to serve local traffic travelling between Richmond and South Delta. If this traffic could be kept off of Highway 99, then the existing two-tube George Massey Tunnel would be available for use by longer distance traffic oriented to and from points further to the north, i.e. Vancouver, and to the south, i.e. South Surrey and the U.S.A. As the north end of the new crossing was to be linked to an arterial road, it was assumed that the additional capacity provided would be approximately 2,800 vehicles per hour in each direction, i.e. 1,400 vehicles per lane per hour, regardless of whether the new crossing is a bridge or a tunnel.

In establishing the form of this alternative, other options were considered. These included the use of either Shell Road or No. 4 Road connecting in to the west end of Ladner instead of No. 5 Road. Both were, however, rejected as they would require constructing a significantly longer bridge or tunnel to cross not only the Fraser River but also Rose, Kirkland, Williamson and Gunn Islands plus the Ladner Reach and Ladner Marsh.

The key improvements included in this No. 5 Road alternative are as follows:

- the construction of a four-lane bridge or tunnel west of the George Massey Tunnel connecting No. 5 Road in Richmond with Highway 17 in Delta - an analysis of the geometrics of both options indicates that either could be constructed and brought back to grade well before the terminal points at Highway 17 in the south and Steveston Highway in the north.

- the construction of full interchanges along the alignment of this new route at its junction with Highway 17 and at the Highway 17/Ladner Trunk Road intersection;

- the widening of No. 5 Road to a four-lane arterial standard from the north end of the new crossing north to Westminster Highway; and

- the upgrading of the existing No. 5 Road intersections with Steveston Highway, Blundell Road, and Westminster Highway.

The conceptual configuration of this new crossing, along with the related improvements to the adjacent road network, is illustrated in Figure 4.3. It should be noted that in the analysis undertaken with this alternative, the upgraded No. 5 Road was not extended north beyond Westminster Highway and it therefore did not connect to any new interchange on Highway 99.

4.6 Alternative E - 72nd Street - No. 8 Road Freeway

This alternative consists of a new four-lane freeway, to start in the south at Highway 17 north-east of Tsawwassen, passing to the east of the East Ladner residential community and extending north all the way to Boundary Road in Vancouver, via 72nd Street in Delta, and No. 8 Road in Richmond, with new bridge crossings of both the North and South Arms of the Fraser River. It did not include any upgrading of Boundary Road north of Marine Way. This alternative was designed to assess the impact on travel patterns of introducing a new major crossing of the South Arm coupled with a new crossing of the North Arm on travel patterns.

The proposed alignment of this new route is located approximately midway between the existing George Massey Tunnel (Highway 99) and Alex Fraser Bridge (Highway 91). It is therefore anticipated that it would divert significant amounts of traffic from both of these existing crossings. The key improvements in this alternative are as follows:

- the construction of a new four-lane high-level bridge across the South Arm of the Fraser River along the 72 Street/No. 8 Road alignment;

- the construction of a four-lane medium level bridge across the North Arm of the Fraser River along the No. 8 Road/Boundary Road alignment;

- the construction of a four-lane freeway from Highway 17 in the vicinity of its existing intersection with 56th Street at the north end of Tsawwassen to the intersection of Boundary Road and Marine Way in Vancouver;

- the construction of a new four-lane east-west arterial road from 46A Street in Ladner to the new freeway along the south side of the Municipal Hall complex via the 44th Avenue alignment;

- the construction of full interchanges on the new freeway at Highway 17, the new Ladner

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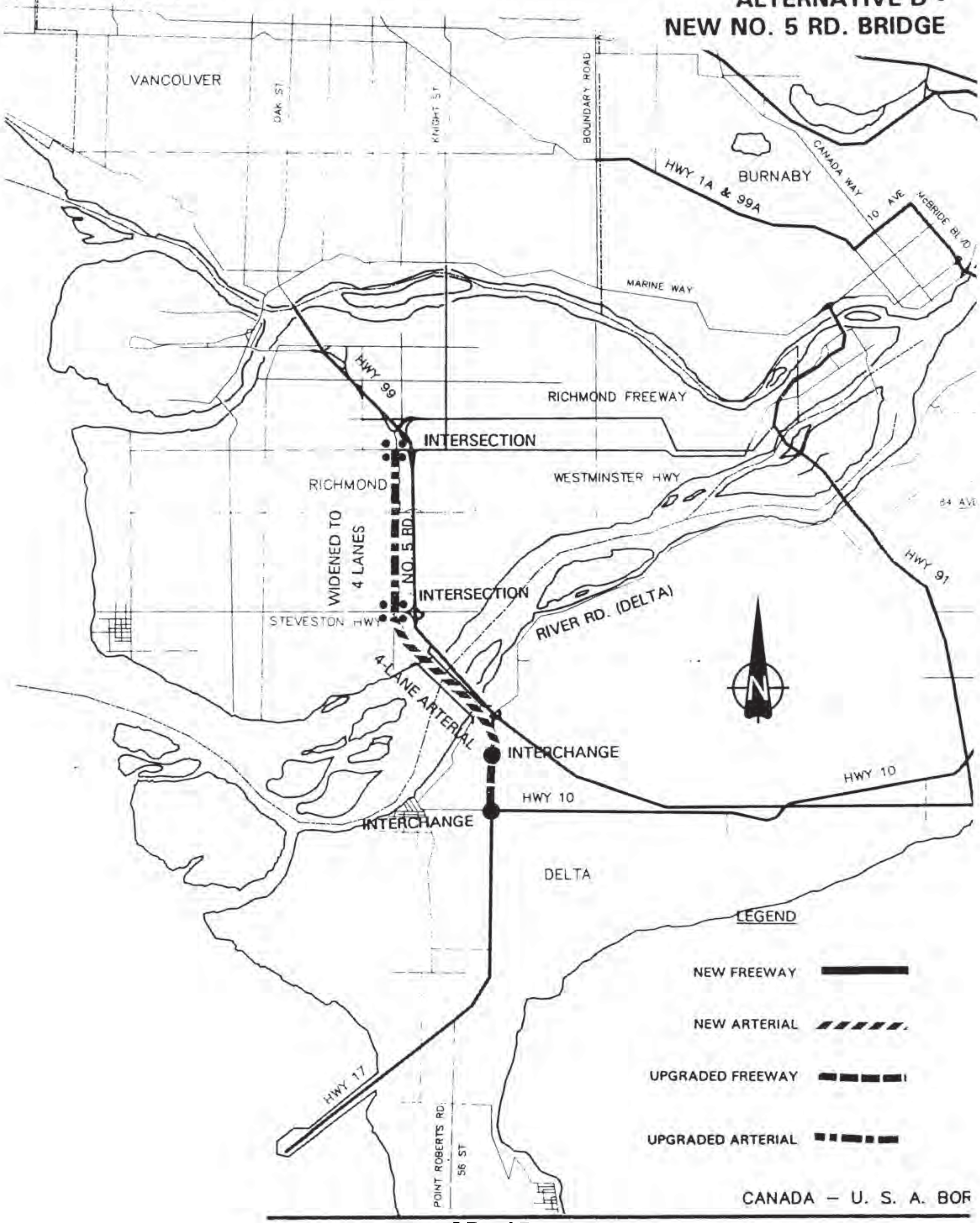
EXHIBIT **4.3**

ALTERNATIVE D - NEW NO. 5 RD. BRIDGE



arterial, Highway 99, River Road (in Delta), Richmond Freeway, River Road (in Richmond) and Marine Way (in Vancouver); and

- the construction of new signalized intersection on Highway 17 at its intersection with the new Ladner arterial.

This scheme is illustrated conceptually in Exhibit 4.4.

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EXHIBIT **4.4**

ALTERNATIVE E - 72 ST./NO. 8 RD. FREEWAY

5.0 ANALYSIS OF ALTERNATIVE CROSSINGS

5.1 Use of EMME/2 to Establish Future Volumes

As has been described in Chapter 3.0, the GVRD's EMME/2 transportation planning model was used to project the 2001 traffic volumes on the alternative crossing configurations. This model was first used to establish a fixed trip table representing the number of trips between each origin-destination pair. Once the travel demand, in terms of these origin-destination patterns, was established, i.e. fixed, for the design year (as shown in Table 3.2), the model then assigned the traffic volumes to the various links of the specified road network for each alternative based on minimum time/distance paths, projected volume/capacity ratios, and speed/volume curves. The projected volumes on each of the existing river crossings resulting from the assigning of this trip table to the "Do Nothing" network alternative was presented earlier in Table 3.2 for both the "calibration" year of 1987 and the design year of 2001 for the morning and afternoon peak hours.

5.2 Projected Traffic Volumes On Alternative Networks

The projected volumes on each of the networks within the study area relevant to this particular study as output by EMME/2 are included as Appendix I. The projected 2001 morning and afternoon peak hour traffic volumes at each of the major river crossings for each alternative, presented both individually and by screenline total, are presented in Table 5.1.

From this analysis, there are a number of key findings regarding the impact of the different alternatives on the resultant projected traffic volumes. These findings are as follows:

(a) Alternative A - "Do Nothing": Based on the results of the model's analysis, of the 4,490 vehicle increase in northbound traffic volumes across the South Arm of the Fraser River during the morning peak hour, 2,520 or 56% will be on the Alex Fraser Bridge. A further 990 or 22% are assigned to the George Massey Tunnel even though it is theoretically at capacity. This is because all of the trips included in the fixed demand trip table must cross the river somewhere even if all crossings are at capacity. In the afternoon peak hour, 1,798 or 62% of the total increase of 2,911 in southbound traffic volumes are on the Alex Fraser Bridge. This bias towards the Alex Fraser Bridge is not surprising since this bridge is one crossing that is presently operating below its theoretical capacity.

(b) Alternative B - Reversible Third Tube of Tunnel: The addition of a third tube in the tunnel increased the morning peak hour northbound volume in the tunnel by 460 vehicles over the base "Do Nothing" network which had 6,067 in the tunnel (an increase of 7.5%) or by 675 vehicles over the 1989 actual volume which was 5,850. The afternoon peak hour southbound volume increased by 650 vehicles or 15.6% over the base network which had 4,134 vehicles. These increases in the tunnel volumes result in corresponding decreases in volumes on the Alex Fraser Bridge when comparing the results to the Base Network. The increase in capacity provided through the tunnel, assuming that the capacity of the supporting road network can also be increased, is of the order of 1,900 vehicles per hour indicating that the tunnel would be operating well below its capacity of 7,600 vehicles in this scenario.

It should also be noted that the volumes through the tunnel in the off-peak direction increase very marginally even though there are now two lanes in this direction rather than the one as at present.

Table 5.1
Projected 2001 Volumes for Crossing Alternatives

	A-Base Network		B-Reversible Third Tube		C-Reversible Fourth Tube		D-No. 5 Road Bridge		E-72 Bridge Bndy.Rd.Bridge	
(a) Morning Peak Hour	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
North Arm										
Arthur Laing Bridge	3,664	2,550	3,668	2,535	3,693	2,540	3,681	2,540	3,463	2,530
Oak St. Bridge	4,413	2,038	4,493	2,062	4,490	2,060	4,428	2,051	4,205	1,981
Knight St. Bridge	4,804	4,085	4,842	4,051	4,903	4,046	4,878	4,049	3,601	3,245
Queensborough Bridge	4,035	2,456	4,032	2,483	3,997	2,472	4,027	2,472	3,363	1,938
Boundary Rd. Bridge	-	-	-	-	-	-	-	-	2,660	1,585
Total Volumes	16,916	11,129	17,035	11,131	17,083	11,118	17,014	11,112	17,292	11,279
South Arm										
George Massey Tunnel	6,067	1,746	6,523	1,917	6,765	1,928	4,968	1,555	5,129	1,502
Alex Fraser Bridge	6,149	1,950	5,814	1,785	5,635	1,774	5,882	1,905	4,890	1,524
No. 5 Rd. Bridge	-	-	-	-	-	-	1,482	239	-	-
72nd St. Bridge	-	-	-	-	-	-	-	-	2,749	778
Total Volumes	12,216	3,696	12,337	3,702	12,400	3,702	12,332	3,699	12,768	3,084
(b) Afternoon Peak Hour										
North Arm										
Arthur Laing Bridge	2,785	2,942	2,793	2,928	2,797	2,935	2,790	2,926	2,763	2,839
Oak St. Bridge	2,138	4,293	2,157	4,357	2,158	4,373	2,143	4,312	2,082	4,100
Knight St. Bridge	4,066	4,184	4,047	4,308	4,143	4,288	4,061	4,259	3,289	3,154
Queensborough Bridge	2,870	3,460	2,871	3,420	2,867	3,431	2,872	3,436	2,367	2,677
Boundary Rd. Bridge	-	-	-	-	-	-	-	-	1,535	2,527
Total Volume	11,859	14,879	11,868	15,013	11,865	15,027	11,866	14,933	12,036	15,297
South Arm										
George Massey Tunnel	2,070	4,134	2,386	4,780	2,413	4,859	1,722	3,500	1,888	3,426
Alex Fraser Bridge	2,607	4,966	2,292	4,446	2,260	4,379	2,389	4,771	1,948	3,686
No. 5 Rd. Bridge	-	-	-	-	-	-	577	886	-	-
72nd St. Bridge	-	-	-	-	-	-	-	-	859	2,353
Total Volume	4,677	9,100	4,678	9,226	4,673	9,238	4,688	9,157	4,695	9,465

(c) Alternative C - Reversible Fourth Tube of Tunnel: The addition of a fourth tube in the tunnel to provide five lanes in the peak direction and three in the off-peak increased the morning peak hour northbound volume in the tunnel by only another 240 vehicles or 3.7% over the volume projected for the third tube alternative and the afternoon peak hour southbound volume by only another 80 vehicles or 1.7%. These increases could be accommodated in the third tube and it is therefore apparent that a fourth tube would provide no real benefit.

(d) Alternative D - New No. 5 Road Bridge Tunnel: The introduction of the No. 5 Road Bridge attracted 1,480 northbound vehicles in the morning peak hour and 890 southbound vehicles in the afternoon peak hour. The corresponding tunnel volumes decreased by 1,100 northbound vehicles from the "Do Nothing" volume of 6,067 or 18.1% in the morning peak hour and 634 southbound vehicles from the "Do Nothing" volume of 4,134 or 15.3% in the afternoon peak hour. These model results indicate that firstly, there is a significant volume of traffic travelling between Richmond and South Delta, and, secondly, that they would be attracted to this route.

(e) Alternative E - New 72 Street/No. 8 Road Bridge: This new bridge, which is part of the proposed new 72 Street/No. 8 Road freeway system from Tsawwassen in the south to Vancouver in the north attracted 2,749 northbound vehicles in the morning peak hour, and 2,353 southbound vehicles in the afternoon peak hour when compared to the results using the 2001 base network with no new or improved crossings. The decrease of traffic in the George Massey Tunnel due to the addition of this new bridge was 940 vehicles in the northbound direction during the morning peak period, and 710 vehicles in the southbound direction during the afternoon peak period. Based on the model's projections, the resultant volumes through the tunnel would then be lower than they are at present. The decrease of traffic on the Alex Fraser Bridge in the two directions was even greater at 1,260 and 1,280 respectively.

These results indicate that this new bridge is very attractive in terms of providing a route as close as possible to the desire line of many commuters who live south of the Fraser River and work in Richmond or Vancouver.

(f) Alternative E - New No. 8 Road/Boundary Road Bridge: This bridge, which is included in Alternative E, not unexpectedly, has a positive effect in terms of reducing traffic volumes on some of the other bridges across the North Arm of the Fraser River. In the morning peak hour these are most significant at the Queensborough Bridge with a reduction in the northbound traffic volume of 670 or 17% when compared to the 2001 base network and the Knight Street Bridge with a reduction of 1,200 or 25%. In order to enable this river crossing to be as attractive as possible, it is necessary to have new interchanges on Highway 91 at Highway 91A and Hamilton. It is understood that a separate study being undertaken on upgrading the Queensborough Bridge and Interchange has projected significantly higher volumes on this bridge than those given in Table 5.1. This is no doubt a result of the more refined modelling process being undertaken in the vicinity of the Queensborough Bridge in this study.

It must be remembered, that the construction of the proposed rapid transit link between Downtown Vancouver and Richmond which is currently in the planning stage will provide a significant increase in the people moving capacity across the North Arm and this in turn will result in a reduction in traffic volumes across the existing bridges.

5.3 Impact on Alex Fraser Bridge

The amount of traffic diverted to or from the Alex Fraser Bridge in the peak direction in each alternative is provided in Table 5.2. The smallest impact is with the No. 5 Road Bridge in place (Alternative D) with a projected decrease of 270 northbound vehicles or 4.3% in the morning peak hour and 195 southbound vehicles or 3.9% in the afternoon peak hour. The largest impact is with the 72nd Street/No. 8 Road Bridge in place (Alternative E), with corresponding diverted volumes projected to be 1,260 northbound vehicles or 20.5% in the morning peak hour and 1,280 southbound vehicles or 25.8% in the afternoon peak hour.

This comparison clearly indicates that the 72nd Street/No. 8 Road Bridge alternative with its supporting freeway would not only divert a significant amount of traffic from the tunnel, but would also provide considerable relief to the Alex Fraser Bridge.

Table 5.2
Impact of Alternatives on Alex Fraser Bridge Volumes

Alternative	Projected Change in 2001 Volumes on Alex Fraser			
	a.m. Northbound		p.m. Southbound	
	volume	%change	volume	% change
A: Do Nothing (Base)	0	0%	0	0%
B: Third Tube	-335	-5.4%	-520	- 10.5%
C: Fourth Tube	-514	-8.4%	-587	- 11.8%
D: New No. 5 Road	-267	-4.3%	-195	- 3.9%
E: New 72 Street/No. 8 Road	-1259	-20.5%	- 1280	- 25.8%

In analyzing historic and future traffic volumes, the volumes quoted are taken to be typical spring or fall volumes. In actual practice, volumes are often higher or lower depending upon the time of the year and whether or not a ferry has just been unloaded at the terminal. For the purpose of this study, those ferry-induced surges, which will be of the order of 450 - 470 vehicles over a 10 minute period once the new ferries currently under construction are in service, have not been taken into consideration.

5.4 Travel Patterns of Tunnel Users

In order to obtain an understanding of the origin and destination patterns of traffic using the George Massey Tunnel under Alternative B - Third Tube, a select link analysis was carried out for the afternoon peak hour and the results are presented in Exhibit 5.1.

This indicates that, based on the model's theoretical analysis, only 17% of the southbound traffic in the tunnel should get onto Highway 99 at Steveston Highway with a further 8% at Westminster Highway. This is clearly much lower than what the existing traffic counts indicate. It is concluded that the high volume actually entering Highway 99 at this point is caused by many drivers simply trying to bypass the excessive delays on Highway 99 whereas the model does not fully take these delays into account when assigning traffic. In reality this traffic should therefore be entering Highway 99 at other points to the north of the Steveston Interchange.

South of the tunnel, 23% of the traffic is oriented to Ladner and a further 28% to Tsawwassen and the ferries. It is clear therefore, that the actual desire for travel between Ladner/Tsawwassen and the southern segment of Richmond is not significant. It is not surprising therefore to find that the volumes assigned to the No. 5 Road Bridge alternative were not high.

5.5 Impact of Ferry Traffic

Although the computer model does include the traffic generated by the ferries arriving and departing the

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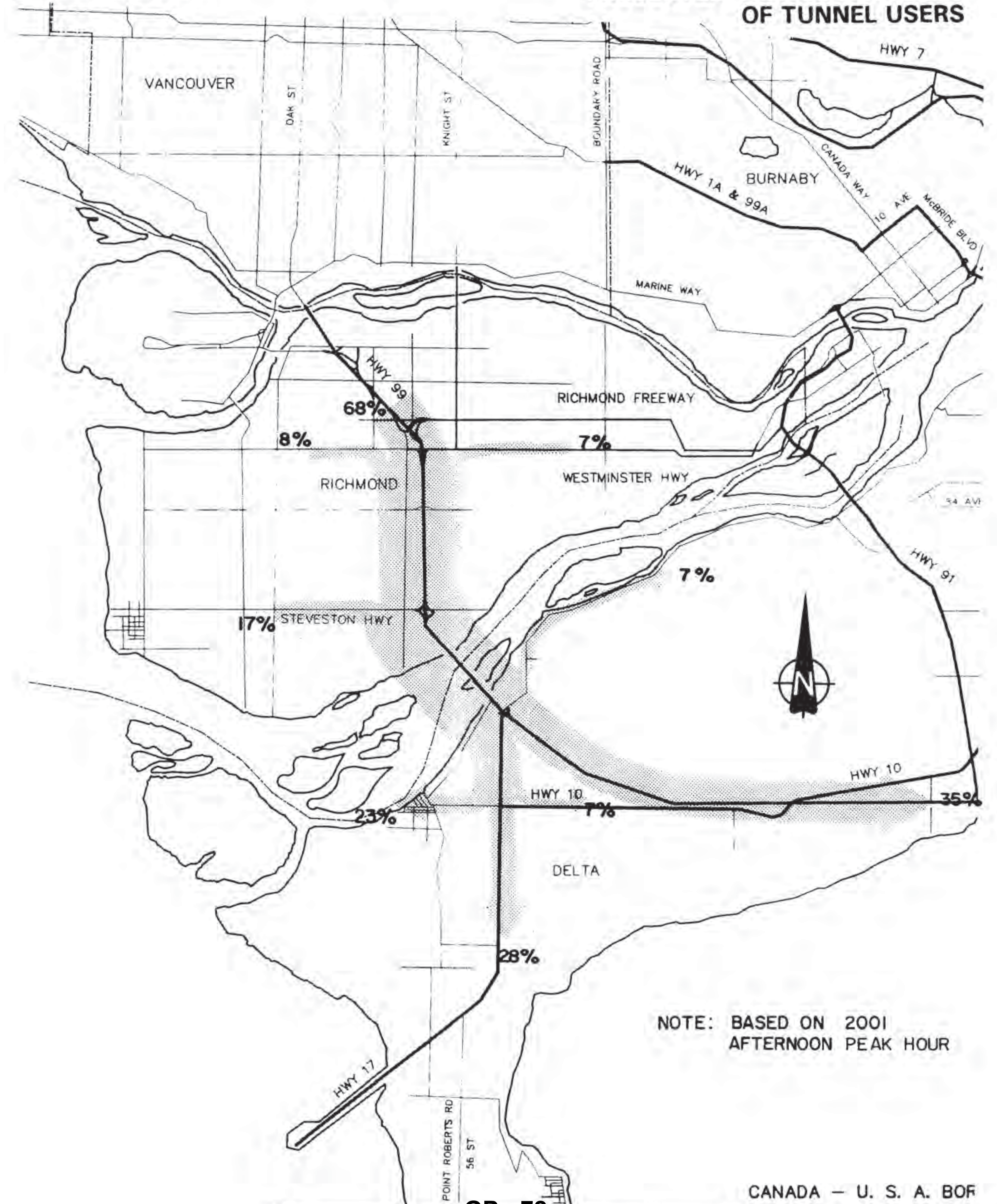
EXHIBIT **5.1**

PROJECTED TRAVEL PATTERNS OF TUNNEL USERS



Tsawwassen Ferry Terminal, it does not take into account the effect of the very high peaking characteristics of this traffic immediately following a ferry's arrival.

Any transportation planning model is based on an analysis of conditions over a one hour period. All trip generation rates and traffic counts used to calibrate the model are based on a one hour time period. Ferries on the other hand unload all of their vehicles in approximately ten minutes. This means that if a single vessel arrives in a one hour time period, the traffic counters on Highway 17 record this event as 280 northbound vehicles passing over the loop in that one hour. In actual fact, they passed over the loop in a ten minute time period and therefore the true arrival rate, if they are to be "processed" through the tunnel as soon as they arrive, is six times that, i.e. 1,680 vehicles. Even if 30% are assumed to exit Highway 17 to Tsawwassen, Ladner, Highway 10 east or Highway 99 east, it still means an arrival rate of 1,180 vehicles per hour. Once the new superferries are in service, this arrival rate will increase to 1,975 vehicles per hour. B.C. Ferries' summer 1991 schedule indicates that two vessels will arrive during one of the morning peak hours, one at 7:05 a.m. from Swartz Bay and one at 7:30 a.m. from Nanaimo. During the evening peak period, an even bigger problem occurs in that one ferry arrives at 5:30 p.m. from Nanaimo and another arrives at 5:35 p.m. from Swartz Bay and at the same time there is at present only one northbound lane open in the George Massey Tunnel. It is clear therefore from these observations that any analysis of traffic based on the typical peak hour conditions does not truly reflect the real world in this situation and any results must be tempered or modified accordingly.

Table 5.3
Summary of 2001 EMME/2 Network Statistics

		Greater Vancouver		Richmond	
		Veh-Hr	Veh-Km	Veh-Hr	Veh-Km
Base Network 2001:	A.M.	71,620	3,271,494	11,991	574,355
	P.M.	89,744	3,805,145	14,016	620,981
Reversible Third Tube of Tunnel:	A.M.	71,239	3,275,709	11,677	578,648
	P.M.	89,137	3,808,662	13,448	625,669
New Bridge at No. 5 Road	A.M.	71,164	3,273,310	11,611	577,771
	P.M.	89,474	3,808,837	13,633	622,703
New Bridges at 72 St./No. 8 Rd., and Boundary Rd:	A.M.	70,165	3,271,475	11,272	588,524
	P.M.	88,782	3,805,566	13,567	636,062
Reversible Fourth Tube of Tunnel:	A.M.	71,027	3,275,743	11,567	581,032
	P.M.	89,134	3,809,952	10,919	515,233
Irreversible Third Tube of Tunnel:	A.M.	71,678	3,273,647	11,911	575,053
	P.M.	89,331	3,809,333	13,585	624,085
Irreversible Fourth Tube of Tunnel:	A.M.	71,346	3,274,998	11,738	577,594
	P.M.	89,371	3,810,695	13,549	624,790

Table 5.4
Unit Construction Cost

Item		Unit Cost	
Bridges:	New high level	$ 12.50M/km/lane	
	New mid level	$ 10.00M/km/lane	
Tunnel Tubes:	One Additional	$ 19.00M/km/lane	
	Two additional	$ 38.00M/km/lane	
Overpasses:	New 4-lane over railway tracks	$ 0.41	M each
	New 4-lane over 2-lane road	$ 0.37	M each
Freeways:	New 4-lane	$ 5.00	M/km
	Existing 4-lane widened to 6-lane	$ 2.00	M/km
	Widening of existing by one lane	$ 1.00	M/km
Arterials:	New 4-lane	$ 2.00	M/km
	Existing 2-lane widened to 4-lane	$ 2.60	M/km
	2-lane undivided widened to 4-lane	$ 1.50	M/km
Interchanges:	Major urban (freeway to freeway)	$ 10.00	M each
	Minor urban (freeway to arterial)	$ 5.50	M each
	Tight diamond	$ 4.00	M each
Intersections:	Major improvement (at-grade)	$ 0.20	M each
Land:	Agricultural	$ 2 K	/hectare
	Suburban	$ 3 M	/hectare
	Urban	$10 M	/hectare

5.6 Analysis of Network Statistics for Alternatives

One element of the output produced by the EMME/2 output is a summation of the total number of vehicle-hours and vehicle-kilometres projected on the network within Greater Vancouver. A summary of these statistics for each of the alternatives is presented in Table 5.3. Note once again that these results ignore the effect of the delays that often occur at the interchanges on either side of most of the bridges and the tunnel across the rivers.

Based on this summary, the 72nd Street/No. 8 Road Freeway alternative yielded the smallest totals for both vehicle-hours and vehicle kilometres. Although the differences in the numbers presented appear insignificant, they really are not as they reflect the total of all vehicles on all links on the entire Greater Vancouver network in the first two columns and on all links within Richmond in the second two columns. The results of Table 5.3 indicate that the 72 Street/No. 8 Road Freeway alternative has the best performance in terms of:

(a) minimizing the total time spent by vehicles travelling between their origins and destinations - this in turn means less person time spent travelling, and less vehicle operating time, meaning that expensive commercial vehicles can be used more effectively.

(b) minimizing the total distance travelled meaning less fuel consumption and therefore less air pollution and less road maintenance costs.

Table 5.5
Construction Cost Estimates for Crossing Alternatives

	Altern. B Third Tube		Altern. C Fourth Tube		Altern. D No. 5 Road		Altern. E 72 Rd/Bdy	
	# Units	Cost	# Units	Cost	# Units	Cost	# Units	Cost
Bridges:								
High level (in lane kms)					8.0	100.0	10.0	125.0
Mid level (in lane kms)							4.0	40.0
Tunnel Tubes:								
Single (in lane kms)	7.0	133.0						
Double (in lane kms)			7.0	266.0				
Overpass:								
New 4-lane over railway tracks (each)							4.0	1.6
New 4-lane over 2-lane road (each)					1.0	0.4		
Freeways:								
New 4-lane (in kms)			2.0	10.0			14.0	70.0
4-lane widened to 6 lanes (in kms)	6.0	12.0	6.0	12.0	0.5	1.0		
Widening of existing by one lane (in kms)	3.0	3.0	3.0	3.0				
Arterials								
New 4-lane (in kms)					3.5	7.0	5.0	10.0
Existing 2-lane widened to 4 lanes (each)					4.0	6.0	3.0	7.8
Interchanges:								
Major urban (each)	1.0	10.0	1.0	10.0			3.0	30.0
Minor urban (each)	1.0	5.5	1.0	5.5	2.0	11.0	3.0	16.5
Tight diamond (each)							1.0	4.0
Intersections:								
Major improvement (each)					3.0	0.6	2.0	0.4
Land:								
Agricultural (hectares)	10.0	2.0	13.0	2.5	101.0	20.2	10.1	20.2
Suburban (hectares)	3.00	9.0	3.5	10.5	0.5	5.0		
Urban (hectares)							0.5	5.0
TOTAL COST		$174.5 M		$319.5 M		$151.2 M		$330.5 M
With 10% contingency included		$195 M		$355 M		$165 M		$365 M

5.7 Cost of Construction

The cost of constructing each alternative was established by estimating the construction cost of each element in each alternative. This included all bridges and tunnels, new or expanded arterial roads and freeways, new or expanded interchanges, and land acquisition. The unit construction costs used in this study were based on those established and used in the 1989 Greater Vancouver Transportation Task Force Study, and these are presented in Table 5.4. For the purpose of this costing, it was assumed that the No.

5 Road alternative would be a bridge and not a tunnel. The resultant cost of each alternative, together with the lengths of the various components, are presented in summary form in Table 5.5.

Based on the results presented in Table 5.5, Alternative D - No. 5 Road Bridge has the least cost at $175 million, while Alternative E - 72 Street/No. 8 Road Freeway with two new bridges, a high level one at 72nd Street and a mid-level one at No. 8 Road, and Alternative C - Third and Fourth Tubes in Tunnel have the highest costs at approximately $360 million each.

5.8 Cost-Benefit Evaluation of Alternative Crossings

In order to evaluate the effectiveness of each alternative in reducing the total vehicle-hours projected by the model, a modified version of cost-benefit analysis was adapted for use in this study. The benefits of each alternative were based on the results already presented in Table 5.3. By establishing the "do nothing" alternative as the base scenario, the benefits resulting from each of the real improvement alternatives were calculated and quantified in terms of the reduction of total vehicle-hours in comparison to the base scenario.

The "cost effectiveness" of each alternative was then measured as the quantified benefits, i.e., reduction in vehicle-hours by travel on the total network for each one million dollars of construction cost. The results of this calculation for each of the alternatives are presented in Table 5.6 in order of increasing effectiveness.

Table 5.6
Cost Effectiveness of Crossing Alternatives

Alternative	Veh-Hr. Reduction/$ Mil A.M. Peak	Veh-Hr. Reduction/$ Mil P.M. Peak	Averaged
Do nothing	0	0	0
Fourth Tunnel Tube	1.67	1.72	1.70
No. 5 Road Bridge	2.61	1.54	2.08
Third Tunnel Tube	1.95	3.11	2.53
72nd Street/No. 8 Road Freeway	3.99	2.64	3.32

Based on the above summary of benefits versus costs, the 72nd Street/No. 8 Road Freeway alternative yields the highest "effectiveness" with an average of 3.32 vehicle-hours savings in a peak hour per million dollars spent on the overall road network even though it has the highest cost of construction. The effectiveness of this alternative is 31% higher than that of the next highest effectiveness, the Third Tube in the Tunnel alternative. The No. 5 Road Bridge alternative was a distant third.

In order to put these savings into perspective, 3.32 veh-hours in the peak hour at a vehicle operating cost of $20/hour - this effectively excludes the driver's time cost - assuming 6 days/week and a peak hour volume to 24-hour volume ratio of 1:10 produces an annual cost saving of $210,000 for each million dollars of capital expenditure. In very simple terms, this means a pay back of this project to users and taxpayers alike, in less than 5 years.

5.9 Possible Modifications to Alternatives Analyzed

Subsequent to the previous evaluation of the scenarios tested, all of the alternatives were analyzed further with the inclusion of several changes to each of the original concepts. This refining process was carried out to incorporate minor complimentary improvements to the road network so that:

- the attractiveness of each alternative could be maximized; and/or
- the sensitivity of volume projections to these changes could be tested.

Each of these refinements are discussed as follows:

(a) Alternative F - Irreversible Third Tunnel Tube: This alternative was previously developed as a contra-flow scheme in which there were four lanes for the peak direction of travel and two lanes for the opposite direction during weekday peak periods. In order to identify the projected impact on both traffic volumes and corresponding level of service without the reversibility feature included in the third tube, a new alternative was created to represent the irreversible third tube in which three lanes of travel are maintained at all times of the day.

The results projected for this alternative indicated, not surprisingly, that the volumes through the tunnel in the peak direction were the same as for the "do nothing" alternative which also has three lanes in the peak direction. Furthermore, this irreversible flow concept yielded total vehicle-hours that are higher than those values yielded for the reversible flow option and very similar to those of the "do nothing" alternative. It was therefore concluded that if a third tube is added to the tunnel it should be reversible as it is beneficial in maximizing the attractiveness of the Third Tube alternative.

(b) Alternative G - Irreversible Fourth Tunnel Tube: Under the same rationale as outlined above, similar modifications were made to the Fourth Tube alternative so that the impact of reversibility on the effectiveness of this improvement could be identified. Again, the results indicate that the reversible four tube concept with six lanes in the peak direction would function more effectively in reducing the total vehicle-hours on the road network than the irreversible concept would with only four lanes in each direction.

(c) Alternative H - No. 5 Road Expressway: In order to maximize the attractiveness of any new No. 5 Road Bridge as included in Alternative D, No. 5 Road which was previously defined as an arterial road with a speed of 60 km/h, was upgraded to a four-lane expressway standard with a speed of 80 km/h. In addition, a new full interchange on Highway 99 at Blundell Road was included in order to provide more direct access to the highway from the upgraded No. 5 Road via Blundell Road. The south side of the existing Steveston Highway interchange on Highway 99 was closed so that the majority of the Richmond-oriented traffic still using the tunnel even with the No. 5 Road Bridge in place was either encouraged to use the new bridge or forced to use the Blundell Road interchange.

With all of the above revisions in place, the refined "high-speed" No. 5 Road Bridge concept was tested and the results are shown in Table 5.7, together with the previous "low-speed" concept.

Table 5.7
Comparison of Low-Speed and High-Speed No. 5 Road Bridge Alternatives

	Low Speed Bridge (1)				High Speed Bridge (2)			
	A.M. Peak Hour		P.M. Peak Hour		A.M. Peak Hour		P.M. Peak Hour	
	NB	SB	NB	SB	NB	SB	NB	SB
North Arm								
Arthur Laing Bridge	3,681	2,540	2,790	2,926	3,652	2,537	2,789	2,957
Oak St. Bridge	4,428	2,051	2,143	4,312	4,489	2,052	2,153	4,331
Knight St. Bridge	4,878	4,049	4,061	4,259	4,861	4,053	4,060	4,190
Queensborough Bridge	4,027	2,472	2,872	3,436	4,025	2,470	2,863	3,451
Total North Arm Volumes	17,014	11,112	11,866	14,933	17,027	11,112	11,865	14,292
South Arm								
No. 5 Rd. Bridge	1,482	239	577	886	1,920	538	863	1,438
George Massey Tunnel	4,968	1,555	1,722	3,500	4,601	1,317	1,502	2,941
Alex Fraser Bridge	5,882	1,905	2,389	4,771	5,824	1,844	2,323	4,776
Pattullo Bridge	4,100	2,483	2,931	3,089	4,091	2,486	2,928	3,067
Port Mann Bridge	4,473	3,470	3,799	4,004	4,475	3,469	3,802	3,996
Total South Arm Volumes	20,905	9,652	11,418	16,250	20,911	9,654	11,418	16,218

Note: 1. Low speed alternative retains the existing Steveston Highway interchange and does not include any new Blundell Road interchange on Highway 99.
2. High Speed alternative includes a new Blundell Road interchange on Highway 99 and restricts some movements at the Steveston Highway Interchange.

The assignment and select link analysis results show firstly that this bridge is used primarily by those commuting to and from work in Richmond, i.e. the northbound volume is significantly higher than the southbound volume in the morning peak hour. Secondly, it shows that the morning northbound peak hour volume on the new bridge increased from 1,482 vehicles per hour to 1,920 vehicles per hour while the southbound volume increased from 890 vehicles per hour to 1,440 vehicles per hour, for a combined increase of 42% over the "low-speed" concept. The attractiveness of the No. 5 Bridge in these two alternatives, regardless of the design speed assumed for No. 5 Road, was found to be significantly lower however than the 72nd Street/No. 8 Road Bridge alternative, based on a comparison of the total traffic volume attracted to each of the new facilities. This is not surprising since a No. 5 Road Bridge would serve a relatively limited "catchment" area whereas the 72nd Street/No. 8 Road bridge serves a much broader catchment area. Assuming bridges rather than tunnels in either case, both would have to be high level structures to allow ships to pass under. One of the key advantages of either of the two No. 5 Road concepts is that it could allow for some improvements in the operational problems that presently exist at either end of the tunnel.

A further improvement that could be made to a No. 5 Road concept is to extend the south end east to a new interchange on Highway 99 rather than terminating it at an interchange at Highway 17 as has previously been shown in Exhibit 4.3. With this extension, the catchment area would be expanded as trips from South Surrey would also have a new direct link to Richmond. This concept is shown in Exhibit 5.2.

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EXHIBIT **5.2**

POSSIBLE NO. 5 RD. BRIDGE CONNECTION TO HIGHWAY 99

5.10 Impact of Blundell Interchange on Steveston Interchange

At the present time there is severe congestion in the vicinity of the southbound approach to the tunnel caused by the high volume of traffic seeking to access the tunnel from Steveston Highway. Some additional analysis was therefore also carried out on the reversible Third Tube network (Alternative B) to evaluate the impact of restricting, by ramp metering, or closing, the eastbound to southbound ramp at this interchange. This was analyzed by examining the traffic volumes that were re-directed from the Steveston Highway interchange to the new Blundell Road interchange under a number of different conditions. For the purpose of analyzing the most adverse time period, only the afternoon peak hour volumes were examined. The turning movements at both interchanges for three different scenarios as produced by the model runs are included as Appendix III.

The projected volumes suggest that 83% of the Steveston Highway interchange's eastbound-to-southbound ramp traffic would be diverted to the Blundell Road interchange with the closure of the existing ramp, while only 59% of the same traffic would be diverted with ramp metering imposed. Therefore, it was concluded that the Steveston Highway interchange would remain a desirable access point to southbound Highway 99 for Richmond-based traffic, in spite of the creation of the Blundell Road interchange to the north. Once the expansion of the tunnel has been completed, it would be beneficial to have this ramp remain open at least for an initial trial period with on-going monitoring of traffic delays. Ramp metering signals or periodic closure should then be considered if the ramp capacity is found to be at or near saturation. This evaluation found that both interchanges are in fact required and it is not desirable to eliminate any of the existing movements at the Steveston Interchange.

5.11 Phasing of the 72nd Street/No. 8 Road Freeway

As was illustrated in Exhibit 4.4, this alternative included a considerable length of new highway and two new bridges. In implementing this concept, it would be highly desirable to divide its construction into several phases so that the costs of purchasing the necessary right-of-way and constructing the related infrastructure can be spread over a number of years. Ideally, the first phases of construction should result in a beneficial usable addition to the existing regional road network.

Four different phasing options, each representing various partial sections of the entire project, were examined once again by building the appropriate computer model network and testing using EMME/2. The options considered were as follows:

Option 1:	Highway 10 (Delta) to Richmond Freeway (Richmond)
Option 2:	Highway 10 (Delta) to River Way (Richmond)
Option 3:	Highway 10 (Delta) to Marine Way (Vancouver)
Option 4:	Highway 17 (Delta) to Richmond Freeway (Richmond)

Note that options 1, 2 and 3 all require a temporary or permanent interchange being constructed on the new freeway at Highway 10. Since this study was oriented to addressing the issue of providing increased crossing capacity for the South Arm, construction of the section between Richmond Freeway and Marine Way as a separate phasing option was not considered since it would offer no improvement in the capacity across the South Arm.

Each of the above phasing options were tested for their cost effectiveness in attracting traffic to the new facility as well as in reducing traffic in the tunnel. For the purpose of comparison, only the morning peak hour was used in this evaluation. The results of these assignments are presented in Table 5.8.

The key findings from these results are as follows:

- As would be expected, Option 3 with the new freeway extending from Highway 10 all the way north to Marine Way is the only option that results in any reduction in volumes on the existing crossings of the North Arm.

- All four options have similar impacts on volumes on the Alex Fraser Bridge with Option 3 being marginally better (70 less vehicles).

- Option 3 has the highest volume on the new 72nd St. Bridge at 3,420 vehicles total; the other three are 18% lower at 2,870 vehicles.

- Option 3 has a marginally greater impact on the George Massey Tunnel; the volumes through the tunnel are 190 - 280 lower in this option than in Options 1, 2 and 4.

- The total two-way crossings of the South Arm are higher in Option 3 by 330 vehicles - this is as a result of some double crossings.

- Option 1 has the least cost of construction of all three options at $206.4 M compared to $221.9 M for Option 2 and $262 M for Options 3 and 4.

The highest accumulated effectiveness was calculated to be in the order of 17.3 vehicles per hour/million dollars. This number was obtained by adding together the sum of the volume of traffic using the new 72nd Street/No. 8 Road Bridge as well as the reduction in the volume of traffic in the tunnel and dividing the sum by the cost of constructing the phasing option. The two options of Highway 10 to Richmond Freeway (Option #1) and Highway 10 to Marine Way (Option #3) both achieved this same measure of effectiveness. It was therefore concluded that if the 72nd Street/No. 8 Road Freeway were to be selected as the recommended improvement, either one of these two phasing options could be considered for any Phase 1 implementation program.

Table 5.8
Evaluation of Phasing Options of 72nd Street/No.8 Road Freeway Alternative

		Highway 10 To Richmond Fwy	Highway 10 To River Road	Highway 10 To Marine Way	Highway 17 To Richmond
Estimated Construction Costs ($millions)		$206.4	$221.9	$262.1	$261.2
Queensborough Bridge	NB	4,182	4,133	3,357	4,166
	SB	2,490	2,479	1,943	2,492
Boundary Rd. Bridge	NB	-	-	2,869	-
	SB	-	-	1,542	-
Knight St. Bridge	NB	4,925	4,964	3,630	4,928
	SB	4,091	4,100	3,259	4,090
Oak St. Bridge	NB	4,416	4,463	4,152	4,414
	SB	2,047	2,061	1,986	2,052
Total Volumes at North Arm Crossings	NB	13,523	13,560	14,008	13,508
	SB	8,628	8,640	8,730	8,634
Alex Fraser Bridge	NB	4,916	4,907	4,935	4,920
	SB	1,613	1,610	1,520	1,612
New 72 St. Bridge	NB	2,176	2,296	2,665	2,245
	SB	562	562	758	566
George Massey Tunnel	NB	5,401	5,304	5,179	5,307
	SB	1,583	1,583	1,523	1,578
Total Volumes at South Arm Crossings	NB	12,493	12,507	12,779	12,472
	SB	3,758	3,755	3,801	3,756
Richmond Fwy Between Knight/Boundary	WB	3,789	3,646	3,507	3,818
	EB	-	-	-	-
Volume Reduction at George Massey Tunnel	NB	666	763	888	760
	SB	163	163	223	168
Effectiveness: In Attracting Traffic at New Bridge (vph/$mil)		13.27	12.88	13.06	10.76
Effectiveness: In Reducing Traffic at Tunnel (vph/$mil)		4.02	4.17	4.24	3.55
Accumulative effectiveness		17.29	17.05	17.30	14.31

6.0 RECOMMENDED UPGRADING FOR THE SOUTH ARM

6.1 Selecting the Preferred Long Term Alternative

The previous chapters of this report have presented both the alternative concepts considered in this study for providing additional capacity across the South Arm of the Fraser River in the long term as well as the analysis carried out. Long term at this point refers to the year 2001 selected for analysis purposes. These results are now presented in summary form, as a comparison of all of the various features of each alternative, in Table 6.1.

Based on the information presented in this table, it is concluded that the construction of a new 72nd Street/No. 8 Road Freeway ultimately linking Highway 17 in the vicinity of Tsawwassen to Boundary Road at Marine Way in the City of Vancouver is the preferred long term alternative. This alternative is selected since it:

- results in the highest cost effectiveness in terms of the reduction in vehicle-hours per million dollars spent;
- provides distinct benefits even when constructed in phases;
- results in the best overall performance of Greater Vancouver's regional road network in terms of minimizing the total number of vehicle hours and therefore air pollution;
- has no direct major impact on residential or business areas and no restrictions on the right-of-way widths that need to be acquired;
- results in the highest volume of additional traffic on a new facility and therefore results in the highest relief on the existing crossings; and
- sets the stage for ultimately providing a direct freeway connection between Highway 99 (and the U.S.A.'s I-5) and Highway 1 (the TransCanada Highway).

This long term plan is illustrated in Exhibit 6.1.

6.2 Selecting Short Term Improvements

The implementation of the above recommended long term plan will obviously result in a relatively major project in which 16.5 kms of new freeway together with two new bridges, one high-level and one mid-level, must be constructed. The process of acquiring the necessary properties for the road and bridgehead rights-of-way and obtaining municipal agreement and support may in themselves prove to be time consuming and it is expected that this project would take 8-10 years to implement.

The continued growth in travel demand across the South Arm together with the capacity limitation of the existing crossings, as was illustrated in Exhibit 2.10, clearly indicates that some form of improvement is required considerably earlier than 1998 - 2000. An interim or short term improvement concept must

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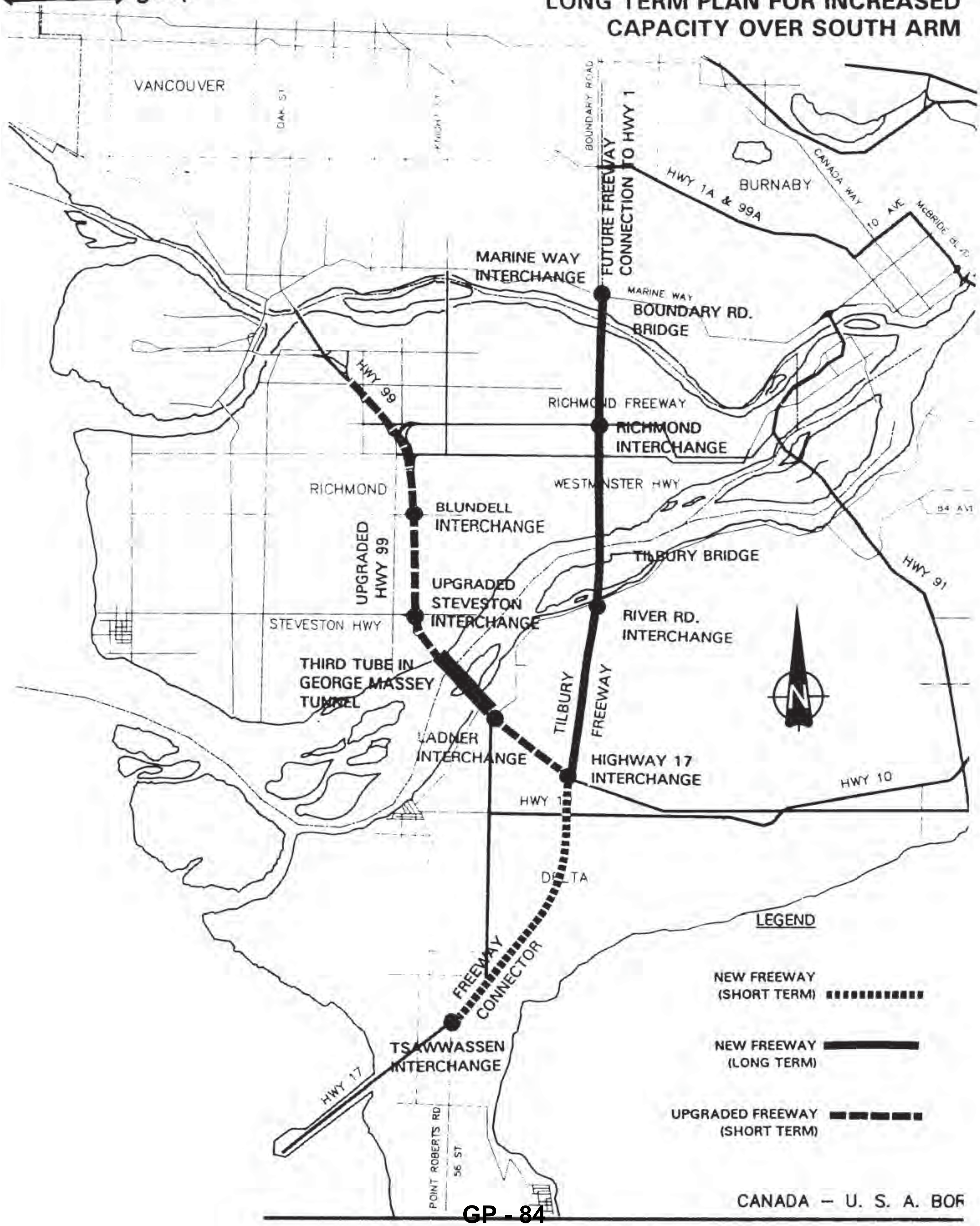
EXHIBIT 6.1

LONG TERM PLAN FOR INCREASED CAPACITY OVER SOUTH ARM



therefore be considered in order to provide additional capacity to the road network to handle the increasing travel demand across the river. For this reason, the above recommended alternative should be regarded as a long-term plan.

Based on the analysis undertaken, the addition of a reversible Third Tube to the George Massey Tunnel is considered the preferred short-term alternative since it:

- maximizes the use of the existing highway infrastructure;
- yields a relatively high level of cost effectiveness;
- creates one earthquake resistant tube below the Fraser River - either of the proposed new bridges also provide this advantage;
- requires no new major roads to be constructed in conjunction with the widening of the tunnel;
- physically allows for the closure of any one tube in the tunnel for maintenance purposes - it should be noted however that it will be difficult if not impossible to construct any automatic lane switching that allows for this feature - some form of manual lane changing may have to be utilized;
- requires no major right-of-way acquisition;
- would be ideal in handling the growing traffic demand across the Fraser River in the short-term;
- requires no major negotiations with the affected municipalities; and
- could be implemented in the shortest time frame.

The reasons for selecting the reversible Third Tube as the short term alternative rather than the No. 5 Road Bridge are as follows:

- the new crossing would have to be a high level bridge - this is expensive and it has a significant impact on adjacent lands;
- in order to attract a higher volume of traffic to the No. 5 Road crossing of the Fraser River, it would need to be extended east of Ladner Trunk Road to a new interchange at Highway 99 - this in turn would interfere with the new East Ladner facility;
- the Steveston Highway/No. 5 Road intersection is already congested and it is possible that an interchange at this location is the only feasible solution should the No. 5 Road alternative be selected as the short term alternative; and
- it would result in a very short distance between two interchanges or an interchange and a major intersection on Steveston Highway.

The recommended road network, which is comprised of both short and long-term improvements, is therefore a combination of the 72nd Street/No. 8 Road Freeway and the Third Tube alternatives. Although the most desirable interim phasing of the 72nd Street/No. 8 Road Freeway was previously identified as starting at Highway 10 in the south and constructing the section north to the Richmond Freeway as a first phase, a new freeway connection linking Highway 17 immediately north of Tsawwassen to Highway 99 south of the existing Highway 17 interchange and in line with the future 72 Street/No. 8 Road Bridge would have a number of benefits when constructed in conjunction with the implementation of the third tube as a short-term improvement. The benefits of this connection are:

- it reduces the high volume of traffic using the existing Highway 17 interchange on Highway 99 immediately south of the tunnel thereby reducing the operational problems in the vicinity;
- it would result in a more adequate weaving distance before the start of the reversible lanes for traffic arriving from Tsawwassen and the ferry terminals and entering and exiting the tunnel at its south end;
- it avoids having to build a grade separation at the existing junction of Highways 17 and 10;
- it relocates traffic to the east side of East Ladner thereby allowing this community to be more closely linked to the remainder of Ladner;
- is one of the recommendations of the 1989 Greater Vancouver Transportation Study;
- it is one component of the ultimate 72 Street/No. 8 Road Freeway system recommended for the long term; and
- it is one step towards providing an improved freeway connection between the Tsawwassen Ferry Terminal and Highway 1 East - also a recommendation of the 1989 study.

6.3 Developing a Phasing Plan

The recommended overall road network improvements required to provide adequate capacity arose the South Arm of the Fraser River over the next ten years should therefore be phased as follows:

Phase I

- Construct a Third Tube in the George Massey Tunnel with reversible lanes to provide 4 lanes in the peak direction and 2 lanes in the opposite direction.
- Widen and/or upgrade Highway 99 between a point southeast of the Ladner/Highway 17 interchange in line with 72nd Street and the Richmond Freeway in order to provide sufficient capacity to allow the tunnel to operate as 4 lanes in the peak direction and 2 lanes opposite in the two peak periods.
- Upgrade the Steveston and Ladner Interchanges.

Table 6.1
Comparison Summary of Alternative Crossings

	Criteria		Alternative B-Third Tube	Alternative C-Fourth Tube	Alternative D-No. 5 Road Bridge	Alternative E-72nd No.8 Rd
1.	Cost		$187 M	$333 M	$159 M	$331 M
2.	Projected Add. Traffic (two-way)	a.m.	630	880	1720	3530
		p.m.	960	1070	1460	3212
3.	Accessibility		All Traffic	All Traffic	Richmond-Sth Delta Only	All Traffic
4.	Direct Impact on Existing Development		None	None	Industrial Park	Farmland
5.	Ease of Construction		No Problems	No Problems	Longer bridge than Annacis	No Problems c.f. Annacis
6.	Impact on Residential		None	None	Significant along No. 5 Road	Some along Boundary Rd
7.	Adds Missing Link to Long Term Regional Road Network		No	No	No	Yes
8.	Ratio of Peak Direction to Opposite Direction Per Lane a.m. peak hr.		1.7	6.2	3.5	2.1
9.	Ability to be Phased		No	Yes	No	Yes
10.	Overall Performance in Vehicle-hrs (a.m. peak)		71.24	71.03	71.16	70.16
11.	Limitations		None	None	Arterial Road	None
12.	Volume/Capacity Peak Direction	a.m.	0.76	0.39	0.72	0.59
		p.m.	0.63	0.23	0.62	0.51
13.	Cost effectiveness in reducing traffic (vph/$ Mil)		2.65	1.81	2.29	3.66

Phase II

- Construct the first segment of a new four-lane Tilbury Freeway between Highway 17 at the north-east corner of Tsawwassen and Highway 99 at a point approximately in line with 72nd Street in Delta, with full interchanges at both Highway 17 and Highway 99 and no interchange at Highway 10;

- Construct a new four-lane Ladner Arterial from 46A Street in Ladner to the existing Highway 17 approximately along the 44th Avenue alignment in Ladner and then continue east and north to Highway 10 to provide a second connection between East Ladner and the remainder of Ladner - this new arterial will not connect to the new Tilbury Freeway; and

- Construct a new interchange on Highway 99 at Blundell Road.

Phase III
- Extend the new Tilbury Freeway north to meet the Richmond Freeway via 72nd Street in Delta and No. 8 Road in Richmond with a new four-lane high level Tilbury Bridge across the South Arm of the Fraser River and full interchanges at River Road in Delta and at the Richmond Freeway.

Phase IV
- Extend the Tilbury Freeway further north to Marine Way in Vancouver in line with Boundary Road via a new four-lane mid-level bridge across the North Arm of the Fraser River with an interchange at Marine Way in Vancouver.

The recommended plan for upgrading the capacity of the South Arm crossing and the supporting road network by phases on a short term basis is illustrated in Exhibit 6.2.

6.4 Timing for Implementation

In order to establish what particular year the two additions to the capacity of the South Arm crossings should be implemented, assuming that both the Third Tube and a Tilbury Bridge are to be ultimately constructed, the projected demand in cross river travel through to the year 2001 was plotted over time and the impact of the additional capacity at different time horizons evaluated. The provision of three lanes northbound on Highway 91 between the Cliveden Interchange and Highway 91A in conjunction with the new grade separation of the junction of Highway 91 and Highway 91A was assumed to be implemented in 1992 in this analysis. The results of this process are illustrated in Exhibit 6.3 and presented in summary form in terms of the number of vehicles that can be accommodated in the peak hour in the peak direction in Table 6.2.

Table 6.2
Future Capacity of South Arm Crossing

Facility	Date	Incremental Peak Direction Capacity	Total Peak Direction Capacity
Pattullo Bridge	1937	4000	4,000
Port Mann Bridge	1958	4000	8,000
George Massey Tunnel	1964	4000	12,000
NB Counter Flow Lane in Tunnel	1981	2000	14,000
Alex Fraser Bridge - 4 lanes	1986	4000	18,000
Alex Fraser Bridge - 6 lanes throughout	1992	2000	21,000
Additional Tube in Tunnel	1994	2000	22,000
New 72 St./No. 8 Road Bridge	1996	4000	26,000

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EXHIBIT **6.2**

SHORT TERM PLAN FOR INCREASED CAPACITY OVER SOUTH ARM

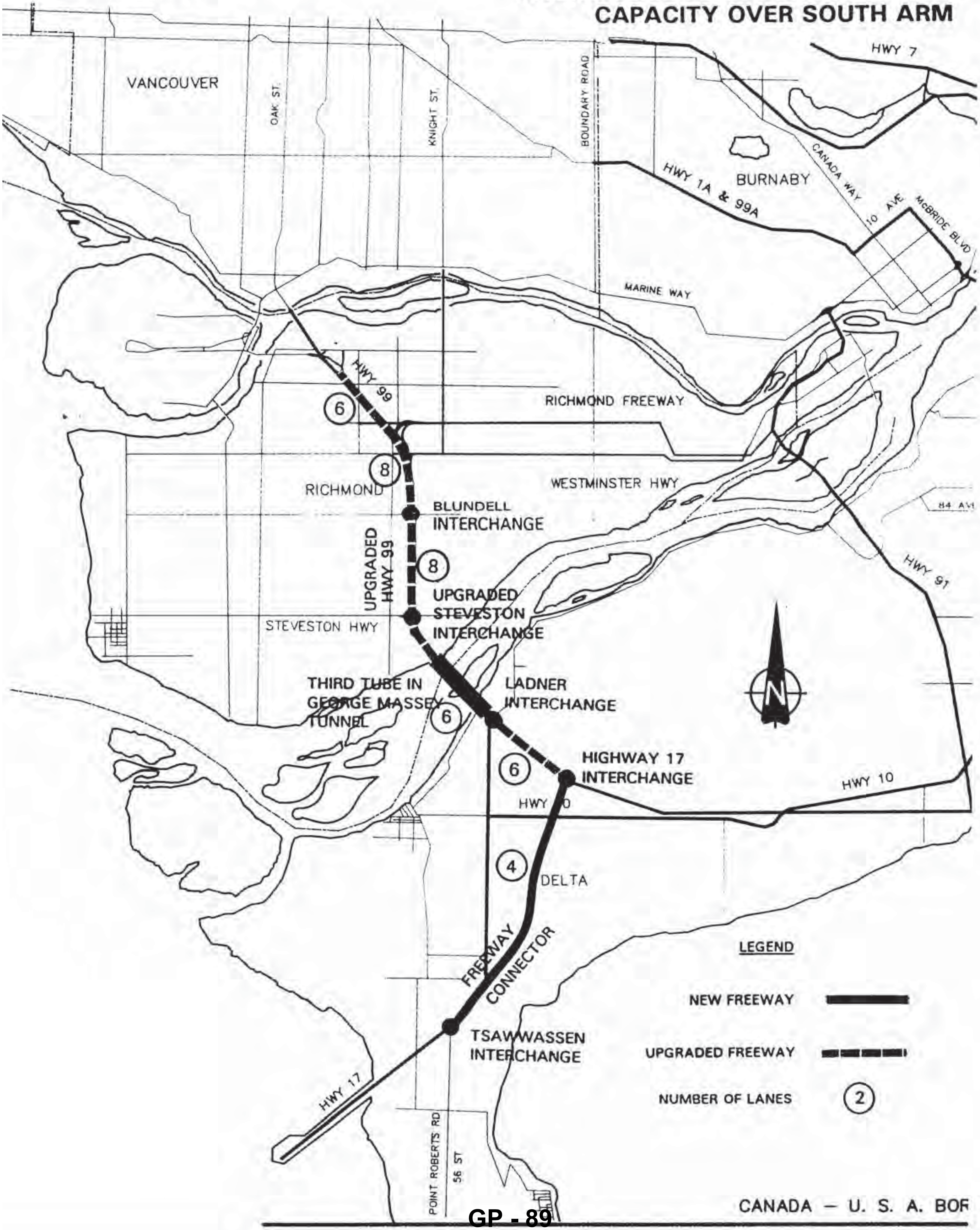

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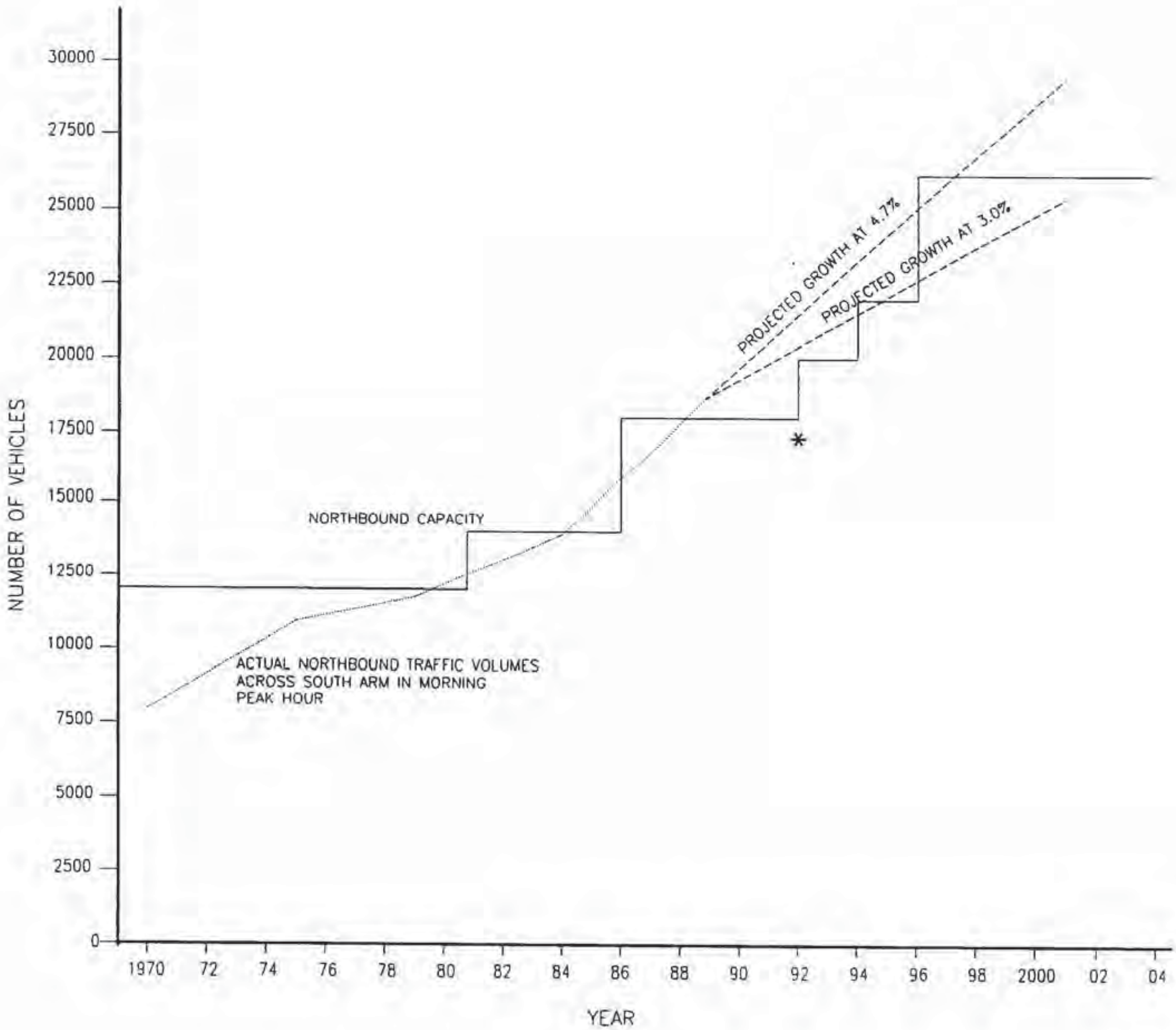
EXHIBIT **6.3**

PROJECTED RELATIONSHIP OF SOUTH ARM CAPACITY TO DEMAND 1979-2001



* 1992 - WIDENING OF ALEX FRASER NORTH APPROACH TO SIX LANES-CLIVEDEN INTERCHANGE TO HIGHWAY 91A

1994 - ADDITIONAL TUBE IN GEORGE MASSEY TUNNEL

1996 - NEW FOUR-LANE TILBURY BRIDGE

This clearly indicates that even if it is assumed that the previously recommended improvements to Highways 91 and 91A are implemented within the next two years, a third tube is required to be in place by the year 1994 and ideally earlier if severe congestion is to be avoided for northbound traffic flows across the South Arm in the morning peak period in 1992 and 1993. If the existing congestion in the non-peak direction at the George Massey Tunnel is taken into account, i.e. southbound in the morning peak period and northbound during the afternoon peak hour, then a third tube is required immediately.

A new bridge and connecting highway (the Tilbury Freeway) between Highway 99 and the Richmond Freeway needs to be open to use by 1996 if the historic growth rate is to be accommodated. If a lower growth rate is more realistic because of the increased transit ridership resulting from the extension of the SkyTrain service across the Fraser River to Scott Road and Whalley then the target date for the new Tilbury Bridge can be delayed until 1999. It should be noted that this analysis does not take into account the impact of the extension of the SkyTrain across the Fraser River to Scott Road at the beginning of 1990, the overall increased use of transit through more express bus services and park-and-ride lots, and any High Occupancy Vehicle (H.O.V.) lanes that may be introduced on Highway 99.

6.5 Highway 99 Interchanges with Third Tube

In order to develop the appropriate lane configurations for Highway 99 and its associated interchanges related to the expansion of the tunnel from the existing four lanes to six lanes, the projected 2001 turning movements on all ramps and associated interchanges for the Third Tube alternative were examined. The interchange ramp volumes as output by EMME/2 for this alternative are included in this report as Appendix II. Since the EMME/2 projections of 2001 traffic volume were found to be lower than those obtained by extrapolating the historic trend into the future at the same rate (as was discussed in Chapter 5.0), the turning movements estimated by the model as presented in Appendix II were factored up by 19% to compensate for this discrepancy.

Based on the adjusted traffic volumes, capacity analyses were carried out using three components of the Highway Capacity Software, viz.: Basic Freeway, Weaving Access, and Unsignalized Intersections. The results of these analyses were then used to establish the lane configurations for each interchange and segment of highway along the upgraded Highway 99.

The resultant recommended configuration of the upgraded Highway 99 interchanges at Highway 17 and Steveston Highway, and the new Blundell Road interchange, together with the afternoon peak hour traffic volumes, i.e. EMME/2 projections factored up by 19%, resulting from the addition of a third tube but no new freeway connecting Highway 17 to Highway 99 around the east side of East Ladner are shown in conceptual form in Exhibits 6.4, 6.5 and 6.6 respectively. The key improvements at each location are as follows:

(a) Highway 17 (Ladner) Interchange: The proposed concept for this interchange is illustrated in Exhibit 6.4 and the overall reversible lane concept on Highway 99 from a point south of the existing Highway 17 Interchange to north of the Steveston Highway Interchange is illustrated very schematically in Exhibit 6.7. Key changes are:

- Force traffic wishing to exit at this interchange after travelling through the tunnel to use the west side tube at all times, i.e. they will not be able to exit at this location if they take the two lanes in the centre tube. This applies during the afternoon peak period when

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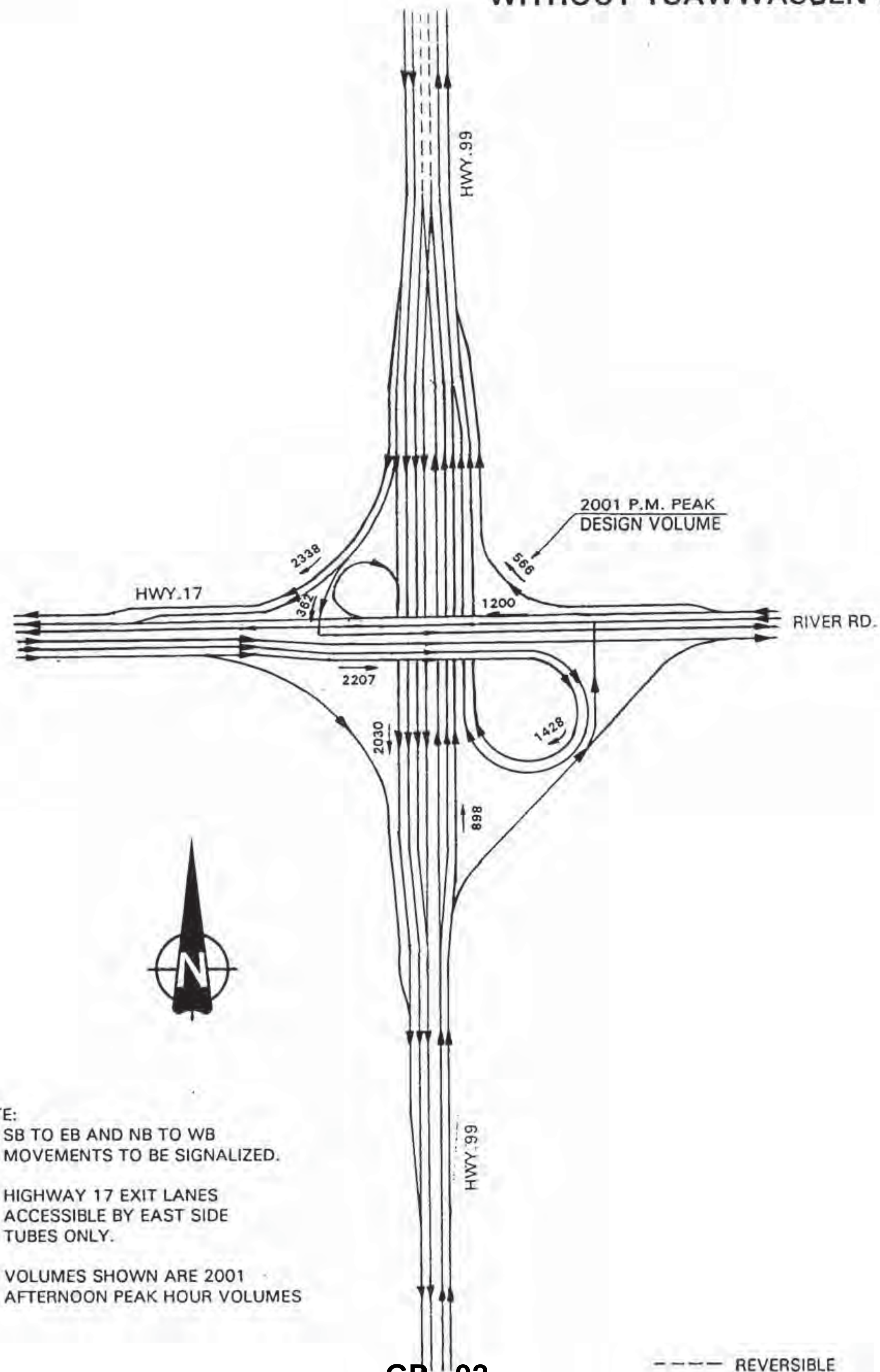
EXHIBIT **6.4**

PROPOSED CONCEPTUAL PLAN OF UPGRADED HIGHWAY 17 INTERCHANGE WITHOUT TSAWWASSEN FREEWAY



NOTE:
1. SB TO EB AND NB TO WB MOVEMENTS TO BE SIGNALIZED.
2. HIGHWAY 17 EXIT LANES ACCESSIBLE BY EAST SIDE TUBES ONLY.
3. VOLUMES SHOWN ARE 2001 AFTERNOON PEAK HOUR VOLUMES

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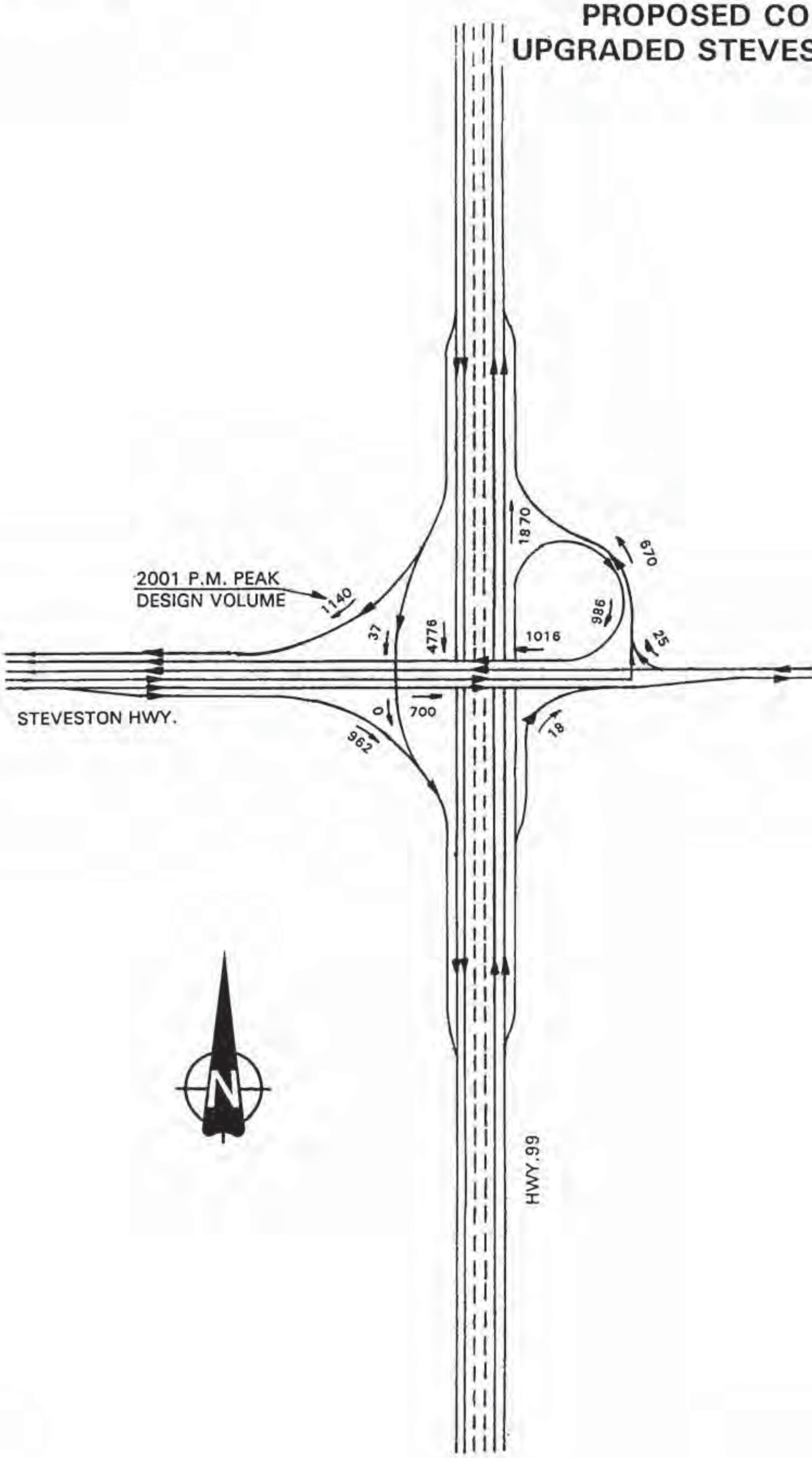
EXHIBIT **6.5**

PROPOSED CONCEPTUAL PLAN OF UPGRADED STEVESTON INTERCHANGE

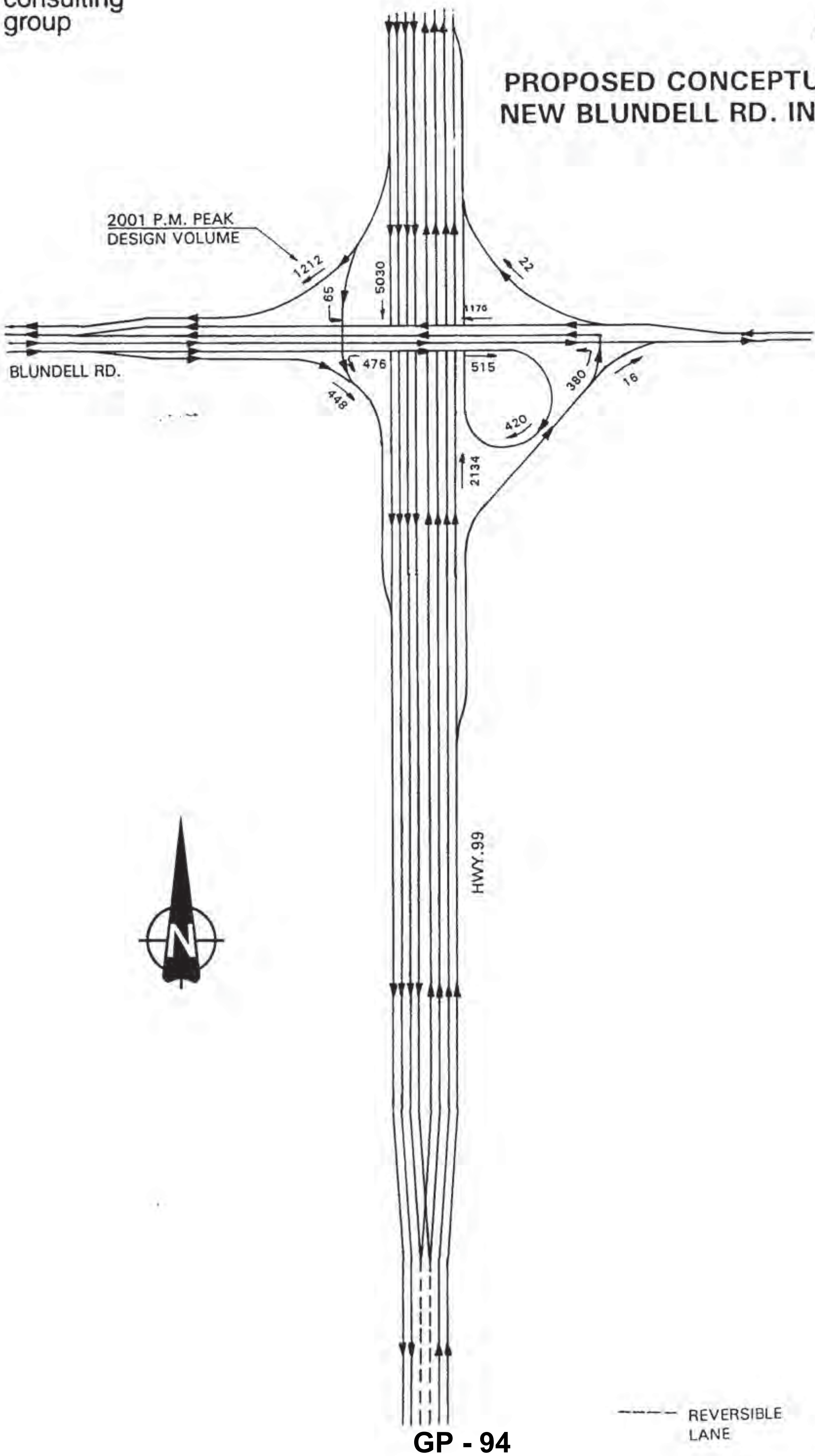


NOTE:
BUS LANE OMITTED
IN THIS SCHEME

---- REVERSIBLE LANE

EXHIBIT **6.6**

PROPOSED CONCEPTUAL PLAN OF NEW BLUNDELL RD. INTERCHANGE



both of these lanes are for southbound traffic and during all off-peak times when the west side lane is also for southbound traffic. This does not affect traffic entering Highway 99 at the Steveston Highway Interchange as they do not have a choice of tubes. It does mean however that traffic on Highway 99 north of the Steveston Highway must be directed by signage to keep in the two right hand lanes with the centre tube lanes being dedicated to traffic continuing on beyond the Highway 17 Interchange. This restriction in itself will reduce some of the existing operational problems south of the tunnel.

- Signalize the intersection of the exit ramp for southbound to eastbound traffic with the westbound through traffic lanes.

- Add a second westbound lane to the overpass for River Road traffic, crossing Highway 99 and continuing on to Highway 17 - this is in addition to a lane for westbound traffic leaving River Road to travel northbound on Highway 99.

- Add a separate eastbound through lane to the overpass to ensure that this traffic is not tied up by the traffic waiting to enter the tunnel via the eastbound to northbound spiral ramps - this will require widening Highway 17 northbound to three lanes for a distance of 1 kilometre. Beyond this distance tunnel traffic should be directed by signs to keep in the right lane only.

- Direct northbound tunnel traffic arriving on Highway 99 from south of the Highway 17 Interchange to the centre tube which will have two northbound lanes in the morning peak period and one northbound lane during all off-peak periods. This traffic stream has the option of staying in the east side tube at all times and in order for these vehicles to exit at the Steveston Highway Interchange they must do this. This laning concept is illustrated diagrammatically in Exhibit 6.7.

The only accesses to adjacent properties that are affected by the upgrading of this interchange is the Town and Country Inn and associated gas station as well as the adjacent recreational vehicle dealership. The accesses for these facilities are at present directly off of River Road a short distance east of the interchange. The volume of traffic on River Road at this location will continue to increase regardless of whether or not the new freeway connector between Tsawwassen and Highway 99 is constructed. This is because, firstly the Tilbury Industrial Park continues to expand, and secondly River Road or its proposed River Way replacement is being upgraded in segments and this in itself makes this road a more attractive route for some origin-destination pairs thereby attracting more trips. Furthermore, as this segment of River Road is essentially an eastern extension of the Highway 99 expressway, travel speeds are high. It is therefore concluded that direct access to adjacent properties off of River Road west of Vasey Road be eliminated as redevelopment in the area proceeds over time.

(b) Steveston Highway Interchange: Traffic exiting from the tunnel northbound to westbound on Steveston Highway at present must wait at Steveston Highway before making a left turn and heading west. This traffic sometimes extends south towards the tunnel interfering with the smooth flow of northbound traffic on Highway 99. In addition, traffic entering Highway 99 and the tunnel from Steveston Highway causes severe congestion both on Steveston Highway and on Highway 99 at the tunnel entrance. The proposed concept for upgrading this interchange is illustrated in Exhibit 6.5. Key changes are as follows:

- Eliminate the existing eastbound to northbound loop and construct a new circular ramp in the north east quadrant of the interchange to allow free movement for northbound to westbound traffic. This will eliminate any of the queuing back on to the highway as this traffic has an uninterrupted path all the way to the traffic signals at the Steveston Highway/No. 5 Road intersection. All traffic travelling northbound through the tunnel and wishing to exit at this interchange, no matter whether it is entering Highway 99 at the Highway 17 Interchange or further beyond, must stay in the east side tube at all times, i.e. morning and afternoon peak periods as well as off-peak. Highway 99 must therefore be clearly signed in this manner. The overall laning concept for Highway 99 both north and south of the tunnel showing all of the lane transitions are illustrated diagrammatically in Exhibit 6.7.

- Construct a new ramp for eastbound to northbound movements around the outside of the new northbound to westbound circular ramp. As the westbound traffic volume on Steveston Highway at this point is very light, these left turn movements will be almost unrestricted. If this westbound traffic volume does increase in the future and the traffic oriented to Highway 99 northbound does face some delays, they will queue up on Steveston Highway. This is considered to be preferable to having the northbound to westbound traffic stream exiting from Highway 99 experience the delays as at present and queue up on Highway 99.

- Construct a new direct northbound to eastbound off-ramp.

- Widen the Steveston Highway overpass to accommodate two lanes in each direction to ensure optimal operational conditions for northbound traffic on Highway 99 entering and exiting the highway.

- As traffic continues to increase, introduce ramp metering for eastbound to southbound movements as a means of encouraging this traffic to enter Highway 99 via the Westminster Highway Interchange or the new Blundell Road Interchange (when constructed) since many of the vehicles entering Highway 99 at this point during times of congestion at the tunnel entrance do so to avoid the delays on Highway 99 caused by the long queue of traffic.

The intersection of Steveston Highway and No. 5 Road is already at capacity and the cause of a significant amount of congestion in the peak hours. Although the municipality of Richmond have plans to upgrade it, the improvements included in this plan are not sufficient to provide any real relief. With the continued development of the industrial area to the south and the residential areas to the west, traffic volumes on Steveston Highway will also increase. It is therefore concluded that all access directly off of Steveston Highway between Jacobs Road and No. 5 Road be eliminated in order to allow for the unrestricted operation of the Highway 99 interchange.

(c) New Blundell Avenue Interchange: A new all-movements partial diamond interchange should be constructed at this location with a circular ramp in the south-east quadrant for eastbound to northbound traffic since this movement is the heaviest in the morning peak hour. This concept is illustrated in Exhibit 6.6.

Once again, any existing direct accesses off of Blundell Road between Jacobs Road and No. 5

Road should be eliminated.

6.6 Highway 99 Lane Configuration with Third Tube

At the beginning of this study, one of the objectives was to develop a functional plan of Highway 99 with a Third Tube in position such that the lanes could be readily switched from one direction to another to provide for the following combinations:

- three lanes in each direction;
- two lanes southbound, four northbound (morning peak period);
- four lanes northbound, southbound (afternoon peak period);
- centre tube closed, two outside tubes each one-directional (for maintenance); and
- either outside tube closed, remaining two tubes each one-directional (for maintenance).

In establishing this plan, particular attention was given to three key issues. They are:

(a) the selected lane configuration should minimize the number of different lane allocations for through traffic on Highway 99 at different times of the day;

(b) lane change points, including ramp exits and entrances, should be located sufficiently far apart that there is adequate distance for safe and efficient weaving, merging, lane changing, etc.

(c) the lanes should be allocated so that the amount of traffic arriving from one direction is proportional to the number of lanes available - this is particularly relevant to the south end of the tunnel where traffic arriving via Highway 99 from the south is in fact less than that arriving via Highway 17 from the west and River Road from the east.

The preliminary overall lane configurations and the related lane transition arrangement of the recommended Third Tube alternative, are presented in conceptual form in Exhibits 6.7 and 6.8.

6.7 Proposed Highway 17-Highway 99 Connector

The construction of the first leg of the new Tilbury Freeway between Highway 17 and Highway 99 with new interchanges at either end will mean that traffic presently travelling between Tsawwassen and the B.C. Ferry Terminal and the George Massey Tunnel will now take the new freeway instead of Highway 17. The only traffic still using Highway 17 will be Ladner/Tsawwassen traffic oriented to River Road.

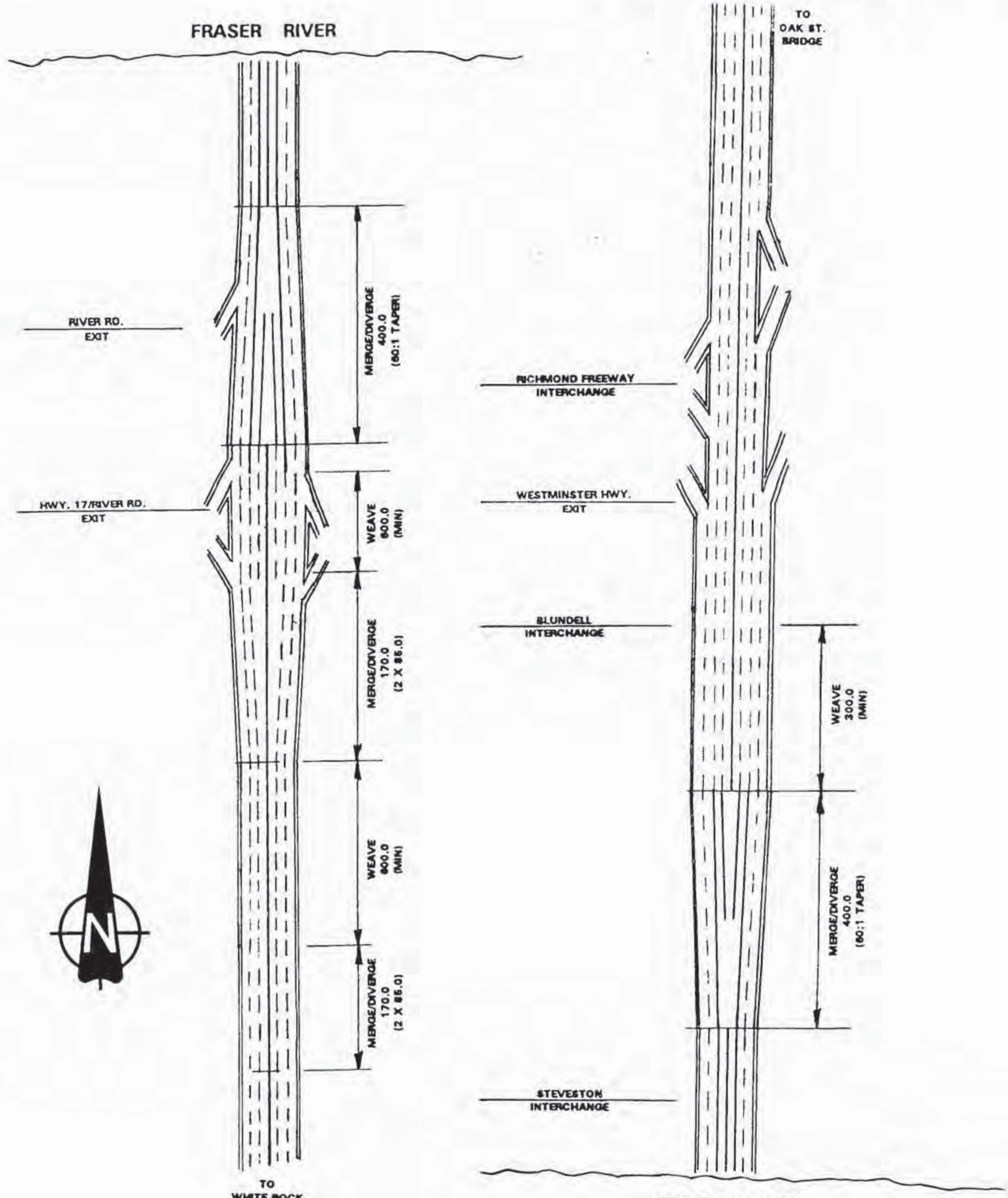
The proposed lane configuration for this new connection together with the revised concept for the Ladner interchange are shown in Exhibits 6.9 and 6.10 respectively.

6.8 Proposed Functional Plan

A proposed preliminary functional plan of the recommended Third Tube option as outlined in this report was prepared to a scale of 1:2,000 as part of this study in order to establish all right-of-way requirements for implementing the recommended plan. All features of the plan were to the Ministry of Transportation

EXHIBIT **6.7**

PROPOSED CONCEPTUAL PLAN OF REVERSIBLE LANES IN TUNNEL



and Highways' standard design criteria, except for locations where existing geometrics govern. Basic design criteria were as follows:

Design Speed:	110 km/hour
Minimum Freeway Curve Radius:	600 m
Minimum Ramp Curve Radius:	80 m
Lane Width:	3.70 m
Outside Shoulder Width:	3.00 m
Inside Shoulder Width:	1.20 m
Concrete Median Barrier Width:	0.60 m
Maximum Side Slope:	3:1
Minimum Parallel Lane Length:	100 m
Minimum Acceleration/Deceleration Lane Taper:	100 m
Minimum Merge Taper:	170 m
Minimum Diverge Taper:	85 m

The additional right-of-way required to accommodate an expanded tunnel was estimated by examining the existing profile of the surrounding ground as indicated on available as-built drawings, together with the expected impact of the proposed widening. It should therefore be regarded as only a preliminary estimate. The actual right-of-way requirements should be calculated with greater accuracy when more detailed engineering design drawings are prepared. The of property acquisition, assuming a unit land cost of $3.0 million per hectare in the vicinity of the tunnel, was estimated at $11 million for the recommended Third Tube option.

All pavement widening to accommodate additional lanes and new interchange ramps are shown in the functional plan together with the proposed actual lane configurations. The proposed functional plan drawing of the two segments of Highway 99 immediately north and south of the tunnel are shown in Exhibits 6.11 and 6.12. In these drawings, no assumption has been made concerning which side of the existing tunnel the new tube should be located. The centre line of the widened Highway 99 as shown in these plans therefore simply lines up with the centre-line of the existing tunnel, i.e., between the two tubes.

Based on the as-built, existing right-of-way, and proposed functional plan drawings, it is difficult to make any firm recommendation on which side of the existing tunnel the new tube should be located. The right-of-way through which the approaches to the actual tunnel are located is 230 to 270 metres in width. Beyond the approaches, the right-of-way varies significantly. Between the south end of the south approach to the tunnel and River Road it is 90 metres but between River Road and Highway 17 it is 60 metres. North of the north approach to the tunnel it narrow to 70 metres and between Steveston Highway and Blundell Road it is 60 metres. The highway is typically located approximately in the centre of the available right-of-way. If it is assumed that the entire width of the paved highway is to be repaved and remarked, then, in theory, it does not matter which side the new tube is positioned, since if the tunnel is added on one side and the highway widened on the other as there is sufficient distance - 700 metres north of the tunnel and 1200 metres south of the tunnel - to create any realignment between the curves in the highway located south of the Steveston Highway Interchange and north of the Ladner Interchange. This can be seen in Exhibits 6.11 and 6.12. There is however a need to obtain additional property at a number of locations, particularly on the east side of the highway in the vicinity of the curve in the highway north of the tunnel and on both sides of Highway 99 between River Road and Highway 17. As much of the land adjacent to Highway 99 is still basically undeveloped, it is recommended that a right-of-

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EXHIBIT 6.11

FUNCTIONAL PLAN OF UPGRADED HIGHWAY 99 - STEVESTON INTERCHANGE TO TUNNEL

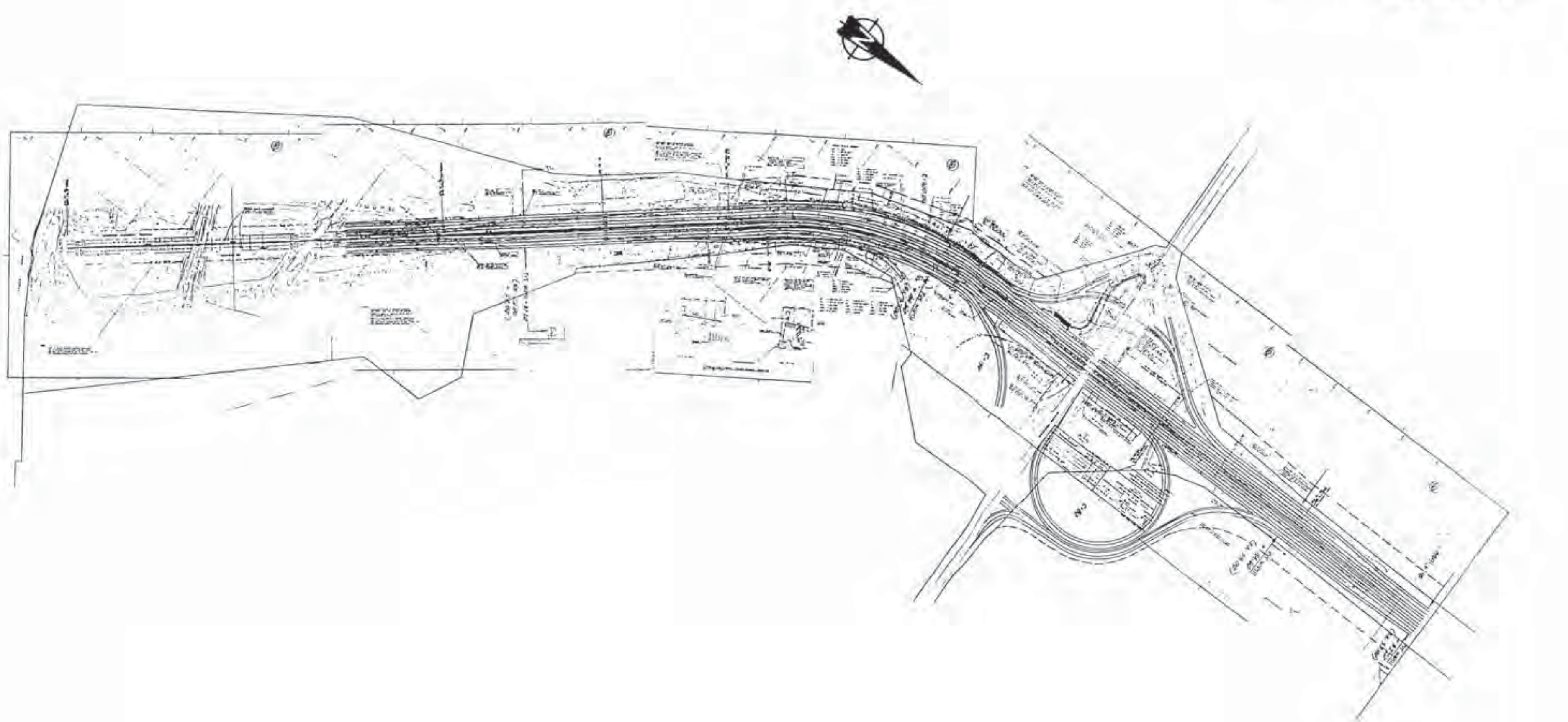
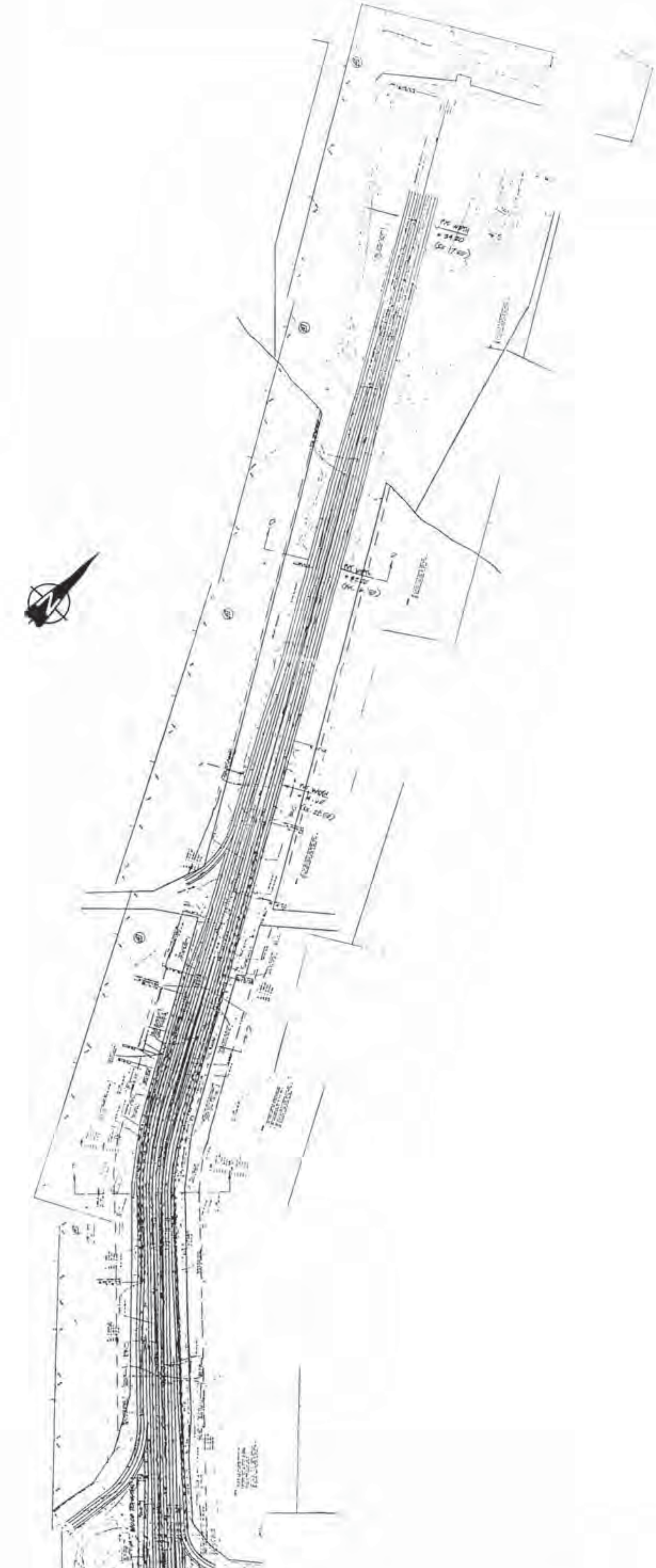


EXHIBIT 6.12
FUNCTIONAL PLAN OF
UPGRADED HIGHWAY 99
- TUNNEL TO LADNER INTERCHANGE



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-way width of 100 metres be established as the minimum through this corridor now thereby preserving sufficient right-of-way for any future eventualities. This will alow for:

- three basic lanes in each direction;
- transition zones for reversible lanes;
- queue jumper lanes for transit; and
- possible future expansion.

The recommended right-of-way widening for an upgraded tunnel based on this standard is shown in Exhibits 6.11 and 6.12. The key widenings in order to meet this requirement are as follows:

	West Side	East Side
• Blundell Road to Steveston Highway	20m	20m
• Steveston Hwy to the north end of the tunnel approach	10m	20m
• south end of the tunnel approach to River Road	5m	5m
• River Road to Highway 17	20m	20m
• Highway 17 to 64th Street/Crescent Island Road	20m	20m

Based on the work carried out in preparing this functional plan, it is concluded that from a geometrics perspective, it is preferable to place the new tube on the east side of the tunnel. This would mean that all of the widening of the highway north of the tunnel could also take place on the east side of the highway. This would result in an improvement in the horizontal curvature on Highway 99 north of the tunnel and minimize the impact on the developed lands on the west side of the highway. Furthermore the existing ramps on the east side of the Steveston Highway Interchange are to be eliminated and new ramps constructed whereas the west side ramps require only minor changes. This therefore supports an east side tube location. South of the River Road turnoff it is concluded that the right-of-way and highway widening should take place on both sides of the existing highway. This would then minimize the impact of the upgraded highway on the properties along both sides of the highway rather than concentrate it on one side. This widening of the right-of-way as given above would be changed slightly with the section between Steveston Highway and the north end of the tunnel approach being widened 30 metres on the east side and nothing on the west side.

It is acknowledged that from a hydrological and geotechnical perspective, it may be desirable to place the new tube on the west side of the existing tunnel. This is the downstream side and it is expected that placing a new tube on this side would create less problems during and after construction. Obviously this aspect will have to be examined in more detail in the next phase of this project.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis carried out in this preliminary planning study of the expansion of the George Massey Tunnel, the following are the conclusions and recommendations:

a. *Traffic volumes across the South Arm of the Fraser River have increased from 11,800 in 1979 to 18,700 in 1989 northbound in the a.m. peak hour and from 11,300 in 1979 to 17,520 in 1989 southbound in the p.m. peak hour. This is approximately a 60% increase in 10 years or 4.7% per annum compounded.*

b. *The capacity across the South Arm has increased approximately in line with the increase in demand, increasing by 50% in 9 years from 12,000 vehicles per hour in the peak direction in 1980 to 18,000 vehicles in 1989.*

c. *The demand for travel through the George Massey Tunnel exceeds its capacity in both directions during the morning peak hour. During the afternoon peak hour, the demand in the northbound direction also exceeds the capacity of the one lane available, while in the southbound direction the Alex Fraser Bridge provides adequate relief for this movement.*

d. *The 2001 traffic volumes projected by the GVRD's transportation planning model, EMME/2, were found to be significantly lower than those projected by extrapolating the historic growth rates, i.e. 1.7% per annum vs 4.7% per annum. Adjustments were therefore necessary to bring the projected volumes into line.*

e. *If existing traffic volumes are factored up to the horizon year of 2001 at a rate of 3.0% per annum, the existing morning peak direction volume of 18,700 will increase by 7,000 vehicles to 26,700 vehicles. This means that 3.5 additional freeway lanes or the equivalent will need to be constructed in order to provide the same level of service.*

f. *Four different alternatives for increasing the capacity across the South Arm were analyzed. A new Tilbury Freeway along 72nd Street in Delta and No. 8 Road in Richmond offered the greatest effectiveness per unit cost on the regional road network as a whole, in minimizing the increase in traffic volumes through the tunnel, and in attracting traffic to the new facility. It is therefore recommended that this alternative, which extends from Highway 17 north of Tsawwassen in the south to Marine Way opposite Boundary Road in the north be implemented in the long term. This alternative:*

- *was recommended in the 1989 "Freedom to Move" study as part of a long term requirement for the region;*
- *is able to be extended north to provide a freeway connection to Highway 1 in the future;*
- *is included in Delta's transportation network; and*
- *has little impact on existing developments.*

g. *The reversible Third Tunnel Tube alternative resulted in the second-highest ranking of effectiveness in the reduction of total vehicle-hours consumed on the overall road network, and this is recommended as the short term improvement to increasing the South Arm crossing* *capacity. This alternative:*

- *maximizes the use of the existing infrastructure;*
- *provides one more lane in each direction in each time period, i.e. 4 lanes in the peak direction with 2 in the opposite direction and 3 in each direction during off-peak periods;*
- *has only a minor impact on existing developments;*
- *requires no new freeways or river crossings;*
- *creates one earthquake resistant tube below the Fraser River; and*
- *enables one tube to be close for maintenance purposes while keeping two tubes or 4 lanes open.*

h. *A new Tsawwassen Freeway should be constructed connecting Highway 17 at 56th Street with Highway 99 in line with 72nd Street in conjunction with the construction of the Third Tube - this would then become the south end of the new Tilbury Freeway. This connection:*

- *provides a bypass of East Ladner thereby allowing this community to become an integral part of Ladner;*
- *avoids the necessity to construct a new Highway 17/Highway 10 Interchange which would further isolate East Ladner if built;*
- *is the first stage of the new Tilbury Freeway linking Highway 17 and Highway 99 to Highway 1;*
- *provides for improved operation of Highway 99 on the south side of the tunnel as more traffic can use the centre lanes; and*
- *provides for improved operation on the north side of the tunnel as traffic destined for Tsawwassen can now use the contra flow lanes.*

i. *The new Tilbury Freeway linking Highway 99 at the north end of the Tsawwassen Freeway to Marine Way in Vancouver should include interchanges at River Road (Delta) for the Tilbury Industrial Park, Richmond Freeway (Richmond), and Marine Way (Vancouver). The section between Highway 99 and the Richmond Freeway can be constructed as a first phase.*

j. *Other improvements required in conjunction with the Third Tube are:*

- *widen Highway 99 to six and eight lanes between 72nd Street and the Richmond Freeway;*
- *modify the Steveston Interchange to allow for the free movement of northbound to westbound traffic; and*
- *construct a new Blundell Road interchange on Highway 99 allowing for all movements with a circular ramp for eastbound to northbound movements.*

k. *If the Tsawwassen Freeway is not constructed in conjunction with the Third Tube, then the Highway 17/Ladner Interchange should be upgraded through:*

- *signalizing the intersection of the southbound to eastbound exit ramp with the River Road to Highway 17 westbound through lane; and*
- *the addition of two lanes on the overpass, one a separate lane for Highway 17 to River Road eastbound through traffic and the other a second lane for westbound through traffic.*

l. *Ideally, the third tube should be constructed as soon as possible with the new 72nd St./No. 8 Road Bridge open to use by 1998 at the latest in order to ensure that the capacity provided across the South Arm keeps pace with the demand. It is recommended that every effort be made to have third tube open to the public by 1994.*

m. *Although the additional right-of-way required for the widening and upgrading associated with the recommended Third Tube option was found to be minimal along both sides of Highway 99 within the study area, it is recommended that the existing right-of way along Highway 19 be widened to a minimum of 100 metres. This means widening in the following sections:*

- *Blundell Road to Steveston Highway - 20m both sides;*
- *Steveston Highway to North End of the Tunnel approach - 30m east side only;*
- *south end of Tunnel approach to River Road - 5m both sides;*
- *River Road to Highway 17 - 20 m both sides; and*
- *between Highway 17 to 64th Street/Crescent Island Road - 20m both sides.*

n. *The total construction cost for the recommended network, consisting of the Third Tube in the George Massey Tunnel and the 72 Street/No. 8 road Freeway was estimated at $555 million.*

o. *The proposed improvements in the George Massey Tunnel and on Highway 99 will provide additional capacity across the South Arm of the Fraser River, while the proposed Richmond-Vancouver rapid transit facility will provide additional capacity across the North Arm to complement the South Arm increases. The Blundell Road Interchange provides good accessibility between Highway 99 and the new rapid transit terminal in Richmond.*

p. *One of the additional lanes through the expanded tunnel could be dedicated to buses and other high occupancy vehicles. The feasibility and viability of this should be investigated in more detail in the next phase of this project.*

APPENDIX I
2001 Vehicle Assignments to the Alternative Networks

EXPLANATION OF APPENDIX I

Appendix I presents the 2001 Vehicle Assignments to the key alternative networks analyzed. In examining this information, the following should be noted:

1. The output for each network covers two or three 8 1/2" X 11" pages which must be placed one on top of the other, i.e. for Scenario 22, 22A covers Highway 99 from the City of Vancouver at the top almost to Blundell Road at the bottom, 22B covers Blundell Road at the top to Ladner at the bottom and 22C covers Ladner at the top to Tsawwassen at the bottom.

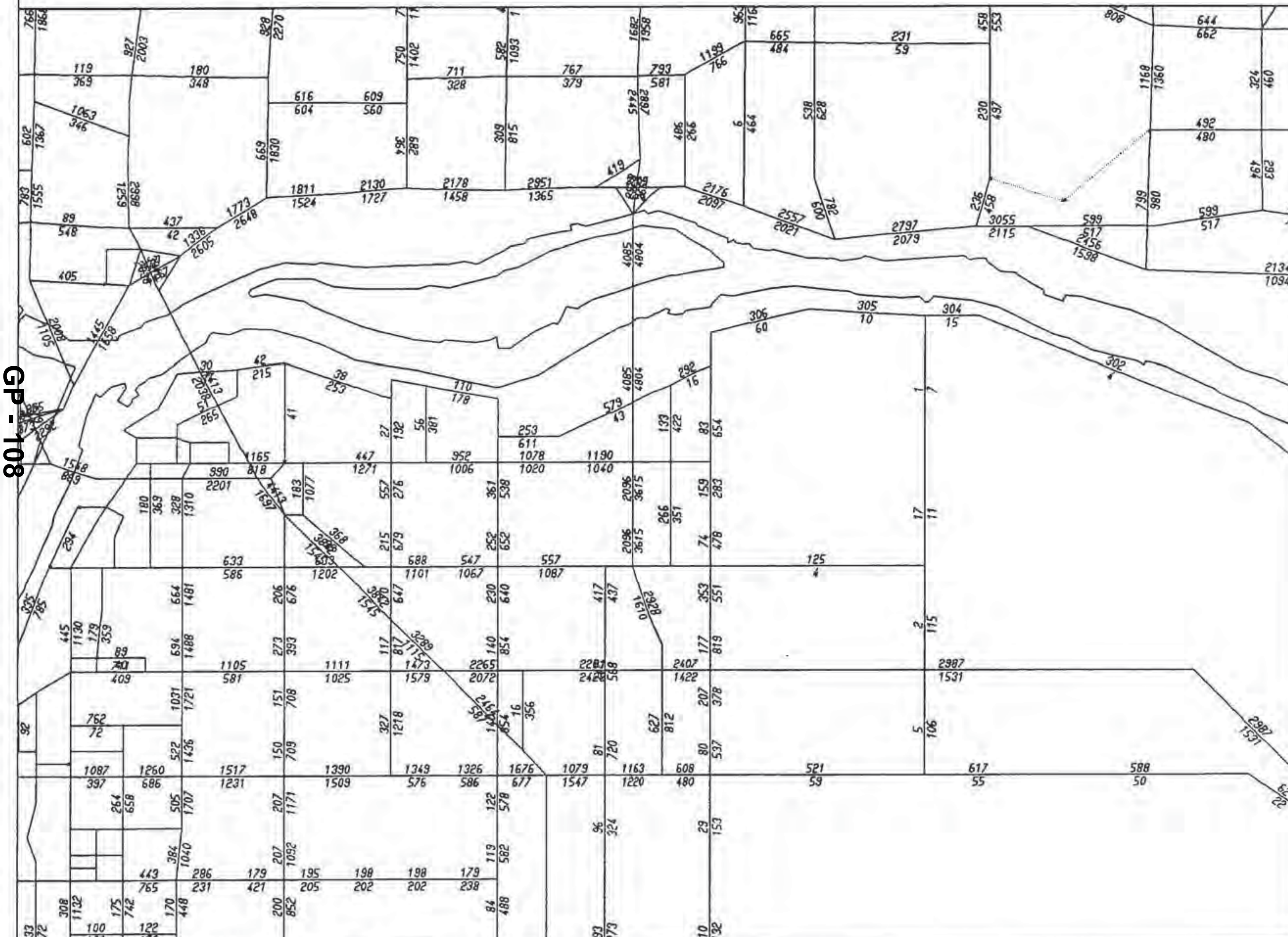
2. The alternative is referenced in the bottom left hand corner of the page (when viewed from the right side of the report) as Scenario XX. They are as follows:

Scenario 22	Base network (Do Nothing) a.m. peak hour
Scenario 111	Reversible Third Tube a.m. peak hour
Scenario 112	Reversible Third Tube p.m. peak hour
Scenario 201	New No. 5 Road Bridge a.m. peak hour
Scenario 311	72nd Street/No. 8 Road Freeway a.m. peak hour
Scenario 411	Reversible Fourth Tube a.m. peak hour

TOTAL VOLUMES ON AUTO NETWORK

emme/2

LINKS:
I=3000,9999
& J=3000,9999



WINDOW
14 091/18 967
23 779/26 233

EMME/2 PROJECT: RICHMOND SUBAREA MODEL
SCENARIO 22: 2001 AM Base with 2001 Demand and GVRD Recommendations

DATE 90 07 31
MODULE 6 12
GVRD vw

TOTAL VOLUMES ON AUTO NETWORK

emme/2

LINKS:
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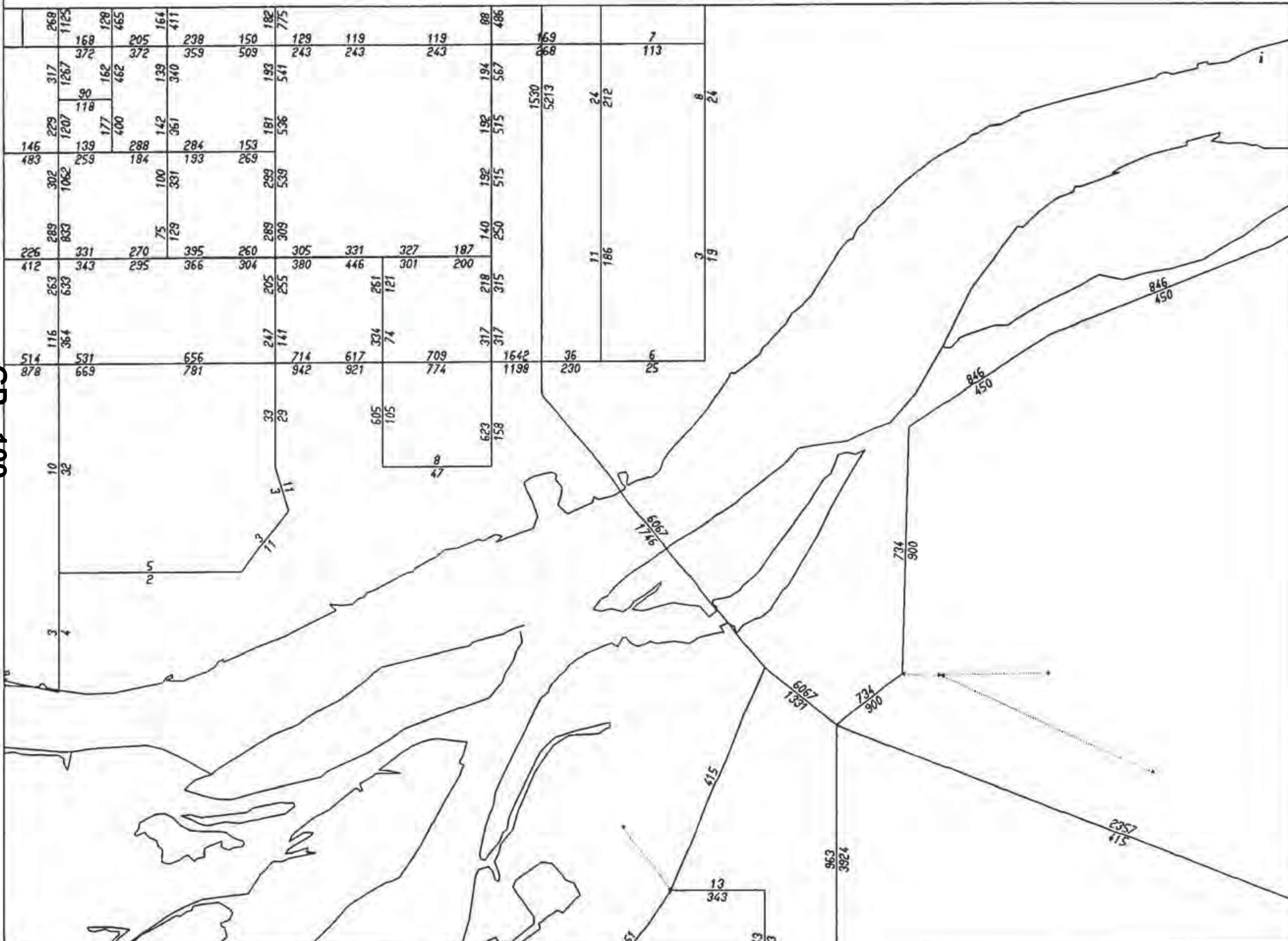
& J=3000,9999



WINDOW
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23 779/18 967

EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO 22 2001 AM Base with 2001 Demand and GVRD Recommendations

DATE 90 07 31
MODULE 6 12
GVRD vw

TOTAL VOLUMES ON AUTO NETWORK

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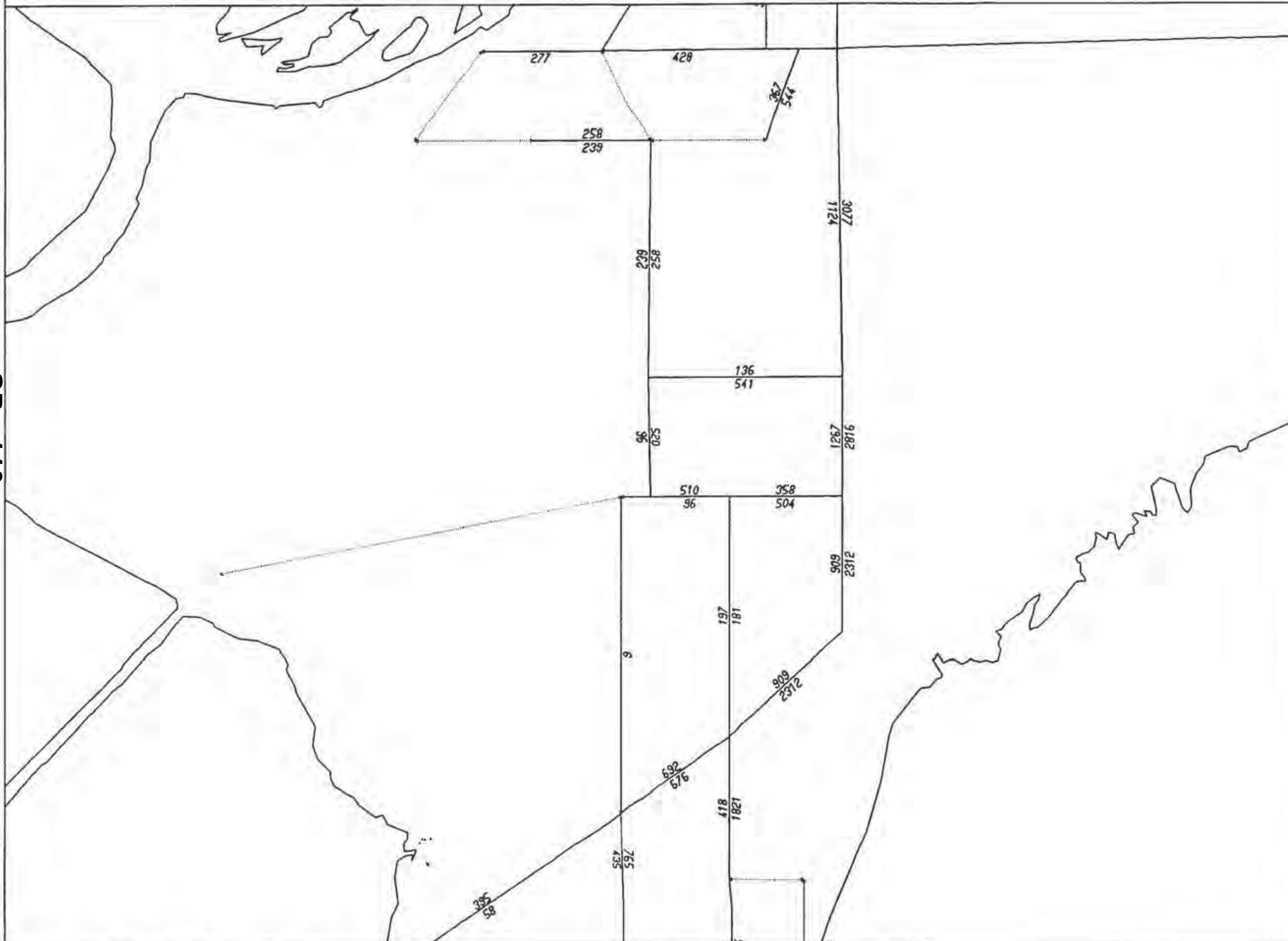

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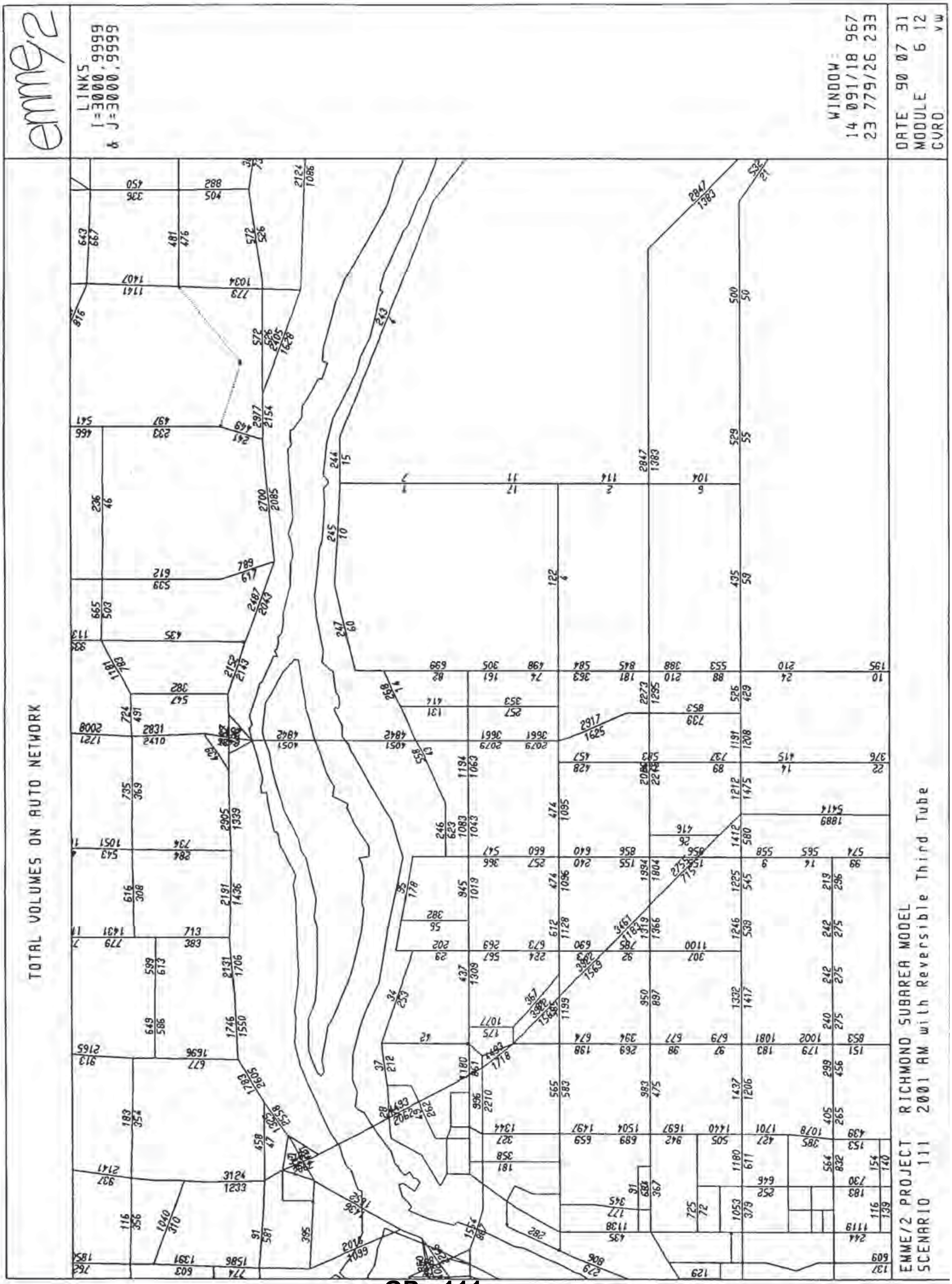
GVRD vw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DATE 90 07 31
MODULE 6 12
GVRD vw
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SCENARIO 111 2001 AM with Reversible Third Tube

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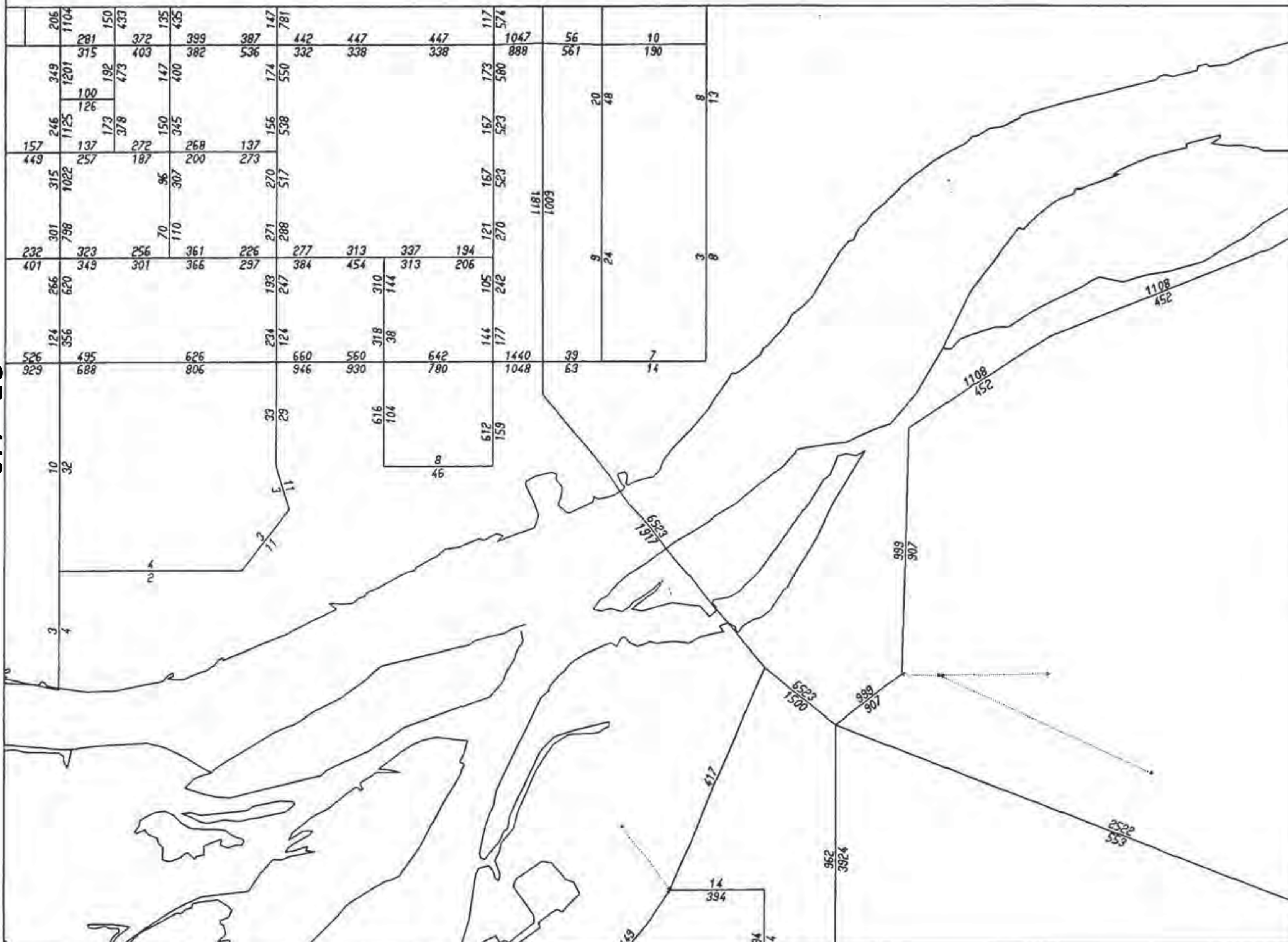
emme/2



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SCENARIO   111   2001 AM with Reversible Third Tube

DATE   90 07 31
MODULE   6 12
GVRD   vw

TOTAL VOLUMES ON AUTO NETWORK

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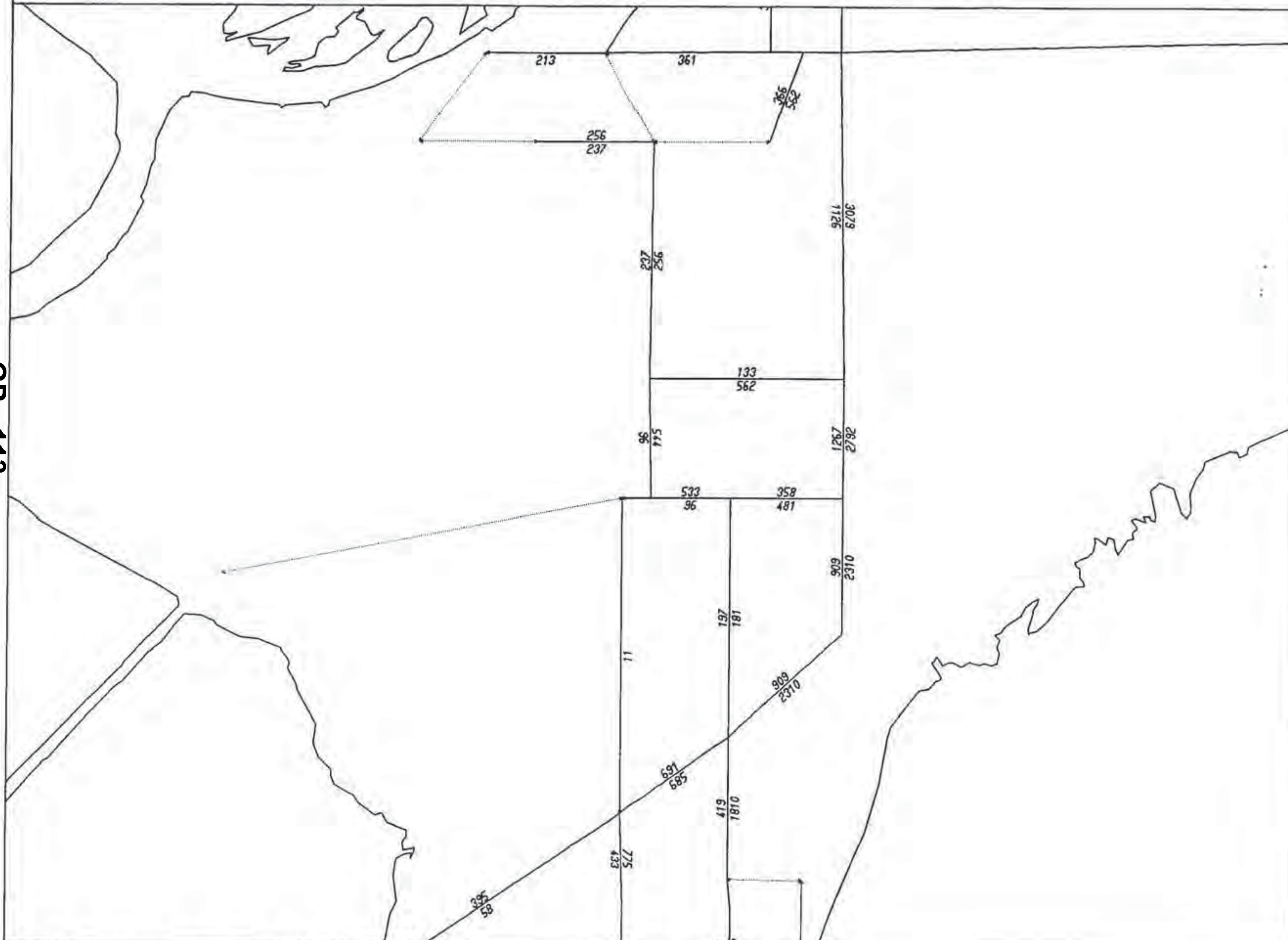

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23 779/11 701

EMME/2 PROJECT: RICHMOND SUBAREA MODEL
SCENARIO 111: 2001 AM with Reversible Third Tube

DATE 90 07 31
MODULE 6 12
CVRD VW

TOTAL VOLUMES ON AUTO NETWORK

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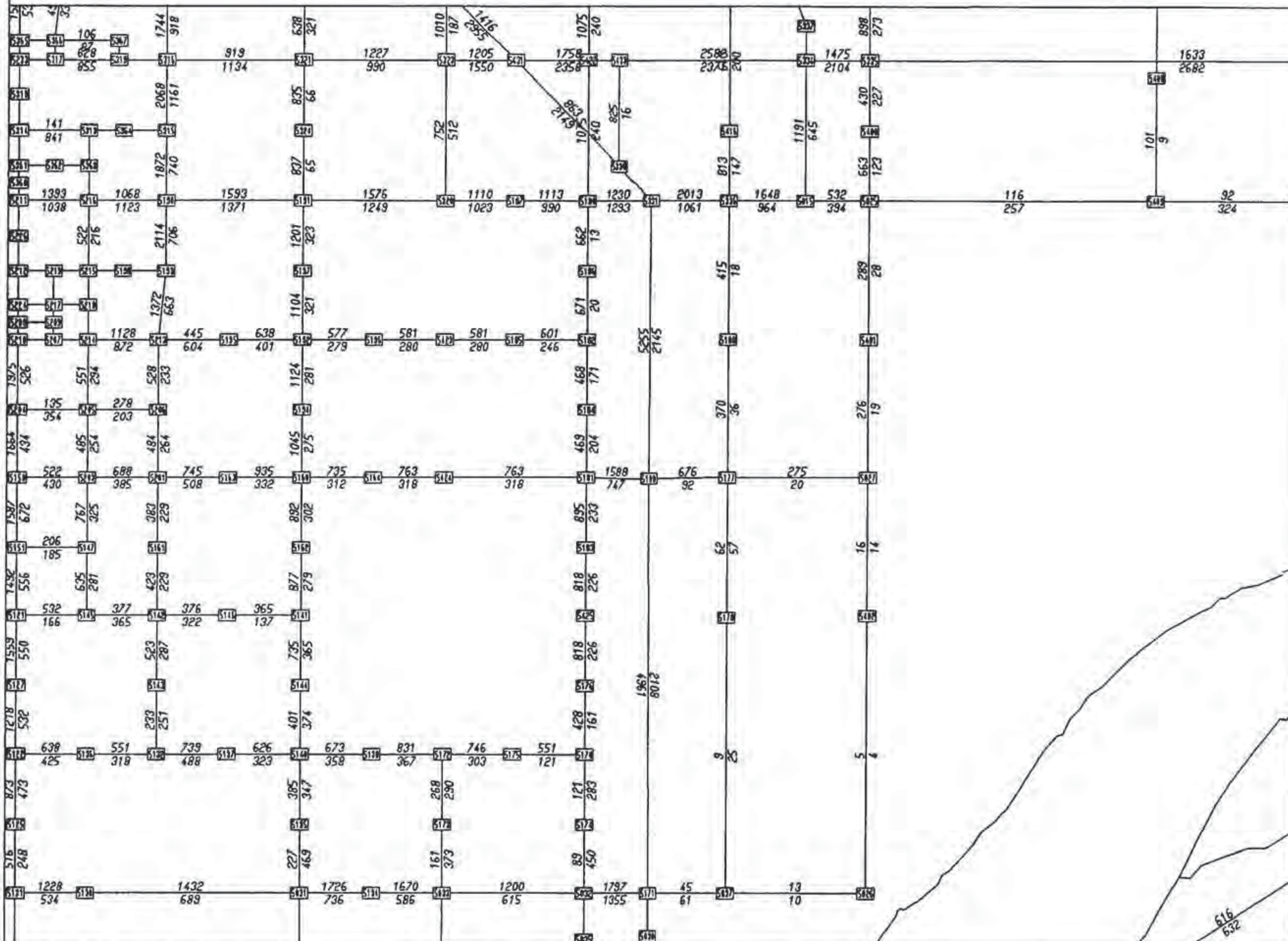

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MODULE 6 12
CVRD vw

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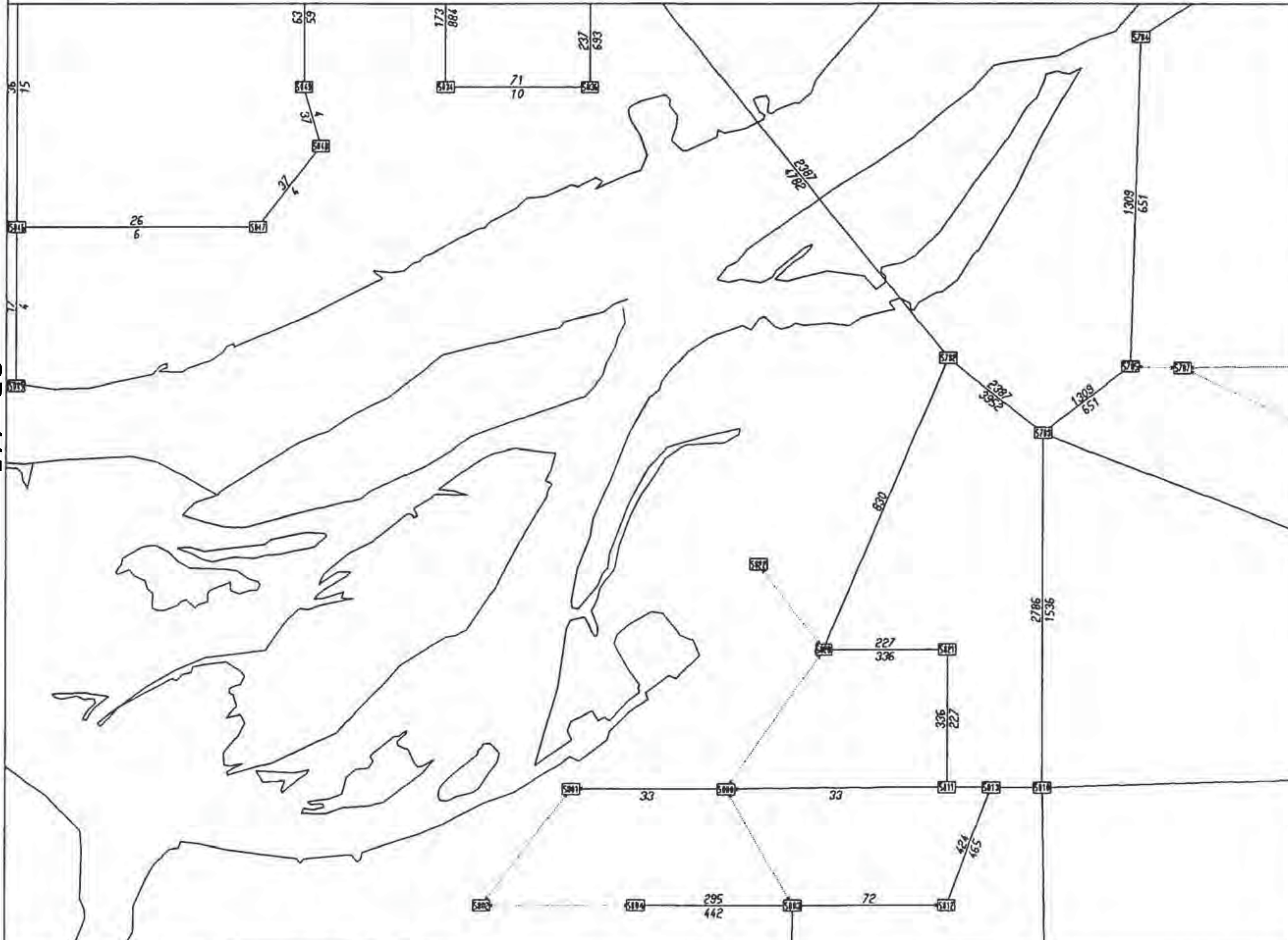

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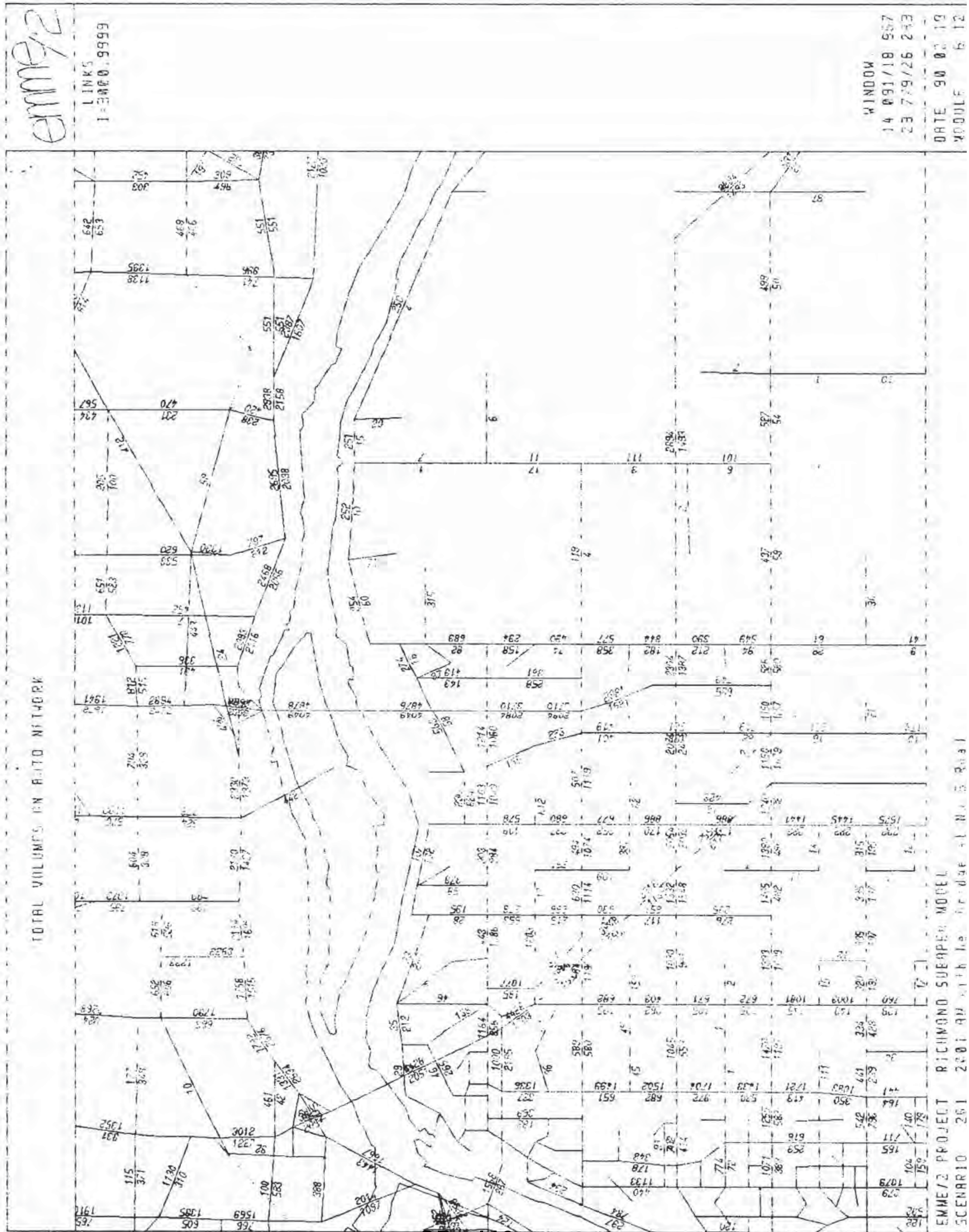
MODULE 6.12
GVRD vw



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MODULE 6.12
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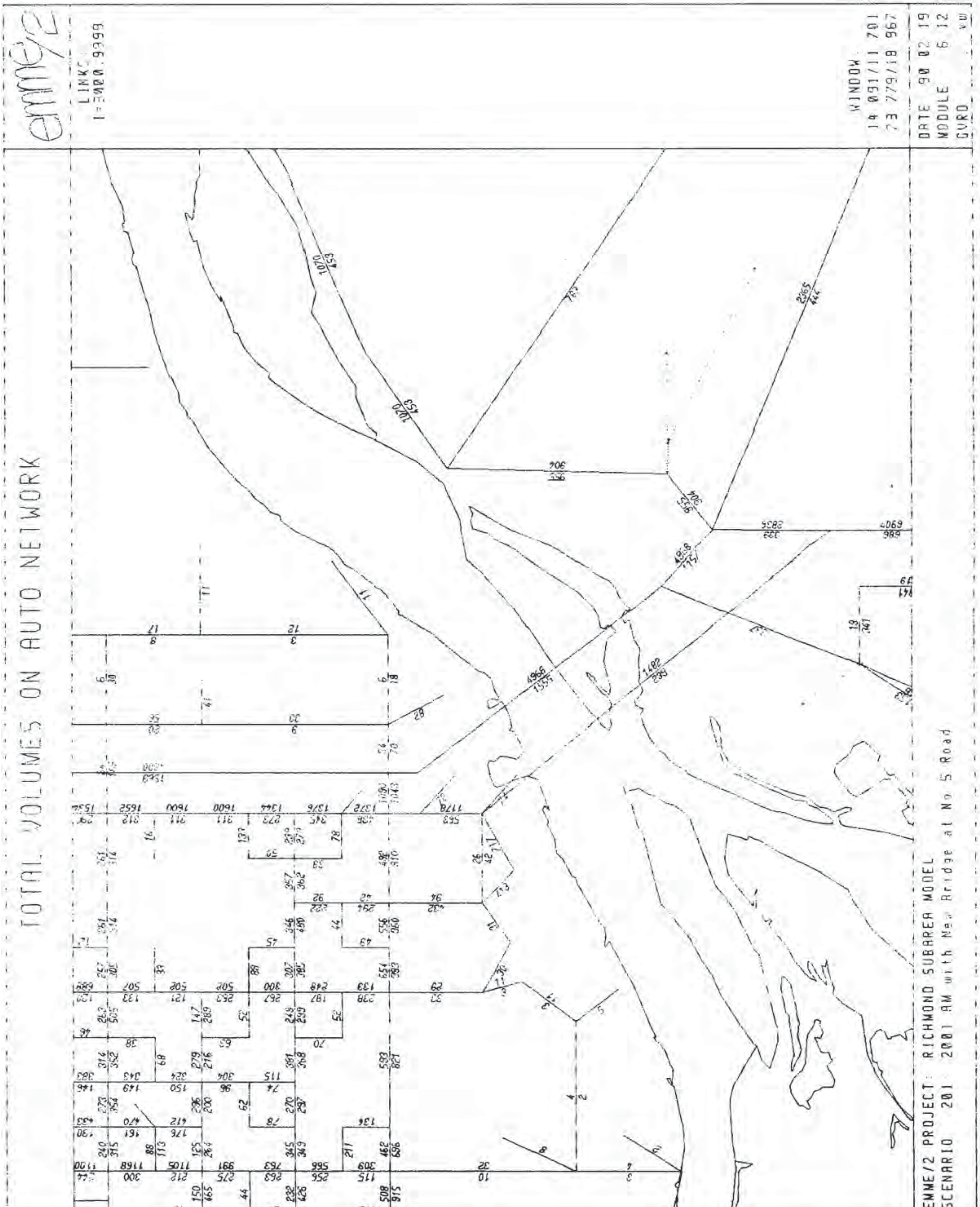
SCENARIO 261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23 779/18 967
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MODULE 6.12
CVRD vw
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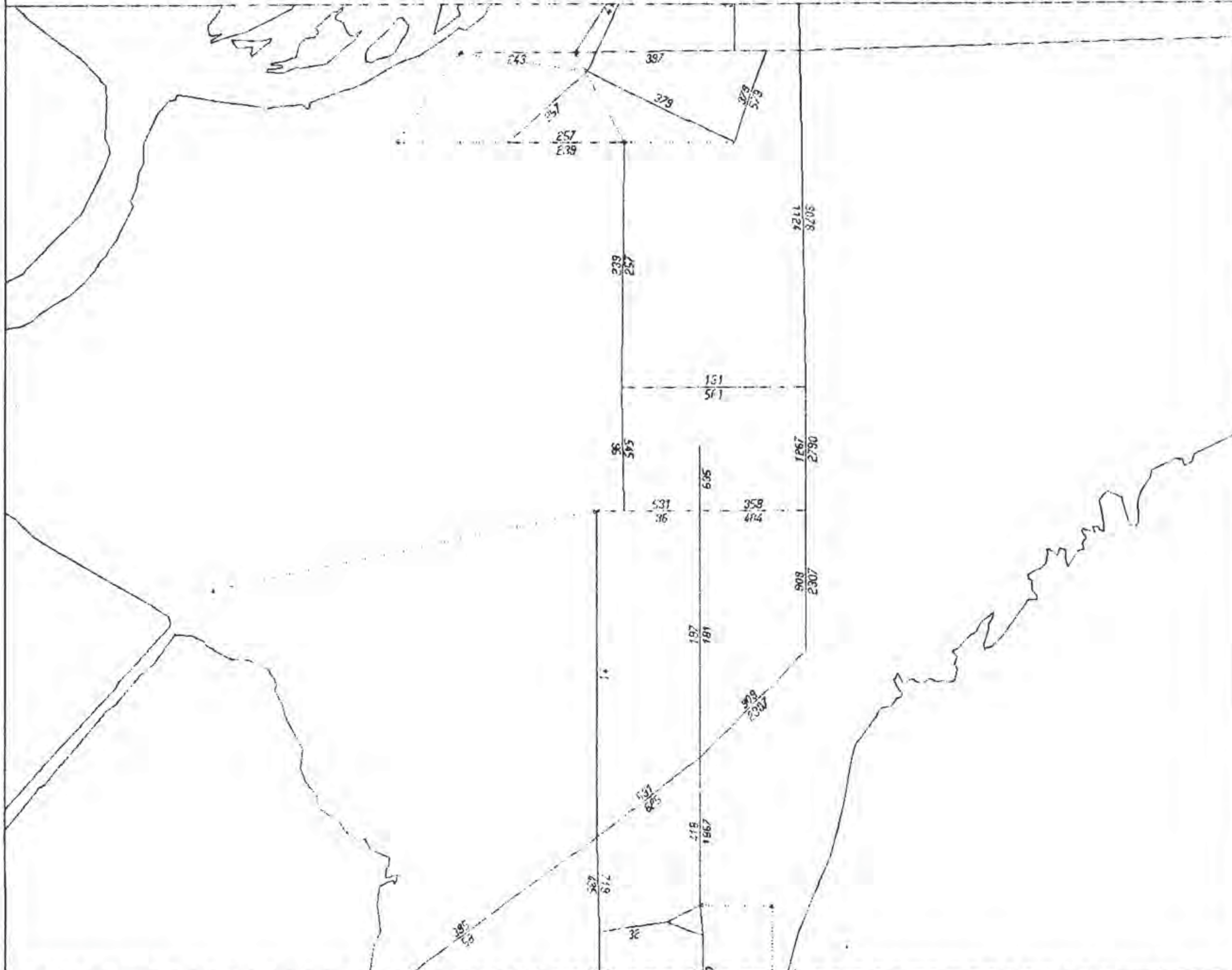

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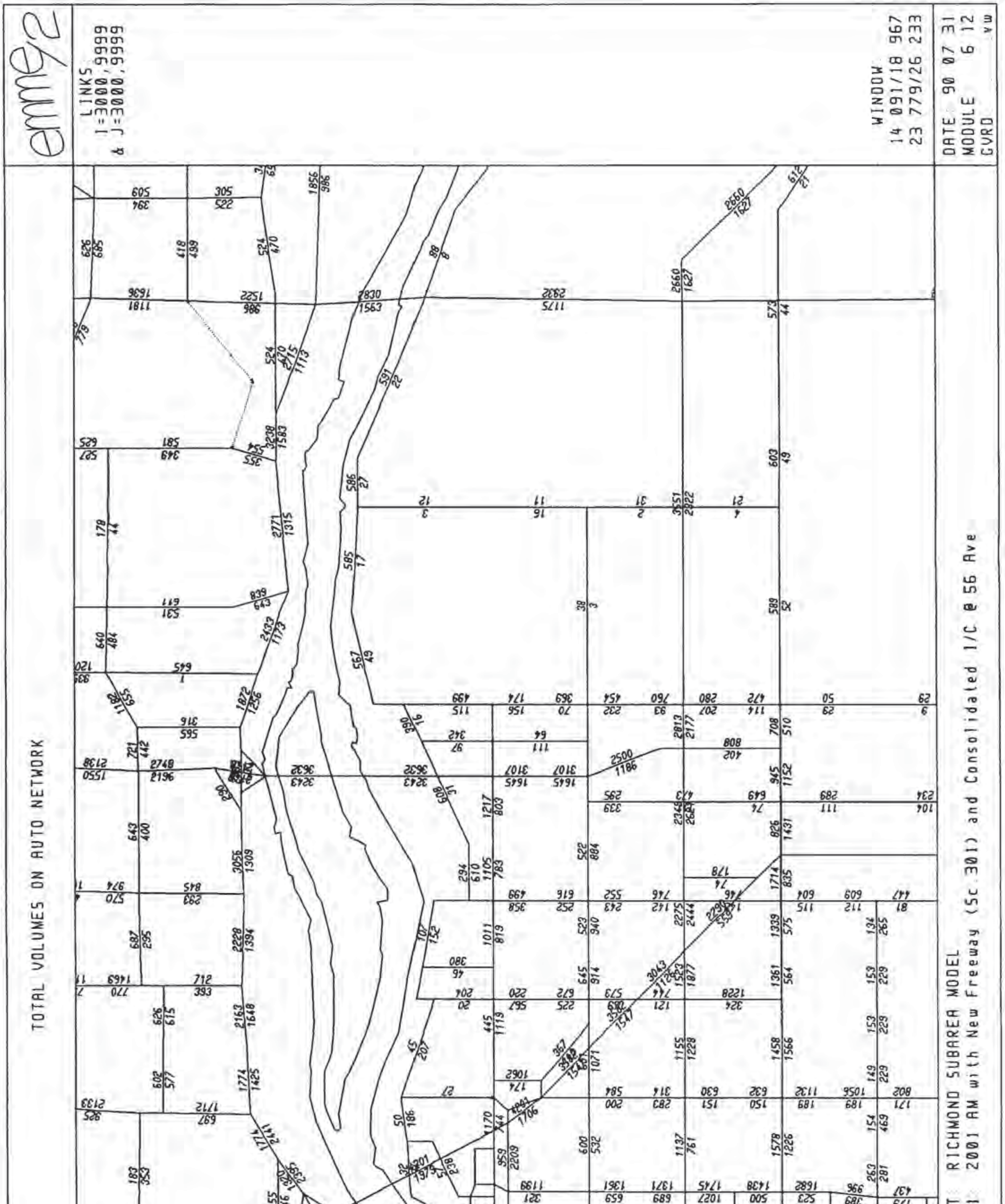
DATE 90 02 19
MODULE 6.12
GVRD vu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WINDOW
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23 779/26 233
DATE 90 07 31
MODULE 6.12
GVRD vw
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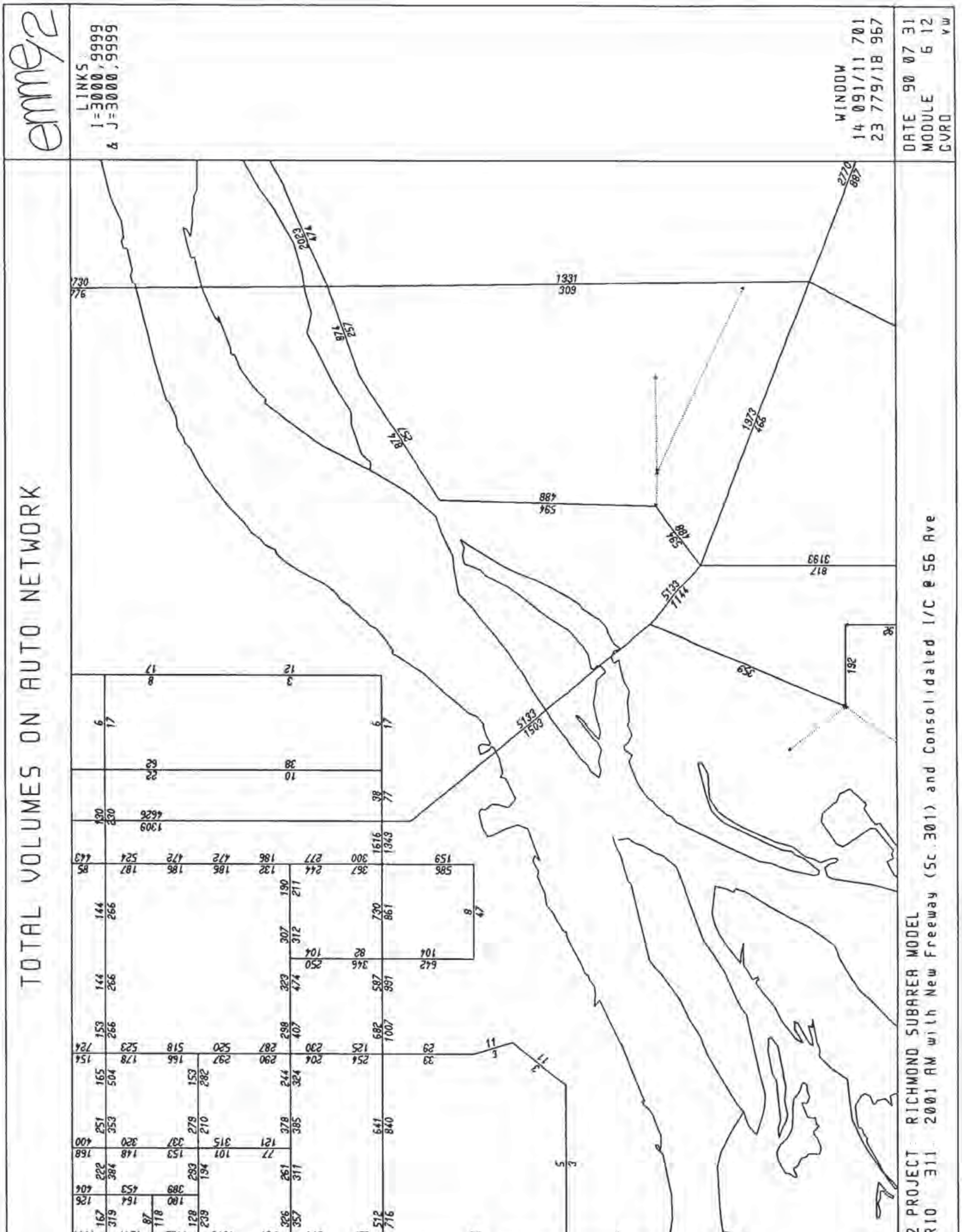
SCENARIO 311 2001 AM with New Freeway (Sc.301) and Consolidated I/C @ 56 Ave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DATE 90 07 31
MODULE 6 12
GVRD vw
EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO 311 2001 AM with New Freeway (Sc 301) and Consolidated I/C @ 56 Ave

TOTAL VOLUMES ON AUTO NETWORK

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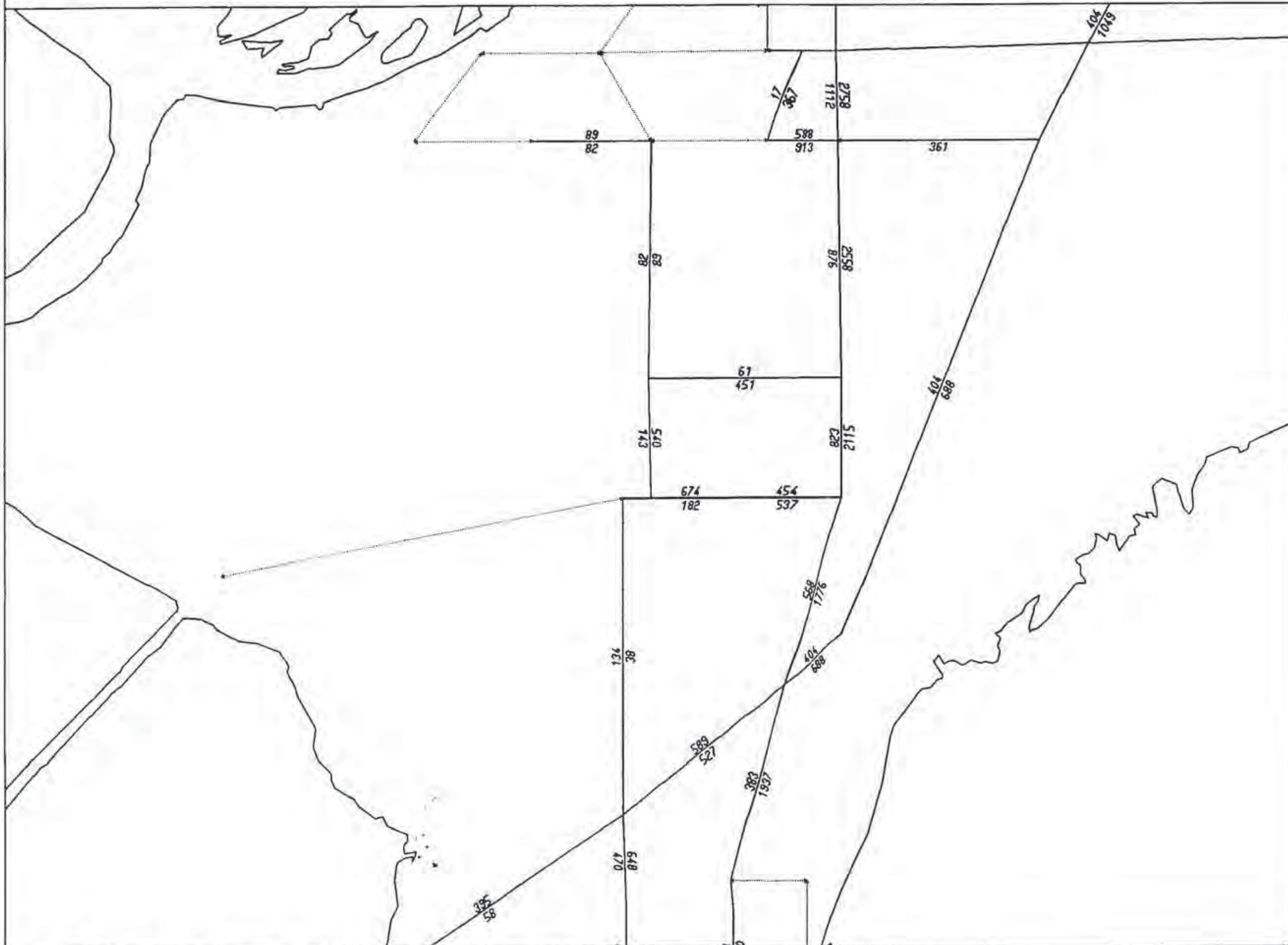

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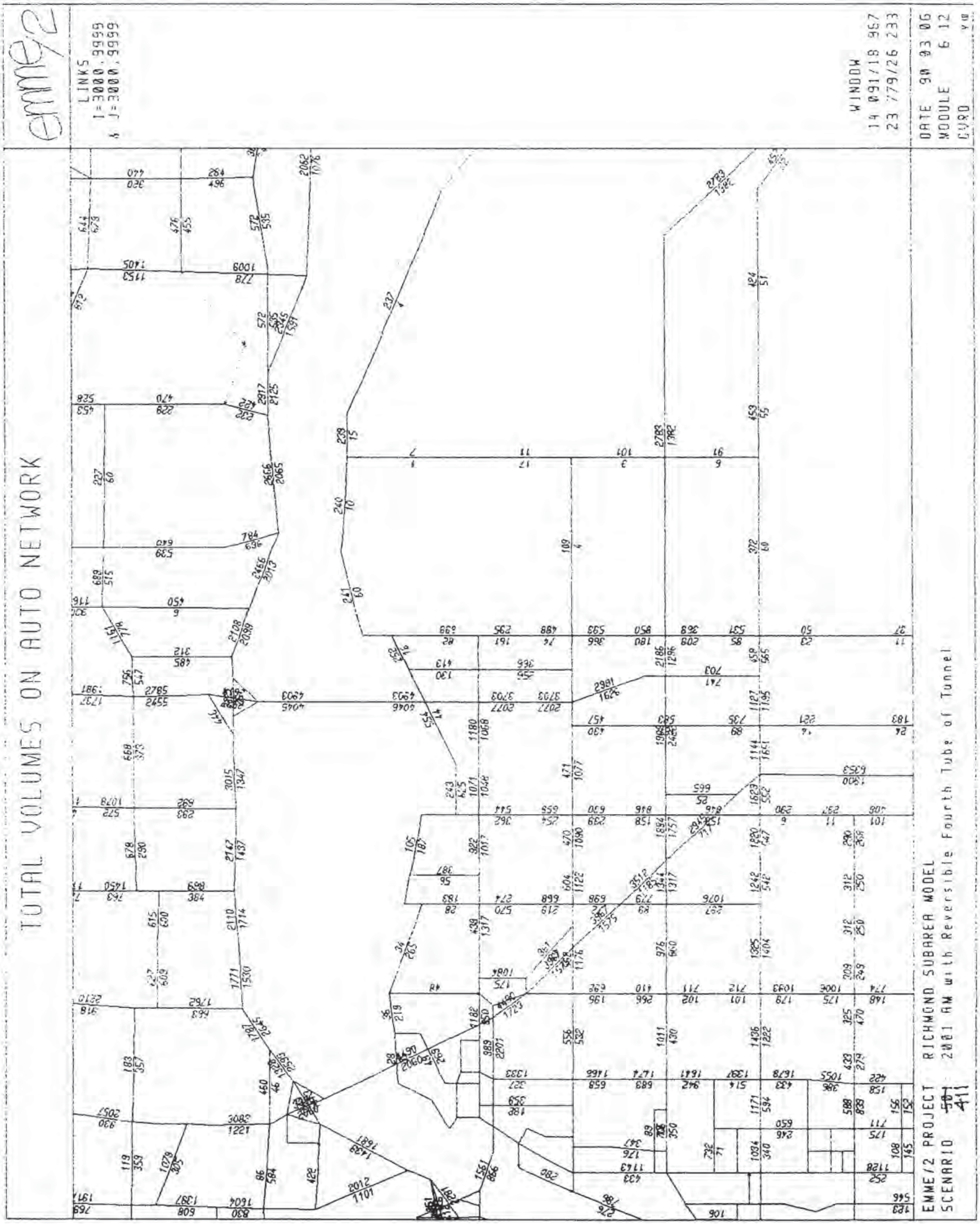
SCENARIO 311: 2001 AM with New Freeway (Sc 301) and Consolidated I/C @ 56 Ave

DATE: 90 07 31
MODULE 6 12
CVRD vw



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WINDOW
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23 779/26 233
DATE 90 03 06
MODULE 6 12
EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO 411 2001 AM with Reversible Fourth Tube of Tunnel

TOTAL VOLUMES ON AUTO NETWORK

emme/2

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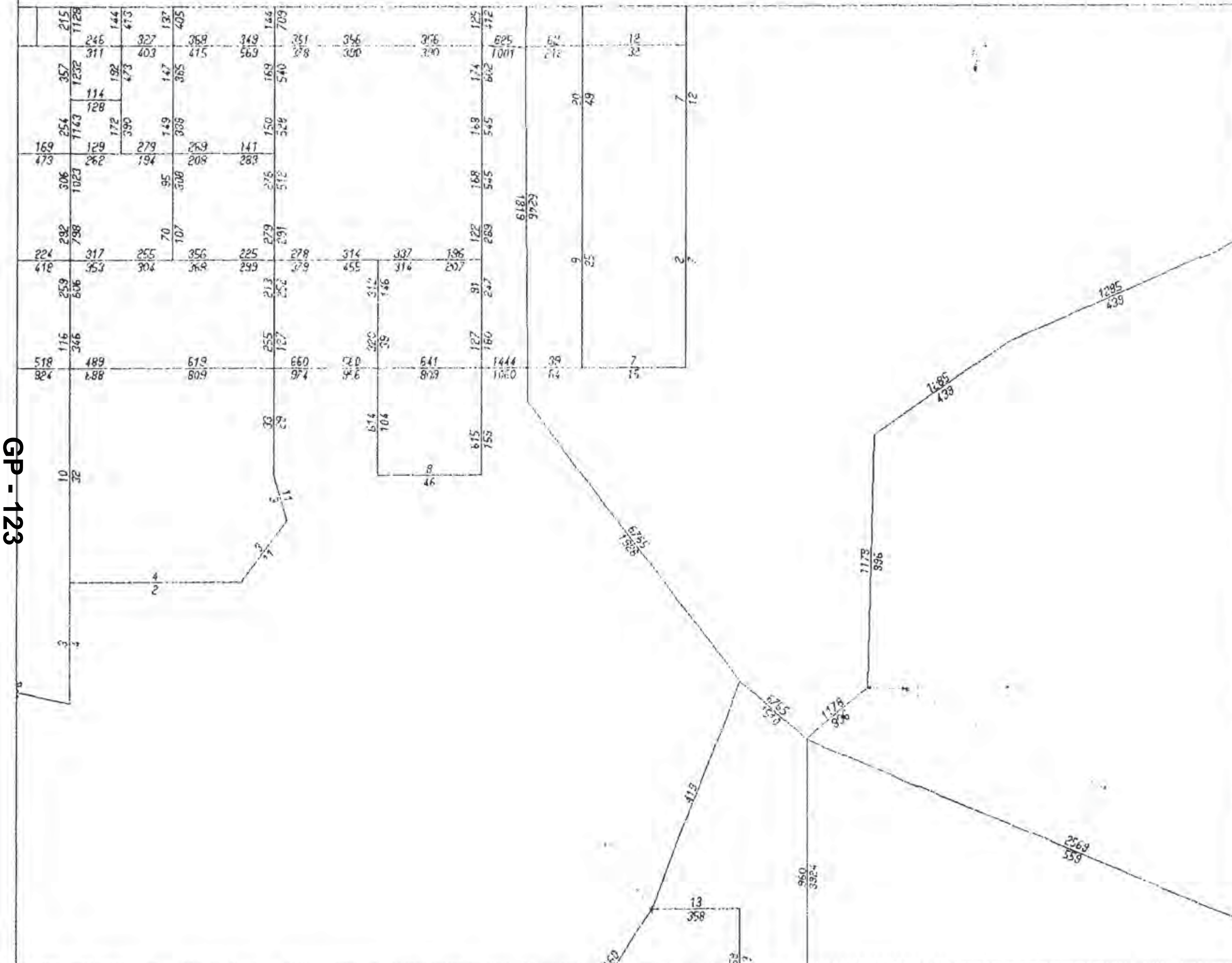

WINDOW:
14 891/11 701
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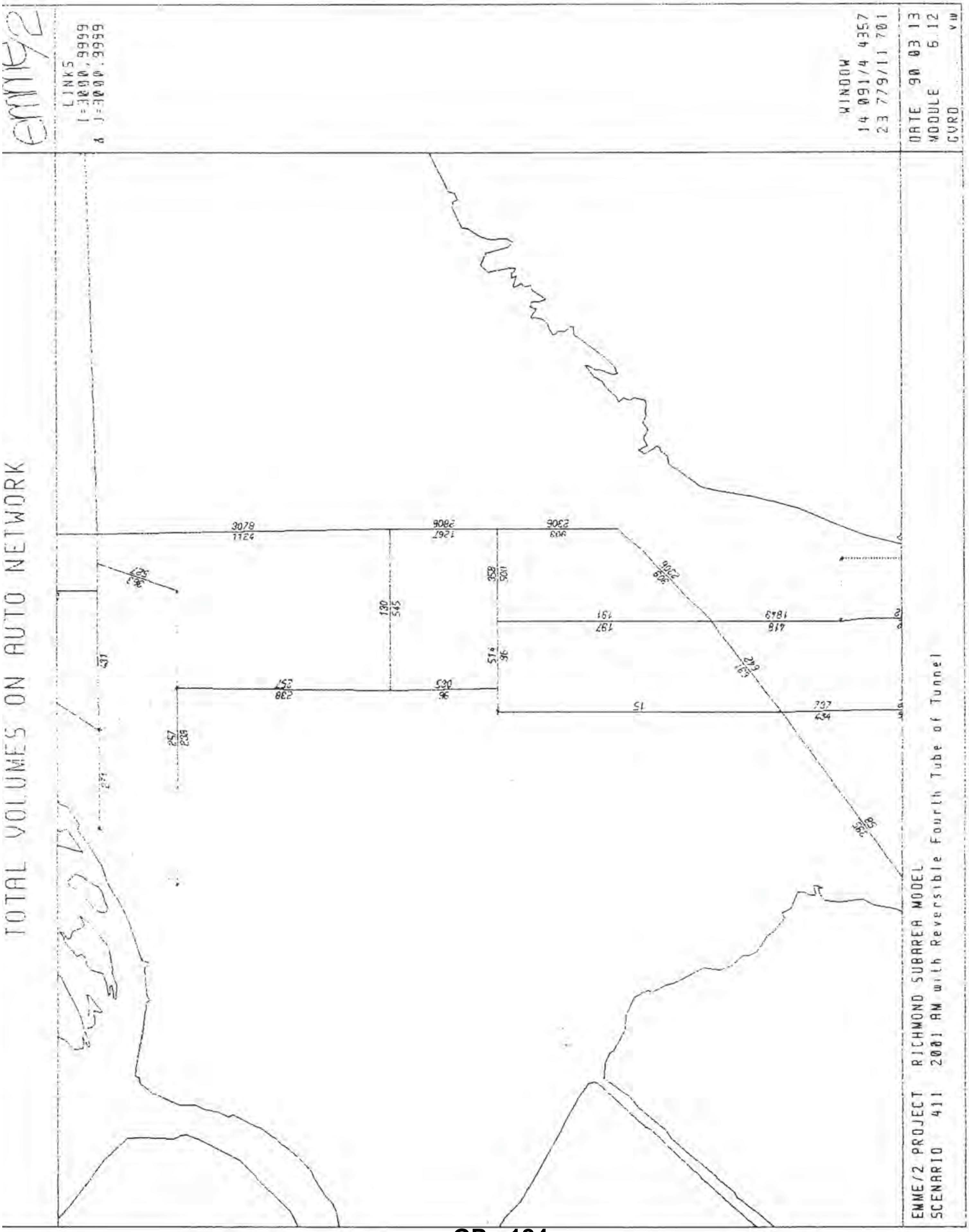
EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO ~~501~~ 111 2021 AM with Reversible Fourth Tube of Tunnel

DATE 90 03 06
MODULE 6 12
CVRO vw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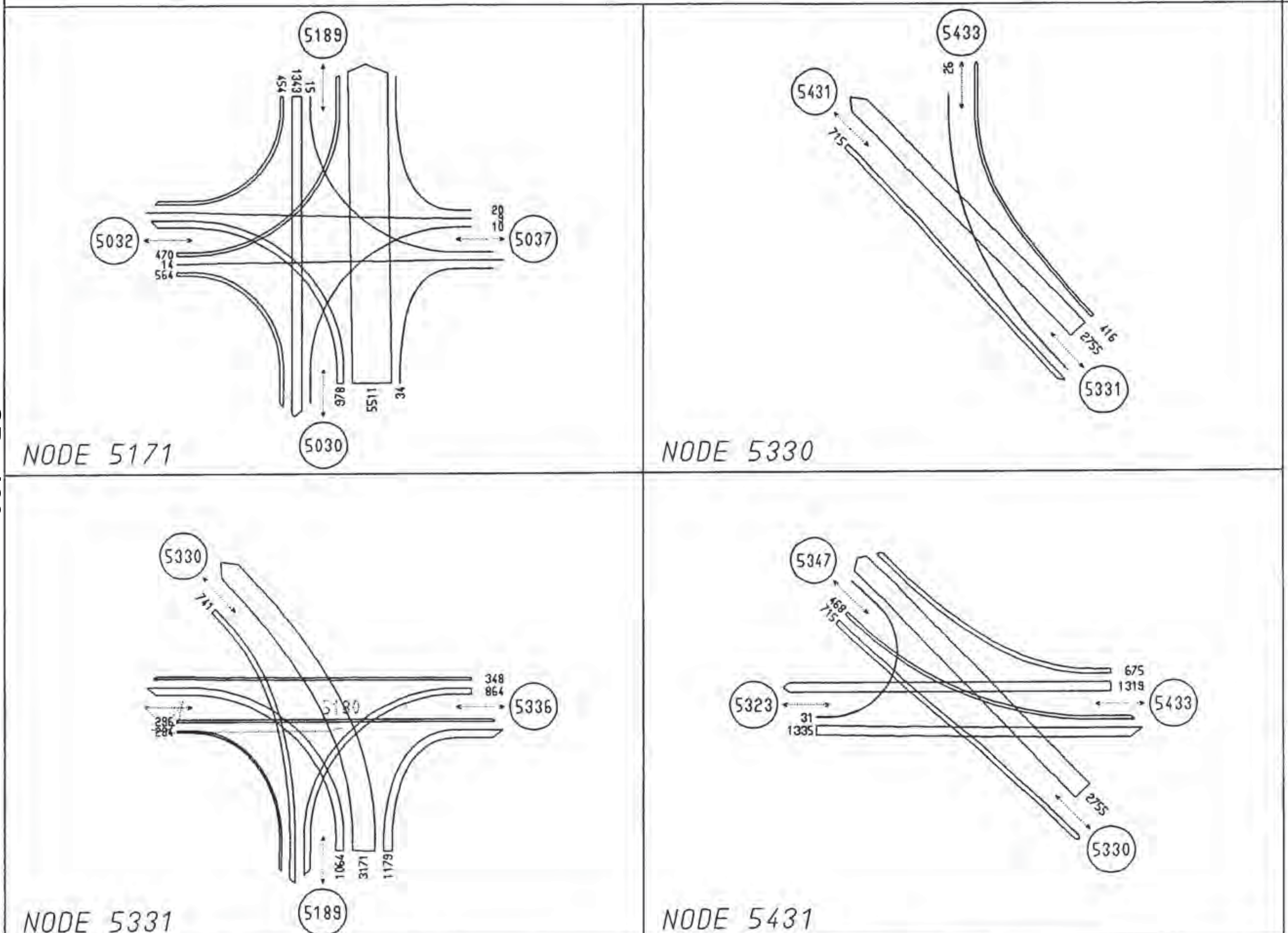
DATE 90 03 13
MODULE 6.12
GVRD vw
EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO 411 2001 AM with Reversible Fourth Tube of Tunnel

APPENDIX II
2001 Projected Interchange Ramp
Volumes for Third Tube Alternative

TOTAL VOLUMES ON INTERSECTIONS

emme/2



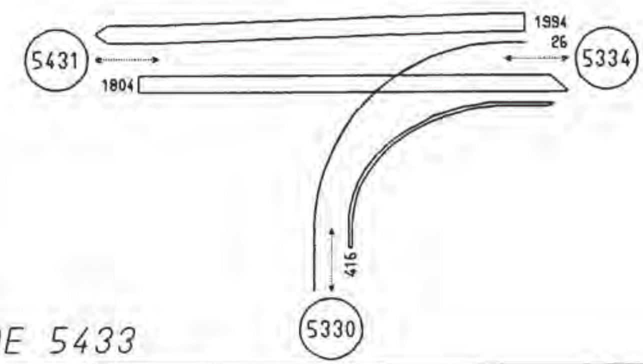
SCALE 200
500
1000
1500
2000
2500

EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO 111 2001 AM with Reversible Third Tube

DATE 90 12 06
MODULE 6 14
CVRD vw

TOTAL VOLUMES ON INTERSECTIONS

emme/2



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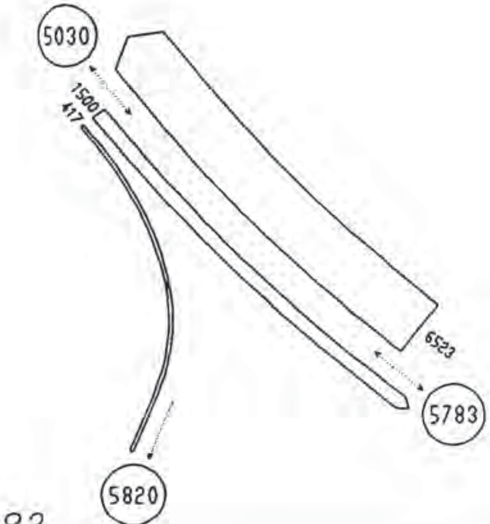

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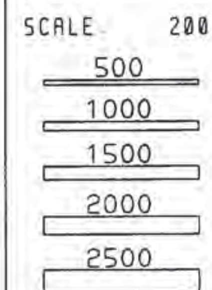

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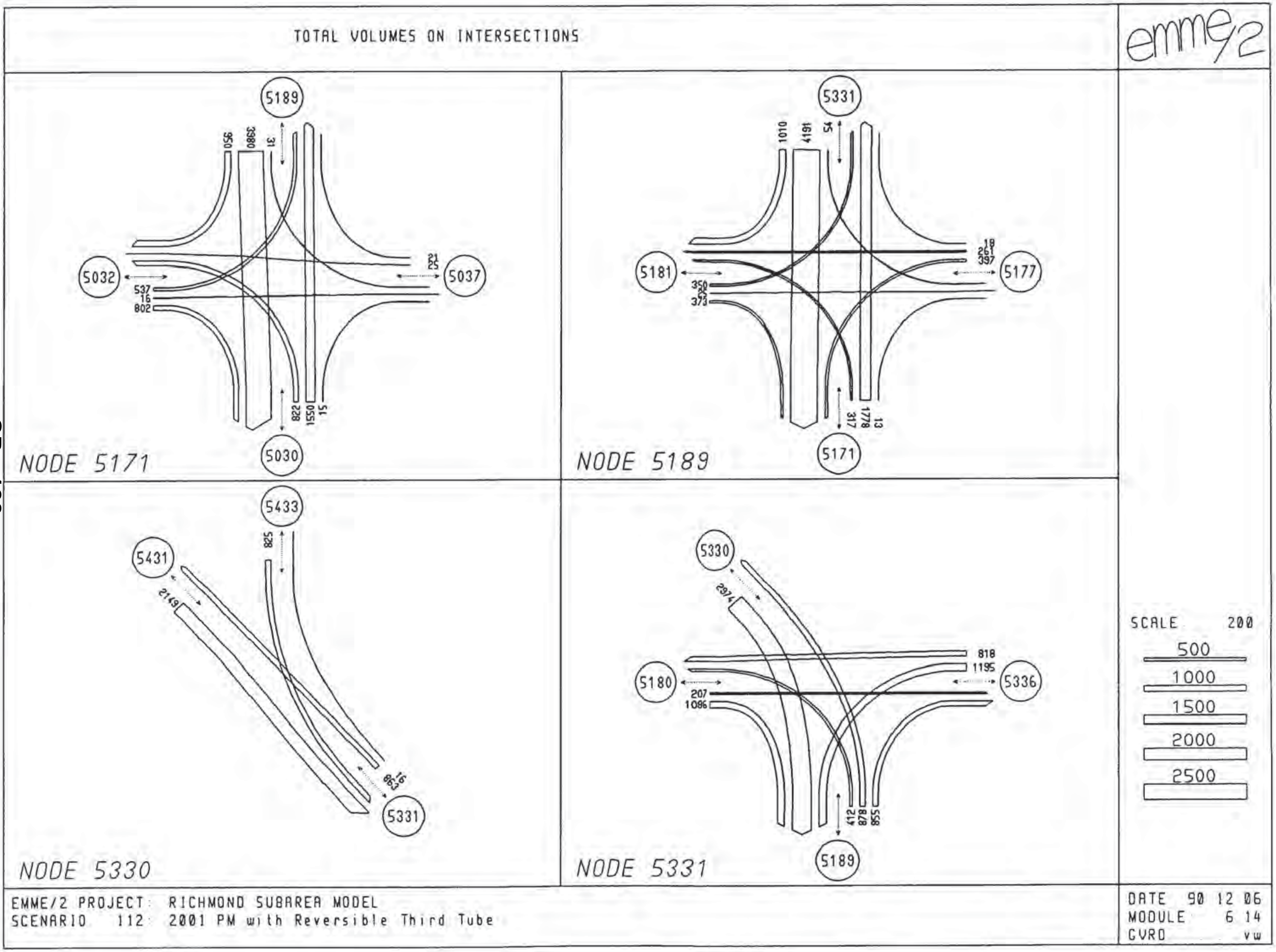
SCENARIO 111 2001 AM with Reversible Third Tube

DATE 90 12 06
MODULE 6 14
CVRD vw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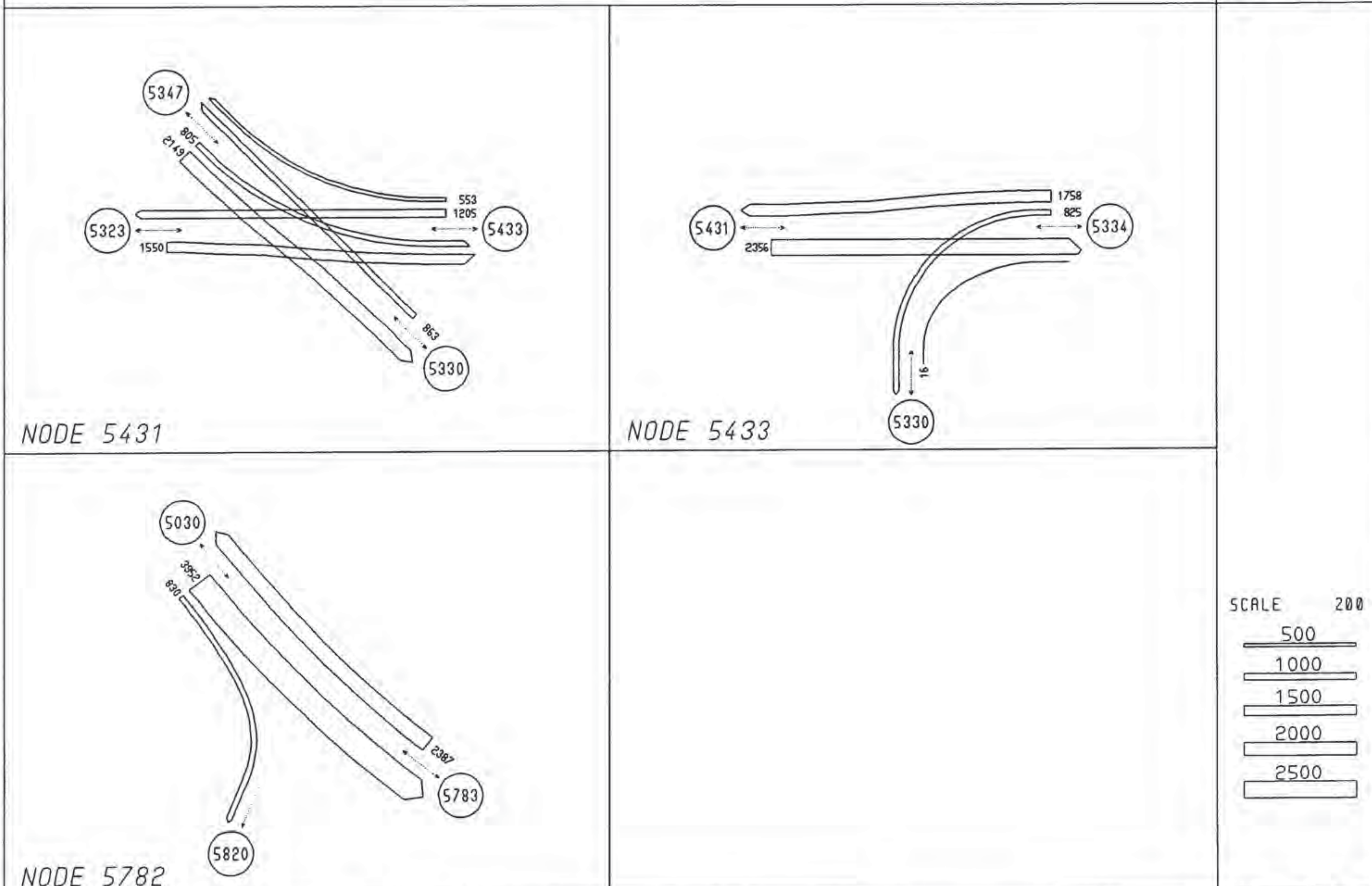
16
802
822
1550
15
NODE 5189
5331
5181
5177
5171
1010
4191
54
18
261
397
350
373
317
1778
13
NODE 5330
5433
5431
5331
528
2149
16
863
NODE 5331
5330
5180
5336
5189
2974
818
1195
207
1086
412
878
855
SCALE 200
500
1000
1500
2000
2500
EMME/2 PROJECT: RICHMOND SUBAREA MODEL
SCENARIO 112: 2001 PM with Reversible Third Tube
DATE 90 12 06
MODULE 6.14
GVRD vw

TOTAL VOLUMES ON INTERSECTIONS

emme/2



EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO 112 2001 PM with Reversible Third Tube

DATE 90 12 06
MODULE 6 14
CVRO vw

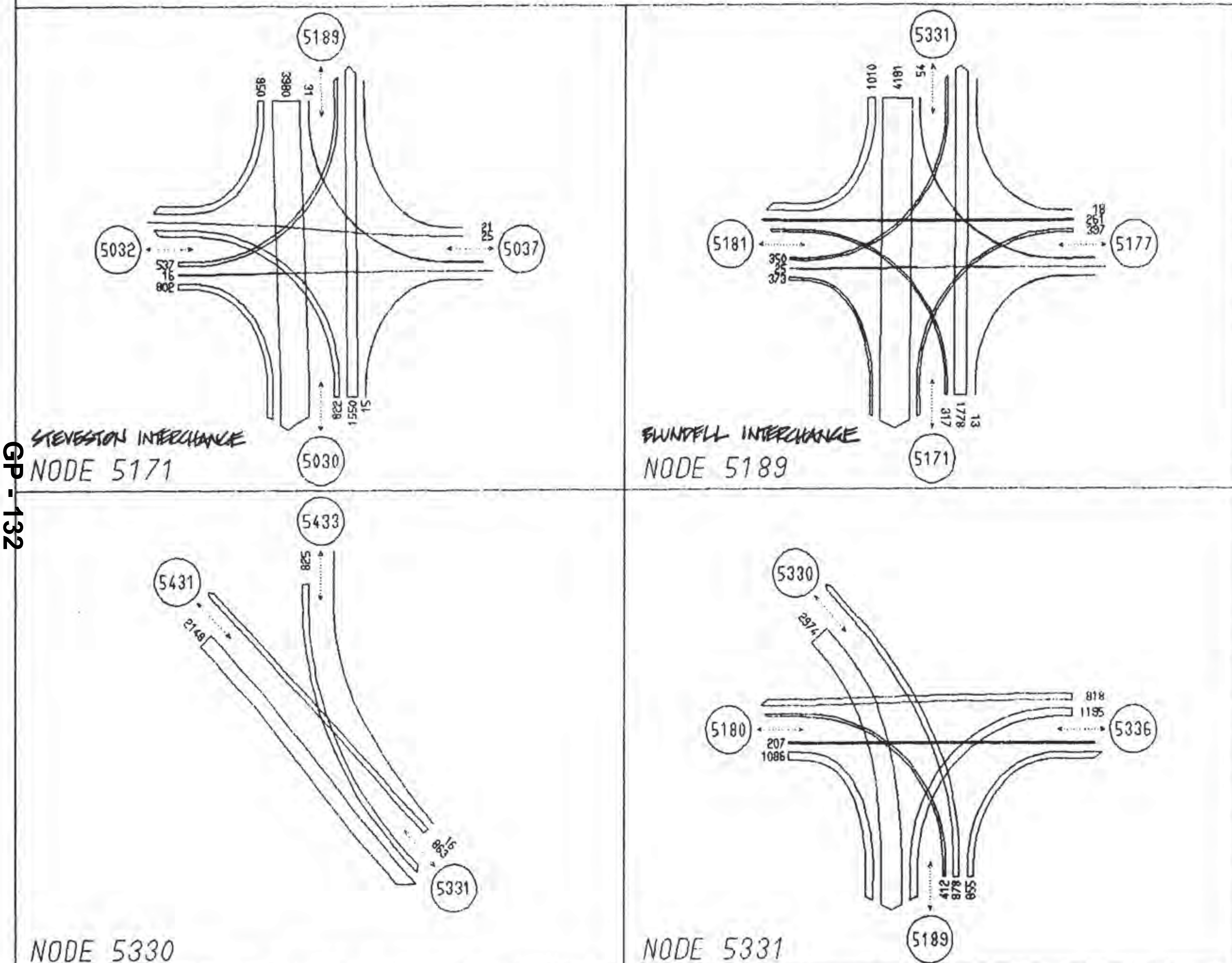
APPENDIX III
Turning Movements at Steveston and Blundell Interchanges
Under Alternative Access Controls

EXPLANATION OF APPENDIX III

Scenario 112	Reversible Third Tube P.M. Peak Hour
Scenario 122	Reversible Third Tube with Eastbound to Southbound Movement Prohibited at Steveston Interchange - also P.M. Peak Hour
Scenario 132	Reversible Third Tube with Eastbound to Southbound Movement Restricted to Simulate Ramp Metering - also P.M. Peak Hour

TOTAL VOLUMES ON INTERSECTIONS

emme/2



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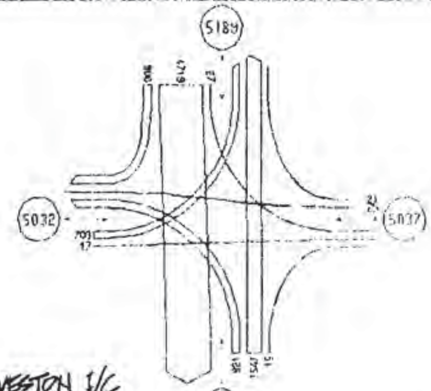
2500

EMME/2 PROJECT: RICHMOND SUBAREA MODEL
SCENARIO 112: 2001 PM with Reversible Third Tube

DATE: 90 03 29
MODULE: 6.14
CVRD vw

TOTAL VOLUMES ON INTERSECTIONS

emme/2



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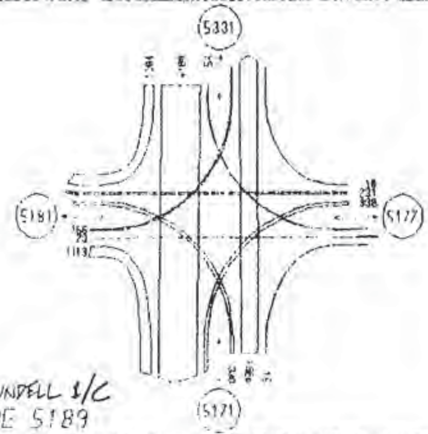
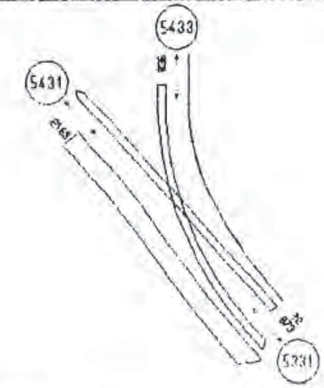
NODE 5171



BLUNDELL I/C
NODE 5189



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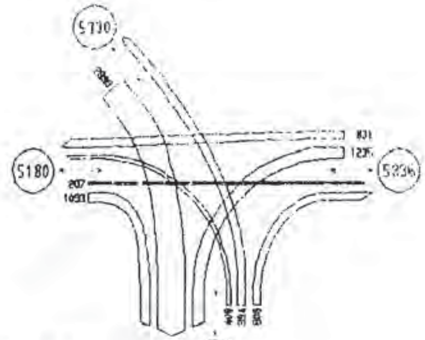

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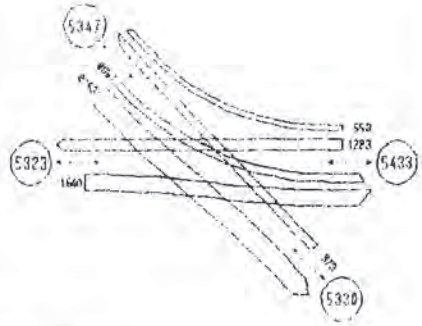

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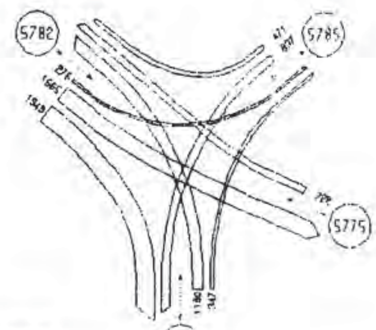

NODE 5783

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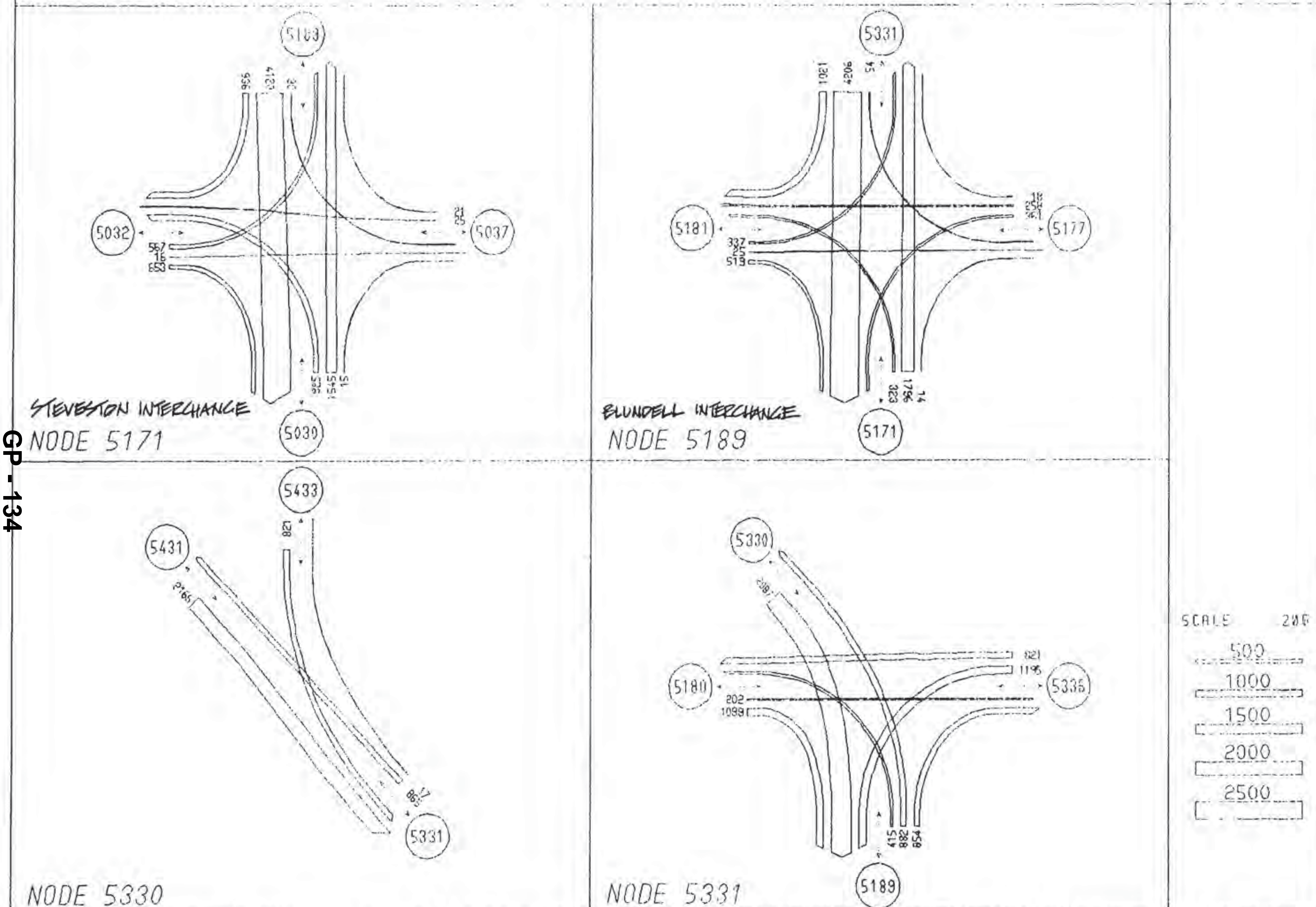
800
1000

EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO 122 2001 PM with Reversible Third Tube - No EB to SB @ Steveston I/C

DATE 90 03 13
MODULE 6.14
GVRD VW

TOTAL VOLUMES ON INTERSECTIONS



EMME/2 PROJECT RICHMOND SUBAREA MODEL
SCENARIO 132 2001 PM with Reversible Third Tube - Impeded EB to SB @ Steveston I/C

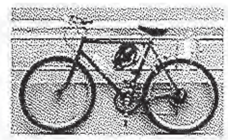
DATE 90 03 14
MODULE 6 14
CVRD vw

GP - 134
(Special)

Attachment 2

A Long-Range Transportation Plan for Greater Vancouver

TRANSPORT 2021 Report
September 1993



TRANSPORT 2021

a joint project of the Greater Vancouver Regional District and the Province of British Columbia

Copies of this Report and its companion Medium-range Transportation Plan to the year 2006 can be obtained from:

GVRD Communications and Education Department
4330 Kingsway
Burnaby, B.C., V5H 4G8
Tel: (604) 432-6339
Fax: (604) 432-6399

A Long-Range Transportation Plan for Greater Vancouver

Transport 2021

September, 1993

GP - 136
(Special)

TRANSPORT 2021
6th Floor, 4330 Kingsway, Burnaby, B.C., Canada V5H 4G8

Telephone (604) 432-6368
Fax (604) 436-6970

July 23, 1993

Hon A. Charbonneau,
Minister of Transportation and Highways
Province of British Columbia
Parliament Buildings
Victoria, B.C.
V8V 1X4

Mr. G. Campbell,
Chairperson,
Greater Vancouver Regional District
4330 Kingsway
Burnaby, B.C.
V5H 4G8

Dear Sirs:

Long Range Transportation Plan for Greater Vancouver

We are pleased to present to you our recommended long range transportation plan for Greater Vancouver.

Undertaken at the joint initiative of your governments, the plan aims to meet both provincial and regional goals for the development of the Greater Vancouver region.

We have brought many perspectives to bear on this task. Our Steering Committee comprises nine provincial and regional officials, plus observers from the federal government and from neighbouring regions. The plan was prepared in collaboration with the GVRD's concurrent Livable Region Strategy, for which it provides the transportation component.

Our plan is the product of an extensive program of research and public consultation. Some 20 working papers provide the technical foundation of our report. During its two years of work, our committee met 18 times, co-sponsored two major public conferences on growth management and transportation, surveyed public opinion and conducted several seminars and workshops.

The result is not a "business as usual" transport plan which follows and reinforces current trends.

Instead, our transport plan is based on the values of the region's residents and communities; it would serve and help shape the land use pattern proposed in the GVRD's Livable Region Strategy. That strategy protects a regional green zone, reverses urban sprawl into the Fraser Valley, and concentrates growth in centres throughout the region. This approach to urban form is essential if we are to wean the region from its troubling and growing dependence on the private automobile.

At the same time, our plan provides the mobility for people and goods which is vital to the region's internal and external trade—most notably to the region's roles as the Province's main distribution centre and Canada's primary Pacific trade gateway.

We believe that a broad, sustained campaign must be mounted, using both incentives and penalties, to change travel habits and re-shape the demand for travel. Selectively building new transport capacity is but one aspect of our plan.

Our proposals are interdependent and mutually supportive. Steps are required in all the recommended areas—land use and growth management, transport demand and supply management, and investment in new transport capacity—to achieve the desirable results we believe are within reach.

The estimated capital cost of our recommendations to the Province and municipal governments is some $10 billion over the next 30 years. This requires less than the per-capita annual rate of spending in the last decade, and there are good indications that if necessary it could be debt-financed on the basis of the revenue stream flowing from demand management measures.

Forecasting is an inexact science. We can be sure that the future will not unfold as we imagine. Accordingly, we have included proposals to help make the plan as flexible and robust as possible with respect to unexpected developments in the future.

Our final task—to produce a medium range transport plan with recommended priorities for action—is now underway. We will be reporting further to you, on time and on budget, in the coming weeks.

Bringing our plan to reality will be a challenging process requiring unprecedented cooperation by many parties. We believe we have made a good start with the creation of this plan. Coordinated actions, most notably by the agencies of the Province and local governments, will be absolutely essential if Greater Vancouver is to have the transportation system it wants, needs and deserves.

Respectfully submitted,
The TRANSPORT 2021 Steering Committee

B.E. Marr
Chairperson

c.c.
Hon. R. Blencoe, Minister of Municipal Affairs, Recreation and Housing
Hon. G. Clark, Minister of Finance and Corporate Relations
Mr. J. Les, Chairperson, Regional District of Fraser Cheam
Mr. G. Peary, Chairperson, Central Fraser Valley Regional District
Mr. C. J. Tiedeman, Chairperson, Dewdney Alouette Regional District

CONTENTS

Executive Summary

Introduction

Greater Vancouver's
1.6 million citizens
operate
1 million
motor vehicles
(cars, buses, trucks,
trains & vessels)
over the region's
10,000 km
of roads, trackage and ferry lanes.

Of all journeys in the region
some 83%
are taken by
private automobile,
9%
by public transit
and the remainder by
foot and bicycle.

Greater Vancouver depends on its transportation system for its existence. The system permits people to reach work, school, shopping, recreational, cultural and sports events, and to visit friends and family. It allows employers to access a supply of labour, and goods to be sent and received in the course of domestic and international trade.

Goals for the transport system

The primary economic goal of the transport system is to move people and goods effectively, efficiently, safely and reliably. It must adapt and expand to serve the region's changing population—which is expected to grow by 70% to nearly 3 million in 30 years—and it must do so at affordable cost.

In addition, the region's citizens expect their transport system to meet social and environmental goals, such as:

- to provide transportation **equitably** to a diverse population (30% of whom are either too old or too young to drive); and
- to help **reduce its negative impacts** on the region's livability (e.g. to limit urban sprawl and land consumption, preserve green space, limit congestion and traffic intrusion into local neighbourhoods, and cut air and noise pollution).

Problem of automobile dependence

In common with many other urban regions in the developed world, Greater Vancouver has concluded that heavy reliance on the private automobile is unhealthy. The desire for **greater choice in mode of transport**—meaning strategic expansion of public transit, and creating walking- and bicycling-oriented communities—is a recurring theme in public meetings and opinion polls.

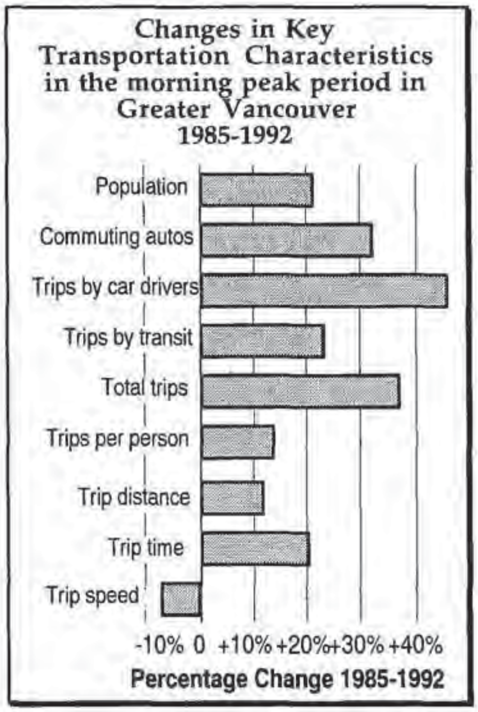
A policy of reversing the past practice of favouring the automobile has been adopted under the GVRD's "Creating Our Future" program and therefore forms part of TRANSPORT 2021's terms of reference.

Where Are Current Trends Leading?

However, the region is becoming **more, not less, dependent on cars**, and the system's **performance is deteriorating**.

The number of cars used for commuting is growing faster than the population and the average person is travelling more; the speed of travel is dropping and people are also travelling longer distances.

That means that the total amount of time spent travelling has increased substantially. The busy morning and afternoon periods lengthen to fill more of the day.



Surveys also show that homes and jobs are dispersing into the suburbs. This is producing a less core-focussed pattern of travel, with **travel between suburbs growing faster than travel to and from the core**. Such an increasingly diffuse pattern is awkward for conventional public transit to serve effectively; transit performs best along high-volume corridors, where transit vehicles can be reasonably full while offering frequent, convenient service and connections.

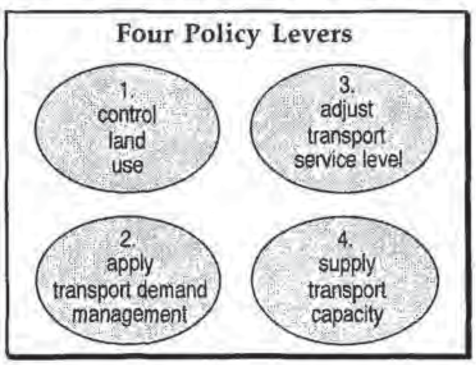
Accordingly, transit usage has not kept pace with automobile usage: public transit's percentage share of travellers has declined since 1985, while that of car drivers has risen.

Computer simulations of the trend over the next 30 years point to a further 80% growth of peak period travel (by all modes), with the number of car trips growing by a projected 86%. Public transit will continue to lose ground. If congestion is to be held at bay, large scale road construction will be necessary.

Air pollution

The total amount of local air pollutants being emitted from vehicles is dropping and will continue to do so until about 2005 due to better technologies and enforcement of standards. Later, even cleaner engines and fuels will have to be employed to keep emissions down. Emissions of the greenhouse gas carbon dioxide will rise.

How Can the Trends Be Changed?



Government policy makers have **four major levers** available to steer the transport system towards the desired goals. They are:

1. control land use (e.g. by zoning regulations);
2. apply transport demand management (to change travellers' behaviour);
3. adjust transport service levels (e.g. by letting congestion worsen); and
4. supply transport capacity (e.g. by building more roads and transit).

This report looks at each lever in turn.

1. Control Land Use

The **land use** pattern—especially where people live and work —is important to transportation at two levels: regional and neighbourhood.

Regional or "Macro" Level

Where people live and work within the region (i.e. urban structure on a large scale) determines much of their daily travel needs. **Whether people spread out in suburbia or live closer together in** tighter communities (measured in terms of number of people per hectare—or population density) is one aspect of this.

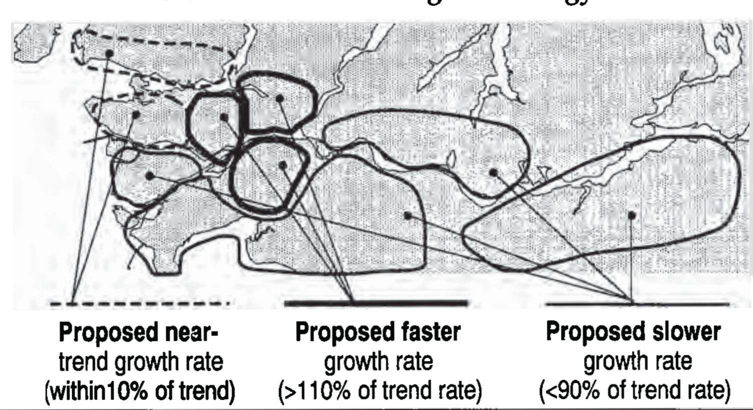
Different transport systems are suited to different population densities: less dense cities (e.g. in the south and western U.S.) tend to be automobile-oriented; denser cities (e.g. in Europe and Asia) lean towards much more transit.

At time of writing this Report, the GVRD's proposed Livable Region Strategy is under consideration by local governments. It would have local governments control land use to:

- **re-allocate the region's growth** (i.e. an extra 1.2 million people and 0.6 million jobs over 30 years) among the municipalities to form a more compact, less sprawling region than would occur if the system were left to follow current trends; and in particular
- **cluster population and jobs** near regional activity centres of various sizes, sited along transport corridors (helping to make them less automobile-dependent and more effectively serviced by transit); and simultaneously
- create a better **balance between work force and jobs** in each area, so that communities can be more complete, people can have an opportunity to live close to work, and long-haul commuting can be reduced.

*The Livable Region Strategy proposes that growth rate be **nearly the same** in some areas, **faster** in some others, and **slower** in yet others—compared with the growth rate that would occur in those areas under the "business as usual" trend.*

Proposed Growth Rates under the Livable Region Strategy



To implement the Livable Region Strategy, it is necessary that:

- **local governments in the B.C. Lower Mainland**—28 in total—coordinate changes to their Official Community Plans and zoning regulations in the future; and
- **agencies of the Provincial Government** (notably B.C. Transit and the Ministry of Transportation and Highways) and local governments coordinate transportation policies and investments in infrastructure so as to serve and help create the more compact region.

The Livable Region Strategy and the TRANSPORT 2021 project both view land use and transport planning as interactive and interdependent.

Neighbourhood or "Micro" Level

Changing the the look and feel of neighbourhoods and "streetscapes" is key to giving walking and bicycling an opportunity to take hold. Governments can create neighbourhoods where non-drivers are less disadvantaged or where a car (especially a second family car) is actually not required by:

Neighbourhoods for non-drivers

- **creating small-town or village street patterns** in suburban areas—where homes surround stores and services. Commercial buildings are closely spaced and front directly onto streets and sidewalks, not set back for parking. Routine neighbourhood trips are by foot. Priority for vehicles is downgraded.
- **intensifying residential areas** by lowering minimum lot sizes for detached housing, allowing building right up to lot line and relaxing single-purpose zoning.
- **calming traffic** by modifying the street and its regulations to slow down traffic and create better pedestrian environments and more livable neighbourhoods.

Bicycling promotion

A major obstacle to more cycling is that existing roads and bridges do not accommodate cyclists very well. Also, many destinations have no secure bicycle storage, with no change rooms, showers or lockers.

If cyclists were better accommodated, transit could also benefit: more people from further away could access transit by bike than by foot alone, giving transit stops a greater "catchment" area.

Those modern western cities which have successfully adapted their road systems to accommodate cycling have shown that bicycle travel can become an important component of the transportation system and may reduce the number of motor vehicles on the roads.

2. Apply Transportation Demand Management

Transportation demand management is the second lever available to policy makers. It comprises a variety of techniques to change the behaviour of travellers in order to make better use of the existing transport system. It encourages off-peak travel and discourages single-occupant vehicles, incorporating measures such as tolls, gas taxes and parking management.

Though not the complete solution, it can postpone capital investment and reshape travel demand to boost transit and carpool use.

Research shows that people respond more to penalties than incentives. TRANSPORT 2021 is proposing a package of mutually supportive measures which would:

Incentives or "Carrots"

1. promote telecommuting;
2. encourage medium-sized and large employers to help cut vehicle trips to their worksites;
3. install high-occupancy vehicle lanes;
4. give buses traffic priority on the street;

Disincentives or "Sticks"

5. increase and broaden parking charges (e.g. 50% increase of average all-day parking charges in the downtown core, and increases in all-day parking at other major town centres to equal 3/4 of today's downtown levels);
6. raise fuel prices, through higher fuel taxes (e.g. a 50% increase in the real price of gasoline); plus
7. introduce bridge tolls (e.g. $2 peak hour toll on all bridges leading into Burrard Peninsula) as a first step to a more general road pricing scheme.

Estimated impact

Such a package could **decrease rush hour vehicle trips by 10% and increase transit ridership some 25%** compared with current trends for the year 2021, other things being equal. A more aggressive package (e.g. higher tolls) might achieve an even greater impact. The actual effect of transportation demand management will depend much on how well it is introduced, publicized and coordinated.

Link to user pay

In Greater Vancouver, as in most cities, passenger transportation is provided to users at less than cost: for instance the private automobile and public transit are both subsidized—directly through the public purse and also indirectly through the hidden costs they impose on the environment and non-users.

Transport is underpriced

One estimate is that travellers on all transport modes combined pay only 2/3 to 3/4 of the full economic costs. An essential element of transportation demand management is to get travellers to pay their way and in particular to inform them—as near as possible to the actual time and place of their trip— of the true cost of that trip.

In the long run the prices paid by users should correspond to their actual costs, otherwise over-use results. The goal of economic efficiency therefore supports a policy of generally increasing the price of all transport modes.

Link to financing

By 2021, transportation demand management and toll-financing will probably be commonplace in the developed world; it will be seen as necessary to combat urban traffic congestion and pollution and to support transport investment. Electronic technology is now available for streamlined collection of tolls.

3. Adjust Transport Service Level

Service level means speed, convenience, frequency of service, comfort and other qualities of a journey, other than price. **Selectively accepting congestion** to change travel patterns is another policy lever.

Problem of insufficient congestion to make carpool lanes work

Currently, on most transportation routes in the region, the level of service to mixed traffic is too high to make separate carpool lanes attractive through time savings. This suggests that for carpool lanes to be utilized, congestion would have to be allowed to accumulate in the mixed traffic lanes alongside. To attract people to use carpool lanes, there must be a tangible benefit to them (most likely in terms of travel time saved).

Congestion is usually considered an evil; however, allowing congestion to deteriorate for the single-occupant vehicles is a practical method of promoting transit and carpools. More congestion for single-occupant vehicles would magnify the impact of transportation demand management.

Caution: cost of congestion

There is a delicate balance between the cost of congestion and its merits as a lever to encourage transit and carpool use.

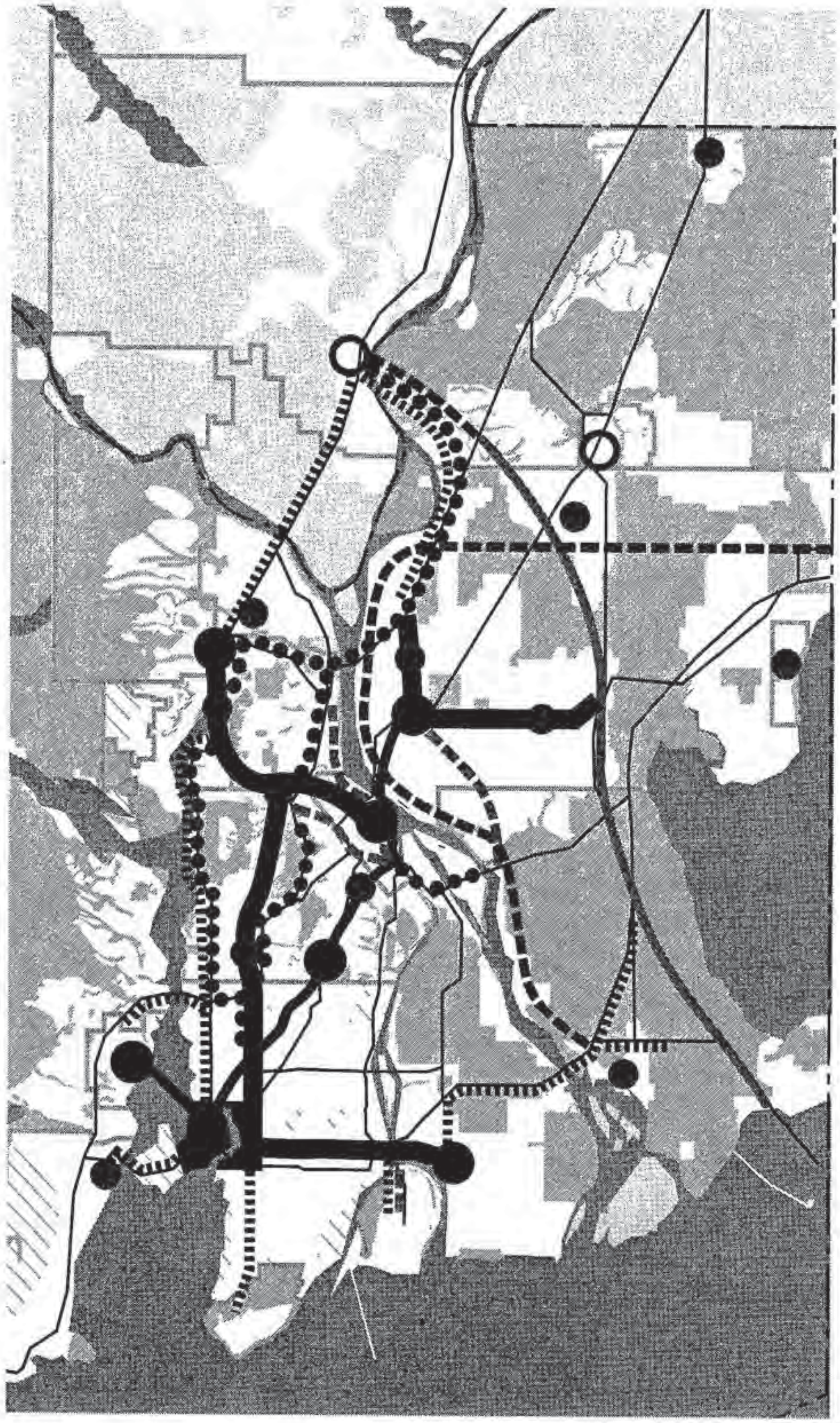
Since urban goods transport has no practical alternative to trucks, a policy of selectively increasing congestion should also protect trucks from being caught in queues, e.g. by separating truck flows from mixed traffic—although practical opportunities for doing so may be limited.

4. Supply Transport Capacity

Historical Spending
In the 10 years ending 1992, local and provincial governments together spent a total of **$3.3 billion** (in $1992) on transportation capital works in the B.C. Lower Mainland.

The fourth and final policy lever is to build more transport capacity. Clearly, availability of funds is a key constraint. Given the declared goals and objectives for the transportation system, TRANSPORT 2021 has taken the following approach:

- support the GVRD's Livable Region Strategy by increasing relative accessibility in areas where the land use plan calls for greater densities, and reducing it elsewhere;
- estimate the demands for transportation capacity which remain after the application of the first three policy levers;
- restrain the single-occupant vehicle by supplying more physical capacity for this mode very selectively; and
- emphasize transit and high-occupancy vehicles.



Livable Region Strategy Concept

Transit service in dense urban areas

The relatively high target population densities within the Burrard Peninsula, the North East Sector (Coquitlam, Port Coquitlam and Port Moody) and North Surrey create an opportunity for transit. The concept for the year 2021, therefore, is a transit system which has better coverage over these areas, permitting travellers to connect between several origins and destinations without having to travel via the downtown hub. Accordingly, the concept for the year 2021 shows an intensive pattern of transit services in these areas.

High-occupancy Vehicles

The approach points to a network of High-occupancy Vehicle (HOV) lanes, offering travel time advantages for HOVs, together with queue-jumping facilities to give priority at bridge heads. Each specific application of HOV facilities will require a further, complete assessment in order to determine its practicality.

Bridges and tunnels

The choke points of the bridges and tunnels across the Fraser River and across Burrard Inlet would be used to "draw the line" and limit access by the single-occupant vehicle.

Within areas of rapid population growth, considerable new local road construction will be necessary to accommodate mixed traffic.

The long-haul vs. commuter traffic conflict

Certain roads intended as long-haul links with other parts of the Province—such as the Trans Canada Highway between the Port Mann Bridge and Chilliwack—are encouraging urban sprawl and are losing their function for long-haul traffic.

Deterring solo-commuting from valley towns

The solution to this problem is to reverse past practice and limit all single-occupant long-haul commuting from the valley towns, e.g. through deterrent tolls or traffic lights at on-ramps.

What Will The Plan Achieve?

Extensive computer modelling by the project indicates what the recommended plan will achieve. The following figures should be read as showing the magnitude and general direction of change, rather than precise data.

Impact on passenger transport

Under the recommended plan, in the year 2021,

- the total number of people travelling in the rush hour by all modes would be 80% higher than in 1991;
- the number of people driving in rush hour would grow more slowly, being 60% higher than in 1991 but lower than the trend for 2021 by some 13%;
- the 30-year trend growth in the number of rush hour car drivers would be reduced by one third;
- the number travelling as car passengers in the rush hour would double by 2021; the number would be 3% higher than trend (but notable because there are 13% fewer cars for them to ride in, compared with trend);
- the number of transit riders in the rush hour would be 160% higher than 1991 and 59% higher than trend in 2021;

Reverses transit decline and car occupancy decline

- the share of the total rush hour travel served by transit, currently 13%, would rise to 18% reversing the projected decline; and
- the plan would also reverse a projected decline in the number of people carried per car in the morning rush hour.

Reduces car dependence; better access to rapid transit

The region would become less dependent on the automobile. The car would continue to be the largest single mode of transport, but the percentage of car drivers would fall.

Access to transit service would be improved, with four times the length of rapid transit services in place; population living within 1 km of a rapid transit line would increase from 8% to 30%.

Local air pollutants down

Emissions of local air pollutants—carbon monoxide and smog-forming contaminants (oxides of nitrogen and volatile organic compounds) of which vehicles are the primary source—are projected to decline to 1/3 of current amounts, due mainly to better engine technology and enforcement, and partly to a reduction in automobile dependence. This is a major contribution towards reaching and maintaining the GVRD's Creating Our Future goal of a 50% cut in these emissions.

Global air pollutant up

Fossil-fuelled engines emit carbon dioxide (CO_2), generally accepted to cause global warming. The provincial and national target is to stabilize CO_2 emissions from all sources (home heating, transportation, power generation, waste incineration, etc. combined) at 1990 levels by the year 2000. Transportation is not the primary source of CO_2, emitting less than a sixth of province-wide or a quarter of Canada-wide CO_2.

Vehicles in the Lower Mainland will themselves not achieve the target for all sources combined; their CO_2 emissions will likely rise 10% in the 1990s and climb thereafter: a 15% to 20% increase by 2021 is projected under this plan, compared with 25% to 30% under trend conditions.

Speed down, congestion worse

However, congestion would worsen on the roads. While average speeds would decline (by 3%), the congestion seen today would be more widespread, affecting more roads.

Impact on goods transport

Inevitably, trucks would be caught in this congestion; the extra congestion costs for trucks in the Lower Mainland would be $185 million per year or some $70 per capita per year—a cost which truckers can be expected to pass on to their customers where they can. These costs are significant, but they are not intolerable.

Only with a completely separate circulation system, which would be difficult to justify economically, would the goods movement system be unaffected by general traffic congestion.

Capital cost and affordability

An important test of the transport plan is its affordability.

With budgets under pressure, governments in other provinces of Canada and in other countries are turning to private sources of capital, using dedicated tolls or other user charges to pay interest and debt charges. The Government of B. C. has announced a Transportation Financing Authority intended to operate along these lines.

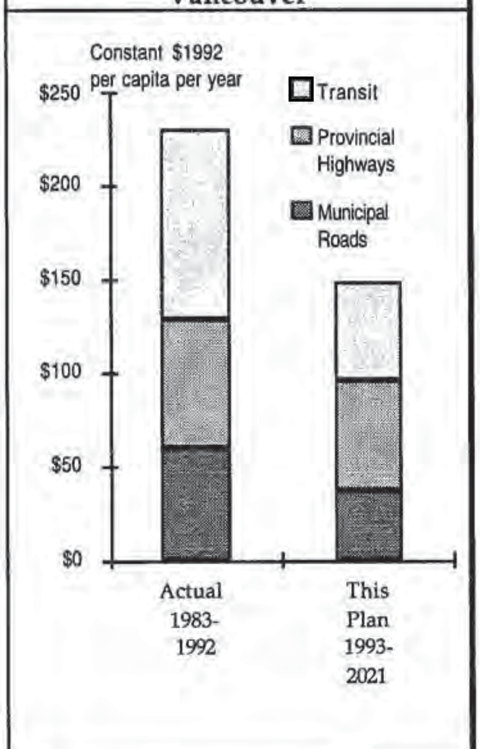
Preparing a financial plan goes beyond the terms of reference for TRANSPORT 2021; but the plan is considered affordable.

The estimated capital cost of this plan through to the year 2021 is $10 billion in 1992 dollars:-

Projected Public Sector Capital Expenditures
on Transportation in Greater Vancouver
for the period 1993 to 2021, in 1992 dollars

Transit	$3.6 (36%)
Provincial Roads	$3.9 (39%)
Municipal Roads	$2.5 (25%)
Total	$10.0 (100%)

Road and Transit Capital Expenditures in Greater Vancouver



A useful measure of the size of transport investment is the per capita annual capital expenditure for the region, in real terms (see chart on left), actual historical vs. this plan.

To pay for the total $10 billion in future transport investment identified above, the plan would require about two thirds of the historical amount— $149 per capita per year compared with $231 over the past decade—to be sustained through the period 1993-2021.

This suggests that the magnitude of investment is not unreasonable.

Further, even if past sources of funds were not available at all, it is projected that the capital expenditure could be financed through new revenues generated from the transportation demand management measures—tolls, gas taxes and parking taxes.

Using traffic volumes projected in the year 2021, but at current dollar prices, one estimate of the cash revenue flowing to government is as follows:-

$1 billion/year revenue from demand management in 30 years

Projected Revenue Generated in the B.C. Lower Mainland in the Year 2021 from Transportation Demand Management under the TRANSPORT 2021 Long-range Plan	
	Millions of 1992 dollars per year
Bridge Tolls	$540
Gas Taxes	$483
Parking Taxes	$65
Total	$1.1 billion

Supposing that (a) transportation demand management revenues are phased in uniformly from zero in 1992 to $1.1 billion in 2021, and (b) capital expenditures are made in equal annual amounts per year, to total $10 billion by the year 2021, then the accumulating debt service charges are about equal to the projected revenues in any given year (conservatively amortized over a relatively short 30-year life and at relatively high 10% real annual interest).

This is the second test of affordability of the plan; all of the capital cost of the proposed transportation system could indeed be financed by the revenue from demand management.

Conclusion

In conclusion, the recommended long-range transport plan broadly meets the test of its own objectives.

To obtain these results it is crucial that all policy levers operate successfully.

Unexpected and unforeseeable developments over the next 30 years could mean that some of the underlying assumptions will not hold true. Accordingly, the project has also considered how best to make the plan robust and flexible.

Keeping Options Open

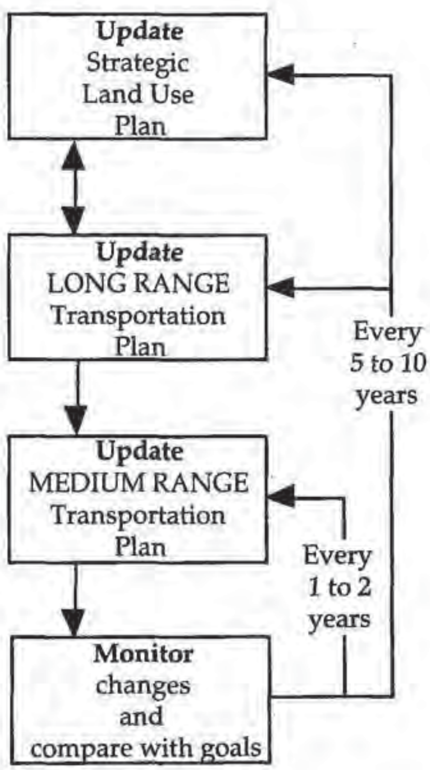
A particular source of uncertainty is the region's success in attaining the required targets in the management of (a) urban growth and (b) transportation demand. The transport plan will require amendment if its assumptions in these areas are not borne out.

Default is more roads

In both cases, the system would tend to follow "business as usual", i.e. towards more suburban and ex-urban development, less transit use, more automobile dependence and the need for more roads.

First, options to use transport corridors not in the long-range plan must be kept open. While this Report does not recommend that facilities be built in such corridors, they may be needed in light of the above uncertainties, either within the 30-year horizon or beyond it.

Therefore, the Steering Committee believes that agencies such as the Ministry of Transportation and Highways should continue to preserve options for routes and corridors, as they see fit within the limits of their regulatory powers. This is a fully legitimate activity of agencies charged with responsibilities to provide for the long-term needs of the region and the Province. It does not conflict with the Committee's long-range transport plan.



Second, the plan must be a "living document", regularly updated. A stable planning cycle would:

- cover all modes of transportation, goods and passengers;
- integrate land use planning with transportation planning, with the transport planning being based on local, regional, provincial and national transport goals and objectives;
- be methodical and have continuity, being able to monitor the transport system and maintain records of data, past strategic thinking and decisions; and
- be associated with a sustained, predictable funding basis to support the required capital projects.

This means establishing a regional transport planning cycle and identifying a responsible body, able to recognize and respond to structural changes and surprise events.

A steady, consistent focus, and coordinated implementation of the policies, which are the responsibility of many groups, will be vital if the Province and local governments are to achieve the goals and objectives they have set out for Greater Vancouver's transportation system.

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Appended: Consolidated List of Recommended Policies

The following pages present a consolidated list of all the recommended policies of TRANSPORT 2021, drawn from the Long Range Transportation Plan.

Consolidated List of Recommended Policies

Most policies require joint or parallel actions by the Province and local governments together. The term "**governments**" as used below means the Government of British Columbia and local governments.

1. Land Use Policies

1.1 The GVRD should pursue the completion of its Livable Region Strategy as a reference point for all public and private sector agencies which have an influence over urban development.

1.2 The Strategy should allocate growth and concentrate development in multi-use activity centres and high-density development corridors.

1.3 The Strategy should define areas of higher density which will be targeted for intensive transit service by the transport plan.

1.4 The Strategy should identify towns outside the urban area which are (a) intended to become more complete and self-sufficient and therefore (b) through transportation and other policies, to be discouraged from becoming suburban "bedroom communities" with easy commuting into the metropolitan core.

Local friendliness to walking, cycling and transit

1.5 Near and within all activity centres, the Strategy should propose a range of housing, within a pedestrian- and bicycle- friendly urban design, both by construction of new centres and by re-development of existing ones.

1.6 Municipalities should provide a transit-friendly local street pattern allowing transit routes to pass within walking range of a large proportion of dwellings, job sites, schools, shops and other activity centres.

1.7 Municipalities should develop bylaws and guidelines to help attain long range transport goals at both regional and local levels, including retrofitting neighbourhoods which currently have street patterns which are difficult to serve by transit.

Coordination of Official Community Plans

1.8 Governments should provide a framework whereby municipal land use plans are effectively coordinated in a sustained fashion over several decades, using the GVRD's Livable Region Strategy as reference point; neighbouring regions and their member municipalities should be included in this process.

2. Demand Management Policies

2.1 Governments should regard Transportation Demand Management (TDM) strategies as an integral part of transport planning in the B.C. Lower Mainland.

2.2 Governments should use TDM as the primary public policy instrument to restrain growth in travel by the single occupant automobile.

2.3 Governments should wherever possible exempt urban goods movement, which has no practical choice other than truck, from the policy of auto restraint.

2.4 Neighbouring local governments which feed traffic into Greater Vancouver should be asked to respect and support the TDM policy by encouraging transit and carpool traffic, and discouraging single occupant commuter traffic into/out of Greater Vancouver.

2.5 Governments should generally use "carrot" measures (persuasion and incentives) to achieve objectives before using "sticks" (penalties and disincentives); however, since "carrot" measures alone are not likely to effect significant change, "stick" measures will be required.

Telecommuting

2.6 Governments should encourage businesses to adopt telecommuting by devising a framework of fiscal incentives, justified on the basis of saved or postponed infrastructure investments that would otherwise be required.

Employer trip reduction

2.7 A regional agency, to be identified, should foster employer trip reduction programs, which look to medium and/or large scale employers to take action to reduce the number of commuter vehicles serving their worksites. The agency should provide support by information and public awareness campaigns, a regional ride-share match-up programme, and other advisory services which encourage employers to participate.

2.8 Governments should leave voluntary the employers' participation in trip reduction programs, i.e. not require it by law, to avoid regulatory imposition on employers and associated public sector administrative costs (with the exception of policy 2.16, below).

HOV/Bus priorities

2.9 Governments should recognize provision of HOV lanes and bus priority measures as necessary and mutually reinforcing with TDM, to provide more time-competitive alternatives over the single-occupant vehicle.

Road pricing, tolling and gas tax

2.10 The Province should introduce road pricing measures or tolls structured to reduce congestion, provide clearer price signals to users for the costs they incur and impose on others, and to raise revenue for transportation improvements.

2.11 The Province should apply road pricing/tolls with the long run purpose of shaping travel demand in addition to obtaining revenues. The Province should not remove tolls unless it is clear that the external costs of the automobile have otherwise been accounted for and are recognized by the user.

2.12 The Province should dedicate toll revenues to system-wide transportation improvements, including transit/HOV improvements, retrofitting infrastructure to withstand earthquakes, rehabilitation of deteriorating facilities and construction of new facilities.

2.13 Governments should institute methods of converting fixed costs of auto ownership/operation to variable costs, where practical (e.g. pay-as-you-drive insurance).

2.14 The Province should increase gas prices, though these are a "blunt" instrument with more merit as a revenue-generating measure than as a demand management measure.

Parking management

2.15 Governments should use parking management as a TDM instrument. The provision of parking should be coordinated throughout the urban area, e.g. through a regional focal point recommended under "coordination" below. A comprehensive parking strategy is required covering short and long term, park-and ride, public and private, supply and price considerations.

2.16 Governments should phase out subsidized parking for commuters e.g. by means of municipal bylaws requiring employers who wish to provide free or subsidized parking to employees also to offer those employees the option of the equivalent value in cash and/or travel subsidy.

Coordination

2.17 Governments should identify a regional focal point for coordinating TDM. This focal point, which could be a coordinating committee of principal agencies, should function with a mandate to monitor impacts, detect conflicts and coordinate TDM in the region among the agencies responsible for implementing the measures.

3. Service Level Policies

Single-occupant vehicles

3.1 Until road pricing or an extensive tolling system is instituted, governments may have to accept worse congestion for single-occupant vehicles in the peak period as a necessary evil to encourage other travel options, notably transit and carpooling.

Trucks

3.2 Governments should permit truck traffic to escape the auto congestion/auto restraint policy wherever feasible by separating truck flows from auto flows, consistent with cost effectiveness.

3.3 Governments should develop minimum service level standards for major truck links to trigger action for improvement if service drops below the accepted level.

Long-haul and inter-regional traffic

3.4 Governments should maintain a high level of service for traffic moving between the Lower Mainland, the U.S. and other parts of B.C. This will require a lower level of service for long-haul commuters by car into the urban area by restricting their access to interregional facilities.

4. Transport Supply Policies

Transit

4.1 Transit providers should add high quality, fast, frequent services linking facilities linking regional town centres.

4.2 Transit providers should offer a family of local transit services, including para-transit and flexible-route transit services, to serve demand for different time periods and different markets.

4.3 Transit providers should place priority on improving local transit services in designated urbanized and denser-developed areas within the compact metropolitan area.

High-occupancy vehicle (HOV) and bus priorities

4.4 To make best use of existing investment, the governments should re-allocate existing roadway capacity to maximize people-carrying capacity, not vehicle-carrying capacity, and take into account the expected number of passengers per vehicle rather than the number of seats.

4.5 In particular, where congestion is not serious and where operationally feasible, the governments should provide HOV capacity by removing mixed traffic or parking lanes from the existing system; where this is not operationally feasible, it will be necessary to construct new HOV facilities.

4.6 The Province and municipalities should install bus/HOV priority measures, wherever an advantage for transit can be demonstrated, and accept that a time penalty to other road users may occur.

4.7 On regional roads intended for inter-regional and regional traffic as opposed to local traffic, the Province should provide new capacity preferably by new HOV facilities, recognizing some mixed traffic capacity expansion may be necessary.

4.8 The Province and municipalities should consider opening HOV lanes to trucks and other mixed traffic in the off peak period, provided that the performance or safety of transit is not compromised.

Single-occupant vehicle restraint

4.9 Governments should follow a single-occupant vehicle restraint strategy, consistent with the regional objective of reversing the past priorities among the transport modes, increasing the choice of modes available, complementing the TDM policy and allowing investment in transit to be maximized.

4.10 In particular, on regional facilities within the urban area, the Province and municipalities should not increase mixed traffic peak hour capacity, except for the limited increase resulting from displacement of HOVs into new exclusive HOV lanes.

Inter-regional road traffic and goods movement

4.11 The Province and municipalities in both the GVRD and neighbouring regions should do everything within their power to limit the use of interregional, long haul roads for commuting, which may involve restriction at the point of access from valley towns onto the long-haul facilities.

4.12 Governments and transit providers should facilitate the transfer of passengers between long haul transport and regional transit services to promote the movement of passengers by non-auto modes (e.g. buses to airport, ferry terminals, bus priorities internally).

4.13 The Province should designate interregional roads which are to be protected from congestion by long-haul commuter traffic.

4.14 The Province should make the necessary legislative changes to permit transportation corridors to be reserved, especially for the purposes of inter-regional travel.

5. Policies for Keeping Options Open

5.1 All parties should regard the preservation of future potential corridors, even though such corridors are not recommended for functioning transport facilities under this long range plan, as a fully legitimate activity of responsible agencies in order to keep options open and deal with the uncertainties of the future.

5.2 The agencies responsible for transport facilities should continue with those activities required to define, assess and protect long range options in support of continuous planning.

5.3 The Province and local governments should establish a stable planning cycle covering all modes of transportation, passenger and goods movement, which fully recognizes the interaction between land use and transportation.

* * *

Preface

TRANSPORT 2021 and its Objectives

This Report is part of the output of TRANSPORT 2021, a joint, two-year project funded equally by the Province of British Columbia and the Greater Vancouver Regional District (GVRD).

The objective of the TRANSPORT 2021 project is:

"based on
the GVRD's Creating Our Future action plan,
its Regional Strategic Plan and
the mission statements of the Ministry of Transportation and Highways and B.C. Transit,
to recommend,
by the end of 1993,
a long-range transportation plan for Greater Vancouver,
with associated policies, demand management measures and priorities for transportation investment."

The project is guided by a Steering Committee of senior staff officials from provincial and local governments, with observers from the federal government and neighbouring regions.

Related Strategic Plans

The GVRD's Regional Strategic Plan for managing growth is incorporating the TRANSPORT 2021 Long-range Plan as its transportation component. The two plans are concurrent and interactive; in particular they consider the interaction of land-use patterns and transportation services. The two projects also conduct a joint public communications programme.

A province-wide transport plan is being assembled by the Government of B.C.; the TRANSPORT 2021 long-range plan contributes to its B.C. Lower Mainland portion.

Also concurrent is the GVRD's Air Quality Management Plan, which shares analysis and findings with TRANSPORT 2021.

About This Report

This Report presents all the elements of a 30-year transportation plan for Greater Vancouver. It contains the principal findings and long-range recommendations of its authors, the TRANSPORT 2021 Steering Committee.

Addressed to the GVRD and the Province of B. C. as the project's joint sponsors, this Report is also a public document intended for all groups interested in the future of the transportation in the B.C. Lower Mainland.

Contents

First, the Report provides a snapshot of the region's transportation system as it exists today. It explains **why** action is necessary. It finds that the system is following undesirable trends—i.e. increasing dependence on the automobile coupled with sprawling urban growth— which lead away from the region's declared values and aspirations. Next, the Report outlines in detail **how** an alternative future can be achieved. It presents methods for governments to swing the current trends around to a more desirable direction. It recommends a strategy, in the form of transportation policies and capital improvements (such as transitways, high-occupancy vehicle lanes and new road links) expected to be needed within 30 years.

The Report then describes **what** would be the result of such a strategy over the next 30 years—i.e. as measured by transport service, cost and livability parameters, and demonstrates that the plan is a preferable direction. The analysis is based on the project's research program guided by regional and provincial goals. The result is presented both as a transportation vision and as a target for the year 2021.

Note that the Report does **not** identify **when** actions should be taken. This report describes an "end state" and makes no comment on priority or timing. Investment priorities and phasing recommendations are presented in the project's **medium-range** plan. [18][1]

Nor does the Report detail changes in the **institutional** framework which would be required to make the plan function effectively—though it does indicate areas where improved coordination will be essential; it concludes by identifying **who** will have to act; it lists the commitments required from partner agencies in order to bring the Long-range Plan to reality.

Finally, the Report does not present a **financial** plan, although it does estimate **capital** costs and indicates the **affordability** of its recommended future transport system.

Public communications

Public communications activities undertaken in the course of the project are described in Appendix 1. Appendix 2 contains a list of publications, including a series of technical papers and research documents.

[1] Square brackets [ ] contain the number of a TRANSPORT 2021 Working Paper which contains more details. Working Papers are listed at the end of Appendix 2.

Steering Committee Members

B. E. (Ben) Marr, GVRD Regional Manager and Chair, TRANSPORT 2021 Steering Committee

J. D. (Doug) Allan, Municipal Manager, District of West Vancouver

R. W. (Bob) Collier, Municipal Administrator, Corporation of Delta

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A. Where Are Current Trends Leading?

Today's System

A Day's Travel
Currently, on a typical day the people of Greater Vancouver journey 3 1/2 million times (or 83%) by **PRIVATE CAR**, 1/3 million times (or 9%) by **PUBLIC TRANSIT** and nearly 1/3 million times (or 8%) by **FOOT** or **BICYCLE.** ——— Travel is uneven throughout the day, with the **morning peak period** (6 to 9 a.m.) and the **afternoon peak period** (3 to 6 p.m.) together accounting for **over 40%** of all vehicle trips.

Today 1.6 million people and 1 million motor vehicles—cars, buses, trucks, trains and vessels—circulate over Greater Vancouver's 10,000 km network of roads, trackage, and ferry lanes.

The system permits people to reach work, school, shopping, recreational, cultural and sports events, and to visit friends and family; employers to access a supply of labour; and goods to be sent and received in the course of domestic and international trade.

A transport system is basic to any urban area. Along with the telephone system and other means of communication, it makes possible constant exchanges of goods, services, and information among people—planned and unplanned—which are the essence of a city. The benefit and very purpose of a transport system is to make such exchanges possible.

The benefit is very large and hard to measure. However, it comes at a cost, at least part of which can be measured.

For instance, in the B.C. Lower Mainland, the current cost to vehicle owners of owning and operating the 1 million vehicles is about $4.3 billion per year.

The additional cost of providing "free"parking for them at residences, work places and other locations is about $600 million per year; roads cost some $600 million annually to build and maintain; and the "external" costs of accidents, air and other pollution have been estimated at a further $2 billion per year. This excludes the value of land occupied by the roads and other rights-of-way and the value of the personal time that people spend in travelling about.

One estimate [11][3] places the full annual cost of transporting people within the B.C. Lower Mainland at nearly $14 billion (of which $5 billion is the value of personal time), a figure which includes tangible and intangible costs borne by users and non-users.

[3] Square brackets [ ] contain the number of a TRANSPORT 2021 Working Paper which contains more details. Working Papers are listed at the end of Appendix 2.

Most of this is accounted for by the car and other private motorized transport. Public transit accounts for about $1 billion of the total annual economic costs. Non-motorized transport (by cyclists, pedestrians and telecommuters) represents a tiny proportion of the total.

In addition, the cost of moving **goods** within the region—primarily by truck—is about $2 billion annually. [7]

Trade Gateway Function

The region is B.C.'s main provincial distribution centre and is home to Canada's primary airports and seaports for Pacific Rim trade. Other regions in the Province and other areas of Canada depend on parts of Greater Vancouver's transportation system for their livelihood. Effectively, the region sells transport as a service to customers outside its boundaries.

This gateway function directly employs 30,000 people; when indirect and induced employment are added in, it generates some 60,000 to 90,000 jobs in the region, or roughly 8% to 12% of total regional employment. [8]

The region's role as a gateway therefore represents both an obligation and an opportunity for its economy.

Expectations and Goals for the Transport System

As one of the vital organs of the region, the transport system is expected to help achieve the region's values and aspirations. [1][4]

For instance, it is expected to provide the required mobility and accessibility for the economy, while simultaneously reducing its negative impacts on livability and the environment. It is asked to:

- support the regional economy by providing a **wide range of effective, efficient, safe and reliable** transportation services for goods and people; and, in particular,
- **serve a rapidly growing and diverse population** which is spreading south and east up the Fraser Valley away from the metropolitan core; and
- **limit disruption** of neighbourhoods caused by through-traffic; **minimize intrusion** of new roads into agricultural land and other green spaces; and **cut down polluting emissions** into the atmosphere.

Further goals and objectives for the transport system are to:

- help **contain urban sprawl**, shape urban structure and conserve the land resource;

[4] The TRANSPORT 2021 Working Paper titled "Goals, Objectives and Criteria for Developing a Long Range Transportation Plan for Greater Vancouver" contains a comprehensive statement of these objectives, based on the GVRD's Creating Our Future statements and the mission statements of the Ministry of Transportation and Highways and BC Transit.

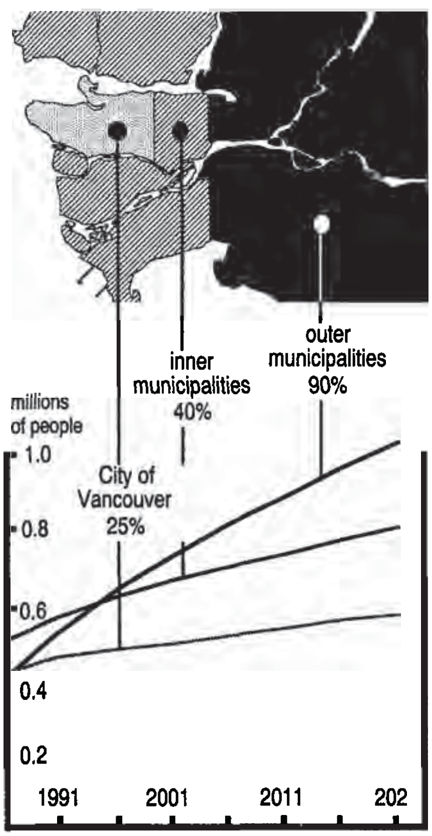
- **offer equitable service** to all citizens in all geographic areas; and
- **generate public-sector revenues**, reduce subsidies, live within tight public-sector financial constraints, and ensure that limited capital resources are deployed most effectively.

The above goals and objectives represent what is at stake—**why** transport policy makers pay attention to the transport system. This Report recommends **how** it could be changed to achieve the goals.

"Business As Usual" Consequences

The "Do Nothing" Option

Projected Trend Population Growth 1991-2021



But first, to place the current system in context, it is useful to explore:

- what will happen **if no changes are made**, i.e. under current trends, policies, habits and practices;

and, in particular,

- whether the goals and objectives can be achieved **without** a change in direction.

Population growth: basic force

One of the most basic forces propelling change in the B.C. Lower Mainland is growth of population.

According to census data, in the 20 years between 1971 and 1991:

- the region's total population grew by nearly 50%, with slower growth in the City of Vancouver than in other parts of the region and
- families shrank in size: the average number of people per household dropped by nearly 20%. That means that the number homes was growing faster than the number of people.

South-eastward sprawl

In more recent times, heavy growth has been seen in outer suburbs such as the North East Sector[5], Surrey, Delta, White Rock, Langley, and Fraser North[6]. In the 5 years through 1991, their population grew at 2 to 4 times the rate of the inner areas such as Vancouver City, the North Shore, Burnaby and New Westminster.[7]

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[5]In this Report, the term "North East Sector" means the municipalities of Coquitlam, Port Coquitlam, Port Moody and the Villages of Anmore and Belcarra.

[6]"Fraser North" means that part of the B.C. Lower Mainland to the east of the Pitt River and north of the Fraser—including Pitt Meadows, Maple Ridge and Mission.

[7]1992 Greater Vancouver Travel Survey.

In the 30 years ending in the year 2021, the population of the B.C. Lower Mainland is expected to grow by a further 70% to reach nearly 3 million. Unless current travel habits change, the number of road vehicles will double to 2 million.

If trends continue, by 2021 the outer municipalities will see population growth of over 90%, the more mature inner municipalities of 40% and the more densely-settled City of Vancouver by 25%—i.e. a major decentralization of homes.[8]

Trends in employment

In the 20 years between 1971 and 1991:

- the number of people available for paid work (i.e. the labour force) grew by 72%—faster than the population in the same period, due in part to the greater participation of women.
- the number of actual jobs (i.e. employment) grew even faster, by 84%. That means that the demands on the transportation system—from people travelling to work—also increased faster than the population.

Suburbanization of jobs

More recently, the wave of employment growth is also spreading south and east, but it is behind the wave of population growth. In the five years through 1991:

- the fastest job growth was recorded in Richmond, the North East Sector, Surrey, Delta and White Rock and Burnaby, all of which saw 30% to 50% increases; while
- Vancouver City, the North Shore and Fraser North saw almost no increase in jobs.

Common to other metropolitan areas

Greater Vancouver is not alone in experiencing suburban growth; the pattern is well established in many similar-sized and larger metropolitan regions in North America, being typically more advanced than in Greater Vancouver.

In some regions with lower regional growth pressures (e.g. Montreal), the urban core and inner suburbs are actually de-populating in absolute terms even as the suburbs grow; this is partly caused by the shrinking size of families, which therefore occupy a larger number of homes.

Employment projection

Under current trends, the number of jobs in the Lower Mainland is expected to rise nearly 90% from 0.77 million in 1991 to 1.45 million in 2021.[8]

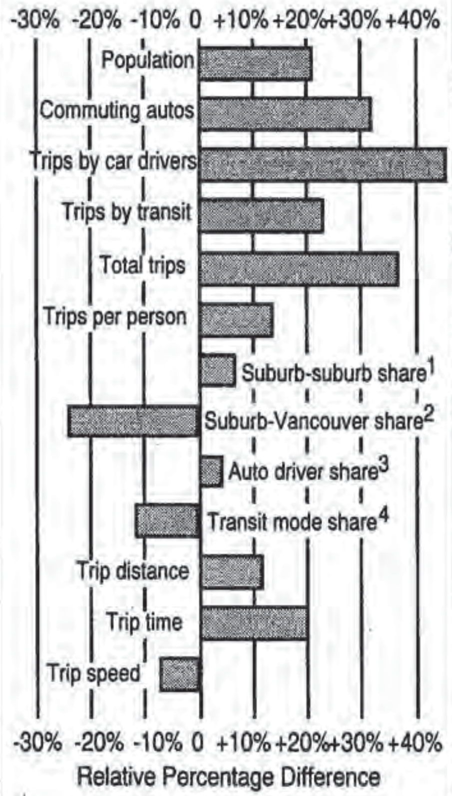
[8]GVRD Strategic Planning Department. Population, Household, Labour Force and Employment Projections for the Metropolitan Vancouver Region: 1991 to 2021.

Service sector jobs are expected to grow fastest; for instance, finance, insurance and real estate and commercial services are forecast to increase by 100% to 120%; primary industry and manufacturing jobs are projected to grow more slowly, in the 30% to 60% range over the 30-year period.

Recent travel patterns

The GVRD conducted surveys on travel in the region in 1985 and 1992. There were notable changes in the critical morning peak period (6 a.m. to 9 a.m.), partly the result of the demographic trends described above.

Changes in Key Transportation Characteristics in the morning peak period in Greater Vancouver 1985-1992



1. Change in the share of total trips which begin in one suburb and end in another.
2. Change in share of total trips which end in Vancouver City.
3. Change in the share of total trips which are undertaken by car drivers.
4. Change in the share of total trips which are undertaken by transit passengers.

Source: 1992 Greater Vancouver Travel Survey—Comparisons of Travel Demand Characteristics, 1985-1992.

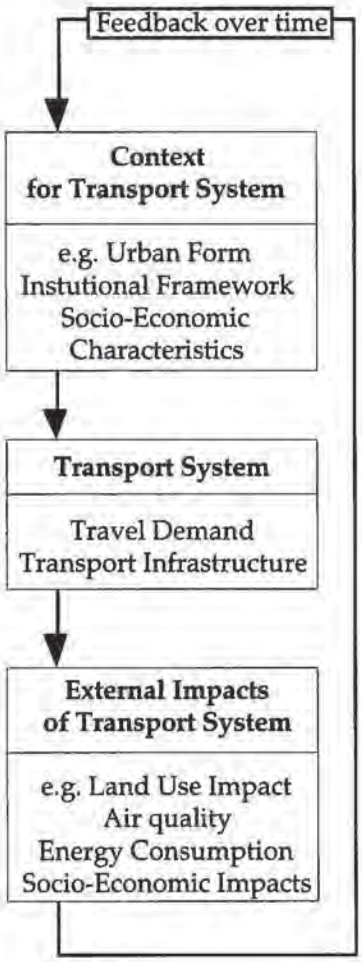
In the period 1985 to 1992:

- **travel grew faster than population:** although population grew by 21%, the number of trips made in the peak period grew by 37%;
- **transit lost ground:** transit's region-wide share of the travel declined by 1.3 percentage points (from 11.2% to 9.9% of the total number of peak period trips); for the portion of travel ending in downtown Vancouver, where transit is traditionally strongest, transit's share dropped proportionately more, by 2.2 percentage points (from 35.3% to 31.2%);
- **automobile dependence increased:** the share of all trips represented by automobile drivers increased by 2.3 percentage points (from 54.3% to 56.6%), while the share of trips represented by automobile passengers fell by 0.2 points (to 16.7%). That means that the average number of people in a car went down. The number of automobiles registered with the Insurance Corporation of B.C. for commuting to work grew by 32%—or one-and-a-half times the rate of growth of the population;
- **suburb-to-suburb travel dominated further:** trips with suburban destinations gained 4 percentage points to 64.4% of total trips in the region; trips with suburban origins to the City of Vancouver declined by 2.9 points, to 12.0% of the total trips in the region; and
- **people travelled further and slower:** the average trip distance to work increased 12% to 14.0 km; the average trip speed declined by 7% to 34.7 kph; and the average trip time increased by 20% to 24 minutes.

Outlook for travel patterns

- Based on survey results, the long-range pattern of suburbanization of homes continues to alter travel into a **less-focussed travel pattern**, which is more difficult to serve with conventional core-oriented transit services. Despite major transportation infrastructure investments in the 1985-1991 period, transit usage has not kept pace with automobile usage. The region **remains automobile-dependent, and that dependency is growing.**

- In 30 years, trends point to many **more unfocussed suburb-to-suburb** trips which are difficult to serve well with conventional public transit.
- Computer simulations of travel patterns reveal that current demographic trends, land development and transportation policies will further **erode transit's market share, for a drop of several more percentage points** over the next 30 years, with a corresponding increase in the share of the automobile.
- To keep congestion at bay under trend conditions, a **large road building programme will be required.** One measure of the increase is the number of traffic lanes required on bridges and tunnels to cross the region's major water bodies. Computer simulations indicate this number would increase from the current 47 road lanes of capacity to a total of 85 lanes by 2021. [13]



In reality, such trends are unlikely to continue unchecked. The people and the institutions of the region will adapt and intervene to cause changes in direction to occur.

This self-correcting process is illustrated on the left. The physical, social, environmental and economic context within which the transportation system operates is itself changed over time by the external impacts of transportation.

This Long-range Plan is itself part of the feedback loop, identifying the conflicts with society's goals and proposing changes to the system and the context in which it operates.

Conflict with Goals

The goals of the region expressed in the GVRD's "Creating Our Future" programme call for more reliance on walking, cycling and transit, and place the automobile lowest in priority.[9]

The loss of transit share, increase in auto dependence and implications for major road building is **contrary to those goals.** The current trends were discussed and rejected at a public conference held in May 1992.

Air quality trends

Air pollution is one of the external impacts which TRANSPORT 2021 is specifically asked to address in its terms of reference.

The GVRD "Creating Our Future" goals call for a reduction of 50% in the emitted tonnage of five named atmospheric pollutants

[9] GVRD. Creating Our Future, 1993 (adopted by the GVRD Board of Directors on 26th February, 1993)

by the year 2000 (compared with a base year of 1985). Based on emissions calculation undertaken for TRANSPORT 2021, this goal is within sight.

Motor vehicles currently account for 2/3 of total emissions of five major **local air pollutants** (oxides of nitrogen, oxides of sulphur, volatile organic compounds, carbon monoxide and particulate matter). Two of these—oxides of nitrogen and volatile organic compounds—are precursors to the formation of smog. Motor vehicle emissions of particulate matter and carbon monoxide are also of concern to the region's air quality.

Despite traffic growth, the offsetting effects of less-polluting and more fuel-efficient new vehicles will cause a net decline in emissions; in particular, the AirCare emission inspection and maintenance program and cleaner fuels will cause total emissions to decline, even under trend conditions—i.e. without the TRANSPORT 2021 recommendations being implemented (which, as shown later in this Report, would reduce them further).

Technical breakthroughs (e.g. replacing gasoline engines with electric batteries or fuel cells) will help further. [17]

Accordingly, the total tonnage of the five major local air pollutants (mostly carbon monoxide, but including the smog-forming compounds) from vehicles in 2021 will be lower than they are today. [10]

In addition, vehicles contribute a share of **global air pollutants** known as "greenhouse" gases, such as carbon dioxide (of which motor vehicles contribute a quarter of the total emitted, Canada-wide) and chlorinated fluorocarbons. Carbon dioxide emissions from vehicles will parallel total consumption of carbon-based ("fossil") fuels such as gasoline, diesel fuel, natural gas, propane and others, and is expected to see a net increase.

In summary

Overall, the **region is on a development path that carries it away from, rather than towards, its own declared goals.**

The trends are already established and have considerable momentum. They have been assisted by the existing transportation system, which has increased the accessibility among the various parts of the region over the past 30 years.

Changing direction will require significant changes in real estate development and investment patterns, in the behaviour of people and households, and in the priorities for public infrastructure.

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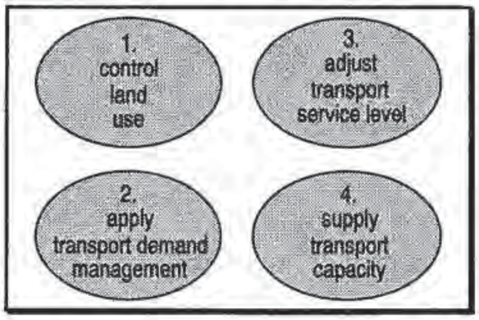
[10] Estimates provided by GVRD Air Quality and Source Control Department based on traffic projections provided by TRANSPORT 2021.

B. How Can the Trends Be Changed?

The Transport Policy Levers



Four transport policy levers are available to steer the transport system away from current trends onto a more desirable path.

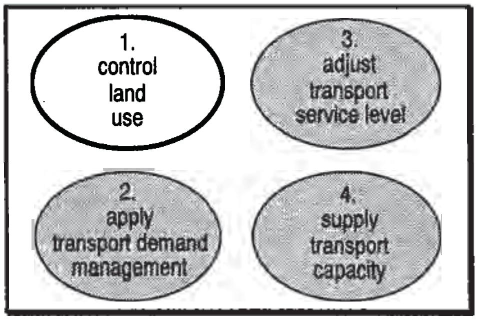
They are:

1. **Control Land-use** through planning and zoning regulations, which shape a compact urban form, resist urban sprawl, and foster pedestrian- and transit-friendly neighbourhood design.
2. **Apply Transport Demand Management**, which comprises a variety of new techniques to make better use of the existing transport system, encourages off-peak travel and discourages single-occupant vehicles, and incorporates measures such as tolls, gas taxes and parking management.
3. **Adjust Transport Service Level**, allowing more congestion for single-occupant automobiles, but making improvements in the speed and convenience of public transport and shared private transport such as car- and van-pools.
4. **Supply Transport Capacity**, by investing capital with a bias towards public transport and shared private transport, both in construction and in continuing operation, and by locating it to improve selectively the accessibility of growth centres.

The task of producing a long-range plan amounts to finding the optimal setting of these four policy levers in order to meet best the goals and objectives of the transport system.

There are **trade-offs** possible among these levers. For instance, if more money is spent on transportation capacity (lever 4), congestion could be reduced and service levels improved (lever 3). Or, if strong intervention to reshape travel behaviour is used (e.g. in lever 2 by road tolls), then investment in new capacity (lever 4) could be postponed or reduced.

This section describes the results of the TRANSPORT 2021 research program to determine <u>how</u> the levers should be used to effect a desirable shift away from adverse trends. The project has established that **all the levers must be used in a coordinated way** to be successful [14]. This Report deals with the four levers in turn.



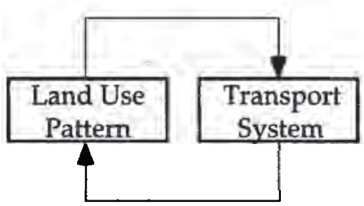
1. Control Land-use

Land-use Defined

"Land-use" means "how the land is used" and in particular what human activities, if any, are conducted in what location.

A "land-use plan" states what land is planned to be left undeveloped (e.g. in a "green zone") and what is planned to be developed or re-developed.

Knowledge of the geographical settlement pattern of people and economic activity is crucial to transport planning. It is one of the most important **drivers of the demand for travel**—how much travel is desired between any two points.



In turn, transportation investment is believed to influence land-use, by directing growth to areas which become more accessible via the new transport links. Transport shapes land-use by **selectively providing access**—good access to some areas but not to others.

Transportation is properly **only one consideration** in the development of the desired urban form. The land-use pattern is fundamental to achieving a wide range of regional objectives **other** than transport. These include preservation of open space and the land's physical characteristics such as slope and soil stability.

Relationship Between Urban Density and Mode of Transport

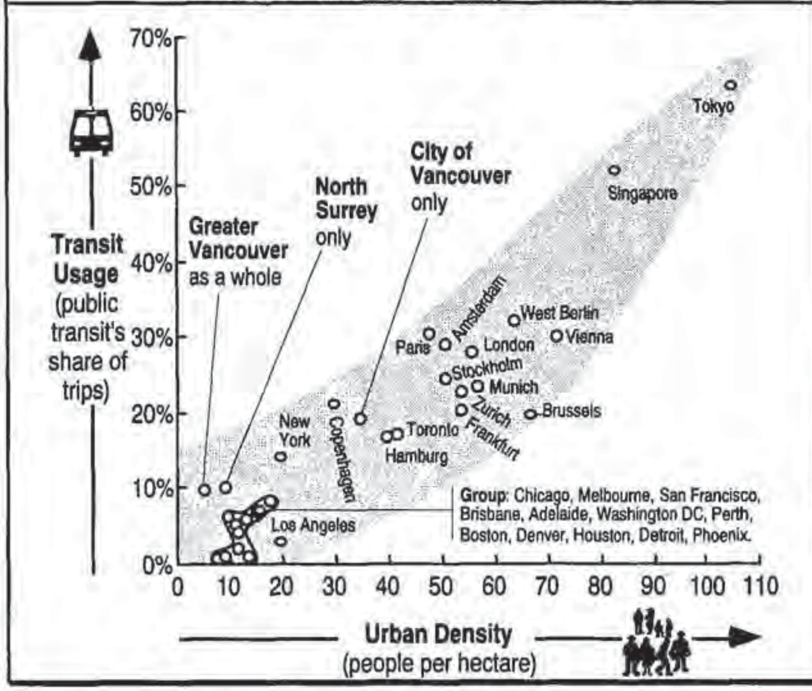
A city's reliance on different modes of transport is related to its **population density**. Less dense, sprawling cities (e.g. in the south and western U.S.) are more on automobile-oriented, while compact cities (e.g. in Asia and Europe) are more transit-oriented.

Compared with other areas in the world, Greater Vancouver is not very densely populated. Today, the region has an average of 5 people per hectare. However, particular areas within the region have higher density; for example, the City of Vancouver at 35 people per hectare is as dense as some European cities.

Given its low density, Greater Vancouver has **relatively high transit usage**, especially when compared with U.S. cities. However, the chart below strongly suggests that **greater transit usage** (i.e. moving up the chart)—which is one of the region's objectives—requires **greater density** (i.e. moving to the right).

Considering its density, Greater Vancouver has high levels of transit usage.

Transit Usage and Urban Density
for selected cities in developed countries



Source: Adapted from "Greenhouse, Oil and Cities", Peter Newman, "Futures", May 1991, supplemented with data from TRANSPORT 2021 and the Greater Vancouver Livable Region Strategy, 1993.

Livable Region Strategy for Growth Management

During 1992 and 1993, the GVRD developed a land-use strategy to h growth in Greater Vancouver. During the evolution of the strategy, the question of density came to the fore.

"Manhattan", "Bi-Polar", "Beads on String", and other options for urban structure.

Initially, some seven options for urban structure were reviewed, each with very different transportation implications. For instance, the "Manhattan" option featured a single, very powerful centre in downtown Vancouver requiring much core-focussed travel. Another called for a "bi-polar" region, with a strong Vancouver and Surrey. A third featured a series of more equal centres, "beads on a string" stretching along a southeasterly transportation corridor. Another saw self-sufficient or complete communities with relatively little interchange among them.

The list was pared to three options which were analyzed more deeply: Current Trends and Development Policies; Fraser North Corridor; and Compact Metropolitan Area[11]. These were discussed at a public conference held in Richmond, B.C., in November, 1992. While opinions were diverse, the Compact Metropolitan Area received the greatest support. Current Trends was least favoured.

Proposed more compact region

Following a series of refinements, cross-checks, and further consultations, a proposal for a more compact region emerged.

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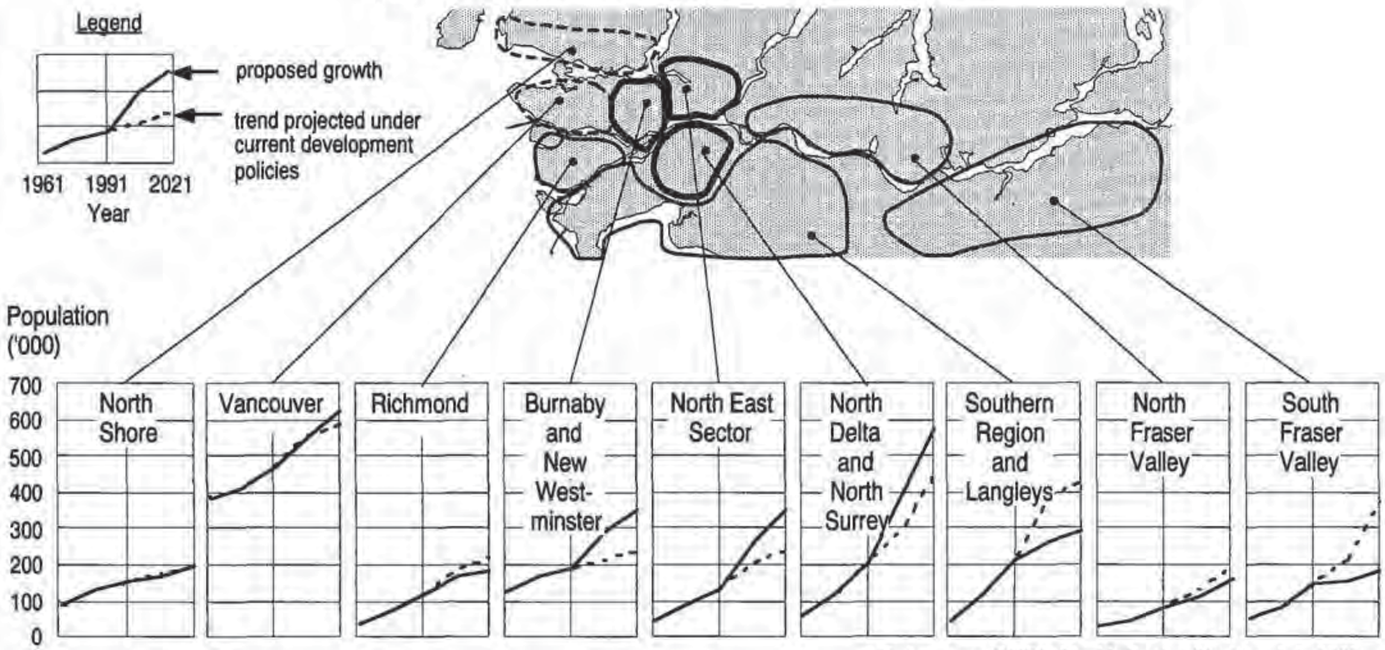
11 GVRD Strategic Planning Department. Vancouver Metropolitan Region: Options for Growth Management, 1992.

GVRD Livable Region Strategy Proposals, 1993
proposed population growth compared with trend



Data source: GVRD Livable Region Strategy, July 1993

This structure has the following features[12]:

- population growth is **close to the "business as usual" trend** for the North Shore and the City of Vancouver;
- growth is **above trend** in Burnaby and New Westminster, the North East Sector and North Delta and North Surrey;
- growth is **below trend** in Richmond, South Delta, South Surrey, the Langleys, the North Fraser Region, Abbotsford, Matsqui and Chilliwack;
- in sub-areas (analyzed in finer detail than shown on the map), population and jobs are **clustered in higher densities** than under the current trend. They are sited near regional activity centres of various sizes, and sited along transport corridors. This concentration helps to make them more effectively serviced by transit; and
- the land-use plan strives for a **balance between work force and jobs** in each sub-region, to give people an opportunity to live close to work so that the need for long-haul commuting can be reduced.

[12]Greater Vancouver Regional District, Livable Region Strategy Proposals–A Strategy for Growth Management and Environmental Protection, 1993.

TRANSPORT 2021 long-range plan assumes proposed Livable Region Strategy is implemented

The long-range transport plan is intended to serve and support this compact urban structure. It assumes that the proposed growth pattern will be achieved through the combined effect of forces including:

- physical constraints such as mountains and water-bodies;
- the operation of the marketplace in the land development business;
- the availability of land for development, determined by co-ordinated changes to Official Community Plans and attendant zoning regulations of municipalities, with such coordination being sustained over several decades; and
- coordinated transportation investments and policies, also over a long period.

Neighbourhood Land-use Strategy

Local urban form and street design are keys to encouraging pedestrian and bicycle modes of travel and giving them an opportunity to take hold. [15]

Greater Vancouver's best example of pedestrian-friendly design is the downtown peninsula, where 60% of the people who live and work there actually walk to work and school. In contrast, in a typical suburban municipality, fewer than 15% walk.

Making neighbourhoods more friendly requires new approaches to neighbourhood planning. Three possible ideas are "neotraditional" town planning in new areas, "intensification" of existing urban areas and "calming" of traffic. These offer practical methods of reducing the region's dependence on the automobile. They would make transit, bicycle and pedestrian travel more attractive, not only for commuting but also for recreation, shopping and other journeys.

In addition, social and aesthetic benefits can follow from these approaches. They help to create neighbourhoods which many consider more pleasant, healthier and more "livable", with a keen sense of community, and where non-drivers (notably the young and the old) and those who do not own a car are not so disadvantaged as to personal mobility. Typically in North America, about 1 in 8 households do not own a car, and some 30% of the population in all countries is either too young or too old to drive.

Town planning

Neotraditional town planning aims to place small-town landscapes in new suburban areas—a return to some of the human-scale features of the pre-automobile era.

In this approach, residential areas are not widely separated from stores and services, but surround them. There is a mixture of housing forms with moderate but not high-density housing clustered around a neighbourhood commercial core. Commercial buildings are closely spaced and front directly onto streets and sidewalks, not set back for parking.

The goal is to maximize travel by foot for routine neighbourhood trips, while downgrading priority for vehicles. Access to local amenities is provided by a grid of relatively narrow streets, allowing vehicle and foot traffic many route choices, and slowing autos. Block faces are short; buffer zones between potentially compatible land-uses and different housing densities are removed.

Examples of benefits reported for this urban form, which can have a regional impact, are:

- 17-23% fewer vehicle trips generated than in current suburban developments;
- lower auto use (64% of trips by auto versus 86% in typical suburbs) and higher walking (17% vs. 8%) and transit shares (17% vs. 3%); and
- shorter trips: 12% fewer vehicle miles travelled with the same number of trips; 40% fewer with the reduced number of trips. [15]

There are potential obstacles to success: plans may fail if not all elements of the comprehensive package are present; suburbanites may not adopt the new form of community; safety implications of narrow streets and parked cars are not clear; existing suburban residents may oppose innovative forms of development; and housing prices in such neighbourhoods may be relatively high.

Intensification

Residential intensification aims for a moderate and marginal increase in population density of **existing low-density neighbourhoods**.

Approaches include: lowering minimum lot sizes for detached housing; allowing a second dwelling to be built (e.g. in a large back yard with access onto a back lane); allowing building right up to lot line; relaxing the forced segregation of housing types (e.g. single family homes set apart from multiple family); allowing secondary suites in single family districts; and main street intensification.

Potential regional benefits include fewer and shorter trips, and lower (by 50%) vehicle costs for households.

Intensification also faces obstacles: in particular, single-purpose suburban zoning prohibits diverse housing forms, and attempts to change it often encounter opposition from existing residents.

Both intensification and neo-traditional planning take time to have their impact. The opportunity for immediate change is limited. The majority of housing and commercial structures in the region in 30 years' time is already on the ground today.

Traffic Calming

Traffic calming is a technique is to modify the street and its regulations to **slow down traffic**[13]. Automobiles are not treated as the primary and most important user of road space in urban residential areas.

In Europe, road widths and clearances are reduced, obstacles are sited to cut down the straight-line path, and speed limits are reduced (e.g. by 50%). On-street parking is used as a buffer between moving cars and pedestrians.

Among reported benefits of traffic calming are a greater sense of community among residents, lower accident rates, education of drivers to the needs of other road users, and more business for small-scale local retail and public services.

Walking and Bicycling

Percentage of Total Daily Trips By Bicycle	
Groningen, Netherlands	50%
Delft, Netherlands	43%
Erlangen, Germany	26%
Davis, California, USA	25%
Odense, Denmark	25%
Copenhagen, Denmark	20%
Basel, Switzerland	20%
Hanover, Germany	14%

Source: Lowe, M. The Bicycle: Vehicle for a Small Planet (1989)

The range for comfortable cycling is 5-10 km; its potential to replace automobile trips is even greater than for walking, since most shopping, social and recreational destinations are found within this range.

When combined with public transit, **cycling extends the catchment areas of transit stations.** Bike-and-ride services expand the potential market further, especially if bicycles are allowed on buses, trains and ferries, when they can be ridden at both ends of a trip.

A major problem preventing improvements in cycling is a poorly adapted system: roads and bridges do not accommodate cyclists. Many destinations have no secure bicycle storage, with no change rooms, showers or lockers.

While suburbs have quiet streets suitable for cycling, these are often not well connected. Bicycle path connectors to join these quiet streets to shops, jobs and transit stops could induce a larger portion of the population to cycle.

Those modern western cities which have successfully adapted their road systems to accommodate cycling have shown that bicycle travel can become an important component of the transportation system and may reduce the number of motor vehicles on the roads (see table, left).

Several initiatives are underway by governments in Greater Vancouver to promote cycling: for instance, the City of Vancouver has opened the Adanac Bikeway. The B.C. Ministry of Highways has produced an Interim Cycling Policy: cycling is to be integrated into all stages of provincial road planning and alternative routes are to be provided when bicycle use cannot safely be built in.

[13] The West End in the City of Vancouver provides a local example of traffic calming.

Requirements for the long-range transport plan

It is not the purpose of the regional long-range transport plan to recommend the design of particular centres and neighbourhoods. However, the TRANSPORT 2021 Steering Committee commends these principles of local urban design to local authorities in the region. They can have significant regional benefits.

Accordingly, the long-range transport plan assumes that local governments will act to ensure that (a) new urban development will be designed to favour short trips by foot and bicycle, rather than by automobile, and (b) existing urban areas are adapted to better accommodate the non-motorized modes of travel.

Land-use Policies Endorsed by TRANSPORT 2021

Without the coordinated control of land-use through government planning and zoning regulations, transport policies and initiatives will be compromised and cannot be effective.

Because they are so central to achieving other transportation goals and objectives, these policies are fully endorsed by the TRANSPORT 2021 Steering Committee:

GVRD's Livable Region Strategy

1.1 **The GVRD should pursue the completion of its Livable Region Strategy as a reference point for all public and private sector agencies which have an influence over urban development.**

1.2 **The Strategy should allocate growth and concentrate development in multi-use activity centres and high-density development corridors.**

1.3 **The Strategy should define areas of higher density which will be targeted for intensive transit service by the transport plan.**

1.4 **The Strategy should identify towns outside the urban area which are (a) intended to become more complete and self-sufficient and therefore (b) through transportation and other policies, to be discouraged from becoming suburban "bedroom communities" with easy commuting into the metropolitan core.**

Local friendliness to walking, cycling and transit

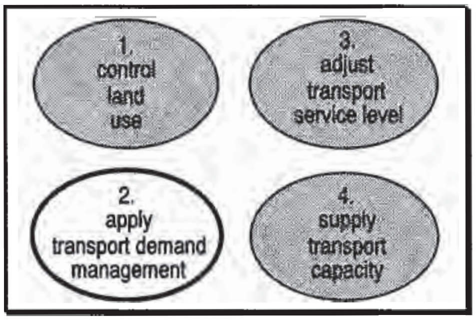
1.5 **Near and within all activity centres, the Strategy should propose a range of housing, within a pedestrian- and bicycle- friendly urban design, both by construction of new centres and by re-development of existing ones.**

1.6 **Municipalities should provide a transit-friendly local street pattern allowing transit routes to pass within walking range of a large proportion of dwellings, job sites, schools, shops and other activity centres.**

1.7 **Municipalities should develop bylaws and guidelines to help attain long-range transport goals at both regional and local levels, including retrofitting neighbourhoods which currently have street patterns which are difficult to serve by transit.**

Coordination of Official Community Plans

1.8 **Governments should provide a framework whereby municipal land-use plans are effectively coordinated in a sustained fashion over several decades, using the GVRD's Livable Region Strategy as reference point; neighbouring regions and their member municipalities should be included in this process.**



Layers of Travel Demand

2. Apply Transport Demand Management

Transportation demand management (or TDM) is the second lever available to policy makers. It comprises a variety of techniques to change the behaviour of travellers in order to make better use of the existing transport system. It encourages off-peak travel and discourages single-occupant vehicles, incorporating measures such as tolls, gas taxes and parking management.

The project divides the travel demand in Greater Vancouver into three layers, being:

Three Layers of Transport Demand In Greater Vancouver

TOTAL DEMAND FOR TRANSPORT IN GREATER VANCOUVER

EQUALS:

Layer A: inter-regional

the movement of people and goods originating from and/or destined to places outside the region (e.g. goods from the U.S. into B.C.; air passengers travelling to the airport; goods transferred at the waterfront from ship to truck; ferries to and from Vancouver Island and the Sunshine Coast)

PLUS

Layer B: regional

the movement of people and goods internal to the region (e.g. commuters from Surrey to Downtown; goods from North Shore to New Westminster)

PLUS

Layer C: local

the neighbourhood movement of people and goods, either accessing the regional and inter-regional system or circulating entirely within a small area of the region.

Aimed at Peak Period Demand

TDM is aimed primarily at peak period, regional passenger travel (part of layer B). This is the demand component which tests the overall passenger-moving capacity of the transport system most severely.

Transportation Demand Management

most promising public policy lever

Research points to transportation demand management (TDM) as a promising public policy lever to change travel behaviour and help solve urban transport problems. Though no panacea, it can postpone capital investment and reshape travel demand to boost transit and carpool use. [2]

Changes which can be effected by TDM fall into three types:

Three Changes Effected through Demand Management

1. **Change Amount of Travel**

   to cut the number of trips made, e.g. by promoting:

   - telecommuting from home or remote work centres
   - the "compressed work week" (e.g. nine day fortnight with longer days)

2. **Change Mode of Travel**

   to switch away from solo-commute trips to public transit, car pools, van pools, bicycles and walking, by

   - providing dedicated "diamond lanes" to allow high-occupancy vehicles (HOVs) such as buses and carpool vehicles to move faster than others
   - giving buses priority over other traffic, e.g. at bridges, congested intersections and traffic signals
   - promoting car- or van- pools by putting carpoolers in touch with each other, priority parking, or changing the way carpools are financed or regulated
   - increasing the relative cost and inconvenience of solo auto driving by limiting the supply or increasing the cost of parking, increasing fuel taxes, or charging tolls for the use of the road network.

3. **Change Time of Travel**

   to travel during off-peak periods,e.g. by:

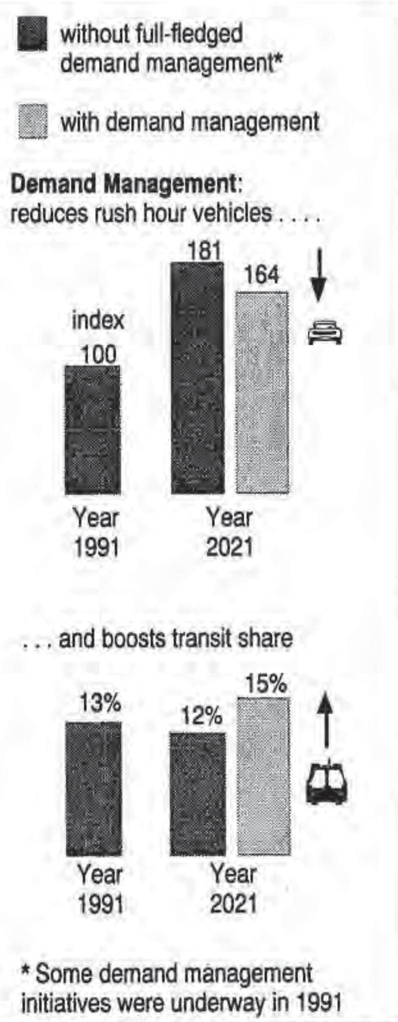
   - further promoting flex-time working
   - imposing peak hour tolls and structuring parking rates to discourage peak travel.

By 2021, TDM and toll-financing will probably be commonplace in the developed world, being regarded as cost-effective ways to combat urban traffic congestion and pollution and support transport investment.

TRANSPORT 2021's long-range plan is based on the assumption that Greater Vancouver will be no exception to this.

The project has identified a package of measures aimed at managing travel demand: [2] [6]

Impact of Transportation Demand Management in Greater Vancouver



Proposed Package: Transportation Demand Management Measures

"Carrots"

1. promotion of telecommuting;
2. steps to encourage medium-sized and large employers to help cut vehicle trips to their worksites;
3. application of bus priority measures;
4. installation of high-occupancy vehicle lanes;

"Sticks"

5. higher and more broadly applied parking charges (e.g. 50% increase of average all-day parking charges in the downtown core, and increases in all-day parking at other major town centres to equal 3/4 of today's downtown levels);
6. higher fuel prices, through higher fuel taxes (e.g. a 50% increase in the real price of gasoline); plus
7. downtown cordon/bridge tolls (e.g. $2 peak hour toll on all bridges leading into Burrard Peninsula).

Research shows that the most effective measures are not the "carrot" but "stick" variety. To be successful, TDM requires a package of mutually supportive "carrot" and "stick" measures.

10% vehicle reduction estimated

A strategy combining "carrot" and "stick" in a significant package of TDM measures could produce about a **10% reduction** in the number of peak hour vehicle trips in 2021, compared with the "base case" trend forecast for 2021. It would shift some travellers from solo-commute driving into carpools and transit, resulting in **transit ridership some 25% higher** than it would otherwise be—provided that transit services are available to receive the additional riders.

Depends on degree

The actual traffic reduction achieved will depend on the degree of intervention (e.g.: in the case of tolls, the dollar amount). An aggressive, dramatic application of TDM might achieve an even higher reduction in vehicle trips. [3]

Link to user pay

Currently, urban transportation is underpriced, i.e. users pay less than the economic cost of the facilities and services they use. According to one estimate, travellers on all modes of transport combined pay only 2/3 to 3/4 of the full costs[14]. [11]

In the long run the prices paid by users should approach the underlying costs they impose, otherwise over-use tends to result.

Accordingly, research supports a policy of generally increasing the price of transport by all modes, consistent with the use of increases in prices as a TDM measure.

Implementation is the key

For the long-range plan, exact TDM measures and settings do not have to be specified in detail. This is because of the level of uncertainty involved in long-range plans, and the probability that underlying attitudes and behaviours and the responsiveness of individuals will change over time[15]. The actual effect of TDM may depend much on how it is introduced, publicized and coordinated. [4] [5]

Link to financing and the public purse

TDM measures which raise revenue (e.g. parking fees, bridge tolls, gas taxes) could support financing of capacity (e.g. build bridges) and/or services and other travel options (e.g. by funding transit revenue shortfall).

A prime reason for implementing TDM is economic efficiency. TDM is cost effective because it helps to make better use of the existing system and postpones or reshapes growth in transport supply (e.g. new roads) otherwise needed to alleviate congestion, and move towards a more efficient allocation of resources and lower total costs.

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[14] Depending on whether the value of personal time is included as a cost to the user.

[15] There are significant issues to be resolved as to how, when, and by whom TDM should be implemented. To test its current acceptability to the public. TRANSPORT 2021 undertook a region-wide opinion survey, which provides guidance for the project's medium-term plan recommendations on the introduction of TDM.

However, public transit currently receives a higher **financial** subsidy from government (in percentage terms) than does private vehicle transportation. Private vehicles, in contrast, receive a higher percentage subsidy in **non-financial or hidden** costs which they impose on society as a whole.

This suggests that as TDM increases demand on transit, greater demand on the public purse will follow if those services continue to be subsidized financially as they have been in the past.

Unless revenues are captured from private transportation, and to the extent that current financing and pricing policies are continued, the net result of TDM could be a shift in financial responsibility away from private sources to public sources.

Recommended Transport Demand Management Policies

General demand management policies

2.1 **Governments should regard Transportation Demand Management (TDM) strategies as an integral part of transport planning in the B.C. Lower Mainland.**

2.2 **Governments should use TDM as the primary public policy instrument to restrain growth in travel by the single-occupant automobile.**

2.3 **Governments should wherever possible exempt urban goods movement, which has no practical choice other than truck, from the policy of auto restraint.**

2.4 **Neighbouring local governments which feed traffic into Greater Vancouver should be asked to respect and support the TDM policy by encouraging transit and carpool traffic, and discouraging single-occupant commuter traffic into/out of Greater Vancouver.**

2.5 **Governments should generally use "carrot" measures (persuasion and incentives) to achieve objectives before using "sticks" (penalties and disincentives); however, since "carrot" measures alone are not likely to effect significant change, "stick" measures will be required.**

Telecommuting

2.6 **Governments should encourage businesses to adopt telecommuting by devising a framework of fiscal incentives, justified on the basis of saved or postponed infrastructure investments that would otherwise be required.**

Employer trip reduction

2.7 **A regional agency, to be identified, should foster employer trip reduction programs, which look to medium and/or large- scale employers to take action to reduce the number of commuter vehicles serving their worksites. The agency should provide support by information and public awareness campaigns, a regional ride-share match-up programme, and other advisory services which encourage employers to participate.**

2.8 **Governments should leave voluntary the employers' participation in trip reduction programs, i.e. not require it by law, to avoid regulatory imposition on employers and associated public sector administrative costs (with the exception of policy 2.16 below).**

HOV/Bus priorities

2.9 **Governments should recognize provision of HOV lanes and bus priority measures as necessary and mutually reinforcing with TDM, to provide more time-competitive alternatives over the single-occupant vehicle.**

Road pricing, tolling and gas tax

2.10 **The Province should introduce road pricing measures or tolls structured to reduce congestion, provide clearer price signals to users for the costs they incur and impose on others, and raise revenue for transportation improvements.**

2.11 **The Province should apply road pricing/tolls with the long-run purpose of shaping travel demand in addition to obtaining revenues. The Province should not remove tolls unless it is clear that the external costs of the automobile have otherwise been accounted for and are recognized by the user.**

2.12 **The Province should dedicate toll revenues to system-wide transportation improvements, including transit/HOV improvements, retrofitting infrastructure to withstand earthquakes, rehabilitation of deteriorating facilities and construction of new facilities.**

2.13 **Governments should institute methods of converting fixed costs of auto ownership/operation to variable costs, where practical (e.g. pay-as-you-drive insurance).**

2.14 **The Province should increase gas prices, though these are a "blunt" instrument with more merit as a revenue-generating measure than as a demand management measure.**

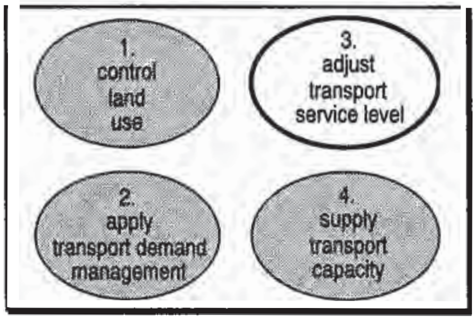
Parking management

2.15 **Governments should use parking management as a TDM instrument; the provision of parking should be coordinated throughout the urban area, e.g. through a regional focal point recommended under "coordination" below; a comprehensive parking strategy is required covering short and long term, park-and ride, public and private, supply and price considerations.**

2.16 **Governments should phase out subsidized parking for commuters, e.g. through municipal bylaws requiring employers who wish to provide free or subsidized parking to employees also to offer those employees the option of the equivalent value in cash and/or travel subsidy.**

Coordination

2.17 **Governments should identify a regional focal point for coordinating TDM. This focal point, which could be a coordinating committee of principal agencies, should function with a mandate to monitor impacts, detect conflicts and coordinate TDM in the region among the agencies responsible for implementing the measures.**



3. Adjust Transport Service Level

Importance of Service Level

Service level means the **quality of the service** experienced by the traveller or freight being transported. Aspects of service level include speed, convenience, frequency of service, comfort and other qualities.

Service level is a **key competitive factor** among modes of transport. Passengers will change their choice of travel mode because of service levels. For instance, many travellers will not ride transit, regardless of the fare, because it is not quick and convenient enough compared with the auto. A proportion of single-occupant auto drivers will change to carpooling when they observe fast-moving carpool traffic passing them in dedicated lanes.

Selectively improving the relative service levels of the different modes or in different places can cause shifts in travel patterns. For instance, better service on transit, coupled with congestion for solo-driver commuters, will shift some into transit at the margin.

Congestion is usually considered an evil; however, allowing congestion to deteriorate for single-occupant vehicles is a practical method of promoting transit and carpools. More congestion for single-occupant vehicles would magnify the impact of some TDM. For instance, buses/carpools in HOV lanes will gain an edge since the relative time saved by escaping lineups will be greater.

Caution

This is a policy lever that requires **cautious use**. The value of personal time spent in travelling in the BC Lower Mainland was $5 billion in 1991, being more than half of the total of all other costs (operating costs, land and infrastructure, accidents, environmental and other hidden costs) combined [11]. Degradation of service therefore carries with it costs in the form of longer travel times. As the system moves into a general state of gridlock, these costs escalate steeply.

Problem of insufficient congestion to give carpools lanes time advantage

Currently in most (not all) corridors in the region the level of service to mixed traffic is too high to make HOVs attractive through time savings. This suggests that for HOV lanes to be utilized, congestion would have to be allowed to accumulate in the mixed-traffic lanes alongside. There must be a tangible benefit to HOV users (most likely in terms of net travel time savings) in order to attract their use.

Cost truck congestion

The estimated cost of delays to Lower Mainland truck traffic (i.e. additional time spent on the road beyond that which would be spent in free flow conditions) is $110 million per year [7]. As explained later in this Report, this figure will nearly triple over the next 30 years. This cost is the rationale for permitting truck traffic to bypass congestion wherever feasible.

Similar concerns apply to other commercial vehicles (e.g. small pick-up trucks carrying goods in private service, light vans and couriers, cars of commercial travellers and others). This market segment will grow with economic activity and is unlikely to respond to demand management.

Opportunities for separating the flow of trucks and other commercial vehicles may be limited (e.g. to border crossings or local access to industrial facilities such as port areas).

Recommended Service Level Policies

Single-occupant Vehicles

3.1 **Until road pricing or an extensive tolling system is instituted, governments may have to accept worse congestion for single-occupant vehicles in the peak period as a necessary evil to encourage other travel options, notably transit and carpooling.**

Trucks

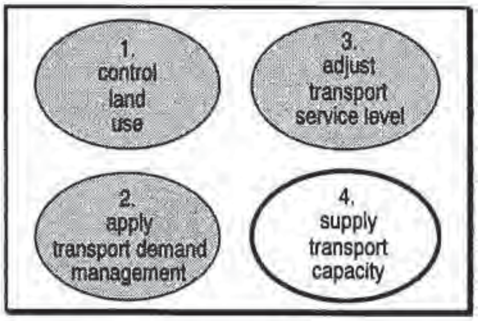
3.2 **Governments should permit truck traffic to escape the auto congestion/auto restraint policy wherever feasible by separating truck flows from auto flows, consistent with cost effectiveness.**

3.3 **Governments should develop minimum service level standards for major truck links to trigger action for improvement if service drops below the accepted level.**

Long-haul and inter-regional traffic

3.4 **Governments should maintain a high level of service for traffic moving between the Lower Mainland, the U.S. and other parts of B.C. This will require a lower level of service for long-haul commuters by car into the urban area by restricting their access to inter-regional facilities.[16]**

[16] This subject is explored further under policy lever 4 - Supply Transport Capacity, following.



4. Supply Transport Capacity

Transport Supply Strategies

Given that the three preceding policy levers are used as recommended—i.e. that demand management is in place, that a more compact urban form is supported by municipal land-use controls, and that a policy for acceptable congestion has been adopted—the question remains: how much, what type and where should **additional physical transport capacity** be supplied?

How much?

A key constraint is money. How should the plan deploy limited resources more effectively to meet the defined goals and objectives of the transportation system?

Building new capacity can be expensive. For instance, in the ten years ending in 1992, capital investment by municipal and provincial government in transportation facilities (roads and transit only) in Greater Vancouver totalled $3.3 billion in 1992 dollars, or $330 million per year. [12]

Public Sector Capital Expenditures on Transportation in Greater Vancouver 1983-1992

	in current dollars	in constant 1992 dollars
	billions	
Transit Capital	$1.3	$1.5 (45%)
Provincial Road Capital	$0.9	$1.0 (30%)
Municipal Road Capital	$0.8	$0.9 (26%)
Total	$3.0	$3.3 (100%)

some totals do not add due to rounding

Further, spending on transportation may not be as affordable in the future as it was in the past, given the current financial circumstances of governments.

In Greater Vancouver, the majority of the **transit** capital above was financed through long term debt; to continue the pattern of the last decade would imply mounting levels of debt for the coming decades. The **road** investments were made from their respective governments' annual expenditure budgets; there are indications that funds from this source too may be harder to find in future. The issue of affordability is explored more deeply in the next chapter of this Report.

One parameter of interest is the **split between investment in capacity for public transit versus capacity for private transport.** Currently public transit handles 9% of the daily person trips in the region, whereas the private automobile handles over 80%. In the last decade, 45% of capital expenditures went to transit, 55% to roads (which carry cars, trucks and public transit buses). Should future investment be split in similar proportions?

What type and where?

Several types of transportation **technology** are available.

For instance, for **transit** there is local bus, express bus, busway (i.e. a separate roadway or guideway), commuter rail, and several variations of rapid transit, such as conventional light rail (found in Edmonton and Calgary), intermediate capacity rail (such as the local SkyTrain) and heavy rail or subway systems (e.g. found in Toronto or New York). **Roads** vary by width and spacing of access points, range from narrow local streets with frequent intersections to multi-lane freeways with widely spaced interchanges.

Each type of facility has its own cost, capacity, life-cycle, performance and other characteristics. Which type of capacity best fits in what location? What new technologies will be available over the next 30 years, with improved characteristics?

These are complex questions. Many different transport networks could serve a given pattern of transport demand. Unfortunately, there is no simple mechanical, computerized method available for adding new "optimal" links to the existing system.

The project's long-range plan is intended to provide a vision of the transport system in 2021, based on what is known today. The balance of this chapter explains how the project approached the questions of how much, what type and where new transport capacity should be supplied. It concludes with a description of the proposed system concept.

How the Project Identified the Proposed System: An Explanation

The project team approached the problem in four steps.

Step 1. The team built a large **inventory** of potential transport improvements (e.g. new or widened roads, transit links of various types). It included links previously considered in other studies, plus entirely new ideas thought to have potential.

Scenario approach

Step 2. The team constructed "**supply scenarios**" for the year 2021 from this inventory. The number of scenarios was limited to three—judged to represent reasonable extremes. The scenarios amounted to different mixtures of the different modes of transport:

- Scenario A, "**road oriented**", relied on road investment, using carpool lanes and mixed-traffic road capacity, with only enough transit to handle a moderate transit demand. It was thought that this would minimize operating costs and capital investment.
- Scenario B, "**lean and mean**", saw very little road development (for either carpools or mixed traffic), but added a significant level of transit service. The idea was to rely on the "push" of transport demand management and the "pull" of much better transit to handle travel needs. It was expected that this would result in road congestion and poor performance for goods traffic.
- Scenario C, "**balanced**", added some high-occupancy vehicle lanes to the scenario B, intended to relieve some of the pressure on the roads.

The scenarios had some common elements. They all aimed to:

- support the **land-use** plan for a more compact region;
- be consistent with applying **transportation demand management;**
- match **transit** passenger demand with capacity and service levels which at a minimum meet the projected demand in each corridor;
- accommodate **international, interprovincial, and inter-regional** passenger traffic and goods movement; and
- restrain the **solo driver** by supplying little or no additional capacity for this mode except in areas of rapid growth.

Step 3. The team **measured** the scenarios against a list of "measures of effectiveness" or criteria (both quantitative and qualitative). These criteria came from the project's formal goals and objectives for the transport system. For instance, travel speeds and congestion, system capital and operating costs, time lost for goods movement, the degree of automobile dependence, atmospheric emissions, amount of farmland consumed, and other factors were estimated for each scenario.

The team gained insights into the trade-offs involved by comparing one scenario to another (e.g. capital cost vs. performance, travel time vs. transit orientation). [9]

Step 4. Based on these insights and on guidance of the Steering Committee, the team **constructed a preferred scenario** D, which aimed to combine the best features of the initial scenarios. This was refined with further work, and became the proposed system concept illustrated in the accompanying maps. [10]

How well the proposed system concept rated is discussed in the next chapter "What Will the Plan Achieve?" There follows a description of the concept itself.

Proposed System Concept

Transit in dense urban areas

The relatively high target population densities within the Burrard Peninsula, the North East Sector and North Surrey create an opportunity for transit. The concept for the year 2021 features a transit system less oriented to downtown Vancouver; it has a greater presence over the denser areas; it links regional centres and permits travellers to connect between several origins and destinations without having to travel via the downtown hub.

The system shows more intensive transit services in the Burrard Peninsula, the North East Sector, and in North Surrey and North Delta.

HOV network

A network of **High-occupancy Vehicle (HOV) lanes**, offering travel time advantages for HOVs, together with queue-jumping facilities to give priority at bridge heads, is also warranted.

Note that each specific application of HOV facilities will require a further, complete assessment in order to determine (a) its physical/operational feasibility (e.g. in light of limited room and complex weaving patterns of different traffic streams) and (b) the best arrangement to ensure the person-carrying capacity (as opposed to the vehicle-carrying capacity) is optimized.

Limited additional capacity for mixed traffic in compact area

New capacity for HOVs would be required to penetrate across bridges into the Burrard Peninsula, but virtually no additional capacity for intra-regional **mixed traffic** would be required. The choke points of the bridges and tunnels across the Fraser River and across Burrard Inlet would be used to "draw the line" and limit access to the single-occupant vehicle.

In areas of rapid population growth, considerable new local and arterial road construction will be necessary to accommodate mixed traffic. These roads will have to be carefully designed to facilitate transit, walking and bicycling.

The long-haul vs. commuter traffic conflict

A problem is occurring on roads intended as long-haul links with other parts of the Province—such as the Trans Canada Highway between the Port Mann Bridge and Chilliwack. These roads are **acting as conduits for urban sprawl and are increasingly losing their function for long-haul traffic**. They are instead providing commuter capacity for outlying areas where there is affordable housing, but this is occurring through the pre-emption of long-haul transport capacity provided at the provincial taxpayer's expense and that of the overall economy.

Some roads (such as the King George Highway in Surrey, or the Lougheed Highway through Burnaby) have already reached the point where they have lost their original function and have been surrendered to local or intra-regional traffic. But it is not too late to protect critical sections (e.g. of the Trans Canada Highway) which lie outside the currently urbanized area.

Deterring solo-commuting from valley towns

The proposed solution to this problem is to **restrain tightly all single-occupant vehicles commuting from the valley towns** (such as Langley, Abbotsford, Matsqui, Maple Ridge, Mission and Chilliwack) into the urban area. Long-haul road capacity should be rationed by limiting access onto the inter-regional links, e.g. by:

- charging deterrent tolls at or near on-ramps at the valley towns, large enough to cut down demand; and/or
- restricting access through computerized, coordinated traffic lights at on-ramps; these would feed vehicles into the traffic flow at a rate which maintains travel speeds and prevents congestion from developing on the long-haul facility.

This approach represents a dramatic reversal of past practice, which would typically suggest a major widening of roads such as the Trans Canada Highway for mixed traffic, and improving interchanges to give better access to the rapidly growing valley towns.

Such an approach is also consistent with a policy of using transportation to help shape the target land-use plan, since it reduces in relative terms the accessibility of areas—the valley towns—which the growth management proposals suggest should follow a less-than-trend growth rate.

It is important to note that the proposed solutions will fail unless the change in supply policy is enunciated clearly, applied consistently for decades, and backed by parallel municipal land-use controls, acre-by-acre, in the valley towns.

Corridor protection will be needed

Considering the high cost of acquiring continuous rights-of-way through developed areas, existing corridors (including rail rights of way being abandoned by rail carriers, hydro rights of way and other potential transport and communications corridors) should be protected from development.

Transport Supply Policy Recommendations

Transit

4.1 **Transit providers should add high quality, fast, frequent services linking facilities linking regional town centres.**

4.2 **Transit providers should offer a family of local transit services, including para-transit and flexible-route transit services, to serve demand for different time periods and different markets.**

4.3 **Transit providers should place priority on improving local transit services in designated urbanized and denser-developed areas within the compact metropolitan area.**

High-occupancy vehicle (HOV) and bus priorities

4.4 **To make best use of existing investment, the governments should re-allocate existing roadway capacity to maximize people-carrying capacity, not vehicle-carrying capacity, and take into account the expected number of passengers per vehicle rather than the number of seats.**

4.5 **In particular, where congestion is not serious and where operationally feasible, the governments should provide HOV capacity by removing mixed-traffic or parking lanes from the existing system; where this is not operationally feasible, it will be necessary to construct new HOV facilities.**

4.6 **The Province and municipalities should install bus/HOV priority measures, wherever an advantage for transit can be demonstrated, and accept that a time penalty to other road users may occur.**

4.7 **On regional roads intended for inter-regional and regional traffic as opposed to local traffic, the Province should provide new capacity preferably by new HOV facilities, recognizing some mixed-traffic capacity expansion may be necessary.**

4.8 **The Province and municipalities should consider opening HOV lanes to trucks and other mixed traffic in the off peak period, provided that the performance or safety of transit is not compromised.**

Single-occupant vehicle restraint

4.9 **The Province and municipalities should follow a single-occupant vehicle restraint strategy, consistent with the regional objective of reversing the past priorities among the transport modes, increasing the choice of modes available, complementing the TDM policy and allowing investment in transit to be maximized.**

4.10 **In particular, on regional facilities within the urban area, the Province and municipalities should not increase mixed-traffic peak hour capacity, except for the limited increase resulting from displacement of HOVs into new exclusive HOV lanes.**

Inter-regional road traffic and goods movement

4.11 **The Province and municipalities in both the GVRD and neighbouring regions should do everything within their power to limit the use of inter-regional, long-haul roads for commuting, which may involve restriction at the point of access from valley towns onto the long-haul facilities.**

4.12 **Governments and transit providers should facilitate the transfer of passengers between long-haul transport and regional transit services to promote the movement of passengers by non-auto modes (e.g. buses to airport, ferry terminals, bus priorities internally).**

4.13 **The Province should designate inter-regional roads which are to be protected from congestion by long-haul commuter traffic.**

4.14 **The Province should make the necessary legislative changes to permit transportation corridors to be reserved, especially for the purposes of inter-regional travel.**

Recommended Future System Maps

The following two maps and lists of new or improved transport connections, taken together, are recommended as best satisfying the transport system's goals and objectives.

Note that:

- exact alignments or facilities are **not** implied by the maps.
- the maps show connections intended to deal with **only the first two layers of demand**, i.e. inter-regional and regional travel demand.
- not shown is the supply response to the **third** layer, i.e. local demand, i.e. local bus routes, and local feeder and access roads which would require considerable expansion in tandem with the first two layers.
- **rapid transit lines** which are shown would typically have to cater to demands in the range of 5,000 to 10,000 people per hour in each direction. To achieve capacities at this level will require dedicated transit facilities. These may be provided by dedicated bus-way or rail transit. The exact technology to be used will depend on the physical feasibility and most cost-effective technical solution.

Long-range System Concept -
Transit (Map #1)

A. Provide Intermediate Capacity Transit System from:

1.	Richmond to Vancouver Central Business District
2.	Lougheed Municipal Centre to the Vancouver Broadway business district
3.	Existing SkyTrain Line and Coquitlam Town Centre
4.	Surrey City Centre south to Newton and Surrey Municipal Hall
5.	Surrey City Centre east to Guildford Municipal Centre

B. Provide bus lanes along the:

6.	Broadway Corridor - UBC to Vancouver-Richmond Rapid Transit
7.	Hastings corridor - North Burnaby to Vancouver Central Business District
8.	Trans Canada Highway corridor - 200 Street to Guildford Municipal Centre

C. Provide bus lanes across the:

9.	Middle Arm of the Fraser River - Vancouver International Airport to Richmond Rapid Transit
10.	Main Arm - Maple Ridge to Trans Canada Highway

D. Apply bus priority treatment across:

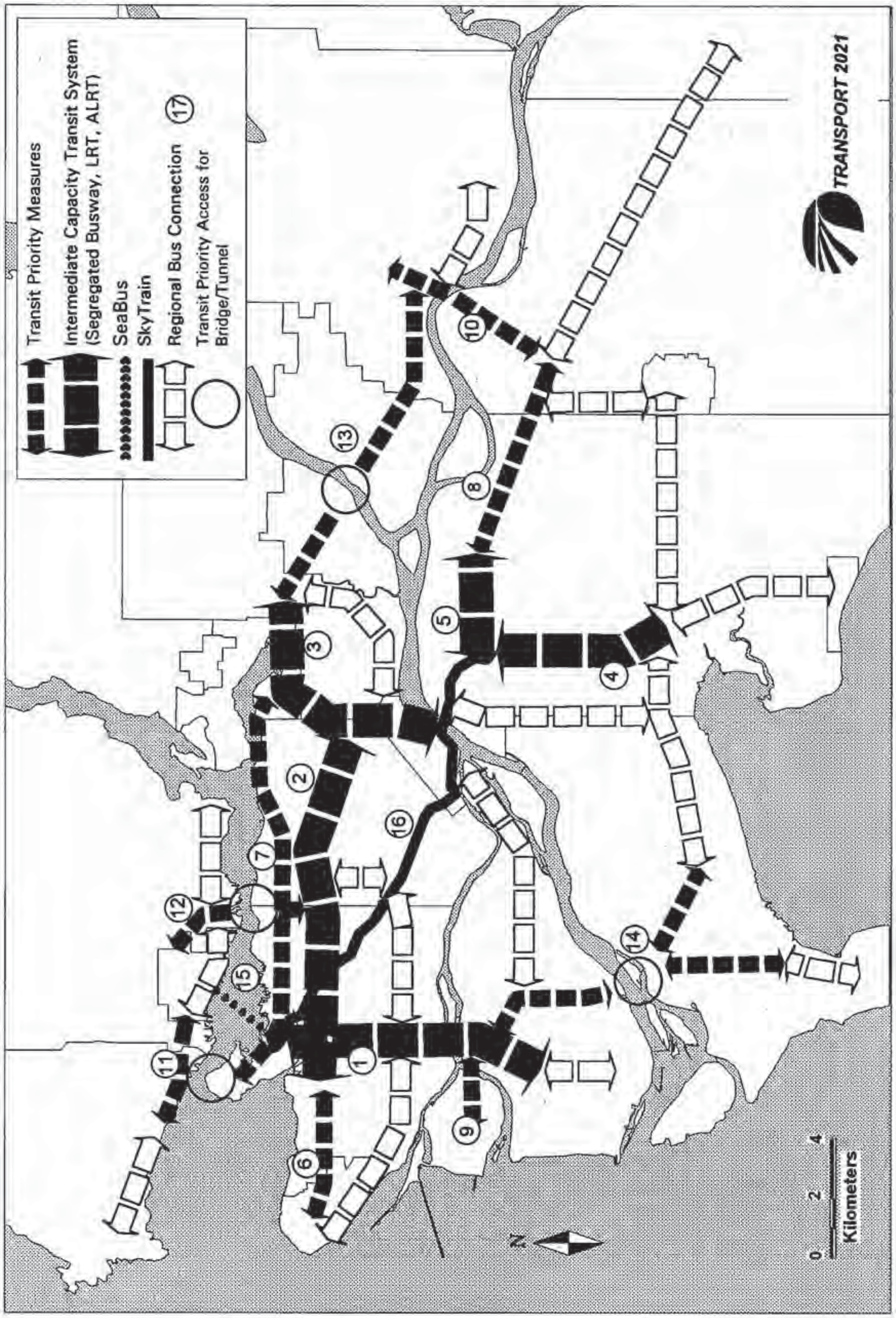
11.	Burrard Inlet at or in the vicinity of First Narrows Bridge
12.	Burrard Inlet at or in the vicinity of Second Narrows Bridge
13.	the Pitt River in the vicinity of the Pitt River Bridge - Fraser North to Coquitlam Town Centre
14.	the South Arm of the Fraser in the vicinity of the Highway 99 corridor- Ladner to Richmond

Item numbers are keyed to Map #1 and do not indicate priority

E. Provide other additional transit:

15.	Add SeaBus capacity across Burrard Inlet
16.	Increase the existing SkyTrain capacity
17.	Increase main-line and feeder bus coverage and service hours

Map #1
Long Range Transportation System Concept - Transit



Long-range System Concept -
High-occupancy Vehicle and Mixed-traffic Improvements (Map #2)

Item numbers are keyed to Map #2 and do not indicate priority

F. Provide HOV lanes in the vicinity of the:

21.	Barnet-Hastings corridor - Northeast Sector to Boundary Road
22.	Lougheed corridor - Highway 7 to Trans Canada Highway
23.	Trans Canada Highway and Grandview Highway corridor - Cape Horn Interchange (North of the Port Mann Bridge) to Clark Drive
24.	Trans Canada Highway corridor - 200 Street to the Cape Horn Interchange (North of the Port Mann Bridge)

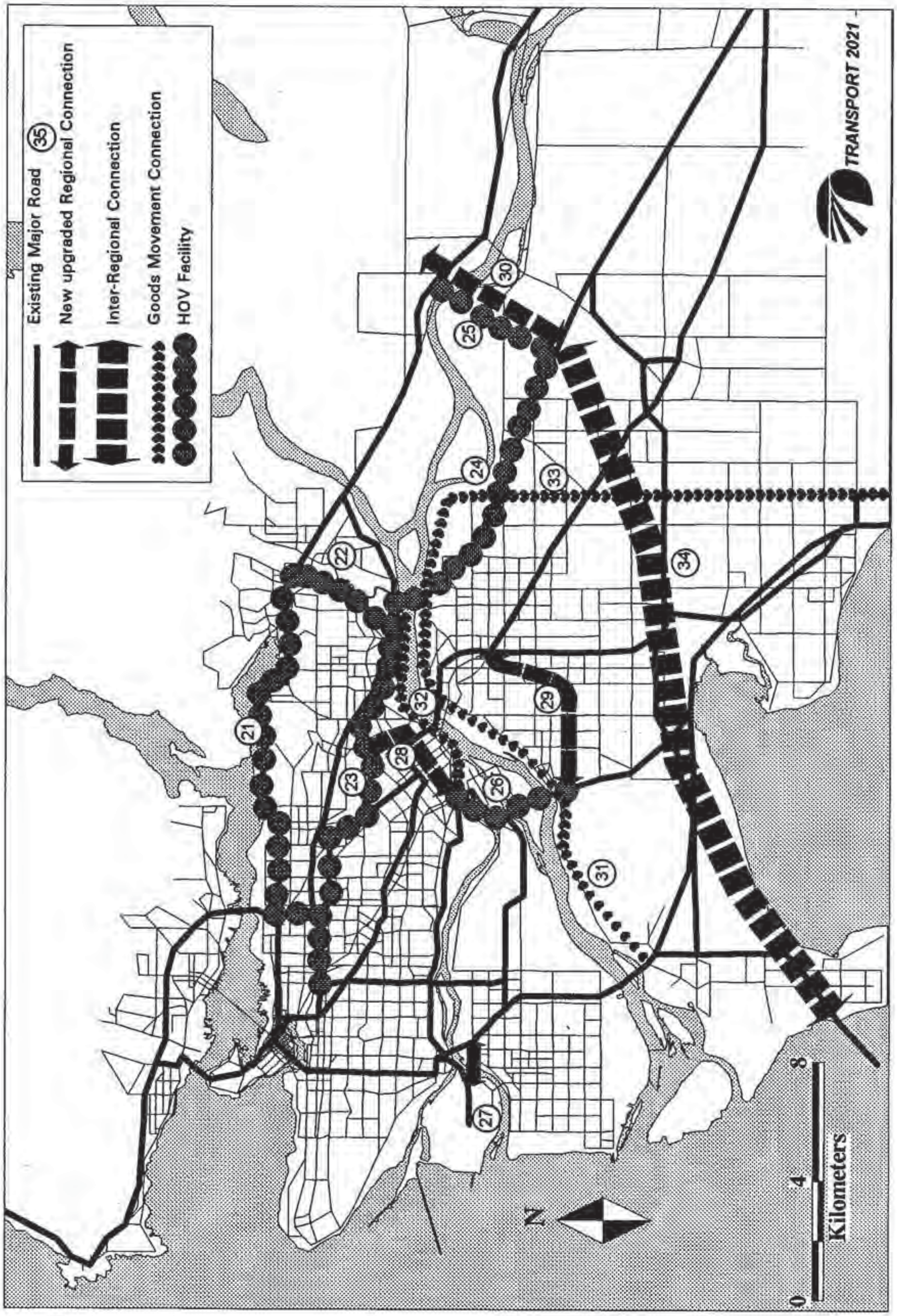
G. Provide HOV lanes across the:

25.	Fraser River at or in the vicinity of the new river crossing between Maple Ridge and Surrey
26.	North Arm of the Fraser River at or in the vicinity of the Alex Fraser Bridge-Queensborough Bridge corridor

H. Provide other improved connections as follows:

27.	Provide an improved Moray Channel Bridge and associated roadway improvements - Highway 99 to the Vancouver International Airport
28.	Improve north-south connections from Pattullo Bridge and Marine Way to Trans Canada and Lougheed Highways
29.	Improve road access from Highway 91 at Nordel Way to the Surrey City Centre
30.	Provide a new river crossing over the Main Arm of the Fraser River from Fraser North to Fraser South
31.	Improve east-west connection from Highway 17/99 to Highway 15/Highway 1 (South Perimeter Road)
32.	Improve east-west connection Southeast Port Road - Mary Hill Bypass/Highway 1 to Queensborough Bridge/Marine Way
33.	Improve Highway 15 from Trans Canada Highway to the Canada U.S. border
34.	Provide east-west highway connection from Highway 17 to Trans Canada Highway
35.	Provide new arterials and widen existing arterials to serve development.

Map #2
Long Range Transportation System Concept - HOV and Mixed Traffic



C. What Will The Plan Achieve?

A Numerical Assessment of the Plan's Performance

The key elements of the long-range transport plan are the policy recommendations listed under the policy levers—including the investment in physical facilities of the type and location shown on the associated maps.

This section describes **what** can be achieved by such a plan, i.e. by using the policy levers as recommended. Does the plan achieve the goals and objectives set for it?

The section compares numerically the projected results of the plan with (a) the situation today and (b) what is otherwise expected to happen by 2021, under "business as usual" trends.

The data presented below stems from extensive numerical analysis of many possibilities. The analysis uses the art and science of computer modelling. It is internally consistent and draws on surveys of past traffic patterns and behaviours in the B.C. Lower Mainland. Readers should interpret the data as indicating the magnitude and general direction of change, and should not attach great significance to the apparent precision of the figures. [10]

The projected growth in population and the economy between 1991 to 2021 means more traffic of all types, in absolute terms. The plan cannot eliminate growth of travel—rather, it reduces its rate and shapes its pattern, as described below.

Passenger Transport

Changes in urban density and transit usage

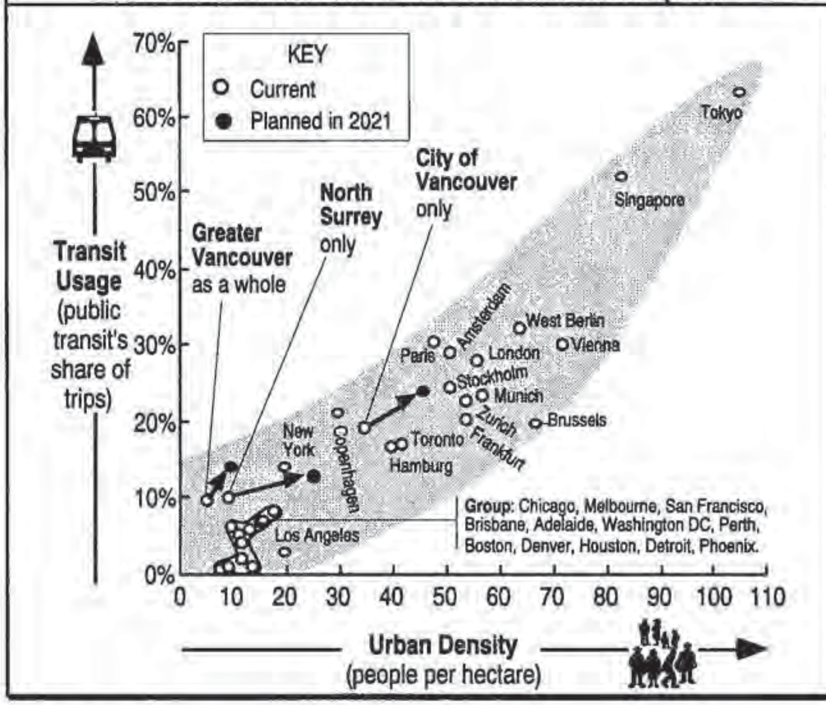
Under the Livable Region Strategy and TRANSPORT 2021 proposals, as Greater Vancouver grows it would become more transit-oriented. For the region as a whole, transit would achieve a share of the travel market comparable to that reached today in cities such as Sydney and Toronto.

The City of Vancouver would reach densities and transit usage comparable with those found in cities such as Stockholm, Zurich and Munich today.

For the region as a whole, urban density would not be sufficient to bring transit usage into the range experienced in Europe or Asia today.

Parts of the region (e.g. North Surrey and Vancouver City) would see higher densities and transit usage, with the City of Vancouver reaching transit usage comparable with some European cities today.

Changes in Urban Density and Transit Usage in Greater Vancouver 1991-2021 under this plan



Source: Adapted from "Greenhouse, Oil and Cities" by Peter Newman, in "Futures", May 1991, supplemented with data from TRANSPORT 2021 and the Greater Vancouver Livable Region Strategy, 1993.

Under the recommended plan for the morning rush hour in 2021:

- the total number of people travelling by all modes would be nearly 700,000, which is 80% higher than in 1991. This figure is slightly lower than trend for 2021 (by 1%), due largely to telecommuting.
- the number of people driving in rush hour would grow more slowly, being 350,000 in 2021 which is 60% higher than in 1991 but lower than the trend for 2021 by some 13%.
- the number travelling as car passengers would double to 140,000 in 2021, which is 3% higher than trend (but notable because there are 13% fewer cars for them to ride in, compared with trend).

- the number of transit riders would be 130,000, 160% higher than 1991 and 59% higher than trend in 2021.

Recommended Plan vs. Current Trends for 2021	In 1991	In 2021		
		Current Trends	The Plan	Change from trend*
Person Trips in Morning Rush Hour (millions)				
Total by all modes	.39	.70	.70	-1%
As car drivers	.22	.41	.35	-13%
As car psgrs (non-drivers)	.07	.14	.14	+3%
As transit riders	.05	.08	.13	+59%
Transit's Share of Person Trips in Morning Rush Hour				
For people travelling:				
- to downtown peninsula**	37%	37%	48%	+30%
- to 6 regional town centres	13%	15%	29%	+93%
- within region overall	13%	11%	18%	+64%
Average Number of People in A Car in the Morning Rush Hour				
For people travelling:				
- to downtown peninsula**	1.36	1.35	1.42	+5%
- to 6 regional town centres	1.30	1.29	1.40	+9%
- within region overall	1.34	1.33	1.40	+5%
Total Distances Travelled in the Morning Rush Hour (million km)				
By all vehicles	3.1	5.6	4.8	-17%
By transit passengers	0.6	1.1	1.8	+62%

*Differences are due to rounding of numbers in columns to left
**Includes central business district plus "West End" residential area

These figures can also be expressed as changes in the *growth which would otherwise occur*. For instance:

Cuts car growth a third

- the growth in car drivers which would have been 190,000 (.41 minus .22 million) is cut back to 130,000; i.e. the plan would reduce the 30-year growth in the number of rush hour car drivers by a third.
- the total distance driven by all vehicles combined, which would have risen from 3.1 million km today to 5.6 in 2021,

is cut back by 17% to 4.8, with the 30-year growth being reduced by a third.

Increases transit growth by over 150%

- the growth in transit riders which would otherwise have been 30,000 is increased to 80,000; i.e. the plan would increase the 30-year growth in rush hour transit ridership by 166%.

Therefore, the plan increases the share of the total travel market held by transit:

Reverses transit decline

- the share of the total rush hour travel served by transit, projected to decline under trend conditions by 2 percentage points, would be higher by 7 percentage points, for a total of 18% of the market; i.e. the plan would reverse a projected decline in transit's share of the total travel market.
- in certain sub-markets—to downtown Vancouver and to regional town centres—the plan would raise transit's share significantly above the "business as usual" trend.

The plan would also increase the **average number of people riding per car**:

More people per car instead of less

- the average number of people riding per car, projected to decline by 0.01 people/car region-wide under trend conditions, would rise by 0.07 to 1.40; i.e. the plan would reverse a projected decline in the number of people carried per car in the morning rush hour.

Reduces car dependence

The region would become **less dependent on the automobile**. The car would continue to be the largest single mode of transport, but the proportion of journeys taken by car would drop; the percentage of car drivers is projected to fall from 59% under current trends to 50% under the long-range plan.

More homes near rapid transit

Access to transit service would be improved, with four times the length of rapid transit services in place; 30% of the population would live within 1 km of a rapid transit line compared with 8% today.

There are different outlooks for local and global **air pollutants**:

Emissions of local air pollutants down

- Five **local** air pollutants (carbon monoxide, oxides of nitrogen and sulphur, particulate matter and volatile organic compounds) originate **mainly from motor vehicles.** The GVRD's goal is to cut these emissions to 1/2. Total emissions from vehicles are actually projected to **decline more than this**—to 1/3 of current amounts by 2021—due mainly to better engine technology and enforcement, and partly to a reduction in automobile dependence under this plan.

Emissions of greenhouse gas up

- All fossil-fuelled engines also emit carbon dioxide (CO_2), generally accepted to cause **global** warming. The provincial and national target is to stabilize CO_2 emissions from all sources (home heating, transportation, power generation, waste incineration, etc. combined) at 1990 levels by the year 2000. Transportation is **not the primary source** of CO_2, emitting less than a sixth of province-wide or a quarter of Canada-wide CO_2.

Vehicles in the BC Lower Mainland will themselves **not achieve the CO_2 target** for all sources combined; their CO_2 emissions will likely rise 10% in the 1990s and climb thereafter: a 15% to 20% increase between 1991 and 2021 is projected under this plan, compared with 25% to 30% under trend conditions[17].

Congestion worse

Congestion will worsen on the roads. While average speeds would decline somewhat (by 3%), the congestion seen today would be more widespread, affecting more roads.

Goods Transport

Inevitably, **trucks will be caught** in the greater congestion which will occur in the region in the future; the extra congestion costs for trucks in the Lower Mainland would be $185 million per year or some $70 per capita per year—a cost which truckers can be expected to pass on to their customers where they can.

To provide better service for trucks would require more roads. Only with a completely separate circulation system, which would be difficult to justify economically, would the goods movement system be unaffected by congestion in general purpose traffic.

Trucks face more, but tolerable, delay

The **cost of truck delays** due to congestion would increase from 20% of truck running costs in 1991 to 27% in 2021.

These costs are significant, but they are not intolerable. They would be worse if measures recommended elsewhere in this plan were not put in place, i.e.:

- demand management to limit automobile traffic which competes for road space;
- system management to preserve the flow of traffic on major truck corridors such as the Trans Canada Highway;
- a policy of admitting trucks to high-occupancy lanes where possible and appropriate; and
- specific road improvements directed at assisting the flow of truck movement.

[17] Estimates provided by GVRD Air Quality and Source Control Department based on traffic projections generated by TRANSPORT 2021.

Additional Parameters of the Recommended Plan	Current 1991	Plan 2021	Change %
Livability and Amenity Factors			
Emission of local air pollutants ('000 tonnes/year of 5 pollutants)	380	130	-66%
Emission of "greenhouse" gas ('000 tonnes/year of carbon dioxide)	4900	5700 - 5900	+15% to 20%
New roads in protected areas (lane-km)	na	150	na
Route-km of rapid transit	23	99	+330%
High-occupancy vehicle/bus lanes (lane-km)	mar-ginal	180	na
Percentage of total population close to transit service (in census metro area):			
- within 400 metres of a bus route	87%	90%	+3%
- within 1 km of rapid transit line	8%	30%	+22%
Congestion Factors			
Cars: rush hour avg speed (km/h)	38.5	37.5	-3%
Trucks:			
- 24 hr avg truck travel speed (km/h)	53.0	49.0	-8%
- cost of congestion delays ($m/yr)	$110	$295	168%
- total truck running costs ($m/yr)	$525	$1100	110%
Other System Measurements			
Number of vehicle-hours of operation (million vehicle hrs/yr):			
- for automobiles	290	443	+53%
- for buses	86	148	+72%
- for rapid transit	12	88	+633%
- for SeaBus	1	2	+100%
- for trucks	10	22	+120%
Annual vehicle km travelled (billion)	11.1	16.6	+50%

Capital Costs and Affordability

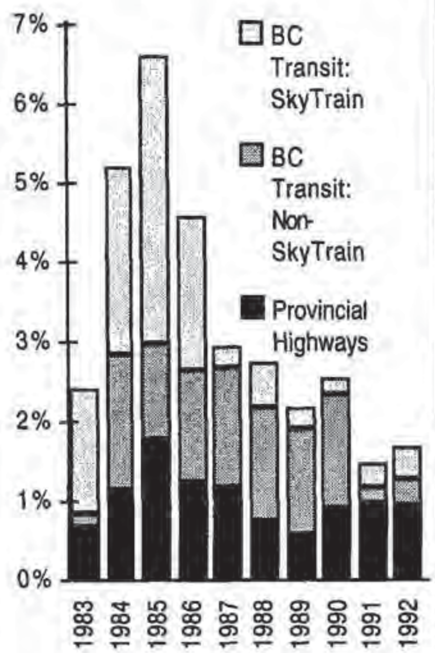
An important test of reasonableness of the transport plan is affordability[18].

*The estimated capital cost of expanding the transportation system under this plan through to the year 2021 is estimated at **$10.0 billion in 1992 dollars.** Note that this is an approximate cost intended for broad evaluation of the plan, not for project budgetting purposes. [10]*

Public Sector Capital Expenditures on Transportation in Greater Vancouver (in billions of 1992 dollars)

Period	Actual over 10 years 1983-1992	This Plan over 28 years 1993-2021
Transit Capital	$1.5 (45%)	$3.6 (36%)
Provincial Road Capital	$1.0 (30%)	$3.9 (39%)
Municipal Road Capital	$0.9 (26%)	$2.5 (25%)
Total	$3.3 (100%)	$10.0 (100%)

Provincial capital investment in transportation in Greater Vancouver as a percentage of Provincial budget



How such future capital expenditures could be paid for, and by whom, is a large topic for further research.

Urban transportation financing is currently being re-thought in many jurisdictions; this is partly due to escalating demands for transportation capital when the traditional sources of funds—government budgets—are being pre-empted by educational, health, and other social programs.

Governments in other provinces of Canada and in other countries are turning to private sources of capital, using tolls or other user charges dedicated to help fund transportation infrastructure. The Government of British Columbia has announced the formation of a Transportation Financing Authority with similar features.

Preparing a financial plan goes beyond the terms of reference for TRANSPORT 2021. However, indicators of affordability of the project's recommendations are available. This section presents two tests of affordability:

Affordability Indicator #1:
Comparison of future vs historical rates of capital spending.

18 Not addressed in this discussion are Federal Government expenditures; historically, these have been concentrated in airport and seaport infrastructure, with certain contributions to urban transport capacity (e.g. capital contribution of $60 million BC Transit for SkyTrain development and construction of the Arthur Laing road bridge between Vancouver and Richmond in the vicinity of the international airport). Also not considered are private investments in the vehicle fleet (cars and trucks) and private parking facilities, and investments by BC Ferries and BC Rail.

Affordability Indicator #2:
Prospects for new dedicated transportation revenue adequate for financing future capital expenditures.

Affordability Indicator #1

In the past in British Columbia, road and rapid transit facilities have been paid for in different ways: [12]

- **Road** building has been paid for through current expenditures, both at provincial and municipal levels. Roads have not been capitalized or financed by raising debts tied to the road assets, so no interest costs are recognized for road investment.
- **Rapid transit**, on the other hand, has been financed through debt. In the 10 years ending in 1992, 82% of all transit capital expenditure was for rapid transit (i.e. SkyTrain).

Therefore, for consistency of comparison, all figures below exclude the interest costs on the transit debt.

For the provincially funded facilities, transportation capital expenditures in Greater Vancouver averaged 3.23% of total provincial budget for the ten-year period, with a downward trend from 1985 (see chart, previous page).

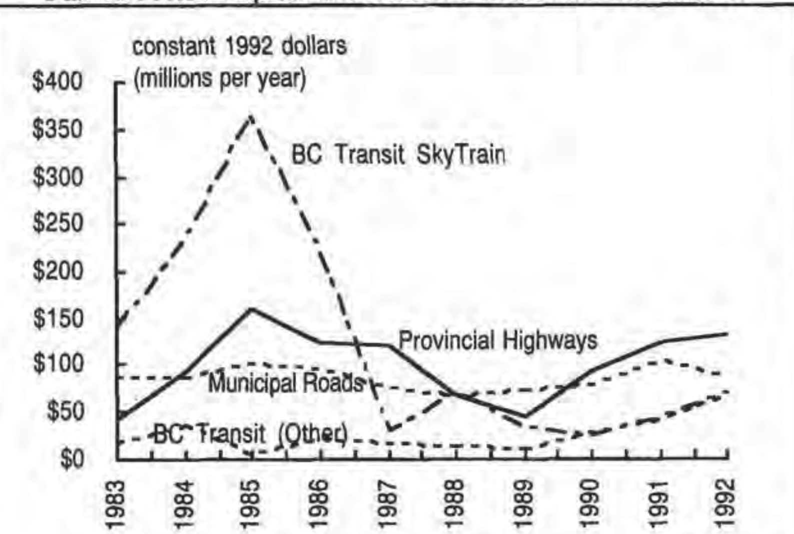
Historical Capital Expenditure

The historical capital expenditure on transport in the GVRD by both provincial and local government combined is shown below.

The Provincial government peaks in 1985 result from the construction of major road facilities such as the Alex Fraser bridge and related Annacis Island road system and SkyTrain and in the early and mid-1980s,.

Municipal expenditures are relatively stable, and reflect steady expansion in local road networks to access new development areas and to accommodate general increases in traffic.

Greater Vancouver
Public Sector Capital Investments in Roads and Transit



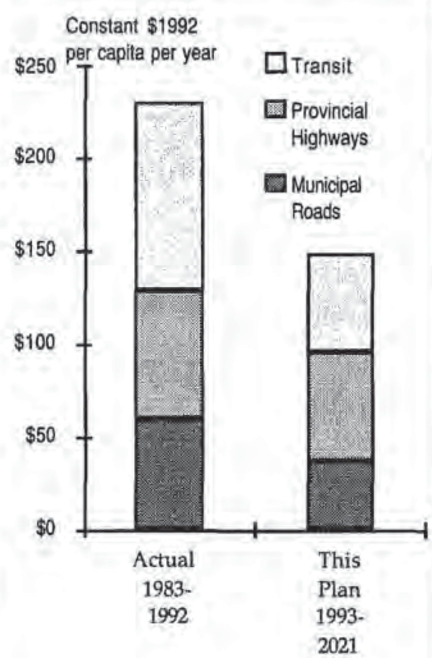
A useful measure of the transport investment is the annual capital expenditure for each resident of the region, in real terms, as follows.

About 35% lower per capita rate of capital spending in real terms would have to be sustained to 2021.

Average Annual Per Capita Public Sector Capital Expenditures on Roads and Transit in Greater Vancouver

Period	Over 10 years 1983-1992	This Plan: over 28 years 1993-2021	Difference
Transit Capital	$103	$54	-48%
Provincial Road Capital	$69	$59	-15%
Municipal Road Capital	$59	$37	-37%
Total	$231	$149	-35%

Road and Transit Capital Expenditures in Greater Vancouver



To pay for the total $10 billion in future transport investment identified above, the plan would require a smaller amount— $149 per capita per year , or 35% lower than past spending rates—to be sustained through the period 1993-2021.

This suggests that the magnitude of capital investment is not unreasonable—one indicator of affordability.

Affordability Indicator #2

However, it can be be argued that the benchmark for indicator #1—past total rate of capital spending (roads plus transit in the last decade)—is not sustainable in any case. In particular, the 1980s saw an obligation assumed (the SkyTrain debt), which will require servicing for decades to come with cash from future budgets. To repeat that 1980s pattern of spending would mean escalating debt and corresponding service charges.

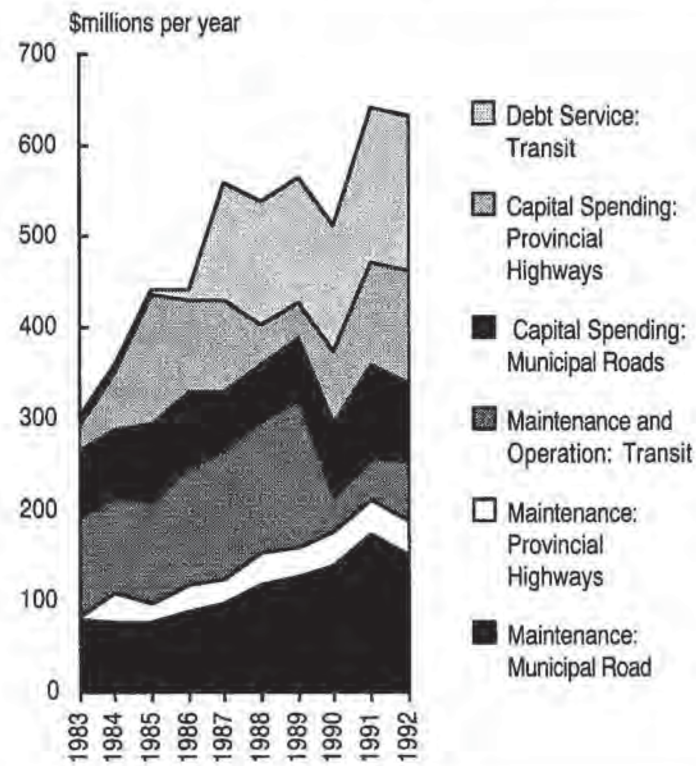
Further, the portion of capital expenditures not funded by debt but from current budgets in the last decade—roads, both provincial and municipal plus the non-SkyTrain portion of transit—may not be sustainable, due to other spending priorities.

Could future capital expenditure in Greater Vancouver be financed through new revenues generated from the transportation system, e.g. as a result of the demand management measures—tolls, gas taxes and parking taxes? This question requires a discussion of other expenditures and other revenue sources.

Operation and maintenance expenditures

In addition to capital expenditures, the public sector applies its revenues to maintaining the transport system, through general maintenance and operating expenditures. These expenditures are totalled with capital expenditures in the chart below. To portray cash flow as experienced by the public sector, transit debt service charges are used, rather than capital investment in transit.[19]

Greater Vancouver
Public Sector Cash Expenditures on Roads and Transit
(excluding Federal Government)



Existing Revenue Sources

Today, public sector revenues associated with transportation come from several sources.

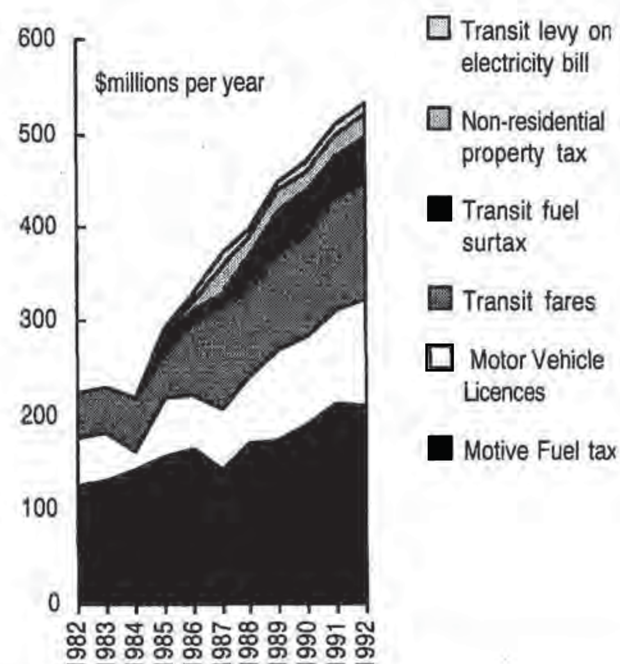
Some revenues are not generated by transportation activity but are earmarked for spending on transportation (e.g. BC Hydro levy). Others have the opposite features: historically, they are generated by transport activity but have not been earmarked for transportation (e.g. fuel tax).

[19]Administrative overheads are excluded from expenditures .

In order of dollar importance (highest first) the revenue sources associated with roads, transit and automobiles in Greater Vancouver are:

- province-wide fuel taxes collected within Greater Vancouver;
- licenses and permits for motor vehicles in Greater Vancouver;
- BC Transit fuel surtax (collected in a defined transit service area);
- transit fares from fare box;
- Non-residential property tax for transit; and
- BC Transit levy on BC Hydro power bills.

Public Sector Revenues Associated with Roads and Transit Activity in Greater Vancouver
(excluding Federal Government)



These revenues are relatively stable and can be expected to continue to climb with transportation activity and inflation.

A comparison of revenues and expenditures (see previous page), indicates that, for the Province and municipalities combined:

- public sector cash expenditures in Greater Vancouver have exceeded revenues in Greater Vancouver in every year;

- if the debt service expenses (for transit) are removed, there is a rough balance between revenues and expenditures; and
- if all capital-related expenditures are removed (i.e. road capital as well as transit debt service), then total revenues are more than sufficient to pay for the operation and maintenance of the system.

If future capital expenditures were to be covered by new sources of revenue, it is reasonable to assume that future operation and maintenance expenditures would be covered by the existing revenue base.

New Sources of Revenue

Three potential new sources of revenue are the result of the proposed transportation demand management measures:

- bridge tolls;
- higher fuel taxes, dedicated to roads and transit; and
- parking taxes structured to raise parking charges.

Using traffic volumes projected in the year 2021, but at current dollar prices, and given that demand management measures are implemented as shown, one estimate of the revenue generated is as follows:

Bridge tolls: assuming a 24-hour toll is implemented in both directions on all major bridges into the Burrard Peninsula.	
Annual auto volume (millions)	270
Annual revenue in 2021	**$540 m**
Gas Tax: assumes a doubling of the motive fuel tax to increase the operating cost of autos from 8.15 cents/km to 10.86 cents/km.	
Annual vehicle-km travelled (millions)	17, 830
Annual revenue in 2021	**$483 m**
Parking Charges: assumes an increase in long-term parking (work trips) in the central business district by 50%, and raising parking charges in regional town centres to an average $3 per day. More revenue would be raised if charges were applied to short- term parking.	
Annual revenue in 2021	**$65 m**
The total annual revenue potential in 2021 therefore approximates in $1992	**$1.1 bn**

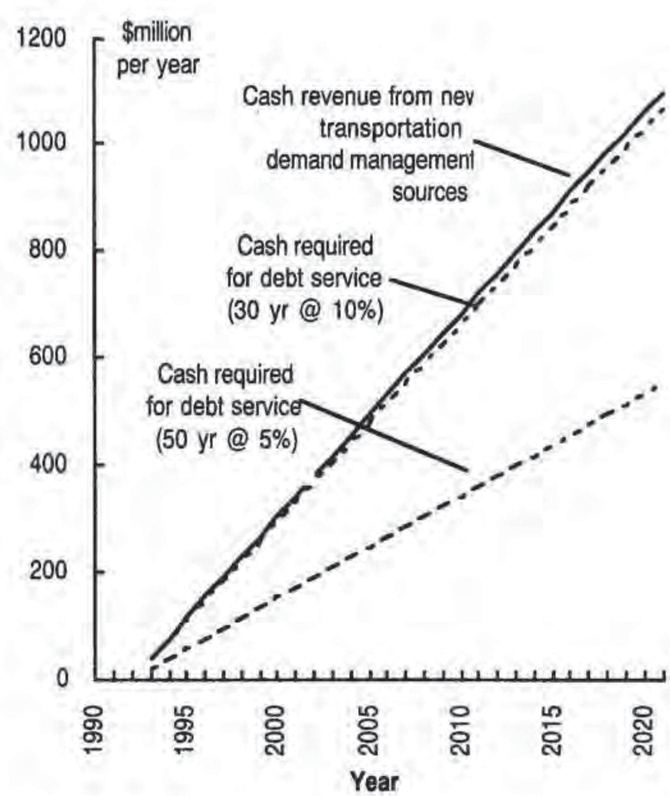
This revenue is sufficient alone to fund the estimated $10 billion capital cost of the proposed transportation system capital cost, as follows.

Assuming for the purposes of illustration that:

- transport demand management pricing measures are phased in over the period to the year 2021 in such a way that additional annual revenue climbs from zero in 1992 to $1.1 billion in 2021;
- capital expenditures are made uniformly in equal amounts per year over the same 28-year period, to total $10 billion by the year 2021 (being an investment of $345 million per year);

then the debt service charges are less than the projected revenues in any given year. Shown below are two calculations of debt service: one for a relatively short amortization period and high real interest rate (30 years at 10% per year), which places debt service charges about equal to revenues in any given year; and one at a longer period and lower rate (50 years at 5%), which places them at about half of revenues.

Demand Management
Potential Revenues vs. Debt Service Payments
for $10 billion total capital investment in transportation system in Greater Vancouver in the period 1993-2021



This is the second test of affordability of the plan, which suggests that all of the capital cost of the proposed new transportation facilities could be financed from alternative revenue sources.

Conclusion

In conclusion, the recommended long-range transport plan is considered to meet its own objectives. Forecasts indicate that the plan will serve the 30-year increase in travel needs for people and goods while:

- reducing the growth in the number of rush hour drivers by one third;
- reversing the projected decline in the average number of people per car, i.e. reducing solo-commuting;
- increasing transit ridership four times from today's level;
- increasing transit's share of the travel market, reversing the projected decline;
- providing convenient access to rapid transit to a larger proportion of the population;
- seeing a 2/3 decline in the vehicle emissions of five major local air pollutants, and limiting increases in the emissions of the greenhouse gas carbon dioxide which would otherwise occur;
- limiting increases in congestion for passenger and goods movement to acceptable levels; and
- requiring a level of capital investment which appears to be affordable.

The plan is projected to turn the transport system and the service it provides in a more desirable direction, as measured by the parameters described in this section.

Finally, it is important to remember that these results require that all policy levers operate successfully and in mutual support of each other. How to cope with the uncertainty attached to this requirement is addressed in the next section.

D. Keeping Options Open

The long-range transport plan represents a vision of the transportation system in 2021 which best meets the system's goals and objectives as they are seen today.

It is impossible to predict all the conditions under which the transportation system will operate in 30 years' time. Unexpected and unforeseeable developments will occur. The Plan contains many underlying assumptions which may not hold true over 30 years. It will have to be revised periodically for a course correction.

In addition, the plan looks forward only 30 years. Beyond that time, initiatives may be required which are not recommended or even considered here.

Further, events which foreclose options are certain to occur. For instance, land values escalate. It becomes too costly to acquire property for transport infrastructure after the fact. Continuous corridors may be permanently blocked by land development.

This chapter makes recommendations for keeping options open so that the plan can be as flexible and robust as possible, and that the region's transportation system can adapt to an uncertain future.

Surprises Since 1960

A glance backwards over the past 30 years reveals shifts which urban transport planners of the early 1960s might have missed or could not foresee. For instance:

- many more **women** joined the paid workforce from the 1960s onwards, changing the amount and type of travel needed—especially the desire for quick, convenient transport;
- the size of **family units** shrank—so that the demand for housing grew faster than the population;
- the heavy **road and bridge construction** phase of the 1950s ended in the early 1960s. The Lower Mainland Regional Planning Board's 1963 "Choice and Challenge" strategic transport plan envisaged an extensive freeway grid of roughly 10-mile spacing throughout the Burrard Peninsula and Fraser Valley to support large new towns, but this did

not come to pass. This was in part due to policy choices made in the 1970s under the "Livable Region Plan";

- western Canada's natural resource industries enjoyed a boom in **international trade** from the late 1960s to the early 1980s; and **commercial aviation** across continents and oceans became both affordable and common. Both helped establish Greater Vancouver as a trade and transportation gateway of global importance;
- the **environmental protection** movement grew strongly from the 1970s on; concern about air pollution in many countries, and crises in the supply of petroleum fuels in the 1970s, caused cars to be re-engineered for fuel economy, efficiency and low emissions;
- in B.C., **agricultural land**, which was not protected in 1960, was increasingly seen as a valuable resource; today its protection is generally taken as a given, and the location of urban development and transport corridors are constrained by an Agricultural Land Reserve; and
- cheap, much more powerful **computers** and related communications technology became widely available by the early 1980s—and with it the ability to monitor, measure, and manage transportation activity both remotely and automatically.

Sources of Uncertainty

Several **future developments** could affect the development of the region and its transport system compared to that identified in this long-range plan. For example, natural disasters, social or political disturbances, technological breakthroughs, or changes in community values or attitudes could all change the future as it appears today.

The **long lead times** (e.g. 10 years) required to install major pieces of transport infrastructure magnify the uncertainties, because of the need to plan far ahead.

Unanticipated shifts in immigration policy, birthrates and housing preferences (e.g. ground-oriented vs. apartments) and other **demographic** variations could move the actual travel demand pattern away from that projected for the year 2021.

Uncertainty in Underlying Assumptions

If the underlying assumptions of the plan do not hold true, then the transport plan will have to be modified.

Human behaviour variables and the response of the system

There are limits on the ability to model human behaviour, preferences and values; for instance, although the plan requires changes in travel behaviour, there may be *unanticipated* degrees of change in:

- the social acceptance of use of **automobile**;
- the image of **public transit, bicycling and walking**; and

- how people value their **travel time.**

All of these could affect people's choice of transport mode in ways not predicted in the plan.

Changes in daily routines or work practices and other factors could mean that the **morning peak hour**, modelled as the key demand component in the TRANSPORT 2021 research program, may not be as important in the future as it is today. Other time periods with other characteristics may be more important.

How people respond in a **more congested transport** system is also a variable, as well as the response of the system itself. Some considerations relating to congestion are as follows:

- in a more congested system, the response to clearing up **blockages** caused by stalls and accidents will become more critical if reliability of service is to be maintained;
- if congestion reaches a point where rush hours occupy six to eight hours per day on extensive sections of the road network, the **cost of rehabilitation and maintenance** for the system rises unacceptably (since contractors' crews must be mobilized work for only short off-peak periods), and/or excessive delays are caused for road users when work is done in busy traffic conditions;
- the response of **truckers** to more congestion will depend on how successfully they can be insulated from its effects through separate facilities or use of HOV lanes; and
- **transit** service will face greater challenges to achieve the higher service levels called for in the plan while operating buses on busier streets.

Assumptions for success in implementation

Among the most crucial assumptions of the plan are that (a) future decision makers will adopt the policies recommended by the plan and that (b) these policies will actually work. The plan requires a number of mutually reinforcing actions to be taken; it will not function on a "pick and choose" basis. Success in one area depends on that in another.

In particular, the plan assumes that

- **urban growth will be managed** based on the Livable Region Strategy's land-use pattern of population and employment throughout the B.C. Lower Mainland, which by choice is quite different from the "business as usual" or trend option.

  Success in zoning controls is also assumed at the local level. This is the key to preventing urban sprawl from clogging long-haul provincial transport corridors, which may otherwise become local roads (as for example has already happened on the Kingsway, King George, Lougheed, and Barnet corridors).

- **transport demand management** will be successfully implemented, which is the key to reducing automobile dependence.

If the targets for growth management and demand management are missed, the system would default towards the "business as usual" or trend option, i.e. towards more suburban and ex-urban development, less transit use, more automobile dependence with more congestion and hence the need for more roads.

The plan also assumes that more detailed studies (e.g. for feasibility and functional design of facilities where operational considerations become important) will not result in a complete re-think of the strategy, but rather an adaptation of it.

Coping With Uncertainty

The TRANSPORT 2021 Steering Committee proposes that the long-range plan be flexible and robust with respect to both types of uncertainty. These qualities are incorporated by two means.

First, options to use transport corridors not in the long-range plan must be kept open.

Corridor preservation

The Steering Committee recognizes that the agencies responsible for supplying transport, notably the Ministry of Transportation and Highways, should continue to plan and investigate, respond to changing conditions and preserve options for routes and corridors, as they see fit within the limits of their responsibilities and powers.

This is a fully legitimate activity of agencies charged with responsibility to provide for the long term needs of the region and the Province. This activity is not a commitment to construct and does not conflict with the Committee's long-range transport plan.

Long-range highway options

In particular, Ministry of Transportation and Highways has identified several long term corridor options for investigation:

- an east-west North Fraser Freeway through the northern portion of Pitt Meadows, Maple Ridge and Mission;
- an additional crossing of the Pitt River as an extension of the North Fraser Freeway to either David Pathan Way or the Trans Canada Highway;
- additional capacity over both the South Arm and North Arm of the Fraser River; and
- a third crossing of the Burrard Inlet near Burns Point to provide a north-south connection between David Pathan Way and Highway 1 onwards to both the Annacis system and King George Highway.

In addition, the Ministry has made other observations relating to more detailed planning:

- on the Massey Tunnel where the counter-flow lane may prove operationally unsatisfactory over an extended period and may require new solutions;
- on the Trans Canada highway to support its provincial and national role; and
- other strategies for infrastructure which may emerge as investments are required for seismic security (earthquake-proofing) and major rehabilitation.

Further, there have been discussions with regions neighbouring Greater Vancouver on the merits of an additional link from the east of the Fraser Valley, being:

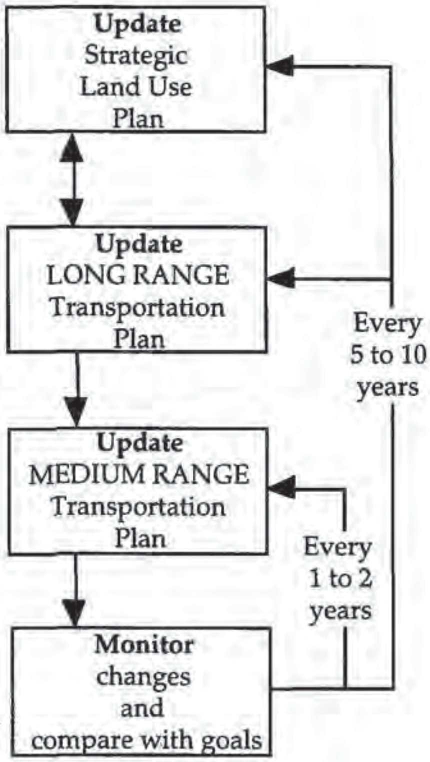
- an east/west corridor parallel to the US border linking Abbotsford/Matsqui and Highway 99 near Boundary Bay to allow for a future high-speed link (not necessarily a freeway) between Vancouver International and Abbotsford airports.

Treatment of Long-range Options: not recommended in 30-year horizon under this plan

While this Report does not recommend that facilities be built in such corridors, they may be needed in light of all the above uncertainties, either within the 30-year horizon or beyond it. The Steering Committee does not recommend the construction of facilities in the above corridors within the 30-year planning horizon because:

- under the assumptions of the long-range plan, they are not required to serve demand before the horizon year; and
- all the corridors, if put into operation, work against the proposed land-use objectives and the pro-transit orientation of the GVRD Livable Region Strategy which the transport plan is intended to reinforce.

Stable planning cycle



The second method of coping with uncertainties is to make it a "living document", regularly updated. This means establishing a regional transport planning cycle and a responsible body, able to recognize and respond to structural changes and surprise events. The planning cycle would:

- cover all modes of transportation, goods and passengers;
- integrate land-use planning with transportation planning, with the transport planning being based on local, regional, provincial and national transport goals and objectives;
- be methodical and have continuity, being able to monitor the transport system and maintain records of data, past strategic thinking and decisions; and
- be associated with a sustained, predictable funding basis to support the required capital projects.

The responsibility for monitoring the condition, usage and operation of the transportation infrastructure, maintaining these records as a database, tracking performance measures against past strategic thinking and decisions would naturally fall to the agencies which are charged with the delivery of this plan and its operational components.

Such a regime does not exist today. The TRANSPORT 2021 project has some of the above attributes but is a single-shot program.

Recommendations to Keep Options Open

5.1 **All parties should regard the preservation of future potential corridors, even though such corridors are not recommended for functioning transport facilities under this long-range plan, as a fully legitimate activity of responsible agencies, in order to keep options open and deal with the uncertainties of the future.**

5.2 **The agencies responsible for transport facilities should continue with those activities required to define, assess and protect long-range options in support of continuous planning.**

5.3 **The Province and local governments should establish a stable planning cycle covering all modes of transportation, passenger and goods movement, which fully recognizes the interaction between land-use and transportation.**

E. What Commitments Are Required—By Whom?

Unprecedented levels of cooperation and coordination will be required to implement this plan successfully.

Because the policies are interdependent, it will be important that each group be able to act with confidence that partner groups are committed to parallel supporting actions.

The long-range plan does not recommend what mechanisms should be used to achieve the plan, but it does list the main items on which a commitment is required from the main parties.

For **local governments**, the most important commitment is to make coordinated changes to local community plans and zoning practices to manage and shape the location of growth within the region. In addition, the local road network for which they are responsible will have to be developed in accordance with the plan.

For the **Province of B.C.** the most important actions are to commit to develop the transportation system to support the proposed Livable Region Strategy , to introduce transportation demand measures (including "sticks" or penalties) and to supply management at the region-wide level.

The following table summarizes the policy commitments required of the partner agencies in order to realize the TRANSPORT 2021 Long-range Plan. Since the TRANSPORT 2021 medium-range plan [18], published under separate cover, deals with timing matters, the table does not answer the question of when these actions should be taken.

The policies are roughly divided into three areas—policy and coordination items, legislative and regulatory items, and finance and implementation items. Some of the policies could be listed in more than one of these areas.

Every recommended policy is keyed to relevant policy numbers {in brackets} in the preceding sections. The table covers all recommended policies—none has been omitted.

	Policy and Coordination	Legislation and Regulation	Finance and Implementation
Provincial Gov't	• Designate inter-regional long-haul road network to be protected from congestion by commuter traffic by restricting access {4.14} • Define, assess, protect long-range options (including those not in this plan) {5.2}	• Change collection of user charges from fixed annual to "pay as you drive" basis (e.g. ICBC premiums) {2.13} • Revise laws to permit corridors to be protected {4.15}	• Create fiscal incentives to promote telecommuting {2.6} • Use road pricing/bridge tolls as primary TDM measure {2.10, 2.11}. Dedicate TDM revenue to transport improvements, not general revenue fund {2.12}; in particular use gas taxes as revenue source for transport improvements {2.14}
Local Gov't (regional and/or municipal)	• Complete Livable Region Strategy for more compact region; allocate growth; define high-density areas {1.1 to 1.4} • Recognize provider-agencies' keeping options open by preserving corridors {5.1}	• Align Official Community Plans with Livable Region Strategy {1.1}	• Provide mixed housing near centres within a transit-, bicycle- and pedestrian-friendly neighbourhood design {1.5, 1.6} • For already urbanized areas: retrofit street patterns for transit service {1.7} • Expand road capacity on regional links primarily for HOV {4.5, 4.7}
Joint Provincial and Local Gov'ts	• Accept increased congestion for solo commuters in order to encourage other options {3.1, 4.6}; protect trucks where possible {3.2} • Establish a stable planning cycle and responsible body for medium and long-range transportation planning {5.3} • Provide framework to facilitate coordination of municipal land-use plans under a regional strategic plan {1.8} • Identify focal point for coordinating TDM {2.17}	• Reallocate existing roadway capacity to maximize throughput of people not vehicles or seats {4.4, 4.5} • Exempt goods movement from demand management {2.3}; develop service standards for trucks {3.3} • Phase out subsidized parking e.g. through by-law requiring employees to also be offered cash-in-lieu of subsidized parking {2.16}	• Integrate TDM into planning; implement as the primary auto-restraint lever; use carrots before sticks, follow solo-driver restraint policy when supplying capacity {2.1, 2.2, 2.5, 4.9, 4.10} • Install HOV/bus priority measures to reinforce TDM {2.9, 4.6}; open HOV lanes to mixed traffic in off-peak hours, including trucks {4.8} • Maintain high mobility for external trade and tourism {3.4}; limit commuter use of long-haul roads {4.11} • Facilitate passenger transfers between regional transit and long-haul transport the region {4.12}
Transit Providers			• Add high-quality services linking regional town centres {4.1}. Offer family of services including paratransit and flexible routes {4.2}; place priority on improving local transit within urban area {4.3}
Other/ to be identified			• Regional TDM body: support voluntary employer trip reduction programs, e.g. with regional rideshare program {2.7, 2.8}; develop regional parking strategy {2.15} • Neighbouring local government (in Fraser Valley): discourage long-haul solo commuting to urban area {2.4, 4.12}

Appendix 1: Public Communications

Introduction

In the spring of 1992, a joint communication plan was launched for the TRANSPORT 2021 project and the GVRD's Livable Region Strategy. The plan was delivered jointly by the GVRD Communications and Education Department, TRANSPORT 2021 and the GVRD Strategic Planning Department. It was designed to ensure that public information and consultation was integrated and occurred at appropriate stages.

Below are the joint communication activities carried out during the TRANSPORT 2021 project in the period September 1991 through August 1993.

Shaping Our Communities: The Challenges of Regional Growth and Transportation
May 1992

This conference provided an opportunity for over 300 residents, private sector stakeholders and decision-makers to examine the implications of current development trends and policies and to discuss the key choices that can shape Greater Vancouver's future settlement pattern and transportation network. Participants included municipal councillors and senior staff, representatives from business, professional organizations, community and special interest groups, and provincial and federal government agencies as well as private citizens.

Transportation Think Tank Seminar
September, 1992

Fifty individuals, including members of the TRANSPORT 2021 Steering Committee, the real estate development industry, members of the academic community, and the transportation and communications industry attended an invitational seminar held at New Westminster, B.C. Its purpose was (a) to broaden the project by exploring what areas merit more attention and (b) to narrow the wide range of scenarios the project should test, by offering informed judgments on how strongly the policy levers might realistically be pulled, and opinions on the practical tradeoffs among them.

Shaping Our Communities: Critical Choices Conference
November 1992

Over 450 stakeholders, community leaders, elected officials and members of the public attended the second major conference. This conference provided an opportunity for participants to consider the implications of alternative ways to share growth among communities and to discuss a preferred direction for regional land-use and transportation planning.

Choices Bulletins
May 1992 to August 1993

Five public information bulletins produced between May 1992 and August 1993 provided progress reports. The bulletins were circulated to community leaders, stakeholders and members of the public.

Transport 2021 Focus Group
February 1993

Two focus groups were conducted with randomly-selected residents of the GVRD to assess public acceptability of transportation demand management measures.

Council of Councils Meeting
March 1993

A half-day Council of Councils meeting was held to discuss growth management challenges facing the region. Attendance (119 people) included elected officials, municipal staff and members of the public from throughout the region.

Public Opinion Survey
April 1993

A public opinion survey (with a sample size of 1200 to produce statistically significant results) was conducted to test public acceptability of transportation demand management measures.

Creating Our Future: Critical Choices Consultation
May 1993

The Critical Choices consultation gave residents the opportunity to learn about all of the GVRD's programmes—including land-use and transportation—and to provide input to the GVRD Board on the affordability and priority of these programmes. More than 2000 residents participated by completing a questionnaire included in a newspaper insert, by viewing the consultation on cable television or by attending one of six public forums held simultaneously in different locations in the region on May 15. The consultation for growth management and transportation asked participants how they would design their community to reduce sprawl, protect the green zone and help to maintain the livability of the region.

Council of Councils Meeting
June 1993

A half-day Council of Councils meeting was held to discuss Livable Region Strategic Plan Proposals and the Transport 2021 proposals for the long and long-range transportation plans. A total of 76 elected officials attended, in addition to municipal staff and members of the public.

Pacific National Exhibition (PNE) Display
August and September 1993

The long-range transportation plan proposals and Livable Region Strategic Plan proposals were highlighted in a land-use and transportation display at the Pacific National Exhibition (PNE). PNE management targeted for 1.1 million visitors to the PNE.

The display was designed for use after the PNE at other appropriate venues to promote the plan proposals.

Presentations and Interviews

Members of the Steering Committee and the Project Team provided briefings, presentations, interviews or speeches at the invitation of these groups during the life of the TRANSPORT 2021 project.

Association of Professional Economists of BC
BC Agricultural Land Commission
BC Chamber of Commerce
BC Energy Council
BC Liberal Caucus Committee on Land-use and Transportation
BC Mortgage Investors' Association
BC New Democratic Party Lower Mainland MLAs
Calgary-Vancouver Transport Corridor Business Group
Canadian Federation of University Women, North Vancouver
CBC French Language Television News
CBC Radio Morning Show
CBC Television Evening News
CFVR 850 (Abbotsford) Radio
Chartered Institute of Transport-B.C and Yukon Section
City of Richmond Planning Dept.
CKNW Bill Good Radio Show
CKNW Fanny Keefer Radio Show
Delta Chamber of Commerce
Dewdney Alouette Regional District
Dewdney Alouette Regional District Transportation Task Force
Fraser Cheam Regional District Transportation Task Force
Fraser Valley Liberal Riding Association
GVRD Air Quality Advisory Committee
GVRD Regional Engineers' Advisory Committee
GVRD Strategic Planning–Technical Advisory Committee
Institute of Transportation Engineers, Vancouver
Institute of Transportation Engineers, Victoria
Richmond Chamber of Commerce–Transportation Committee
Squamish-Lillooet Regional District Transportation Task Force
Sunshine Coast Regional District Transportation Task Force
Surrey Chamber of Commerce–Transportation Committee
Transportation Ass'n of Canada-Urban Transportation Council
Tri Cities Chamber of Commerce
Urban Development Institute
UTV Evening Television News
Vancouver Board of Trade
Vancouver City Plan Ideas Fair
Vancouver Courier Newspaper
Vancouver Electric Club
Vancouver International Airport Authority Management
Vancouver International Airport Transportation Seminar
Vancouver Port Corporation Municipal Liaison Committee
Vancouver Province Newspaper
Vancouver Quilchena–Community Forum on Transportation
Vancouver Sun Newspaper
Weather Network Television
Z95.3 FM and CISL 650 Radio Environmental Show

Appendix 2: List of Publications

Publications can be obtained from
GVRD Communications and Education Department
4330 Kingsway
Burnaby, B.C., V5H 4G8
Tel: (604) 432-6339
Fax: (604) 432-6399

Proceedings of Public Conferences
(held jointly with the GVRD's Strategic Planning Department)

First Conference:
Shaping Our Communities: The Challenges of Regional Growth and Transportation
(held May 23, 1992 in Surrey, B.C.) *July 1992*

Second Conference:
Shaping Our Communities: The Critical Choices
(held November 28, 1992 in Richmond, B.C.)
February 1993

Third Conference:
Creating Our Future: Critical Choices
(held May 15, 1993 simultaneously in six locations in the region)
June 1993

Council of Councils Meeting:
(held March 27, 1993 in Delta, B.C.) *May 1993*

Council of Councils Meeting:
Creating Our Future: Critical Choices
(held June 12, 1993 in New Westminster, B.C.)
June 1993

"Choices" Bulletins
(eight-page bulletins published jointly with the GVRD's Strategic Planning Department)

1. "Preparing for the 21st Century" *May 1992*
2. "Conference Rejects Business As Usual Planning" *September 1992*
3. "Critical Choices" *November 1992*
4. "Building A Livable Region" *March 1993*

Newspaper Inserts
(distributed in community and/or region-wide newspapers)

"Critical Choices"
A sixteen-page newspaper insert *May 1993*

"Greater Vancouver into the 21st Century"
A four-page newspaper insert *August 1993*

Working Papers
(published by TRANSPORT 2021)

Working Papers are referenced by their number in square brackets [ ] in the body of this Report.

Objectives

[1] Goals, Objectives and Criteria for Developing a Long-range Transportation Plan for Greater Vancouver *May 1993*

Demand for Transportation

[2] Transportation Demand Management Measures and Their Potential for Application in Greater Vancouver *January 1993*

[3] Transportation Demand Management: A Forecast Modelling Approach *February 1993*

[4] A Qualitative Research Study on Transportation Demand Management Measures *March 1993*

[5] Public Opinion Surveys on Transportation Demand Management *July 1993*

[6] Parking, Mobility and Accessibility in Greater Vancouver *May 1993*

[7] Trucking in Greater Vancouver: Demand Forecast and Policy Implications *August 1993*

[8] Urban Access to Gateways - Seaports, Airports, and Major Routes into and out of the British Columbia Lower Mainland *March 1993*

Supply of Transportation

[9] Evaluation of Three Transportation Supply Scenarios for Greater Vancouver *July, 1993*

[10] Derivation of a Long-range Transportation Supply Strategy for Greater Vancouver *August 1993*

Transportation Costs

[11] The Cost of Transporting People in the British Columbia Lower Mainland *March 1993*

[12] Historical Public Transportation Expenditures in the BC Lower Mainland *August 1993*

Land-use and Transportation

[13] Transportation Implications of Regional Growth Options in Greater Vancouver *March 1993*

[14] Transportation Implications of a Compact Metropolitan Growth Option *May 1993*

[15] Regional Transportation Implications of Neighbourhood-Level Planning Initiatives *August 1993*

Other Topics

[16] Economic Development Perspectives on Transportation Planning *October 1992*

[17] New Transportation Technologies and Their Implications for Greater Vancouver *February 1993*

[18] A Medium-range Transportation Plan for Greater Vancouver *September, 1993*

Attachment 3

FINAL REPORT

FRASER RIVER NORTH AND SOUTH ARM CROSSING STUDY

Prepared For:

PROVINCE OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND HIGHWAYS
BC TRANSPORTATION FINANCING AUTHORITY
GREATER VANCOUVER REGIONAL DISTRICT
AGRICULTURAL LAND COMMISSION
BC FERRIES CORPORATION
BC TRANSIT

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32802-3

July, 1995

EXECUTIVE SUMMARY

A) Background to the Study

The South Coast Transportation System Plan builds from and responds to the recommendations of the GVRD's Livable Region Strategy Plan (LRSP) and Transport 2021[1] and represents an important stage in an on-going transportation planning process. The general principles set out by the Provincial Transportation Strategy apply to this process and these are:

- To make better use of existing transportation facilities and services.
- To make more strategic transportation investments
- To develop more costs effective methods for project service and delivery.
- To strengthen links between transportation revenues and expenditures, and between responsibility and accountability for transportation initiatives; and
- To maintain competitiveness of transportation service providers.

The Fraser River North and South Arm Crossing Study is one of four component studies of the South Coast Transportation System Plan. The regional studies include:

- East-West Connector Study
- Trans-Canada Highway Study
- HOV Study
- Fraser River Crossing Study (with a sub-component dealing with the Ladner-Tsawwassen Area.)

[1] Transport 2021. 'A Long Range Plan for Greater Vancouver.' A Joint Project of the Greater Vancouver Regional District and the Province of British Columbia. September, 1992.

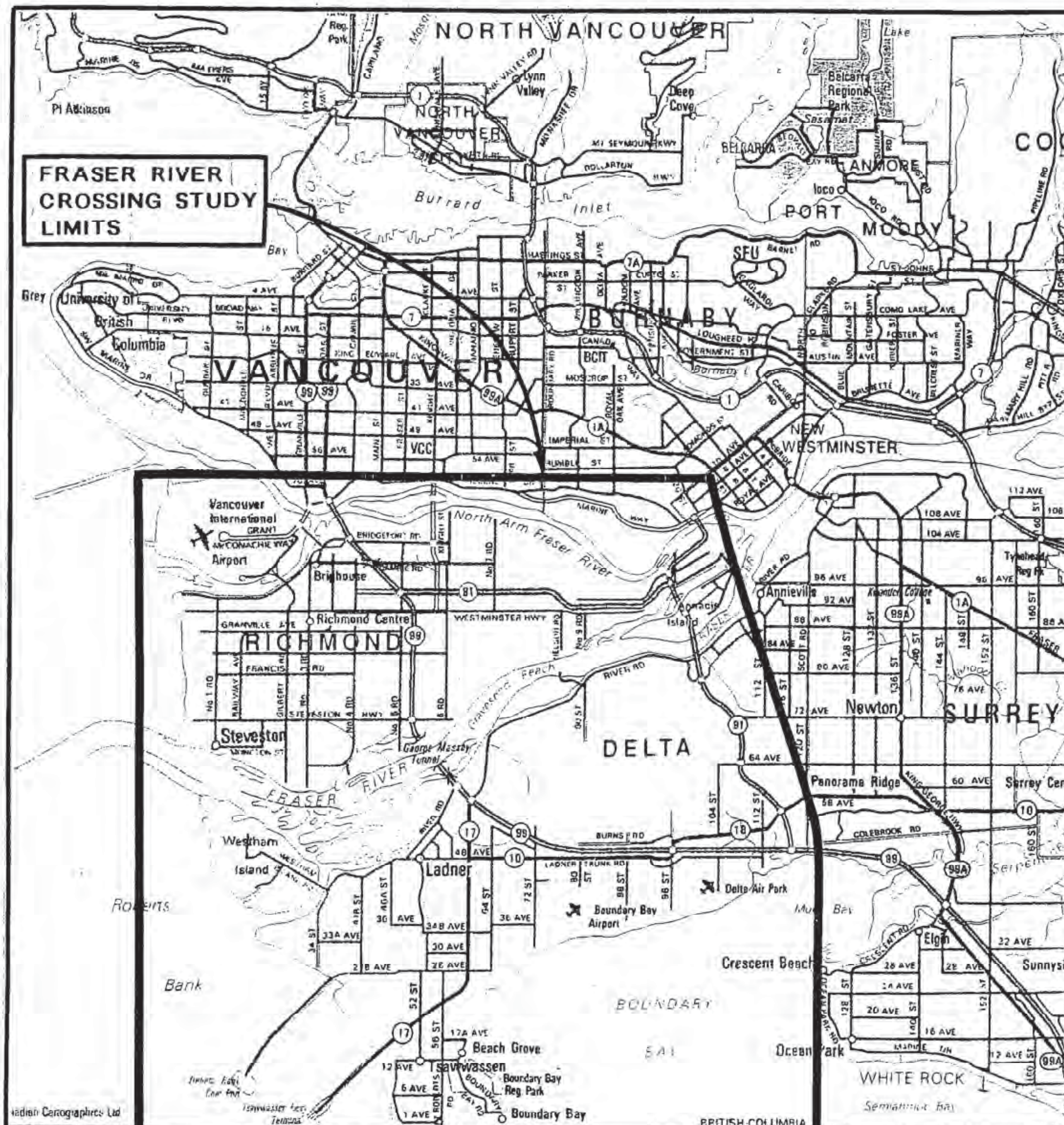

Exhibit ES.1

STUDY AREA

FRASER RIVER CROSSING STUDY

Reid Crowther

ward consulting group

GP - 225 (Special)

This report summarizes an assessment of the traffic characteristics of the demand for the crossing of the North and South Arm of the Fraser River during the morning peak period. The base land use data for this study is the Livable Region Strategic Plan and the traffic data is taken from the recommendations of the Transport 2021 Study. The Transport 2021 recommendations could result in increased transit and High Occupancy Vehicle trips during peak periods through the implementation of selected infrastructure and transport demand measures. In the analysis, this report examines these implications through a series of twelve options. The options are reduced to three using an evaluation technique based on Multiple Account Evaluation. A preferred option is identified and an implementation strategy developed for inclusion in the regional transportation system.

B) *Study Area*

The Study Area is located in Exhibit ES.1. The area is bounded by the Strait of Georgia on the west, the east end of Annacis Island in the east, Marine Way in the North and the Canada-U.S. border in the south, and encompasses most of Richmond and Delta.

The existing crossings of the North Arm in the area are the Arthur Laing Bridge, the Oak Bridge, the Knight Street Bridge and the Queensborough Bridge. The South Arm is currently crossed by the Alex Fraser Bridge and the George Massey Tunnel. Additionally, the Puttallo, Port Mann and Pitt River Bridges east of the study area affect the total traffic in the area at any time.

Major controlled access highways in the area include the following:

Highway 99 from the United States border to the Oak Street Bridge. There are interchanges at the King George Highway, Crescent Road, Highway 91(south interchange), Matthews and Highway 10 south of the Fraser River. Highway 99 crosses the river through the George Massey Tunnel. There is a southbound access to River Road immediately south of the tunnel. On Lulu Island, there are interchanges with Highway 99 at Steveston Highway, Westminster Highway, Highway 91(north interchange) and Bridgeport Road. Peak Hour volumes through the George Massey Tunnel in excess of 6000 vph have been observed.

Highway 91 extends from Highway 99 (north of Westminster Highway) eastward to Hamilton/Highway 91A and then south across the Alex Fraser Bridge to rejoin Highway 99 west of 120th Street. There are interchanges at Knight Street, River Road/Nordel Way, 72nd Avenue, 64th Avenue and Highway 10 before the facility rejoins Highway 99. There are traffic signals on Highway 91 at Hamilton Avenue, Highway 91A, and 72nd Avenue. Northbound morning peak period volumes have been observed in excess of 5800 vph.

Highway 17 between Highway 99 and the ferry terminal has limited access control with signalized intersections at Highway 10, 56th Street and 52nd Street. There is a partial interchange at Deltaport Way. Tsawwassen Road is an at grade intersection.

Additionally, major urban arterials in the study area include Steveston Highway, Gilbert Road, Bridgeport Road, No 3 Road, Westminster Highway and Garden City Road in Richmond. In Delta, major arterials include Highway 10 and River Road.

The population of the study area proper is projected to be 335,000 persons by the year 2021, while employment is expected to be 175,000 jobs.

Activity centres are defined as centres of economic activity which has significance nationally, provincially, regionally and locally. Many of these tend to be important traffic attractors and generators. It is further assumed that because of the economic significance of the activity centre, a higher value can be placed on these trips. As such, service to and from these centres should be available at a very high level of service. Three primary activity centres have been identified in the study area and these are the BC Ferries Terminal at Tsawwassen, the seaport facilities at Roberts Bank, and the Vancouver International Airport. Additionally, four secondary centres have been identified and these are the Boundary Bay Airport, the North Richmond Industrial area, the South Richmond Industrial Area and the Mitchell Island, Marine Drive area.

C) Review of Study Approach

A base transportation network encompassing the recommendations of the Transport 2021 Study served as a basis for developing traffic projections for the study area. The traffic simulations for the morning peak period for the year 2021 were examined in respect to capacities of the river crossings in the study area and selected expressway links on Highway 99 and Highway 91. From this examination, it was possible to establish transportation objectives for a series of feasible options. The objectives for the transportation options, included the following:

- Improve levels of service for the river crossings in the Study Area including; George Massey Tunnel, Alex Fraser Bridge, Queensborough Bridge, Knight Street Bridge and the Oak Street Bridge. Options identifying new capacity and new HOV designations were developed.

- Improve level of service for the East West traffic by improving Highway 91 capacity and or adding HOV lanes
- Reduce the high traffic accident rate at the south entrance to the Massey Tunnel.
- Improve service to the BC Feries' Terminal at Tsawwassen by improving the level of service from Highway 99 along the Highway 17 Corridor.
- Improve service to the Vancouver International Airport by improving network connectivity in a north/south and east west direction. At the same time, cross border and provincial traffic would receive increased levels of service.
- Ensure that transit competitiveness is maintained.

D) *Evaluation of the Options*

In total, 12 feasible options were identified in three corridors; the Highway 99 Corridor, the Highway 91/Tree Island Corridor and the Boundary Corridor. An analysis of the traffic planning model output indicated that from a traffic perspective, the options met the objectives to a greater or lesser degree and that they could be implemented. In other words, all the options were feasible.

The feasible options were compared in an evaluation matrix, that identified criteria from a number of sources as follows:

- The transportation planning model provided base information of vehicular and transit volumes, average speeds, vehicle kilometers travelled and so on.
- Financial information was developed for each option through capital and maintenance estimates.
- An environmental overview of the study area provided base information on the environmental impacts.
- Estimates were developed for the land requirements that would be needed for each option from the Agricultural Land Reserve and from Indian lands.

- Other variables such as emergency response, transit encouragement and provincial connectivity which were qualitative in nature were based on descriptions.

The evaluation was used to identify three favoured options and these were:

- One option based on the Tree Island Corridor
- One Option based on the Highway 99 Corridor
- One Option combining features of the Tree Island and Highway 99 Corridors.

The options were modified to incorporate the recommendations of the Ladner/ Tsawwassen area and to ensure the overall network was continuous, logical and flexible. The transportation planning model again served as a basis for projecting the morning peak period travel for the year 2021. The evaluation criteria were reassessed and a preferred option identified.

E) *The Preferred Option*[2]

The preferred option is shown in Exhibit ES.2 and the physical components are summarized as follows:

⇒ The Oak Street Bridge[3] is extended to five lanes and additional lanes are constructed on Highway 99 from 8th Avenue in White Rock to the Oak Street Bridge, a road distance of approximately 35 kilometers. The deficiency of river crossing capacity over the North Arm in the Highway 99 corridor was identified through sensitivity analysis. The Oak Street Bridge improvement is recommended as additional infrastructure along with the HOV lanes on Highway 99 South to the Richmond Freeway. These are added to the preferred option for logical system development, HOV and SOV traffic service improvements, and future flexibility.

[2] The timing and need for specific facilities will ultimately be influenced by transportation demand initiatives which are outside the scope of this study but which could be in effect at the time of implementation.

[3] Additional north arm crossing capacity is recommended on the Highway 99 Corridor. The Oak Street Bridge location may not be the best location. Feasibility analysis of alternative crossing capacity is recommended.

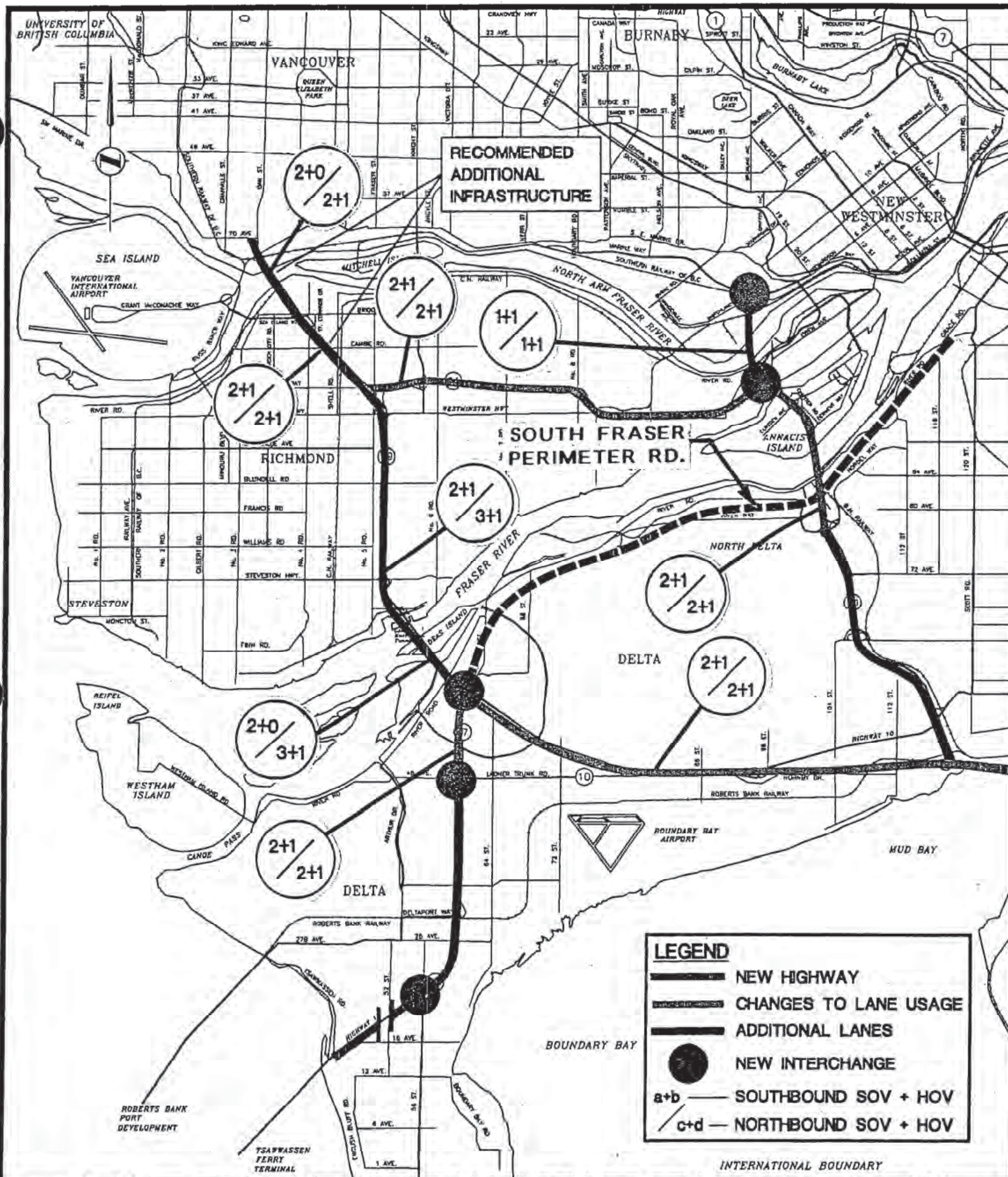

Exhibit ES.2

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⇒ A new two lane tunnel tube is added at the George Massey crossing. This includes two additional lanes between the Steveston Highway and Highway 99/17 interchanges. Further, both of these interchanges are modified to accommodate the additional lanes. The Highway 99/17 northbound ramps from Highway 17 are realigned southeast to reduce the difficulty of the merge between that interchange and the tunnel.

⇒ Highway 17 between Highway 99 and the causeway is upgraded. New interchanges are provided at Highway 10 and 56th Street and an overpass is provided at 52nd Street.

⇒ The Tree Island Component adds two lanes to the entire length of Highway 91. A new four lane connection is provided between the Highway 91/91A interchange and Marine Way. This includes a new four lane crossing of the North Arm at Tree Island

⇒ Lane designations call for the Oak Street Bridge to operate with two SOV lanes in each direction and one HOV lane reversible with the peak traffic direction. Highway 99 would operate as two SOV's and one HOV in each direction. The length of the Highway 91 Corridor will operate as two SOV's and one HOV lane in both directions. The Tree Island Corridor including the crossing, will operate as one SOV and one HOV in each direction. Transit buses would operate on the HOV lanes.

The preferred option has a number of strengths and these were identified as follows:

⇒ The Highway 99 Corridor will have one additional HOV lane across the North Arm directly on the corridor. This is achieved by adding the lane to the Oak Street Bridge superstructure.

⇒ HOV capacity will be added to the Highway 99 Corridor.

⇒ The Highway 99 Corridor will have superior flexibility and be able to respond in traffic service to traffic increases outside of the Transport 2021 projections.

⇒ The increased road capacity in the north/south direction will improve access to the Tsawwassen Ferry terminal, Vancouver International Airport and the Vancouver Central Business District. Access to the secondary activity centres at Mitchell Island and the Richmond Industrial Centre will also be improved. The level of service to trans-border traffic will also be positively affected.

⇒ Transit and HOV usage are encouraged.

⇒ The Livable Region Strategic Land Use scenarios are encouraged.

⇒ The use of current facility location for improvements minimizes the intrusion on new facilities on Indian Lands and the Agricultural Land Reserve.

⇒ The Tree Island crossing provides a new crossing location spreading out the vehicles entering the Vancouver and Burnaby road systems across the North Arm. There is the opportunity to improve connectivity to the provincial system and reduce congestion on the Queensborough Bridge.

The preferred option will operate more than satisfactorily under the TDM and land use assumptions made in the traffic simulations. Sensitivity analysis examined what is likely to happen if the actual land use is not as concentrated or if the Traffic Demand Measures are less successful than assumed with the transportation planning model.

F) Sensitivity Analysis

The sensitivity tests on the preferred alternative included the following:

- Removal of all river crossing tolls in the study area. The crossings include the Oak Street, Knight Street and Tree Island Bridges on the North Arm and the George Massey Tunnel and the Alex Fraser Bridge on the South Arm.
- Removal of all TDM measures, including tolls, gas tax increases and HOV priority.
- Imposition of trend land use growth, that is the cluster densities of the livable region strategic plan were assumed not achieved.
- Removal of the Richmond Sky Train from the network and no Richmond Skytrain or bridge tolls.
- Implications of not improving the Highway 99 capacity north of the Richmond Freeway

If the north end of the Highway 99 Corridor is improved through additional crossing capacity, the system can respond to unanticipated growth in traffic. The system is flexible, delays are reduced and provincial level traffic on the Highway 99 Corridor is appropriately served. The importance of improving the roadway capacity of the Highway 99 Corridor between the Richmond Freeway and 70th Street regardless of the level of TDM measures or the success of the Richmond Skytrain is demonstrated in the sensitivity analysis. If the Oak Street Bridge, for financial or technical reasons, cannot accept an additional lane, then other options in the area should be pursued.

G) *Implementation Strategy*

An implementation strategy for the preferred alternative is shown in Table ES.1.

Table ES.1: Proposed Implementation Strategy for the North South Crossing Study

Component and Time Frame	Individual Tasks	Comments
Phase I Design Phase 1996-2002	Detailed design of Oak Bdg lanes, tunnel tube, merge lanes, I/C modifications on Hwy. 99. Traffic operations for Highway 99. Land requirements, negotiations, EIS if req'd & approvals	Seismic review of Oak Bdg and tunnel. Implement TDM's. Monitor success of TDM's. Use performance measures as design input. Obtain approval and financing. Initiate construction phase I for summer of 1998.
Construction 1998-2000	S/B lane on Hwy. 17: 56th St to Causeway. HOV lanes from Oak B.to Steveston. Modify interchanges	Construction Estimates • Hwy. 17: 56 to Cswy $3.0M • HOV lns to Steveston $13.0 M • I/C modifications $8.0M
Performance Measures 2000-2008	Measure success of TDM's, track tolls, Hwy. 99 Corridor	Understand TDM's. Identify land use patterns. Identify traffic patterns. Growth in traffic on Hwy. 99 corridor
Construction 2001-2005	Hwy. 99: Oak Bridge HOV lane Steveston to Hwy. 17 Two lane tunnel tube I/C Steveston I/C Hwy. 99/17	Construction Estimates: • Oak Bdg HOV lane $43.0 M • Steveston - Hwy. 17 $16.0 M • Tube $68.0 M • I/C Steveston $10.0 M • I/C 99/17 $8.0 M
Construction 2006-2010	Hwy. 17: HOV lanes Hwy. 17 Interchanges 52nd St Overpass Hwy. 99: HOV lanes Hwy. 17- 8th Ave. Modify Interchanges	Construction Estimates • Addt'l Lanes $21.2 M • Interchanges $42.5 M • 52nd St. Overpass $ 5.0 M • Addt'l Lanes $48.0 M • Modify I/C $8.0 M
Performance on Hwy. 91 2004 - 2008	Measure success of TDM's, track tolls, Hwy. 91 Corridor	Understand TDM's. Identify land use patterns. Identify traffic patterns for Tree Island. Growth in traffic on Hwy. 91 corridor
Phase II Construction 2008-2012	Highway 91: Knight - 91A, HOV lanes 91A - 99 via Fraser Interchange Modifications	Construction Estimates: • HOV: Knight - 91A $22.5 M • HOV: 91A-99 South $22.0 M • I/C modifications $18.0 M

Component and Time Frame	Individual Tasks	Comments
Construction 2013-2016	Tree Island Connector: 4 lanes 91A - Marine Way River Crossing I/C @ Marine Way	Construction Estimates: • HOV & SOV lanes $16.0 M • Bridge $45.0 M • I/C @ Marine $22.0 M

Performance measures are recommended from the time TDM's are implemented through the first Phase of construction. This will provide the opportunity to develop better planning information and to review the decision to upgrade Highway 17 from 56th Street to Highway 99 and the advisability of proceeding with the Highway 99 and Tree Island improvements. The opportunity is available to implement the most appropriate transportation network serving the Richmond / Delta area.

H) Construction Scheduling

The proposed construction schedule covers the period from 1998 to 2016. Phase I of the schedule is the Highway 99 corridor. This includes the improvements from the Ladner/Tsawwassen area through the tunnel and on Highway 17.

Phase II of the schedule is for the Highway 91 and Tree Island Corridors. It is proposed to begin construction on the Highway 91 Corridor in 2008. The Tree Island connections are scheduled to begin construction in 2013 and be completed by the year 2016.

The total estimated construction cost for all improvements is $460.0 million spread over a twenty year time frame. The proposed construction scheduling is summarized in Exhibit ES.3.

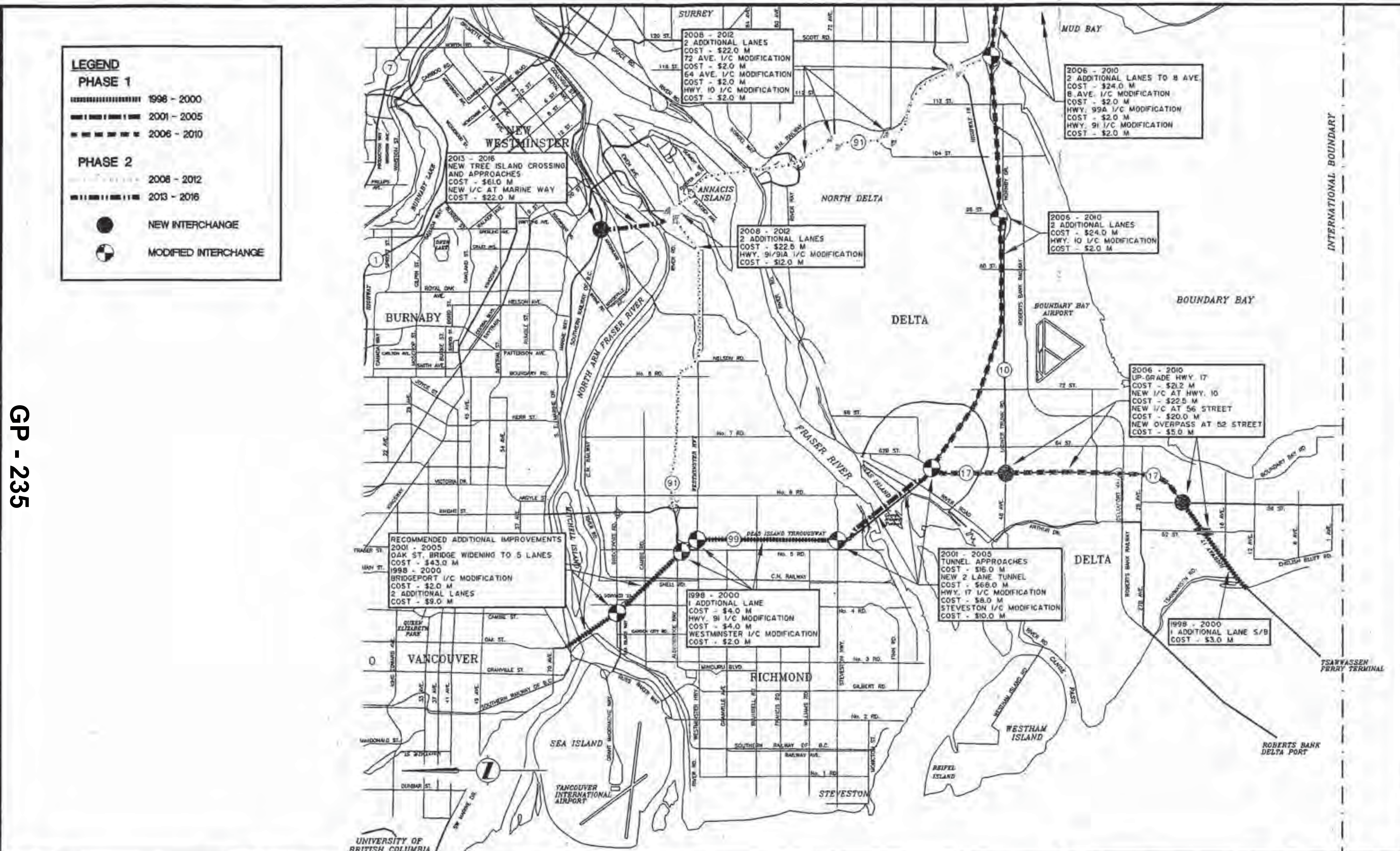

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Exhibit ES.3
PREFERRED OPTION
IMPLEMENTATION STRATEGY
FRASER RIVER CROSSING STUDY

Attachment 4

Gateway Program

Improving Roads and Bridges for people, goods and transit throughout Greater Vancouver

Program Definition Report

January 31, 2006

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1. INTRODUCTION

Greater Vancouver has seen tremendous change over the past decade. Significant population and economic growth combined with changing regional travel patterns and expanding trade has placed considerable strain on our transportation system. Congestion on regional roads and highways is increasing, with growing impacts to residents, communities, the environment and the economy.

High levels of congestion lead to unreliable travel times for vehicles and transit, as well as uncertain operating conditions that increase driver stress and contribute to a growing number of vehicle collisions. Congested roads make incident management more difficult and increase the use of community streets as drivers attempt to avoid queues and delays on major routes. Transportation is now the top concern for Lower Mainland residents[1].

The business community is also concerned. The BC Trucking Association estimates that goods movers are stopped or slowed in Lower Mainland traffic 75% of the time, and approximates the current cost of congestion to goods movers at approximately $500 million per year. Transport Canada estimates the economic impact of congestion on all traffic in the region is up to $1.5 billion per year[2], with the rising costs of delivering goods and services eventually passed on to consumers.

Over the next 25 years, Greater Vancouver's population is expected to grow by about 900,000 residents (more than the population of New Brunswick). Without action, congestion will get worse, quality of life will suffer and economic opportunities will be foregone. Investment in transportation is required to improve the region's livability and its competitiveness as a trading centre and a place to do business.

Addressing this situation requires a comprehensive and integrated response that addresses the need for both goods and people movement. Significant investments are required in transit services, roads and facilities to accommodate other modes of transport.

The Province and other levels of government have committed substantial resources to developing comprehensive plans for measures such as expanding the region's rapid transit system and cycling networks. However, such investments can only address some of the needs. Significant investment in roads and the highway system is also required.

This report focuses on addressing congestion in three priority corridors that fall under the Gateway Program, which is part of a broader strategy called "Opening up B.C.":

1. Along the south shore of the Fraser River – referred to as the South Fraser Perimeter Road;
2. Along the north shore of the Fraser River – referred to as the North Fraser Perimeter Road; and,
3. The Highway 1 corridor from Vancouver to Langley, including the Port Mann Bridge.

These corridors are not only major commuter routes; they are also major goods movement corridors. Congestion on these routes, particularly the Highway 1 and North Fraser Perimeter Road corridors, has become much worse than anticipated 10 years ago (when the Livable Region Strategic Plan [LRSP] was adopted), and traffic volumes are projected to continue increasing. Improvements to the North Fraser corridor are also required to realize the full potential benefits of the Golden Ears Bridge.

Along the south shore of the Fraser River, commercial traffic has grown significantly. A new continuous route is required to accommodate this traffic as well as to facilitate planned port expansion and other economic growth.

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This report is organized into four major parts as follows:

Part 1: Problem Definition discusses the problem of congestion, where and why this congestion is occurring, and implications for future growth. It provides the reader with an understanding of key trends, which help in determining appropriate solutions.

Part 2: Responding to the Problem describes the comprehensive and integrated response proposed to improve transportation in Greater Vancouver, and presents pre-design concepts for proposed improvements under the Gateway Program.

Part 3: Benefit-Cost Analysis outlines the preliminary analysis of Program benefits and costs.

Part 4: Moving Ahead describes key activities over the next 18 months to move the Gateway Program forward, including continued work with local governments, public consultation, First Nations consultation and Environmental Assessment review.

PART 1: PROBLEM DEFINITION

2. THE CAUSES AND EFFECTS OF CURRENT CONGESTION

Over the past decade, the LRSP and its associated transportation components, including Transport 2021, have guided transportation investment in Greater Vancouver. The primary goals of the LRSP are to maintain regional livability and protect the environment in the face of anticipated growth. This is to be accomplished by:

- Concentrating population and employment growth in the Growth Concentration Area and in regional town centers;
- Protecting green spaces between and within town centers; and
- Increasing transportation choice (transit, car-pooling and cycling) and discouraging single-occupant vehicle use, while maintaining mobility for goods movement.

The intent is to encourage people to live close to where they work, increase the share of trips taken with transit, in high occupancy vehicles (HOV), on bicycles or by walking, and decrease the share of trips taken in private automobiles. The intent was also to discourage lengthy commuter trips and leave existing road space available to serve goods movement trips. The LRSP acknowledged that if the economic impact of congestion increased beyond what was envisioned, the plan would require revision.

In reality, dispersed employment growth, changing social trends and increasing trade have caused Greater Vancouver's growth to evolve differently than anticipated by the LRSP. As a result, the region's transportation network shows increasing strain from rising traffic volumes and congestion on major roads and bridges.

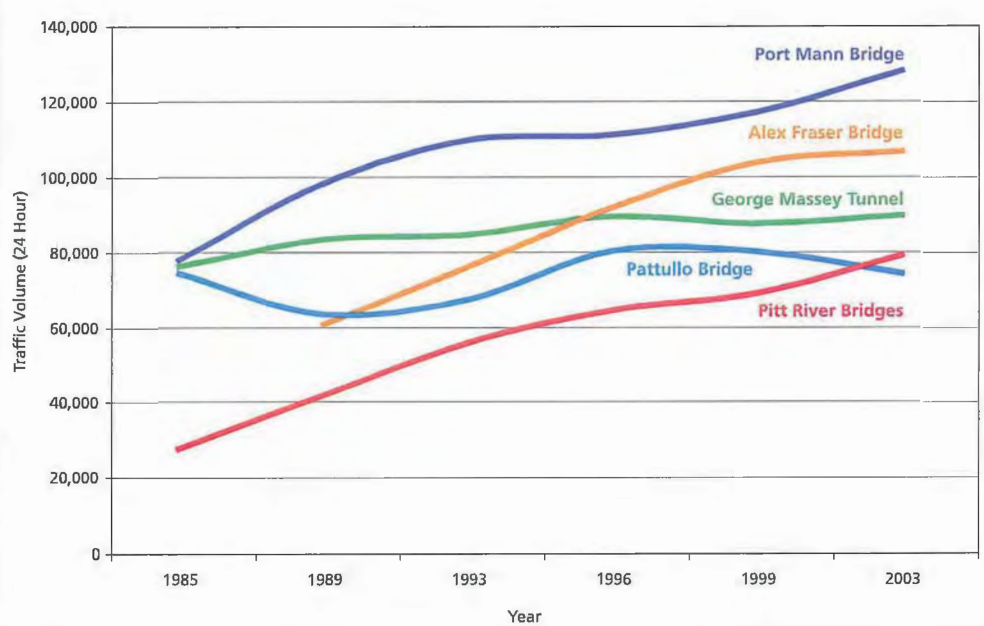
The balance of this chapter provides insights into the nature of these trends to help characterize the transportation challenges now facing our region.

2.1 INCREASING VEHICLE VOLUMES

Increasing traffic volumes can be seen on almost all of the region's major roads but most notably at water crossings. Since 1985, the highest rates of growth in traffic over the Fraser and Pitt Rivers have been over the Port Mann (connecting Coquitlam and Surrey), Pitt River (connecting Pitt Meadows and Port Coquitlam) and Alex Fraser (connecting New Westminster and Delta) bridges, as shown in Figure 1.

The Port Mann Bridge has the highest daily traffic volumes per lane among all major water crossings in Greater Vancouver. Built as a 4-lane bridge in 1964 when the population of Greater Vancouver was 800,000 (and now 5 lanes), the Port Mann Bridge carries approximately 127,000 vehicles per day, a 65% increase since

Figure 1: Growth in Traffic Volumes Crossing the Fraser and Pitt Rivers (1985 - 2003)[3]



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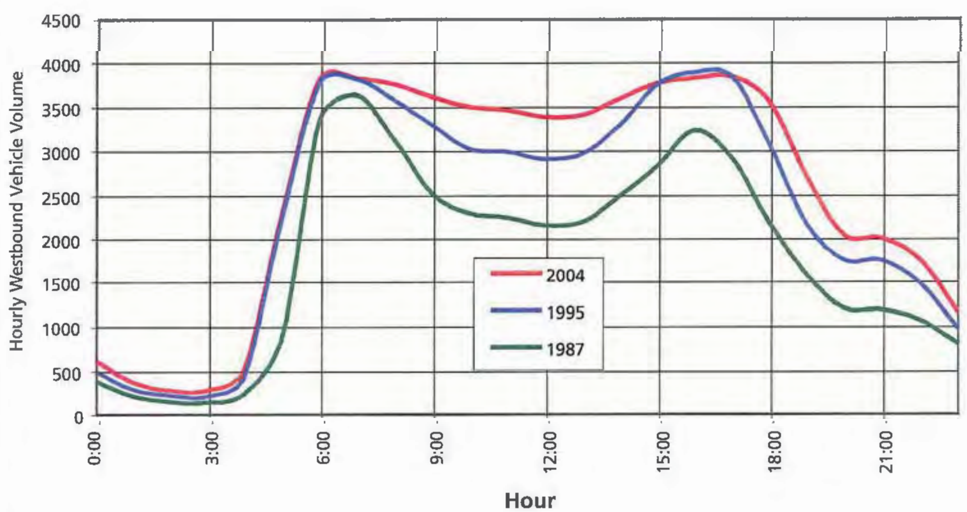
1985 when daily traffic numbered 77,000 vehicles. Daily Port Mann Bridge traffic volumes are 20% higher than the 6-lane Alex Fraser Bridge and 43% higher than the 4-lane Massey Tunnel (even with its reversible lane operations). Daily traffic on the Port Mann Bridge is 20% higher than San Francisco's Golden Gate Bridge, despite having fewer lanes.[4]

The Port Mann Bridge is now congested for 13 hours a day (between 6 a.m. and 7 p.m.).[5] On average, it now takes almost three times as long to travel from 200th Street to the Port Mann Bridge in the peak period as during free-flow conditions. During extremely congested driving conditions when there are vehicle stalls or crashes, it can take over two hours to travel the 29 km stretch between 200th Street in Langley and Willingdon Avenue in Burnaby, with up to an hour and a half spent queuing for the Port Mann Bridge.

Figure 2: Average Weekday Hourly Traffic Volumes on the Port Mann Bridge[6]



With growing demand for travel over an increasingly congested crossing, the "peak" period is now spreading into the midday, as illustrated in Figure 2.

It is estimated that, if current trends continue, the bridge will reach full capacity in the westbound direction between 6 a.m. and 7 p.m. by 2009.[7] This means that the congestion currently experienced in the morning and evening peaks will be experienced all day.

The Pitt River swing bridges are also heavily congested during peak travel periods. The daily traffic volume over the bridges has nearly tripled from 27,000 to 78,000 between 1985 and 2003, and is expected to reach 88,000 by 2007. In addition, traffic volumes in the already congested off-peak direction are expected to increase by 20-30% following completion of the Golden Ears Bridge by TransLink. This will have a small positive impact on the Port Mann Bridge. Complications related to the opening and closing of the swing bridges, while infrequent, can also cause significant congestion and travel delays for both marine and vehicle traffic.

As a new structure, substantial traffic growth was anticipated over the Alex Fraser Bridge when it opened in 1986. This additional capacity has helped to relieve congestion and limit traffic growth at the George Massey Tunnel and Pattullo Bridge.

While congestion at water crossings is an obvious example of traffic bottlenecks, delays are also felt on many of the region's municipal arterial roads, and increasingly along community streets. This is particularly the case in areas that have seen significant growth in freight-related commercial activity.

For example, the largest concentration of industrial and international trade-related facilities in Greater Vancouver is along the Fraser River in Delta and Surrey. Freight-related commercial activity from areas such as the Deltaport container terminal, Fraser Surrey Docks and CN Intermodal yard is growing strongly, despite the lack

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of a suitable transportation route, leading to increasing truck traffic on residential streets and key community connectors such as River Road.

2.2 POPULATION AND EMPLOYMENT GROWTH

Greater Vancouver has seen significant population and employment growth in the past 10 years. However, because Statistics Canada changed the way in which it records employment census data beginning in 1996, relevant population and employment comparisons can only be made for the last five years (1996 to 2001).

Between 1996 and 2001, Greater Vancouver's population grew by about 8.7%, from 1.9 million to 2.1 million. During the same five-year period, total employment grew by 8.6% and the employed labour force[8] by 9.5%.

Figure 3 illustrates the growth in employment and employed labour force by municipality over the past 5 years. Employed labour rather than population is a better indicator of where workers are living. This provides a better benchmark for comparison with where they are working and illustrates changes in commuting patterns.

For example, Vancouver accounted for approximately 21,000 or 24% of the growth in labour force across the region, but less than 5,000 or 4.9% of new jobs, whereas Richmond accounted for 10% of the growth in labour force and 17% of new jobs.

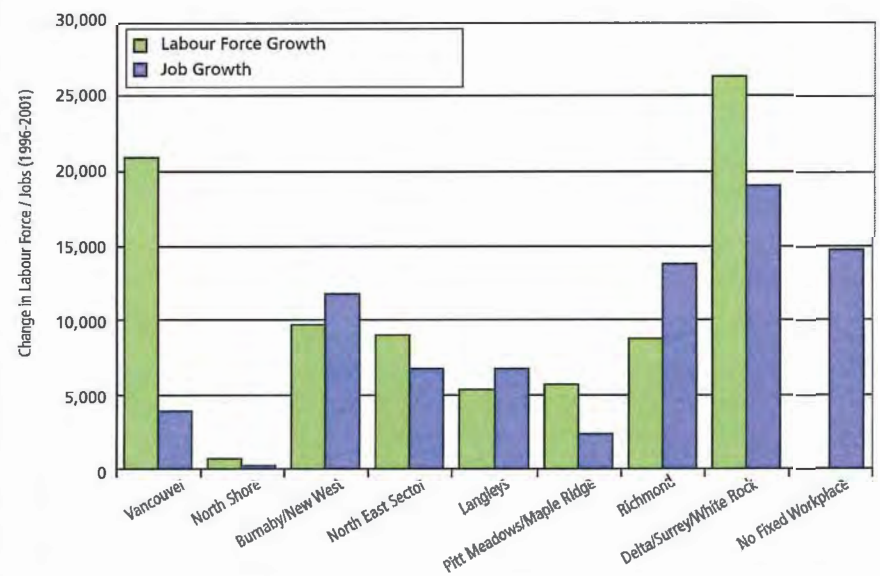
In comparing labour force and employment growth numbers, it is clear that in some municipalities, notably Vancouver, Surrey, Delta, Pitt Meadows, Maple Ridge and White Rock, labour force grew much more than employment. In other municipalities, such as Richmond, the Langleys, Burnaby and New Westminster, employment grew more than labour force. It is also clear that employment with no fixed workplace is growing rapidly.

2.2.1 Growth in Industrial and Office Parks

While overall employment is generally growing as anticipated in regional plans, the location of employment growth and nature of trips being made by the growing population are somewhat different than expected. This is in part due to significant growth in "business park" development over the past 10 years.

Office-based employment comprised approximately 35% of regional employment in 2001. The LRSP anticipated that growth in office-based employment would primarily occur in urban and/or regional town centres, efficiently served by transit. However, in the last 10 years, only 7% of new office jobs have been based in regional town centers while almost 50% have gone into suburban office parks,[10] located primarily in Burnaby, New Westminster and Richmond.

Figure 3: Change in Labour Force and Jobs[9] by Sub-Area (1996-2001)



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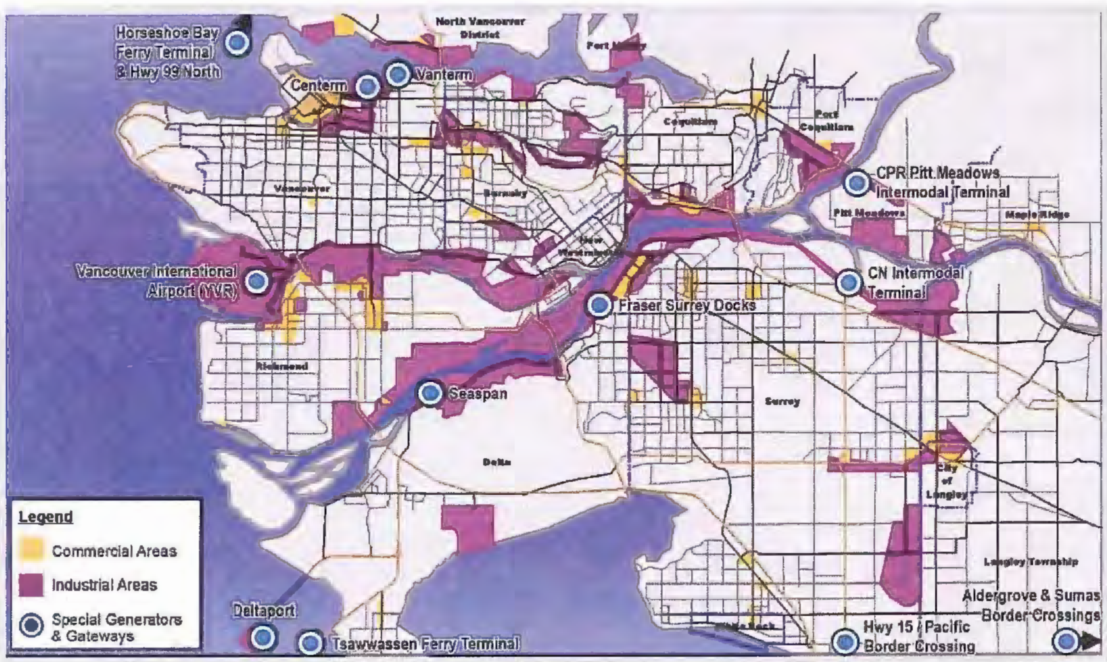
While still only representing 16% of the total regional office market, employment in business parks grew by 240% (24,000 workers) between 1991 and 2001 – the fastest of all floor-space types. Projections indicate that this trend will continue, with business park employment in the region anticipated to increase by another 46,000 workers by 2021, representing a 135% increase for the 20-year period (2001 to 2021).[11]

Commercial and industrial areas in Greater Vancouver as well as the major transportation gateways and important generators of truck traffic such as ports, airports and intermodal yards (see Figure 4) are also key employment generators. Industrial areas are primarily clustered along the Fraser River, with growing importance along the south and eastern shores in Delta, Surrey and Langley as residential development encroaches in the north and western areas such as Vancouver. Commercial areas are scattered throughout the region. These are highlighted in Figure 4.

Figure 4: Major Commercial and Industrial Areas in Greater Vancouver[12]



While some commercial office parks are located along existing transit routes, they tend not to be well served by transit due to low density of development and more remote locations. For tenants, the lower cost of office space and larger square footage in business parks is often of greater importance than transit access. High-rise, multi-tenant buildings found in town centres cost up to 40% more per square foot than low-rise business park locations.[13]

Industrial areas and facilities, also highlighted in Figure 4, accounted for approximately 41% of regional employment in 2001. While industrial development was well distributed within the region, it was led by south of the Fraser communities of Delta (22%) and Langley (24%).[14]

Many of these employment locations are even more challenging in terms of the provision of high quality transit service than the office parks of Burnaby, New Westminster and Richmond. They often see less frequent transit service and require multiple transfers. For example, the 35 km trip from Coquitlam Town Centre to the Tilbury Industrial area of Delta takes more than two hours and three transfers by transit during the business day, but less than 50 minutes by car.

Future projections indicate that growth in industrial areas will be dominated by Surrey and Delta, due to inventory limitations in other areas from encroaching residential development.

2.2.2 New Commuting Patterns

With continued growth in the size of the employed labour force and employment outside of the traditional core of Vancouver, new commuting patterns are emerging. Greater Vancouver no longer exhibits the predominant "suburb-to-downtown" commuting

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pattern of many other major metropolitan centres. Instead, as implied in Figure 5, commuting patterns are becoming increasingly dispersed.

Commuting within and between GVRD municipalities other than Vancouver has increased substantially. Also, while commuting from other GVRD municipalities to Vancouver was essentially unchanged between 1996 and 2001, commuting from Vancouver to other GVRD municipalities increased. In fact the growth in Vancouver residents working in other Greater Vancouver municipalities exceeded the growth in other GVRD residents working in Vancouver by a factor of 9 to 1.

The resulting demand in travel is now much more complex and people are increasingly travelling from everywhere to everywhere.

Figure 6 *(next page)* summarizes travel patterns for City of Vancouver residents. Figure 7 *(next page)* summarizes the same information for the Township and City of Langley (the Langleys).

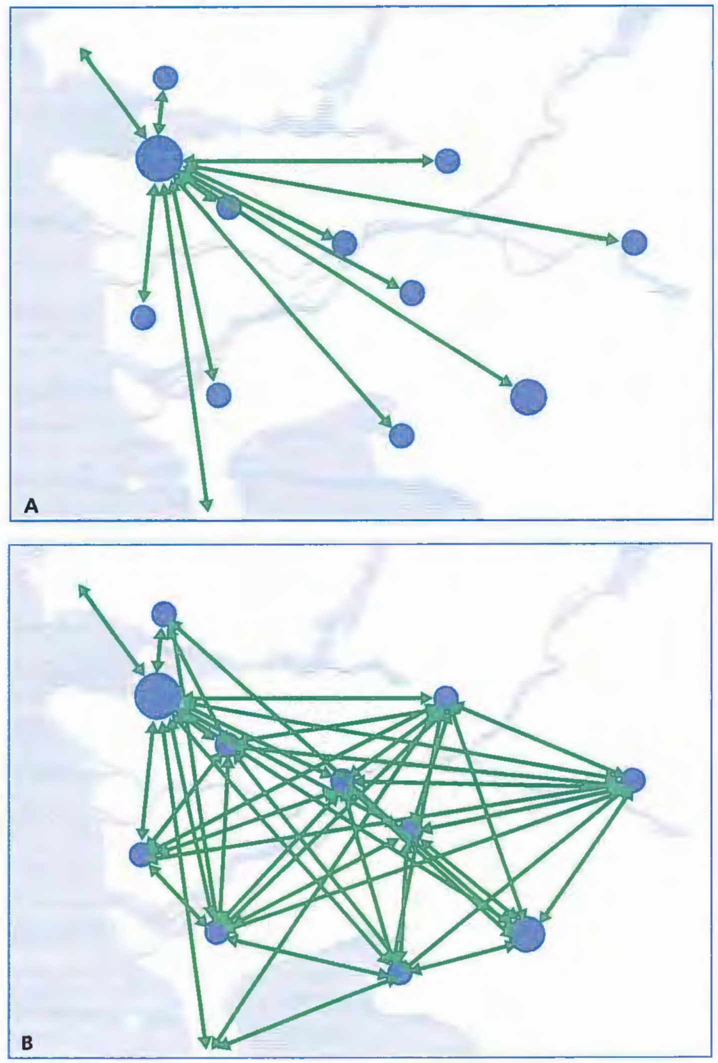
As can be seen in Figure 7, transit is not a significant factor in work travel for many Langley residents, reflecting the relatively less developed transit network in Langley, as well as the lack of transit service in the Port Mann and Highway 1 corridor.

Travel patterns for other municipalities are included in Appendix A.

Considered together, these figures illustrate the important travel demand trends emerging in Greater Vancouver:

- Across Greater Vancouver, a growing number of people live and work in different municipalities;
- Long commutes are relatively small portions of the observed travel volumes; and
- For trips to and within less densely populated areas, automobiles continue to capture a higher share of trips. These trips are difficult and expensive to serve by transit.

Figure 5: Change in Greater Vancouver Commuting Patterns (illustrative purposes only)



Change in Nature of Trips *- There has been in a shift in the traditional suburb to downtown travel pattern (A), to more complex travel patterns (B) as a result of increasing population and dispersed locations for job creation.*

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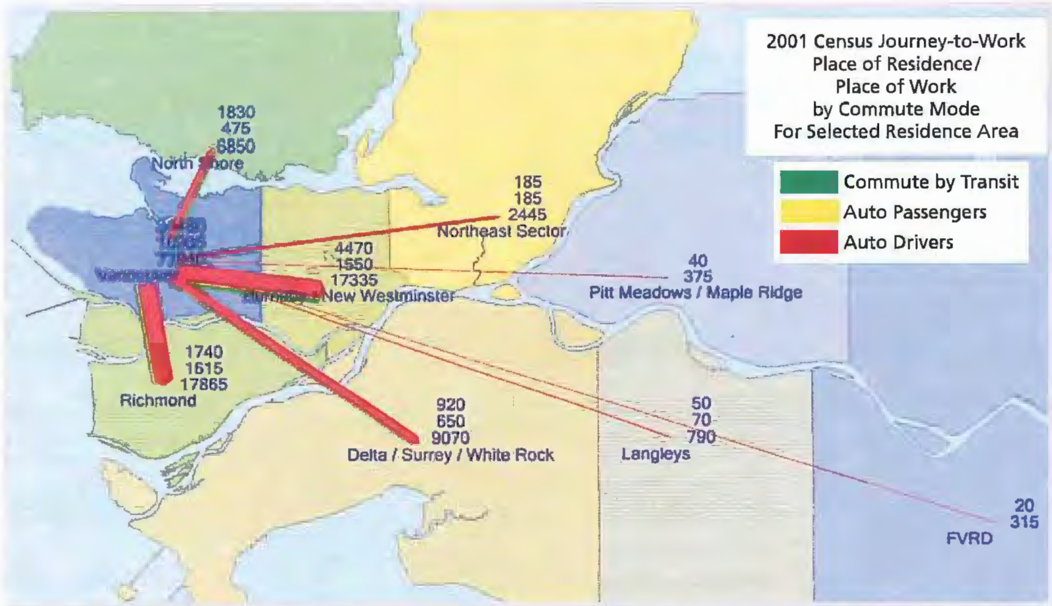

Figure 6: Vancouver Commuting Patterns (2001)

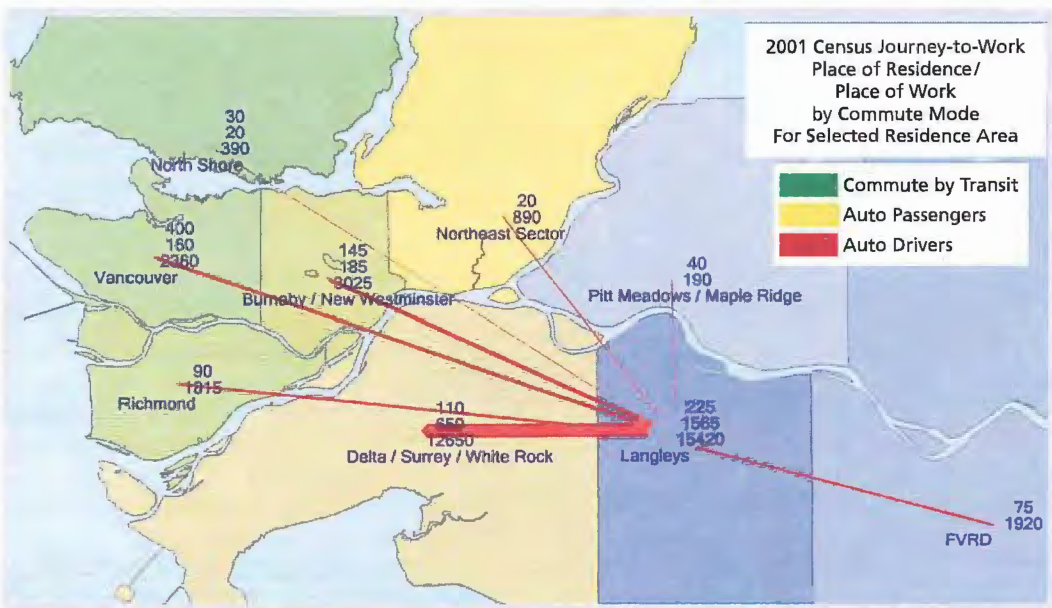

Figure 7: The Langleys Commuting Patterns (2001)

The combination of increased population and employment with more dispersed commuting patterns has contributed to an increase in road congestion.

2.3 EXPANDING TRADE AND TOURISM

The emergence of China as an increasingly important player in the international marketplace, exponential growth in containerized goods movement and the impact that these trends will have on the Lower Mainland were not anticipated when the LRSP was developed. This growth in international trade through Greater Vancouver has contributed significantly to recent improvements in the British Columbia economy.

The transportation sector is vital to trade. In British Columbia, transportation accounts for 114,000 jobs (5.6% of total employment)[15] and contributes over 10% or $8.1 billion to provincial GDP.[16] A large portion of this transportation activity is linked to the ports, airports and intermodal facilities in Greater Vancouver known collectively as "gateways" *(see Figure 4, page 6)*.

As Canada's main Pacific gateway, Greater Vancouver has been a primary beneficiary of the growth in Asia-Pacific trade. The gateway facilities now account for 75,000 jobs and $10 billion in business output annually in Greater Vancouver alone.[17] Vancouver's gateways also support 6,500 jobs and $250 million of the GDP of the provincial economies of Alberta, Saskatchewan and Manitoba.[18]

The recent growth in gateway-related employment has not only contributed to the growth in commuter traffic, it has also been a significant contributor to growth in commercial traffic.

Emerging as a strategic North American transportation gateway for international trade with the Asia-Pacific region, Greater Vancouver has become Canada's highest volume container shipping location, with over 1.6 million twenty-foot equivalent units (TEUs) handled in 2004, transporting goods from all over the world.[19] The Port of Vancouver is 30 hours closer to Shanghai

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than the Port of Los Angeles; therefore, a container arriving at Vancouver can be unloaded and shipped by train to Chicago before a similar container has arrived in Los Angeles.

In addition, the Fraser River Port Authority is the fourth busiest auto port in North America, with 445,000 vehicles received in 2003. Contributing to the expansion of trade with China, Japan and Korea is the increasing demand for Canadian raw materials including minerals and forest products.

The Port of Vancouver has seen a 56% growth in trade with China alone in the past year.[20] Trade with Asia now accounts for 35% of British Columbia's trade, 55% of cargo movements and 95% of container movements through the Port of Vancouver.[21]

Containerized freight movement by rail remains most feasible for containers going to destinations well beyond Greater Vancouver, while trucks are the most feasible option for local and regional transportation. The strong growth of containerized freight volumes has also led to corresponding strong growth in container freight facilities providing related transportation services (packaging and repackaging, warehousing, logistics, supply chain management, etc.). These factors have led to significant growth in container truck volumes. In the past five years, truck traffic from key generators *(ref. Figure 4, page 6)* in the region has grown by approximately 20%.

The growth in trade has come not just from overseas. Increasing Canada-US trade in B.C., now $23.9 billion annually[22], has resulted in the Pacific Highway Border Crossing becoming Canada's fourth busiest.

Economic growth has also come from increased tourism. The Greater Vancouver region attracts more tourists than any other part of British Columbia.

Home to Canada's largest cruise ship facility, Vancouver's Canada Place and Ballantyne Cruise Terminals attract close to 1 million passengers annually.[23] While forecast growth in cruise passenger travel is moderate, the cruise industry is an important seasonal employment generator. The cruise industry generates 4,500 direct jobs, $177 million in wages and $508 million in economic output annually to the region.[24]

The Vancouver International Airport is the second largest international passenger gateway on the West Coast of North America, with some 15.7 million passengers annually,[25] anticipated to grow to 21 million by 2010.[26]

This strong economic growth resulting from increases in trade and tourism through Greater Vancouver's gateways has resulted in more traffic on our roads, connecting to local, national and international destinations. This growth is expected to continue.

2.4 LIMITED INVESTMENT IN TRANSPORTATION INFRASTRUCTURE AND TRANSPORTATION DEMAND MANAGEMENT DURING THE 1990s

The LRSP envisioned substantial investment in transportation infrastructure by 2006. Proposed initiatives included significant investments in transit facilities and services, limited investments in roads, and transportation demand management (TDM) measures such as tolls on all crossings onto the Burrard Peninsula, to provide a disincentive for long-distance commuting as well as to finance proposed transit improvements. The LRSP also identified areas where new roadways were required, including the South Fraser Perimeter Road, to serve goods movement needs.

Since the adoption of the LRSP, the Province built the Millennium Line, and with other partners is investing in the Canada Line (Richmond-Airport-Vancouver Rapid Transit Project) and Coquitlam Light Rail Transit Line. TransLink has expanded bus service and the Province and municipalities have built significant components of the HOV network and are expanding the cycling network.

However, some key components of the regional transportation strategy have not been implemented. Most notably, key demand management measures such as tolling water crossings have not been implemented; the investment in transit, although substantial, has not met projected targets; and there has been no significant increase in major road capacity since the completion of the Alex Fraser Bridge in 1986.

Despite slower than projected progress in transportation investment, Greater Vancouver has seen a significant increase in transit use compared with other North American cities. In 2003, TransLink analyzed trends in ridership for eight Canadian cities for the period 1990-2000. During this period, with the exception of Greater Vancouver, Calgary, and to a limited extent Edmonton, all Canadian cities saw significant declines in overall transit ridership[27] over this period. In fact, Vancouver saw in excess of a 20% increase in ridership. However, during this same period, vehicle use also increased, and transit's share of trips in the morning peak period has remained at about 10% since 1993.

2.5 OTHER FACTORS AFFECTING DEMAND FOR TRANSPORTATION

Other social and demographic trends that are influencing how and when people travel include the following:

Changes in the Nature and Tenure of Work. In recent years, the nature of work has continued to change, with more people telecommuting, becoming self-employed and working part-time.[28] In 2001, just over 10% of people employed in the GVRD had no fixed workplace.[29] Technologies such as cell phones have facilitated mobile offices, and just-in-time manufacturing has created mini-warehouses throughout the region. As a result, people and goods are more mobile and work-related trip-demand is increasing at all times of the day.

People are also changing jobs more frequently than they have in the past. Although changing jobs often results in a change in employment location, people are less inclined to change the location of their residence in response. A recent study by Urban Futures highlights the way in which personal choices such as these are often at odds with regional planning assumptions: "If a person is not certain where they will work in five years, they will not give place of work much importance in deciding where to establish a home."[30]

Increasing Number of Multiple-commute Households. A combination of continued growth in two primary income earners as well as more live-at-home adult children is creating multiple daily commute destinations from individual residences.[31] Between 1996 and 2001, growth in the number of adult children living at home has been highest in the 20 to 29 age group, with 40% of adult children aged 20 to 29 now living with their parents, up substantially from 29% in 1981.[32]

Increasing Number of School-commuting Trips. Almost half of trips to elementary and high school in the GVRD in the morning peak period are made by auto.[33] Growing safety concerns for children have increased the amount of travel to school that is done in private automobiles.

Increasing Number of "Mid-day" Trips. As the region's population has started to reach retirement age in larger numbers, their transportation needs have changed. This trend is seen in travel patterns, with a greater demand for "off-peak" travel contributing to a significant growth in trips made during the midday period. Between 1999 and 2004, the number of people in the 60-64 age group increased by over 25%,[34] compared to total population growth of 6%.

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2.6 SUMMARY OF KEY IMPACTS

The demographic and economic trends described above have created a significantly different transportation situation than envisioned 10 years ago. Growth in inter-municipal travel and other trips is causing increasingly complex travel patterns in our region that are difficult to serve with our existing transit system (or with cycling or car-pooling).

Transit demand in outer municipalities is primarily served by bus due to their lower population densities, while rapid transit is most appropriate for travel between high-density areas. Connections between outer municipalities require multiple transfers and increased travel time. These connections are less frequent, difficult to schedule and expensive to serve. Demand for transit on the Port Mann Bridge cannot be satisfied despite it being one of the busiest commuter corridors in the region. While the Port Mann Bridge is unable to facilitate any reliable transit service due to congestion, other significant commuter water crossings such as Lions Gate and Oak Street Bridges see a transit share of between 10 and 15%.[35]

As a result, more and more vehicles are squeezing onto a static road network. In the past five years, the number of registered vehicles in the GVRD grew by 12.5% (143,400). This growth is greater than population growth during the same time period, and represents an increase of approximately 3.25 vehicles every hour.

Key impacts of growth in congestion include:

- An increase of 30% in average vehicle trip times, although average trip length has remained constant over the past 10 years;
- An increase in the cost of congestion up to $1.5 billion annually; and
- Road users experiencing increasingly fluctuating service levels and longer and more unpredictable travel times – one major incident can cause gridlock in the entire system.

Significant investment in the transportation network is required not only to address these needs but to also accommodate future growth, as described in Chapter 3.

3. THE FUTURE WITHOUT ACTION

3.1 EFFECTS OF FUTURE POPULATION AND EMPLOYMENT GROWTH

The GVRD estimates that the population of Greater Vancouver will increase from the current 2.1 million to 3.0 million by 2031. Most of this growth is expected to take place in the southern and eastern sections of the region. Over 50% of forecast population growth is anticipated to take place in the Northeast Sector (Coquitlam, Port Coquitlam, Port Moody, Anmore and Belcarra) and Surrey/Delta, and only 24% in Vancouver, Burnaby and New Westminster.

Employment in Greater Vancouver is expected to increase by about 500,000 jobs by 2031. This includes strong employment growth in Surrey and Delta.

While transit, cycling, and walking will contribute significantly to travel in the region, using GVRD population and employment targets and assuming currently planned transit and road improvements are in place, the majority of commuting trips will continue to be by private vehicle. It is projected that there will be another 82,000 to 115,000 vehicle trips to accommodate on the road network in the morning peak hour by 2031[36] *(see Figure 8)*. By comparison, the Port Mann Bridge currently carries approximately 127,000 vehicles in an entire 24-hour day.

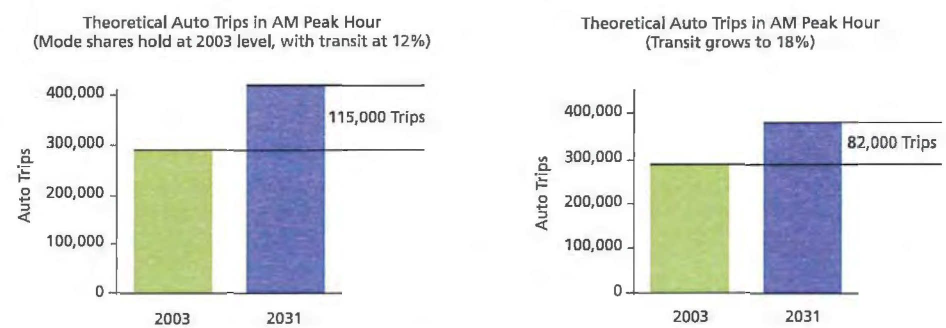
Without additional investment in both transit and road transportation infrastructure, the result will be increasing congestion, longer travel times on Greater Vancouver's already-congested roads and transit lines, and continued deterioration in safety, reliability and quality of life.

For example, Figure 9 *(next page)* provides a simple illustration of what could happen if population continues to grow according to projections and there are no improvements to the Port Mann Bridge.

Currently, the bridge is congested approximately 13 hours per day. The average morning peak period queue to access the Port Mann Bridge westbound is approximately 5 km long, extending as far as 176th Street. By 2011, analysis indicates the average queue could extend 12 km to 200th Street, and by 2021 it could extend 17 km to 216th Street.

This loss of mobility will compromise the region's ability to take advantage of significant economic development opportunities, negatively impact the region's competiveness and reduce safety. Regional and inter-regional traffic will spill onto local streets. Congested conditions result in collision rates at least double that of free-flowing conditions and congestion-related idling contributes significantly to the region's greenhouse gas emissions.

Figure 8: Projected Auto Trips in Morning Peak Hour on Greater Vancouver Road Network (2031)



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3.2 IMPLICATIONS FOR OPPORTUNITIES TO EXPAND TRADE GATEWAYS

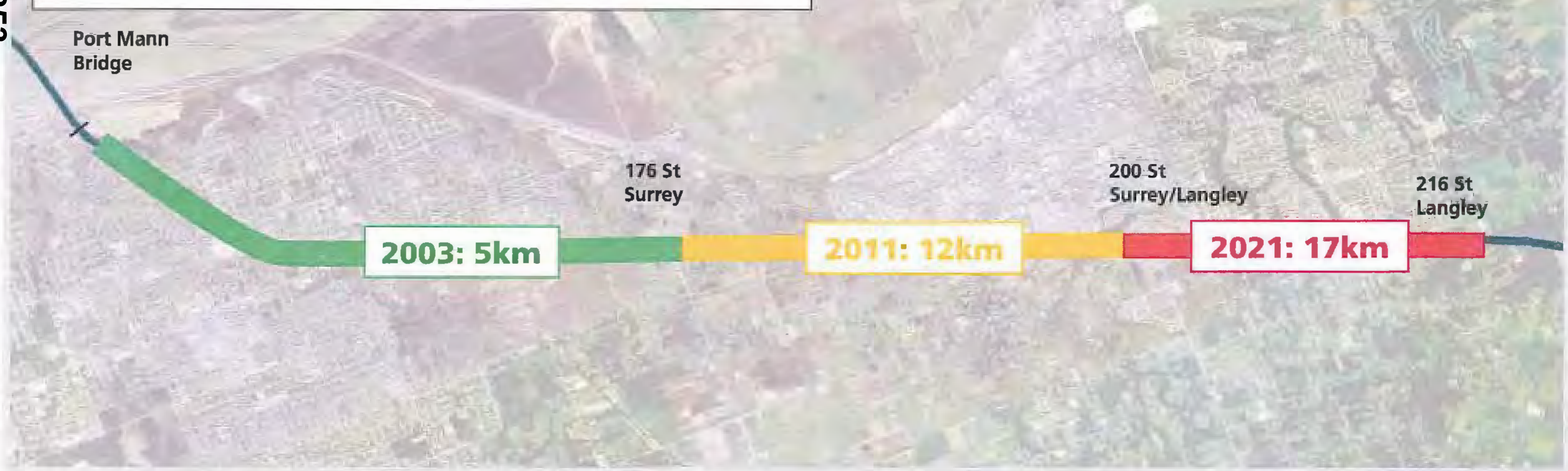
The continued growth of Asia-Pacific trade presents British Columbia and Canada with significant economic development opportunities. The most significant arises from expanding container traffic, which on the west coast of North America is projected to increase 300% by 2020. The Province of British Columbia has adopted a Ports Strategy with an objective to expand British Columbia's market share of Asia-Pacific container traffic from 9% to 17% by 2020. This would result in British Columbia container traffic increasing from 1.8 million TEUs to 8.8 million TEUs by 2020. This would create more than 50,000 new jobs and contribute over $3 billion annually to Canadian GDP by 2020. Each percentage point in container market capture in 2020 is worth approximately $250 million a year in GDP and 4,000 jobs.[37]

Approximately 50% of containerized goods are currently transported to and from Greater Vancouver's terminals by truck; the other 50% move by rail.[38] Figure 10 *(next page)* illustrates the projected growth in truck volumes associated with the forecast growth in international trade.

A significant portion of this growth is in light trucks, serving growing commercial markets that are spin-off businesses from increasing international trade, such as warehousing and distribution centres for containerized goods as well as equipment repair facilities.

Other West Coast centres, such as Los Angeles, San Francisco and Seattle, compete directly with Vancouver for port business. As a result, British Columbia will face strong competition in achieving its Port Strategy goals.

Figure 9: Forecast Port Mann Bridge morning westbound typical queue lengths (2011-2021)



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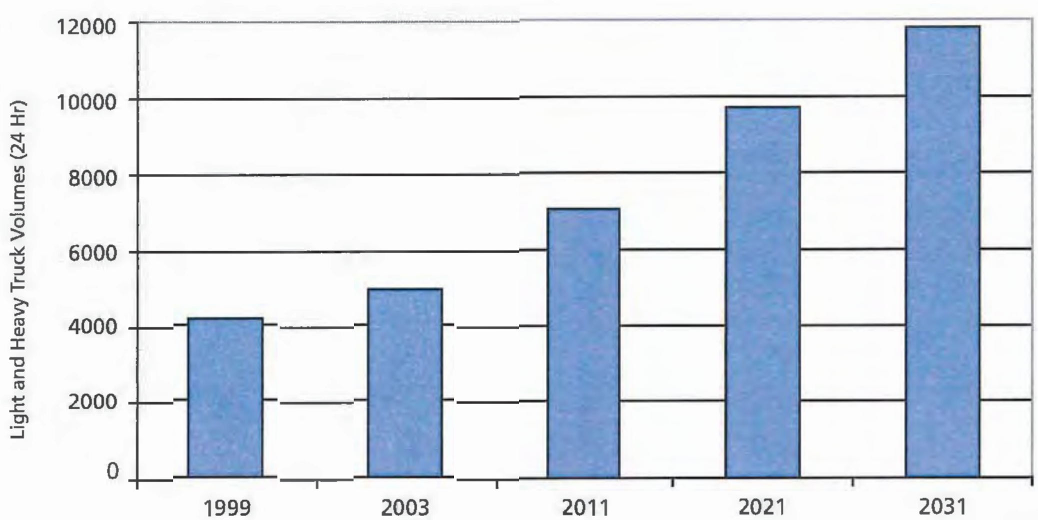
U.S. jurisdictions are acting to support their gateways by providing improved transportation links to highway networks and rail depots. If Greater Vancouver is to maintain its competitive advantage as a trade gateway, and British Columbia is to achieve the goals of the Ports Strategy, we need to do the same. A key consideration will be road access to and between ports and other gateway facilities.

Figure 10: Forecast Gateway Truck Volume, 1999-2031



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PART 2: RESPONDING TO THE PROBLEM

4. A COMPREHENSIVE AND INTEGRATED RESPONSE IS REQUIRED

Coordinated transportation infrastructure and service improvements are needed throughout the region to address current and future transportation needs and to realize potential economic development opportunities from increasing trade.

Required improvements include:

- Expansion of the transit system;
- Additional transit service;
- Expansion of the HOV network;
- Expansion of cycling networks;
- Construction and improvement of key roads, particularly facilities that improve connections to trade gateways (ports, border crossings, rail-truck intermodal yards, national highways) and relieve congestion on major trade routes; and
- Expansion of port facilities.

The provincial government and other agencies already have initiatives underway to provide these needed improvements.

The Gateway Program was established as part of a broader response by the Province of British Columbia to relieve congestion and improve mobility for all modes of transportation. Its focus is on key commuter and goods movement routes that are heavily congested.

Figure 11 *(next page)* summarizes key transit and road investment projects planned or in progress.

4.1 CURRENT INITIATIVES

Canada and the Province have several cost-shared initiatives underway to improve goods movement in the region, including the Border Infrastructure Program (BIP)[39] and Strategic Highway Improvement Projects (SHIP), with specific emphasis on improving Canada-U.S. border trade connections.[40] These initiatives will improve key sections of the region's road network resulting in better links between border crossings, ports, container facilities, industrial parks, airports and railways.

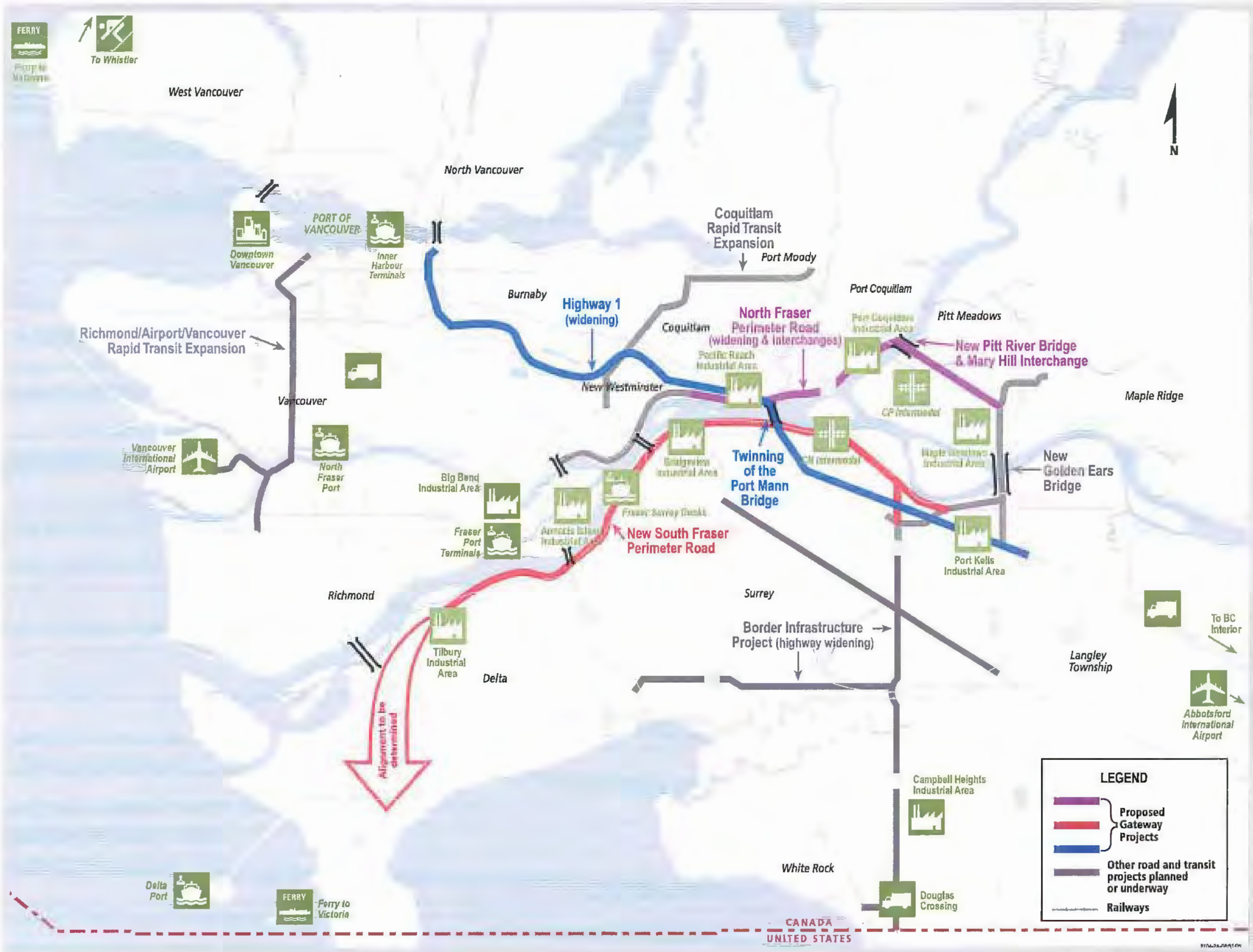
The Province, Canada, TransLink and other partners are investing in the Richmond-Airport-Vancouver Rapid Transit (Canada Line) and Coquitlam Light Rail Transit (Evergreen Line). TransLink, under its Three-Year Plan and 10-Year Outlook, also has significant plans to increase bus and SeaBus service and expand the successful U-Pass program.[41]

In addition, TransLink is expanding key components of the region's major road network, and providing for the Golden Ears Bridge connection between Surrey/Langley and Maple Ridge/Pitt Meadows.

Municipalities, with support from the Province and TransLink, are implementing significant investments in cycling network, upgrading safety and connecting key routes.

Under the Pacific Gateway Initiative, Canada and the Province are anticipating supporting infrastructure development to maximize Asia-Pacific trade opportunities, and to strengthen British Columbia's position as a world cruise destination.

Figure 11: Gateway Program: Part of an Integrated Solution



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4.2 THE ROLE OF THE GATEWAY PROGRAM

Even with all of these improvements, Greater Vancouver will still require significant additional investment to relieve congestion and create a robust transportation system to service a growing economy and population base. In 2003, the provincial government, through the Ministry of Transportation, established the Gateway Program to complement other regional road and transit improvements already underway or planned. Three priority corridors were identified for consideration:

- A new east-west corridor along the south shore of the Fraser River;
- An improved east-west corridor along the north shore of the Fraser River; and
- The existing Highway 1 corridor from Vancouver to Langley.

Measures to restore mobility to the Highway 1 corridor were determined to be necessary as the corridor is the most significant commuter and goods movement route in the Lower Mainland. This route suffers from the worst congestion of all major routes and is experiencing the most rapid growth in traffic.

Measures to improve east-west mobility on both sides of the Fraser River were also determined to be a priority. These corridors contain key port, intermodal facilities and industrial areas, and are vital to achieving the goals of British Columbia's Port Strategy.

Currently, east-west routes adjacent to the Fraser River are heavily congested city streets and do not provide direct, continuous connections to and between growing port areas and the other key gateway facilities. Traffic in these areas is presently served by a patchwork of portions of provincial highways, local arterials and collectors that provide partial, fragmented, discontinuous, and inappropriate routes for goods movement.

The Gateway Program is intended to be part of an integrated solution to address the needs of our growing region, as shown in Figure 11 *(previous page)*. Improvements in these priority corridors would also integrate with and expand the benefits from other initiatives such as the Border Infrastructure Program as well as TransLink improvements to the Major Road Network, including the new Golden Ears Bridge.

Improvements in these corridors will also facilitate expansion of transit services, the HOV network and cycling networks.

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5. STRATEGIC CONSIDERATIONS

As part of the development of the Gateway Program to date, consideration has been given to a number of strategic alternatives for dealing with congestion in the Highway 1 corridor and at crossings of the Fraser River. These alternatives and the results of their analyses are summarized below.

Installing a rapid transit line along the Highway 1 corridor between Vancouver and the Fraser Valley. A review of transit opportunities in the Highway 1 corridor was commissioned by the Gateway Program. The report concluded that the Highway 1 corridor is not well located relative to regional town centres, and therefore, is not the right location for high capacity rail transit service relative to future transit demands based on existing and expected development.

The report further concluded that better transit service on existing routes could significantly increase transit usage (this increase could be served by 20 buses per hour) and that the initial focus for the development of transit service in the corridor should be on providing fast, easy access to the existing rapid transit system for both buses and cars.

For possible longer term implementation, the report indicated that consideration should be given to protecting opportunities for passenger rail operations. The pre-design concept for the twinned Port Mann Bridge described in Chapter 7 will accommodate potential future light rail rapid transit.

Widening/Replacement of the Pattullo Bridge. The aging Pattullo Bridge currently provides the closest alternative to the Port Mann Bridge for crossing the Fraser River. Because of this, the Gateway Program considered the appropriateness of improvements to this crossing as an alternative to twinning the Port Mann Bridge. For example, improvements to the Pattullo Bridge such as widening to provide a six lane cross-section would increase the capacity of the structure from approximately 3,500 vehicles per hour to approximately 5,700 vehicles per hour in either the westbound or eastbound directions. The ability of the supporting road network on either side of the bridge to accommodate the demand will ultimately dictate the traffic volume that can be accommodated across the improved bridge structure. To accommodate the new demand associated with this increase in capacity across the bridge – upwards of 2,200 vehicles per hour in the peak direction – improvements to the supporting regional and municipal roadway network would be required, such as the construction of the Stormont-McBride Connector and widening of the main connection elements including McBride Boulevard.

Due to severe constraints posed by urban development on either side of the existing Pattullo Bridge, it was determined that supporting road capacity improvements at this location could not be realized in the near term and would therefore not provide the large measure of congestion relief that is needed.

George Massey Tunnel Expansion. Consideration was given to widening the George Massey Tunnel in conjunction with development of the South Fraser Perimeter Road.

To capture sufficient benefits, twinning the tunnel would also require improvements to other crossings over the North Arm of the Fraser River, such as the Oak Street or Knight Street bridges, or a new crossing to serve projected commuting patterns associated with employment growth in central Burnaby.

While upgrades to the George Massey Tunnel remain part of the Ministry of Transportation's longer term plans, widening of the Port Mann Bridge and development of the South Fraser Perimeter Road would provide greater overall benefit to the region.

Tolling the Port Mann Bridge without investment in new bridge capacity. In keeping with demand management measures proposed as part of the LRSP, the Gateway Program analyzed the effect of tolling the existing Port Mann Bridge as a means to address congestion at the bridge. Analysis has indicated that in an urban environment such as Greater Vancouver, tolling the Port Mann Bridge (which has the highest daily volume of traffic of any bridge across the Fraser River) *without any new capacity* would result in seriously overloading untolled alternative routes such as the Pattullo Bridge.

It also is estimated that the existing demand for westbound travel over the Port Mann Bridge in the AM peak hour is 5,000 vehicles; however, the capacity of the bridge is only about 3,600 vehicles per hour. As such, upwards of 1,400 vehicles/hour over the AM peak period would need to be diverted from the Port Mann Bridge to achieve the same user benefits as the proposed Port Mann Bridge twinning.

The Pattullo Bridge is the next closest river crossing to the Port Mann Bridge. An additional 1,400 vehicle/hour demand at the Pattullo Bridge would exacerbate existing congestion at that east bridgehead to the extent that queues would potentially extend an additional two to three kilometres on both King George Highway and Scott Road. Subsequent diversion of traffic demand from the Pattullo Bridge to the Alex Fraser Bridge and again from the Alex Fraser Bridge to the George Massey Tunnel would therefore be expected, since all of these crossings fall short in meeting the traffic demand during the AM peak period. Associated transit service required to shift people to alternate modes would be difficult to provide because transit vehicles would be caught in the same congestion at the bridge crossings.

To effect the diversion at the Port Mann Bridge, tolls in the range of $5 to $8 per trip would be needed. For daily commuters using the Port Mann Bridge, the toll would amount to payments ranging from $2,000 to $3,500 per year.

Due to the negative system-wide impacts and significant financial burden on existing bridge users, just tolling the existing bridge as a strategy for dealing with congestion at the bridge is not recommended. It is also inconsistent with Provincial policy, which requires that tolling be applied only for major projects that result in significant increases in capacity.

Applying system-wide tolling without investment in new bridge capacity. The LRSP contemplated the use of system-wide tolling as a travel demand management measure for maintaining mobility at water crossings. Further, TransLink has identified the concept as one that may need to be studied over a longer term. System-wide tolling in the context of the LRSP generally includes tolling of all bridges connecting to the Burrard Peninsula, including the Lions Gate, Ironworkers Memorial, Pitt River, Port Mann, Pattullo, Alex Fraser, Knight Street, Oak Street and Arthur Laing bridges as well as the George Massey Tunnel.

System-wide tolling of existing bridges would mitigate the diversion of traffic from a tolled Port Mann Bridge, as described above. However, in order to achieve traffic flow conditions on the Port Mann Bridge comparable to the pre-design concept described in Chapter 7, individuals require adequate opportunities to use alternative modes. The feasibility of such alternatives is questionable and they are not contemplated within TransLink's 10-Year Plan. As such, imposition of a system-wide congestion toll could have a significant detrimental impact on the region's economic development.

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6. DEVELOPMENT OF THE GATEWAY PROGRAM

As a result of the strategic considerations outlined in Chapter 5, the focus of the Gateway Program has remained on the noted three priority corridors. In developing the reference concepts described in Chapter 7, careful attention was given to ensuring the proposed improvements are compatible with adjacent road systems and how these systems are likely to evolve over the next 7 to 10 years. This consideration established boundaries for the scope of the Gateway Program improvements that could be contemplated over the same period.

6.1 PLANNING APPROACH FOR PRIORITY CORRIDORS

With the Gateway Program priority corridors identified, the Ministry of Transportation adopted a comprehensive planning approach for each corridor. This process is outlined in Figure 12. Stakeholder consultation including dialogue with staff at TransLink, the GVRD and area municipalities has been ongoing throughout this process.

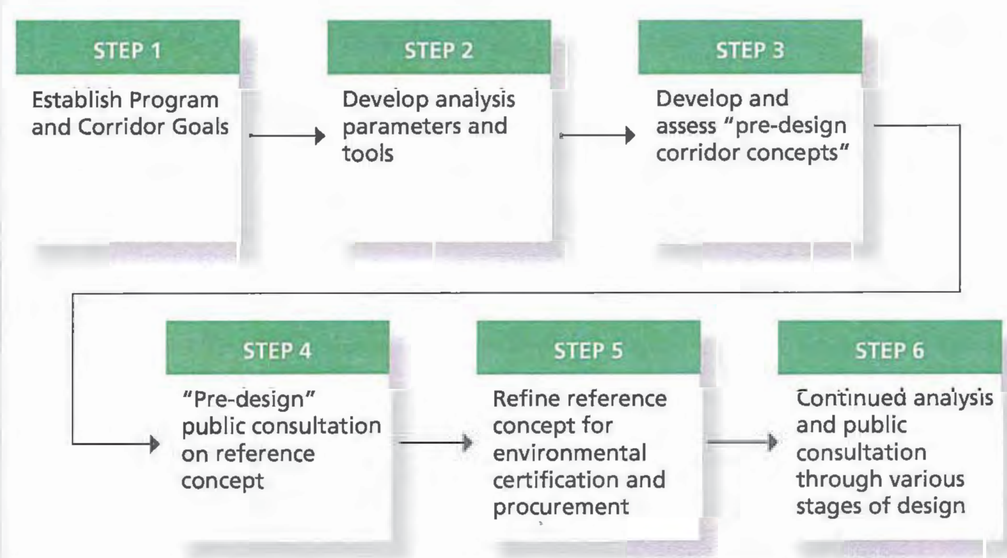
The remainder of this chapter outlines the results of steps 1 to 3 at a program level. Chapter 7 provides more detailed results of steps 3 to 5 for each corridor as appropriate. The planning work for each corridor is at different stages and will move forward on different schedules.

6.2 PROGRAM AND CORRIDOR GOALS

Based on the analysis outlined in Chapters 2 and 3, the following goals were established for the Gateway Program:

- Address congestion;
- Improve the movement of people and goods in and through the region (through to 2031);
- Improve access to key economic gateways through improved links between ports, industrial areas, railways, airports and border crossings;
- Improve safety and reliability;
- Improve the region's road network;
- Improve quality of life in communities by keeping regional traffic on regional roads instead of local streets and restoring municipal streets as community connectors;
- Reduce vehicle emissions by reducing congestion-related idling;
- Facilitate better connections to buses and SkyTrain, cycling and pedestrian networks; and
- Reduce travel times along and across the Fraser River during peak periods.

Figure 12: Gateway Program Development Process



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6.3 ANALYTICAL PARAMETERS AND TOOLS

As a precursor to developing and assessing "pre-design concepts" for the Gateway Program, it was important to establish the parameters and assumptions upon which the technical analysis would be based. It was also necessary to develop analytical tools. These are described below.

6.3.1 Population and Employment Projections

The GVRD, in consultation with municipalities, is responsible for developing population and employment projections for the Greater Vancouver region. These projections are used by municipal and regional planners to develop appropriate infrastructure and programs to serve the forecast growth.

Forecasts maintained by the GVRD are known as the "Growth Management Scenario" (GMS). GMS is updated regularly by the GVRD, with GMS 4 being the most recent and GMS 5 under development. GMS 4 provides forecasts through to the year 2021.

The Gateway Program commissioned recognized experts Urban Futures Inc. to extend the GVRD's population and employment projections out to the year 2031.[42] Base case population and employment projections are outlined in Figure 13.

6.3.2 Travel Patterns and Trends

The Gateway Program commissioned an extensive data collection program to better understand the nature of travel demand today, and to calibrate transportation planning models used to forecast future travel demand. A key element of this data collection program was the 2004 Trip Diary Survey,[43] which was conducted jointly with TransLink and is referenced extensively in previous chapters. 4,800 households were included in the survey. In addition to this extensive research, the Gateway Program also conducted a range of origin-destination, travel time and speed-flow surveys, as well as detailed vehicle volume and occupancy counts along the priority corridors. The results were compiled and shared with area municipalities and TransLink.[44]

Figure 13: Greater Vancouver Population/Employment Projections (2001-2031)

Municipality	Population					Employment				
	2001	2011	2021	2031	('01-'31) % chg	2001	2011	2021	2031	('01-'31) % chg
North East Sector	195,640	245,970	323,620	386,470	98%	65,780	90,280	122,410	151,450	130%
Burnaby/N Westminster	255,520	287,530	346,360	379,840	49%	158,700	178,070	205,670	219,480	38%
Langley(s)	114,420	143,340	188,100	209,270	83%	55,790	71,380	95,770	105,590	89%
Pitt Mdws / Maple Ridge	80,540	91,400	112,870	125,170	55%	24,860	30,390	37,960	44,760	80%
North Shore	178,040	181,800	195,350	211,330	19%	74,000	82,320	89,020	94,110	27%
Richmond	170,220	180,530	207,230	230,820	36%	122,030	155,320	172,880	185,690	52%
Delta/Surrey/ White Rock	479,150	540,120	653,070	759,380	58%	180,390	212,320	265,700	307,120	70%
Vancouver / UBC	572,510	593,490	632,060	702,850	23%	379,000	425,500	451,810	466,330	23%
Electoral Area C	4,080	3,300	3,470	3,750	-8%	1,080	1,130	1,300	1,370	27%

6.3.3 Model Development and Calibration

The Regional Transportation Model was originally developed in the 1980s and is maintained primarily by TransLink. It is the traffic forecasting tool used by planners in developing long term transportation plans and determining the effects of new transportation infrastructure. The model was updated using the travel data collected by the Gateway Program and TransLink and includes the planned infrastructure improvements.[45]

Enhancements to the model were developed to project traffic flows in the afternoon peak hours, not just in the morning peak hours, and to provide more detailed traffic information. The enhanced model allowed for the testing of design concepts. A separate model was developed to forecast revenues under various tolling options.

Operational micro-simulation models were also developed for specific projects to assess queuing (line-ups), lane-changing and other operating characteristics at a finer level.

Data collection and model development and calibration required an extensive work program, which took place from 2003 to early 2005. It has provided significant improvement in the information and tools available to transportation planners throughout the region. These tools have enabled development of a better understanding of the problems and the implications of potential solutions in each corridor.

6.3.4 Potential Mode Priority and Congestion Reduction Options

In developing a pre-design concept for each corridor, consideration was given to all modes of transportation including transit, HOV and cycling. The Gateway Program also conducted a review of recent experiences and practices in transportation demand management measures with a view to identifying a range of such congestion reduction measures that could be appropriate for each of the corridors.

To determine the appropriateness of these measures, a number of initial studies were undertaken. The results of these studies are contained in companion reports available under separate cover. A summary of each study follows. Detailed options for each of the Gateway corridors are described in Chapter 7.

Transit.[46] Potential opportunities to facilitate and enhance transit services on the Highway 1 corridor were identified. These include new bus service, future expansion of light rail transit, transit queue jumpers or other transit priority measures.

Further details on potential transit measures are outlined in Chapter 7. The Gateway Program will continue to liaise with TransLink to explore various opportunities to support regional plans for transit.

Cycling.[47] The Gateway Program developed a draft cycling plan overview that outlines how cyclists could be accommodated within the Gateway Program corridors. Cycling deficiencies and potential improvements were identified with input from the TransLink Bicycle Advisory Group, municipalities, GVRD Regional Parks Department, Better Environmentally Sound Transportation (BEST) and the Vancouver Area Cycling Coalition, and used in the development of the draft plan, which provides for significant improvements in the cycling network across the region.

The plan provides for an estimated $50 million of pedestrian and cycling facilities improvements within the three corridors in accordance with Ministry of Transportation policy. It also includes up to $10 million to fund additional off-corridor projects that will improve the overall effectiveness of the regional cycling network. This funding will be provided on a cost-shared basis with municipalities.

Further details on potential cycling measures for each corridor are contained in the Draft Cycling Plan as well as in Chapter 7 of this report.

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Lane Allocation.[48] Lane allocation refers to the practice of implementing operational strategies and design features that support the designation or allocation of traffic lanes for the use of specific vehicle types or user groups, providing them with superior service during congested periods. Two strategies, HOV lanes and ramp metering, are currently in use in Greater Vancouver.

The Gateway Program lane allocation study investigated several operational strategies and design features that could support the designation or allocation of lanes for the exclusive use of specific user groups. Potential strategies and design features included priority for transit and/or HOVs, site-specific features to support and facilitate efficient goods movement, and queue jumpers that provide priority access for specific vehicles such as transit or HOVs while regulating (through traffic signals or ramp meters) access by other vehicles to optimize efficiency of through-traffic along the corridor.

For the Highway 1 corridor, several strategies and design features were deemed applicable. These include HOV lanes along the corridor, ramp metering to manage traffic demand with priority access to the corridor for HOVs and new access ramps and improved interchange geometry to enhance accessibility and efficiency for goods movement.

The Gateway Program also considered the use of High Occupancy Tolled (HOT) lanes as a possible lane allocation strategy for Highway 1. In a number of other jurisdictions, under-utilized HOV lanes have been converted to HOT lanes, whereby single occupancy motorists are offered the opportunity to pay for access to the HOV lanes, thereby also realizing a travel time advantage over the more congested general purpose lanes. This concept is not considered suitable for the Highway 1 corridor as the present HOV system is relatively well utilized and the addition of significant tolled traffic to the HOV lanes would quickly erode the advantages afforded HOVs by the present arrangement.

To support the Gateway Program's goal of facilitating the movement of goods, consideration has been given to lane allocation strategies which would give advantage to commercial vehicles using Gateway Program roads and bridges, particularly on the Highway 1 corridor. Strategies that have been examined include dedicated roadways or lanes for commercial vehicles, shared use of HOV lanes by commercial vehicles, and site-specific features designed to give advantage to commercial vehicles (typically queue jumper/bypass lanes or geometric improvements at heavy truck traffic locations). While each of these strategies has the potential for application in specific circumstances, it is apparent that a single strategy will not be suitable in every situation. In the coming months, the Gateway Program is committed to working with goods movers to identify the locations, strategies, and specific features that will provide a sustained and cost-effective advantage to the movement of goods within the project corridors.

For the North Fraser Perimeter Road, retention and extension of the westbound peak period HOV lane on the Lougheed Highway segment in Pitt Meadows is under consideration, in addition to the inclusion of ramp metering to manage traffic demand at future interchanges along the overall corridor. For the South Fraser Perimeter Road, applicable design features focused on enhancing accessibility through new connections to industrial areas and other major goods movement corridors.

Road Pricing. Road Pricing can be used as a congestion reduction measure as well as a means of generating revenues to defray the cost of infrastructure. Tolling is one example of road pricing and British Columbia has

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a long history of tolling. In addition to the Coquihalla Highway, TransLink's new Golden Ears Bridge will be tolled, and in the past the Lions Gate, Iron Workers Memorial, Pattullo and Oak Street bridges and the George Massey Tunnel were all tolled.

Tolling could be structured to encourage road users to take alternative routes, to choose alternative destinations, to travel at alternate times, to use alternate modes (e.g., transit or carpooling) or to not make some trips. This reduces current congestion and/or the build-up in traffic volume in the tolled corridor.

Based on the results of analysis commissioned by the Gateway Program and application of the provincial tolling guidelines[49], it was concluded that consideration should be given to using tolling on the Port Mann/Highway 1 corridor as a congestion reduction measure and as a means of defraying the cost of improvements. In combination with HOV lanes, transit and commercial vehicle priority access to highway on-ramps, and commercial priority lanes, tolling could potentially be an option to further reduce congestion and limit growth in traffic on the highway and Port Mann crossing.

Tolling of the Pitt River Bridge and Mary Hill Bypass is not being considered, given that TransLink's Golden Ears Bridge will be tolled. The provincial tolling guidelines require the availability of a viable untolled alternative. Highway 7 and the Pitt River Bridge will be the only viable untolled alternative route for travel between Pitt Meadows/Maple Ridge and other parts of Greater Vancouver. In addition, traffic forecasts indicate that the proposed capacity improvements for the Pitt River Bridge are sufficient to serve forecast travel demand through to 2031 without the need for additional transportation demand management measures.

Tolling of the South Fraser Perimeter Road is not recommended as traffic analysis has indicated that tolling would divert a significant portion of traffic, including trucks, to the local road network in Surrey and Delta. This would take away from one of the primary benefits of this route. Further, the number of potential access and egress points would render tolling difficult and expensive (relative to the revenues that could be produced) to administer and enforce. In addition, should tolling of the Port Mann/Highway 1 corridor occur, the SFPR would be part of a viable untolled alternative route.

As discussed above, system tolling and/or tolling the Port Mann Bridge without improvements were not considered viable options.

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7. PRE-DESIGN CONCEPTS

Using the goals, analytical parameters and tools established for the Gateway Program, and initial studies considering potential mode and transportation demand management options, a pre-design reference concept was developed for each corridor. Each pre-design concept represents the initial proposal of the Program Team based on the compendium of technical analysis and municipal consultation to date.

For each corridor, the following pre-design elements are described:

- Features to accommodate alternate modes;
- Proposed physical characteristics; and,
- Congestion reduction/demand management measures under consideration.

The purpose of the pre-design concepts is to provide a reference point for undertaking pre-design public consultation.

Through the pre-design public consultation process, feedback within technical and financial constraints will be considered and a report describing the public input that has been received will be prepared. Subsequent to decisions on scope and timing, the preferred concepts will be submitted for Environmental Assessment review. The concepts will continue to be refined as a result of community input, further technical and financial analysis and environmental assessment review.

A description of the Gateway program's comprehensive public consultation process is contained in Section 10.1 of this report.

7.1 PORT MANN/HIGHWAY 1 CORRIDOR

Various components of the Highway 1 corridor have been studied, with each study indicating the need to provide significant improvements to accommodate forecast 2021 traffic levels.[50] These studies also strongly recommend addressing safety along the highway, including insufficient merge lengths, extensive off-ramp queues that back up onto the highway, and undesirable lane changing at on- and off-ramps.

The following goals have been established for the Port Mann/Highway 1 Project:

- Reduce travel times for trips along the corridor and increase their predictability;
- Reduce congestion at entry and exit points to Highway 1;
- Reduce travel times for trips across the corridor and improve connections within and between communities;
- Improve access to and egress from the corridor for goods movement;
- Facilitate the introduction of transit service along the corridor and the improvement of transit service across the corridor;
- Expand HOV, cycling and pedestrian networks along or in the vicinity of the corridor; and,
- Improve safety for vehicle operators and passengers, cyclists, and pedestrians.

Figure 14 provides an overview of the project's proposed geographic scope. More detailed drawings are contained in Appendix B.

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(Special)

Figure 14: Extent of Port Mann/Highway 1 Project

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(Special)

7.1.1 Features to Accommodate Alternate Modes

The Gateway Program is working with TransLink and municipalities to identify areas where alternatives to the automobile (such as transit, car-pooling services and cycling) could be improved. In this regard, the pre-design concept for the Port Mann/Highway 1 Project includes the following features:

Expansion of Highway 1 HOV Lanes:

Consistent with provincial and regional plans, the pre-design concept calls for extending the westbound HOV lane from its current starting point just west of the Cape Horn interchange in Coquitlam across the Port Mann Bridge to 200th Street, and extension of the existing eastbound HOV lane from its current terminus just west of 152nd Street to 200th Street.

Cycling and Pedestrian Infrastructure:

Cycling on Highway 1 is prohibited due to safety concerns associated with cyclists crossing the on- and off-ramps carrying freeway traffic volumes. This restriction will remain; however, the pre-design concept calls for significant cycling improvements along the Highway 1 corridor in three key areas:

- Provision for cyclists and pedestrians to cross the Fraser River via a two-way shared-use path on one side of the new Port Mann Bridge structure (barrier separated from traffic), with connections to regional and/or municipal cycling routes on either side of the bridge;
- Accommodation of cyclists and pedestrians across Highway 1 at all interchanges and overpasses; and,
- Additional (cost-share basis with municipalities) off-corridor improvements yet to be determined to cycling networks to help make cycling a more viable alternative to driving.

See also **Gateway Program Draft Cycling Plan,** a companion document to this report (available under separate cover).

Transit Priority Measures:

Congestion at the Port Mann Bridge is currently a significant barrier to transit use. With queues to access Highway 1 spilling onto the local street network, reliable bus service is impossible for most of the day. TransLink has indicated a desire to run this service, provided that a reliable schedule can be maintained. The current pre-design concept will facilitate the introduction of bus service through transit queue-jumpers and extended HOV lanes (see Section 7.1.3).

In preliminary discussions with TransLink, several opportunities for other transit priority measures have been identified along the corridor. These include:

- Park and Ride lots at key interchanges in Surrey and Langley to enhance ridership for transit services being considered for this segment of the corridor; and
- Priority bus access to the highway corridor from the various Park and Ride lots.

The pre-design concept also proposes the construction of bridge foundations that will accommodate future light rail transit expansion across the twinned Port Mann Bridge.

For more information, a companion report, **Overview of Future Transit Needs,** is available under separate cover.

7.1.2 Physical Characteristics*

The proposed Port Mann/Highway 1 project includes widening of the highway, twinning the Port Mann Bridge, upgrading interchanges and improving access and safety on Highway 1 from the McGill interchange in Vancouver to 216th Street in Langley, a distance of approximately 37 kilometres. It is anticipated that due to insufficient width and/or vertical clearance, a majority of the structures that cross over the highway will be replaced as part of the project.

**Note: Prior to broad public consultation regarding access and interchange improvements, further technical liaison is required with municipalities.*

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McGill Street to Grandview Highway (Vancouver): *Two new lanes (one in each direction) and interchange improvements*

This section of Highway 1 currently consists of four lanes (two in each direction). The current pre-design concept calls for one additional lane in each direction, for a total of six lanes. All proposed widening is within the existing highway right-of-way, primarily within the existing centre median. The Cassiar Tunnel as well as most of the overpass structures were originally designed to accommodate this width and as a result do not require reconstruction.

New highway lanes through Cassiar Tunnel would function primarily as dedicated entry and exit lanes between Hastings and McGill. This would reduce congestion and weaving (lane-changing) westbound through the Cassiar Tunnel as well as reducing slow-downs and back-ups on the municipal streets that result from eastbound traffic merging onto Highway 1.

McGill Street Interchange:

The McGill Street Interchange connects Highway 1 to Commissioner Street, the primary access road for Port of Vancouver facilities located on the south shore of Burrard Inlet, including Vanterm and Centerm. Opportunities to consider truck priority movements at this interchange are being analysed as part of this project.

Hastings, First Avenue and Boundary Road Interchanges:

The pre-design concept calls for localized operational and safety improvements, with no property acquisition or changes to municipal streets.

Concerns have been raised regarding the potential of the Port Mann/Highway 1 Project to increase traffic using First Avenue, which provides a route to the downtown core of Vancouver. Traffic modelling results to date indicate that improvements to Highway 1 will not substantially change forecast traffic volumes on this route. For example, with or without the Gateway Program, westbound peak period traffic volumes on First Avenue are expected to increase by less than 5%. Therefore, the pre-design concept envisions mainly operational and safety improvements without reconstructing this interchange.

Grandview Highway Interchange:

Currently, traffic entering Highway 1 eastbound via the Grandview Highway on-ramp mixes with traffic exiting Highway 1 eastbound to Willingdon Avenue. The mixing of these two high-volume traffic streams over a short distance results in a weaving pattern that slows all traffic, including through-traffic on Highway 1. The pre-design concept calls for separation of these two traffic movements and eliminating the weave through construction of a new overpass.

The pre-design concept also calls for improvements to the Highway 1 westbound to Grandview Highway off-ramp to address safety concerns.

Grandview Highway to Douglas Street Overpass (Burnaby): *Interchange improvements and new Highway 1 overpass*

Currently, the Grandview Interchange is a transition point where Highway 1 changes from four lanes to six lanes (three in each direction). This six-lane segment extends east to the Cape Horn Interchange in Coquitlam. Two of these lanes (one in each direction) are designated as HOV lanes, restricted to vehicles with two or more persons. This area of Highway 1 sees some of the highest traffic volumes, with complex traffic operations due to the close spacing of several interchanges and resulting interaction of the on- and off-ramps.

The pre-design concept calls for maintaining the existing six lanes, including the HOV lanes, between the Grandview Interchange and the Douglas Street Overpass (located between Willingdon and Sprott Street Interchanges) for highway through-traffic.

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Barrier separated auxilliary lanes are being considered to have high volume merging take place away from through-traffic, thus avoiding traffic slowdowns and associated safety concerns that currently exist on the highway on/off-ramps. These improvements can be done within the existing highway right-of-way.

Willingdon Interchange/Wayburne Overpass:

The Willingdon Interchange is a key connection point between Burnaby and Highway 1. Currently, a large volume of through-traffic mixes with vehicles entering the highway via the interchange on-ramps. Traffic volumes exiting the highway are also high, which frequently results in large queues forming on highway off-ramps extending to the highway itself. Drivers on Highway 1 must reduce their speed or change lanes to adjust for slower moving merge traffic and exiting vehicles. This results in a high number of accidents at this interchange. The addition of barrier separated auxilliary lanes in this location will see these merge points occur at reduced speeds, away from highway through lanes.

The pre-design concept also provides for a new, dedicated overpass across Highway 1 at Wayburne Drive for local north-south traffic, leaving Willingdon as the primary access point for traffic bound for Highway 1 as well as the north-south route. Transit and HOV priority measures would remain on Willingdon and, with the replacement of the existing Willingdon structure, HOV and transit can be extended over the highway to connect with existing transit priority routes on either side.

Ramp safety improvements are also proposed to reduce weaving for traffic exiting Highway 1 eastbound at Willingdon to Canada Way eastbound.

Douglas Street Overpass to North Road (Burnaby): *Two new lanes (one in each direction) and interchange improvements*

Between the Douglas Street Overpass and North Road, the existing Highway 1 has a six-lane configuration with two dedicated as HOV lanes. The pre-design concept calls for two additional lanes (one in each direction) for a total of eight lanes.

Sprott Street and Kensington Avenue Interchanges:

The Sprott Street and Kensington Avenue Interchanges work together to provide all-direction access to Highway 1. The pre-design concept calls for replacement of both interchanges with increased cross-highway capacity for Sprott Street. In addition, localized operational and safety improvements such as eliminating undesirable weaving and merging conditions between Canada Way and the Kensington Avenue ramps will be addressed.

Gaglardi Way Interchange and Cariboo Road Overpass:

The pre-design concept calls for replacement of both overpasses, as well as some reconfiguration of the ramps at the Gaglardi Way Interchange to improve safety and operations.

North Road to Cape Horn (Coquitlam): *Two new lanes (one in each direction) and interchange improvements*

The pre-design concept calls for one additional through lane in each direction for a total of eight lanes. Opportunities are being explored for maintaining the westbound climbing lane for trucks entering the highway at the Brunette Interchange.

Brunette Avenue Interchange:

Currently there are safety concerns at the westbound Highway 1 off-ramp to southbound Brunette, resulting from heavy truck queues that often extend onto the highway. The pre-design concept contemplates improvements to the Brunette Avenue interchange. However, due to the complexity of numerous connecting municipal streets, including the Brunette Avenue/Blue Mountain Street/Lougheed Highway intersections, as well as geographic constraints in the area, the development of improvements requires further consultation with municipalities, particularly the City of Coquitlam.

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King Edward Street:

Currently, King Edward Street provides the primary road connection between Coquitlam and the Pacific Reach commercial and industrial area, crossing under the highway as a three-lane road. It also traverses a multi-track, at-grade rail crossing, which creates traffic gridlock in this area when trains pass through. The City of Coquitlam has identified an improved highway crossing at this location as a municipal priority.

The pre-design concept includes an option for a dedicated crossing over the highway and railway to eliminate this conflict.

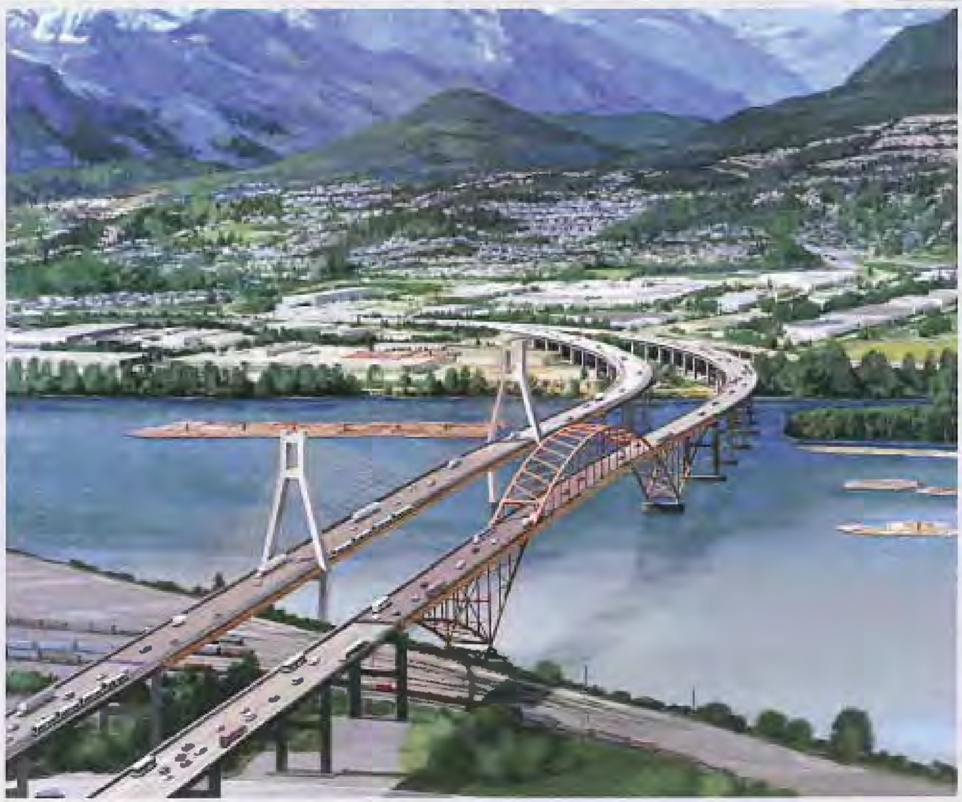

Figure 15: Pre-design concept for twinned Port Mann Bridge

Cape Horn Interchange:

The Cape Horn Interchange sees the confluence of numerous major roads and highways, many of which did not exist when the interchange was constructed. As a result, the interchange accommodates numerous trip patterns at traffic volumes that are far in excess of what the interchange was designed for. In addition, much of the area surrounding the interchange, in particular Pacific Reach, has become a significant business and employment area.

The pre-design concept calls for major reconstruction of the interchange to better integrate the network of roads in the Cape Horn area. Of particular note is the need to provide high-volume connections to Lougheed Highway for traffic travelling between the Tri-cities and Surrey. Improved connections between the Mary Hill Bypass and Highway 1 are also proposed. Finally, major reconstruction of the existing interchange provides an opportunity for better direct access from Highway 1 to the Pacific Reach business area.

The Port Mann Bridge (Coquitlam – Surrey): *New four-lane bridge for eastbound traffic*

Traffic analysis conducted by the Gateway Program indicates the Port Mann Bridge is congested, and at or near capacity for most of the time between 6 a.m. to 7 p.m. daily. The bridge currently carries about 127,000 vehicles per day, including 10,000 trucks.

In addition to experiencing significant daily congestion, the existing bridge is more than 40 years old and in need of rehabilitation, including painting, roadway resurfacing, and seismic upgrading.

The pre-design concept includes construction of a new parallel bridge on the downstream or western side of the existing bridge. The downstream side was selected based on a review of numerous constraints in the area such as environmental, potential archaeological and roadway geometry impacts.

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The pre-design concept for the twinned bridge is illustrated in Figure 15 *(previous page)*. The new structure would accommodate four lanes of traffic eastbound. It would also be built to accommodate potential future light rail rapid transit.

The new structure's design will factor in the following marine community needs:

- River hydraulics and protection from potential silting or scouring;
- Protection of the main navigation channel for marine transportation;
- Protection of ancilliary channels that provide access to log boom areas; and
- Commercial and First Nations fishing interests.

152nd Street to 200th Street (Surrey/Langley): *Four new lanes (two in each direction), extension of HOV lanes and interchange improvements*

The pre-design concept calls for two new lanes in each direction for a total of eight lanes including one in each direction designated for HOV traffic. Most of this work will be within the existing highway median. The interchanges at 152nd, 160th and 176th Streets serve not only Highway 1 traffic but also local traffic needs. All of the overpasses at these interchanges were constructed in the 1960s and are proposed to be replaced to meet horizontal requirements and vertical clearance standards. Pre-design concepts for each interchange are described below.

152nd Street Interchange:

The 152nd Street corridor is a major feeder route from North Surrey to Highway 1. Traffic analysis indicates that a high volume of this traffic crosses the Port Mann Bridge to access the Tri-Cities. Current year traffic modelling indicates 52% of all morning peak-hour traffic entering Highway 1 westbound at 152nd Street exits at the Cape Horn Interchange.

The pre-design concept calls for replacement of the existing overpass and extending/reconfiguring the westbound on ramp to better accommodate the short-distance travel demand between Surrey and Coquitlam.

160th Street Interchange:

Congestion at this interchange often results in significant traffic queuing on local streets, creating gridlock on the overpass resulting in long delays for local traffic. Backups on the eastbound off-ramp can also extend onto the highway itself, causing safety concerns. The interchange is also in close proximity to the truck weigh scale on Highway 1.

The pre-design concept calls for significant reconstruction of the interchange, replacing structures and reconfiguring ramps to meet the new and more diverse travel patterns that have developed. Increased cross-highway capacity and better separation from highway traffic will provide a good connection between Fraser Heights and the rest of Surrey. Although significant changes are planned at this interchange, all work is expected to be contained within the existing right-of-way.

176th Street Interchange:

The existing 176th Street Interchange currently connects Highway 1 to Highway 15 and the Pacific Border crossing to the south along with local streets to the north. It also serves as the primary western access point from Highway 1 to the Port Kells industrial area, and can experience congestion at peak travel times.

In the future, this interchange will become a much more significant and important access point with new connections to the South Fraser Perimeter Road as well as the Golden Ears Bridge.

The pre-design concept calls for significant redesign and reconstruction of the interchange to address forecast changes in travel patterns and provide for connections to new road networks created by the South Fraser Perimeter Road and Golden Ears Bridge. Improvements will include replacement of the overpass to meet new clearance standards and increase cross-highway capacity. All on/off ramps will be reconfigured and reconstructed. As part of the interchange work, widening on 176th Street will be required between Barnston Drive East and 96th Avenue, to provide efficient connections to the South Fraser Perimeter Road and the Golden Ears Bridge.

Although significant changes are contemplated at this interchange, most can be contained within the current right of way.

192nd Street Partial Interchange (west facing ramps):

Currently 192nd Street north of Highway 1 connects to Harvie Road south of the highway via a dedicated overpass (no connections to the highway). 192nd Street serves the Port Kells industrial area, whereas south of Highway 1, the area is generally rural.

As a means to partially address the significant travel pattern changes expected for the nearby 176th Street and Port Kells areas, the pre-design concept calls for construction of a Highway 1 westbound on-ramp and Highway 1 eastbound off-ramp at 192nd Street. The ramps would be configured to provide access to the industrial area, while limiting access to rural areas to the south.

Canada and British Columbia, under the Strategic Highway Infrastructure Program, are cost-sharing the construction of these ramps. Work is scheduled to be completed in 2006.

200th Street – 216th Street (Langley) : *Transition to six lanes at 200th Street, then back to four lanes (two in each direction) at a new 216th Street Interchange*

The pre-design concept calls for the transition from eight lanes to six lanes at the 200th Street interchange and transition from six lanes to the current four lanes at 216th Street. An additional westbound truck climbing lane from Glover Road to approximately 208th Street is being considered. Interchange improvements are described below.

200th Street Interchange:

A new 200th Street interchange was completed in 2004. No changes are contemplated at this location, apart from possible minor modifications to existing on/off ramps to accommodate highway widening.

216th Street Interchange:

Currently there is no interchange at 216th Street, which is centrally located between the two existing Langley interchanges at 200th and 232nd Streets.

Traffic analysis conducted by the Gateway Program indicates that, with development plans for this area and increasing traffic volumes to and from the east, a full-movement interchange will be required within the 2031 time horizon. In addition to serving planned growth in this area, the interchange would also provide some relief to the busy 200th and 232nd Street interchanges.

The pre-design concept proposes a new interchange providing full movements (i.e., all directions of travel can access to and from the highway).

Intelligent Transportation Systems

The pre-design concept includes the implementation of Intelligent Transportation Systems (ITS) for the Port Mann/Highway 1 corridor. ITS measures contemplated include:

- Dynamic message signs;
- Closed-circuit cameras; and,
- Vehicle detectors.

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Introduction of ITS technology will provide for early detection of traffic incidents, effective emergency response and efficient removal of vehicles and debris. Other benefits include improved safety through more efficient traffic management and a reduction in collisions, resulting in improved trip reliability and user satisfaction.

7.1.3 Additional Congestion Reduction Measures

In addition to extension of HOV lanes and other measures to accommodate alternative modes described in Section 7.1.1, other transportation demand management measures are being considered for the Highway 1 corridor.

Queue Jumper Lanes or Dedicated Ramps:
Queue jumpers provide priority access at interchanges for specified users such as commercial vehicles or HOV, allowing them to enter the freeway more quickly than other users. Dedicated ramps are ramps restricted to specific types of users, such as commercial vehicles or HOVs, usually at certain times of the day such as peak traffic periods. This restricted use allows these users priority access to the highway.

Transit/HOV queue jumpers at 152nd Street and/or 160th Street on-ramps to westbound Highway 1 are proposed as part of the initial works. In the longer term, westbound queue jumpers at on-ramps between 216th Street in Langley and First Avenue in Vancouver, and eastbound queue jumpers at on-ramps between First Avenue and Brunette Avenue may prove to be beneficial. For commercial vehicles, facilities may be desireable at the following locations:

- Commercial-vehicle-only ramps connecting United Boulevard with Highway 1 eastbound;
- Commercial-vehicle-only access to 192nd Street ramps;
- Commercial vehicle priority at McGill Street.

Tolling and other Congestion Reduction Measures:
The Ministry of Transportation will be conducting the first of three stages of public consultation in February, March and April, 2006 regarding proposed improvements to the Port Mann/Highway 1 project. This first stage of consultation, the pre-design stage, will specifically consult on congestion-reduction measures such as HOV lanes, transit and commercial vehicle priority access to highway on-ramps, and a proposed toll on the Port Mann Bridge. The public will be asked to consider the pros, cons and trade-offs of measures that limit growth in traffic such as tolls and HOV lanes. The public will have clear choices regarding the acceptability of tolling and other congestion-reduction measures.

The pre-design concept considers tolling on the Port Mann/Highway 1 improvements as a potential option to reduce congestion, limit growth in traffic demand and generate revenue to pay for the improvements. Tolling could potentially be an option in combination with HOV priority lanes, transit and commercial vehicle priority access to highway on-ramps, and commercial priority lanes. These measures are being considered in various combinations to reduce congestion and limit growth in traffic on the highway and Port Mann crossing.

If the improved highway is not effectively managed through tolls and/or other congestion-reduction measures, analysis shows that it would reach current levels of congestion 5 to 10 years after project completion. Additionally, without these measures, the level of congestion in the corridor would make it difficult to offer improved transit services along the route.

A potential toll on the Port Mann Bridge could be in the order of $2.50 (2005$) each way for private vehicles. The rate for trucks could, if implemented, be higher, and the rate for motorcycles could be lower. The potential Port Mann Bridge toll would be generally consistent with tolls proposed for the Golden Ears Bridge.

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This proposed tolling option on the Port Mann Bridge, combined with improved transit service, HOV lanes, transit and commercial vehicle priority access to highway on-ramps, and/or commercial priority lanes, would keep bridge congestion below current levels until 2031 or beyond.

Other tolling measures that could be considered include:

- Reduced toll rates for HOVs to encourage HOV use and improve mobility;
- Variable toll rates for peak and off-peak periods to encourage those users who have flexibility to travel in less busy times; and,
- A possible free period overnight.

If the proposed tolling and congestion-reduction measures were implemented, the benefits to users of the expanded bridge and improved highway would include vehicle operating cost savings and time savings. For example, a daily commuter traveling from Vancouver to Langley could expect to realize $0.50-1.50 in vehicle operating cost savings and approximately $5.00 in travel time savings in each direction.

Electronic tolling similar to the tolling technology contemplated for the Golden Ears Bridge could be used. An electronic system maximizes efficiency of traffic flow and minimizes driver inconvenience as vehicles are not required to slow down or stop to pay the toll.

Following consultation, if tolls were introduced on the Port Mann Bridge, it would affect traffic on the Pattullo and Alex Fraser bridges. Some users of the Port Mann Bridge would choose to use these crossings instead of paying a toll. Traffic modeling indicates that the volume of traffic in 2021 would not be appreciably different on the Pattullo and Alex Fraser bridges than it would be if the Gateway Program was not built. However, with respect to the Pattullo Bridge, the Ministry of Transportation would work with TransLink to contribute funding for safety and reliability improvements, as required.

7.1.4 Environmental Assessment

Due to its length, the Port Mann/Highway 1 Project is subject to a harmonized federal/provincial environmental review process. Following public consultation, and subsequent pre-design concept refinements, the Project Team will prepare an Environmental Assessment application for the project. The application and supporting studies will be submitted to the B.C. Environmental Assessment Office for review. Potential environmental and socio-community impacts will be identified along with proposed mitigation and compensation measures. Through the review, additional opportunities for public input will be provided, wherein additional issues may be identified and addressed in accordance with Environmental Assessment Review procedures.

Fieldwork required to support analysis for the environmental assessment application is continuing. It is anticipated that the project would enter the environmental review process in late 2006, following pre-design community consultation. For more information on the Environmental Assessment Review Process, please see Section 12.

7.2 SOUTH FRASER PERIMETER ROAD

Currently, there is no corridor that serves east-west travel demand for port, industrial and regional users along the south side of the Fraser River. Opportunities for port expansion, resulting from significant growth in Asia-Pacific trade, and increasing industrial development in Surrey and Delta, reinforces the need for a South Fraser Perimeter Road (SFPR).

The SFPR has long been part of provincial, regional and municipal transportation plans. With connections to Highways 1, 15, 91, 99 and 17, and the future Golden Ears Bridge, the SFPR will take a significant step towards improving the region's road network.

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The SFPR will link primary gateway facilities such as Deltaport, Fraser Surrey Docks, CN Intermodal yard, Canada/U.S. border crossings and the Tsawwassen ferry terminal to Vancouver Island. It would also serve the growing industrial centres in Delta, Surrey and Langley. The route would also benefit tourists accessing borders, Vancouver Island and the BC Interior.

The following goals have been established for the South Fraser Perimeter Road Project:

- Improve access to major trade gateways such as Deltaport, Fraser Surrey Docks, CN Intermodal yard, Canada/U.S. border crossings, and the Tsawwassen ferry terminal to Vancouver Island;
- Provide a better connection between Highways 1, 15, 91, 99 and 17, and between the bridges and the George Massey Tunnel that cross the Fraser River;
- Improve access to numerous industrial areas along the south side of the Fraser River;
- Reduce east-west travel times, particularly for heavy trucks, on the south side of the Fraser River;
- Restore municipal roads as community connectors by reducing truck and other traffic on municipal road networks; and,
- Improve safety.

7.2.1 Physical Characteristics

The pre-design concept for the SFPR calls for a four-lane divided roadway primarily on the south shore of the Fraser River through Delta and Surrey.

Figure 16 *(next page)* provides an overview of the project's proposed geographic scope. More detailed drawings are contained in Appendix C.

By 2031, it is envisioned that SFPR will be a totally grade-separated expressway with interchanges at all access points. However, based on the results of traffic modelling, the pre-design concept for "opening day" includes a combination of intersections and interchanges as described below.

Highway 17 to Highway 99 (two options):

Option 1: Relocated Highway 17 – North Option begins on Highway 17 at the Deltaport Way Interchange, with the addition of a northbound truck lane to the existing Highway 17 configuration. The truck lane continues for approximately three kilometers north of Deltaport Way where the South Fraser Perimeter Road would diverge and follow an easterly direction through vacant farmland to where it would pass over 64th Street, south of Ladner, in order to maintain local connectivity and farm access. The new road would connect to Highway 17 at a new interchange that would provide free-flow movement on/off SFPR for regional and heavy commercial traffic while maintaining on/off connections for local traffic to the existing Highway 17.

Beyond 64th Street the route would continue east and then turn north adjacent to the BC Rail Port Subdivision rail line. The road would pass over Ladner Trunk Road and connect via a new interchange to Highway 99 near the Vancouver Land Fill. This will be a full movement interchange except for Highway 99 southbound to SFPR eastbound. This movement was not provided due to the low traffic demand. An alternative connection for this movement is provided via Highway 91.

Option 2: Relocated Highway 17 – South Option begins at the Deltaport Way Interchange and parallels the BC Rail Port Subdivision rail line. The existing Deltaport Way Interchange would be modified to provide free-flow movements on/off SFPR for regional and heavy commercial traffic while maintaining on/off connections for local traffic to existing Highway 17. 64th Street would pass over the new road and the rail line, as would 36th Avenue, to maintain local connectivity and farm access. Continuing northward parallel to the rail line, the new road would turn east south of Ladner Trunk Road then north again towards Highway 99.

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Figure 16: Extent of South Fraser Perimeter Road Project

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(Special)

Figure 17: Southwest Delta Alignment Options

1 *Relocated Highway 17 (North)*

2 *Relocated Highway 17 (South)*

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The road would pass over Ladner Trunk Road and connect to Highway 99 as per the North Option. Figure 17 *(previous page)* outlines the general alignment of the two alternatives.

After connecting to Highway 99, SFPR continues north adjacent to 72nd Street and Burns Bog towards the Tilbury and Sunbury industrial areas. Intersections at 72nd and 80th Streets would provide access to the Tilbury and Sunbury industrial areas as well as local farms. The 80th Street intersection would also provide emergency access to Burns Bog.

Public consultation on three alignment options for the southwest Delta segment of the SFPR was held in January and February of 2005. Approximately 1,650 people participated in the consultation process, and 753 feedback forms were received. Those who participated generally supported the SFPR and 78.5% of those filling out feedback forms preferred the Relocated Highway 17 – South Option. This was followed by 12.2% support for the Relocated Highway 17 – North Option and 9.3% for the Upgraded Highway 17 Option. A petition containing 509 signatures from residents of East Ladner opposing the North Option was also received. The consultation report is available on the project website at www.gatewayprogram.bc.ca.

Figure 18: Relocated Highway 17 North Option

Since the completion of pre-design consultation, the Gateway Program continued receiving input on the alignment options through the Community Relations Program. This input included a petition containing 431 signatures in favour of the North Option and against the Upgraded Highway 17 Option.

During consultation, groups and individuals also indicated an interest in potential adjustments to the alignment options such as:

- Further exploring 72nd Street as a refinement to the proposed Relocated Highway 17 options; and
- Adjusting the Relocated Highway 17 – North Option to reduce potential impacts on East Ladner.

More detailed analysis of potential agricultural impacts of the options was also suggested.

Following completion of additional analysis, the Upgraded Highway 17 Option was eliminated due to its higher costs, technical challenges and higher community impacts during and after construction. The two Relocated Highway 17 Options are being refined to reduce potential impacts and it is anticipated that both options will be put forward for further public consultation. Figure 18 illustrates the pre-design concept for the relocated Highway 17 (North) option, which provides a greater noise buffer between the SFPR and the East Ladner community.

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The Program Team also evaluated a proposed truck-only route put forward by local residents Greg Hoover and Olav Naas. The authors' initial and revised proposals were reviewed and it was determined that the proposals did not meet the Project's goals.

Analysis determined that the proposed route addressed only about 10% of traffic, resulting in a minor mobility improvement for most people; longer travel times for trucks, particularly those with origins or destinations north of the Fraser River or to the Tilbury/Sunbury industrial areas; added traffic to other routes such as Highway 91; and did not reduce congestion on River Road west of Highway 91, offering little benefit to local industrial areas.

In support of their proposal, the authors raised some specific questions, namely agricultural land impacts and soil conditions related to the Gateway Program's Relocated Options and traffic analysis conducted on their truck route proposal.

While the Gateway Program's Relocated Options do affect agricultural lands, the Hoover & Naas option would have a similar impact if constructed as a two-lane facility and would exceed the Gateway options if protected for a four-lane corridor.

As to soil conditions, it is recognized that soft soils in this segment of the corridor will pose particular construction challenges. In addition to detailed geotechnical and hydrogeological evaluations, the Ministry of Transportation has conducted an independent review of field conditions and related engineering work. This review confirmed that the Gateway Program's analyses and construction assumptions are appropriate.

Traffic projections for the proposed truck route were modelled using the same forecasting tools employed for all segments of the corridor, and reflect the traffic volumes that could be expected, based on the characteristics of the route.

80th Street to Highway 91:

From 80th Street SFPR bears eastward parallel to the Fraser River. The pre-design concept calls for a new route along the southern edge of Delta industrial lands and north of the protected Burns Bog lands. The pre-design concept also calls for a new full movement interchange (Sunbury Interchange) to provide free flow access to and from SFPR and Highway 91, to connect to the local road network at River Road and Nordel Way and to serve the Sunbury Industrial area and Fraser Port lands. Figure 19 *(next page)* provides an artist's rendering of what a new Sunbury Interchange could look like. SFPR then turns northeast passing below the Alex Fraser Bridge and over the BNSF and CN rail lines.

Highway 91 to Tannery Road:

After passing over the rail lines, SFPR continues northeast near the base of the North Delta escarpment, in split-grade fashion (westbound lanes are separated from the eastbound lanes), on the south side of the BNSF rail line. A typical cross-section of the split-grade concept is illustrated in Figure 20 *(next page)*. Based on municipal and community input, no local access to the SFPR is contemplated through North Delta. Residents will use existing local roads to access SFPR at the new Sunbury or Tannery Road Interchanges.

Near Knudson Road, the split-grade configuration merges into a single grade cross-section on South Fraser Way. From Elevator Road, SFPR utilizes the existing South Fraser Way right-of-way to Tannery Road. The existing at-grade rail crossing at Elevator Road is replaced by an elevated structure linking Fraser Surrey Docks directly with the municipal road network and providing a connection to the SFPR through a new interchange at Tannery Road. The Elevator Road Overpass would also maintain access to the commercial fishery/recreational docks located on the south side of Alaska Way and allow heavy commercial traffic to pass over the BNSF and CN rail lines, thereby eliminating the associated traffic delays and congestion.

Figure 19: Sunbury Interchange

Figure 20: North Delta Split Grade

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The Tannery Road Interchange will be a full movement interchange to serve the growing South Westminster industrial area and provide access to the local road network, including the King George Highway and the Patullo Bridge via Scott Road. The pre-design concept also calls for an overpass across the railway tracks between the developing industrial warehouse facilities south of SFPR and port and rail facilities to the north.

The SFPR then continues eastward, passing over Old Yale Road to maintain community access to parkland, industrial and residential properties in the South Westminster area.

Tannery Road to 130th Street/Bridgeview Drive:
From Old Yale Road, SFPR passes underneath the SkyTrain and Patullo Bridges and the Southern Rail trestle, and parallels the existing Industrial Road/116th Avenue alignment to the Bridgeview area. An intersection at Bridgeview Drive/130th Street provides access to CN Rail's fuel storage facility and industrial areas to the north and the local network to the south. The intersection also provides connections to the King George Highway via Bridgeview Drive.

130th Street/Bridgeview Drive to 176th Street Interchange and Golden Ears Bridge:
From 130th Street/Bridgeview Drive, SFPR continues east to an intersection at 136th Street, maintaining the cross-corridor connection to CN Rail's Thornton Yard and residential properties. From 136th Street, SFPR continues eastward following the south boundary of the CN Rail corridor along the Fraser River, passing underneath the Port Mann Bridge and along the bottom of the Fraser Heights escarpment. Due to the topographic constraints of the Fraser Heights escarpment, access to the SFPR is not provided between 136th Street and 176th Street.

Community and environmental agency input has assisted in the identification of the SFPR alignment below Fraser Heights. Significant residential growth in Fraser

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Heights over the past five years means that previous alignment options developed for the SFPR were no longer viable. Working with the community and Fisheries and Oceans Canada and negotiating a purchase of approximately 67 hectares of land from CN Rail allowed an alignment along the bottom of the Fraser Heights escarpment to be developed. A substantial bridge is proposed for this section to mitigate the effects of the project through the environmentally sensitive wetlands.

Figure 21 *(right)* illustrates the alignment through Fraser Heights. This significantly reduces socio-community and fisheries impacts.

A new interchange at 176th Street and 104th Avenue connects the local road network, the CN Intermodal Yard and the Golden Ears Bridge project to the SFPR. From 104th Avenue the SFPR runs adjacent to 176th Street connecting with Highway 1 and Highway 15 to the south.

The pre-design concept calls for a non-signalized intersection at Barnston Drive and 176th Street, permitting free flow regional and heavy commercial traffic movement on the relatively steep slope of this section. The intersection will provide for right in/right out movements, as well as protected left movements for access to the local road network. East/west movements across SFPR at Barnston Drive would no longer be allowed. These movements would be accommodated via 176th Street and connections to the local road network. A pedestrian overpass is also proposed.

The 176th Street to 184th Street Golden Ears Connector, approximately two kilometres long and paralleling the CN Rail corridor, would connect SFPR from the intersection of 176th Street and 104th Avenue to the Golden Ears Bridge Project at approximately 184th Street. The pre-design concept calls for a 60km/h, urban arterial standard road with intersections at 177A, 179 and 182A Streets.

7.2.2 Features to Accommodate Alternate Modes

The Gateway Program is working with TransLink and the municipalities of Delta and Surrey to identify means through which to facilitate the use of alternatives to single occupancy vehicles on SFPR. As this corridor is primarily a goods movement corridor, and given projected traffic volumes to 2031, it was determined that priority lanes (e.g., HOV, truck only, transit) were not required as relative time savings would be minimal. However, the pre-design concept for the SFPR includes the following cycling, pedestrian and transit features.

Cycling and Pedestrian Infrastructure:

The pre-design concept calls for cyclists to be accommodated on roadway shoulders, with alternative cycling routes via parallel local road networks in the vicinity of major interchanges. This will reduce conflict between vehicles and cyclists where there are significant grades, high volumes of vehicles and/or multiple merge lanes.

Figure 21: SFPR Fraser Heights

Cross-corridor access for cyclists is proposed at all interchanges and overpasses.

Transit:

Transit will continue to primarily use the local road system. The Gateway Program will work with TransLink and municipalities to minimize any impacts that SFPR would have on transit routes, including providing appropriate transit access to River Road in North Delta and to the area north of SFPR in the Bridgeview area.

7.2.3 Additional Congestion Reduction Measures

Forecast volumes do not indicate that congestion will be a major consideration in the operation of the corridor through to 2031. As such, the pre-design concept for SFPR does not call for specific transportation demand management measures. In particular, no tolls are proposed for the South Fraser Perimeter Road, as discussed in Section 6.3.4. Analysis indicated that tolling would cause significant diversion and that it would be expensive to collect tolls due to the many entrance and exit points along the route. Also, as SFPR is primarily a goods movement route, there is less opportunity for demand management measures to shift traffic to alternate modes.

7.2.4 Environmental Assessment

Similar to the Port Mann/Highway 1 Project, the South Fraser Perimeter Road Project is subject to a harmonized federal/provincial environmental review process. The project is currently in the pre-application stage of environmental review, under the direction of the BC Environmental Assessment Office (BCEAO). Working groups comprised of representatives of provincial and federal environmental permitting agencies, municipalities, the GVRD and First Nations are assisting the Gateway Program Team in reviewing draft impact assessment reports and identifying potential mitigation measures.

Following public consultation, the Project Team will prepare an Environmental Assessment application for the project. For more information on the environmental assessment review process, please see Section 12.1.

7.3 NORTH FRASER PERIMETER ROAD

Substantial growth in employment in Burnaby, New Westminster and Coquitlam, as well as the increase in office park, industrial, and transportation-related development on the north shore of the Fraser River, has given rise to considerable growth in the demand for travel in an east-west direction along the north shore of the Fraser River.

The North Fraser Perimeter Road is a set of proposed improvements to existing roads to provide an efficient, continuous east-west route between the Queensborough Bridge in New Westminster and TransLink's new Golden Ears Bridge in Maple Ridge/Pitt Meadows. Proposed upgrades would improve safety and reliability along this key goods movement corridor and better serve growing communities in the northeast sector of Greater Vancouver. The North Fraser Perimeter Road has been the subject of several studies in recent years, with each study recommending the need for significant corridor improvements to meet forecast growth.[51]

Proposed North Fraser Perimeter Road improvements are being planned and delivered under three different programs:

- The Border Infrastructure Program (Queensborough – 6th Street) includes reconfiguration of the Highway 91A interchange at the north end of the Queensborough Bridge in New Westminster. Additional information on this project is available at http://www.bip.gov.bc.ca.
- TransLink's 3-Year Plan and 10-Year Outlook include improvements to Front and Columbia Streets in New Westminster as well as construction of a new United Boulevard Extension to replace the single lane bridge and existing connection to Braid Street, with a new connection to Brunette Avenue just to the south of Braid Street.

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- The Gateway Program component stretches from King Edward Street in Coquitlam to Maple Meadows Way and is described below. Its purpose is to provide an efficient roadway along the north shore of the Fraser River from the Cape Horn Interchange to the new Golden Ears Bridge.

The following goals have been established for the Gateway Program component of the North Fraser Perimeter Road corridor:

- Reduce travel times for trips along the corridor and increase their predictability, particularly for heavy trucks;
- Improve access to the CP Intermodal facility, a major trade gateway;
- Improve access to the Port Coquitlam, Mary Hill and Pacific Reach commercial/industrial areas;
- Improve cycling and pedestrian facilities and connectivity to existing networks on either side of the Pitt River crossing;
- Support improved transit service;
- Reduce regional traffic on municipal road networks; and,
- Improve safety.

7.3.1 Physical Characteristics

Figure 22 *(next page)* provides an overview of the geographic scope of the Gateway Program component of the North Fraser Perimeter Road. The project includes the following proposed improvements. Further detail is contained in Appendix D.

7.3.1.1 Pitt River Bridge and Mary Hill Interchange Project

The existing Pitt River swing bridges on Highway 7 (connecting Pitt Meadows to Port Coquitlam) are heavily congested during peak travel periods. The volume of daily traffic over the bridges has increased from 27,000 to 78,000 vehicles between 1985 and 2003, and is expected to reach 88,000 by 2007.

With construction of TransLink's Golden Ears Bridge (scheduled for completion in 2009), the level of congestion at the bridges will worsen. Additional traffic from Coquitlam, Port Coquitlam, Port Moody and Burnaby will be using the bridges to travel to/from Langley and Surrey. The introduction of the Golden Ears Bridge is expected to increase peak hour traffic in the already strained single-lane direction of the counter-flow system by 20 – 30%, significantly exacerbating congestion and delays.

The Pitt River bridges were built in 1956 and 1978 and the swing mechanisms are 27 and 30 years old. These mechanisms experience breakdowns resulting in unexpected closures of the bridges and lengthy delays to the travelling public.

Construction of a new high-level bridge and a new interchange at the west end of the bridge, where the Lougheed Highway and Mary Hill Bypass meet, will significantly improve travel times and safety and reduce unexpected closures for all users, including goods movers, transit and cyclists. In addition, provision of an auxiliary east-bound truck lane on the bridge and modifications to the intersection at Lougheed Highway and Kennedy Road will serve to improve access to and from CP Rail's Pitt Meadows intermodal yard.

The congested Mary Hill Bypass/Lougheed Highway intersection, immediately to the west of the existing bridges, needs to be converted into an interchange to fully capture the operational benefits of the new bridge.

Pitt River Crossing:

The pre-design concept calls for a new high-level bridge with six through lanes, and auxiliary truck lane

Figure 22: Extent of North Fraser Perimeter Road Corridor

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in the eastbound direction. This measure will minimize weave and merge movements for trucks ascending and descending the grades of the bridge without interfering with other traffic. On the eastern end, truck traffic bound for the CP Rail inter-modal yard needs to exit immediately after crossing the bridge, requiring trucks to slow down considerably to negotiate the exit.

The bridge foundation will also be designed to accommodate additional width in the future for potential light rail transit.

The height of the new bridge will provide up to 16 metres of clearance over a 100-metre-wide shipping channel in the Pitt River and will have bicycle and pedestrian facilities.

Lougheed Highway/Mary Hill Interchange:

The pre-design concept calls for an interchange with free-flow operations for the current major highway movements, improved local access via a new local road network and potential for upgrading and expansion in the future when the Fremont connector is constructed. This connector is anticipated to serve future development to the north and would tie into the proposed new Mary Hill Bypass/Lougheed Highway interchange. Figure 23 *(right)* illustrates the pre-design concept for the new bridge and interchange.

Pre-design consultation for the project was undertaken in May and June 2005. Approximately 500 people participated in small group meetings, open houses or through a web-based feedback form. A copy of the complete consultation summary report is available on the Gateway Program website at www.gatewayprogram.bc.ca.

Since consultation was completed, refinements to the interchange as well as cycling network improvements have been made, reflecting public input and value engineering. These include additional measures for eastbound cyclists on the south side of the new Pitt River Bridge and modifications to local connections between the Southeast and Northeast quadrants of the interchange.

7.3.1.2 Longer-Term Improvements

The remainder of the Gateway Program component of the NFPR is currently in the high-level planning stages and will require additional traffic modeling and dialogue with local and regional governments before pre-design concepts can be finalized. Based on preliminary analysis, the following improvements are contemplated.

United Boulevard (Coquitlam):

Only intersection improvements are contemplated in this section.

Figure 23: Pitt River Bridge and Lougheed / Mary Hill Interchange Pre-design concept

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King Edward Street:

As described previously for the Port Mann/Highway 1 Project (Section 7.1.2), King Edward Street in Coquitlam is the primary access point to the busy and growing Pacific Reach/South Coquitlam commercial/industrial area along the United Boulevard section of the NFPR. The existing access is significantly restricted by the narrow Highway 1 underpass (3 lanes) and the at-grade crossing of the CP Rail Sapperton Yard.

The pre-design concept includes an option for a dedicated crossing over the highway and railway to eliminate this conflict.

Mary Hill Bypass:

Near the Port Mann Bridge, United Boulevard currently connects to the Mary Hill Bypass at a signalized intersection. The pre-design concept calls for this intersection to be upgraded to an interchange to improve access to the Mary Hill Bypass eastbound as well as Highway 1 westbound.

Preliminary traffic modeling suggests that the Mary Hill Bypass will continue to function efficiently through to 2031 with the existing four-lane configuration and intersection improvements or conversion of intersections to interchanges. However, in light of planned improvements to Highway 1 and the Cape Horn Interchange, the short section between the Cape Horn Interchange and Shaughnessy Street will likely require additional capacity in the medium term.

Shaughnessy Street Intersection:

Traffic forecasts suggest that the existing high volume of left-turn movements from Mary Hill Bypass eastbound to Shaughnessy Street northbound in the afternoon peak period will continue to grow; within the 2031 planning horizon of the Gateway Program, construction of a grade-separated interchange may be required.

Pre-design concepts for this interchange continue to be developed. However, options are significantly constrained by the proximity to Colony Farms Regional Park, heron nesting habitat, the Fraser River, and existing residential development. Further traffic modelling and discussions with the City of Port Coquitlam and environmental permitting agencies are required to complete this work.

Pitt River Road Intersection:

Future traffic growth suggests that an eventual grade-separated interchange will be necessary. Once again, the configuration of an interchange at this location is constrained by existing development and the proximity to the Fraser River. At present, the pre-design concept calls for an overpass structure with Pitt River Road passing over the Mary Hill Bypass and a directional ramp for eastbound to northbound traffic.

Broadway Street Intersection:

With completion of the Coast Meridian overpass project, Broadway will become a major access point to the Mary Hill Bypass for traffic from Coquitlam and Port Coquitlam. Traffic modelling suggests that a Broadway/Mary Hill Bypass interchange will be required late in the 2031 planning horizon. The pre-design concept calls for a tight-diamond interchange configuration.

Coast Meridian Road Intersection:

As discussed above, with the construction of the Coast Meridian Overpass, Broadway will become the primary access point to the Mary Hill Bypass. The pre-design concept calls for the existing Coast Meridian access point to be closed.

Kingsway Avenue Intersection:

Traffic modelling suggests that a Kingsway/Mary Hill Bypass interchange will be required late in the 2031 planning horizon. The current concept calls for a tight-diamond interchange configuration.

Lougheed Highway (Pitt Meadows)

Preliminary traffic modelling suggests that Lougheed Highway will function efficiently through to 2031 with a six-lane configuration. As such, in addition to intersection improvements or conversion of intersections to interchanges, the pre-design concept calls for extension of the westbound HOV lane from its current starting point west of Harris Road to where the Golden Ears Bridge to Lougheed Highway on-ramp enters, just west of Maple Meadows Way. Pre-design concepts are as follows:

Old Dewdney Trunk Road/Kennedy Road Intersection:

Because of the proximity to the CP Rail intermodal yard, this intersection sees significant truck movements and is an important part of the freight network. It is anticipated that improvements will be required to the existing Old Dewdney Trunk Road/Kennedy Road intersection, with the likelihood of a fully grade-separated interchange in the longer term.

Harris Road Intersection:

Traffic forecasts suggest that a full movement, grade-separated interchange will be required at Harris Road within the 2031 planning horizon, with particular measures to address the large volumes of northbound to westbound left turns in the morning peak period. Interchange alternatives will be significantly constrained by the extensive development to the south of Highway 7.

Harris Road to Maple Meadows Way:

The pre-design concept calls for widening to a full six-lane cross-section. For the most part, this can be accommodated within the existing right-of-way.

7.3.2 Features to Accommodate Alternate Modes

HOV Lanes:

East of the Pitt River Bridge, a westbound HOV lane extends from just west of Harris Road to Kennedy Road. It primarily acts as a transit peak-period queue-jumper lane, sending buses to the front of the bridge queue where they merge with general traffic. Long term regional plans call for extension of HOV lanes along Lougheed Highway west of the bridge. HOV lanes are not contemplated along United Boulevard or the Mary Hill Bypass.

While technically challenging, the pre-design concept for the Pitt River Bridge allows for future extension of the existing westbound HOV lane. However, public feedback during pre-design consultation overwhelmingly supported configurations having all general purpose lanes, primarily due to the lack of supporting HOV networks east and west of the bridge.

Cycling and Pedestrian Infrastructure:

The initial pre-design concept for the Pitt River Bridge provided for a two-way shared-use path on the north side of the new Pitt River Bridge structure (barrier separated from traffic). Reflecting public input during pre-design consultation, the concept now also includes an eastbound cycling shoulder on the south side of the bridge to accommodate cyclists who are comfortable riding with traffic. The pre-design concept for the Mary Hill Bypass/Lougheed Highway Interchange accommodates all cyclist movements through a combination of dedicated cycling paths and roadway shoulders and/or parallel existing routes.

While pre-designs for other elements of the NFPR are still in development, it is planned that cyclists will be accommodated on the shoulders of the Mary Hill Bypass and Lougheed Highway consistent with current facilities, as well as across any new interchanges and overpasses.

Transit:

The Gateway Program is currently working with TransLink to identify appropriate transit priority measures. The new Pitt River Bridge foundations will be constructed to allow for future widening that could be used for light rail transit or other purposes.

7.3.3 Additional Congestion Reduction Measures

In the near term, specific additional congestion reduction measures are not contemplated. However, as the regional HOV network west of the bridge is expanded, ramp metering with HOV and transit priority facilities at access points and bridgeheads will be considered. Options for truck priority features near intermodal facilities are also being explored.

As previously discussed in Section 6.3.4, tolls are not being considered for the NFPR.

7.3.4 Environmental Assessment

The Gateway Program submitted a Canadian Environmental Assessment (CEAA) screening report on the Pitt River Bridge and Mary Hill Interchange Project for review by regulatory agencies in July 2005. Completion of the CEAA review is anticipated in early 2006.

The Project is expected to provide significant long-term benefits. The key findings of the screening are summarized below:

- Net increase in the amount of riparian habitat along the shores of the Pitt River due to removal of existing bridges and old roadway areas;
- Reduced shading of riparian and littoral habitats (i.e., shallows where light reaches the river bottom), as well as enhanced connectivity of the riparian corridor along both shorelines of the Pitt River;
- Improved management of stormwater and road run-off, thereby enhancing water quality and quantity management for both road drainage and fish habitat;
- Improved green space and recreation corridor connectivity along the Pitt River shorelines;
- Improved safety and reliability for all modes of transport;
- Improved navigation channel (better vertical and horizontal clearances and location); and,
- Enhanced habitat connectivity along the Pitt River foreshore.

For more information on the environmental assessment review process, please see Section 12.1.

PART 3: BENEFIT-COST ANALYSIS

8. PROGRAM BENEFITS

This section of the report provides a summary of the benefit-cost analysis undertaken to date of the pre-design concepts described in Chapter 7 of this report.

8.1. USER BENEFITS

The Gateway Program will provide road and bridge user benefits primarily in the form of travel time savings (avoided delays), reduced vehicle operating costs and improved safety.

8.1.1 Travel Time and Operating Cost Savings

To estimate the travel time savings and reduced vehicle operating costs, the Gateway Program engaged the international transportation consulting firm Steer Davies Gleave, supported by Vancouver-based transportation planning and economic consulting experts. The consultants used transportation models (see Section 6.3.3) to predict Gateway's impact on traffic patterns and overall travel times, on Gateway and other local roads. The analysis involved comparing travel time in the region today with the Gateway Program pre-design concept improvements.

The analysis indicates that the Gateway Program will result in travel time and operating cost savings at a present value of $8 billion, based on a real discount rate of 4.5%. Depending on their origin and destination, travellers could see time savings of between 5 and 30% over 2003.

Figure 24 presents travel times between representative origins and destinations today and with the Gateway Program. Illustrated in the table are the free flow travel time (theoretical travel time based on distance and speed limits), the average morning peak period travel time in 2003 and the forecast travel time for the same period in 2031 with the Gateway Program in place.

A high level summary of total annual travel time savings for different vehicle types is shown in Figure 25 *(next page).*

Figure 24: Comparison of Travel Times for Morning Peak Hour

	Travel time (minutes)		
Trip origin and destination	**Free Flow**	**2003**	**2031 with Gateway**
Langley City to Port of Vancouver (Centerm/Vanterm)	36	62	47
CP Rail Pitt Meadows Intermodal Yard to Vancouver International Airport	46	66	63
Surrey City Centre to Pacific Reach, Coquitlam	14	21	16
Pacific Reach, Coquitlam to Port of Vancouver Centerm/Vanterm	20	36	31
CN Rail Surrey Intermodal Yard to Tilbury Island, Delta	27	35	24

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Figure 25: Annual Travel Time and Vehicle Operating Cost Savings with The Gateway Program (2005$)

	($ Million) 2021	2031
Cars	$474	$811
Light Trucks	$21	$34
Heavy Trucks	$36	$58
Total	$530	$903

8.1.2 Other User Benefits

Transit users will also experience significant travel time savings and improved transit services as a result of the Gateway Program.

Cyclists and pedestrians will benefit from improved service across the Port Mann Bridge, across Highway 1, along the North and South Fraser Perimeter Roads and on improved municipal cycling networks.

8.1.3 Safety Benefits

The Gateway Program will provide significant safety improvements along major transportation corridors and redirect regional traffic off local streets and onto regional routes. The safety benefits associated with the Gateway Program road and bridge improvements were evaluated by expert transportation safety consultants.[52] Analysis indicates that the Gateway Program will have a positive impact on network safety performance. With tolls on the Port Mann Bridge, the net impact would be in the range of 7-8% improvement, which is valued at approximately $60 million per year. Without tolls, the improvement would be in the range of 2-3%.

8.2 ECONOMIC BENEFITS

Construction of Gateway Program facilities will generate approximately 17,000 person-years of direct employment and will contribute $1.7 billion to British Columbia's gross domestic product.

Program facilities will provide long-term economic benefits by:

- Improving the competitiveness of Greater Vancouver ports and airports as conduits for the growing trade flows between Asia and North America;
- Improving the competitiveness of British Columbia and Canadian businesses moving goods to market through and within the region;
- Reducing the cost of goods and services for consumers; and,
- Increasing the productivity of workers by reducing the travel times of service providers in the region (i.e., tradespeople) and the number and extent of unanticipated delays.

These benefits, while difficult to quantify, are expected to be significant.

8.3 OTHER BENEFITS

Program facilities will provide long-term socio-community benefits by:

- Improving intra-municipal access by reducing highway queuing that currently spills onto municipal streets;
- Providing improved cross-highway connectivity within municipalities that span both sides of Highway 1;
- Maintaining local streets for local use by improving the efficiency of regional corridors; and,
- Improving air quality by reducing congestion-related idling vehicle emissions (see Section 9.2.3).

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9 PROGRAM COSTS

9.1 PROGRAM COST ESTIMATES

The initial cost estimate of the pre-design concepts described in Chapter 7 is in the range of $3 billion. The Port Mann/Highway 1 Corridor is the largest component, followed by the South Fraser Perimeter Road and the North Fraser Perimeter Road. The current estimated cost breakdown is indicated in Figure 26 below. Capital cost estimates will be refined in response to scope changes resulting from public consultation, and the environmental assessment process.

Figure 26 — Initial Gateway Program Cost Estimates (2005$)

COMPONENTS	(billion)
Highway 1/Port Mann Corridor	$1.5
South Fraser Perimeter Road	0.8
North Fraser Perimeter Road	0.4
Program Contingency	0.3
	$3.0

Based on quantifiable benefits and costs, the Gateway Program has a strong business case, with a benefit to cost ratio of 3 to 1.

9.2 OTHER CONSIDERATIONS

In addition to financial costs, other potential impacts of the Gateway Program have been identified. These include the following:

9.2.1 Land Use

The Gateway Program conducted a literature review with respect to the relationship between road network expansion and changes in land use.[53] The review indicated that transportation accessibility is only one of many factors that can contribute to changes in land use. Factors such as land availability, land prices, access to utilities, crime rates and zoning can have equal or greater impacts on land use. Better access to transportation facilities can facilitate, but not initiate, changes in land use patterns.

In Greater Vancouver, municipalities, together with the GVRD, control land use. How land use will change in the future will primarily depend on the land use decisions taken by municipalities and the GVRD. It is not possible to determine the effect of the Gateway Program on land use without making assumptions on how other governmental agencies will alter their decisions on land use matters. As previously discussed in Section 6.3.1, planning for the Gateway Program is based on population and employment projections outlined in the GVRD's GMS 4 land use plan as well as individual municipalities' official community plans.

9.2.2 Agriculture

The South Fraser Perimeter Road traverses agricultural land in Delta. Depending on the final alignment option selected, the project could directly impact between 70 and 86 hectares of agricultural land, which would be required for road right-of-way. The project team has been working with the Delta Farmers' Institute and the Agricultural Land Commission to minimize agricultural impacts and explore opportunities for mitigation. These measures will be reflected in the environmental assessment application for the South Fraser Perimeter Road.

Other Gateway Program corridors are in more urban areas and no additional impacts to agricultural land are anticipated, with the exception of a small portion within the proposed 216th Interchange at Highway 1 and potentially within future new interchanges at Harris Road and Dewdney Trunk Road.

9.2.3 Vehicle Emissions

Congestion related to idling is one of the most significant contributors to reduced regional air quality. By freeing up traffic movement along arterial corridors, Gateway projects have the potential to alleviate some of these emissions. However, there is also the potential for increased roadway capacity to result in increased number of vehicles on the road, and therefore a reduction in air quality.

As part of the environmental impact analysis for the Gateway Program, a regional air quality impact assessment is being conducted.

The preliminary analysis indicates that, despite the increase in roadway capacity, implementation of the Gateway Program is predicted to have an insignificant effect (less than 0.1%) on the region's ambient air quality and minor net effect (0.7%) in greenhouse gases in the region. That is to say, implementation of the Gateway Program would result in 0.1% more vehicle emissions in 2021 than if the program did not proceed. This preliminary analysis is based on total traffic volumes only, in the absence of demand management measures. It is expected that combined with congestion reduction measures described in the pre-design concepts (Chapter 7), positive air quality benefits will result from reduced congestion-related idling in the Gateway Program corridors.

The Gateway Program will work to refine pre-design concepts and obtain environmental certification for the Pitt River Bridge and Mary Hill Interchange project, South Fraser Perimeter Road and the Port Mann/ Highway 1 project. Key to achieving these objectives will be:

- Working with municipalities, regulators and review agencies;
- Ongoing community relations;
- Consultation at key design stages; and,
- Facilitating review and comment on the studies undertaken as part of the environmental review process.

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10. PUBLIC CONSULTATION AND COMMUNITY RELATIONS

Budget provisions have been made by the provincial government to fund approximately 50% of the SFPR and Pitt River Bridge/Mary Hill Interchange projects.

In October 2005, the federal government announced up to $90 million in cost-shared funding for the Pitt River Bridge/Mary Hill Interchange Project. This commitment was part of a broader announcement of the Pacific Gateway Strategy to improve infrastructure, border services and links with the Asia-Pacific Region for the purpose of expanding trade and cultural ties.

Federal cost-sharing for the SFPR Project is also being pursued. The October 2005 federal announcement indicated that an additional $400 million was to be allocated to support additional Pacific Gateway Strategy initiatives.

The schedule for the Gateway Program contemplates phased construction of the various components. Construction of the Pitt River Bridge/Mary Hill Interchange is planned for completion by the opening of the new Golden Ears Bridge in 2009. As noted previously, the Golden Ears Bridge will increase traffic flows at the Pitt River Bridge such that additional capacity in the non-peak direction is needed. The additional capacity is required to fully take advantage of the potential benefits offered by the Golden Ears Bridge.

The schedule then anticipates construction of the SFPR by 2012, in advance of the Port Mann/Highway 1 improvements. The SFPR will provide a high quality link between Highway 1 and other Fraser River crossings as well as improving access to port and industrial areas along the river.

Construction of the Port Mann/Highway 1 improvements is contemplated by 2013.

The Gateway Program recognizes the importance of consultation and ongoing communication with interested parties and is committed to a comprehensive consultation program as well as an ongoing community relations program to ensure that community and public input is considered in the development of the Program.

10.1 CONSULTATION

Consultation with municipalities and the public is ongoing and has been underway for more than two years.

Public consultation takes place at three key design stages: pre-design, preliminary design and detailed design. Input will be considered with financial and technical information as projects proceed.

Pre-design consultation gathers community feedback on proposed concepts designed to meet congestion safety, movement and access goals. This stage is based on conceptual proposals for new or improved roads and bridges, lane use and other travel demand management measures, as well as consideration for alternate transportation such as transit and cycling.

Preliminary design consultation discusses more specific elements of the project such as refinements to key interchanges and access features, lane use and transportation demand management measures. This stage deals with specific rather than conceptual improvements. A key outcome is community feedback on preliminary designs for consideration by the project team and highway designers in developing detailed designs.

Detailed design consultation generally focuses on fewer but more detailed treatments, such as specific interchange and access features, aesthetic treatments such as lighting and landscaping, and discussion of mitigation measures where required. This stage also involves more financial and technical analysis to ensure designs are financially and technically feasible.

PART 4: MOVING AHEAD

The preliminary schedule for the Gateway Program calls for pre-design consultation to be complete in 2006, followed by environmental assessment reviews and the procurement and construction phases as outlined in Figure 27 below.

10.1.1 Methodology

Consultation will take place via a series of small group meetings and open houses as well as through web-based consultation materials and feedback forms. Public and stakeholder notification will include:

- Local Governments
- Municipal Technical Liaison Committees
- First Responders (police, fire, ambulance)
- Neighbourhood Organizations
- Business Organizations
- Transportation Groups
- Sustainability Groups
- Tourism Organizations
- Members of the Public
- Other groups and organizations

Key aspects of the project being discussed will be presented through discussion guides, display boards and staff presentations. Input will be gathered through meeting notes, feedback forms, fax, e-mail, phone and correspondence. Community and stakeholder input received during each phase of consultation will be summarized in a Consultation Summary Report. These reports will be available for public review on www.gatewayprogram.bc.ca.

10.1.2 Current Consultation

In 2005, pre-design public consultation was undertaken in Delta regarding options to improve or relocate Highway 17 as part of the southwest segment of the South Fraser Perimeter Road (SFPR), and in Port Coquitlam, Pitt Meadows and Maple Ridge regarding improvements to the Pitt River Bridge and Mary Hill Bypass. The Consultation Summary Reports for both consultation processes are available on www.gatewayprogram.bc.ca.

Pre-design consultation on the 80th to Nordel segment of the SFPR is taking place in January 2006.

Pre-design consultation on the Port Mann/Highway 1 project and on the remainder of the SFPR alignment is being undertaken during 2006.

Figure 27: Gateway Program Development Preliminary Schedule

	PMH 1 PROJECT	SFPR PROJECT	PITT RIVER BRIDGE PROJECT
Pre-design Consultation	2006	2006	Complete
Environmental Assessment Review	*2006 – 2007*	*2006*	*2006*
Start of Procurement	*2007*	*2006*	*2006*
Design and Construction	*2008 – 2013*	*2007 – 2012*	*2006 – 2009*

Note: Dates are subject to change pending environmental certification and further technical and financial analysis.
Prelminary design consultation and detailed design consultation will be conducted as the projects proceed.

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10.2 COMMUNITY RELATIONS

The Gateway Program has an ongoing Community Relations Program to ensure that interested parties can provide input and have their questions answered on an ongoing basis. The Community Relations Program facilitates ongoing two-way communications with stakeholders and helps build understanding between the Program and interested and potentially affected individuals and groups. Activities undertaken as part of the Community Relations Program include preparation and distribution of Community Updates, Fact and Information Sheets, presentations to community groups and associations, responding to questions, and maintaining the Gateway Program website.

10.3 PUBLIC REVIEW DURING ENVIRONMENTAL ASSESSMENT

In addition to comprehensive consultation at the pre-design, preliminary design and detailed design stages, the Gateway Program will include public review periods associated with the environmental assessment of each project, as described in Chapter 12. Public reviews generally involve public notices and open houses to review socio-economic, noise, water and other studies that form the environmental assessment.

Following environmental assessment certification, formal public consultation (including community meetings, open houses and web-based consultation) will continue as each of the Gateway projects progress through the key design stages.

Figure 28 outlines the public consultation process and its relationship to design stages and environmental assessment.

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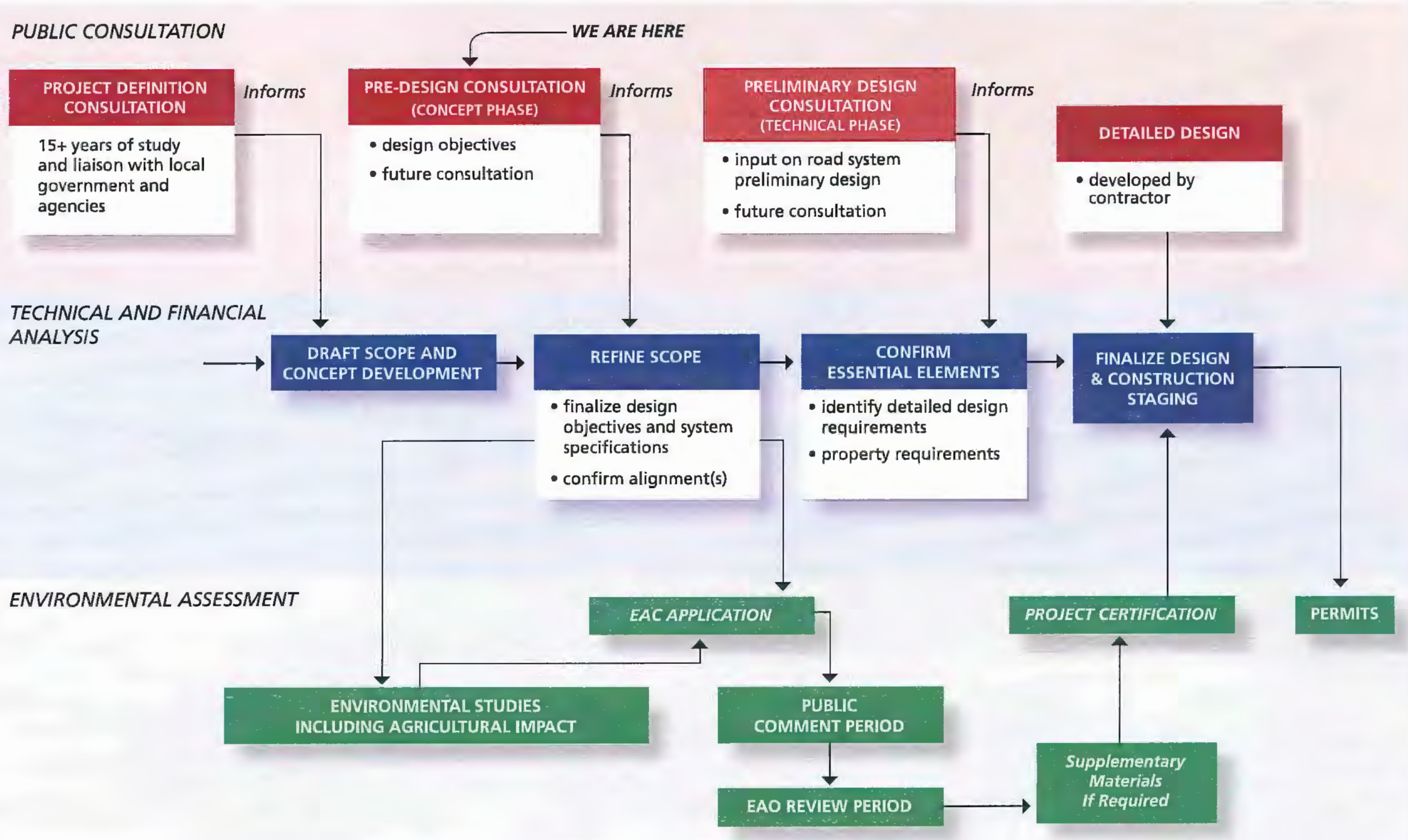
Figure 28: Gateway Program – Relationship between Planning, Consultation and Environmental Assessment



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11. FIRST NATIONS CONSULTATION

In accordance with legal and policy requirements, the Province will consider aboriginal interests in relation to the Gateway Program component corridors to ensure that First Nations issues and concerns are identified, and the Province's obligations towards First Nations are met.

Consultation with First Nations was initiated in the spring of 2003, and will continue throughout development of the Gateway Program. Project-based consultations have taken place with:

- Katzie First Nation
- Musqueam Indian Band
- Tsawwassen First Nation
- Sto:Lo Nation
- Kwikwetlem First Nation
- Kwantlen First Nation
- New Westminster Indian Band
- Semiahmoo First Nation

Since initiating consultation, the Gateway Program has continued to share project-related information and has provided an opportunity for these First Nations to participate in the environmental assessment (EA) process associated with the South Fraser Perimeter Road and Pitt River Bridge & Mary Hill Interchange projects. More focused information sharing and consultation has occurred with several of these First Nations based on their interest and willingness to engage in EA-related matters. This has included opportunities to participate in and/or review key EA study components (i.e., archaeology). More detailed Port Mann/Highway 1 consultations are scheduled to begin in early 2006.

The Gateway Program will undertake additional consultation initiatives with First Nations as efforts to further identify and resolve issues of potential concern continue, leading up to the filing of EA applications (see Section 12.1).

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12. ENVIRONMENTAL ASSESSMENT REVIEW PROCESS

As agency, community and stakeholder feedback is received and technical analysis is completed, the notional scope for each project will be refined. The program team will then prepare the respective environmental assessment applications and work with review agencies, stakeholders and the public throughout the review process to obtain environmental assessment certification.

The Ministry of Transportation is committed to minimizing environmental impacts and is continuing to consult with key stakeholders in the process of conducting comprehensive environmental reviews.

12.1 ENVIRONMENTAL REVIEW

Environmental assessment for medium to large scale projects in British Columbia follows one of two processes. For projects that trigger the Reviewable Projects Regulation of the BC Environmental Assessment Act (BCEAA), a harmonized review is to be undertaken in accordance with the Canada-BC EA Cooperation Agreement (March 2004). For projects that trigger federal legislation only, such as the Fisheries Act or Navigable Waters Protection Act, an environmental review under the Canadian Environmental Assessment Act is required. For additional detail on the provincial and federal environmental review processes, refer to www.eao.gov.bc.ca and www.ceaa.gc.ca.

Just how a project is reviewed by regulatory agencies is dependent on the physical and geographic scope of a project as well as the natural and socio-community resources that are potentially affected. Due to their length, both the South Fraser Perimeter Road and the Port Mann/Highway 1 projects are subject to a harmonized federal/provincial environmental review process. The review process for the Pitt River Bridge and Mary Hill Interchange and North Fraser Perimeter Road, due to their smaller scale and non-contiguous scope, are subject to review under the Canadian Environmental Assessment Act (CEAA) only.

The Gateway Program Team will prepare environmental assessment applications for each project. These applications and supporting studies will be submitted to the relevant assessment office for review. Potential environmental and socio-community impacts will be identified, along with proposed mitigation and compensation measures. Subject areas to be addressed include:

- Aquatics and fisheries, including water quality;
- Vegetation and wildlife;
- Local and regional air quality;
- Socio-community;
- Agriculture;
- Noise;
- Archaeology;
- Contaminated sites; and
- Water resources (e.g., hydrogeology, hydrology, hydraulics).

Public consultation and First Nations involvement in the environmental assessment process is an important aspect of the review process, wherein additional issues may be identified and addressed by the Gateway Program in accordance with environmental assessment review procedures.

For each project, subject to completion of these steps to the acceptance of the environmental review agencies, a conditional approval will be issued, allowing the project to proceed with procurement. For South Fraser Perimeter Road and the Port Mann/Highway 1 projects, Environmental Assessment Certificates (EACs) would be issued. For the North Fraser Perimeter Road and Pitt River Bridge & Mary Hill Interchange projects, a CEAA Conclusion would be issued. The EAC and CEAA Conclusion constitute approvals-in-principle for the design concepts presented, recognizing that approval to proceed to construction is issued only after environmental agencies have approved a final design as per their legislated mandate.

12.2 PROJECT ENVIRONMENTAL ASSESSMENT STATUS

A federal CEAA review of the Pitt River Bridge and Mary Hill Interchange component of the North Fraser Perimeter Road is underway. A screening document has been submitted to the responsible federal agencies and to the Fraser River Estuary Management Program, which coordinates environmental reviews of projects within its mandated area.

The South Fraser Perimeter Road is currently in the pre-application stage of a harmonized federal-provincial review, coordinated by the BC Environmental Assessment Office. Working Groups are comprised of representatives of provincial and federal environmental permitting agencies, local municipalities, the GVRD and First Nations. The Working Groups are assisting the Gateway Program Team in providing technical review of draft impact assessment reports and ensuring that the assessments will meet regulatory approval requirements.

The Port Mann/Highway 1 project is anticipated to enter pre-application under BCEAA/CEAA in 2006. Preliminary environmental assessment work is currently underway. Input from the assessments will assist in refining project scope.

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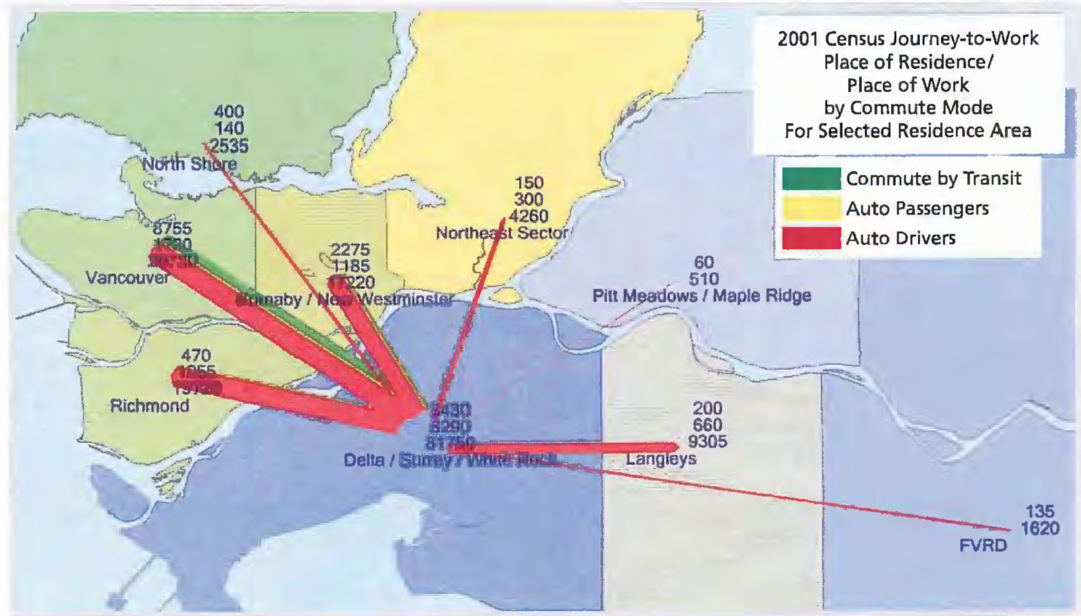
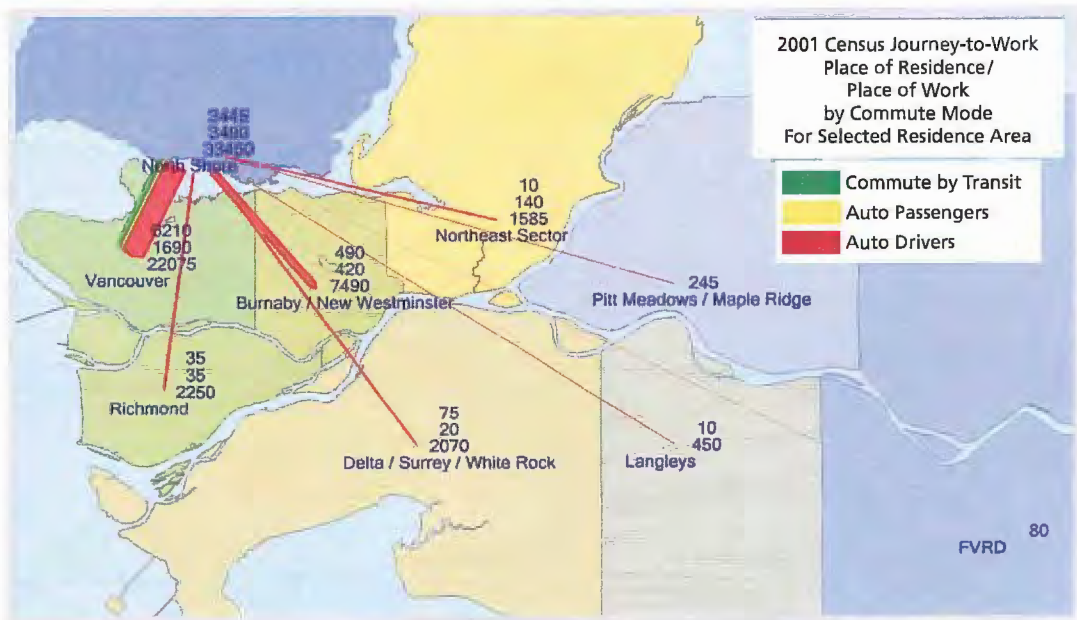
DELTA/SURREY/WHITE ROCK RESIDENTS' COMMUTING PATTERNS (2001)

Examples to illustrate representative distribution of place of employment for residents in various geographic locations within Greater Vancouver are presented and discussed in this appendix. The number of commuters bound for different destinations are listed in groups of three. The top number refers to the number of transit commuters, followed by vehicle passengers and vehicle drivers. The thickness and direction of the arrows corresponds to the volume and direction of travellers. Note that commuting patterns for residents of Vancouver and the Langleys are contained in Section 2.2 (page 8) of this report.



NORTH SHORE RESIDENTS' COMMUTING PATTERNS (2001)



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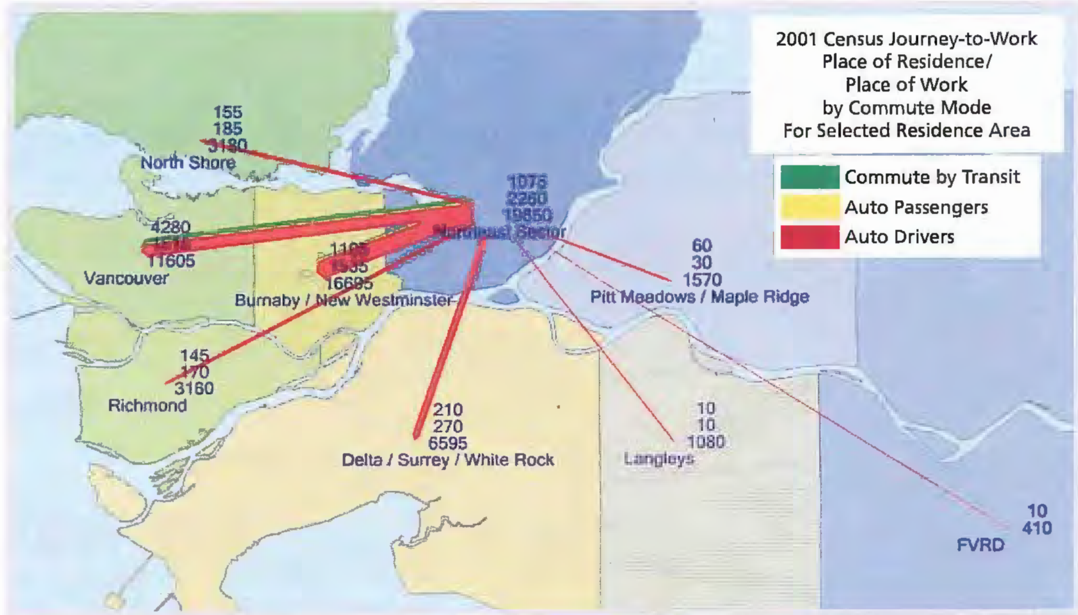
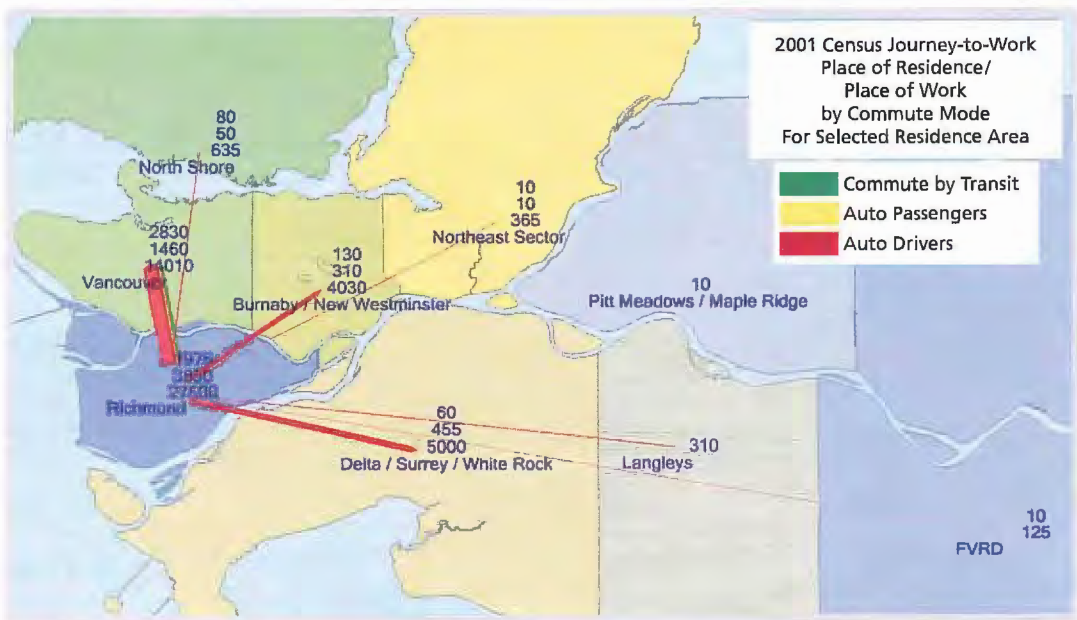
NORTHEAST SECTOR* RESIDENTS' COMMUTING PATTERNS (2001)

*Includes Coquitlam, Port Coquitlam, Port Moody, Anmore and Belcarra.



RICHMOND RESIDENTS' COMMUTING PATTERNS (2001)



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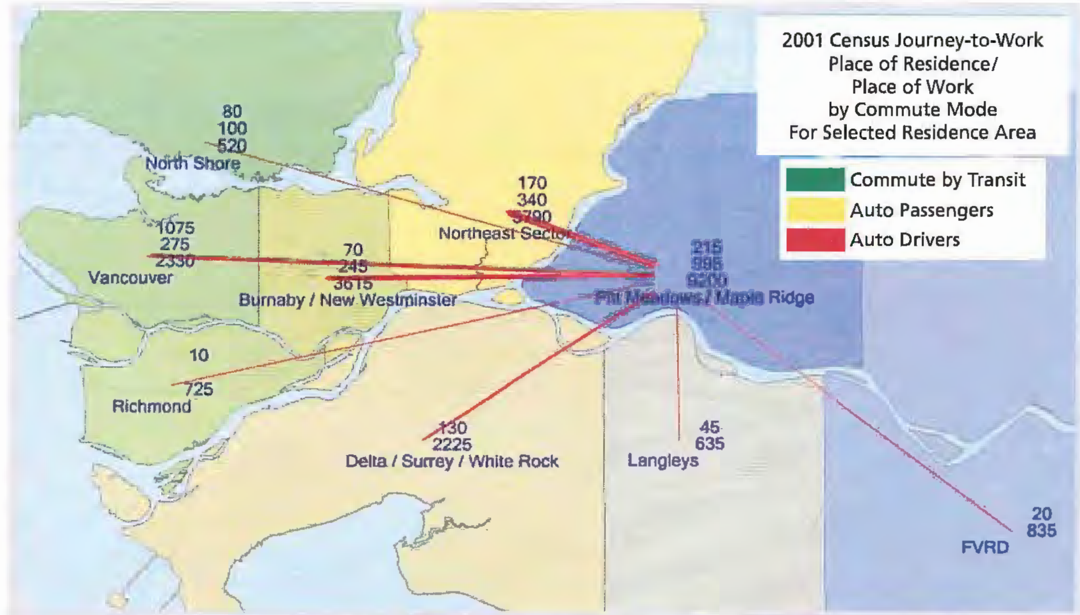
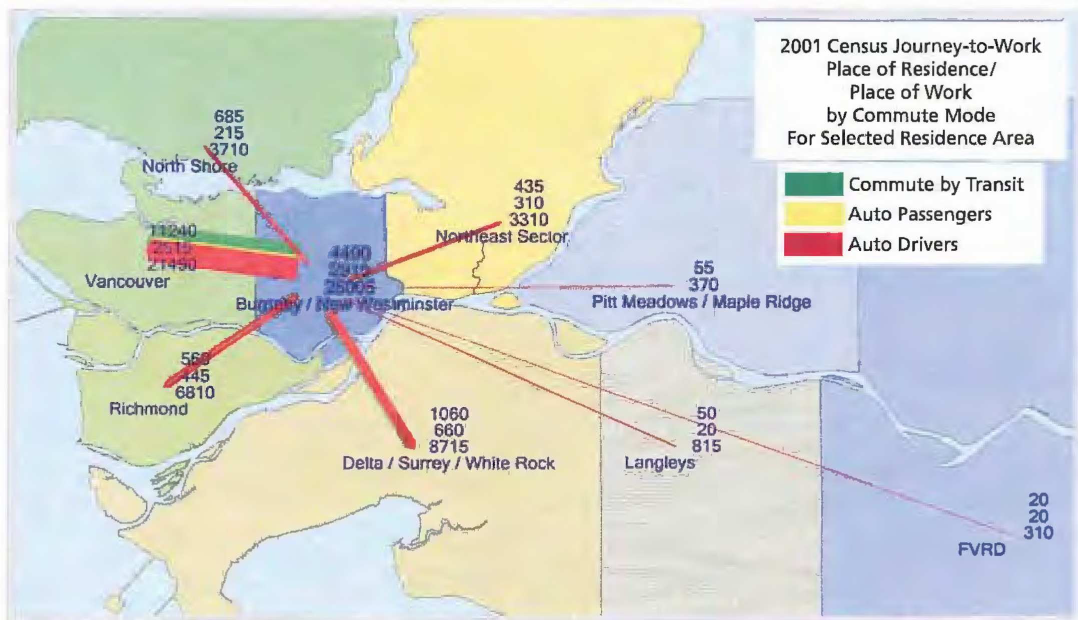
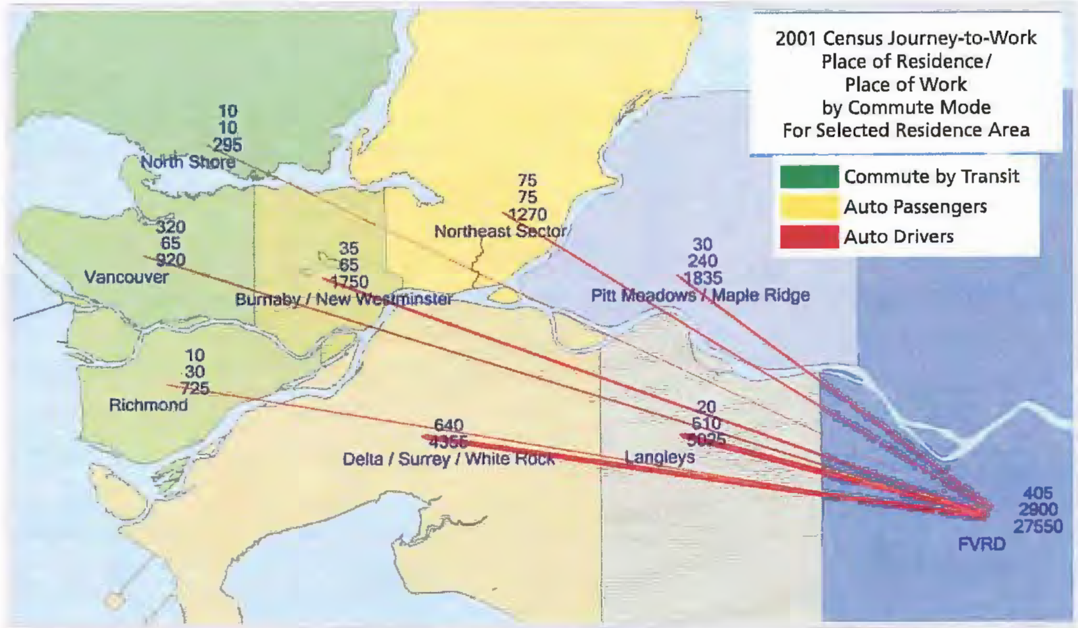
PITT MEADOWS AND MAPLE RIDGE RESIDENTS' COMMUTING PATTERNS (2001)



BURNABY AND NEW WESTMINSTER RESIDENTS' COMMUTING PATTERNS (2001)



FRASER VALLEY RESIDENTS' COMMUTING PATTERNS (2001)



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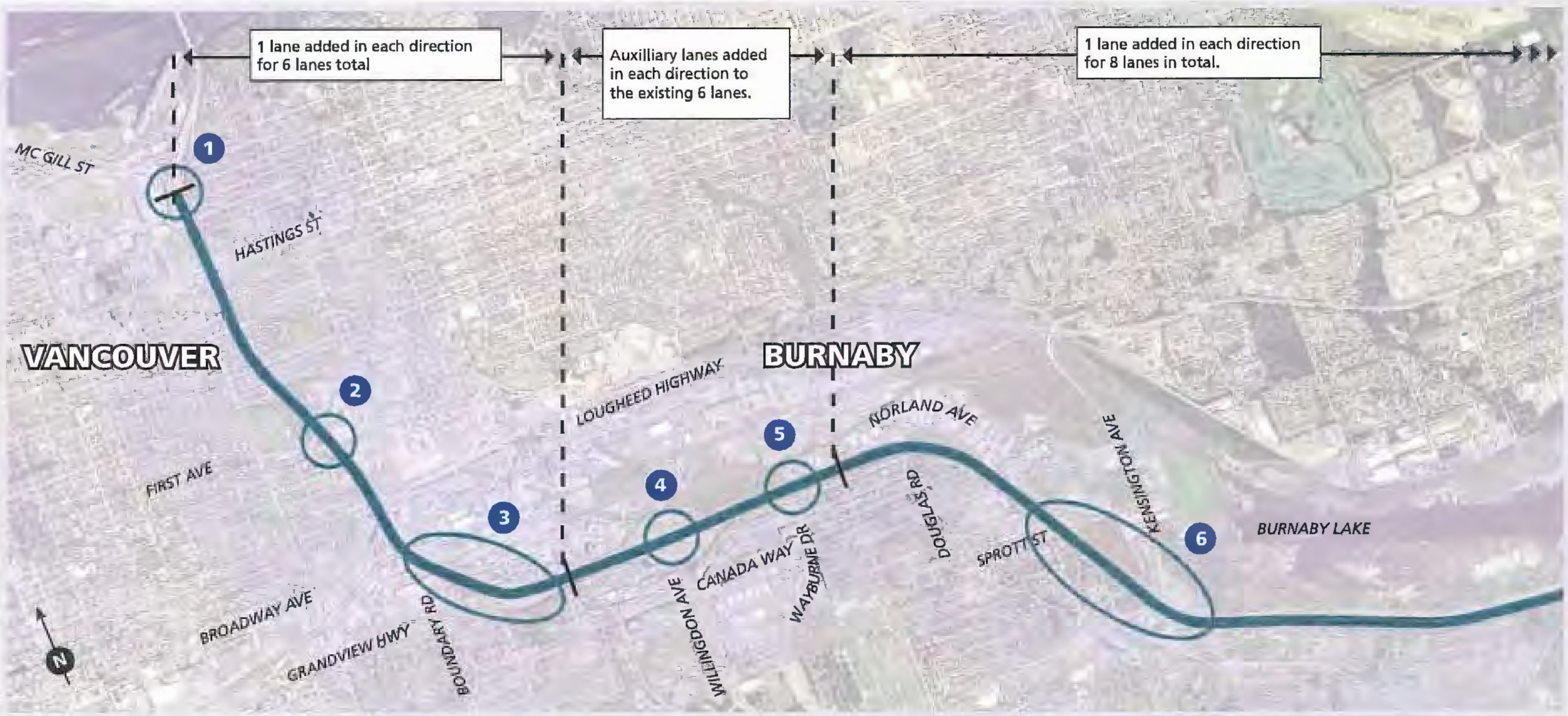
HIGHWAY 1 IMPROVEMENTS: MCGILL STREET TO KENSINGTON AVENUE



1 McGill Street ramp modifications would:
- Enhance highway operation by improving traffic flow entering and exiting the highway
- Improve safety by eliminating the short merging distance for traffic entering the highway

2 First Avenue ramp modifications would:
- Improve safety on the highway by reducing traffic queues exiting the highway

3 Extension of the Boundary Road on-ramp and reconstruction of Grandview Highway overpass would:
- Enhance highway operation by improving traffic flow entering the highway
- Improve safety on the highway and municipal roads by reducing conflict points

4 Reconstruction of the Willingdon Avenue interchange would:
- Enhance the operation of the interchange by improving access to and from the highway
- Improve connections across the highway
- Improve safety on the highway and municipal roads by reducing traffic weaving with auxilliary lanes and ramp improvements

5 Construction of a potential new overpass at Wayburne Drive would:
- Improve connections across the highway
- Assist the operation of the Willingdon Interchange by reducing traffic volumes
- Address current and future traffic in the Still Creek/Willingdon Area

6 Reconstruction of the overpass at Sprott Street and interchange at Kensington Avenue would:
- Improve the traffic flow entering the highway
- Improve connections across the highway
- Improve safety on the highway and municipal roads

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HIGHWAY 1 IMPROVEMENTS: GAGLARDI WAY TO THE PORT MANN BRIDGE

7 Reconstruction of the interchange at Gaglardi Way and the overpass at Cariboo Road would:

- Enhance the operation of the interchange by improving the traffic flow entering the highway
- Improve connections across the highway
- Improve safety on the highway by increasing the distance traffic has to enter and exit the highway

8 Reconstruction of the Brunette Avenue interchange would:

- Address current and future traffic
- Improve connections to and across the highway
- Enhance the operation of the interchange by improving traffic flow entering and exiting the highway
- Improve safety on the highway by reducing traffic queues exiting the highway

9 Construction of a potential new dedicated overpass at King Edward Street would:

- Improve safety on the highway by smoothing the highway and improving the sight lines
- Improve connections across the highway
- Remove an at-grade rail crossing on King Edward Street
- Address current and future traffic anticipated in the south Coquitlam and Pacific Reach area
- Assist the operation of the Brunette Interchange

10 Reconstruction of the Cape Horn Interchange and twinning of the Port Mann Bridge would:

- Enhance the operation of the highway and interchange by allowing free traffic flow between the major arterial roads
- Address current and future traffic
- Improve connections between the major arterial roads and the highway
- Improve connections between Surrey and the Tri-Cities
- Improve safety on the highway by improving directional signage and reducing traffic weaving

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HIGHWAY 1 IMPROVEMENTS: PORT MANN BRIDGE TO 176TH STREET

11 Reconstruction of the 152nd Street overpass would:
- Improve safety at the interchange
- Address the current and future traffic

12 Reconstruction of the 160th Street interchange would:
- Improve connections across the highway for the Fraser Heights community
- Address the current and future traffic
- Enhance the operation of the highway and municipal roads by improving access to and from the highway
- Improve safety by relocating the weigh-scales and improving adjacent intersections

13 Reconstruction of the 176th Street interchange would:
- Enhance the operation of the highway and interchange by improving access to and from the highway
- Address forecast changes in travel patterns due to the Golden Ears Bridge and South Fraser Perimeter Road projects
- Improve connectivity across the highway and to other major transport routes
- Improve safety on the highway and municipal road network

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HIGHWAY 1 IMPROVEMENTS: 192ND STREET TO GLOVER ROAD

14 Construction of a proposed partial interchange at 192nd Street would:

- Address changing future travel patterns in the Port Kells Area
- Improve access to and from the highway for the Port Kells area
- Improve operation of the 176th Street and 200th Street interchanges
- Improve connectivity across the highway

15 Construction of a potential new interchange at 216th Street would:

- Address the changing travel patterns
- Assist the operation of the 200th Street interchange
- Improve connectivity across the highway
- Improve access to and from the highway

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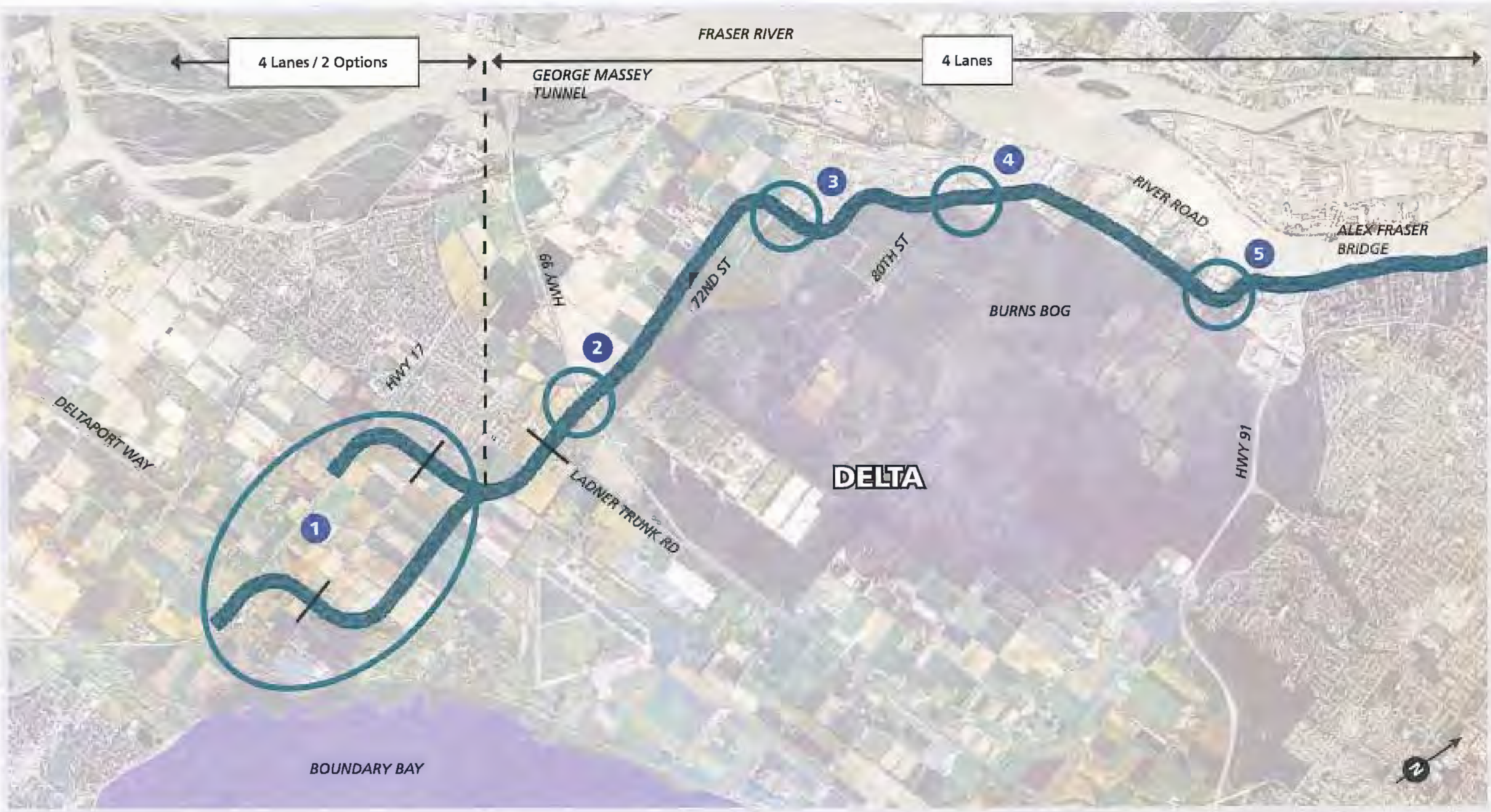
SOUTH FRASER PERIMETER ROAD IMPROVEMENTS: HIGHWAY 17 TO ALEX FRASER BRIDGE



1 Two relocated Highway 17 alignment Options in Southwest Delta.

2 Highway 99/SFPR interchange provides connections between SFPR and Highway 99

3 Intersection at 72nd Street provides access to the Tilbury Industrial Park and to local farms

4 Intersection at 80th Street provides access to Sunbury industrial area and emergency access to 80th Street South of SFPR

5 Sunbury Interchange provides connections between SFPR, Highway 91 and River Road

SOUTH FRASER PERIMETER ROAD IMPROVEMENTS: ALEX FRASER BRIDGE TO 182A STREET

6 Tannery Road Interchange provides connections between Fraser-Surrey Docks, Scott Road and the King George Highway

7 Intersection at 130th Street provides access to industrial and rail facilities north of SFPR and connections to Scott Road and the King George Highway south of SFPR

8 Intersection at 136th Street provides access to residences and the CN Rail Thornton Yard

9 Fraser Heights Interchange provides connections between SFPR, Highway 15, Highway 1, Golden Ears Bridge and the local road network

10 Intersection east of 182A Street provides access to Golden Ears Bridge and Port Kells.

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NORTH FRASER PERIMETER ROAD IMPROVEMENTS

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"Tunnel will be twinned," *Richmond Review*, February 18, 2006

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Tunnel will be twinned

Matthew Hoekstra, Staff Reporter

The George Massey tunnel will be twinned and both Highway 99 approaches widened from four lanes to six once the province's more pressing transportation projects are complete, Transportation Minister Kevin Falcon said Thursday.

Ministry officials considered adding the massive project to its recently announced $3-billion Gateway Program, but left out upgrades to the 47-year-old link—for now.

"What we have done is noted that that is part of our longer range plan. So post-Gateway, the next project that would come onto the radar screen would be the Massey Tunnel," Falcon said.

The Gateway Program includes the twinning of the Port Mann Bridge, the widening of the Trans-Canada Highway on each side of the Fraser, building new perimeter roads on both sides of the river and erecting a new Pitt River Bridge.

Falcon said the twinning the tunnel isn't an immediate priority of government since tunnel bottlenecks occur only during the morning and afternoon commutes.

"The latest numbers show us that that's not the crisis point. In fact when we go ahead with the Gateway Program, especially the new South Fraser Perimeter Road, we believe we will see increased flows of traffic through the Massey Tunnel because of traffic diversion."

The Gateway Program definition report says twinning the tunnel would also require improvements to other crossings over the North Arm of the Fraser, such as the Oak Street and Knight Street bridges, or a new crossing to connect with growing central Burnaby.

Falcon said the plan is to twin the tunnel—and pay for it in part through tolls—after the Gateway project and other major infrastructure projects, such as the Sea-to-Sky Highway widening and Golden Ears Bridge, are complete. That puts tunnel upgrades at least 15 years away.

But veteran Richmond Coun. Harold Steves said the time to move on the tunnel expansion is now.

"I wanted Richmond council to get involved a year ago and insist that they should twin the tunnel. Instead we end up with a motion of council that we tabled saying we should twin the Port Mann Bridge," he said, referring to a Jan. 15, 2005 motion supporting the bridge project.

"Why are we worried about the Port Mann when we've got an opportunity of twinning the tunnel?"

Steves said he discovered two years ago the Transportation Ministry was considering twinning the tunnel, largely due to the impact of the Vancouver Port expansion at Roberts Bank, which would add a third berth to the existing two-berth Deltaport terminal, in addition to a new three-berth terminal.

Steves said a tunnel expansion wouldn't impact farmland as another idea floated years ago would—a bridge connecting with No. 8 Road. And now that it's part of

"Tunnel will be twinned," *Richmond Review*, February 18, 2006

the province's long-term plans, the city should go "full out" in trying to secure the project, including expanding and elevating Highway 99, which could also act as a mid-island dyke.

A twinned tunnel could also incorporate light rail transit, said Steves, and ultimately connect with the Richmond's future Canada Line.

"I don't think it's a matter of the money or when to do it, because they're looking to do it with tolls."

To solve the problem of getting traffic out of Richmond, Steves suggested the idea he floated last year—a ferry terminal at Iona Island. That would put less traffic on the highways, and a new bridge connecting Iona with Vancouver would alleviate stress on other links, he said. Otherwise a new bridge to Burnaby could be built.

"The sad part of the Gateway Project was it's been so secret," he said. "On the Gateway Project we've had no role on it, and I think it's time we did."

Falcon said he's willing to sit down with Richmond council and discuss the timing of the tunnel project. But he cautioned the province can only take on so many projects at one time or risk straining the workforce and drive up prices.

Mayor Malcolm Brodie said any step to create more capacity over the Middle Arm of the Fraser is "important." He said twinning the tunnel is the logical solution, but might not be the only one—although he ruled out a new bridge that would drive highways through farmland.

"To me, the biggest need in terms of decongesting that corridor is in relation to the movement of goods, because we have the land in the Fraser Port in the southeast corner of Richmond, and we're hoping as part of any kind of major improvement that they would put in a Blundell interchange. That will enable the land to be fully developed."

Progress on a new Highway 99 interchange at Blundell Road has stalled, as a provincial feasibility report is already a year behind schedule.

Brodie fears provincial transportation planners might wait until the tunnel is twinned before building the Blundell interchange.

Public works and transportation committee chair Coun. Linda Barnes said she's skeptical of massive road improvement plans. She said a balance needs to be struck between new roads and bridges with rapid transit and dedicated truck lanes for goods movement.

"I'm not sure at this point that just simply twinning is going to make a difference, whether it's twinning the Port Mann, or twinning the tunnel."

Attachment 6

Proposed Project Components: Bridge and Highway 99-Steveston Highway Interchange

Rendering of Proposed Bridge

Scale Model of Highway 99-Steveston Highway Interchange:
Looking from northwest (The Gardens site) to southeast (Country Farms site)

Proposed Project Components: Bridge and Highway 99-Steveston Highway Interchange

Scale Model of Highway 99-Steveston Highway Interchange:
Looking from north to south

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METRO VANCOUVER RELEASES IMPACT ASSESSMENT OF GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

Collaboration Needed to Find Viable Solutions to Solve Congestion

The Metro Vancouver Board seeks to work with the Province, TransLink and other stakeholders to find mutually acceptable solutions to reduce congestion on the Highway 99 corridor in an economically and environmentally sustainable manner.

“History has demonstrated the world over, you can’t reduce congestion by simply building more roads,” said Greg Moore, Chair of Metro Vancouver. “This project represents an expansion of car-oriented infrastructure and diverts crucial funds from transportation projects that support the regional growth strategy.”

Metro Vancouver understands the congestion issues facing Highway 99 and the George Massey tunnel, but is unable to support the George Massey Tunnel Replacement Project as proposed based on an evaluation of potential impacts to regional assets, infrastructure and legislative responsibilities.

“We recognize the necessity to enhance the movement of people and goods on Highway 99 and throughout the region, but the magnitude of a ten-lane bridge estimated at $3.5 billion, has not been demonstrated and cannot be justified,” adds Moore.

Released today, a Metro Vancouver report identifies key areas of concern, including the direct, indirect and cumulative regional impacts of the proposed bridge:

- Insufficient consideration of alternatives to a ten-lane bridge
- Lack of integration into the regional growth strategy and transportation network
- Ecological disruption to the Fraser River estuary, an important habitat for salmon and birds
- Impacts on Metro Vancouver infrastructure, including water mains and sewer lines
- Recreational and ecological disruption on Deas Island Regional Park
- Downloading of major expenditures onto local governments for road improvements
- Negative effects on transit ridership and affordability
- Insufficient consideration to climate change and air quality
- Lack of transparency and consultation with respect to design and business case

Metro Vancouver is participating in the provincial environmental review process, and has requested that the Minister of Environment and Climate Change order a federal environmental assessment review process through which Metro Vancouver and other key stakeholders would participate.

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The regional growth strategy, Metro 2040: Shaping Our Future, promotes compact transit-oriented development, the efficient use of land and a transportation network that reduces energy consumption, greenhouse gas emissions and improves air quality.

"We are genuinely concerned about the possible impacts of bridge construction, roadway improvements, tunnel removal and possible future dredging which could impact between $500-million to $1-billion in regional infrastructure and assets," said Darrell Mussatto, Chair of Metro Vancouver's Utilities Committee.

The Fraser River estuary is the single most important area of aquatic bird and raptor habitat in BC, and the intertidal marshes provide critical rearing areas for juvenile salmon. Metro Vancouver has a legislative responsibility to consider the cumulative impacts of projects on the region's ecology. The potential environmental disruption on the ecologically rich land and sensitive marine environment including the Fraser River and Deas Island Regional Park is a significant risk.

"There is a need to improve sustainable transportation options throughout the region by adding capacity for more efficient public transit, HOV lanes, cycling and pedestrians," added Mussatto. "A ten-lane bridge would simply shift congestion elsewhere, further exacerbating the issue of single-occupancy vehicles. Other solutions may be considered that are in alignment with the regional growth strategy, as identified in the Mayors' Council ten-year transportation plan."

Metro Vancouver also raised concerns about the lack of a meaningful public consultation process, and incomplete information relating to project details and alternatives.

Metro Vancouver will send a letter communicating its analysis, position and concerns with respect to the project to the BC Minster of Transportation and Infrastructure, the BC Environmental Assessment Office, the BC Premier, and the Ministry of Environment and Climate Change.

"Transportation and housing affordability are the most urgent challenges impacting the livability of the region, and they are inextricably linked. We urge the Province to work with us to develop viable alternatives to the George Massey Tunnel Replacement Project as currently proposed and commit to funding the Mayors' Council ten-year transportation plan," said Chair Moore.

Contact Information

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Rise and Report (Items Released from Closed Meeting)

On June 24, 2016 the following was authorized by the Greater Vancouver Regional District Board of Directors to be released to the public:

George Massey Tunnel Replacement Project – Analysis of Regional Impact
That the GVRD Board:

a) *send a letter to the BC Minister of Transportation and Infrastructure and to the BC Environmental Office conveying:*
   i. *its wish to work with the Province, TransLink and other stakeholders to find mutually acceptable solutions for the issues facing Highway 99 and the George Massey tunnel based on:*
      - *the recognition of the congestion problems affecting the Highway 99 corridor and the need to work with the Province and other stakeholders to find an integrated transportation solution*
      - *the importance of aligning projects designed to increase highway capacity with Metro 2040, the regional growth strategy, with an emphasis on compact, vibrant communities connected by an efficient transit network, an effective goods movement system, and affordable infrastructure*
      - *the need to focus solutions to traffic congestion problems on public transportation investments as well as alternative modes as pedestrians, cycling and HOV lanes*
      - *the negative impact of increases in road capacity on transit ridership and affordability*
      - *the importance of considering traffic congestion impacts elsewhere in the region's road system caused by enhancements to the Highway 99 corridor*
      - *equitable regional mobility pricing to manage travel demand*
      - *the property impact to Metro Vancouver's regional park lands and to its utilities infrastructure*
      - *the potential risk and impact to utilities infrastructure and the financial costs associated with replacement or relocation of existing utility services*
      - *protection of the environment and the need and value of pursuing the federal environmental assessment review process*
   ii. *its opposition to the proposed George Massey Tunnel Replacement Project, based on its analysis regarding the direct, indirect, and cumulative regional impacts of the Project, and its ongoing concerns about an inadequate stakeholder input process and insufficient access to background technical analysis;*

iii. *its request that the Ministry of Transportation and Infrastructure provide commitments, assurances, compensation, monitoring, and other conditions that will be necessary to mitigate the impacts of the George Massey Tunnel Replacement Project on Metro Vancouver assets, infrastructure, and legislated responsibilities, in the event that the project receives approval by the Provincial government;*

b) *direct staff to forward this correspondence to the Federal Minister of Environment and Climate Change and the Premier of BC communicating the GVRD Board's analysis, position and concerns.*

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SERVICES AND SOLUTIONS FOR A LIVABLE REGION

CLOSED MEETING

To: GVRD Board of Directors

From: Intergovernment and Finance Committee

Date: June 17, 2016 Meeting Date: June 24, 2016

Subject: **George Massey Tunnel Replacement Project – Analysis of Regional Impact**

INTERGOVERNMENT AND FINANCE COMMITTEE RECOMMENDATION

That the GVRD Board**:**

a) send a letter to the BC Minister of Transportation and Infrastructure and to the BC Environmental Office conveying:
   i. its opposition to the proposed George Massey Tunnel Replacement Project, based on its analysis regarding the direct, indirect, and cumulative regional impacts of the Project, and its ongoing concerns about an inadequate stakeholder input process and insufficient access to background technical analysis;
   ii. its request that the Ministry of Transportation and Infrastructure provide commitments, assurances, compensation, monitoring, and other conditions that will be necessary to mitigate the impacts of the George Massey Tunnel Replacement Project on Metro Vancouver assets, infrastructure, and legislated responsibilities, in the event that the project receives approval by the Provincial government;
   iii. <u>its wish to work with the Province, TransLink and other stakeholders to find mutually acceptable solutions for the issues facing Highway 99 and the George Massey tunnel;</u>

b) direct staff to forward this correspondence to the Federal Minister of Environment and Climate Change <u>and the Premier of BC</u> communicating the GVRD Board's analysis, position and concerns; and

c) authorize the Corporate Officer to release to the public the report dated June 14, 2016, titled "George Massey Tunnel Replacement Project – Analysis of Regional Impact".

At its June 17, 2016 meeting, the Intergovernment and Finance Committee considered the attached report titled "George Massey Tunnel Replacement Project – Analysis of Regional Impact", dated June 14, 2016. The Committee subsequently passed the recommendation as presented above in underline, and requested that staff prepare associated background communications materials to be provided for the Board's consideration.

The Committee suggested that communications materials be prepared that give consideration to the following:

- the recognition of the congestion problems affecting the Highway 99 corridor and the need to work with the Province and other stakeholders to find an integrated transportation solution

- the importance of aligning projects designed to increase highway capacity with *Metro 2040*, the regional growth strategy, with an emphasis on compact, vibrant communities connected by an efficient transit network, an effective goods movement system, and affordable infrastructure
- the need to focus solutions to traffic congestion problems on public transportation investments as well as alternative modes as pedestrians, cycling and HOV lanes
- the negative impact of increases in road capacity on transit ridership and affordability
- the importance of considering traffic congestion impacts elsewhere in the region's road system caused by enhancements to the Highway 99 corridor
- equitable regional mobility pricing to manage travel demand
- the property impact to Metro Vancouver's regional park lands and to its utilities infrastructure
- the potential risk and impact to utilities infrastructure and the financial costs associated with replacement or relocation of existing utility services
- protection of the environment and the need and value of pursuing the federal environmental assessment review process

Among the comments expressed was the importance of preparing communications materials clearly identifying concerns and potential impacts of the proposed George Massey Tunnel Replacement Project on the region and its communities, and to provide these materials to the public, key decision-makers, and stakeholders. Staff have followed up, and a Communications Brief will be presented to the GVRD Board at its June 24, 2016 meeting.

Attachment:
"George Massey Tunnel Replacement Project – Analysis of Regional Impact", dated June 14, 2016.

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SERVICES AND SOLUTIONS FOR A LIVABLE REGION

CLOSED MEETING

To: Intergovernment and Finance Committee

From: Elisa Campbell, Director, Regional Planning & Electoral Area Services
Marcin Pachcinski, Division Manager, Electoral Area & Environment
Planning, Policy and Environment Department

Date: June 14, 2016 Meeting Date: June 17, 2016

Subject: **George Massey Tunnel Replacement Project – Analysis of Regional Impact**

RECOMMENDATION

That the GVRD Board**:**

a) send a letter to the BC Minister of Transportation and Infrastructure and to the BC Environmental Assessment Office conveying:
   i. its opposition to the proposed George Massey Tunnel Replacement Project, based on its analysis regarding the direct, indirect, and cumulative regional impacts of the Project, and its ongoing concerns about an inadequate stakeholder input process and insufficient access to background technical analysis;
   ii. its request that the Ministry of Transportation and Infrastructure provide commitments, assurances, compensation, monitoring, and other conditions that will be necessary to mitigate the impacts of the George Massey Tunnel Replacement Project on Metro Vancouver assets, infrastructure, and legislated responsibilities, in the event that the project receives approval by the Provincial government;
b) direct staff to forward this correspondence to the Federal Minister of Environment and Climate Change communicating the GVRD Board's analysis, position and concerns; and
c) authorize the Corporate Officer to release to the public the report dated June 14, 2016, titled "George Massey Tunnel Replacement Project – Analysis of Regional Impact".

PURPOSE

This report provides the Intergovernment and Finance Committee with an analysis, based on the information available, of the potential impacts of the proposed George Massey Tunnel Replacement Project on Metro Vancouver assets, infrastructure, and legislated responsibilities. This report also provides information on federal and provincial environmental assessment processes, including an update on the status of the application by the Ministry of Transportation and Infrastructure (MOTI) to the BC Environmental Assessment Office.

This matter is being presented at a closed meeting pursuant to *Community Charter* provision Section 90(1)(d):

> *90 (1) A part of a meeting may be closed to the public if the subject matter being considered relates to or is one or more of the following:*

d) the security of the property of the regional district;

BACKGROUND

At its May 27, 2016 meeting, the GVRD Board considered a report titled "George Massey Tunnel Replacement Project Update", dated May 25, 2016. The Board subsequently passed the following motion:

a) write a letter in response to the correspondence titled "George Massey Tunnel Replacement Project" dated May 17, 2016 from the Honourable Todd Stone, Minister of Transportation and Infrastructure;
b) direct staff to obtain information on the environmental assessment process from the Canadian Environmental Assessment Agency or other federal authorities in order to recommend an appropriate course of action; and
c) direct staff to report back through the Intergovernment and Finance Committee as soon as possible with an analysis of the George Massey Tunnel Replacement project based on the information available.

This report presents an analysis of potential impacts of the proposed George Massey Tunnel Replacement Project on Greater Vancouver Regional District, Greater Vancouver Water District, and Greater Vancouver Sewerage & Drainage District (collectively known as 'Metro Vancouver') assets, infrastructure and legislated responsibilities. This assessment is based on the information available at the time of preparing this report. It also provides information on federal and provincial environmental assessment processes, including an update on the status of MOTI's application to the BC Environmental Assessment Office. Finally, in response to a Board request for information from the City of Richmond and Corporation of Delta related to the George Massey Tunnel Replacement Project, this report conveys the following attachments:

- Attachment 1: City of Richmond Briefing Paper titled "George Massey Tunnel Replacement – City of Richmond Concerns" dated June 2, 2016.
- Attachment 2: Corporation of Delta Council Report titled "George Massey Tunnel Replacement Project" dated February 26, 2016.

ANALYSIS OF GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

The BC Ministry of Transportation and Infrastructure is the proponent of the George Massey Tunnel Replacement Project (the Project), which is intended to replace the existing George Massey Tunnel (Tunnel) with a new 10-lane tolled bridge spanning the Fraser River South Arm, Deas Island, and Deas Slough with navigation clearances similar to those at the Alex Fraser Bridge. The Project also entails decommissioning the Tunnel, and modifying Highway 99 between the Bridgeport Road interchange in Richmond to the Highway 91 interchange in Delta. As identified by MOTI, Project goals include reducing congestion and improving travel times and reliability for commuters, transit, commercial vehicles, and tourists; improving safety; providing new travel options for cyclists and pedestrians; and providing capacity for improved transit.

Metro Vancouver has a range of broad interests and concerns related to the Project in terms of its assets, infrastructure and legislated responsibilities. These include regional planning and growth management; air quality and climate change; environment; regional parks; and regional utilities.

While there still exist substantial gaps in design details, impact analysis, and associated technical documentation related to the Project, staff have conducted a high-level assessment of the potential impact of the Project on Metro Vancouver interests. A more detailed assessment is contained in the "George Massey Tunnel Replacement Project: Summary Assessment Table" (see Attachment 3). Metro Vancouver staff will conduct a more thorough assessment of impacts as part of the 60-day public comment period once the BC Environmental Assessment Office (BC EAO) confirms if the Application is reviewable.

A comprehensive review of Metro Vancouver's interests and the potential anticipated impacts of the Project on Metro Vancouver assets, infrastructure and legislated responsibilities is provided below. This analysis has been prepared based on available but limited information regarding this Project.

Regional Planning and Growth Management

The proposed Project will have implications for regional growth management, including land use, transportation, agriculture and human health impacts. With a key focus of the Project on expanding road / highway capacity by the construction of a new bridge, there are many aspects of the proposed Project that appear to be inconsistent with the direction of *Metro 2040*, the regional growth strategy. While MOTI proposes that the Project design is based on assumptions that the Urban Containment Boundary will not change, and has taken account of municipal plans, experience, both direct and as documented in research related to relevant transportation infrastructure projects indicates that there is a strong likelihood that the Project will have effects on growth management and land use plans. For example, it may result in impacts on the distribution and growth of traffic, in choices about the location of businesses and households, and in overall potentially substantial land use shifts that differ from the regional vision and municipal plans that have been pursued over many decades. The result may be increased pressures for land use conversion, including the conversion of agricultural and industrial land.

The current information is incomplete in many regards, including documentation related to potential land use impacts of new highway interchanges, the transportation effects of the new bridge on the regional transportation system, human health impacts, the impact of decommissioning the Tunnel on irrigation water for agriculture, and others.

Air Quality and Climate Change

The proposed Project will result in changes in the levels of emissions of common air pollutants, toxic air pollutants and greenhouse gases. The changes in emission levels may lead to direct impacts in the vicinity of the Project, including exposure to harmful pollutants, as well as impacts in the regional airshed, including smog and reduced visual air quality.

The current analysis of Project-related air quality and greenhouse gas impacts is inadequate. The analysis needs to examine traffic impacts across a broader study area to assess changes in traffic volumes and congestion at other points in the regional transportation system, and the associated changes in emissions and resultant environmental impacts. The analysis also needs to consider a range of future traffic scenarios to improve public confidence and address any criticisms of the selection of optimistic scenarios for the analysis. The MOTI's Application also indicates that "Air quality comprises one of the 'steps' along the pathway of effects of the Project, with human health identified as the ultimate receptor of Project-related effects." With this statement in mind, and consideration of the concerns identified with respect to the analysis of air quality impacts, there are consequential concerns about the basis for the analysis of air quality-related health impacts.

Environment

Construction of the Project as proposed (including the BC Hydro transmission line relocation) and the decommissioning of the Tunnel may have impacts on land and marine environments with ecological importance, and may directly affect fish and wildlife, and their habitat. The Fraser River estuary is the single most important area of aquatic bird and raptor habitat in British Columbia; Deas Island hosts one of the largest and most significant bat colonies in the Lower Mainland; and the intertidal marshes found in the Fraser River estuary provide critical rearing areas for juvenile salmon.

Potential direct environmental impacts include:

- Changes in fish habitat quality due to acoustic effects, changes in ambient water quality, induced turbidity, riverbed lowering, and local scouring.
- Direct mortality and disturbance to upland birds (e.g., destruction of raptor and passerine nests).
- Habitat loss and direct mortality of terrestrial wildlife during vegetation clearing and grubbing, stripping, and soil excavation.

Potential indirect and cumulative environmental impacts include:

- An increase of impervious surface area and stormwater runoff entering the river which could increase concentrations of nutrients, organics, metals, chlorides, bacteria, and hydrocarbons.
- The reduction of and changes to existing fish and wildlife habitat quality due to acoustic effects, changes to ambient water quality, and the permanent placement of in-stream piers in Deas Slough, piers adjacent to Green Slough, and temporary bridge structures during construction.
- Permanent habitat alteration and loss as well as disturbance to wildlife (mainly birds and bats) due to increased noise levels and increased ambient light environment from vehicle traffic.
- Potential for indirect habitat disturbance through the introduction of invasive species by construction vehicles or equipment.
- Impacts on agricultural lands, which provide habitat and other ecological health values.
- The possibility of additional impacts from additional dredging in the Fraser River following Tunnel decommissioning.

Regional Parks

The proposed Project is expected to follow the alignment of the existing Tunnel, bisecting Deas Island Regional Park through the existing MOTI right-of-way. The proposed bridge and the associated BC Hydro transmission relocation project will permanently change the character of the park, have an impact on visitor experience, and create permanent noise, debris and visual impacts. Construction activities from both projects will have negative impacts on park visitors' experience and will result in vegetation removal, thereby impacting habitat. The potential exists to improve trail connectivity between the sides of Deas Park; however, these potential benefits are diminished by the impact of the proposed 10-lane bridge along with the transmission line towers.

At this stage, insufficient information is known about how the land under the bridge will be designed and used, making it difficult to understand associated impacts on connectivity through the Regional Park.

Regional Utilities

The proposed Project affects both the regional water supply system and the regional liquid waste system. In particular, the River Road West Main in Delta, the Lulu Island-Delta Main in Richmond and crossing under the Fraser River into Delta, along with the Brighouse Branch Sewer North, may all be impacted by the Project. New information provided in MOTI's Environmental Assessment Application indicates that additional highway improvement works are planned for the section of the Project extending north to the Oak Street Bridge in Richmond. Therefore, the potential impacts to the regional water supply and liquid waste systems are greater than previously reported.

Both the Lulu Island-Delta Main and the River Road West Main are critical components of the regional water system supplying residents, businesses and industry south of the Fraser River as well as back-feeding the City of Richmond during an emergency. Loss of either of these mains would have a significant impact on water supply to Richmond and Delta. It is imperative that both mains be adequately monitored and protected throughout all phases of the proposed construction work and that there are no interruptions or reductions in service, especially during the peak summer water demand period. As shown on Attachment 4, given the proposed additional works within the expanded project area, and the configuration of the regional system supplying Richmond and Delta, there would be critical risks to water supply in the event construction of all project components within the Richmond/Delta corridor proceed on a concurrent basis, regardless of the time of year.

MOTI recognizes the importance of Metro Vancouver's infrastructure, and has committed to working closely with Metro Vancouver staff to ensure the integrity of regional utilities. In their Application, MOTI has indicated that given the current stage of project design, detailed utility relocation requirements have not yet been finalized. Protection and possible relocation of utilities will be the responsibility of the Contractor retained by MOTI to design and build the bridge and highway improvements. Details of works pertaining to utilities will be confirmed during final design.

While Metro Vancouver's Lulu Island-Delta Main crossing the Fraser River downstream of the Project site is not directly adjacent to the Project works and will not require relocation, this portion of the Main may be affected by tunnel decommissioning. Further modelling of river hydraulics and river bed lowering is required in this regard.

Relocation of BC Hydro Transmission Line

As noted in previous sections in this report, BC Hydro is planning to relocate a 230-kilovolt transmission line that currently spans the length of the Tunnel to coincide with the proposed George Massey Tunnel Replacement Project. Although BC Hydro has not yet announced which of three relocation alternatives it will implement, it is continuing to study Alternative 1, an overhead transmission line crossing the Fraser River. Metro Vancouver has both regional utility and regional park assets located in close proximity, and may experience direct and cumulative impacts to these assets. Regional Park ecology, visitor experience, and viewsheds will be impacted and similarly, the construction of the new transmission line may have impacts on the above-noted regional water supply mains.

Fraser River Dredging
The proposed decommissioning of the Tunnel raises the possibility that additional dredging may occur in the Fraser River. While very little information is known about future potential dredging plans, the impact of any increased dredging on the Fraser River estuary, GVWD and GVS&DD marine crossings of the Fraser River, and land uses along the Fraser River could be significant.

FEDERAL AND PROVINCIAL ENVIRONMENTAL REVIEW PROCESSES

BC Environmental Assessment Act
The Project is subject to an environmental review under the B.C. *Environmental Assessment Act* due both to the area of land disturbed associated with the decommissioning of the Tunnel, and to the length of additional lanes being added to an existing public highway.

The BC EAO established an Advisory Working Group comprised of federal, provincial, local government and First Nations representatives to assist it with the assessment process. Metro Vancouver staff attended two Pre-Application stage working group meetings on January 21 and March 10, 2016. On May 30, 2016, the MOTI submitted its application for an Environmental Assessment Certificate to the BC EAO. As prescribed through the provincial environmental assessment process, the BC EAO has thirty days from the submission of the application to evaluate the application for completeness. Stakeholders, including Metro Vancouver, have fifteen days within this timeframe to provide comments on the completeness of the application. Metro Vancouver staff are preparing comments in this regard, to be submitted to the BC EAO by June 15, 2016.

If the MOTI's application is deemed to be complete, the BC EAO will make the application available for a 60-day public comment period. This period also represents the start of the 180-day application review period, during which the BC EAO prepares an assessment report for referral to the provincial Ministers with decision-making authority. In this case, the Ministers responsible for the decisions on whether to issue an Environmental Assessment Certificate are the Minister of Environment and the Minister of Community, Sport and Cultural Development.

MOTI's Application to the BC Environmental Assessment Office
On May 30, 2016, the BC EAO confirmed receipt of an application for an Environmental Assessment Certificate for the George Massey Tunnel Replacement Project (the Application) from the MOTI. The first step of the provincial process to review the Application involves a screening by the Advisory Working Group and by the BC EAO to ensure that the Application meets all Application Information Requirements. The Advisory Working Group, on which Metro Vancouver staff participate, has fifteen days to identify any deficiencies to the BC EAO. The BC EAO then has fifteen days to determine if the Application meets the Requirements, and to provide direction for changes if appropriate. All screening comments about the completeness of the Application must be provided to the BC EAO by Advisory Working Group members (including Metro Vancouver staff) by June 15, 2016.

Canadian Environmental Assessment Act
While the Project does not automatically trigger a federal review under the *Canadian Environmental Assessment Act, 2012 (CEAA 2012)*, it will require issuance of a permit, approval or authorization from Fisheries and Oceans Canada, Environment Canada, Transport Canada, and the Vancouver Fraser Port Authority. As well, in a letter to the federal Minister of Environment and Climate Change dated April 5, 2016, the Metro Vancouver Board requested that the Minister, pursuant to section 14(2) of the

Canadian Environmental Assessment Act, 2012, order a federal environmental assessment of the Project.

Some key features that characterize the environmental review of a project through *CEAA 2012* include:

- greater independence between project proponents and reviewers, to ensure that project impacts are assessed in an impartial and objective manner;
- greater rigour of the analytical process;
- longer timeframe (at least 365 days for an environmental assessment conducted by the Agency and at least 24 months for an environmental assessment by a review panel);
- more substantial public / stakeholder input, including the opportunity to comment on the draft environmental assessment report;
- incorporation of broader impacts into assessment, including direct, indirect and cumulative effects;
- mitigation measures identified in the environmental assessment decision statement are incorporated into the design plans and implemented with the project;
- review of projects by a review panel is conducted by members selected on the basis of their knowledge, experience and expertise, who must be free from bias or conflict of interest relative to the project;
- a review panel has the ability to assess whether the environmental impact statement prepared by the proponent is sufficient to proceed to public hearings;

Metro Vancouver Request for Mitigation Conditions and Measures
Recognizing that the BC EAO's assessment will be referred to the provincial Ministers with decision-making authority, Metro Vancouver staff are also developing a list of issues and impacts, along with commitments, assurances, compensation, monitoring, and other conditions that are necessary to mitigate the impacts of the Project on Metro Vancouver assets, infrastructure and legislated responsibilities if the Project is approved. Initial work in this regard is contained in the "George Massey Tunnel Replacement Project: Summary Assessment Table" (see Attachment 3). This information can be provided by Metro Vancouver to the BC EAO as part of its submission during the 60-day public comment period, or can be conveyed under separate cover.

ALTERNATIVES
1. That the GVRD Board:
   a) send a letter to the BC Minister of Transportation and Infrastructure and to the BC Environmental Office conveying:
      i. its opposition to the proposed George Massey Tunnel Replacement Project, based on its analysis regarding the direct, indirect, and cumulative regional impacts of the Project, and its ongoing concerns about an inadequate stakeholder input process and insufficient access to background technical analysis;
      ii. a request that the Ministry of Transportation and Infrastructure provide commitments, assurances, compensation, monitoring, and other conditions that will be necessary to mitigate the impacts of the George Massey Tunnel Replacement Project on Metro Vancouver assets, infrastructure, and legislated responsibilities, in the event that the project receives approval by the Provincial government;

b) direct staff to forward this correspondence to the Federal Minister of Environment and Climate Change communicating the GVRD Board's analysis, position and concerns; and
c) authorize the Corporate Officer to release to the public the report dated June 14, 2016, titled "George Massey Tunnel Replacement Project – Analysis of Regional Impact".

2. That the Intergovernment and Finance Committee receive for information the report dated June 14, 2016, titled "George Massey Tunnel Replacement Project – Regional Impacts and Concerns" and provide alternate direction to staff.

FINANCIAL IMPLICATIONS

If the Board supports alternative one, letters will be sent to the Minister of Transportation of Infrastructure and to the BC Environmental Assessment Office conveying that, should the Project proceed, Metro Vancouver will be seeking commitments, assurances, and compensation from the Province to mitigate the impacts on Metro Vancouver assets, infrastructure and legislated responsibilities. It is anticipated that the new bridge, the accompanying BC Hydro transmission line relocation, and the decommissioning of the existing Tunnel, will have both direct and indirect financial implications for regional water supply and liquid waste utilities infrastructure and service delivery, along with anticipated direct and indirect impacts to the Deas Island Regional Park.

Given the lack of detail available about the Project and the relocation of the BC Hydro transmission line, the specific financial implications for Metro Vancouver as a result of the Project are unknown and difficult to estimate at this time. Metro Vancouver staff will continue to liaise with MOTI and with BC Hydro to protect the interests of Metro Vancouver with respect to its assets and operations.

It should also be noted that significant Metro Vancouver staff time has been dedicated to the George Massey Tunnel Replacement Project. The need for staff time is anticipated to continue at variable intensity until the completion of the George Massey Tunnel Replacement Project, including decommissioning of the Tunnel.

Project Business Case

The business case provided by MOTI for the Project includes an assumption of incremental GDP growth of $13 million / year every year from 2021–2045, but it does not provide important information related to how stated values were arrived at. Similarly, it is unclear how other Project-related benefits were calculated, including the benefit of seismic improvements. The breakdown of project costs is redacted in the original business case from October 2015, so the amount of construction plus contingency is unknown as is the interest during construction and the decommissioning of the tunnel. If contingencies are insufficient, project costs could well exceed the stated amount of $3.5 billion. As well, there is a lack of clarity related to the calculation of the present value of net project costs, including whether there have been any deductions incorporated into the calculation of the net amount.

The business case also does not present analysis of the range of transportation options that were considered by the Province before deciding upon a 10-lane bridge as the preferred alternative for achieving Project goals. For example, no information is available that assesses the investment of $3.5 billion in funding towards the new bridge against other alternatives that would achieve Project goals, but would better align with *Metro 2040* and enhance the proposed investments included in the TransLink Mayors' Council 10-Year Vision.

SUMMARY / CONCLUSION

At its May 27, 2016 meeting, the GVRD Board considered a report titled "George Massey Tunnel Replacement Project Update". This report responds to requests from the Board and presents, based on the information available, an analysis of the potential impacts of the proposed George Massey Tunnel Replacement Project on Metro Vancouver assets, infrastructure, and legislated responsibilities. It also provides information on federal and provincial environmental assessment processes, an update on MOTI's application to the BC Environmental Assessment Office, and conveys information from the City of Richmond and Corporation of Delta related to the George Massey Tunnel Replacement Project.

Metro Vancouver has a range of broad interests and concerns related to the Project in terms of its assets, infrastructure and legislated responsibilities, including regional planning and growth management; air quality and climate change; environment; regional parks; and regional utilities. Although substantial gaps in design details, impact analysis, and associated technical documentation related to the Project still exist, this report provides a high-level staff assessment of the potential impact of both the Project and related proximal works on Metro Vancouver interests. The potential impacts, including direct, indirect and cumulative effects, are considered to be broad and potentially substantial. In all cases, the lack of sufficient access to the full breadth of technical information including financial and business case documentation has made it very difficult to clarify and quantify these impacts in more detail. Moreover, the limited timeframes provided for stakeholder input to specific reports and applications throughout this process have created ongoing difficulties in conducting analysis to the appropriate level of detail.

There continue to be concerns about the direct, indirect, and cumulative regional impacts of the proposed George Massey Tunnel Replacement Project on the integrity and security of Metro Vancouver assets, as well as ongoing concerns about an inadequate stakeholder input process and insufficient access to background technical analysis. Timelines for stakeholder analysis and feedback on MOTI's Project Definition Report and the Application Information Requirements submitted to the BC EAO have been challenging. As previously noted, the BC EAO has given stakeholders with 15 days to review the Application Information Requirements (2,500+ pages) for completeness. There will be a 60-day public comment period after the BC EAO accepts the application. A potential concern is how meaningful the solicitation of public comment will be on information that is often highly technical or specialized.

Based on the foregoing analysis of the information available on the Project and the potential impact on Metro Vancouver assets, infrastructure, and services, staff recommend that the Board support alternative one and that a letter be sent to the BC Minister of Transportation and Infrastructure and to the Federal Minister of Environment and Climate Change conveying the Board's opposition to the Project. Further, should the Project be approved, that the Province of British Columbia commit to providing compensation, monitoring, and other conditions that will be necessary to mitigate the impacts of the George Massey Tunnel Replacement Project on Metro Vancouver assets, infrastructure, and legislated responsibilities.

Attachments and References: *(Orbit #18482936):*

1. City of Richmond Briefing Paper titled "George Massey Tunnel Replacement – City of Richmond Concerns" dated June 2, 2016
2. Corporation of Delta Council Report titled "George Massey Tunnel Replacement Project" dated February 26, 2016.
3. George Massey Tunnel Replacement Project: Summary Assessment Table
4. Map: Areas of Potential Impact to Metro Vancouver Utilities
5. Project Definition Report

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George Massey Tunnel Replacement

City of Richmond Concerns

The key areas of concern for the City include:

- Tunnel Decommissioning & Preference for New/Improved Tunnel: The removal of the existing tunnel coupled with a new bridge encourages future increased dredging of the Fraser River to enlarge the shipping channel and thus greater industrialization of the river as well as the surrounding area.

- Highway 99 Widening & Impacts to Agricultural Land/ESAs/RMAs: Project information indicates a "net positive impact" to agricultural lands but has not been confirmed nor quantified. The widening of Highway 99 to an undisclosed depth on the west side will impact the viability of adjacent existing farm land as well as the City's designated Environmentally Sensitive Areas and Riparian Management Areas. The project team has indicated they wish to acquire a depth of 36 meters along the highway where Steveston Highway meets Highway 99.

- Regional Concerns: It is not clear that a new 10-lane bridge is consistent with the Regional Growth Strategy or the Mayors' Council Vision for Regional Transportation Investments. Additionally, what are the environmental and other impacts of encouraging increased use of the single occupant motor vehicle instead of investing in public transportation.

- Funding for the Proposed Bridge: It remains unclear how the proposed bridge will be funded and what portion of its cost, if any, will be contributed by Port of Vancouver. The details of the project funding model should be shared sooner rather than later in order to ensure the financial planning process for the project is fully transparent.

- Bridge Toll versus Mobility Pricing: No information is available on the toll rate or how it will be equitably applied given that the region's existing and planned tolled facilities will be located solely on bridge crossings linking the region south of the Fraser River. A tolling policy that focuses only on river crossings penalizes an island city like Richmond. Now is an opportune moment to initiate work on a region-wide mobility pricing policy for roads and bridges consistent with the long-term funding strategy for the Mayors' Council Vision.

- Potential Congestion at Oak Street Bridge: The project scope does not include any improvements to the Oak Street-70th Avenue intersection, which is the primary source of traffic queuing at the Oak Street Bridge, nor at the Knight Street Bridge to where the Oak Street Bridge traffic may eventually divert.

- Impacts on & Required Improvements to Local Road Network: The project scope may have potentially significant impacts on the local road network but there are no details as to the scale and cost of needed improvements to these local roads.

- Sustainable Transportation Options: The integrated transit stops should be operational on opening day. Pedestrian and cycling facilities should be incorporated in all new structures, including a pathway on both sides of the bridge, with safe and convenient connections to the local network.

- Origin-Destination Surveys: The Project Definition Report (PDR) states that approximately 60 per cent of traffic through the Tunnel is destined for or originates from Richmond based on two Bluetooth surveys each for a two-week period in the Fall of 2013 and 2014. Further clarification had been requested by the City on the project team's survey methodology to arrive at this conclusion.

- Relocation of BC Hydro Transmission Line: BC Hydro will need to relocate its existing transmission line that runs underground through the tunnel and has identified an overhead crossing as the technically-leading solution. The City's preferred options are either an underground crossing of the Fraser River or attached to the new bridge.

- EA Process: The expectation of the BCEAO for the City to provide comments on both the Project Description and Key Areas of Study document as well as the dAIR by the specified deadlines within the overlapping review periods is unrealistic.

- Decision to replace tunnel with bridge: The City notes the change in direction from upgrading the Tunnel to building a bridge. Until announcing the bridge project in 2012, the publicized intention of the MoTI was to improve and/or expand the Tunnel. Should the project to improve the existing crossing at the Fraser River go ahead, Council's preference is for an upgraded and/or expanded tunnel instead of a new bridge.

Missing Technical Information

Staff have met with the George Massey Tunnel Replacement (GMTR) project team regularly since January 2014 (in more than 70 meetings as noted in MoTI news releases and publications). Although MoTI has indicated that the City has "provided valuable comments that have shaped the project scope" (as noted in the news release distributed in conjunction with Minister Stone's March 30, 2016 presentation at the Richmond Chamber of Commerce), there are many areas on which the City is still awaiting a response and/or more detailed information.

Specifically, in addition to the concerns expressed to MoTI through Council resolutions, the City has not received any further information on the following specific technical issues.

- Outstanding data and technical analysis of the existing and forecast traffic volumes for the Highway 99 corridor and ramps, Oak Street, Knight Street and Arthur Laing Bridges and the Steveston Highway and No. 5 Road intersection.

- Traffic modelling results to demonstrate the extent of any traffic diversion to these bridges, whether there is sufficient capacity and to identify any necessary mitigating traffic management measures.

- Extend the project scope to include the assessment of traffic impacts and implementation of the appropriate improvements at Oak Street and 70th Avenue, as well as Highway 99 northbound on-ramps from Sea Island Way and Bridgeport Road.

- Technical analysis to support the PDR statement that "*there won't be additional cars crossing the Oak Street Bridge because of the new bridge*".

- More information on the methodology and data collection for the Bluetooth O-D studies including sample size and its statistical significance of each study.

- Rationale on why Highway 99 is being widened to the west rather than the east, whether the extent on the west can be reduced from what is currently proposed (e.g. 36 m take from the City's Garden lands) and what options, if any, are available to the City.

- Provide the specific extent of impact of the project on agricultural land as well as the amount and location of land that can be reinstated as agricultural.

- Conduct a safety audit of the Steveston interchange (e.g., northbound to westbound movement and weaving of traffic).

- Evidence to confirm net zero or positive impact on agricultural land (provide quantified number and locations to demonstrate) and net zero or positive impact on RMAs and ESAs.

- The Project Qualified Environmental Professional (QEP) should be conducting an evaluation of the current and future Riparian Management Areas (RMA) and Environmentally Sensitive Areas (ESA).

Project Scope

The City had expected the release of BC MoTI's *Project Definition Report* in June 2014 based on initial information from MoTI and discussions with the GMTR staff, however, these documents were not made public until December of 2015. The following summarizes the project scope of the GMTR initiative:

- Replace the Tunnel with a new 10-lane bridge (eight lanes plus two dedicated transit/HOV lanes) in the same corridor. The clear span structure will have a 57 m navigational clearance, similar to the Alex Fraser Bridge.

- Replace the Westminster Highway, Steveston Highway and Highway 17A interchanges with the latter two new interchanges including integrated transit stops within the centre median.

- Widen the Shell Road overpass and replace the Blundell Road, Ladner Trunk Road and 112th Street overpasses.

- Provide continuous dedicated transit/HOV lanes (50 lane-kms) between Highway 91 in Delta and Bridgeport Road in Richmond including a transit only ramp at Bridgeport Road, which will also support potential future rapid transit expansion.

- Provide access and connections for cyclists and pedestrians with a multi-use pathway on the new bridge.

- Provide a new connection to Rice Mill Road.

- Decommission the Tunnel once the new bridge opens.

- The Project will be funded through user tolls with the amount to be determined.

Consultation

- Following the Province's announcement in September 2012 that the Tunnel would be replaced, the Ministry of Transportation & Infrastructure (MoTI) has undertaken three rounds of public consultation to date:

  - Phase 1 (November-December 2012): Focused on understanding the needs and potential constraints to help develop project scope and design requirements. Based on the feedback, the top three factors to consider in the development of replacement options were: congestion reduction, support economic growth and inclusion of transportation alternatives, rather than impacts such as support for the Regional Growth Strategy, environmental factors and air quality impacts.

  - Phase 2 (March-April 2013): Sought input on draft project scope and goals, five crossing scenarios, and the criteria to evaluate the options. Based on the feedback, the highest support was for a new bridge in the same corridor.

  - Phase 3 (December 2015-January 2016): Feedback on the proposed project scope, success measures, funding options, and traffic management during construction.

- City staff first met with GMTR staff in September 2013 and subsequently established regular meetings (typically every two weeks) to discuss technical issues as of January 2014.

- Further detailed information about the project was requested by staff at each of these technical meetings. While GMTR staff had responded with further information, the necessary details are still missing in order for staff and Council to better assess the local impacts of the project.

- The project as defined and the lack of the requested detailed information has led to concerns regarding the justification of the project and its potential negative impacts on the City and the region.

- These requests from the City are summarized in Missing Technical Information on Page 4 and also generally reflected in Council Resolutions summarized on Page 7.

Environmental Assessment Process

- The GMTR project is subject to review under the BC *Environmental Assessment Act*. The project is triggered by the tunnel decommissioning and the modification of existing public highway equal or greater than 20 kilometres.

- Pre-Application Stage (December 2015-June/July 2016): Initiated with the release of the Project Definition and Key Areas of Study document and the draft Application Information Requirements (dAIR) that is reviewed by Working Group members. This includes:

  - 31-day (January 15-February 15, 2016) public comment period on the Project Definition and Key Areas of Study including two open houses.

  - Meetings of the Environmental Assessment Advisory Working Group to provide comments on the Project Definition and Key Areas of Study by February 15, 2016 and the dAIR by February 10, 2016. City staff received an extension of the February 10, 2016 deadline to February 22, 2016.

- Application Review Stage (June/July-November/December 2016): The final AIR must be approved by the BCEAO prior to MoTI submission of an application for an environmental assessment certificate.

- A dAIR Working Group meeting during this stage of the EA process was held on March 10, 2016 that focused on the collective Working Group comments on the dAIR, the responses of MoTI and a discussion of key outstanding issues of Working Group members on the dAIR.

- On May 24, 2016, the City was notified that the AIR has been finalized by the EAO and starting May 31, Working Group members, including the City, will have 30 days to review the Application for completeness.

- Upon submission of the AIR, the BC EAO will undertake a completeness review and a 30-day screening period including an opportunity for further public consultation. This marks the final stage of pre-application.

- Following this 30-day period, the final application will be submitted and include a minimum 45-day public comment period and at least two BC EAO-led open houses.

Council Resolutions

To date, Richmond City Council has considered six reports on the GMTR:

- March 11, 2013: Report on the five crossing scenarios identified in Phase 2 consultation. Council resolved to oppose any crossing option that would significantly impact existing farm lands and communities, particularly Scenario 5.

- June 23, 2014: Report on proposed project objectives to be considered by MoTI in the development of a preferred project scope of improvements, which were endorsed by Council.

- July 27, 2015: Status update on project including relocation of the BC Hydro transmission line currently housed in the Tunnel. Council resolved to forward the report to MoTI for consideration in the development of the PDR. Council also resolved to advise BC Hydro that should the Tunnel be decommissioned, the City's preferred options for the relocation of the transmission line would be either an underground crossing of the Fraser River or attached to the new bridge.

- October 13, 2015: Report on the impacts of the potential widening of Highway 99 on the west side within Richmond. Council resolved to forward the report to MoTI for consideration in the development of the PDR and advise the Agriculture Land Commission and the Minister of Transportation and Infrastructure of the City's concerns of the potential impacts on existing established institutions and farming of their backlands.

- January 25, 2016: Report on the PDR issued in December 2015. Council resolved that its preference is for a new or improved tunnel rather than a new bridge. Council also resolved to request an extension to the deadline for comments on the draft AIR and to refer the topic to Metro Vancouver for comments on the compatibility of the new bridge with the Regional Growth Strategy. Council further resolved to support in principle the objectives of easing traffic congestion, improving transit and cycling connections and replacing aging highway infrastructure to enhance public safety subject to a number of issues being addressed prior to further design.

- February 22, 2016: Report expressed concern with change in direction from upgrading the Tunnel to building a bridge and included nine supporting documents. Council resolved to request that the Province provide copies of all reports and studies that relate to the original plan to twin the Tunnel and/or provide Rapid Bus service that were considered during the period from 2006 to 2008, and if necessary, that the foregoing request be made as an official Freedom of Information request. Although Minister Stone has recently responded in his letter of March 30, 2016 that the above information would be posted on the project website in Spring, a formal FOI request has been sent out from the City to MoTI to ensure that the information being compiled is thorough and complete. Council also resolved to request the Federal Minister of the Environment to refer the George Massey Tunnel Replacement Project to a Canadian Environmental Assessment Review Panel for review under the Environmental Assessment Act. CEEA responded on March 31, 2016 to indicate that this request would be reflected in their advice to the Minister.

Attachment 1 contains each of the full Council resolutions above.

Federal Government Partnership

The PDR states that the Province is working with the federal government to determine potential funding partnerships. Given that a new bridge will be tolled, the BC Minister of

Transportation & Infrastructure has stated that a contribution may either reduce the toll rate or the length of repayment period. This project can be seen as potentially competing for funding with the regional transportation improvements identified by the Mayors' Council Vision.

Council Meeting	Resolution
March 11, 2013	*WHEREAS:* *(A) the Richmond Official Community Plan envisions the protection of existing farm lands and the improvement to provincial highways be restricted only to within the existing corridors such as Highway 99 in Richmond;* *(B) any proposed new highway corridors through existing farm lands would be detrimental to the City and the region; and* *(C) Richmond has continuously expressed opposition to any new highway crossing in the vicinity of No. 8 Road;* *THEREFORE BE IT RESOLVED* *(1) That the City of Richmond send a letter to the Minister of Transportation and Infrastructure, with copies to the Richmond MLA's, the leader of the Official Opposition, Richmond Agricultural Advisory Committee, the Metro Vancouver Agricultural Advisory Committee, and the Agricultural Land Commission, formally opposing any proposed river crossing options that would significantly impact existing farm lands and communities, particularly Scenario 5 in their recently released documents for Phase 2 public consultation for the George Massey Tunnel Replacement project;* *(2) That all Metro Vancouver municipalities be advised of the above resolution; and* *(3) That staff review and report back on the implications of the George Massey Tunney improvement options once further details of the options are determined.*
June 23, 2014	*(1) That the proposed project objectives for the replacement of the George Massey Tunnel as described in the staff report dated May 23, 2014 from the Director, Transportation be endorsed and forwarded to the Ministry of Transportation & Infrastructure for its consideration in the development of a preferred project scope of improvements; and* *(2) That the above Council resolution and a copy of the above report be forwarded to Richmond MLAs, TransLink, the Corporation of Delta, and the Cities of Surrey, White Rock and Vancouver for information.*
July 27, 2015	*(1) That the staff report titled "Update on George Massey Tunnel Replacement Project" dated July 10, 2015 from the Director, Transportation, be forwarded to the Ministry of Transportation & Infrastructure's George Massey Tunnel Replacement project team for*

Council Meeting	Resolution
	consideration in the development of the Project Definition Report; *(2) That a letter be sent to BC Hydro advising that, should the George Massey Tunnel be decommissioned, the City's preferred options for the relocation of the BC Hydro transmission line from the tunnel would be either an underground crossing of the Fraser River or attached to the new bridge; and* *(3) That a letter be sent to the Auditor General for British Columbia outlining Council's concerns with respect to the replacement of the George Massey Tunnel.*
October 13, 2015	*(1) That the staff report titled "Update on George Massey Tunnel Replacement Project – Highway 99 Widening," dated September 28, 2015, from the Director, Transportation, be forwarded to the Ministry of Transportation and Infrastructure's George Massey Tunnel Replacement project team for consideration in the development of the Project Definition Report;* *(2) That a letter be sent by Mayor Brodie, on behalf of Council, to the Agriculture Land Commission and the Minister of Transportation and Infrastructure, with copies to all Richmond MLA's, advising of the City's concerns with any potential widening of Highway 99 on the west side impacting existing established institutions and farming of their backlands, and reiterating the City's request for the early provision of the Project Definition Report and financing strategy; and* *(3) That a letter be sent to the Agriculture Land Commission confirming that the City wishes to be fully engaged in any discussions regarding the use of Agricultural Land Reserve lands for the George Massey Tunnel Replacement Project.*
January 25, 2016	*(1) That the Ministry of Transportation and Infrastructure (MoTI) be advised that while the City supports the objectives of the George Massey Tunnel Replacement Project to ease traffic congestion at the existing tunnel area, improve transit and cycling connections and replace aging highway infrastructure to enhance public safety, as described in their Project Definition Report, the following issues must be addressed by MoTI prior to advancing the project for further design and the procurement process:* *(a) Provision of further details to demonstrate how the overall project will:*

Council Meeting	Resolution
	(i) Have a net zero or positive impact to agricultural land, and *(ii) Maintain, protect and enhance the City's riparian management areas and environmentally sensitive areas through a net gain approach;* *(b) Determination of how the toll rate will be implemented so that it would be fair, equitable and part of a region-wide mobility pricing policy consistent with the Mayors' Council vision for regional transportation investments in Metro Vancouver;* *(c) Immediate commencement of discussions by MoTI with the Cities of Vancouver and Richmond to jointly establish a contingency plan to address any potential increased traffic queuing on Highway 99 at the approach to the Oak Street Bridge;* *(d) Collaboration with the City to identify appropriate infrastructure improvements to minimize any negative impacts from the widened bridge crossing and associated interchanges on the local road network including Steveston Highway, Westminster Highway, No. 5 Road, Van Horne Way, and Rice Mill Road;* *(e) Encouragement of project proponents by MoTI to achieve a creative and innovative iconic design of the new bridge that recognizes its significance of being the largest bridge to be built in British Columbia; and* *(f) Facilitate excellence in supporting sustainable transportation options through:* *(i) Partnership with TransLink to ensure that the transit stops within the Steveston Highway and Highway 17A interchanges are operational on opening day,* *(ii) Provision of a multi-use path for pedestrians and cyclists on each side of the new bridge of sufficient width to safely accommodate all users in order to:* *i. Improve safety by minimizing the crossing of Highway 99 on- and off-ramps at Steveston Highway that are planned as free flow,* *ii. Minimize circuitousness and maximize convenience, and* *iii. Better address existing and future demand;* *(iii) Inclusion of pedestrian and cycling facilities as part of the new Steveston Highway and Westminster Highway interchanges and on both sides of the Blundell Road overpass, and* *(iv) Provision of improved pedestrian and cycling facilities on*

Council Meeting	Resolution
	Shell Road as part of the widened Shell Road overpass. *(2) That the BC Environmental Assessment Office be requested to extend the deadline for comments on the draft Application Information Requirements from February 10, 2016 to March 15, 2016 to provide the City with sufficient time to provide meaningful input.* *(3) That the matter be referred to Metro Vancouver for comments on the compatibility of the new bridge with the Regional Growth Strategy;* *(4) That overall Richmond City Council prefers a new or improved tunnel rather than a new bridge;* *(5) That a letter be sent to the City of Vancouver request that they involve the City of Richmond in the discussions regarding the Oak Street Bridge and 70th Avenue and Oak Street situations following the completion of construction;* *(6) That a letter be sent to Agricultural Land Commission seeking information on the potential encroachment on the farm land; and* *(7) That a copy of the resolution be sent to the Prime Minister, Premier, City of Vancouver, local MPs and local MLAs.*
February 22, 2016	*(1) That the City of Richmond request that the Provincial Government provide copies of all reports and studies – including but not limited to business plans, feasibility studies, technical studies, seismic studies, and/or environmental impact studies – that relate to the original plan to twin the George Massey Tunnel and/or provide Rapid Bus service that were considered during the period from 2006 to 2008; and that if necessary, that the foregoing request be made as an official Freedom of Information request;* *(2) That a letter be sent to the Auditor General requesting comments on the process leading up to the decision related to the George Massey Tunnel Replacement Project; and* *(3) That the City of Richmond send a letter to the Federal Minister of the Environment requesting that the George Massey Tunnel Replacement Project be referred to a Canadian Environmental Assessment Review Panel for review under the Environmental Assessment Act.*

The Corporation of Delta
COUNCIL REPORT
Regular Meeting

F.23

To: **Mayor and Council** File No.: **5220-30/GMTR**

From: **Engineering Department**

Date: **February 26, 2016**

George Massey Tunnel Replacement Project

The following report has been reviewed and endorsed by the Chief Administrative Officer.

- **RECOMMENDATIONS:**

A. THAT a copy of this report be provided to the Minister of Transportation and Infrastructure and all Metro Vancouver Directors.

B. THAT the Ministry of Transportation and Infrastructure be requested to retain the current timeline for conducting the Project Definition Report review while continuing to receive input from key stakeholders.

- **PURPOSE:**

The purpose of this report is to provide information to Council on the Metro Vancouver staff report that was submitted to the Intergovernment and Finance Committee on the George Massey Tunnel Replacement Project ("Project").

- **BACKGROUND:**

The Ministry of Transportation and Infrastructure ("Ministry") is working on replacing the George Massey Tunnel with a new 10 lane bridge and improving Highway 99 between Bridgeport Road and Highway 91. The proposed bridge will provide a dedicated transit/HOV lane and a separated multi-use path for pedestrians and cyclists. The estimated capital cost for the overall project is $3.5 billion.

Consultations have been ongoing since 2012 on the project. Most recently, consultations and public information sessions were held in conjunction with the release of the Project Definition Report in December 2015. As well, the BC Environmental Assessment Office also sought public comments as part of the pre-application Environmental Assessment process up until February 15, 2016.

- **DISCUSSION:**

In response to the release of the Project Definition Report, Metro Vancouver staff provided written comments to the Ministry and subsequently provided a report to the

Intergovernment and Finance Committee on February 17 (Attachment A) requesting an additional two months to evaluate the impacts of the proposed Project on regional planning and growth management; air quality and climate change; environment; regional parks; and, regional utilities. This report was also presented to the Metro Vancouver Board on February 26, 2016.

There are a number of reasons that this project needs to move ahead within the Ministry's current time frame:

- The Ministry has undertaken numerous detailed studies for the project and has shared the results with key stakeholders including Metro Vancouver staff.
- Consultation with stakeholders has been ongoing over the past three years and to date Metro Vancouver has met with the Ministry more than 20 times. The Corporation of Delta and the City of Richmond have also been consulted with more than 60 times since the project was initiated.
- The submission of the Environmental Assessment Application to the BC Environmental Assessment Office will trigger a further public comment period for a minimum of 45 days. As well, it is anticipated that there will also be at least six months of time for additional discussion and comment between the Ministry and key stakeholders, including Metro Vancouver.
- Metro Vancouver staff reported on the Regional Planning and Transportation impacts in 2014 (Attachment B) to allow the region to respond in a timely and knowledgeable manner upon the release of the Project Definition Report.
- The Province intends to fund the Project through user tolls. As the new bridge may divert traffic to other routes, the Province is committed to receiving feedback to review it's current tolling policy. For reference, a recent summary of major bridge traffic volumes is provided in Attachment C, along with toll revenues from the Port Mann and Golden Ears Bridges.
- The existing tunnel is already beyond required vehicular capacity and reaching the end of its useful life. As such, replacement of the tunnel should not be delayed. Some key facts are as follows:
    - o Queues can extend from 1.5 to 5 km during the rush hours.
    - o The existing tunnel has about 10 years of useful life remaining before major components will need to be completely replaced.
    - o The existing tunnel does not meet modern seismic standards.
    - o The existing traffic congestion and delays are impacting the air quality on either side of the tunnel and the Project is expected to help reduce greenhouse gas emissions as a result of reduced idling. As well, the new bridge will provide much needed transit, cycling, and pedestrian improvements

In addition, Delta staff requested clarification from the George Massey Tunnel Replacement Project Team on the comments made by Metro Vancouver to the local media following their request for additional time. The Project Team provided Delta staff with a response (Attachment D) summarizing the extent to which Metro Vancouver has been involved in the project consultation process as well as providing clarification on the comments made by Metro Vancouver.

Implications:
Financial Implications – There are no financial implications to Delta.

Community Implications – It is essential to maintain project timelines to ensure the bridge will be delivered on schedule to meet the needs of the community.

- **CONCLUSION:**

Rather than incurring further delays and costs to this Project, Metro Vancouver should continue to send comments to the Ministry and work collaboratively with the George Massey Tunnel Replacement Project Team to review and address the regional issues within the existing timelines.

Steven Lan, P.Eng.
Director of Engineering

Department submission prepared by: Hugh G Fraser, P.Eng.
HGF/ll/lf/sl

This report has been prepared in consultation with the following listed departments.

Concurring Departments		
Department	Name	Signature
Human Resources & Corporate Planning	Sean McGill	

- **ATTACHMENTS:**
  A. Intergovernment and Finance Committee Meeting Report dated January 30, 2016
  B. Transportation Committee Meeting Report dated March 5, 2014
  C. Extract from TransLink 2011 Metro Vancouver Regional Screenline Survey
  D. Memorandum February 29, 2016 George Massey Tunnel Replacement Project

metrovancouver
SERVICES AND SOLUTIONS FOR A LIVABLE REGION

To: Intergovernment and Finance Committee

From: Elisa Campbell, Director, Regional Planning
Marcin Pachcinski, Division Manager, Electoral Area & Environment
Planning, Policy and Environment Department

Date: January 30, 2016 Meeting Date: February 17, 2016

Subject: **Update on the George Massey Tunnel Replacement Project**

RECOMMENDATION

That the GVRD Board send a letter to the Minister of Transportation and Infrastructure requesting that an additional two months be granted to review the Project Definition Report for the George Massey Tunnel Replacement Project and to assess the impacts of the proposed Project on Metro Vancouver infrastructure and services.

PURPOSE

This report provides the Intergovernment and Finance Committee with an update on the George Massey Tunnel Replacement Project, including the recent release of the Project Definition Report and the environmental assessment review process that the George Massey Tunnel Replacement Project will undergo and proposes that more time be requested to properly review the report.

BACKGROUND

On December 16, 2015, the Ministry of Transportation and Infrastructure released its Project Definition Report for the George Massey Tunnel Replacement Project (Attachment 1), and requested that comments on the Project Definition Report be submitted by January 28, 2016. On December 16, 2015, the BC Environmental Assessment Office determined that the George Massey Tunnel Replacement Project is subject to provincial environmental assessment review, and requires an environmental assessment certificate prior to proceeding. The Environmental Assessment Office has requested that comments on the draft Application Information Requirements be submitted by February 10, 2016.

This staff report provides the Intergovernment and Finance Committee with a short description of both the Project Definition Report and the environmental assessment review process, briefly outlines Metro Vancouver's broad interests as they relate to the George Massey Tunnel Replacement Project, and requests that additional time be granted to conduct a more detailed assessment of impacts of the proposed Project on Metro Vancouver services and infrastructure.

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

Project Definition Report

The Project Definition Report outlines the Ministry of Transportation and Infrastructure's proposal to construct a 10-lane tolled bridge (eight motorized vehicle lanes plus two dedicated transit/high-occupancy vehicle lanes) to replace the existing George Massey Tunnel. The George Massey Tunnel Replacement Project as described also entails improvements to Highway 99 from Bridgeport Road in Richmond to Highway 91 in Delta, including dedicated transit/high-occupancy lanes, on- and off-ramps, and interchanges. A multi-use cycling and pedestrian pathway will be included in the bridge design. The existing George Massey Tunnel will be decommissioned once the new bridge opens to traffic. The estimated capital cost of the George Massey Tunnel Replacement Project is $3.5 billion.

The Ministry of Transportation and Infrastructure has sought public comments on its Project Definition Report in support of making final decisions. The deadline for comments on the Project Definition Report was January 28, 2016. Given the compressed timeline for making submissions, Metro Vancouver staff provided comments to the Ministry of Transportation and Infrastructure to meet the January 28, 2016, deadline. A copy of these comments is provided to the Intergovernment and Finance Committee for information (Attachment 2). These comments have not been reviewed or endorsed by the Metro Vancouver Board.

Provincial Environmental Assessment Review

Under Section 10 of the *Environmental Assessment Act*, the Environmental Assessment Office may determine that an environmental assessment certificate is required for a project, and that the proponent may not proceed with the project without an assessment, where "a reviewable project may have a significant adverse environmental, economic, social, heritage or health effect, taking into account practical means of preventing or reducing to an acceptable level any potential adverse effects of the project."

On December 16, 2015, the Environmental Assessment Office determined that the George Massey Tunnel Replacement Project is subject to the provincial environmental assessment review process and requires an environmental assessment certificate prior to proceeding. The determination was based on the Ministry of Transportation and Infrastructure's Project Description and Key Areas of Study (Attachment 3).

The Project Description and Key Areas of Study includes *valued components*. The Environmental Assessment Office's User Guide (June 2015) describes valued components as follows:

> *Valued components provide the foundation of environmental assessments in BC. Valued components are aspects of the natural and human environment that have scientific, ecological, economic, social, cultural, archaeological, historical or other importance. Examples of valued components included in environmental assessments are fish and fish habitat, water quality, species at risk, communities and infrastructure, archaeological resources, and noise. The valued components selected for a proposed project guide the focus of the environmental assessment.*

For the George Massey Tunnel Replacement Project, the Ministry of Transportation and Infrastructure has identified the following valued components:

- River hydraulics and morphology
- Sediment quality and water quality
- Underwater noise
- Fish and fish habitat
- Marine mammals
- Vegetation
- Amphibians
- Terrestrial wildlife
- Land and Water Use
  - Marine use
  - Land use
  - Agricultural use
- Visual quality
- Air quality
- Atmospheric noise
- Human health
- Heritage resources

The Environmental Assessment Office has established an advisory working group of federal, provincial, local government and Aboriginal Group representatives to assist the Environmental Assessment Office with the assessment process. Metro Vancouver staff are participating in the process as part of the working group (Attachment 4). In the current pre-application phase of the environmental assessment review process, the focus of input from working group members is to ensure that the application contains the necessary information to allow the Environmental Assessment Office to undertake its assessment and make recommendations to the Ministers making the decision. This effort includes, for example, determining whether all applicable valued components have been identified. Metro Vancouver staff attended the first meeting of a stakeholder Working Group on January 21, 2016, to discuss the Project Description and Key Areas of Study.

The Environmental Assessment Office has requested comments on the draft Application Information Requirements by February 10, 2016. In order to meet this deadline, Metro Vancouver staff have submitted comments to the Environmental Assessment Office, focusing on the completeness of the environmental assessment application materials, including valued components. These comments have not been reviewed or endorsed by the Metro Vancouver Board.

Proposed BC Hydro Transmission Line Relocation

The existing Tunnel will be decommissioned once the new bridge opens to traffic. The decommissioning of the Tunnel will require BC Hydro to relocate a 230 kilovolt transmission line which currently spans the length of the Tunnel. The transmission line connects to overhead cable on either side of the Tunnel, with single pole configuration running adjacent to Highway 99. The transmission line must be relocated from the Tunnel and on both sides of the crossing to allow for construction of the new bridge and prior to the decommissioning of the Tunnel. BC Hydro staff began consulting with Metro Vancouver staff about this issue in 2015. In fall 2015, BC Hydro undertook public consultation on conceptual designs for three alternatives:

- An overhead transmission line crossing the Fraser River supported by towers;
- An underground transmission line running under the Fraser River; and
- A transmission line located on the new bridge.

The BC Hydro Board is anticipated to select a preferred alternative in early 2016. Metro Vancouver staff will continue to engage with BC Hydro and will keep the Intergovernment and Finance Committee and other committees apprised of new information.

Metro Vancouver's Interests
Metro Vancouver's broad interests around the George Massey Tunnel Replacement Project are related to:

- **Regional Planning and Growth Management** – The proposed bridge will have implications for regional growth management, including related effects on the distribution and growth of traffic across the Fraser River, as well as localized effects on communities, industrial development, population and employment growth distribution, and agricultural lands. Metro Vancouver staff convened an agency/municipal/industry meeting on February 5, 2016, to discuss these issues, and to identify and prioritize further analysis to be undertaken either by Metro Vancouver in conjunction with other interested partners including the proponent, or as part of the Environmental Assessment process. Staff received updates from municipalities, health authorities, consultants and the Province as to how potential land use implications are being assessed and addressed. Possible research needs were identified, and staff will continue to work with agency representatives to advance these efforts.

- **Air Quality and Climate Change** – The proposed bridge will result in changes in the levels of emissions of common air pollutants, toxic air pollutants and greenhouse gases. The changes in emission levels may lead to impacts in the vicinity of the George Massey Tunnel Replacement Project, including exposure to harmful pollutants, as well as impacts in the regional airshed such as smog and reduced visual air quality.

- **Environment** – The proposed bridge may have impacts on land and marine environments with ecological importance. These environments include agricultural lands that serve not only a food-production role, but also provide habitat and other ecological health values. Plans to divert Green Slough underneath the future bridge are of particular interest. Consideration of how to reduce, mitigate, and compensate for impacts will be an important part of the environmental assessment review process.

- **Regional Parks** – The new bridge is expected to follow the alignment of the Tunnel, bisecting Deas Island Regional Park through the existing Ministry of Transportation and Infrastructure right-of-way. Ongoing discussions between Regional Park Staff and the Ministry of Transportation and Infrastructure have focused on noise, debris and visual impacts of the proposed new bridge and the associated BC Hydro project, post construction ecological and trail connectivity through the Ministry of Transportation and Infrastructure right-of-way, habitat impacts and restoration opportunities, and trail connectivity from the bridge to the Deas Island Regional Park and broader regional greenway network including the Experience the Fraser Canyon to Coast Trail. The Ministry of Transportation and Infrastructure has indicated they will not require access through the Deas Island Regional Park for construction but may request limited post-construction access for maintenance purposes.

- **Regional Utilities** – Water Services staff have identified that the River Road West Main in Delta and the Lulu Island-Delta Main crossing under the Fraser River, between Richmond and Delta, may be affected by the George Massey Tunnel Replacement Project. The River Road West Main may need protection from ground improvements or changes in loads imparted by both Ministry of Transportation and Infrastructure bridge work and by BC Hydro tower installation. The Ministry of Transportation and Infrastructure is also relocating Green Slough to return the slough back to its original pre-Tunnel alignment. Depending on the final channel alignment, the River Road West Main may require relocation. The specific impacts and costs are difficult to predict at this early stage of project definition. The Ministry of Transportation and Infrastructure is reviewing options for removing sections of the Tunnel from the Fraser River once it is decommissioned. Tunnel removal will alter the river hydraulics, which may result in scour at the Lulu Island-Delta Main crossing. This effect has been demonstrated in modelling undertaken by the Ministry of Transportation and Infrastructure's river hydraulics consultant. Any future dredging of the Fraser River channel to facilitate the movement of larger vessels, following decommissioning of the Tunnel, could have significant implications to Metro Vancouver water and sewer infrastructure within the Fraser River.

Detailed comments will be provided by staff at various points in the process. Staff will continue to provide information to and seek direction as relevant from the Intergovernment and Finance Committee, the Utilities Committee, the Climate Action Committee, the Regional Parks Committee, and the Regional Planning Committee as the George Massey Tunnel Replacement Project proceeds.

PROJECT TIMELINE AND KEY PROCESS DATES

The information in this section of the report provides a timeline for the George Massey Tunnel Replacement Project, as well as key dates in the consultative and approval processes.

September 2012	The Government of BC announces its intention to seek a replacement for the George Massey Tunnel.
September 2013	The Government of BC announces a new bridge is the preferred alternative for the replacement of the George Massey Tunnel.
September 2013 – November 2015	The Ministry of Transportation and Infrastructure undertakes traffic studies, technical and financial analysis, geotechnical investigations, and consultation to support development of its Project Definition Report.
December 15, 2015	The Ministry of Transportation and Infrastructure submits its Project Description and Key Areas of Study to the Environmental Assessment Office to determine if the George Massey Tunnel Replacement Project requires a review under the *Environmental Assessment Act*.
December 16, 2015	The Environmental Assessment Office issues an order under Section 10 of the *Environmental Assessment Act*, determining the George Massey Tunnel Replacement Project requires an environmental assessment review.
December 16, 2015	The Ministry of Transportation and Infrastructure releases its Project Definition Report and seeks public comments.
January 7, 2016	The Environmental Assessment Office issues an order under Section 11 of the *Environmental Assessment Act*, setting out the requirements for the first

	public comment period (beginning January 15, 2016) on the Project Description and Key Areas of Study document.
January 15, 2016	The Environmental Assessment Office starts a public comment period on the Project Description and Key Areas of Study. Comments at this stage will be used to inform the development of the application information requirements.
January 21, 2016	The Environmental Assessment Office hosts the first Working Group meeting with stakeholders (including Metro Vancouver staff) to discuss the Project Description and Key Areas of Study.
January 28, 2016	Deadline for public comments on the Project Definition Report to Ministry of Transportation and Infrastructure.
February 10, 2016	Deadline for Working Group (including Metro Vancouver) comments on the Ministry of Transportation and Infrastructure's draft Application Information Requirements submission to the Environmental Assessment Office.
February 15, 2016	Deadline for public comments on the Project Description and Key Areas of Study to the Environmental Assessment Office.
Early & mid-2016	Environmental Assessment Review Process, including Working Group meetings with stakeholders (involving Metro Vancouver staff) and a public comment period during the application review stage. Metro Vancouver will have a formal opportunity to comment during the application review stage (date to be determined).
2017 – 2022	Construction of new bridge
≥ 2022	Bridge opens to traffic
≥ 2022	George Massey Tunnel decommissioned

ALTERNATIVES

1. That the GVRD Board send a letter to the Minister of Transportation and Infrastructure requesting that an additional two months be granted to review the Project Definition Report for the George Massey Tunnel Replacement Project and to assess the impacts of the proposed Project on Metro Vancouver infrastructure and services.
2. That the Intergovernment and Finance Committee receive for information the report titled "Update on the George Massey Tunnel Replacement Project", dated January 30, 2016, and provide alternate direction to staff.

FINANCIAL IMPLICATIONS

The George Massey Tunnel Replacement Project, including the accompanying BC Hydro transmission line relocation and decommissioning of the existing Tunnel, may have financial implications for water utilities and the Deas Island Regional Park. If the GVRD Board supports Alternative 1, a letter will be sent to the Minister of Transportation and Infrastructure requesting that an additional two months be granted to undertake a more detailed review of the George Massey Tunnel Replacement Project Definition Report and the potential impacts on Metro Vancouver infrastructure and services.

Given the lack of detail in the current Project Definition Report, the specific implications for Metro Vancouver as a result of the new bridge and BC Hydro infrastructure are unknown and difficult to estimate at this time. Metro Vancouver staff will continue to liaise with the Ministry of Transportation and Infrastructure and with Port Metro Vancouver to protect the interests of Metro Vancouver with respect to its assets and operations.

It should also be noted that significant Metro Vancouver staff time has been dedicated to the George Massey Tunnel Replacement Project. The need for staff time is anticipated to continue at variable intensity until the completion of the George Massey Tunnel Replacement Project, including decommissioning of the Tunnel.

SUMMARY / CONCLUSION

This report provides the Intergovernment and Finance Committee with an update on the George Massey Tunnel Replacement Project and responds to the Committee's request to report on the costs and implications of the George Massey Tunnel Replacement Project on Metro Vancouver infrastructure.

The George Massey Tunnel Replacement Project, outlined in the Ministry of Transportation and Infrastructure's Project Definition Report released December 16, 2015, proposes to replace the George Massey Tunnel with a new 10-lane bridge, replace the Westminster Highway, Steveston Highway and Highway 17A interchanges, and widen Highway 99 to accommodate dedicated transit/HOV lanes between Bridgeport Road in Richmond and Highway 91 in Delta.

On December 16, 2015, the BC Environmental Assessment Office determined that the George Massey Tunnel Replacement Project is subject to the provincial environmental assessment review process, and requires an environmental assessment certificate prior to proceeding. The determination was based on the Ministry of Transportation and Infrastructure's Project Description and Key Areas of Study. The George Massey Tunnel Replacement Project is in the pre-application stage of the provincial environmental assessment review process. Metro Vancouver staff are participating in a stakeholder Working Group organized by the Environmental Assessment Office.

Metro Vancouver's broad interests around the George Massey Tunnel Replacement Project are related to regional growth management and planning, air quality and climate change, environment, regional parks, and regional utilities. Deas Island Regional Park, the River Road West Main, and the Lulu Island-Delta Water Main have been identified as Metro Vancouver assets being potentially impacted by the George Massey Tunnel Replacement Project.

This report contains timelines for the George Massey Tunnel Replacement Project and known key dates in consultative and approval processes. Staff will continue to provide information to and seek direction as relevant from the Intergovernment and Finance Committee.

The Ministry of Transportation and Infrastructure requested that comments on the Project Definition Report be received by January 28, 2016. Similarly, the Environmental Assessment Office requested that comments from stakeholders on the draft Application Information Requirements be received by February 10, 2016. Given these compressed schedules, and in order to meet the deadlines, Metro Vancouver staff submitted comments, and have provided them to the Intergovernment and Finance Committee for information. These comments have not been reviewed or endorsed by the Metro Vancouver Board. Staff recommend Alternative 1, that the GVRD Board send a letter to the Minister of Transportation and Infrastructure requesting that an additional two months be provided for Metro Vancouver Board review and assessment.

Attachments *(Orbit # 17222716)*:
1. Project Definition Report
2. Staff comments on Project Definition Report
3. Project Description and Key Areas of Study
4. Environmental Assessment Process
5. Staff comments on draft Application Information Requirements
6. Proposed Bridge Rendering and Metro Vancouver Assets

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metrovancouver
SERVICES AND SOLUTIONS FOR A LIVABLE REGION

To: Transportation Committee

From: Ray Kan, Senior Regional Planner
Planning, Policy and Environment Department

Date: March 5, 2014 Meeting Date: March 12, 2014

Subject: **Preliminary Regional Analysis of the New Delta-Richmond Bridge and Existing George Massey Tunnel**

RECOMMENDATION

That the Transportation Committee receive for information the report dated March 5, 2014, titled "Preliminary Regional Analysis of the New Delta-Richmond Bridge and Existing George Massey Tunnel".

PURPOSE

This report provides an update on the George Massey Tunnel Replacement Project and the preliminary results of an analysis undertaken by TransLink for Metro Vancouver.

BACKGROUND

Staff presented a progress update on the regional analysis of the new Delta-Richmond Bridge to the Transportation Committee at its meeting on December 3, 2013. At the time, TransLink, as requested by the GVRD Board in October, was still conducting the technical analysis and could only share the broad assumptions and methodology. TransLink has now completed a preliminary analysis of the new bridge. The results are discussed in this report.

DISCUSSION

Project Context

The George Massey Tunnel Replacement Project is one of the final pieces of the Provincial Gateway Program. It is important to monitor the development of this project and the potential effects of adding vehicular capacity on the implementation of *Metro Vancouver 2040: Shaping Our Region (Metro 2040)*. This will allow the region to respond in a timely and knowledgeable manner when the Province releases the Project Definition Report in the spring of 2014.

In September 2013, the Premier of British Columbia announced a preferred solution to replace the George Massey Tunnel with a new bridge on the same corridor. At its meeting on October 25, 2013, the GVRD Board approved the following resolution (excerpted):

> "a) *request the Minister of Transportation and Infrastructure to demonstrate how the project scope, design, and performance of the proposed bridge to replace the George Massey Tunnel takes into careful consideration the effects on the implementation of the Regional Growth Strategy, Integrated Air Quality and Greenhouse Gas Management Plan, and Regional Transportation Strategy, and that measures be included to support, and not detract from, regional objectives.*

b) request the TransLink Board provide Metro Vancouver with technical analysis and commentary on the potential transportation and emissions implications of expanding transportation capacity on the George Massey Tunnel corridor and effects with proximate Fraser River watercrossings, including tolling and non-tolling scenarios, and the degree of consistency and support the proposed bridge would have on the Regional Growth Strategy, Integrated Air Quality and Greenhouse Gas Management Plan, the Regional Transportation Strategy, and Regional Goods Movement Strategy.

c) direct staff to investigate in relation to the George Massey Tunnel replacement project the following:

i. the business plan;
ii. the role of the port; and
iii. the balance of phase 2 of the Gateway Program;
iv. the potential for an LRT."

The Board's request to TransLink is consistent with TransLink's requirement, under the *South Coast British Columbia Transportation Authority Act*, to:

> *"review, and advise the Greater Vancouver Regional District, the municipalities and the government regarding the implications to the regional transportation system of (iii) major development proposals and provincial highway infrastructure plans in the transportation service region" (SCBCTA, Section 4(1)(f))."*

In January 2014, staff met with the provincial George Massey Tunnel Replacement team. At this meeting, the provincial project team advised staff of the following:

- A Project Definition Report will be released for consultation in the spring, and will contain details such as the number of lanes on the new bridge.
- A formal environmental assessment process will be undertaken after a project description is submitted to the provincial environmental assessment office.
- The geographic scope of the project extends along the Highway 99 corridor from the Canadian/U.S. border to Bridgeport Road in Richmond. Modifications and upgrades to highway interchanges are within scope.
- All financing options are on the table.
- Geotechnical fieldwork is underway to examine soil conditions.
- Computer modeling analysis is underway on alternative lane capacity and arrangements.
- The project team has initiated dialogue with TransLink on potential bus service improvements along the corridor.

The provincial team and Metro Vancouver staff will schedule a follow-up meeting in early spring.

TransLink's Preliminary Analysis
The Ministry of Transportation and Infrastructure will release a Project Definition Report in the spring to articulate the precise scope, benefits, and costs of the project. For Metro Vancouver to be in a position to respond in a timely and knowledgeable manner, it is important that an independent analysis of this project be undertaken. TransLink has provided Metro Vancouver with a memorandum reporting out on the preliminary analysis of the new Delta-Richmond bridge and the implications for the corridor and the regional network (Attachment 1).

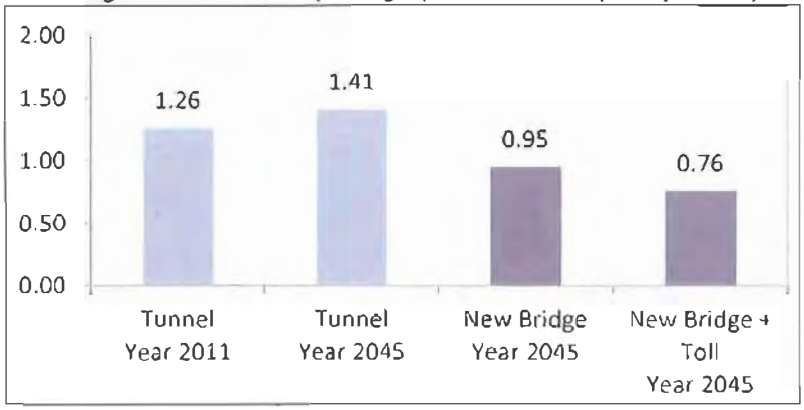
The scope of the analysis and major assumptions are shown below:

Scope of TransLink Analysis	• Transportation impacts of the new bridge on travel behavior (traffic diversion, modal shift, etc.) • Growth impacts of the new bridge on population and job distribution
Analysis Years	• Base Year: 2011 • Future Year: 2045
Analysis Time Period	• AM peak hour (approximately 7:30AM-8:30AM)
Demographics and Population/ Employment Distribution	• Base assumptions prepared by Metro Vancouver for infrastructure planning • Sensitivity test prepared by Coriolis
Tunnel/Bridge Lane Capacity	• George Massey Tunnel: 3 lanes northbound in the AM peak hour; 1 lane southbound • New Bridge: 3 general purpose lanes in each direction; 1 HOV/transit lane in each direction (total of 8 lanes)
Toll	• Consistent with rates assumed for the Golden Ears Bridge and Port Mann Bridge.
Transit Supply	• Base Year 2011: 39 buses/hour • Future Year: 48 buses/hour

The primary tool used by TransLink is the Regional Travel Demand Model, which is a computer model calibrated to 2011 conditions and used for forecasting purposes up to the year 2045. The model has been the primary tool used to evaluate transportation projects for over the past three decades. It must be cautioned that forecasts from any computer model will contain uncertainty and potential errors. When reviewing these model outputs, it is generally more useful to assess the relative change compared to baseline conditions rather than the precision of any one number.

Transportation Effects on the Highway 99/Fraser River Crossing Corridor
Three common transportation performance measures used in evaluating transportation projects are congestion, mode share, and vehicle kilometres travelled (VKT). Congestion and mode share are measured at the tunnel/bridge section only. VKT is aggregated from all road links that feed traffic to the tunnel/bridge in both directions – Highway 99 is the largest component of the corridor. Additional information can be found in the attached document.

#1. Congestion in Tunnel/Bridge (Volume to Capacity Ratio)

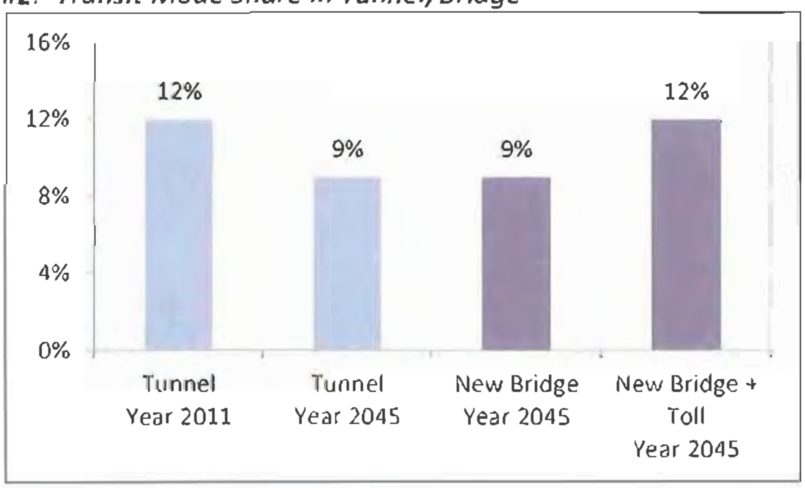


An indicator of congestion is the ratio between volume (demand) and capacity (supply). A ratio above 1 generally means there is more traffic than the roadway can handle efficiently, resulting in slow moving traffic and long queues.

With no new capacity, 2-way congestion continues to rise in the tunnel due to growth in population, employment, and economic activity.

A new bridge in 2045 experiences reduced congestion, but the demand approaches capacity. The addition of tolls helps to manage the growth in demand and prolong the capacity of the bridge beyond 2045.

#2. Transit Mode Share in Tunnel/Bridge

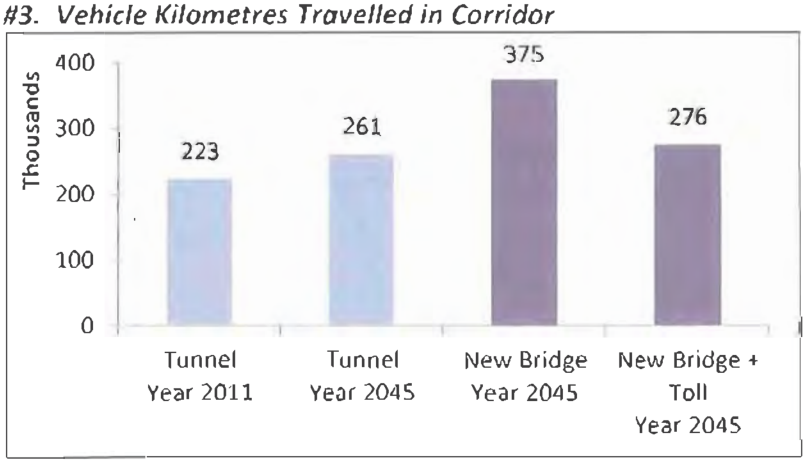


Transit mode share declines over time whether the tunnel remains or a new untolled bridge is built. With the tunnel, travel speed deteriorates for buses, which makes transit a less desirable choice. Transit mode share falls to 9 percent in 2045.

With an untolled bridge, the expanded capacity allows for more people to drive and take transit, but transit mode share remains stuck at 9 percent in 2045.

When tolls are added to the bridge, a transit mode share of 12 percent is achieved due entirely to a decline in people driving or carpooling.

#3. Vehicle Kilometres Travelled in Corridor



Vehicle kilometres travelled (VKT) is a proxy for greenhouse gas emissions.

VKT in the corridor will be higher with a new bridge (no tolls) as compared to the tunnel in 2045. This is because more traffic is drawn to the expanded capacity.

The addition of tolls on the new bridge will help to moderate the growth in VKT in the corridor by nearly 25 percent.

Auto and Truck Patterns on Other Fraser River Crossings
TransLink's analysis also provides a preliminary view of the implications for auto and truck traffic on other water crossings. In 2045, relative to the existing tunnel, a new 8-lane tolled bridge could potentially draw down some auto traffic on the Alex Fraser Bridge, Pattullo Bridge, and Port Mann Bridge and contribute to an increase in traffic on the Oak Street Bridge and Queensborough Bridge. Truck traffic could decrease on the Alex Fraser Bridge and Queensborough Bridge, and increase on the Oak Street Bridge. As noted in the attachment, TransLink is reviewing the "truck component" of the Regional Travel Demand Model to ensure truck traffic is fully captured.

Growth Distribution Effects (Land Use)
TransLink commissioned Coriolis to study the potential redistribution of growth in 2045 as a result of the new bridge, as well as changes in access and travel time. In terms of population, Coriolis notes that about 1% of single family and townhouse growth may shift from West Richmond and Steveston to South Delta and South Surrey (on the order of 4,000 people).

In terms of employment, Coriolis notes that South Delta and South Surrey may receive a slightly higher share of population-serving employment at the expense of West Richmond and Steveston. In the short term, the pace of light industrial development may occur faster in Richmond and Delta and parts of South Surrey. This growth may come at the expense of South Burnaby and North Surrey. Over the long-term to 2045, with the constraint on industrial lands, there is no significant difference in the total amount of light industrial employment at these locations.

TransLink re-evaluated the transportation effects using Coriolis' population and employment analysis and found only nominal differences for traffic levels across the new bridge.

It should be noted that the scope of the Coriolis analysis did not account for potential increases in marine-based goods movement. The removal of the tunnel may remove a marine bottleneck and allow for more ship traffic along the Fraser River to Fraser Surrey Docks. This element could represent a material shift in the region's capacity to move goods. Further, the direct impact on the land acquired or expropriated for the new bridge, approaches, and associated works are out of the scope of the TransLink analysis. Further investigation is warranted on these issues.

Moreover, changes in accessibility may put development pressures on the Agricultural Land Reserve and the *Metro 2040* Urban Containment Boundary. Any relaxation of these policies would render the current analysis obsolete.

Other Effects
TransLink also tested an expanded regional transit system, including improved bus frequencies on the Highway 99 corridor. Generally, along the Highway 99 corridor, there are slightly fewer auto trips and slightly more transit trips. Further investigation is warranted on the optimal level of transit service on this corridor given an expanded facility, and the associated costs and benefits.

ALTERNATIVES
This is an information report. No alternatives are presented.

FINANCIAL AND REGIONAL GROWTH STRATEGY IMPLICATIONS

Due to the implications of expanding the capacity of the current watercrossing between Delta and Richmond on the implementation of *Metro 2040: Shaping Our Region*, it is important for Metro Vancouver to play an ongoing role in assessing the broad dynamics of the options and the potential effects on travel patterns and land use.

SUMMARY / CONCLUSION

The preliminary analysis undertaken by TransLink, as requested by the Metro Vancouver Board, provides a common base from which the Transportation Committee can continue to monitor and query the development of the bridge proposal. This work demonstrates that TransLink and Metro Vancouver are cooperating on issues of regional significance. The region benefits greatly from the mutual sharing of technical information and the exchange of evidence-based policy dialogues.

While still preliminary, the analysis is already improving the collective understanding about the regional transportation system and the Highway 99 corridor. For instance, three major observations can be made for the <u>2045 morning rush hour</u> study period:

- An **8-lane untolled bridge** appears to provide measurable travel time benefits for travelers and sufficient capacity for the projected demand to 2045, but the demand on the bridge does approach capacity in 2045.
- An **8-lane tolled bridge** appears to manage the growth in auto traffic demand and may actually prolong the useful capacity of the bridge beyond 2045.
- A new 8-lane bridge appears to have only minor effects on the redistribution of population and employment growth (assuming the Agricultural Lane Reserve and Urban Containment Boundary remain vigilantly protected).

Staff will continue to bring forward updates to this analysis and the analysis of the forthcoming Project Definition Report to be released by the Province in spring 2014. In particular, some outstanding questions that remain to be answered, including those posed by the GVRD Board, and will require additional investigation are:

1. The incremental benefits and costs of lane capacity above and beyond 8 lanes.
2. The effects on truck trips along Highway 99 and in relation to the other watercrossings.
3. The effects on morning and afternoon rush hour traffic through Richmond and Vancouver.
4. The effects on marine-based goods movement and the associated industrial development and employment growth distribution within the region.
5. The direct land impacts (regional parks and agricultural lands) of the bridge, approaches, interchanges, and other works.
6. The direct air emissions impacts of increased vehicular traffic on the Highway 99 corridor.
7. Opportunities for improved transit service on the Highway 99 corridor.

Staff will continue to work with TransLink on better understanding the role and effects of the new bridge, and to better answer the broader questions about implications to land use, air emissions, and goods movement.

Attachment:
'George Massey Tunnel Replacement: Impacts on Regional Transportation Demand' – Memo dated February 25, 2014 from TransLink addressed to Ms. Elisa Campbell, Director of Regional and Strategic Planning, Metro Vancouver.

8477025

5.2 Attachment

TransLink
400 - 287 Nelson's Court
New Westminster, BC [illegible]
Canada
Tel 778.375.7500
translink.ca

South Coast British Columbia
Transportation Authority

February 25th, 2014

Ms. Elisa Campbell
Director, Regional and Strategic Planning
Planning, Policy and Environment
Metro Vancouver
4330 Kingsway, Burnaby, BC
V5H 4G8

Dear Ms. Campbell,

Re: George Massey Tunnel Replacement: Impacts on Regional Transportation Demand

Attached is a technical memo that provides preliminary modeling analysis on the potential effects of the replacement of the George Massey Tunnel on the regional network. TransLink has recently updated our regional modeling network assumptions to support the development of the new long range Regional Transportation Strategy, which includes the examination of different future investment and management alternatives. TransLink conducted a number of illustrative model runs using the Regional Travel Demand Model. These consider how the additional capacity of a tunnel replacement and resultant changes in the network may affect travel behaviour and how they may impact the distribution of population and jobs over the long term. The exact scope of the new bridge has not yet been confirmed but general expectations and early indications are that the bridge will have more lanes than the existing tunnel.

Preliminary Observations for 2045 Forecasts
The figures here and in the attached report are order-of-magnitude illustrations and are appropriate for relative comparisons between model scenarios. They should not be interpreted as precise predictions of future traffic or passenger volumes, especially on specific road sections or transit route segments. The **results are for the AM peak hour only**. The technical memo provides some more details around the following observations:

<u>Vehicle Kilometres Travelled</u>

- A new **tolled** crossing (with 8-lanes) may experience about 5% more demand and traffic crossing the bridge, but decreases in congestion levels at the bridge, compared to the existing untolled crossing in 2045.

- A new **untolled** crossing (with 8 lanes) may experience in excess of 40% more demand and traffic crossing the bridge, decreases in current congestion levels at the bridge, relative to the existing untolled tunnel.

Mode Choice

- A new **tolled** crossing (with 8 lanes) in 2045 may result in **similar transit mode share (12%)** as in 2011, whereas both an **untolled** 8-lane crossing new crossing and an untolled existing tunnel, may result in a **25% reductions in transit mode share (9%)**.

Travel Times

- A new **tolled** crossing (with 8 lanes) in 2045 may result in a trip time between 8th Ave in Surrey and the Oak Street Bridge **decreasing by about 10%** (3 minutes) relative to 2011, whereas both a new **untolled** crossing and the existing untolled tunnel may result in trips **increasing by about 10%** (3 minutes) relative to 2011.

The preceding observations and findings assume that current regional and local land use policies, and protection of the Agricultural Land Reserve remain.

Land Use Implications

Assuming current provincial, regional and local land use policies remain:

- The changes in transportation accessibility for land uses in the corridor are likely to shift some residential and employment growth patterns relative to the Metro Vancouver's current MGS projections, including:
  - Shifts in the growth of single family residential units to South Surrey and South Delta from West Richmond and Steveston;
  - More rapid development in light industrial land uses in Richmond, Delta and South Surrey, shifting from South Burnaby and North Surrey.
- These land use changes may shift travel demand but because of the resulting redistribution of employment trips, this factor does not appear to affect crossing volumes or mode share.
- Changes in accessibility may put additional development pressure on Agricultural Land Reserve and Urban Containment Boundaries.

The attached technical memo delves into the methodology, sensitivity tests and results in more detail. Please feel free to contact me with any questions.

Best regards,

Tamim Raad
Director, Strategic Planning and Policy, TransLink

CC Bob Paddon, EVP, Strategic Planning & Public Affairs, TransLink

TRANSLINK

BRIEFING MEMO

DATE: February 25, 2014

FROM: Strategic Planning and Policy

SUBJECT: George Massey Tunnel Replacement: Preliminary Modelling of Potential Impacts

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PURPOSE

To provide a preliminary assessment of the potential impacts of replacing the George Massey Tunnel on the regional transportation system.

BACKGROUND

The Province of BC has announced its intent to replace the George Massey Tunnel with a new bridge. The exact scope of the new bridge has not yet been confirmed but general expectations and early indications are that the bridge will have more lanes than the existing tunnel. TransLink has undertaken an analysis to understand how the additional capacity and resultant changes in the network would affect travel behaviour; and how they may impact the distribution of population and jobs over the long term. In order to gain some initial understanding of these potential impacts, TransLink staff conducted a number of illustrative model runs using the Regional Travel Demand Model. The purpose of this memo is to document the preliminary results of these simulations.

DISCUSSION

Methodology

The analysis relies on TransLink's latest regional transportation model, also used to develop TransLink's Regional Transportation Strategy (RTS). The Provincial team working on this project is also applying the same model for its own analysis. The model, calibrated for 2011 conditions, reflects the current system of 682 regional transportation zones. The future model runs were completed for horizon year 2045. This preliminary evaluation focuses only on AM peak hour (7:30 to 8:30 am) conditions; however these results come from full 24-hour model assignments. The AM peak conditions appear to be representative of peak volumes for the crossing, although the PM peak in the outbound direction lasts longer and could lead to longer queuing.

Scope of Modelling Work

The analysis consists of comparing the following five model scenarios:

- *Base Case (run 1)* which reflects the transportation network, land use and Massey tunnel conditions as they existed in 2011. The current tunnel configuration consists of a 4-lane cross section, operating as a counter-flow system in the peak hours with three general purpose lanes in the peak direction and one general purpose lane in the off-peak direction. This 2011 scenario serves as a benchmark against which conditions of future scenarios are compared.

- *Keeping the current tunnel* in the year 2045, *with tolls (run2) and without tolls (run3).*
- *A new bridge* in the current location in the year 2045, *with tolls (run 4) and without tolls (run 5).* These scenarios assumed an 8-lane cross section on the bridge span, including three general purpose lanes and one HOV/transit lane in each direction.

Two additional model runs were also performed as sensitivity testing to identify the impacts of different land use and background transportation network assumptions, as discussed later in this memo. The following table shows the specific modelling input assumptions applied to the five scenarios tested.

Summary of Key Modelling Assumptions (Year 2045, AM Peak Hour):
Land Use Assumptions: The land use data for all scenarios come from the Metropolitan Growth Scenario (MGS) forecasts of employment and population for the year 2045 as provided by Metro Vancouver.
Road Network Assumptions: The 2045 road network modelled in this analysis is the same as the Year 2045 RTS Base Case road network, which includes about 10,500 lane-kilometers within the GVRD. This represents an increase of about 10% over the 2011 road network. Most of the additional lane-kilometers are assumed to occur in Surrey, White Rock, Richmond and Delta, and to a lesser extent in the Tri-cities and Langley. Pattullo Bridge is assumed to be a rehabilitated 3-lane bridge. Apart from the 8-lane bridge section itself, assumption about potential related improvements in the corridor had to be made in order to conduct the analysis (the Province has not announced a concept); the following changes were used: • HOV lanes extending between the King George Boulevard interchange and the Oak Street Bridge • Highway 99 corridor consisting of two general purpose lanes in each direction between the US Border and the Oak Street Bridge • An additional general purpose lane extending in each direction between the SFPR interchange and the Westminster Highway interchange • Highway 99 interchange ramps were modified at SFPR, H17A, Steveston, and Sea Island Way • Highway 17A NB narrowed down to 1 lane from Deltaport Way to Ladner Truck Rd • Improved Bridgeport and South Delta P&R connectivity

Summary of Key Modelling Assumptions (Year 2045, AM Peak Hour):
Transit Network Assumptions: The modelling work assumes the Year 2045 RTS Base Case transit network which does not include any significant upgrades or expansion of transit service. The RTS 2045 Base Case includes about 24,000 daily bus kilometers and 4,000 daily train kilometers (SkyTrain and Canada Line) within the GVRD. This represents an increase of about 16% and 51% respectively relative to 2011. The additional train kilometers are mostly due to implementation of the Evergreen Line. Most of the additional bus kilometers are assumed to occur in Surrey, White Rock, Tri-cities, Richmond and Delta. Within the Massey corridor, and the working assumption is that transit service would increase from 39 buses/hour under 2011 conditions to 48 buses/hour in the 2045 base case (+24%).
Tolling Assumptions: The tolling scenarios, for either a tunnel or a bridge, assume that the Port Mann and Golden Ears Bridges remain tolled in 2045 but that a rehabilitated 3-lane Pattullo Bridge, included in TransLink's current Base Plan, would not be tolled facility. The tolled tunnel and bridge alternatives assume tolls consistent with those for the Port Mann and Golden Ears Bridges.

Preliminary Modelling Results

The following tables summarize the key general network and corridor-specific model outputs for the five scenarios tested. **All statistics are for the 2045 AM Peak hour**. The Network results reflect Origin-Destination demand (matrix data) while the Corridor results reflect actual volumes on specific road sections or transit route segments (assignment data).

Total vehicle demand from south of the Fraser river splits as follows:

Demand	From south of the Fraser river	Crosses to north of the Fraser river	Remains on the south side of river	To destinations east of Langley
AUTO	227,600 trips	21,600 (10%)	201,800 (88%)	4,200 (2%)
TRUCKS	8,600 trips	1,960 (23%)	5,970 (69%)	670 (8%)

The truck component of TransLink's regional model is currently under review and in the process of being upgraded to improve all aspects of truck traffic. The regional figures reflect the observed volumes. Figures 1 and 2 illustrate the distribution of trips originating south of the Fraser River for Auto and Trucks respectively.

Figure 1. Distribution of Auto Demand – 2045 AM Peak Hr

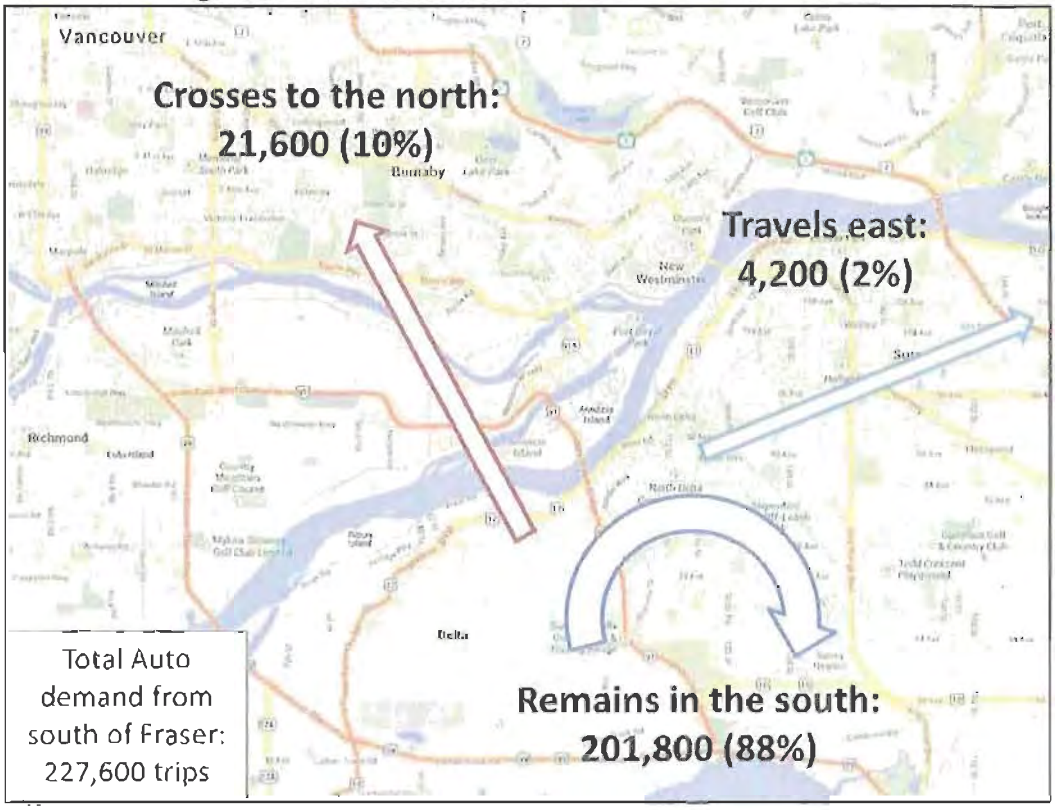
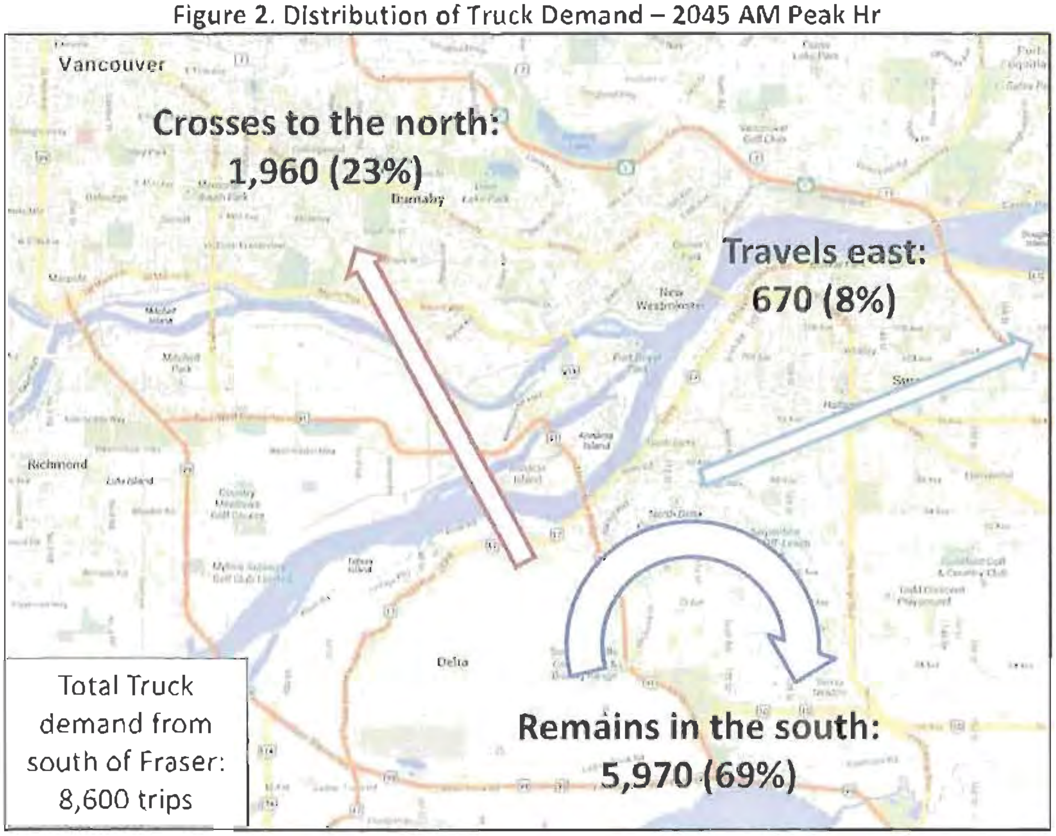


Figure 2. Distribution of Truck Demand – 2045 AM Peak Hr



REGIONAL NETWORK Results - Tunnel and Bridge Options.

Key REGIONAL NETWORK Indicators		Year 2011	Year 2045							
		Base Case - Tunnel	Future - 4-Lane Tunnel. MGS Land Use				Future - 8-Lane Bridge. MGS Land Use			
		WITHOUT Toll	WITHOUT Toll		WITH Toll		WITHOUT Toll		WITH Toll	
Total Regional Person-Trips	- by AUTO	434,300	619,800	(43%)	619,600	(43%)	619,800	(43%)	619,500	(43%)
	- by TRANSIT	91,300	146,500	(60%)	146,700	(61%)	146,600	(61%)	146,600	(61%)
Modal Split (Auto/Transit)		83 / 17	81 / 19	(-2% / 12%)	81 / 19	(-2% / 12%)	81 / 19	(-2% / 12%)	81 / 19	(-2% / 12%)
Vehicle Km Travelled (veh-km)		3,712,700	5,263,700	(42%)	5,248,600	(41%)	5,296,700	(43%)	5,255,800	(42%)
% of Auto Links V/C >1:		13%	20%	(46%)	19%	(46%)	20%	(47%)	19%	(45%)
2-way Volumes at N-S Crossings:	Traffic	32,700	40,300	(23%)	39,300	(20%)	42,200	(29%)	39,200	(20%)
	Transit Trips	1,700	2,300	(35%)	2,300	(35%)	2,800	(65%)	2,600	(53%)

* This is the total 2-way volumes at relevant water crossings across the Fraser River that could reasonably be used to get from south of the Fraser into Richmond and the Burrard Peninsula. Traffic volumes include the Massey Tunnel, Alex Fraser, Pattullo and Port Mann bridges; transit trips are limited to the Massey Tunnel, Alex Fraser and Port Mann bridges.

MASSEY CORRIDOR Results - Tunnel and Bridge Options.

Key MASSEY CORRIDOR Indicators	Year 2011	Year 2045							
	Base Case - Tunnel	Future - 4-Lane Tunnel. MGS Land Use				Future - 8-Lane Bridge. MGS Land Use			
	WITHOUT Toll	WITHOUT Toll		WITH Toll		WITHOUT Toll		WITH Toll	
2-way Person-Trips at Massey crossing - by AUTO	8,200	9,100	(11%)	7,800	(-5%)	14,100	(72%)	10,400	(27%)
- by TRANSIT	1,150	840	(-27%)	970	(-16%)	1,450	(26%)	1,400	(22%)
Modal Split (Auto/Transit)	88 / 12	91 / 9	(3% / -25%)	89 / 11	(1% / -8%)	91 / 9	(3% / -25%)	88 / 12	(0% / 0%)
Total 2-way Traffic Volume at Massey crossing:	7,040	7,870	(12%)	6,730	(-4%).	11,010	(56%)	8,210	(17%)
VKT (veh-km)	223,200	260,800	(17%)	220,300	(-1%)	374,600	(68%)	275,600	(23%)
V/C Ratio (2-way weighted avg.)	1.26	1.41	(12%)	1.21	(-4%)	0.95	(-25%)	0.76	(-39%)
V/C Ratio (inbound peak)	1.27	1.41	(11%)	1.24	(-2%)	1.14	(-10%)	0.91	(-28%)
Avg. Speed (km/hr)	29	22	(-26%)	32	(9%)	54	(83%)	70	(138%)
AUTO travel performance: 8 Ave to Oak St Bridge:									
Time (min)	35	38	(9%)	32	-(9%)	38	(8%)	31	-(10%)
Avg. Speed (km/hr)	68	61	-(9%)	73	(9%)	62	-(8%)	75	(10%)

Figure 3 (passenger vehicles) and Figure 4 (trucks) on the following page compare the 2045 forecasts for a new 8-lane, tolled crossing compared to the current 4-lane tunnel without tolls.

Figure 3. Difference in Auto trips 8-lane bridge (tolled) vs. 4-lane tunnel (untolled) – 2045 AM Peak Hr

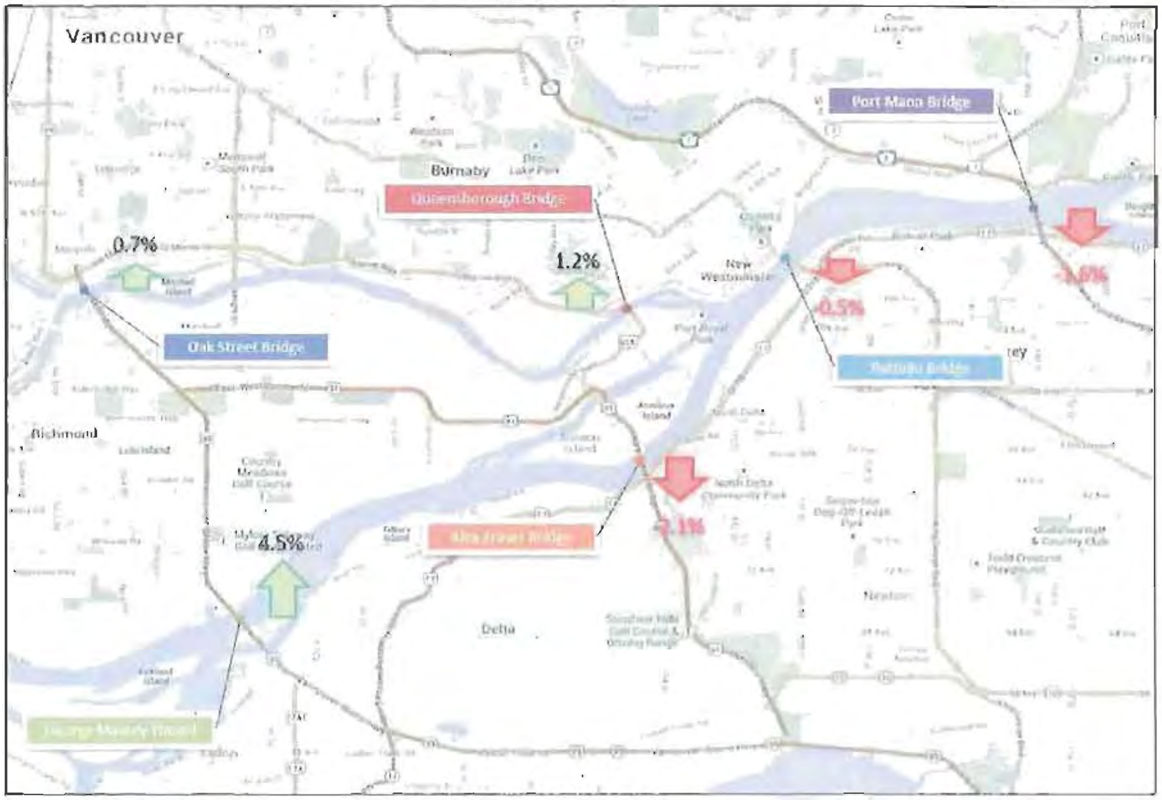
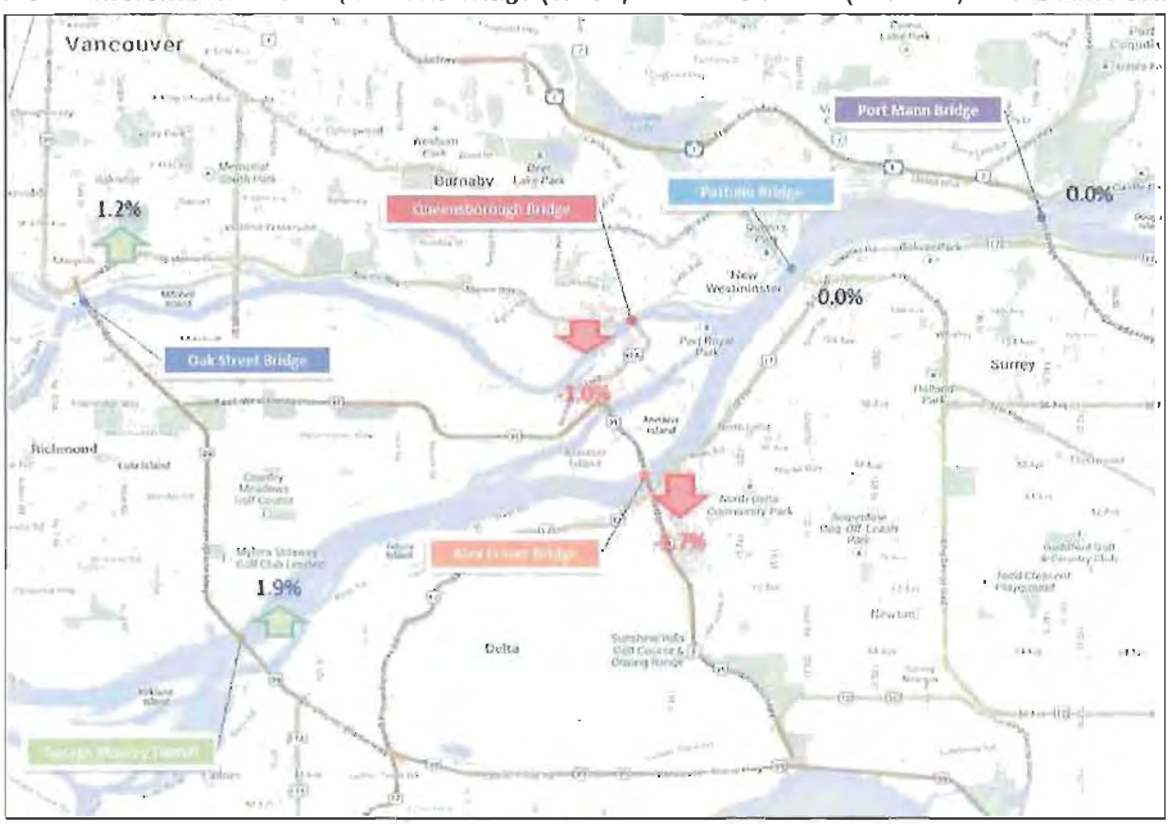


Figure 4. Difference in Truck trips 8-lane bridge (tolled) vs. 4-lane tunnel (untolled) – 2045 AM Peak Hr



Sensitivity Tests

In addition to the five base model runs, this analysis tested the sensitivity of the system to alternative land use assumptions and background network and service conditions. The objective of these tests is to provide a high level assessment of the potential transportation impacts.

Sensitivity Test 1: Alternative Land Use - Methodology and Assumptions

TransLink commissioned Coriolis Consulting Corp, to develop a set of 2045 land use forecasts which illustrate the potential land use impacts of a new 8-lane bridge replacing the Massey tunnel. Coriolis developed these land use forecasts in coordination with TransLink staff and reviewed the findings with Metro Vancouver staff. The future land use was assigned to each transportation zone based on the following observations from the assessment.

The bridge and associated road works could impact the distribution of population and households, due to increased accessibility, as follows:

- About 1% of the suburban population growth that will be accommodated in single family and townhouse development (about 4,400 people) would likely shift from West Richmond and Steveston to South Delta (Ladner and Tsawwassen) and South Surrey.
- There may also be a small shift in population growth from high density nodes (e.g. Yaletown, Lonsdale, Metrotown) to South Delta and South Surrey, but this shift would be small and therefore is not modeled.

The bridge and associated road works could impact the distribution of employment, due to increased accessibility, as follows:

- South Delta and South Surrey would likely receive a slightly higher shares of population-serving employment there (e.g. retail and service employment) and corresponding less in West Richmond and Steveston.
- The pace of light industrial development would likely occur faster in Richmond, Delta (e.g. Tilbury, Tsawwassen First Nation), and parts of South Surrey in the short term and correspondingly slower in South Burnaby and North Surrey. However, the industrial land supply in these areas (and the entire region) is likely to be constrained by 2045, resulting in no significant differences in the total amount of light industrial employment at these locations. [1]

[1] The removal of the tunnel could open up the south arm of the Fraser to deep draught (or higher capacity) vessels. However, Port Metro Vancouver has indicated that the ability to dredge this arm of the Fraser to facilitate deeper or more fully loaded vessels is limited by width of the river. Therefore the Consultant did not assume that these higher capacity vessels would not be going upstream and therefore do not impact employment distribution. Subsequent to the analysis by Coriolis, Metro Vancouver indicated that the potential to open up the south arm of the Fraser River to access Fraser Surrey Docks, either for short-sea shipping or expanded container throughput, could represent a material shift in the region's ability to move goods, which may impact employment distribution- this potential effect was not included in the sensitivity test.

This set of land use forecasts was run through the model for the future bridge, with and without toll, in order to examine how changes in land use may impact travel demand and travel patterns.

Results

The following table summarizes the differences between applying the base and the alternative land use scenarios form Coriolis in the case of a bridge in 2045.

REGIONAL NETWORK Results 2045 - Difference between CORIOLIS Base and Alternative Land Use

Key REGIONAL NETWORK Indicators		Future - 8-Lane Bridge. Coriolis Alternative - Base Land Use	
		Bridge WITHOUT Toll	Bridge WITH Toll
Total Regional Person-Trips	by AUTO	-2,900	-3,000
	by TRANSIT	0	-100
Transit Mode Share (%)		0%	0%
Vehicle Km Travelled (veh km)		600	1,400
% of Auto Links V/C >1:		0%	0%
2-way Volumes at N-S Crossings:	Traffic	100	200
	Transit Trips	0	0

MASSEY CORRIDOR Results 2045 - Difference between CORIOLIS Base and Alternative Land Use

Key MASSEY CORRIDOR Indicators		Future - 8-Lane Bridge. Coriolis Alternative - Base Land Use	
		Bridge WITHOUT Toll	Bridge WITH Toll
2-way Person-Trips at Massey crossing	- by AUTO	0	100
	- by TRANSIT	20	10
Transit Mode Share (%)		0%	0%
Total 2-way Traffic Volume at Massey crossing:		40	70
	VKT (veh-km)	1,200	2,200
	V/C Ratio	1%	1%
	Avg. Speed (km/hr)	0	0

Sensitivity Test 2: Alternative Transportation Network- Network Assumptions

As part of the Regional Transportation Strategy planning process, TransLink developed a number of alternative future transportation network scenarios. These scenarios reflect different levels of investment in the regional transportation network and demand management measures. For the purpose of this sensitivity test, TransLink assumed RTS Alternative 3 regional network background conditions. In terms of network infrastructure and services, RTS Alternative 3 assumes a major expansion of transit, cycling and walking:

- Rapid Transit expansion on key corridors
- Transit priority on high capacity, congested transit corridors
- Expanded Frequent Transit Network and extended supportive transit network to new areas
- Significant investment in cycling and walking
- Minor incremental road expansion
- New, tolled Patullo Bridge

Alternative 3 assumes that general increases in bus service would result in much higher frequency of bus service on most routes within the Massey corridor. This level of planning has not yet occurred, but for working purposes an expansion allocation of 90 buses/hour compared to 39 buses/hour in 2011 was used for modelling.

Results

The following table summarizes the differences between RTS Alternative 3 and RTS Base Case with a new 8-lane tolled bridge in 2045.

REGIONAL NETWORK 2045 - Difference Alt. 3 - Base Network with Tolled I

Key REGIONAL NETWORK Indicators		Future 8-Lane Tolled Bridge with RTS ALT3 - RTS Base Network Bridge WITH Toll
Total Regional Person-Trips	- by AUTO	-11,200
	- by TRANSIT	13,700
Transit Mode Share (%)		9%
Vehicle Km Travelled (veh-km)		-93,800
% of Auto Links V/C >1:		0%
2-way Volumes at N-S Crossings:	Traffic	-300
	Transit Trips	500

MASSEY CORRIDOR 2045 - Difference Alt. 3 - Base Network with Tolled Br

Key MASSEY CORRIDOR Indicators		Future 8-Lane Tolled Bridge with RTS ALT3 - RTS Base Network Bridge WITH Toll
2-way Person-Trips at Massey crossing	- by AUTO	-100
	- by TRANSIT	120
Transit Mode Share (%)		8%
Total 2-way Traffic Volume at Massey crossing:		130
	VKT (veh-km)	-4,900
	V/C Ratio	-1%
	Avg. Speed (km/hr)	4

Summary of Preliminary Observations

In interpreting the model outputs, it is important to keep in mind that they are intended to provide a high level approximation of what transportation behaviour may be like in the future given the current set of land use and network assumptions. The figures are order-of-magnitude illustrations and are appropriate for relative comparisons between scenarios. They should not be interpreted as precise predictions of future traffic or passenger volumes, especially on specific road sections or transit route segments. As noted earlier, the **modelled results are for the AM peak hour only**.

Summary of Current Conditions (Base Case 2011):

- The tunnel shows high levels of congestion and a demand that significantly exceeding capacity, with a volume-to-capacity (v/c) ratio > 1.3 leading to queuing on the approaches to the tunnel.
- The tunnel's two way traffic volume is approximately 7,000 vehicles/hour. This represents 22% of total Fraser River crossings (as defined in the previous Network Regional table).

- Transit mode share at the tunnel (12%) is lower than the network average (17%).

Summary of System Wide Conditions 2045 (all base scenarios):

- At the regional level, there would be over 45% more trips (all modes) compared to 2011.
- The future regional network level travel demand is expected to be similar for all five base model crossing scenarios with only marginal variations.
- The model forecasts the total number of daily regional trips will be about 766,000; total regional transit demand will be about 146,000 trips.
- The regional transit mode share should thus be stable (at about 19% across all scenarios).

George Massey Corridor Level 2045

- Background growth in population and employment alone should result in 11% more person-vehicle trips and 12% more traffic volume through the tunnel in 2045, compared to today.
- Without any changes to the existing tunnel,
    - Congestion would increase, with a volume-to-capacity ratio of over 1.4
    - Transit mode share on the corridor would drop from 12% in 2011 to 9% in 2045.

At the corridor level, the model shows potentially significant differences in transportation behaviour for the four future crossing scenarios. Comparing an 8-lane bridge to a 4-lane untolled tunnel in 2045:

- A new 8-lane bridge without tolls would have:
    - 40% more traffic;
    - a v/c ratio improvement from 1.4 to 0.95 for the 2-way weighted average and to 1.14 for the inbound peak direction;
  - An increase in total two-way transit trips of 73%, but, due to higher vehicle travel, no change in transit mode share (stable at 9%).
- If tolled, a new 8-lane bridge in 2045 could potentially have:
  - 4% more traffic than the existing tunnel;
  - Lower congestion levels than untolled (a v/c ratio of 0.76 for the 2-way weighted average and 0.91 for the inbound peak direction);
- An increase in total two-way transit trips of 67%, and an increase in transit mode share from 9% to 12% due to the lower number of vehicle trips in this scenario. These volumes and mode shares appear reasonable given the Year 2045 RTS Base Case does not assume significant levels of transit investment.

Alternative Land Use Sensitivity Test

At the regional level, the alternative land use tested generates marginal impacts on network level travel demand in 2045; slightly less vehicles trips (0.5% fewer) and about the same number of transit trips. Regional transit mode share forecasts remain stable.

At the corridor level, this alternative land use forecast does not generate statistically more traffic for the new bridge (or the north-south crossings collectively) compared to the Base Case land use. This is likely due to the fact that most of the changes of population relocation are accompanied by similar reallocations of employment.

In 2045, within the corridor, the alternative land use scenario is expected to have similar trends in transportation behaviour as the other bridge crossing scenarios with base land use.

Alternative Transportation Network Sensitivity Test

As described previously, the alternative background transportation network assumptions tested include transit expansion (RTS Alternative 3). At the regional level, this scenario forecasts higher transit trips and transit mode share in 2045 compared to Base Case scenario. The variation in mode share is expected to be slightly less noticeable at the corridor level but it would increase from 19% to 21% region-wide for the AM peak hour.

At the corridor level, the alternative transportation network tested resulted in marginally lower vehicle traffic at the Massey crossing in 2045. Similarly, this reduction in vehicle traffic would translate directly into more transit ridership, though the increase however remains small. The stability of the forecast is likely due to the fact that the transit, cycling and road upgrades envisioned for this corridor do not significantly alter the relative attractiveness of the different modes.

In 2045, within the corridor, the alternative background transportation network scenario is expected to have similar trends in transportation behaviour as the other bridge crossing scenarios with base case transportation network.

This 2045 transportation network sensitivity test includes completion of a practical, comfortable and safe cycling network. These facilities, along with convenient crossing on a new bridge, would provide better options for people to bicycle, likely resulting in large percentage increases. However, the land use and travel patterns around the bridge mean the number of absolute trips that would be conducive for shifting to cycling is unlikely to be large enough to alter the preliminary vehicle and transit travel demand forecasts previously discussed.

Source: TransLink 2011 Metro Vancouver Regional Screenline Survey

Crossing	Daily Traffic Volumes (2011)*	Estimated Annual Trips (Daily x 365 days)	Estimated Annual Weekday Trips (Daily x260 days)
Arthur Laing Bridge	79,000	*28,835,000*	*20,540,000*
Oak Street Bridge	88,000	*32,120,000*	*22,880,000*
Knight Street Bridge	96,000	*35,040,000*	*24,960,000*
George Massey Tunnel	89,000	*32,485,000*	*23,140,000*
Queensborough Bridge	88,000	*32,120,000*	*22,880,000*
Alex Fraser Bridge	117,000	*42,705,000*	*30,420,000*
Pattullo Bridge	68,000	*24,820,000*	*17,680,000*
Port Mann Bridge	112,000	*40,880,000*	*29,120,000*
Pitt River Bridge	79,000	*28,835,000*	*20,540,000*
Golden Ears Bridge	30,000	*10,950,000*	*7,800,000*
Lion's Gate Bridge	63,000	*22,995,000*	*16,380,000*
Iron Workers Memorial Bridge	127,000	*46,355,000*	*33,020,000*
Subtotal	**1,036,000**	***378,140,000***	***269,360,000***

**Daily traffic volumes are based on an average fall weekday in 2011.*

Crossing	Actual Toll Revenue	Year	Document Source
Port Mann Bridge	$122 Million	2014	Transportation Investment Corporation 2014/2015 Annual Service Plan Report
Golden Ears Bridge	$41.6 Million	2014	TransLink 2014 Year-End Financial and Performance Report Appendix A

MEMORANDUM

The Corporation of Delta
Engineering

To: **Mayor Lois E. Jackson**

From: **Steven Lan, P.Eng., Director of Engineering**

Date: **February 29, 2016**

Subject: **George Massey Tunnel Replacement Project: Comments made by Metro Vancouver in relation to their request for additional review time of the Project Definition Report**

File No.: **5220-30/GMTR**

CC: **George V. Harvie, Chief Administrative Officer**

Provided below is additional information from the George Massey Tunnel Project Team in response to the recent Metro Vancouver staff report on the project.

1. **Delay Request**

- Ministry staff have met with Metro Vancouver more than 20 times over the past three years.
- Metro Vancouver staff participate in the technical working group for the Project's environmental assessment review.
- Metro Vancouver staff have already provided written comments on the PDR and the Environmental Assessment Project Definition and Key Areas of Study document.
- The Project Team has met with Delta and Richmond staff more than 60 times each in the past three years and both municipalities have also sent comments.
- Once the EA application is submitted, there will be another 45 to 60 day public comment period and at least six more months of time for discussion and comment from Metro Vancouver staff and directors.

2. **Federal Environmental Review**

- Currently there is no federal trigger for the environmental review.
- Changing federal legislation will take some time.

3. Other Items

Building more roadway lanes encourages more car trips, most of which are made in single-occupant vehicles, ultimately leading to more congestion.

- The Project includes measures to promote transit, carpooling, cycling and walking and to help manage growth in vehicle demand over time.
- With or without the new bridge to replace the George Massey Tunnel, traffic on Highway 99 will continue to grow as more people move to Richmond and Delta and more jobs are created.
- Building an 8-lane bridge will result in congestion on opening day.

Investment in the George Massey Tunnel Replacement Project means that the Province no longer supports the Regional Growth Strategy (RGS).

The RGS calls for measures to reduce greenhouse gases, use land efficiently, build an efficient transportation system and a stable economy, protect natural areas, develop complete communities that support walking and transit, and support sustainable transportation choices. All of these were considered in developing the project scope. For example:

- The Project is expected to help reduce greenhouse gas emissions as a result of reduced congestion-related idling.
- Municipal population and employment targets and existing land use designations were used as the basis for traffic forecasting.
- The Project will reduce congestion, improve travel time and reliability, improve transit service, provide new alternatives for cycling and walking, provide safe alternatives for slower moving traffic, and accommodate future rapid transit. Most of these would not be possible if the Tunnel is not replaced.
- Additionally, the Project provides the opportunity to return Green Slough to its original alignment and reconnect portions of Deas Island Regional Park that are currently bisected by Highway 99.

Most people were unaware of planning for the Project before the Premier announced plans to proceed.

- There have been three phases of public consultation in 2012, 2013, and 2015/16.
- More than 1,000 people participated in each of the three phases of consultation, including 550 people at the Delta open house a few weeks ago.
- Participation levels during this Project's consultation have far exceeded many other recent consultations in this region and hundreds of meetings have been held with First Nations, regional and local government staff, and interested stakeholders.
- The Province's EA communication plan notes that more than 90 presentations have been made to date, in addition to hundreds of meetings with government and agency staff.

Port Metro Vancouver is driving the Project

- The new bridge will have the same vertical clearance as the Alex Fraser Bridge.
- There are no plans to dredge the river to a deeper depth once the Tunnel is removed.
- All current proposals for expansion on the Fraser River can be accommodated with the Tunnel in place.

The Project will take away much needed funding ($4 billion) that should be spent on carbon mitigation, especially in transport for the province.

- The Project will be tolled, ensuring that construction can begin now without taking away from funding for other important initiatives like health care, education, rapid transit and other transportation projects.
- The Province has committed to funding the province's share of the Broadway Line extension and the Surrey-Langley Rapid Transit lines.

The Tunnel should be left for use as a mass transit rail and as a means to prevent proposed LNG and coal expansion on the South Fraser.

- The new bridge will be built to accommodate future rail-based transit, and in the meantime will support improved Rapid Bus service, with dedicated transit lanes, dedicated transit ramps to

connect to Bridgeport SkyTrain Station and integrated transit stops at Steveston Highway and Highway 17A.
- Currently proposed coal and LNG developments can proceed without removing the Tunnel; in fact, LNG vessels have shallower draft requirements than the container vessels using the Fraser River today.

The Project will negatively impact farmland in Delta and Richmond, compromising regional food security and putting pressure to remove land from the Agricultural Land Reserve.

- The Province has committed to no net loss of agricultural land and is working with farmers to achieve a net gain in quality farmland in Delta and in Richmond.
- Like the South Fraser Perimeter Road, this Project also offers potential agricultural benefits like improved cross-highway access and travel time reliability for getting perishables to market.
- The Project Team is working with the Delta Farmers' Institute, the Richmond Farmers' Institute and individual farmers.
- The Agricultural Land Reserve is protected by provincial legislation.

The Project will result in more idling or about the same for vehicles at the other bottlenecks resulting from the construction as well as increased traffic encouraged by the bridge.

- The Project is expected to reduce congestion related idling – both as compared with today and to a future without a new bridge. This will contribute to reduced greenhouse gas emissions.
- Bridge tolls will serve to help manage growth in traffic over time.

Steven Lan, P.Eng., Director of Engineering

LF/ll

George Massey Tunnel Replacement Project
Summary Assessment Table of Issues and Impacts

Metro Vancouver Function	Issue or Impact	Actions Required of the Proponent to Address Issue or Impact (i.e. Commitments, Assurances, Compensation, Monitoring, Mitigation)
Regional Planning and Growth Management – *Land Use*	• No information is provided on how the project may impact industrial lands and industry in the region. • Regarding potential induced land use impacts of the project, although there are no land use re-designation changes directly associated with the project, there will be increased pressures for land use conversion. Consultant work completed to date that assesses the potential land use impacts of the project assumes the existing policy framework as laid out by Official Community Plans, the Regional Growth Strategy and the Agricultural Land Reserve. Assuming that the Urban Containment Boundary and Agricultural Land Reserve will not change is an important baseline, but it is also important to acknowledge that the new infrastructure will increase speculative pressure to expand the Urban Containment Boundary and to convert agricultural lands.	• Address how the proposed project may impact industrial lands and industry in the region. • Acknowledge and assess how the proposed project will increase speculative pressure to expand the Urban Containment Boundary and to convert agricultural lands.
Regional Planning and Growth Management – *Transportation*	• Incomplete information about the transportation effects of the new bridge on the regional transportation system. • Comparative information is missing on the baseline and forecast indicators in the Local Assessment Area, the adjacent watercrossings, and the Regional Assessment Area for personal vehicles and goods movement vehicles: o Queue lengths on adjacent watercrossings, o Mode share, o Crash frequencies, o Fuel consumption, o Total greenhouse gas emissions (emissions from travel + congestion), o Vehicle Kilometres Travelled, and o Vehicle Hours Travelled	• Provide requested information, appropriate mitigation measures, residual effects and significance, cumulative effects and significance, and follow-up strategy.

	• Inadequate documentation of mitigation measures, residual effects and their significance, cumulative effects and their significance, and follow-up strategy to fully address the identified traffic issues.	
Regional Planning and Growth Management – *Agriculture*	• Potential effects of decomissioning the tunnel must consider multiple variables (climate change, sea level rise) and the likely scenario of river dredging on the salinity levels of irrigation water for agriculture during the growing season over the long term (10+ years) due to the high risk of loss of farm viability for one or more farms. • The lack of a comprehensive assessment of the potential effects on the quality of irrigation water from the Fraser River from climate change and future scenarios of dredging when the tunnel decommissioned, raises questions as to how high salinity water quality issues can be fully mitigated.	• Consider the time of year of construction impacts to minimize effects during the growing season or physical degradation on soil quality.
Regional Planning and Growth Management – *Human Health*	• The proponent committed to conducting a Health Impact Assessment and the Application Information Requirements require the proponent to include the HIA's methodology, conclusions and recommendations as part of the Application. The methodology section in the Application does not provide Metro Vancouver reviewers with sufficient confidence in the conclusions. The proponent has not provided the actual HIA report for review.	• Assess and implement mitigative measures to reduce potential health impacts. • Monitor and evaluate the Health Impact Assessment's health issues of interest at several stages post construction.
Air Quality and Climate Change – *Project-Related Air Quality Impacts*	• The Metro Vancouver *Integrated Air Quality and Greenhouse Gas Management Plan* is linked to the *Regional Growth Strategy* in that planning for compact urban areas and complete communities, including transit-oriented development, will reduce transportation emissions and protect air quality in the region. To align with the Plan and its goals for air quality and climate change, major projects in the region should support the goals and guidelines outlined in the Plan.	• Provide a modelling plan to Metro Vancouver to facilitate a complete review of the application. • Incorporate appropriately completed traffic analysis into the subsequent air quality, climate change and health effects assessments. This analysis needs to examine traffic impacts across a broader study area to assess changes in traffic volumes and

	• The proponent has not provided sufficient information to adequately characterize air emissions or assess/mitigate air quality issues and impacts in the following key areas: o Incomplete information on the inputs used in air quality modelling to support the conclusion of "No Project-related residual or cumulative effects on air quality". This includes the absence of a modelling plan that complies with the BC Air Quality Dispersion Modelling Guideline, as well as incomplete information on the effects of the new bridge on transportation and traffic (i.e. traffic volume and distance travelled), such that emissions can be appropriately characterized. Without the technical details that must be included in a modelling plan, staff does not have the necessary information required to fully assess the Air Quality Study. o Lack of comprehensive assessment of secondary formation of air pollutants, such as ground level ozone and secondary fine particulate matter within the Regional Assessment Area. The reduction of ground level ozone has been a focus of Metro Vancouver's air quality program for decades, as articulated in regional air quality management plans in 1994, 2005 and 2011, as well as the Regional Ground Level Ozone Strategy adopted by the GVRD Board in 2014. o Comments in the Regional Planning section on the completeness of the traffic modelling for the project application indicate that there is incomplete information for Vehicle Kilometres Travelled and Vehicle Hours Travelled, amongst other parameters. This information is crucial to the completion of the air quality, climate change and health effects assessments in the application. Without adequate information to review the traffic assessment, these assessments can also not be adequately reviewed.	congestion at other points in the regional transportation system, and the associated changes in emissions and resultant environmental impacts. The analysis also needs to consider a range of future traffic scenarios to improve public confidence and address any criticisms of the selection of optimistic scenarios for the analysis. • Include as part of the modelling plan an approach and methodology to conduct photochemical modelling in order to assess the impacts of the project on regional ground level ozone formation, over a broader study area and under a number of project-related traffic scenarios as noted above. • Commit to contributing to additional ambient air quality monitoring stations, both fixed and mobile, to assess impacts of the project on an ongoing basis. The proponent should consult with air quality authorities in the region to determine the parameters to be monitored, the method of reporting, and the location of the stations.

	• Deficiencies in the completeness of the assessment to date mean there is an inadequate assessment of the potential impact of the project on air quality and climate change.	
Air Quality and Climate Change – *Construction Phase Air Quality and Health Impacts*	• For the construction phase, there is no modelling provided of construction-related air quality and human health impacts. Instead, the proponent indicates that the Air Quality & Dust Control Management Plan (not yet developed) will include best management practices that will mitigate air quality impacts (and associated health impacts) from construction, although no evidence of the efficacy of the best management practices has been provided. • Project information provided by the proponent states that "Air quality comprises one of the 'steps' along the pathway of effects of the Project, with human health identified as the ultimate receptor of Project-related effects." This raises consequential concerns about the basis for the analysis of air quality-related health impacts.	• Prepare the Air Quality & Dust Control Management Plan in advance of project initiation, and provide it for review and comment by relevant air quality regulatory and other agencies. The management plan must include provisions for baseline air quality and dustfall monitoring prior to initiation of construction, during construction, and once construction is complete. The results of this monitoring program must be regularly reported to relevant air quality regulatory and oversight agencies.
Air Quality and Climate Change – *Greenhouse Gases and Climate Impacts*	• Information provided by the proponent describes greenhouse gas emissions in the context of "the Project alignment" comparatively in 2011 and 2031 (with and without the Project). Greenhouse gas reductions are attributed to both engine technology improvements and congestion relief. It is not appropriate to examine greenhouse gas emission changes within a geographic scope as limited as "the Project alignment". The assessment not only fails to consider greenhouse gas emissions in the broader regional context, but also fails to assess changes in greenhouse gas emissions due to either induced traffic as a result of the project, or changes in traffic volumes (and congestion and emissions) in other parts of the regional transportation system.	• Examine potential greenhouse gas emissions impacts associated with the Project over a regional scope and with a range of scenarios to comply with regional greenhouse gas emissions reductions targets.

Environment and Regional Parks – *Habitat, Wildlife and Fish*	• Information provided by the proponent does not identify that Deas Island hosts one of the largest and most significant bat colonies in the Lower Mainland. This colony will be affected by noise and construction activities during the breeding season and will be permanently impacted by increased lighting and noise from the bridge. • The tunnel removal and bridge construction has the potential to effect fish and wildlife and their habitat at Deas Island Regional Park in the water connected to it <u>temporarily</u> in several ways: o Increase turbidity and potential decrease in ambient water quality in the water connected to Deas Island due to sedimentation during clearing and grubbing, and installation of temporary barging facilities. o The possibility of accidental spills of toxic or hazardous materials into the water connected to Deas Island. o Temporary re-suspension of existing contaminants into the water column. o Physical injury or direct mortality to fish from noise during ground improvements and during tunnel decommissioning. o Dredging, tug and barge operations and removal of rip rap have the potential to disturb to fish and mammals. o Changes in fish habitat quality due to acoustic effects, changes in ambient water quality, induced turbidity, riverbed lowering, and local scouring. o Auditory physical injury (impact pile driving) and/or behavioural disturbance (vibratory pile driving and in-river operation of construction vessels) on marine mammals (seals & sea lions) from increased underwater noise. o Temporary changes to the ability of on marine mammals to feed on migrating fish stocks that may in turn be affected from changes in ambient water quality from induced turbidity, and re-mobilization of sediment contaminants.	• Adhere to provincial and federal laws, best management practices, and timing windows to avoid temporary and permanent disturbance to the Deas Island Regional Park Bat Colony. • Continue to work with Metro Vancouver (including but not limited to technical working groups) during the design and construction phases to minimize or eliminate impacts to Deas Island Regional Park and its environs. • Avoid sensitive ecosystems in Deas Island Regional Park • Commit to no net loss of habitat and collaborative work with regional agencies to determine compensation, mitigation, and monitoring requirements. • Work with Metro Vancouver to offset negative impacts on fish and wildlife and their habitat on Deas Island Regional Park by conducting revegetation and restoration of areas within the Project alignment, including under the new bridge to improve ecological conditions. • Work with Metro Vancouver to offset negative impacts on fish and wildlife and their habitat on Deas Island Regional Park and Deas Slough by conducting revegetation and restoration of areas within the Project alignment, including under the new bridge to improve ecological conditions.

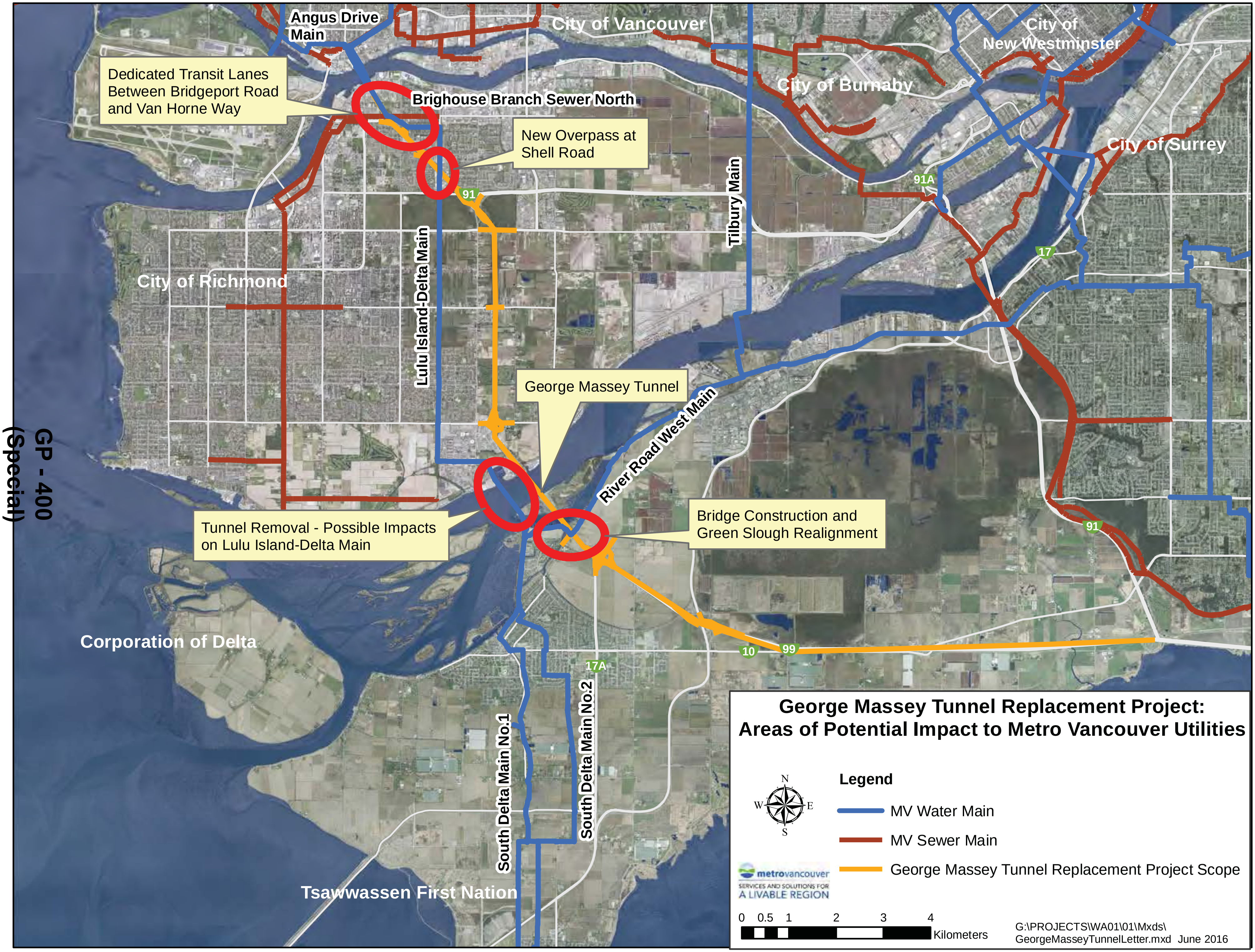
	o Habitat loss and direct mortality of terrestrial wildlife that move between Deas Island Regional Park and adjacent forests, during vegetation clearing and grubbing, stripping, and soil excavation. o Habitat alteration due to sensory disturbance from noise, dust, and presence and movement of construction crews and equipment. o Direct mortality and disturbance to upland birds that move between Deas Island Regional Park and adjacent forests (e.g., destruction of raptor and passerine nests). o Temporary disturbance of vegetation. o Construction of temporary bridges on either side of the existing Deas Slough Bridge, including temporary piers in Deas Slough, will result in vegetation removal and habitat impacts. • The bridge may affect the fish and wildlife and their habitat Deas Island Regional Park and the water connected to it <u>permanently</u> in several ways, including: o An increase of impervious surface area and stormwater runoff entering the river could increase in concentrations of nutrients, organics, metals, chlorides, bacteria, and hydrocarbons in the water connected to Deas Island. o Physical injury or direct mortality to fish due to auditory injuries from pulsed noise (i.e., impact pile driving) and auditory physical injury to marine mammals. o The reduction of and changes to habitat used by existing fish and wildlife that move in and out of Deas Island. Regional Park, due to changes in quality due to acoustic effects, changes to ambient water quality, and the permanent placement of in-stream piers. o Permanent habitat alteration and loss as well as disturbance to wildlife (mainly birds and bats) due to increased noise levels and increased ambient light environment from vehicle traffic. o Species at Risk in the park which are potentially affected by the new bridge include: Barn Swallow, Barn Owl, Great	• Adhere to provincial and federal laws, best management practices, and timing windows to avoid temporary and permanent disturbance to fish and wildlife and their habitat. • Prepare the Invasive Species Management Plan in advance of project initiation, and provide it for review and comment by relevant agencies, including Metro Vancouver's Regional Planning Advisory Committee – Regional Invasive Species Task Force. • Commit to ongoing monitoring and control of invasive species along Highway 99.

	Blue Heron, Trowbridge's Shrew, Olympic Shrew, Pacific Water Shrew, and Southern Red-back Vole. o The permanent destruction of raptor and passerine nests (barn swallow nesting area under the Deas Slough Bridge and bald eagle nest in BC hydro right-of-way) which are used by birds that actively use the park for feeding and resting. o Increased vehicle collisions with avian wildlife. • The proponent committed to developing an Invasive Species Management Plan, but the plan is not included in the application.	
Regional Parks – *Park Land and Visitor Experience*	• Deas Island Regional Park and its recreational values are directly and significantly impacted by the proposed project. In particular, noise, debris, shading and visual effects from the bridge will impact visitor experience. • Construction access through Deas Island Regional Park is not desirable from a park visitor perspective, and existing park infrastructure is inadequate to support this type of use. • Access through the Regional Park will likely be required for long-term maintenance of the Ministry's bridge. Pursuant to Metro Vancouver Regional Parks Bylaw No. 1177, 2012, all commercial access through or on Metro Vancouver Regional Parks must undergo a permitting process. Park roads and trails may require upgrades to support access. Some roads and trails may not be suitable due to adjacent sensitive habitat.	• Provide visual modeling and description of the viewshed under the bridge. • Continue to work with Metro Vancouver staff to secure the required permits for construction and maintenance access through the park. • Confirm the nature of access required post construction and complete an impact assessment that includes the area and park assets.
Regional Utilities – *Water and Liquid Waste*	• The proposed Project involves construction of temporary and permanent works both crossing, and in close proximity to, several existing Metro Vancouver water mains, (Lulu Island-Delta Main and River Road West Main) at multiple locations. Both of these mains are critical for water supply to the City of Richmond and Corporation of Delta.	• Continue to work with Metro Vancouver during the design and construction phases to minimize or eliminate impacts and potential risks to regional utility infrastructure.

	• At this phase of the project development, the design details and construction schedule have not been established. However, water supply to Richmond and Delta would be significantly impacted if construction activity were to damage either main during summer peak demand period. The impact of damaging both mains concurrently would be critical at any time of the year. These same comments would apply to any proposed relocation of these regional water facilities. Construction must be therefore carefully planned and phased to ensure risks are minimized and water supply is maintained. • MOTI indicates that the mitigation of impacts to the Lulu Island-Delta and River Road West Mains for land-based construction will be a Contractor responsibility. • On land, Lulu Island-Delta Main will be impacted by two separate overpass and highway construction activities in north Richmond: the first is dedicated transit lanes starting south of the Bridgeport Road interchange and terminating at Van Horne Way. The second is at Shell Road where new overpass will be constructed. • Multiple construction activities such as ground improvement, foundations, structures, temporary bridges, highway crossings and the realignment of Green Slough are expected adjacent to the River Road West Main in Delta on the south shore of Deas Slough. • Greater Vancouver Sewerage & Drainage District Brighouse Branch Sewer lies within the footprint of the dedicated transit lanes crossing Bridgeport Road. • Metro Vancouver will require access to its infrastructure both during and following construction.	• Commit to bearing all associated costs for protection and/or relocation of regional utilities. • Require project contractors to protect Metro Vancouver infrastructure and specify that risks, responsibilities, costs, methods of protection and schedule must be borne by the Contractor. • Comply with all Metro Vancouver requirements, including any crossing and proximal work approvals and related submissions pertaining to design and construction of temporary and permanent works. • Commit not to undertake GVWD utility relocations (if required) during peak summer water demand period. • Commit to not undertake proximal work adjacent to River Road West Main at Deas Slough and Lulu Island-Delta Main in north Richmond concurrently at any time of the year. • Provide details of support structures for the temporary bridge over Deas Slough, the south approach to the Massey Bridge, the southbound River Road off-ramp, and the Shell Road Overpass and dedicated transit lanes in north Richmond to assess the potential impact to Metro Vancouver utility infrastructure.

	• Tunnel Decommissioning: o Lulu Island-Delta Main crosses the Fraser River between Richmond and Delta buried in a shallow trench under the river bed and may be impacted by Fraser River bed lowering caused by tunnel removal. This bed lowering may impact the existing scour protection and undermine the pipe. o For the Lulu Island-Delta Main Fraser River Crossing, MOTI proposes a mitigation plan to monitor the pipe during, and following, tunnel removal and to add scour protection as required.	• Provide Metro Vancouver with unimpeded access to its utility infrastructure for operation and maintenance activities both during and after construction of the Project. • Improve upon the monitoring and mitigation plan for the Lulu Island-Delta Main Fraser River Crossing in a preventative and proactive manner. There are periods where no in-river construction is permitted due to environmental and other permitting restrictions, or is limited due to high river flows. Metro Vancouver has concerns with the reactive approach proposed by MOTI in its submission to the provincial Environmental Assessment Office. • Extend hydraulic modelling of the Fraser River beyond 210 days from the date of tunnel removal in order to fully assess the impact of downstream scour and bed lowering on the Lulu Island-Delta Main.
Finance – *Costs and Business Plan*	• No sensitivity analysis on construction costs or project benefits is provided (only discount rate and traffic growth rates). • The breakdown of project costs is redacted. Therefore, the amount of construction plus contingency is unknown, as is the interest during construction and the tunnel decommissioning cost (which does not appear to include a contingency.) Contingencies may be insufficient and therefore project costs could well exceed $3.5B. • Construction costs are among the most important components of the business case analysis, as they could easily be higher and because they occur most closely to the present (as opposed to benefits which occur over the period to 2045). The present value of cost overruns will be relatively high.	• Provide a sensitivity analysis on construction costs and project benefits. • Provide project cost details, including contingency details. • Provide 2003 report used to calculate the incremental GDP growth of $13M/year every year from 2021-2045. • Provide complete information on cash flows related to the project, including timing of expenditures. • Provide information on how the benefit of seismic improvements was calculated.

	• Insufficient information is provided on how the assumption of incremental GDP growth of $13M/year every year from 2021-2045 is arrived at, as that information is drawn from another report from 2003, which was not part of the application materials submitted. Information on how the results from the 2003 report were used to arrive at the stated values of GDP growth is not provided and therefore Metro Vancouver staff are unable to provide comments on this assumption. This assumption is critical as the project only becomes a clear winner when assumed incremental GDP effects are included. Also, it is not clear whether the incremental GDP is in real dollars or nominal dollars. • Incomplete information is provided on cash flows related to the project. Therefore, it is not possible to verify calculations of net present value because the information only includes the total for the project cost and not the timing of expenditures. • Unclear how benefit of seismic improvements was calculated. • The business case only compares with status quo. It is quite possible that the Province could gain greater net benefits from another project.	


Angus Drive Main
City of Vancouver
City of New Westminster
City of Burnaby
City of Surrey
Dedicated Transit Lanes Between Bridgeport Road and Van Horne Way
Brighouse Branch Sewer North
New Overpass at Shell Road
Tilbury Main
91A
91
17
City of Richmond
Lulu Island-Delta Main
George Massey Tunnel
River Road West Main
Tunnel Removal - Possible Impacts on Lulu Island-Delta Main
Bridge Construction and Green Slough Realignment
Corporation of Delta
10
99
17A
South Delta Main No.1
South Delta Main No.2
Tsawwassen First Nation
George Massey Tunnel Replacement Project: Areas of Potential Impact to Metro Vancouver Utilities
Legend
MV Water Main
MV Sewer Main
George Massey Tunnel Replacement Project Scope
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S
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metrovancouver
SERVICES AND SOLUTIONS FOR A LIVABLE REGION
0 0.5 1 2 3 4 Kilometers
G:\PROJECTS\WA01\01\Mxds\GeorgeMasseyTunnelLetter.mxd June 2016

Summary of Council Concerns with Current Proposed Project

- **Tunnel Decommissioning:** The removal of the existing tunnel coupled with a new bridge encourages future increased dredging of the Fraser River to enlarge the shipping channel and thus greater industrialization of the river as well as the surrounding area.
- **Highway 99 Widening & Impacts to Agricultural Land:** The Environmental Assessment report states that 20.1 hectares of ALR land will be removed for the Highway 99 widening and offset by 21.4 hectares of surplus highway right-of-way that will be reclaimed for potential agricultural use. The proposed surplus highway right-of-way is mostly occupied with mature trees and there is no certainty that adjacent property owners would choose to farm the land. Further, the significantly expanded vehicle capacity of the crossing may spur unplanned increased development south of the Fraser River and the conversion of agricultural land to other non-farming uses beyond what is anticipated in the Regional Growth Strategy.
- **Highway 99 Widening & Impacts to Environmental Sensitive and Riparian Management Areas:** The widening of Highway 99 to varying widths to accommodate an equivalent of over 20 traffic lanes will impact the City's designated Environmentally Sensitive Areas and Riparian Management Areas as well as potentially impact the hydrology of the Richmond Nature Park's bog system.
- **Highway 99 Widening & Impacts to City Park:** The Project is acquiring a width of 36 metres along the highway on the west side where Steveston Highway meets Highway 99, which impacts the City's Gardens Agricultural Park. The property acquisition equates to an overall 17.8% reduction in the size of the park and the shift in the park's eastern boundary significantly impacts the approved park plan such that a new plan based on a reduced size must be developed.
- **Regional Concerns:** A new 10-lane bridge is not consistent with the Regional Growth Strategy or the Mayors' Council Vision for Regional Transportation Investments. The expanded capacity for private vehicles encourages increased use of single occupant motor vehicles with associated environmental impacts. There is a lack of analysis of crossing alternatives (e.g., expanded transit) that would meet the project objectives.
- **Funding for the Proposed Bridge:** It remains unclear how the proposed 10-lane bridge will be funded and what portion of its preliminary estimated cost of $3.5B, if any, will be contributed by major beneficiaries such as the Port of Vancouver. The $3.5B cost could be better utilized with an alternate and less costly crossing with the balance of funding directed to benefit sustainable transportation modes.
- **Bridge Toll versus Mobility Pricing:** No information is available on the previously proposed toll or how it would be equitably applied given that the region's existing and planned tolled facilities will be located solely on bridge crossings linking the region south of the Fraser River. A tolling policy that focuses only on river crossings penalizes an island city like Richmond and will shift traffic towards free (untolled) alternatives such as the Alex Fraser Bridge.
- **Potential Congestion at Oak Street Bridge:** Although 40% of the traffic through the tunnel is to/from Vancouver as determined by the Project team, the Project scope does not include any improvements to the Oak Street-70th Avenue intersection in Vancouver, which is the primary source of traffic queuing at the Oak Street Bridge, nor at the Knight Street Bridge to where the Oak Street Bridge traffic may eventually divert.
- **Impacts on & Required Improvements to Local Road Network:** The Project scope may have potentially significant impacts on the local road network but the Project team has provided traffic analysis for only one local intersection (Steveston Highway-No. 5 Road). The impacts to this intersection will not be mitigated as the location is beyond the scope of the Project, which is limited to the footprint of the Highway 99 corridor. As the Project team has declined to do any further analysis of other local intersections, there are no details as to the scale and cost of needed improvements to local roads.

Summary of Council Concerns with Current Proposed Project

- **Sustainable Transportation Options:** The integrated transit stops should be operational on opening day. As the location of the transit exchange at Steveston Highway is in the middle of the proposed 3-level interchange, the design should incorporate measures to ensure accessibility and security, and address the noise, visual and air quality impacts to transit passengers. Pedestrian and cycling facilities should be incorporated in all new structures, including a pathway on both sides of the bridge, with safe, grade-separated and convenient connections to local networks. Consistent with the Province's cycling policy for provincial highways, a regional cycling facility within the Highway 99 corridor or on parallel local roads should be part of the project.
- **Relocation of BC Hydro Transmission Line:** BC Hydro must relocate its existing transmission line that runs underground through the tunnel and has selected an overhead crossing as their option for implementation contrary to the City's expressed preferred options of either an underground crossing of the Fraser River or attached to the new bridge. The relocated transmission line will introduce new lattice towers (122 m high and equivalent to a 35-storey building) and poles (75 m high) in the area between Steveston Highway and the new bridge, and have visual and property impacts. The cost of BC Hydro transmission line relocation is not included in the project costs and will be borne by BC Hydro rate payers.
- **Salt Wedge:** The removal of the tunnel will significantly impact the bottom of the Fraser River, which could promote mixing of saline water in the salt wedge with the fresh water above it. Increased mixing could reduce the availability of fresh water in the Fraser River for agricultural purposes. Additional modeling of river flow and the salt wedge are required to determine the impact of removing the tunnel.
- **Scale of Infrastructure:** The bridge will be three kilometres long and the deck suspended from two towers that will each be about 210 m high, which is equivalent to a 60-storey building. The proposed three-level configuration of the Steveston Highway Interchange is likely to have noise, lighting and visual impacts on adjacent residential, park and businesses uses. The width of the widened Highway 99 and the adjacent on-/off-ramps immediately north of the Steveston Highway Interchange are estimated at over 100 m and thus equivalent to approximately 25 traffic lanes.
- **Air Quality Impacts:** An air quality study conducted for the environmental assessment process only addresses emissions from traffic within the Highway 99 corridor but the project could cause significant traffic changes away from the study corridor (e.g., other bridge crossings and gateway intersections in Richmond). Overall emissions may not be reduced but only displaced or even increased.
- **Soil Improvements:** The soil in the project area is generally underlain by loosely consolidated sands and silts. Geotechnical engineering reports developed for the project (obtained through an FOI request from the City) estimate that bedrock is over 300 m below the ground surface throughout the project area. Significant soil improvements and piling will be required throughout the project area to support bridge piers, overpasses, on-ramps, and berms included in the project. Soil improvements and piling required to address seismic issues (liquefaction) and short- and long-term settlement will be a considerable component of the cost of the project.
- **Decision to Replace Tunnel with Bridge & Preference for New/Improved Tunnel:** Until announcing the bridge project in 2012, the publicized intention of the Province was to improve and/or expand the tunnel. Should a project to improve the existing crossing at the Fraser River proceed, Council's preference is for an upgraded and/or expanded tunnel instead of a new bridge.

Media Release from Port of Vancouver regarding Dredging of Fraser River

PORT of vancouver | Media Release

Vancouver Fraser Port Authority confirms there are no plans to deepen the Fraser River

May 25, 2017 | FOR IMMEDIATE RELEASE

Vancouver, B.C.: The Vancouver Fraser Port Authority announced today that it has no plans to further deepen the Fraser River to accommodate larger vessels as it, together with existing marine terminal properties and port industrial lands, can sufficiently handle Canada's trade for the foreseeable future.

The port authority maintains, on behalf of the federal government, a 36-kilometre-long, deep-sea navigation channel in the south arm of the Fraser River, which is designed to accommodate two-way traffic of vessels that fit within the size restrictions of the channel.

The port authority continuously monitors trends in global ship sizes relative to the size of vessel that can be accommodated. Commercial ships are increasing in size because it is more economical and environmentally responsible to run larger vessels. However, there are limitations to the Fraser River that restrict its ability to accommodate larger ships including height, depth and width restrictions.

Recently, the Vancouver Fraser Port Authority completed an analysis of the Fraser River and its potential to accommodate increasing trade. The analysis considered a variety of possible uses of existing port lands and assessed dredging the river at different depths, and it was determined that deepening the Fraser River would be extremely costly, requiring extensive environmental study and consultation over many years.

"We have determined that with more intensive use of the port's existing terminals and further development of the port authority's existing industrial lands along the water, the Fraser River will be well positioned to accommodate Canada's growing trade without deepening the channel, said Peter Xotta, vice president, planning and operations at the Vancouver Fraser Port Authority."

The Vancouver Fraser Port Authority owns about 200 acres of undeveloped industrial land on the river, which is expected to be used in future by commercial operators for major terminals, warehousing and distribution. The port authority intends to use its current land holdings as efficiently as possible through proper planning and collaboration with others in the supply chain, such as railroad companies and terminal operators.

Shippers will continue to use vessels of various sizes to ensure the safe navigation of commercial traffic along the river and the environmental protection of the river's ecosystem. The port authority will continue its program of dredging to maintain current channel depths.

Excerpt from *George Massey Tunnel Replacement: Review of Replacement Options*
Evaluation of Scenario 4(b) – Maintain Tunnel and Add New 6-Lane Tunnel

About the Vancouver Fraser Port Authority

The Vancouver Fraser Port Authority is responsible for the stewardship of the federal port lands in and around Vancouver, British Columbia. It is accountable to the federal minister of transport and operates pursuant to the *Canada Marine Act*. The Port of Vancouver is Canada's largest, and the third largest in North America by tonnes of cargo, facilitating trade between Canada and more than 170 world economies. Located in a naturally beautiful setting on Canada's west coast, the port authority and port terminals and tenants are responsible for the efficient and reliable movement of goods and passengers, integrating environmental, social and economic sustainability initiatives into all areas of port operations. Enabling the trade of approximately $200 billion in goods, port activities sustain an estimated 100,000 supply-chain jobs, $6.1 billion in wages, and $9.7 billion in GDP across Canada.

-30-

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Media Relations Advisor
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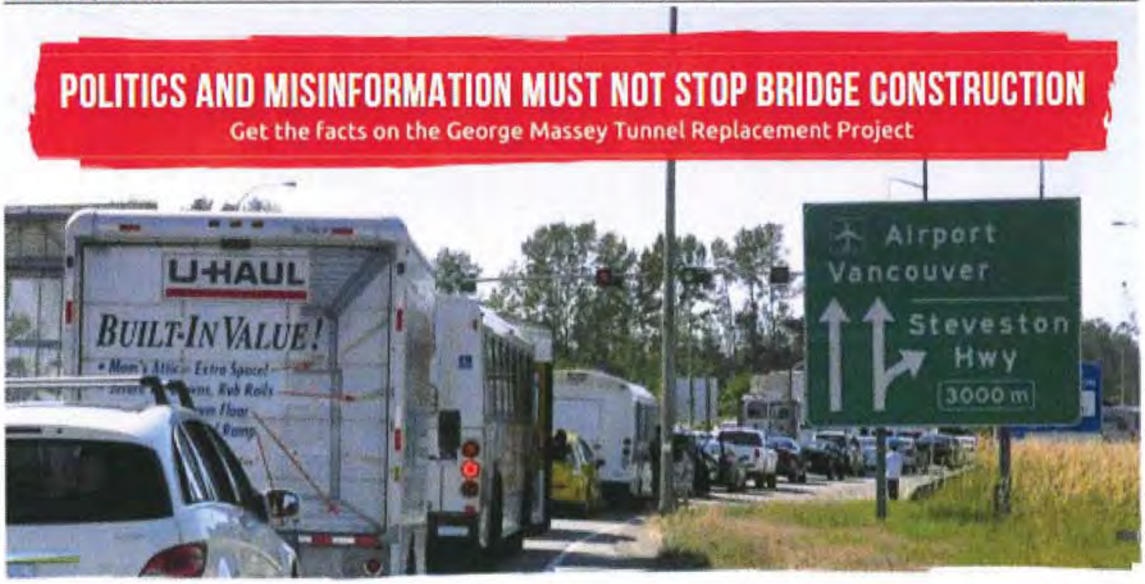
Attachment 10

Newspaper Notice placed in Richmond News by Municipality of Delta

A12 FRIDAY, JULY 14, 2017 RICHMOND-NEWS.COM

POLITICS AND MISINFORMATION MUST NOT STOP BRIDGE CONSTRUCTION

Get the facts on the George Massey Tunnel Replacement Project



"There is a possibility of loss of life if the tunnel experiences catastrophic displacements in a seismic event."

Ker, Priestman & Associates Ltd. *"George Massey Tunnel No. 1509 Response to Earthquakes"*, 1989

Engineering reports + environmental and financial impacts show that **TWINNING THE TUNNEL IS NOT AN OPTION**

THE EXISTING TUNNEL CANNOT BE SUFFICIENTLY SEISMICALLY UPGRADED

Studies confirm that the tunnel is not physically capable of withstanding **A MODERATE TO SEVERE EARTHQUAKE, OVER 6.5**

The risk of a major quake is 30% in the next 50 years

In 2001, nearby Nisqually, WA experienced a 6.8 earthquake

A replacement tunnel is more expensive

$4.3 billion vs. $3.5 billion

WITH MORE ASSOCIATED RISK

In 2016, there was an avg of **24.8 AMBULANCE TRIPS** through the tunnel each day and

37 EVENTS in the tunnel for Delta Fire and Emergency Services

On avg **300+ COLLISIONS ANNUALLY** at tunnel & adjacent interchange

40% (injury or death) OF THESE RESULTED IN CASUALTIES

The tunnel has approximately **10 YEARS LEFT** **BEFORE MAJOR COMPONENTS NEED TO BE REPLACED**

A replacement tunnel has more negative implications for **air quality, agriculture, marine traffic during construction, wildlife and terrestrial habitat, and marine life and habitat**

A bridge would reduce collision rates **BY MORE THAN 35%** based on data from the Port Mann Bridge

A REPLACEMENT TUNNEL PROVIDES LESS TRANSPORTATION EFFICIENCY AND LOWER INCIDENT RESPONSE CAPABILITY

During peak hour traffic, commercial trucks make up **12%** of the traffic moving through the tunnel

MORE THAN 3X HIGHER THAN OTHER BRIDGES IN THE REGION

The Massey Tunnel carries **MORE TRANSIT PASSENGERS** than any other major non-rapid transit crossing of the Fraser River

Delta

Public safety is at risk and the solution is known – the new bridge is necessary, supported by facts and vital for the economy of the region & province.

Get all the facts at: www.WeNeedaBridge.ca

#WeNeedaBridge

Lois E. Jackson, Mayor

George V. Harvie, CAO

"Close up: Vancouver's disaster preparedness – Earthquake strategy is B.C.'s infrastructure priority," *Vancouver Sun,* December 16, 2008

canada.com

Closeup: Vancouver's disaster preparedness

Earthquake strategy is B.C.'s infrastructure priority

BY LARRY PYNN , VANCOUVER SUN DECEMBER 16, 2008

Steel jackets were placed around the columns on Vancouver's Oak Street Bridge to to allow them to better resist earthquake motions.

Photograph by: Ministry of Transportation and Infrastructure, Ministry of Transportation and Infrastructure

VANCOUVER — When you think of earthquakes in North America, some of the first images that come to mind are collapsed freeway overpasses and buckled bridges resulting not just in human death and injury, but massive repair costs and traffic congestion extending for months or even years.

The San Francisco area earthquake of 1989 shut down the San Francisco-Oakland Bay Bridge and destroyed the Cypress Street Viaduct. The Golden Gate Bridge, which had undergone more than $4 million in seismic improvements, remained undamaged by the tremor measuring 7.1 on the Richter scale.

That sort of cost-benefit comparison is why the British Columbia government has spent about $80 million on seismic upgrades to key bridges and highways, projects just now nearing conclusion in the province's earthquake-active south coast region, which includes the Lower Mainland and Vancouver Island.

Kevin Baskin, chief bridge engineer for the Ministry of Transportation and Infrastructure, said the upgrades are designed to "minimize the risk of collapse" of key transportation infrastructures in an earthquake. The upgrades are designed for an earthquake measuring to 6.5 to 7.0 on the Richter scale, once every 475 years.

"There will still be damage," Baskin cautioned in an interview. "There is no such thing as earthquake-proof."

"Close up: Vancouver's disaster preparedness – Earthquake strategy is B.C.'s infrastructure priority," *Vancouver Sun,* December 16, 2008

Older so-called "lifeline" bridges have taken first priority in the seismic upgrades, including Lions Gate, Ironworkers Memorial Bridge, Port Mann, Oak Street, Queensborough, and George Massey tunnel.

Newer structures such as the Alex Fraser Bridge and the forthcoming Golden Ears Bridge already meet modern seismic standards. The Pitt River Bridge is being rebuilt from scratch, and retrofitting is in the planning stage for the Mission Bridge and Agassiz-Rosedale Bridge. The province is responsible for 2,600 bridges.

Next in priority for seismic upgrades are the "disaster response routes" critical to emergency vehicles after an earthquake, including highway underpasses and overpasses, and overhead crossings of railways. All 22 such routes have been seismically upgraded in the region.

The annual budget for seismic upgrades has varied widely over the years depending on the specific projects: $1.7 million in 2008, $4.2 million in 2007, $6.8 million in 2006, $12.2 million in 2005, $1.6 million in 2004, $3.4 million in 2003, $3.4 million in 2002, $6.6 million in 2001.

Construction on the Massey tunnel seismic retrofit started in 2005 with $10 million; the 2008 budget covers completion of the tunnel project. A third category — "other structures" — has involved 32 seismic upgrades at locations considered of less critical importance; such upgrades continue as budgets allow.

Baskin said the B.C. standards are consistent with other jurisdictions and are rooted in the 1983 publication of seismic design guidelines by the American Association of State Highway and Transportation Officials. He said every new earthquake provides engineers with improved information on how transportation structures perform.

"There are constant changes and improvements to design criteria," he said. The collapse of freeway spans in California has emphasized the need in the Lower Mainland for seismic upgrades that better tie spans together and to the bridge structure's pier and abutments, including increasing the 'seat width' so there is less chance of the spans falling down during movement.

"It's a first step," Baskin explained. "You don't want the spans to fall off their supports." Other types of seismic upgrades include the installation of steel jackets around bridge columns, which are typically made of concrete, to better absorb the energy from an earthquake and prevent buckling.

At the soil level, engineers can reduce the chance of liquefaction through installation of porous columns filled with rock and stone next to columns to relieve pressure. John Cassidy, a research scientist at the Pacific Geoscience Centre in Sydney on Vancouver Island, said seismic hazard information has been incorporated into the national building code since 1953, and is updated every 10 to 20 years based on increased knowledge of earthquakes and their impact on structures.

The latest update occurred in 2005. Distance from seismic activity and soil types figure into the hazard rating.

Western Canada is the country's most active earthquake zone. More than 100 earthquakes with a magnitude of 5.0 or greater have occurred over the past 70 years off the west coast of Vancouver Island, most of them in areas of fractured oceanic crust that mark the boundaries of small plates known as the Explorer and Juan de Fuca plates.

"Close up: Vancouver's disaster preparedness – Earthquake strategy is B.C.'s infrastructure priority," *Vancouver Sun,* December 16, 2008

Earthquake activity is also high in the Cascadia Subduction Zone, where the Juan de Fuca Plate dips below the easterly neighbouring North American plate (about 45 kilometres beneath Victoria, 70 km beneath Vancouver). The Juan de Fuca plate extends from the northern tip of Vancouver Island to Northern California.

Megathrust earthquakes are the largest on earth, and have occurred at least 13 times in the last 6,000 years in the Cascadia subduction zone. The last one, estimated at magnitude 9.0, occurred about 300 years ago.

Previous Next

Steel jackets were placed around the columns on Vancouver's Oak Street Bridge to to allow them to better resist earthquake motions.

Photograph by: Ministry of Transportation and Infrastructure, Ministry of Transportation and Infrastructure


Attachment 12

PREPARED FOR: MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

REVIEW OF REPLACEMENT OPTIONS

JULY 2016

GP - 409
(Special)

PURPOSE OF THIS REPORT

As part of WSP|MMM Group's role as Owner's Engineer for the replacement of the George Massey Tunnel (the Tunnel), independent technical and engineering analyses were carried out to determine if a bridge is indeed the preferred replacement option. The results of this independent analysis are provided in this report.

J. Meyboom

Joost Meyboom, Dr.sc.tech., P.Eng.

EXECUTIVE SUMMARY

Congestion at the George Massey Tunnel (the Tunnel) has been of concern for decades and causes significant delays to the public and the movement of goods and services on a daily basis. In addition, there are a number of safety issues associated with the Tunnel including substandard geometry, poor access for first responders and vulnerability to earthquakes. In 2007 it was recognized that the Tunnel's seismic vulnerability could not be fully addressed with a retrofit. As such the Ministry completed sufficient structural upgrades to the Tunnel to protect public safety and installed an early warning system to prevent access to the Tunnel during seismic events greater than the 1-in-275 year event.

Planning for the replacement of the Tunnel commenced in 2012 and, based on the analysis of five replacement options, a public consultation process was completed which identified a new bridge on the same alignment as the Tunnel as the preferred replacement option. As part of WSP|MMM Group's role as Owner's Engineer for the replacement of the Tunnel (the Project), independent analyses were carried out to determine if a bridge is indeed the best replacement option. The results of this independent analysis are provided in this report.

Five replacement scenarios were evaluated:

Scenario 1 – Retrofit Tunnel

Scenario 2 – Replace Tunnel with a bridge

Scenario 3 – Replace the existing Tunnel with a new tunnel

Scenario 4 – **(a)** Retrofit Tunnel and build new adjacent six-lane bridge

(b) Retrofit Tunnel and build new adjacent six-lane tunnel

Scenario 5 – Maintain Tunnel and build a new six-lane crossing in a new corridor

Each Scenario was analyzed from a technical perspective to establish feasibility, scope and an all-inclusive cost. Costs include construction, engineering, project management, property, escalation, risks, contingencies and financing. In addition, each scenario was evaluated by comparing it with the project goals as established during public consultation. These goals were:

1. Reduce congestion
2. Improve safety
3. Support trade and commerce including protection of the Lower Mainland's agricultural land base
4. Support increased transit on the Highway 99 corridor
5. Support options for pedestrians and cyclists
6. Enhance the environment

The results of this evaluation are summarized as follows:

	SCENARIO				
	1 Existing Tunnel	2 New Bridge	3 New Tunnel	4[2] (a) New Bridge +Existing Tunnel (b) New Tunnel + Existing Tunnel	5
Achievement of Project Goals	20%	90%	80%	60%	40%
Risk Profile	High	Medium	High	Medium - High	Medium-High
Cost in $ millions[1]	590	3,500	4,300	3,550 (a) 4,050 (b)	5,800
Assessment	Least cost; high risk associated with geotechnical works adjacent to the Tunnel; very poor achievement of project goals including poor seismic performance.	Second lowest cost; risks associated with bridge construction and traffic management; high achievement of project goals; Minimal property impacts; minimal environmental impacts.	Second highest cost; high risks associated with tunnel construction adjacent to the existing Tunnel; reasonable achievement of project goals; significant property impacts; significant environmental impacts.	Medium to high cost and risk; marginal achievement of project goals; significant property impacts; significant environmental impact (for tunnel option); poor seismic performance of existing Tunnel.	Highest cost; high risks associated with tunnel construction and retrofit of existing Tunnel; poor achievement of project goals; Significant property impacts including ALR; significant environmental impacts from tunnel construction; poor seismic performance of existing Tunnel.

Notes:

[1] Costs include construction, engineering, project management, property, utilities, environmental, escalation, risks, contingencies and financing

[2] Scenario 4(a) is a new six lane bridge adjacent to the Tunnel and Scenario 4(b) is a new six lane immersed tube tunnel adjacent to the Tunnel.

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1. DEVELOPMENT OF TUNNEL REPLACEMENT OPTIONS

As part of WSP|MMM Group's role as Owner's Engineer for the replacement of the George Massey Tunnel (the Tunnel), independent analyses were carried out to determine if a bridge is indeed the preferred replacement option. The results of this independent analysis are provided in this report. In this regard WSP | MMM Group undertook independent evaluation and a review of the documents and reports listed in the reference section of this report and which include:

- Transportation planning studies from the 1990s
- Traffic data collected between 2013 and 2015
- Traffic forecasts to 2045
- Structural and geotechnical engineering reports, studies and designs produced between 1989 and 2009 addressing the seismic vulnerability of the Tunnel
- Extensive geotechnical data collected at the Tunnel site since the 1950s and including seismic cone penetration testing and boreholes taken since 2013 to establish foundation conditions for the Project
- Documents produced by the Ministry for Phase 1 and 2 Project consultation and for the Project Definition Report
- Opinions, presentations and recommendations from international Tunnel and bridge engineering experts (Buckland &Taylor, COWI, TEC) that have been presented at workshops between 2012 and 2014
- Conceptual highway and interchange designs for alternative solutions presented in the March 2014 report by CH2M
- An evaluation of crossing scenarios presented in the March 2014 report by MMK Consulting Inc.

1.1 BACKGROUND

Congestion at the Tunnel has been of concern for decades. Studies of options to address the problem date back to the "Freedom to Move" initiative in 1989. The first comprehensive planning study, by Ward Consulting on behalf of the Ministry of Transportation and Infrastructure (the Ministry), was completed in 1991. [1]

In parallel with these planning studies the Tunnel's seismic vulnerability was the focus of intensive engineering investigations starting in the late 1980's. [2, 3, 4, 5, 6] In 2007 it was recognized that the Tunnel's seismic vulnerability cannot be fully addressed with a retrofit. [7, 8] As such the Ministry completed sufficient structural upgrades to the Tunnel to increase public safety, installed an early warning system to prevent access to the Tunnel for seismic events greater than the 1-in-275 year event [9] and commenced planning for a long-term solution.

In 2012 the Ministry launched a three-phase technical analysis and consultation program to establish a long-term solution for the Tunnel (the Project). This included:

Phase 1: Understanding the Need – Problem identification and understanding of public and stakeholder interests and concerns with respect to the Tunnel. [13]

Phase 2: Exploring the Options – Current analysis of potential options for solving the problem, the criteria to evaluate the options, technical feasibility review, and identification of a preferred solution. [14]

Phase 3: Project Definition – Refinement of the preferred solution including a reference concept and business case, and due diligence review of the preferred solution as compared with the other Phase 2 alternatives. [15, 16]

1.2 PHASE 1 – UNDERSTANDING THE NEED

Phase 1 confirmed that safety and congestion are significant concerns at the Tunnel and that congestion continues to worsen. Key concerns identified during the Phase 1 consultation include: [13]

- An average of 80,000 vehicles use the Tunnel every day. This is more than the capacity of the Tunnel and a counterflow system is used to manage the resultant congestion in the peak direction. Even with a counterflow, the congestion at the Tunnel results in significant delays that can range up to 30 minutes on a typical weekday, and can be several hours if there is an incident at the Tunnel or adjoining Highway 99 corridor.
- The Tunnel is at its capacity and as such significant traffic is diverted to the Alex Fraser Bridge. This additional traffic pressure on the Alex Fraser Bridge results in its capacity being “used up” faster.
- The Tunnel was designed to the very limited seismic design considerations of the 1950s. Even with extensive seismic retrofit work, it is not practical to bring the Tunnel to current seismic standards.
- The Tunnel has substandard highway geometrics including narrow lanes, virtually no shoulders and a substandard vertical clearance. These deficiencies contribute to the Tunnel having a high accident rate and also restricts the movement of goods through the Tunnel.
- Cyclists and pedestrians must take a shuttle through the Tunnel. Walking or cycling through the Tunnel would be very dangerous and is not permitted.
- Although the Tunnel has some of the highest transit usage in the Province and significant efforts have been made to increase transit reliability and use along Highway 99 over the past 15 years, remaining opportunities to improve transit on Highway 99 are limited without providing additional traffic capacity at the Tunnel.
- If there is an incident in the Tunnel, traffic congestion often makes access for first responders slow and difficult, causing unnecessary additional risk to the lives of injured people.

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- The Tunnel's electrical and mechanical systems are at the end of their useful life and complete replacement is required in the next few years.

The following project goals were established using the results of the Phase 1 public consultation [13]:

1. Reduce congestion
2. Improve safety
3. Support trade and commerce including protection of the Lower Mainland's agricultural land base
4. Support increased transit on the Highway 99 corridor
5. Support options for pedestrians and cyclists
6. Enhance the environment

1.3 PHASE 2 – EXPLORING THE OPTIONS

Drawing on work referenced at the end of this report, as well as technical workshops and meetings held with international experts in tunnel and bridge engineering, [10, 11] the Ministry developed and evaluated five scenarios to address the issues identified in Phase 1. Experts consulted in this regard included Buckland &Taylor (Vancouver), COWI (USA) and TEC (Netherlands).

The five scenarios were:

Scenario 1 – Maintain Tunnel. The Tunnel's electrical and mechanical systems would be replaced and work would be undertaken to improve the Tunnel's ability to withstand earthquakes, but the Tunnel's traffic capacity would not be changed and modern seismic standards would not be met.

Scenario 2 – Replace Tunnel with new bridge: A new bridge would be constructed within the existing right-of-way, after which the Tunnel would be decommissioned.

Scenario 3 – Replace the existing Tunnel with a new tunnel. A new tunnel would be constructed alongside the Tunnel, after which the Tunnel would be decommissioned.

Scenario 4 – Maintain Tunnel and build new six-lane crossing along Highway 99 Corridor. The new crossing could be either (a) a bridge or (b) a tunnel to provide a similar traffic capacity as Scenarios 2 and 3.

Scenario 5 – Maintain Tunnel and build a new six-lane crossing in a new corridor. The new crossing could be a bridge or tunnel located in the Tilbury area of Delta between the Tunnel and the Alex Fraser Bridge. The crossing would be accessed via the new Highway 17 on the south side and via a newly constructed connection to the Highway 91 East-West Connector on the north side.

Based on the results of the Phase 2 consultation and concurrent technical analyses, a new bridge on the same alignment as the Tunnel was identified as the most suitable solution. The evaluation of the five solution scenarios was developed and summarized by MMK (2014)[12] and CH2MHill (2013)[11] . The results of this evaluation are summarized in the following table.[12]

Evaluation Area	Specific Criterion	Scenarios 1	2	3	4	5
Transportation efficiency	− Traffic congestion	¤¤	✓✓	✓✓	✓✓	✓
	− Transit capability	¤	✓✓	✓✓	✓✓	✓
	− Travel time reliability	¤¤	✓✓	✓✓	✓✓	✓✓
	− Pedestrian and cyclist accessibility	¤¤	✓✓	✓	✓✓	¤
	Overall assessment	¤¤	✓✓	✓✓	✓✓	✓
Safety	− Incident response capability	¤¤	✓✓	✓	✓	✓
	− Earthquake protection	¤¤	✓✓	✓✓	¤	¤
	− Traffic safety	¤¤	✓✓	✓✓	✓	✓
	Overall assessment	¤¤	✓✓	✓✓	✓	✓
Agriculture	− Agricultural land effects	✓✓	✓	¤	¤	¤¤
	− Access to and from agricultural areas	¤	✓	¤	¤	¤¤
	Overall assessment	✓	✓	¤	¤	¤¤
Environment	− Local air quality	¤	✓	¤	¤	¤
	− Regional air quality	¤	¤	¤	¤	¤¤
	− Wildlife and terrestrial habitat	✓	✓	¤	¤	¤¤
	− Marine life and habitat	¤	✓	¤¤	¤¤	¤¤
	− Contaminated sites	✓	¤	¤¤	¤¤	¤¤
	Overall assessment	¤	✓	¤¤	¤¤	¤¤
Jobs and the economy	− Economic and employment impacts	¤¤	✓✓	✓✓	✓✓	✓✓
	− Marine traffic effects during construction	¤	✓	¤¤	¤	¤
	− Road access to gateways and trade corridors	¤¤	✓✓	✓✓	✓✓	✓
	− Marine access to gateways and trade corridors	¤	✓	✓	¤	¤
	− Access to business and industrial land	¤	✓✓	✓✓	✓✓	✓
	Overall assessment	¤¤	✓✓	✓	✓	✓
Social and community considerations	− Access across the highway within communities	¤¤	✓✓	✓	✓	¤
	− Private-property effects	✓✓	✓	¤	✓	¤¤
	− Compatibility with community/regional	¤	✓	✓	✓	¤
	planning	✓✓	¤	¤	¤	¤¤
	− Noise effects	✓✓	¤	✓	¤	¤
	− Visual effects	✓	✓	¤	¤	¤¤
Financial costs and risks	− Capital construction costs	$	$$	$$	$$	$$$
	− Capital cost risks (construction)	¤¤	✓	¤	¤¤	¤¤
	− Capital cost risks (operations)	¤	✓	✓	¤	¤
	− Operating and maintenance costs	$	$	$$	$$$	$$$
	Overall assessment	¤	✓	¤	¤¤	¤¤

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.

2. REVIEW OF TUNNEL REPLACEMENT OPTIONS

2.1 SCENARIO 1 – MAINTAIN THE TUNNEL

In 1989 the Ministry undertook a study to investigate the Tunnel's seismic vulnerability. [2] The study concluded that unacceptable elastic stresses would develop in the Tunnel cross section with a 1-in-100-year earthquake. It was also noted that there would be a high probability of major movements and buoyancy of the Tunnel caused by liquefaction of the surrounding and founding sands. These results were confirmed in a subsequent investigation carried out in 1991. [3]

In 1996 the Ministry commissioned a study to further understand the effects of liquefaction-induced deformations on the Tunnel. [3] Retrofit concepts were presented in this report including structural modifications to increase the Tunnel's ductility and geotechnical interventions to control liquefaction induced ground movements.

Detailed design for the seismic upgrade started in 2000 [5, 6, 9] as documented in a number of reports, drawings and presentations produced between 2000 and 2007. The scope of the seismic retrofit works included the following:

Stage 1 (Completed in 2006)

- Structural modifications to allow the instream elements of the Tunnel to hold together during a 1-in-475-year seismic event and provide for a ductile structure with crack widths that minimize the rate of water ingress after an earthquake.
- Installation of emergency pumps to manage the water that would flow into the Tunnel as a result of damage caused by an earthquake.

Stage 2 (Not Implemented)

- Installation of stone columns and seismic drains along the side of the Tunnel to control liquefaction-induced deformations (see **Figure 1**). This would require removing the existing riprap, concrete mattress and fill on and beside the Tunnel. Upon completion of stone column work, locking fill and riprap would be re-installed.

In 2003 the Ministry undertook a value engineering review of the proposed Stage 1 and Stage 2 works [7] and, based on the level of uncertainty and risk around the proposed Stage 2 works, it was decided to proceed with only the Stage 1 works and that more geotechnical data and engineering work should be carried out before proceeding with the Stage 2 work.

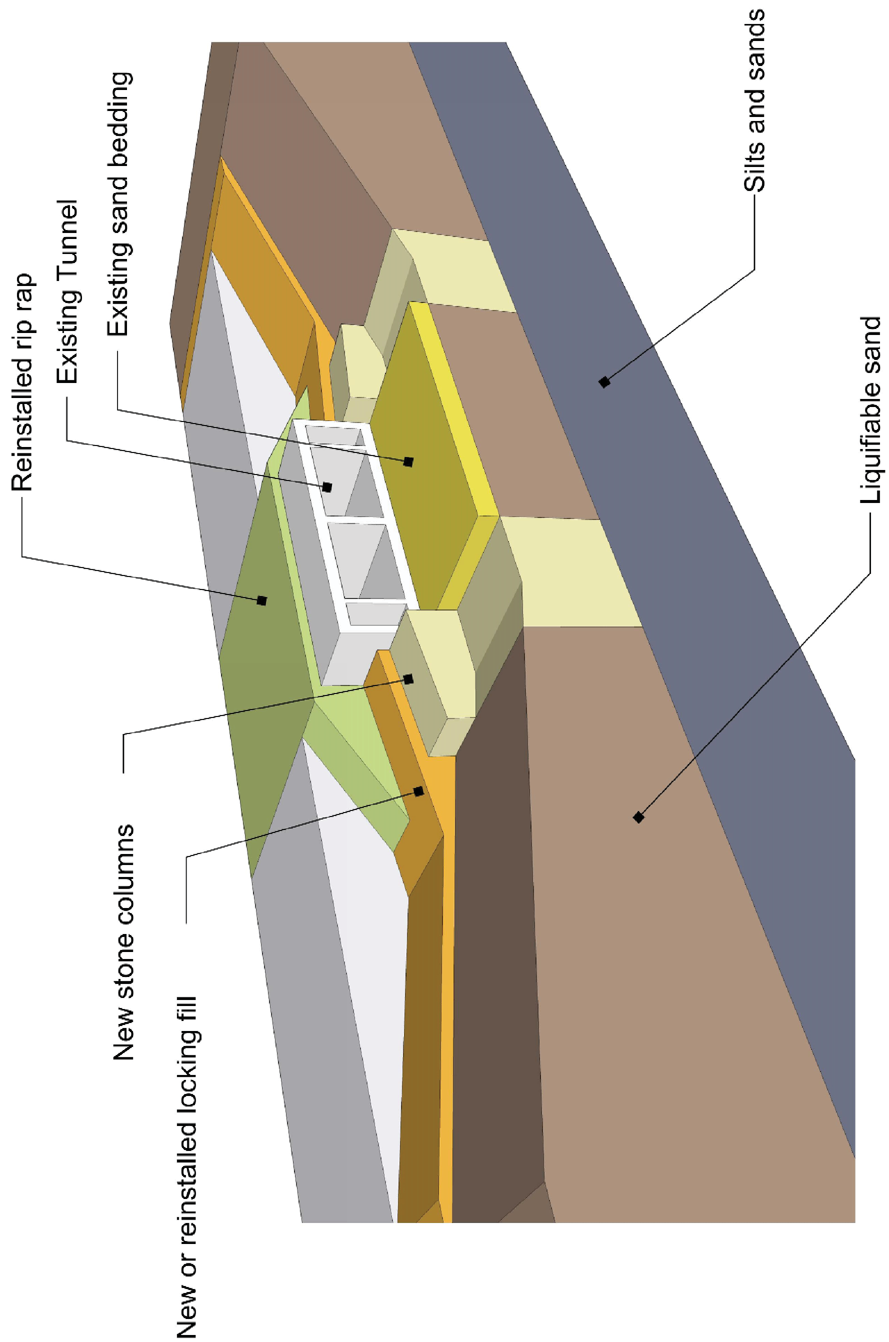

Figure 1 – Schematic showing Stage 2 Seismic Retrofit of existing Tunnel

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Based on additional site investigations carried out in 2006, the design for the Stage 2 works was revisited in a second value engineering review in 2007. [8] This review highlighted the following:

- An earthquake greater than a 1-in-475-year event could result in "fatalities due to drowning" if the "public is unable to exit the Tunnel in a timely manner due to reasons such as vehicle blockage, minor injury, darkness, confusion or panic". [8]
- There is a high risk that the specified ground improvements may not be achievable because of probe refusal or damage if coarse gravel, cobbles and boulders are encountered.
- To protect the integrity of the Tunnel during construction, ground densification directly beside the Tunnel may not be achievable and as such there is a risk that the Stage 2 works would be less effective than intended.

Even if Stage 2 works were completed, there would be permanent damage to the Tunnel after the 1-in-475-year earthquake, which would make it unavailable for immediate use. In this event, repairs, if even practical, or replacement would need to be carried out on an emergency basis at a premium cost and likely over a period of several months.

The extensive ground improvements required for the Stage 2 works could affect the integrity of the Tunnel. Similar retrofit work carried out in San Francisco resulted in the tunnel moving laterally. At the Massey tunnel, movement could result in leakage and it may be necessary to close the Tunnel during the retrofit works.

Given the uncertainty of the effectiveness of the Stage 2 retrofit works, they were abandoned, and an Emergency Road Closure System (ERCS) was installed. The ERCS prevents access to the Tunnel in seismic events greater than 1-in-275-year. Today the Tunnel remains estimated as being able to withstand a 1-in-275-year earthquake [9] – far below today's 1-in-2475-year standard.

In addition to its seismic vulnerability, the Tunnel is now almost 60 years old and in need of a major refit. Such a refit would require significant investment to manage water ingress, upgrade electrical and ventilation systems, repair spalling concrete, replace lighting and surfaces showing significant wear, and to undertake other less significant upgrades. This retrofit work would not address the safety challenges associated with the Tunnel's narrow lanes and substandard vertical clearances, achieve modern seismic standards for a life line crossing or address current congestion challenges.

The following provides a summary of Scenario 1 including its cost and risk profile. Scoring is based on the assumption that the Stage 2 retrofit works are completed.

TABLE 1 - EVALUATION OF SCENARIO 1

PROJECT GOAL	PERFORMANCE	**SCORE** (5 = EXCELLENT) (0 = UNACCEPTABLE
Reduce Congestion	Does not change the level of service provided on Highway 99 at the Tunnel. Congestion will become worse over time. During seismic retrofit works it is likely that the Tunnel wil need to be closed to traffic. This will result in an extended period of time with very significant congestion.	0
Improve Safety	The Tunnel cannot be brought up to modern seismic standards and safety issues associated with its outdated highway geometrics cannot be addressed. Without completion of the Stage 2 retrofit scope, this score would be 0. First responders will continue to have problems accessing the Tunnel.	0 to 2
Support Trade and Commerce	No congestion relief is anticipated resulting in continued impacts to existing trade and severely limiting economic growth.	0
Support Increased Transit on Hwy 99	The effectiveness of the existing queue jumper lanes will continue to diminish over time as congestion on Highway 99 continues to grow. This does not support increased transit.	0
Support Options for Cyclists/Pedestrians	Cyclists and pedestrians will continue to use a shuttle service and there will be no improvements in this regard.	0
Enhance the Environment	Completion of the Stage 2 seismic retrofit program would require considerable excavation and construction in the Fraser River. There are limited opportunities for environmental enhancements if Highway 99 is kept in its current configuration.	2
	TOTAL SCORE (out of 30)	2 to 4
Risk Profile	Excavation and stone column installation adjacent to the Tunnel is a risk to the integrity of the Tunnel and the Tunnel may need to be closed during the retrofit work. Detours and substantial travel time delays are expected during construction. There is a risk that the densification required directly adjacent to the Tunnel may not be achievable and as such, the benefits of the Stage 2 works is questionable.	HIGH
Cost	Costs include some upgrades to the Highway 99 corridor between Bridgeport and Highway 91 in Surrey to replace aging infrastructure. Costs include construction, engineering, project management, property, utilities, environmental, escalation, risks, contingencies and financing.	**$590 million**

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2.2 SCENARIO 2 – NEW BRIDGE ON EXISTING TUNNEL ALIGNMENT

This option has been developed over the past two years [15, 16] and is characterized by the following (see **Figures 2 and 3**):

- A 658 metre clear span would be provided over the Fraser River and an overall length of 3.3 kilometers. This is a significant span but shorter than the world's longest cable stayed spans, some of which are longer than 1,000 metres.
- No permanent works would berequired in the Fraser River.
- The bridge would have a total of 10 lanes – six lanes of general purpose traffic, two dedicated transit/HOV lanes and two lanes to more safely and effectively manage slow moving and merging traffic.
- Multi-use pathways for cyclists and pedestrians would be provided on either side of the bridge.
- The new crossing would be constructed on the existing Ministry right-of-way, with no net impact to agricultural land.
- The new bridge would remain centered over the current Highway 99 alignment but would provide sufficient space to maintain traffic on Highway 99 during construction.
- The new bridge would meet modern seismic requirements for lifeline structures.
- The new bridge would have deep foundations similar to those used for the Alex Fraser, Pitt River, Golden Ears Bridge and Port Mann bridges. These types of foundations are cost effective and constructible using local resources. Installing stone columns in advance of foundation construction will control soil liquefaction effects. This foundation concept has been confirmed with the results of the extensive geotechnical investigations carried out between 2013 and 2016. [15]
- A dedicated southbound off ramp from the new bridge would provide direct access to Ladner along River Road South.
- The new bridge would provide the same navigation clearance as the Alex Fraser Bridge and will improve navigability at Deas Slough.
- Connectivity across Highway 99 would be improved by eliminating the Tunnel approaches and the at-grade sections of Highway 99 between Steveston Highway and River Road South.

Figure 2 – Overview of Scenario 2 bridge

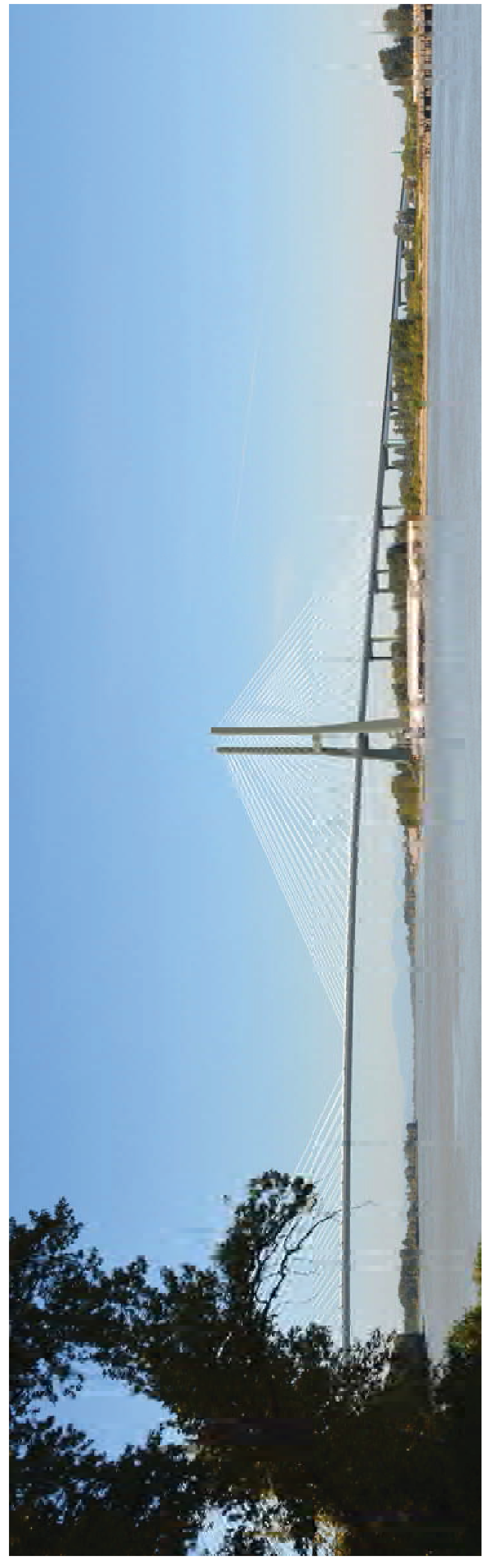

Figure 3 – Scenario 2 bridge seen from the Fraser River

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- Cables would be configured to be vertical and not be over the travelled road. In addition, snow and ice management methods such as used on the new Port Mann Bridge would be included to address ice build-up on cables.
- Environmental enhancement opportunities can be achieved in sensitive areas such as on Deas Island and at Green Slough.
- The Tunnel will be decommissioned at the completion of the bridge construction.
- Bridge construction is estimated to take four to five years; Tunnel decommissioning is estimated to take an additional one to two years, after the new bridge is open for use.

The following table provides a summary of this scenario as well as its cost and risk profile.

TABLE 2 - EVALUATION OF SCENARIO 2

PROJECT GOAL	PERFORMANCE	**SCORE** (5 = EXCELLENT) (0 = UNACCEPTABLE
Reduce congestion	This scenario provides significant enhancements for all modes of transportation including pedestrians, cyclists, transit, car pools and trucks. Free flow traffic is predicted beyond 2045.	5
Improve safety	A new bridge would be designed as a lifeline structure to provide the highest practical post-earthquake performance. Modern highway design standards will be used to improve clearances and geometrics leading to a safer facility. First responder access and incident management along the highway will be significantly improved making the facility safer than it is today. Snow and ice issues are a concern with a cable stayed bridge. This can be mitigated by avoiding cables over the road and by installing snow/ice removal devices as used on the new Port Mann Bridge.	5
Support trade and commerce	In addition to the benefits of congestion relief for access to key gateway facilities like YVR, Deltaport and terminal facilities along both sides of the Fraser River, there is opportunity to add land through a reduced footprint at interchanges to the agricultural land reserve, to support enhanced farm operations. Cross-highway access and accessibility including for local goods movement will be improved.	5
Support transit on Highway 99	Dedicated transit lanes will be provided across the bridge with integrated connections to transit stops at the Steveston and Highway 17A interchanges with potential future conversion to rail transit.	5
Support options for pedestrians and cyclists	Multi-use pathways on both sides of the new bridge will integrate with the municipal trail systems on either side of the Fraser River.	5

TABLE 2 - EVALUATION OF SCENARIO 2

PROJECT GOAL	PERFORMANCE	**SCORE** (5 = EXCELLENT) (0 = UNACCEPTABLE
Enhance the environment	There are no permanent works in the Fraser River and therefore only limited, temporary effects to the river. There are a number of environmental enhancement opportunities including restoring Green Slough to its historic alignment and reconnecting Deas Island Regional Park across Highway 99. Removing the Tunnel will require dredging and excavation in middle parts of the river to remove the four central segments (with temporary effects) Construction of a new bridge would restrict access across Deas Island Regional Park for four years during construction and would have in-river effects for one to two seasons.	3
	TOTAL SCORE (out of 30)	28
Risk Profile	Generally the Project is similar in scope to other recent major highway projects delivered in the Lower Mainland such as the Port Mann/Highway 1 Project, Golden Ears Bridge, Pitt River Bridge and the South Fraser Perimeter Road. As such it has a relatively well understood risk profile. Key technical risks include dealing with soft compressible soils where highway widening is required, risks associated with deep piled foundations and traffic management during construction. Risks associated with working in close proximity to the existing Tunnel are restricted to on shore construction.	MEDIUM
Cost	Costs include rebuilding interchanges and widening Highway 99 between Bridgeport and Highway 91 in Surrey. Costs include construction, engineering, project management, property, utilities, environmental, escalation, risks, contingencies and financing.	$3,500 million

2.3 SCENARIO 3 – NEW TUNNEL

An immersed tube tunnel is a reasonable solution for a replacement tunnel. A bored tunnel, on the other hand, would be very expensive and is not considered practical given the prevailing geotechnical and topographic conditions of the site.

Designing and building an immersed tube tunnel to meet today's seismic standards is feasible and there are a number of precedents in this regard including recent immersed tube tunnels in Turkey, Greece, Mexico, PRC and South Korea. [10] As done in these reference projects, strengthening of the adjacent and underlying soils to prevent liquefaction during an earthquake would be required. Rather than installing stone columns it may be practical to remove all liquefiable material from under the new tunnel and to backfill with a non-liquefiable material such as gravel. As discussed

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under Scenario 1, excavation and construction in close proximity to the existing Tunnel is a risk to the integrity of the Tunnel and construction may require closures of the Tunnel.

To manage transverse bending stresses during construction, tunnel segments are normally limited to a width of less than 40 metres. Two tubes have therefore been assumed – one five-lane southbound tube and one five-lane northbound tube, each with a width of approximately 30 metres.

Property impacts at the Tunnel approaches can be minimized by installing a cut-off wall between the existing Tunnel and the new tunnel (see **Figure 4**). This was done for the Coentunnel in the Netherlands where a 25-metre spacing was achieved between a new and existing tunnel.

A 14.5 metre draft has been assumed in the river to maintain and protect the navigability of the river. As such the new tunnel would be placed in a channel that is dredged to a depth of approximately -23.5 metres. If four-to-one (4H:1V) slopes can be achieved, the excavation required for the new Tunnel would be approximately 150 metres wide.

Special operational precautions would be required to deal with fire, explosions, accidents and flooding in the new tunnel. A level of protection against these types of emergencies can be provided with fire suppression and fire retarding systems, ventilation systems, pumps and emergency egress provisions. Emergency egress for tunnel users would be provided on either side of the river. Security for pedestrians and cyclists in the tunnel would need to be addressed with cameras and lighting.

Sufficient vertical and horizontal clearance inside the new tunnel would be required for ventilation jet fans. Ventilation buildings such as those used for the existing Tunnel would not be required although an operations building located on either side. Ventilation would have to be sufficient for use by cyclists and pedestrians. In stream work would be constrained by fish window and marine traffic access requirements. This would result in an extended overall construction timeline relative to bridge construction. The required in stream excavation and dredging works would also cause considerable disturbance of the river bed and the impact of the resulting turbidity on fish and downstream deposits of sediments would need to be considered. Other instream works would include graving dock construction, tunnel segment fabrication, partial excavation of the existing Tunnel and cut-off wall construction, channel dredging including removal of liquefiable material under the new Tunnel, stone columns installation on either side of the new tunnel alignment, river bed leveling, tunnel segment preparation and lowering into place, sand bedding installation under the Tunnel, backfilling, placing rip rap, and interior finishing including electrical/mechanical installation and paving.

Cut-and-cover construction at the tunnel portals would allow for better connectivity across Highway 99 and help mitigate negative property impacts. Other on shore works (tunnel approaches) would include excavation, slurry wall and tremie plug installation, dewatering, cut-and-cover and retaining wall construction and operations building construction.

Because a new tunnel would be constructed on an alignment beside the existing Tunnel, there would be a greater impact to private property and the agricultural land reserve than with Scenario 2, see **Figure 5**.

A new tunnel would provide better protection for the snow and ice issues experienced by cable supported bridges.

Based on the above, the following assumptions were made for a new tunnel *(see **Figures 4 and 5**)*:

- The total length of tunnel and approaches would be approximately 1.5 km.
- Two lengths of approximately 600-metre long immersed tube tunnel in 100-metre length segments. Each tube would be approximately 30 metres wide and carry five lanes of traffic and a multi-use pathway.
- Negative impacts to connectivity across the Highway 99 corridor and elimination of useable land would be mitigated using cut-and-cover construction.
- Cut-off walls would be installed adjacent to the existing Tunnel to allow the separation between the new and existing tunnels to be minimized and therefore minimize property impacts.
- An approximately 450-metre long low-level bridge would be required across Deas Island.
- Temporary walls and tremie plugs could be used to construct the approaches as a means to minimize the extent of excavation and dewatering.
- The existing Tunnel would be decommissioned after completion of the new tunnel.
- Tunnel segment installation, including fabrication, river bed preparation, segment lowering, backfilling and riprap placement is estimated to take approximately six years.
- Existing tunnel decommissioning once the new tunnel is open for use is estimated to take between one and two years.

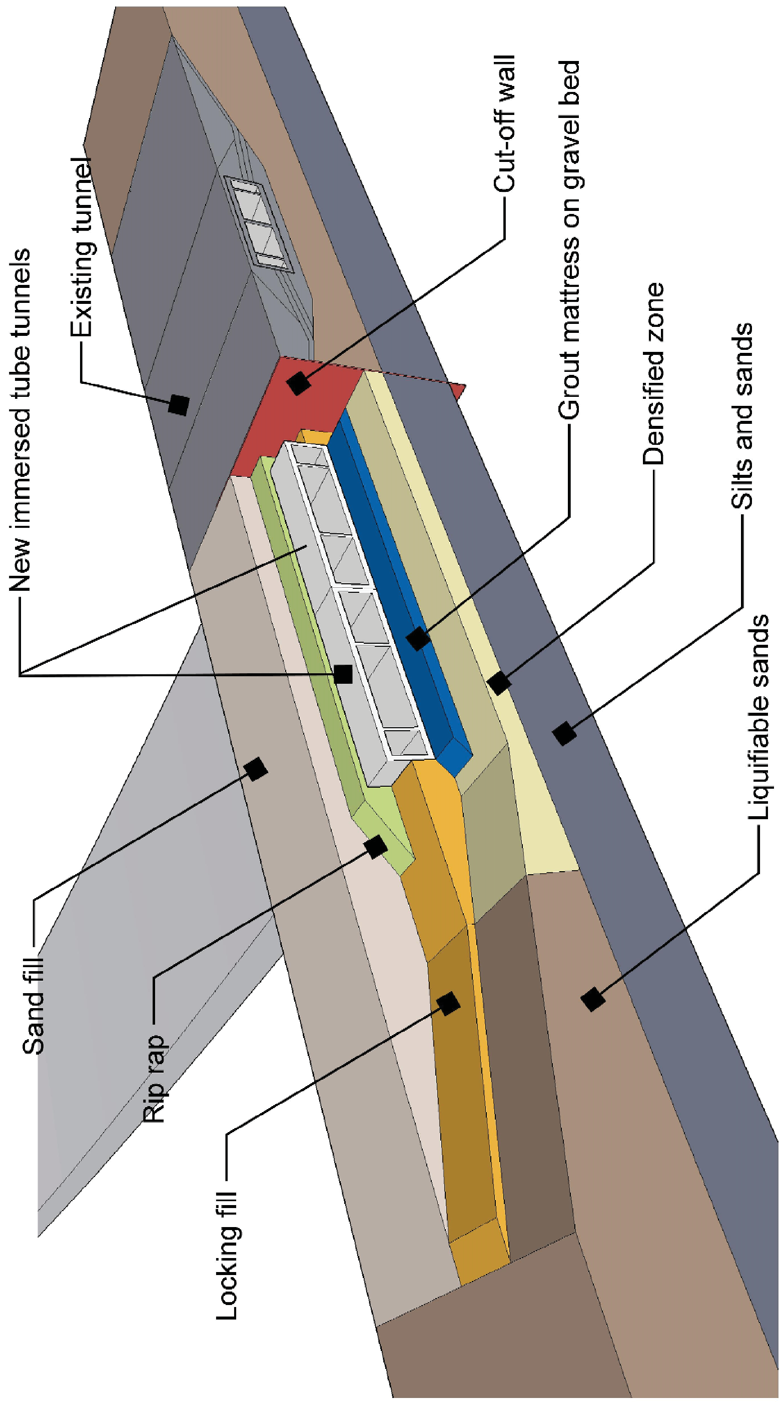

Figure 4 – Section showing Scenario 3 tunnel

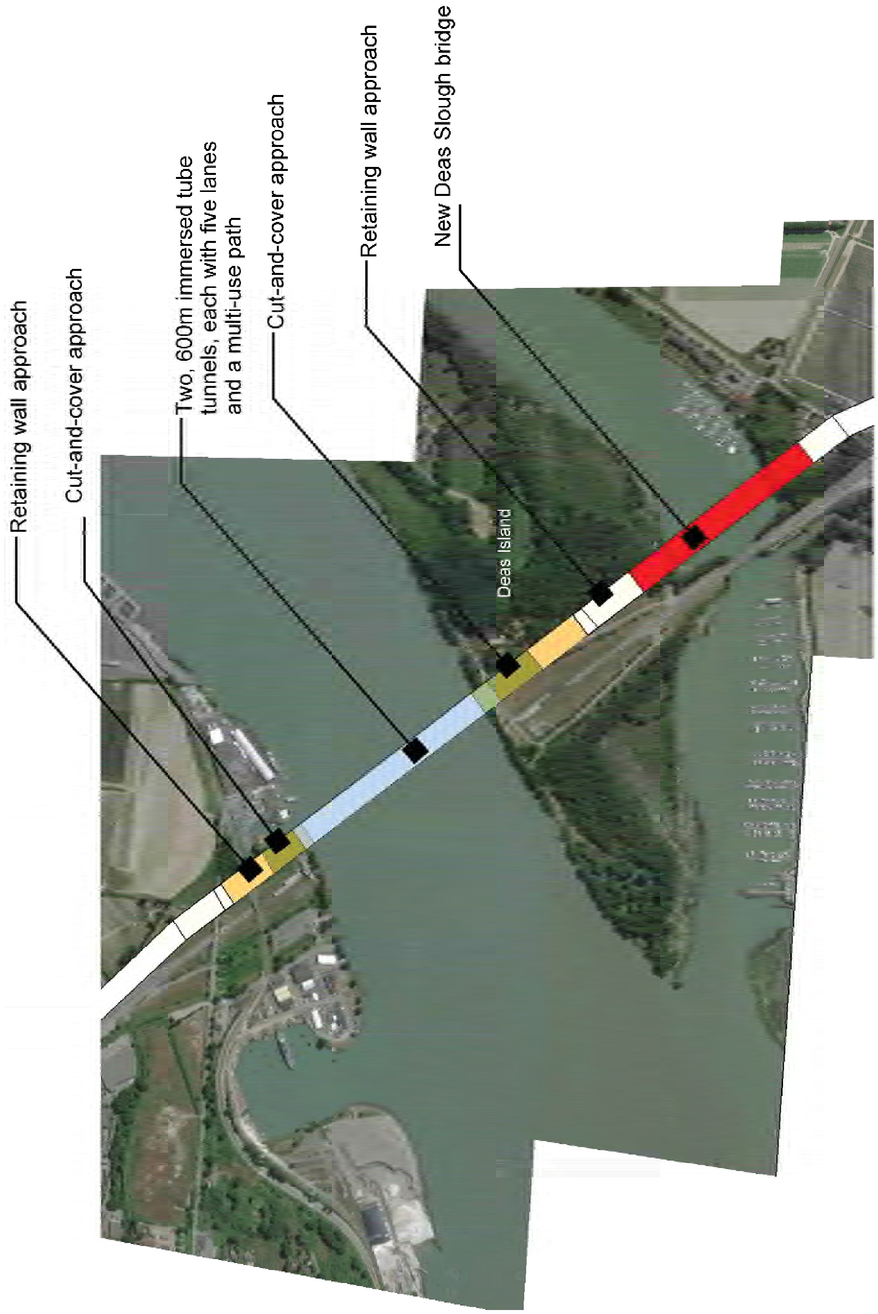

Figure 5 –Scenario 3 alignment

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The following table summarizes this scenario as well as its cost and risk profile.

TABLE 3 - EVALUATION OF SCENARIO 3

PROJECT GOAL	PERFORMANCE	**SCORE** (5 = EXCELLENT) (0 = UNACCEPTABLE
Reduce congestion	This scenario provides significant enhancements for all modes of transportation including pedestrians, cyclists, transit, car pools and trucks. Free flow traffic is predicted for traffic volumes beyond 2045.	5
Improve safety	A new tunnel would be designed as a lifeline structure to provide the highest practical post-earthquake performance. Modern highway design standards will be used to improve clearances and geometrics leading to a safer facility. First responder access and incident management along the highway will be challenged with regard to access between the northbound and southbound tunnel tubes. Fire and explosions are a serious consideration and pose significant risks. This type of risk does not occur with a bridge. A new tunnel would be protected from the snow and ice issues that affect a cable stayed bridge.	4
Support trade and commerce	The alignment of a new tunnel will significantly impact agricultural lands in Richmond and Delta, reducing overall farm production. The approaches to the new tunnel would create a barrier to crossing Highway 99, although this can be mitigated to some extent with cut-and-cover construction. Congestion relief will support trade and commerce.	3
Support transit on Highway 99	Dedicated transit lanes would be provided through the new tunnel, with integrated connections to transit stops at the Steveston and Highway 17A interchanges.	5
Support options for pedestrians and cyclists	The new tunnel would have a multi-use pathway on either side. This trail would be integrated with the municipal trail systems on either side of the Fraser River; however, the travel experience would be inferior to that of a bridge. CPTED principles would need to be considered in the design, to ensure a safe and appropriate cyclist and pedestrian experience through a tunnel. The total elevation change for a tunnel would be about half that on a bridge.	5

TABLE 3 - EVALUATION OF SCENARIO 3

PROJECT GOAL	PERFORMANCE	**SCORE** (5 = EXCELLENT) (0 = UNACCEPTABLE
Enhance the environment	Construction of a new tunnel would have a significant impact on the Fraser River and Deas Island Regional Park for several years during construction and several seasons in the river. Air quality monitoring at the tunnel portals would need to be carefully considered to ensure that contaminant levels are within acceptable ranges.	2
	TOTAL SCORE (out of 30)	24
Risk Profile	Experience with immersed tube Tunnel construction in the Lower Mainland is limited. Constrained construction windows in the Fraser River could amplify the impacts of a schedule delay – a one-month delay could easily become a year delay if an in-stream construction window is missed. Marine works are inherently riskier than land-based work. There is a risk to the integrity of the existing Tunnel as a result of excavation for the new tunnel. There is considerable risk to the integrity of the new tunnel during decommissioning of the existing Tunnel.	HIGH
Cost	Costs include rebuilding interchanges and widening Highway 99 between Bridgeport and Highway 91 in Surrey. Costs include construction, engineering, project management, property, utilities, environmental, escalation, risks, contingencies and financing.	$4,300 million

2.4 SCENARIO 4 – MAINTAIN EXISTING TUNNEL AND ADD ADDITIONAL LANES

A 10-lane crossing of the Fraser River could be provided by keeping the Tunnel and adding either a:

a) A new six-lane bridge over top, directly upstream or directly downstream of the Tunnel.

b) A new six-lane tunnel directly upstream or directly downstream of the Tunnel.

In either case, the Tunnel would be retrofitted to extend its life, including completion of the Stage 2 seismic works.

Although different laning configurations can be envisaged for Scenario 3 the following has been assumed:

- Four southbound general purpose lanes in the existing Tunnel.

- One southbound transit/HOV lane on/in the new bridge/tunnel.
- Four northbound general purpose lanes and one transit/HOV lane on/in the new bridge/tunnel.
- A multi-use pathway on the new crossing.

The seismic and highway geometry considerations described under Scenario 1 apply to this scenario given that the existing Tunnel would be maintained. However, unlike under Scenario 1, the new six-lane facility would provide a significant lifeline connection across the Fraser River and remove congestion. Also, given that the counterflow system would be eliminated with this Scenario, a reduction in traffic incidents can be expected with this Scenario.

The existing Tunnel retrofit could be carried out when the new bridge or tunnel is open to traffic, which would allow closure of the Tunnel while ground densification adjacent to the Tunnel is completed.

The interaction between a new bridge or tunnel and the existing Tunnel during seismic events is a serious risk and the required mitigation introduces additional costs and complexities to this Scenario.

a) New Six-Lane Bridge

A new six-lane bridge could be constructed on either side or over top of the existing Tunnel. An off-set alignment (upstream or downstream) would have the advantage of reducing impacts to Highway 99 traffic during construction. A new six-lane bridge located over top of the Tunnel would have similar characteristics as the bridge described in Scenario 2 including the complexities of building over live traffic. This arrangement would have the additional challenge of more complex approach structures.

b) New Six-Lane Tunnel (See Figure 6)

Twinning the existing Tunnel with a new tunnel would have a similar arrangement as described for Scenario 3 including the need for a new 450-metre-long, low level bridge over Deas Slough. Whereas in Scenario 3, two new tubes would be required, in this scenario a single, wider tube could be constructed to accommodate all six lanes.

It has been assumed that the new six-lane tunnel would be installed at a lower depth than the existing Tunnel, to protect for future navigation requirements in the Fraser River. Additional right-of-way would be required on both sides of the river, and an impact to agricultural land reserve is expected.

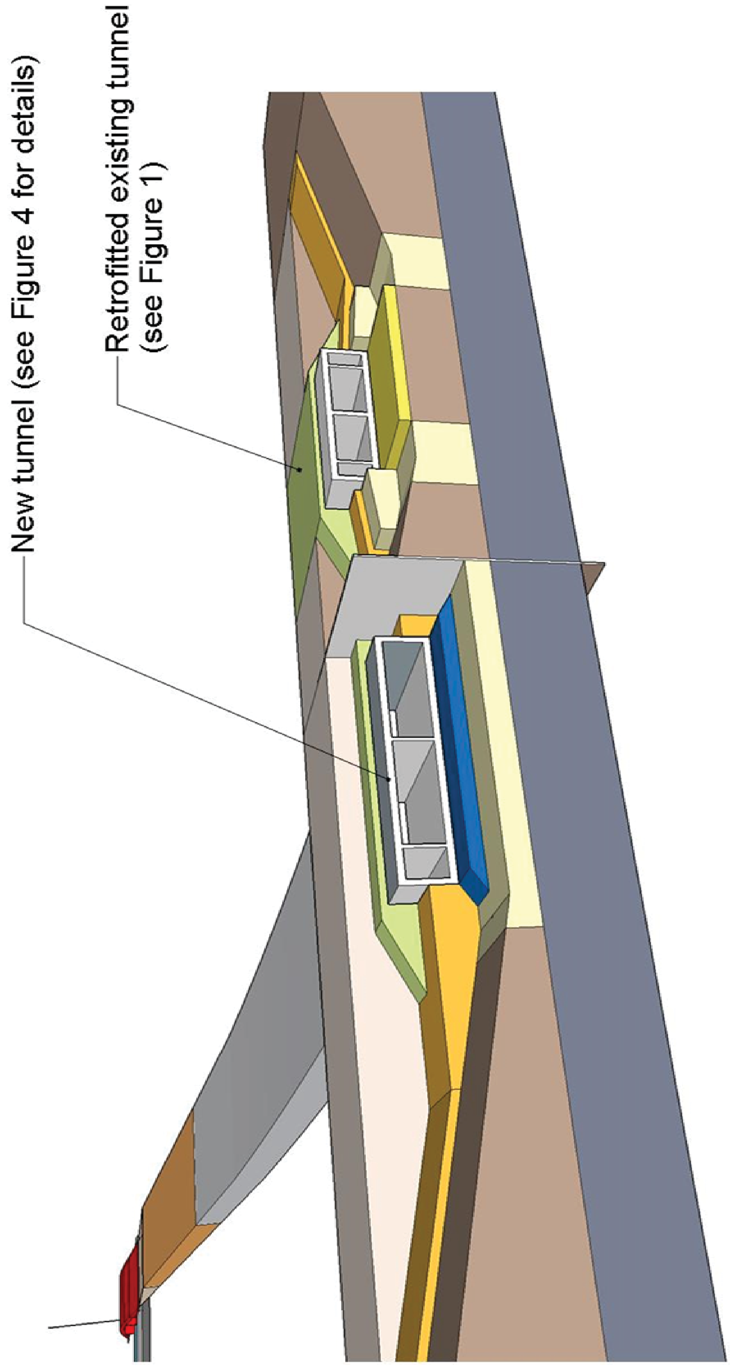

Figure 6 – Scenario 4(b), Twinned tunnel

The following table summarizes this scenario as well as its cost and risk profile.

TABLE 4 - EVALUATION OF SCENARIO 4

PROJECT GOAL	PERFORMANCE	SCORE (5 = EXCELLENT) (0 = UNACCEPTABLE	
		(a) (bridge +Tunnel)	(b) (tunnel +Tunnel)
Reduce congestion	This scenario provides significant enhancements for all modes of transportation including pedestrians, cyclists, transit, car pools and trucks. Free flow traffic is predicted for traffic volumes beyond 2045.	5	5
Improve safety	A lifeline crossing would be achieved for the new six-lane crossing; however, the existing Tunnel would still not meet modern seismic standards, meaning that modern standards for highway geometry would not be achieved for some traffic lanes. Safety issues associated with the Tunnel's substandard geometry and challenges for first responders trying to access the Tunnel cannot be addressed. A tunnel solution would provide better protection from the snow and ice issues that affect a cable stayed bridge.	1	1
Support trade and commerce	The alignment of the new bridge or tunnel on an offset alignment would have significant impact to agricultural lands in Richmond and Delta. Congestion relief will support trade and commerce.	2	2
Support transit on Highway 99	Dedicated transit/HOV lanes with integrated transit stops at both the Steveston and Highway 17A interchanges could be provided.	5	5
Support options for pedestrians and cyclists	A multi-use pathway for pedestrians and cyclists can be provided with either a twinned bridge or tunnel.	5	5
Enhance the environment	Construction of a new tunnel would have a significant impact on the Fraser River during construction. A new tunnel or bridge that is offset from the existing alignment will have a permanent impact on Deas Island Regional Park.	4	2
	TOTAL SCORE (out of 30)	22	20
Risk Profile	The interaction between a new structure and the existing Tunnel in a seismic event is a risk that will need to be mitigated. Completion of the Stage 2 Seismic works is considered to be high risk. Experience in the Lower Mainland with immersed tube tunnel construction is limited. Constrained construction windows in the Fraser River would amplify the impacts of a schedule delay and a month delay could easily become a year delay if an instream construction window is missed.	HIGH	HIGH

TABLE 4 - EVALUATION OF SCENARIO 4

PROJECT GOAL	PERFORMANCE	SCORE (5 = EXCELLENT) (0 = UNACCEPTABLE	
		(a) (bridge +Tunnel)	(b) (tunnel +Tunnel)
Cost	Costs include rebuilding interchanges and widening Highway 99 between Bridgeport and Highway 91 in Surrey. Costs include construction, engineering, project management, property, utilities, environmental, escalation, risks, contingencies and financing.	$3,550 million	$4,050 million

2.5 SCENARIO 5 – MAINTAIN EXISTING TUNNEL AND ADD NEW UPSTREAM BRIDGE

A new bridge or tunnel on a new alignment in the vicinity of No. 8 Road was considered during the Phase 2 public consultation for the Project (see **Figure 7**).[11] A similar concept was considered in the early 1990s[1]. Based on the analyses carried out for Scenarios 2 and 3, a bridge crossing has been assumed for Scenario 5.

From traffic data and analyses [19, 20] carried out for the Project, the following origin/destination patterns are known for northbound morning traffic:

- 54 percent of Tunnel users come from North Delta/Surrey/White Rock/U.S. Border
- 38 percent of Tunnel users come from Tsawwassan/Ladner/Deltaport
- eight percent of Tunnel users come from Tilbury
- 60 percent of Tunnel users are destined for Richmond in the morning. Of these 20 percent leave Highway 99 at the Steveston Interchange.
- 40 percent of Tunnel users are destined for Vancouver in the morning.

This pattern is reversed for evening southbound traffic. Based on these traffic patterns, it has been assumed for the purposes of estimating laning requirements for Scenario 5 that northbound traffic will be evenly split between the existing Tunnel and a new upstream crossing and that the same traffic distribution is true for southbound traffic in the evening.

The Design Hourly Volume (DHV) for the combined crossings can be assumed to be the same as the total for Scenario 2 [x]. As such the Tunnel and the new upstream crossing would each have a DHV in the order of 4,000 vehicles per hour during peak periods in 2045. To accommodate this DHV as well as HOV and transit, it is estimated that six lanes would be required at both the existing Tunnel crossing and the new upstream crossing.

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Based on the above assumptions a six lane upstream crossing would be required consisting of two general purpose lanes in each direction and one transit/HOV lane in each direction. To eliminate counterflow and provide transit/HOV lanes at the Tunnel, two additional lanes at the Tunnel would be required with this scenario.

Access to the new crossing would require adding lanes to Highway 91, Highway 99 and Highway 17. The laning assumed for this scenario is shown in **Figure 7**. This highway widening work will require upgrading and/or reconstruction of a number of major interchanges. These are indicated in **Figure 7**.

It can be seen from **Figure 7** that the Scenario 5 alignment would have a significant impact to both agricultural lands and industrial lands, and potentially to Burns Bog. These impacts would make this alignment very expensive and do meet the Project's goal of supporting trade and commerce or enhancing the environment.

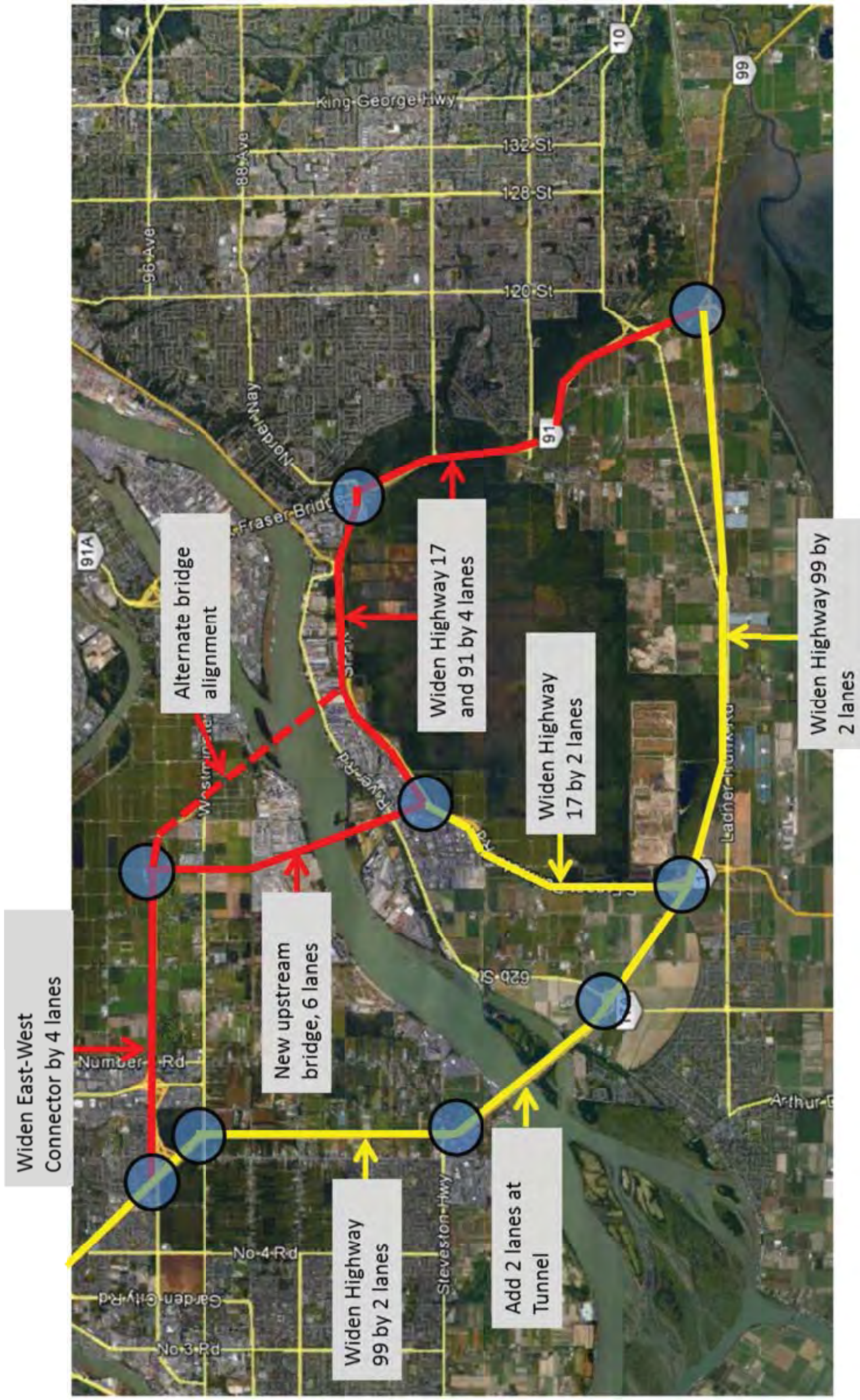

Figure 7 – Scenario 5, New upstream bridge

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The following table summarizes this scenario as well as its cost and risk profile.

TABLE 5 - EVALUATION OF SCENARIO 5

PROJECT GOAL	PERFORMANCE	**SCORE** (5 = EXCELLENT) (0 = UNACCEPTABLE
Reduce congestion	Provides enhancements for all modes of transportation including pedestrians, cyclists, transit, car pools and trucks; however, it is not clear if the proposed alignment will eliminate congestion at the Tunnel and it may increase congestion on Highway 91.	3
Improve safety	Because the Tunnel is retained, existing concerns about seismic vulnerability and outdated highway geometry along Highway 99 will not be addressed.	2
Support trade and commerce	A new alignment would significantly impact agricultural lands in Richmond and Delta, due not only to the new crossing, but also widening of existing highways.	1
Support transit on Highway 99	It is not clear if this scenario would reduce congestion on Highway 99, and as such, if transit service will be improved.	2
Support options for pedestrians and cyclists	Without modifying or replacing the existing Tunnel, there would be no improvements for cyclists and pedestrians along Highway 99. A high quality cyclist/pedestrian facility could be provided on a new alignment but would result in a longer route for cyclists using the Canada Line bridge or destined for BC Ferries, downtown Richmond, Tsawwassen or Ladner.	2
Enhance the environment	The new crossing would require extensive marine works for either a bridge or tunnel, and as such, would have a significant impact on the Fraser River. If marine works are minimized (Phase 2a alignment), the existing green space along the river edge will be eliminated.	2
	TOTAL SCORE (out of 30)	12
Risk Profile	See comments under Scenario 1, 2 and 3.	HIGH
Cost	Costs include rebuilding 9 interchanges and widening Highway 99, 91 and 17 between Bridgeport and Highway 91 in Surrey. Costs include construction, engineering, project management, property, utilities, environmental, escalation, risks, contingencies and financing.	$5,800 million

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3. SUMMARY

The following summarizes how well the five scenarios meet the Project goals, their construction costs and risk profiles.

	SCENARIO				
	1 Existing Tunnel	2 New Bridge	3 New Tunnel	4[2] (c) New Bridge +Existing Tunnel (d) New Tunnel + Existing Tunnel	5
Achievement of Project Goals	20%	90%	80%	60%	40%
Risk Profile	High	Medium	High	Medium - High	Medium-High
Cost in $ millions[1]	590	3,500	4,300	3,550 (a) 4,050 (b)	5,800
Assessment	Least cost; high risk associated with geotechnical works adjacent to the Tunnel; very poor achievement of project goals including poor seismic performance.	Second lowest cost; risks associated with bridge construction and traffic management; high achievement of project goals; Minimal property impacts; minimal environmental impacts.	Second highest cost; high risks associated with tunnel construction adjacent to the existing Tunnel; reasonable achievement of project goals; significant property impacts; significant environmental impacts.	Medium to high cost and risk; marginal achievement of project goals; significant property impacts; significant environmental impact (for tunnel option); poor seismic performance of existing Tunnel.	Highest cost; high risks associated with tunnel construction and retrofit of existing Tunnel; poor achievement of project goals; Significant property impacts including ALR; significant environmental impacts from tunnel construction; poor seismic performance of existing Tunnel.

Notes:

[1] Costs include construction, engineering, project management, property, utilities, environmental, escalation, risks, contingencies and financing

[2] Scenario 4(a) is a new six lane bridge adjacent to the Tunnel and Scenario 4(b) is a new six lane immersed tube tunnel adjacent to the Tunnel.

Project goals, established through consultation, that are key to the analyses presented in this report include congestion reduction, accommodation of all modes of travel including cycling and transit, and minimizing impacts to agricultural land. Scenarios 2 and 3 were the only two scenarios that substantially achieved these goals.

Subsequent to consultation, Scenarios 1, 4 and 5 were deemed to be significantly inferior options because as it was confirmed that the Tunnel could not be improved to meet modern day seismic standards.

Of the two remaining scenarios, Scenario 3 is significantly more expensive and has a higher risk profile than Scenario 2, and would be more challenging, require more agricultural land and have a greater environmental footprint.

The conclusion of the review is that a new bridge over the existing alignment best meets the Project goals and provides best overall value for British Columbians.

Observations on the summary table are:

- Keeping the existing Tunnel without adding additional traffic capacity (Scenario 1) scores very low because congestion is not addressed and the safety issues inherent with the Tunnel remain unchanged.
- All scenarios that keep the Tunnel (Scenarios 1, 4 and 5) score low because safety concerns associated with highway geometrics and seismic vulnerability inherent with the Tunnel are not resolved to meet today's standards. These Scenarios are therefore not recommended.
- All scenarios that keep the Tunnel (Scenarios 1, 4 and 5) have high risk because of the Stage 2 seismic retrofit that would need to be completed. These Scenarios are therefore not recommended.
- A new bridge is recommended over a new tunnel as it better meets the project objectives, is less expensive and intrusive to the environment, agriculture, etc., and involves less risk.

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Attachment 13

PAN-CANADIAN FRAMEWORK

on Clean Growth and Climate Change

Canada's Plan to Address Climate Change and Grow the Economy

GP - 444
(Special)

PDF version
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ISBN: 978-0-660-07023-0

Aussi disponible en français

PAN-CANADIAN FRAMEWORK
on Clean Growth and Climate Change

Canada's Plan to Address Climate Change and Grow the Economy

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(Special)

FOREWORD

The Pan-Canadian Framework on Clean Growth and Climate Change presented here is our collective plan to grow our economy while reducing emissions and building resilience to adapt to a changing climate. It will help us transition to a strong, diverse and competitive economy; foster job creation, with new technologies and exports; and provide a healthy environment for our children and grandchildren.

The Pan-Canadian Framework is both a commitment to the world that Canada will do its part on climate change, and a plan to meet the needs of Canadians. We have built on the momentum of the Paris Agreement by developing a concrete plan which, when implemented, will allow us to achieve Canada's international commitments.

When First Ministers met last March in Vancouver, they agreed to take ambitious action in support of meeting or exceeding Canada's 2030 target of a 30 percent reduction below 2005 levels of greenhouse gas (GHG) emissions. First Ministers issued the Vancouver Declaration on Clean Growth and Climate Change and agreed that a collaborative approach between provincial, territorial, and federal governments is important to reduce GHG emissions and to enable sustainable economic growth.

The Pan-Canadian Framework builds on the leadership shown and actions taken individually and collectively by the provinces and territories, including through the Declaration of the Premiers adopted at the Quebec Summit on Climate Change in 2015. To note, the province of Saskatchewan has decided not to adopt the Pan-Canadian Framework at this time. The federal government has committed to ensuring that the provinces and territories have the flexibility to design their own policies and programs to meet emission-reductions targets, supported by federal investments in infrastructure, specific emission-reduction opportunities and clean technologies. This flexibility enables governments to move forward and to collaborate on shared priorities while respecting each jurisdiction's needs and plans, including the need to ensure the continued competitiveness and viability of businesses.

In the Paris Agreement, Parties agreed that they should, when taking action to address climate change, recognize and respect the rights of Indigenous Peoples. As we implement this Framework, we will move forward respecting the rights of Indigenous Peoples, with robust, meaningful engagement drawing on their Traditional Knowledge. We will take into account the unique circumstances and opportunities of Indigenous Peoples and northern, remote, and vulnerable communities. We acknowledge and thank Indigenous Peoples across Canada for their climate leadership long before the Paris Agreement and for being active drivers of positive change.

Pricing carbon pollution is central to this Framework. Carbon pricing will encourage innovation because businesses and households will seek out new ways to increase efficiencies and to pollute less. We will complement carbon pricing with actions to build the foundation of our low-carbon and resilient economy.

As Canada transitions to a low-carbon future, energy will play an integral role in meeting our collective commitment, given that energy production and use account for over 80 percent of Canada's GHG emissions. This means using clean energy to power our homes, workplaces, vehicles, and industries, and using energy more efficiently. It means convenient transportation systems that run on cleaner fuels, that move more people by public transit and zero-emission vehicles, and that have streamlined trade corridors. It means healthier and more comfortable homes that can generate as much power as they use. It means more resilient infrastructure and ecosystems that can better withstand climatic changes. It means land use and conservation measures that sequester carbon and foster adaptation to climate change. It means new jobs for Canadians across the country and opportunities for growth. It means leveraging technology and innovation to seize export and trade opportunities for Canada, which will allow us to become a leader in the global clean growth economy and will also help bring down the cost of low-emission technologies. It means healthier communities with cleaner air and healthy and diverse ecosystems across the country.

We will maintain a sustained focus on implementation of the Pan-Canadian Framework, consistent with the commitment under the Paris Agreement, to increase the level of ambition over time.

The Pan-Canadian Framework is a historic step in the transition to a clean growth and resilient economy. It is informed by what we have heard from Canadians. We will continue to grow our economy and create good jobs as we take ambitious action on climate change. We will work to ensure that the Pan-Canadian Framework opens new opportunities for Canadian businesses to not only maintain but also enhance their competitiveness. We will continue to engage Canadians to strengthen and deepen our action on clean growth and climate change. And we are committed to transparently assessing and reporting to Canadians on our progress.

Together, we have developed a Pan-Canadian Framework on Clean Growth and Climate Change. This is Canada's plan to address climate change and grow the clean economy.

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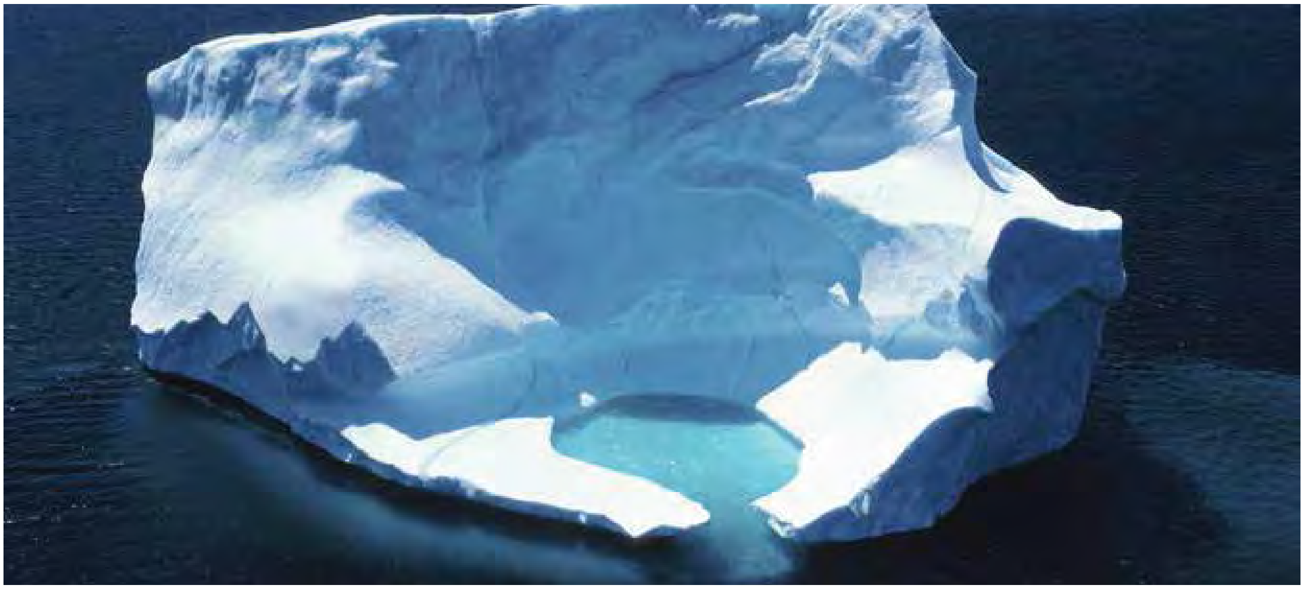

INTRODUCTION

In Canada and abroad, the impacts of climate change are becoming evident. Impacts such as coastal erosion; thawing permafrost; increases in heat waves, droughts and flooding; and risks to critical infrastructure and food security are already being felt in Canada. The science is clear that human activities are driving unprecedented changes in the Earth's climate, which pose significant risks to human health, security, and economic growth.

Taking strong action to address climate change is critical and urgent. The cost of inaction is greater than the cost of action: climate change could cost Canada $21-$43 billion per year by 2050, according to 2011 estimates from the National Round Table on the Environment and the Economy. Businesses and markets are increasingly considering climate risks. In recent years, severe weather events have cost Canadians billions of dollars, including in insured losses. Indigenous Peoples, northern and coastal regions and communities in Canada are particularly vulnerable and disproportionately affected. Geographic location, socio-economic challenges, and for Indigenous Peoples, the reliance on wild food sources, often converge with climate change to put pressure on these communities. Much has been done to begin addressing these challenges, including by Indigenous Peoples.

Acting on climate change will reduce risks and create new economic opportunities and good jobs for Canadians. There is already a global market for low-carbon goods and services worth over $5.8 trillion, which is projected to keep growing at a rate of 3 percent per year. Clean growth opportunities will benefit all sectors and regions. Canada will remain globally competitive through innovation, including through the development and promotion of innovative technologies with the potential to address climate change globally. This includes clean technology to enable the sustainable development of Canada's energy and resource sectors, including getting these resources to market, as Canada transitions to a low-carbon economy. Innovation can help further reduce emissions and the cost of taking action at home. Canadian technologies and solutions can also be exported abroad and deployed around the world, creating new markets and partners for Canadian businesses and supporting global action to reduce emissions.

The federal government will continue to work in close collaboration with other countries on climate solutions, including with partners across North America. A number of provinces and territories have already joined or are exploring entry into regional and international efforts to reduce GHG emissions.

Canadian municipalities will also continue to be important partners in developing and implementing climate solutions locally, as well as through international collaboration with other municipalities around the world.

The international community has agreed that tackling climate change is an urgent priority and also an historic opportunity to shift towards a global low-carbon economy. The adoption of the Paris Agreement in December 2015 was the culmination of years of negotiations under the United Nations Framework Convention on Climate Change. The Paris Agreement is a commitment to accelerate and intensify the actions and investments needed for a sustainable low-carbon future, to limit global average temperature rise to well below 2 °C above pre-industrial levels, and to pursue efforts to limit the increase to 1.5 °C. This will require taking action on long-lived GHGs such as carbon dioxide and short-lived climate pollutants such as methane, hydrofluorocarbons and black carbon.

As a first step towards implementing the commitments Canada made under the Paris Agreement, First Ministers released the Vancouver Declaration on Clean Growth and Climate Change on March 3, 2016.

1.1 How we developed the Framework

The development of the Pan-Canadian Framework was informed by input from Canadians across the country, who made it clear that they want to be part of the solution to climate change. Under the Vancouver Declaration, First Ministers asked four federal-provincial-territorial working groups to work with Indigenous Peoples; to consult with the public, businesses and civil society; and to present options to act on climate change and enable clean growth. The working groups heard solutions directly from Canadians, through an interactive website, in-person engagement sessions, and independent town halls.

Representatives of Indigenous Peoples contributed their knowledge and expectations for meaningful engagement in climate action and provided important considerations and recommendations either directly to working groups or to ministers, which helped shape this framework.

Ministers also reached out to Canadians, businesses, non-governmental organizations, and Indigenous Peoples to hear their priorities. In addition, ministerial tables were convened to provide their advice, including the Canadian Council of Ministers of the Environment, Ministers of Innovation, Ministers of Energy, and Ministers of Finance.

ENGAGING CANADIANS:
The Let's Talk Climate Action website was launched on April 22, 2016 to gather ideas and comments from Canadians about how Canada should address climate change. By the submission deadline of September 27, 2016, over 13,000 ideas and comments were received. In addition, consultations by governments and working groups on clean growth and climate change were held across Canada.

1.2 Pillars of the Framework

The Pan-Canadian Framework has four main pillars: pricing carbon pollution; complementary measures to further reduce emissions across the economy; measures to adapt to the impacts of climate change and build resilience; and actions to accelerate innovation, support clean technology, and create jobs. Together, these interrelated pillars form a comprehensive plan.

Pricing carbon pollution is an efficient way to reduce emissions, drive innovation, and encourage people and businesses to pollute less. However, relying on a carbon price alone to achieve Canada's international target would require a very high price.

Complementary climate actions can reduce emissions by addressing market barriers where pricing alone is insufficient or not timely enough to reduce emissions in the pre-2030 timeframe. For instance, tightening energy efficiency standards and codes for vehicles and buildings are common sense actions that reduce emissions, while also helping consumers save money by using less energy.

Canada is experiencing the impacts of climate change, so there is also a need to **adapt and build resilience**. This means making sure that our infrastructure and communities are adequately prepared for climate risks like floods, wildfires, droughts, and extreme weather events, including in particularly vulnerable regions like Indigenous, northern, coastal, and remote communities. This also means adapting to the impacts of changes in temperature, including thawing permafrost.

A low-carbon economy can and will be a strong and thriving economy. Taking action now, to position Canada as a global leader on clean technology innovation, will help ensure that Canada remains internationally competitive and will lead to the creation of new good jobs across the country. Investing in **clean technology, innovation, and jobs** will bring new and in-demand Canadian technologies to expanding global markets. These investments will help improve the efficiency and cost-effectiveness of mitigation and adaptation measures and will equip Canada's workforce with the knowledge and skills to succeed.

In implementing the Pan-Canadian Framework on Clean Growth and Climate Change, federal, provincial and territorial governments will review progress annually to assess the effectiveness of our collective actions and ensure continual improvement. First Ministers commit to **report regularly and transparently** to Canadians on progress towards GHG-reduction targets, on building climate resilience, and on growing a clean economy.

Our governments will continue to recognize, respect and safeguard the **rights of Indigenous Peoples** as we take actions under these pillars.

1.3 Elements of collaboration

The Pan-Canadian Framework reaffirms the principles outlined in the Vancouver Declaration, including

- recognizing the diversity of provincial and territorial economies and the need for fair and flexible approaches to ensure international competitiveness and a business environment that enables firms to capitalize on opportunities related to the transition to a low-carbon economy in each jurisdiction;
- recognizing that growing our economy and achieving our GHG-emissions targets will require an integrated, economy-wide approach that includes all sectors, creates jobs, and promotes innovation;
- recognizing that a collaborative approach between provincial, territorial, and federal governments is important to reduce GHG emissions and enable sustainable economic growth;
- recognizing that provinces and territories have been early leaders in the fight against climate change and have taken proactive steps, such as adopting carbon pricing mechanisms, placing caps on emissions, involvement in international partnerships with other states and regions, closing coal plants, carbon capture and storage projects, renewable energy production (including hydroelectric developments) and targets, and investments in energy efficiency;
- recognizing that the federal government has committed to ensuring that the provinces and territories have the flexibility to design their own policies to meet emission-reductions targets, including their own carbon pricing mechanisms, supported by federal investments in infrastructure, specific emission-reduction opportunities and clean technologies;
- recognizing the commitment of the federal government to work with provinces and territories to complement and support their actions without duplicating them, including by promoting innovation and enabling clean growth across all sectors;
- strengthening the collaboration between our governments and Indigenous Peoples on mitigation and adaptation actions, based on recognition of rights, respect, cooperation, and partnership;
- recognizing the importance of Traditional Knowledge in regard to understanding climate impacts and adaptation measures;

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- recognizing that comprehensive adaptation efforts must complement ambitious mitigation measures to address unavoidable climate change impacts; and
- implementing a collaborative, science-based approach to inform Canada's future targets that will increase in stringency as required by the Paris Agreement.

Governments recognize the unique circumstances of the North, including disproportionate impacts from climate change and the associated challenges with food security, emerging economies and the high costs of living and of energy.

Federal, provincial, and territorial governments will work collaboratively to grow the economy, create good-paying and long-term jobs, and reduce GHG emissions in support of meeting or exceeding Canada's 2030 target. These actions will be supported by strong, complementary adaptation policies to build climate resilience. Indigenous Peoples will be important partners in developing real and meaningful outcomes that position them as drivers of climate action in the implementation of the Pan-Canadian Framework. All governments across Canada are committed to ambitious and sustained action on climate change, building on current actions and future opportunities.

THE FEDERAL GOVERNMENT'S RENEWED RELATIONSHIP WITH INDIGENOUS PEOPLES:

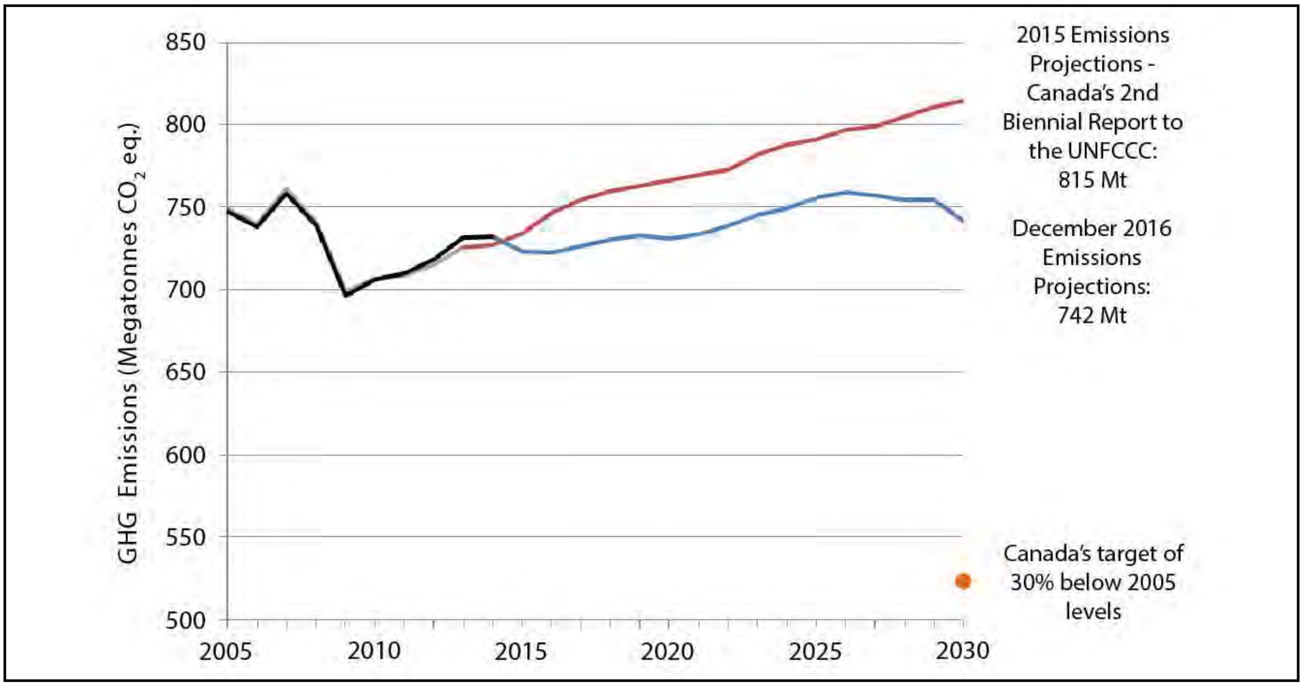
The federal government also reiterates its commitment to renewed nation-to-nation, government-to-government, and Inuit-to-Crown relationships with First Nations, the Métis Nation and Inuit, based on the recognition of rights, respect, cooperation, and partnership, consistent with the Government of Canada's support for the United Nations Declaration on the Rights of Indigenous Peoples, including free, prior and informed consent.

1.4 Emissions trajectory to 2030

The graph below highlights that total Canadian GHG emissions are projected to be 742 megatonnes (Mt) in 2030 under the December 2016 emissions projections (Environment and Climate Change Canada)[1]. Canada's target is 523 Mt.

Projections from the December 2016 emissions projections include revised forecasts for GDP and oil and gas prices and production[2]. Also incorporated are new federal, provincial, and territorial government measures that have legislative or funding certainty as of November 1st, 2016 and were not included in the 2015 emissions projections. These include: federal measures for increasing energy efficiency of equipment in buildings; Ontario's commitment to join the Western Climate Initiative cap-and-trade system; Alberta's coal phase-out, carbon levy, and oil sands emissions cap; Quebec's regulations for new high-rise buildings; and, British Columbia's low carbon fuel standard.

Figure 1: Emissions Projections to 2030



1 Canada's 2016 greenhouse gas emissions projections to 2030 will be released by Environment and Climate Change Canada in December 2016.

2

	Scenarios		
December 2016 Assumptions	**Low**	**Reference**	**High**
Average Annual GDP Growth (2014-2030)	1.0%	1.7%	2.3%
2030 WTI Oil Price (2014 US$/bbl)	42	81	111
2030 Henry Hub Natural Gas Price (2014 US$/GJ)	2.89	3.72	4.62
2030 GHG Emissions (Mt CO2eq.)	**697**	**742**	**790**

PRICING CARBON POLLUTION

Overview

Carbon pricing is broadly recognized as one of the most effective, transparent, and efficient policy approaches to reduce GHG emissions. Many Canadian provinces are already leading the way on pricing carbon pollution. British Columbia has a carbon tax, Alberta has a hybrid system that combines a carbon levy with a performance-based system for large industrial emitters, and Quebec and Ontario have cap-and-trade systems. With existing and planned provincial action, broad-based carbon pricing will apply in provinces with nearly 85 per cent of Canada's economy and population by 2017, covering a large part of our emissions.

The federal government outlined a benchmark for pricing carbon pollution by 2018 (see Annex I). The goal of this benchmark is to ensure that carbon pricing applies to a broad set of emission sources throughout Canada and with increasing stringency over time either through a rising price or declining caps. The benchmark outlines that jurisdictions can implement (i) an explicit price-based system (a carbon tax or a carbon levy and performance-based emissions system) or (ii) a cap-and-trade system. Some existing provincial systems already exceeded the benchmark. As affirmed in the Vancouver Declaration, provinces and territories continue to have the flexibility to design their own policies to meet emissions-reduction targets, including carbon pricing, adapted to each province and territory's specific circumstances.

"THERE IS A GROWING CONSENSUS AMONG BOTH GOVERNMENTS AND BUSINESSES ON THE FUNDAMENTAL ROLE OF CARBON PRICING IN THE TRANSITION TO A DECARBONIZED ECONOMY."

World Bank, State and Trends of Carbon Pricing 2015

The following **principles** guide the pan-Canadian approach to pricing carbon pollution, and they are broadly based on those proposed by the Working Group on Carbon Pricing Mechanisms:

- Carbon pricing should be a central component of the Pan-Canadian Framework.

- The approach should be flexible and recognize carbon pricing policies already implemented or in development by provinces and territories.
- Carbon pricing should be applied to a broad set of emission sources across the economy.
- Carbon pricing policies should be introduced in a timely manner to minimize investment into assets that could become stranded and maximize cumulative emission reductions.
- Carbon price increases should occur in a predictable and gradual way to limit economic impacts.
- Reporting on carbon pricing policies should be consistent, regular, transparent, and verifiable.
- Carbon pricing policies should minimize competitiveness impacts and carbon leakage, particularly for emissions-intensive, trade-exposed sectors.
- Carbon pricing policies should include revenue recycling to avoid a disproportionate burden on vulnerable groups and Indigenous Peoples.

NEW ACTIONS

1) Provincial and territorial actions on pricing carbon pollution are described in Annex II.

2) The federal government will work with the territories to find solutions that address their unique circumstances, including high costs of living and of energy, challenges with food security, and emerging economies. The federal government will also engage Indigenous Peoples to find solutions that address their unique circumstances, including high costs of living and of energy, challenges with food security, and emerging economies.

3) The overall approach will be reviewed by 2022 to confirm the path forward.

"CARBON PRICING IS THE MOST PRACTICAL AND COST-EFFECTIVE WAY TO LOWER GHG EMISSIONS WHILE ENCOURAGING LOW-CARBON INNOVATION."

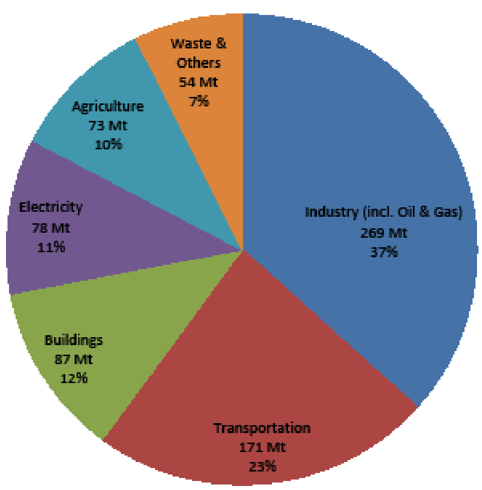
Canada's Ecofiscal Commission

COMPLEMENTARY ACTIONS TO REDUCE EMISSIONS

Overview

To reduce emissions, meaningful action will need to be taken across all regions and sectors of the economy. Many of the things that Canadians do every day—like driving cars and heating homes—produce GHG emissions. Many activities that drive economic growth in the country, like extracting natural resources, industrial and manufacturing activities, and transporting goods to customers, also produce emissions. The policies that help drive down emissions can also help the economy to keep growing by cutting costs for Canadians, creating new markets for low-emission goods and services, and helping businesses use cleaner and more efficient technologies that give them a leg up on international competitors.

Emissions by sector in 2014
(megatonnes of CO_2 eq.)



Federal, provincial, and territorial governments will work together to make sure new actions build on and complement existing plans, policies, programs, and regulations and reflect lessons learned from past experience. New policies will be designed to focus on GHG-emission outcomes and will recognize flexibility for regional differences, including through outcomes-based regulatory equivalency agreements. Indigenous Peoples will be involved in defining and developing policies to support clean energy in their communities.

In developing policies, a number of factors will be considered, including:

- economic, environmental, and social impacts and benefits;
- how individual policies will work with carbon pricing;
- the need to consider and mitigate the impacts on emissions-intensive trade exposed sectors (e.g., resource sectors that are price takers on the global market), including the need to avoid carbon leakage;
- co-benefits such as improved health due to air pollutant reductions, and jobs and business growth;
- opportunities to realize near-term climate and health benefits through reducing emissions of short-lived climate pollutants; and,
- benefits for ecosystems and biodiversity.

FALLING COSTS OF RENEWABLE ENERGY:
Between 2010 and 2015, the costs for new utility-scale solar photovoltaic (PV) installations declined by two-thirds, while over the same period the cost of onshore wind fell by an estimated 30 percent on average (IEA, 2016)

Governments will be supporting the actions outlined in the Pan-Canadian Framework through policies and investments. Federal actions are described in Annex I, and provincial and territorial key actions and collaboration opportunities with the Government of Canada are described in Annex II.

3.1 Electricity

Canada already has one of the cleanest electricity systems in the world. About 80 percent of electricity production comes from non-emitting sources, more than any other G7 country. While electricity emissions are going down in large part due to the move away from coal-fired power toward cleaner sources, electricity generation is still Canada's fourth-largest source of GHG emissions.

Clean, non-emitting electricity systems will be the cornerstone of a modern, clean growth economy. Transformations to electricity systems will be supported by federal, provincial, and territorial governments, and, undertaken by utilities, private-sector players, and Indigenous Peoples.

The approach to electricity will include
(1) increasing the amount of electricity generated from renewable and low-emitting sources;
(2) connecting clean power with places that need it;
(3) modernizing electricity systems; and
(4) reducing reliance on diesel working with Indigenous Peoples and northern and remote communities.

Provinces and territories have already taken action on moving from traditional coal-fired generation to clean electricity. Ontario and Manitoba have already phased out their use of coal, Alberta has plans in place to phase out coal-fired electricity by 2030, Nova Scotia has created a regulatory framework to transition from coal to clean electricity generation, and Saskatchewan has a coal-fired generating unit with carbon capture technology, which captures 90 percent of emissions. New capacity will come from non-emitting sources—including hydro, wind, and solar—as well as natural gas. Energy efficiency and conservation will make added contributions to clean electricity systems.

ONTARIO'S COAL PHASE-OUT:
On April 15, 2014, **Ontario** became the first jurisdiction in North America to fully eliminate coal as a source of electricity generation. This action is the single largest GHG-reduction initiative in North America, eliminating more than 30 Mt of annual GHG emissions and equivalent to taking seven million vehicles off the road. On November 23, 2015, Ontario passed the *Ending Coal for Cleaner Air Act*, permanently banning coal-fired electricity generation in the province.

SASKATCHEWAN'S BOUNDARY DAM INTEGRATED CARBON CAPTURE AND STORAGE PROJECT:
is the world's first commercial-scale, coal-fired carbon capture and storage electricity project, and it is able to capture and sequester up to 90 percent of its GHG emissions.

WIND POWER:
Wind capacity in Canada grew 20 times between 2005 and 2015, and there is strong potential for further growth. For example, 4 wind farms in **Prince Edward Island** now generate almost 25 percent of the province's electricity requirements.

ALBERTA'S COAL PHASE-OUT:
Alberta's commitments to end emissions from coal-fired electricity and replace it with 30 percent renewable energy by 2030 are expected to achieve cumulative emission reductions of 67 Mt between now and 2030, and emissions in 2030 will be at least 14 Mt below what is forecast under the status quo. This reduction is the equivalent of taking 2.8 million cars off the road. This move will improve air quality and the health of Albertans and other Canadians. It will also ensure reliability, encourage private investment, and provide price stability for all Albertans.

Connecting clean power across Canada through stronger transmission-line interconnections will help reduce emissions and support the move away from coal. Many provinces already trade electricity across their borders, and there is potential to increase these flows, consistent with market rules and fair competition among electricity producers.

THE CANADIAN ENERGY STRATEGY:
Provinces and territories are already taking a cooperative approach toward sustainable energy development through the Canadian Energy Strategy, which was released by premiers in July 2015. As agreed under the Vancouver Declaration and building on the Quebec Summit on Climate Change in 2015, federal, provincial, and territorial energy ministers are collaborating on specific actions through the Canadian Energy Strategy, to contribute to the Pan-Canadian Framework on Clean Growth and Climate Change. Actions include energy conservation and efficiency, clean energy technology and innovation, and deployment of energy to people and global markets.

Modernizing electricity systems will involve expanding energy storage, updating infrastructure, and deploying smart-grid technologies to improve the reliability and stability of electric grids and to allow more renewable power to be added. As a leader in the development and deployment of innovative energy-storage solutions and smart-grid technology, Canadian clean technology producers stand to benefit from increased investments in our electricity systems.

Many Indigenous Peoples, as well as northern and remote communities in Canada rely on diesel fuel to produce electricity and heat. Opportunities exist for clean electricity infrastructure, distributed energy systems, renewable energy microgrids, as well as grid connections and hybrid systems, which will enhance wellbeing, create local economic opportunities, and contribute to better air quality and a cleaner environment overall. Investing in clean energy solutions will advance the priorities of Indigenous Peoples, as well as northern and remote communities to transition away from diesel.

COLVILLE LAKE SOLAR PROJECT – Colville Lake, Northwest Territories is located north of the Arctic Circle, and it is served with a winter road that is open just a couple of months each year. To reduce diesel use in this remote, off-grid community, a solar/diesel/battery hybrid electricity system has been installed. This system has allowed the diesel generators to be shut down for extended periods in the summer. This innovative energy solution has reduced diesel use and related emissions by 20-25 percent per year.

Taking these actions will have a number of benefits beyond reducing GHG emissions. Phasing out coal and reducing the use of diesel will reduce harmful air pollutants, which have significant implications for human health and associated health-care costs. Designing and building clean-power technologies and transmission lines represents major economic opportunities for Canada. Increasing the amount of clean and renewable electricity sold to the United States could also bring new revenue to utilities and provinces, respecting open-access rules under the authority of the U.S. Federal Energy Regulatory Commission.

THE CANADA INFRASTRUCTURE BANK: The federal government is creating the Canada Infrastructure Bank, which will work with provinces, territories, and municipalities to further the reach of government funding directed to infrastructure, including clean electricity systems.

COMMUNITY-BASED ENERGY GENERATION: In May 2015, **New Brunswick** introduced legislation to allow local entities to develop renewable-energy sourced electricity generation in their communities. This legislation will allow universities, non-profit organizations, cooperatives, First Nations, and municipalities to contribute to NB Power's renewable energy requirements.

NEW ACTIONS

1. Increasing renewable and non-emitting energy sources

Federal, provincial, and territorial governments will work together to accelerate the phase out of traditional coal units across Canada, by 2030, as recently announced by the federal government (see Annex I) and to build on provincial and territorial leadership.

The federal government has announced it will set performance standards for natural gas-fired electricity generation, in consultation with provinces, territories, and stakeholders (see Annex I).

Federal, provincial, and territorial governments will work together to facilitate, invest in, and increase the use of clean electricity across Canada, including through additional investments in research, development, and demonstration activities.

2. Connecting clean power with places that need it

Federal, provincial, and territorial governments will work together to help build new and enhanced transmission lines between and within provinces and territories.

3. Modernizing electricity systems

Federal, provincial, and territorial governments will work together to support the demonstration and deployment of smart-grid technologies that help electric systems make better use of renewable energy, facilitate the integration of energy storage for renewables, and help expand renewable power capacity.

4. Reducing reliance on diesel working with Indigenous Peoples and northern and remote communities

Governments are committed to accelerating and intensifying efforts to improve the energy efficiency of diesel generating units, demonstrate and install hybrid or renewable energy systems, and connect communities to electricity grids. This will be done in partnership with Indigenous Peoples and businesses. These actions will have significant benefits for communities, such as improving air quality and energy security, and creating the potential for locally owned and sourced power generation.

RAMEA WIND-HYDROGEN-DIESEL ENERGY PROJECT:

The off-grid community of Ramea in **Newfoundland and Labrador** hosts one of the first projects in the world to integrate generation from wind, hydrogen, and diesel in an isolated electricity system. Since 2010, the Ramea Wind-Hydrogen-Diesel Energy Project has successfully produced approximately 680 000 kilowatt hours of renewable energy.

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3.2 Built environment

In Canada, using energy to heat and cool buildings accounted for about 12 percent of national GHG emissions in 2014 or 17 percent if emissions from generating the electricity used in buildings is also included. The emissions in this sector—created by burning fossil fuels and leaks in air conditioning systems—are projected to grow modestly by 2030 unless further action is taken.

In a low-carbon, clean growth economy, buildings and communities will be highly energy efficient, rely on clean electricity and renewable energy, and be smart and sustainable. Making the built environment more energy efficient reduces GHGs, helps make homes and buildings more comfortable and more affordable by lowering energy bills, and can promote innovation and clean job opportunities. Most building owners and architects estimate that retrofitting commercial and institutional buildings pays off in less than ten years, according to data from the Canada Green Building Council. Residential energy efficiency improvements helped Canadians save $12 billion in energy costs in 2013, an average savings of $869 per household.

The approach to the built environment will include (1) making new buildings more energy efficient; (2) retrofitting existing buildings, as well as fuel switching; (3) improving energy efficiency for appliances and equipment; and (4) supporting building codes and energy efficient housing in Indigenous communities.

Advances in clean technologies and building practices can make new buildings "net-zero energy", meaning they require so little energy they could potentially rely on their own renewable energy supplies for all of their energy needs. Through research and development, technology costs continue to fall, and government and industry efforts and investments will accelerate that trend. These advances, supported by a model "net-zero energy ready" building code, will enable all builders to adopt these practices and lower lifecycle costs for homeowners.

EFFICIENCY NOVA SCOTIA:
Canada's first energy efficiency utility—works with more than 100 local partners, and it has helped 225 000 program participants complete energy efficiency projects, saving Nova Scotians $110 million in 2016 alone. For example, the HomeWarming service is funded by the province of Nova Scotia as part of a long-term plan to upgrade all low-income homes in Nova Scotia, over the next 10 years.

At the same time, action is needed on existing buildings, since more than 75 percent of the building stock in 2030 will be composed of buildings already standing today. This can be supported by innovative policies like labelling a building's energy performance, establishing retrofit codes, and offering low-cost financing for retrofits.

Housing for Indigenous communities is particularly pressing. New housing will be built to high-efficiency standards and existing housing will be retrofitted. Indigenous Peoples have also identified the need to incorporate Traditional Knowledge and culture into building designs. Governments will partner with Indigenous Peoples in the design of relevant policies and programs.

Energy efficiency standards for equipment and appliances save consumers and businesses money on energy bills. An early market signal by the government, in the form of an intention to introduce standards by a specific year, can motivate the market to accelerate the uptake of the targeted technologies. Regulations can be supported by actions to educate consumers, to demonstrate benefits, and to overcome market barriers.

Construction in Canada is a $171 billion industry, and it employs well over a million people. New building codes will spur innovation and support Canadian businesses in developing more efficient building techniques and technologies. Investments in retrofits to improve energy efficiency have been shown to be strong job creators, providing direct local benefits, creating local jobs, and reducing energy bills.

NET-ZERO ENERGY BUILDINGS: Construction costs for net-zero energy buildings have dropped 40 percent in the past decade, and they are continuing to fall. The benefits of net-zero energy buildings are significant. Estimated operating costs for a net-zero energy ready house is 30 percent to 55 percent less than for a typical house, depending on region, fuel type and occupant behaviour.
For example, on a -32 °C day, the Riverdale NetZero Project (a semi-detached duplex in Edmonton, Alberta) only needs 6500 W of power for heat—the same amount of heat produced by four toasters.

NEW ACTIONS

1. Making new buildings more energy efficient

Federal, provincial, and territorial governments will work to develop and adopt increasingly stringent model building codes, starting in 2020, with the goal that provinces and territories adopt a “net-zero energy ready” model building code by 2030. These building codes will take regional differences into account. Continued federal investment in research, development, and demonstration, and cooperation with industry will help to reduce technology costs over time.

2. Retrofitting existing buildings

Federal, provincial, and territorial governments will work to develop a model code for existing buildings by 2022, with the goal that provinces and territories adopt the code. This code will help guide energy efficiency improvements that can be made when renovating buildings.

Federal, provincial, and territorial governments will work together with the aim of requiring labelling of building energy use by as early as 2019. Labelling will provide consumers and businesses with transparent information on energy performance.

Provincial and territorial governments will work to sustain and, where possible, expand efforts to retrofit existing buildings by supporting energy efficiency improvements as well as fuel switching, where appropriate, and by accelerating the adoption of high-efficiency equipment while tailoring their programs to regional circumstances. The federal government could support efforts of provinces and territories through the Low Carbon Economy Fund and infrastructure initiatives.

3. Improving energy efficiency for appliances and equipment

The federal government will set new standards for heating equipment and other key technologies to the highest level of efficiency that is economically and technically achievable.

4. Supporting building codes and energy efficient housing in Indigenous communities

Governments will collaborate with Indigenous Peoples as they move towards more efficient building standards and incorporate energy efficiency into their building-renovation programs.

SOCIAL HOUSING RETROFITS:
To help fight climate change, Ontario invested $92 million in 2016 to retrofit social housing buildings to reduce GHG emissions by installing energy efficient boilers, insulating outer walls and mechanical systems, and installing more energy efficient windows and lighting. Ontario's Climate Change Action Plan builds on this initial investment by committing up to $500 million more for social housing retrofits over the next five years.

Aki Energy in **Manitoba** is a non-profit Aboriginal social enterprise that works with First Nations to start green businesses in their communities and to create local jobs and strong local economies. Aki Energy is committed to helping First Nations lower the utility bills to heat buildings, and it has installed over $3 million in cost-effective renewable energy technologies in partnership with Manitoba First Nations.

3.3 Transportation

The transportation sector accounted for about 23 percent of Canada's emissions in 2014, mostly from passenger vehicles and freight trucks. Transportation emissions are projected to decline slightly by 2030 if no further action is taken. Governments are already working to make all modes of transportation more efficient and convenient, but more action is needed.

Low-carbon transportation systems will use cleaner fuels, will have more zero-emission vehicles on the road, will provide convenient and affordable public transit, and will transport people and goods more efficiently.

The approach to transportation will include (1) setting and updating vehicle emissions standards and improving the efficiency of vehicles and transportation systems; (2) expanding the number of zero-emission vehicles on Canadian roads; (3) supporting the shift from higher to lower-emitting types of transportation, including through investing in infrastructure; and (4) using cleaner fuels.

Emissions standards for cars and trucks ensure new engines are more fuel efficient. Retrofitting freight trucks to reduce wind resistance can also cut emissions. And streamlining how goods are transported can improve the overall efficiency of transportation systems.

Zero-emission vehicle technologies include plug-in hybrids, electric vehicles, and hydrogen fuel-cell vehicles. Many of these are becoming increasingly affordable and viable, and governments can help accelerate these trends, including by investing in charging and fueling infrastructure.

ELECTRIFICATION OF TRANSPORTATION:
Québec has committed to take significant action on the electrification of transportation by 2020, including by increasing the number of electric and plug-in hybrid vehicles registered in Québec to 100 000; adding 5000 electric-vehicle jobs and generating $500 million in investments; reducing the amount of fuel used each year in Québec by 66 million liters; and cutting annual GHG emissions from the transportation sector by 150 000 tonnes.

Shifting from higher- to lower-emitting modes of transportation includes things like riding public transit or cycling instead of driving a car, and transporting goods by rail instead of trucks. Improving public transit infrastructure and optimizing freight corridors can help drive these shifts.

Using cleaner fuels such as advanced biofuels can reduce the lifecycle carbon intensities of all fuels across transportation systems, as well as in other sectors like industry and buildings.

Taking these actions will have additional environmental and economic benefits beyond reducing GHG emissions. Efficiency improvements can help Canadians and businesses save money by spending less on fuel and reducing the costs of transporting goods. New, cleaner fuels can create opportunities for resource sectors. Businesses that develop new fuel and vehicle technologies will create jobs, help the economy grow, and give those businesses a competitive edge.

NEW ACTIONS

1. Setting emissions standards and improving efficiency

The federal government will continue its work to implement increasingly stringent standards for emissions from light-duty vehicles, including fuel-efficient tire standards, and to update emissions standards for heavy-duty vehicles.

The federal government will work with provinces, territories, and industry to develop new requirements for heavy-duty trucks to install fuel-saving devices like aerodynamic add-ons.

The federal government will take a number of actions to improve efficiency and support fuel switching in the rail, aviation, marine, and off-road sectors.

2. Putting more zero-emission vehicles on the road

Federal, provincial, and territorial governments will work with industry and other stakeholders to develop a Canada-wide strategy for zero-emission vehicles by 2018.

Federal, provincial, and territorial governments will work together, including with private-sector partners, to accelerate demonstration and deployment of infrastructure to support zero-emission vehicles, such as electric-charging stations.

3. Shifting from higher- to lower-emitting modes and investing in infrastructure

Federal, provincial, and territorial governments will work together to enhance investments in public-transit upgrades and expansions.

Federal, provincial, and territorial governments will invest in building more efficient trade and transportation corridors including investments in transportation hubs and ports.

Federal, provincial, and territorial governments will consider opportunities with the private sector to support refueling stations for alternative fuels for light- and heavy-duty vehicles, including natural gas, electricity, and hydrogen.

4. Using cleaner fuels

The federal government, working with provincial and territorial governments, industry, and other stakeholders, will develop a clean fuel standard to reduce emissions from fuels used in transportation, buildings and industry.

This will take into account the unique circumstances of Indigenous Peoples and northern and remote communities.

3.4 Industry

Canada's industries are the backbone of the economy, but they are also a major source of GHG emissions. In 2014, industrial sectors accounted for about 37 percent of Canada's emissions, the majority of which came from the oil and gas sector. Industrial emissions are projected to grow between now and 2030 as demand grows for Canadian-produced goods, at home and abroad.

A low-carbon industrial sector will rely heavily on clean electricity and lower-carbon fuels, will make more efficient use of energy, and will seize opportunities unlocked by innovative technologies. The province of Alberta has legislated an absolute cap of 100 Mt a year on emissions from the oil sands sector. There are a number of near-term opportunities to reduce industrial emissions while maintaining the competitive position of Canadian firms.

The approach to the industrial sector will include three main areas of action: (1) regulations to reduce methane and hydrofluorocarbon (HFC) emissions; (2) improving industrial energy efficiency; and (3) investing in new technologies to reduce emissions. Together, these actions will help set the path for long-term clean growth and the transition to a low-carbon economy.

Methane and HFCs are potent GHGs, dozens to thousands of times more powerful than carbon dioxide. The oil and gas sector is the largest contributor to methane emissions in Canada. Building on provincial actions and targets, the federal government has committed to reduce methane emissions by 40-45 percent by 2025. Canada joined almost 200 other countries in signing the Kigali Amendment to the Montreal Protocol, which will push the global phase out of HFC emissions. Taking action on HFCs can prevent up to 0.5 °C of global warming due to the potency of these gases, while continuing to protect the ozone layer.

There is significant potential to improve energy efficiency in Canada's industrial sectors. Energy management systems such as ISO 50001, the Superior Energy Performance program (SEP), and the ENERGY STAR for Industry program are useful tools that help businesses track, analyze, and improve their energy efficiency.

Using today's low-emission technologies and switching to clean electricity and lower-carbon fuels are near-term actions industry can take to reduce emissions. Over the longer-term, more dramatic emission reductions will be possible by using new technologies to transform how some industries operate. Investing in promising new technologies is an important area for action. Innovation will help Canadian businesses access global markets and attract foreign investment.

LOWER-CARBON INDUSTRIAL ACTIVITY IN CANADA:
Quebec's aluminum smelters have reduced their emissions by 30 percent since 1990. The modernized world-class aluminum smelter in Kitimat, BC will boost production and reduce emissions by nearly 50 percent. As a result of these investments, Canada's aluminum industry is now the most carbon-efficient producer of aluminum in the world.

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OIL SANDS INNOVATION:
COSIA (Canada's Oil Sands Innovation Alliance) is an alliance of 13 oil sands producers, representing 90 percent of production from the Canadian oil sands, who are working together to develop technologies that help reduce the environmental impact of the oil sands, including reducing GHG emissions. Member companies have shared 936 distinct environmental technologies, costing $1.33 billion, since coming together in 2012.

Taking these actions will benefit businesses. Strengthening energy performance is one of the most cost-effective ways for industry to reduce energy use, it generally has quick payback periods, and it will continually generate financial savings. Measures that help cut costs or develop new technologies can improve competitiveness and create jobs and export opportunities for the clean technology sector.

NEW ACTIONS

1. Reducing methane and HFC emissions

The federal government will work with provinces and territories to achieve the objective of reducing methane emissions from the oil and gas sector, including offshore activities, by 40-45 percent by 2025, including through equivalency agreements.

The federal government has introduced proposed regulations to phase down use of HFCs to support Canada's commitment to the Montreal Protocol amendment.

2. Improving industrial energy efficiency

Federal, provincial, and territorial governments will work together to help industries save energy and money, including by supporting them in adopting energy management systems.

3. Investing in technology

Federal, provincial, and territorial governments working with industry will continue to invest in research and development and to promote deployment of new technologies that help reduce emissions.

Federal, provincial, and territorial governments will also work with industry to identify demonstration projects for promising pre-commercial clean energy technologies required to reduce emissions from energy production and use in the Canadian economy, including in the oil and gas sector.

3.5 Forestry, agriculture, and waste

Emissions from agriculture (livestock and crop production) and extraction of forestry resources accounted for about 10 percent of Canada's emissions in 2014, and they are not projected to significantly change by 2030. Municipal waste accounts for a small portion (about 3 percent) of Canada's total GHGs, and these emissions are projected to decline, largely due to increases in landfill gas capture.

Agricultural soils and forests also absorb and store carbon. The emissions or removals from carbon sinks can fluctuate with natural disturbances (e.g. forest fires), but there are still a number of actions that can increase carbon storage and reduce emissions.

Forests, wetlands, and agricultural lands across Canada will play an important natural role in a low-carbon economy by absorbing and storing atmospheric carbon. Actions taken by jurisdictions and woodlot owners to accelerate reforestation, to continuously improve sustainable management practices, and to plant new forests where they do not currently exist will enhance stored carbon. Clean technology, such as lower-carbon bioenergy, and bioproducts that use feedstock from agriculture and forestry waste and dedicated crops to replace higher-carbon fuels can also reduce emissions. Continued innovation and clean technology in agriculture will build on past GHG reduction successes of decreasing emissions per unit of production. The municipal waste sector will also be a key source of cleaner fuels such as renewable natural gas from landfills.

The approach to these sectors will include (1) enhancing carbon storage in forests and agricultural lands; (2) supporting the increased use of wood for construction; (3) generating fuel from bioenergy and bioproducts; and, (4) advancing innovation.

Forests, wetlands, and agricultural lands can be enhanced as “carbon sinks” through actions such as planting more trees, improving forest carbon management practices, minimizing losses from fires and invasive species, restoring forests that have been affected by natural disturbances, and increasing adoption of land management practices like increasing perennial and permanent cover crops and zero-till farming. Protecting and restoring natural areas, including wetlands, can also benefit biodiversity and maintain or enhance carbon storage.

Increasing the use of wood for construction can reduce emissions as the carbon stored in that wood gets locked in for a long period of time. Increasing domestic demand for Canadian wood products will also support the vibrant forest industries across Canada, which have a long history of innovating to develop new products and more efficient and sustainable forest practices.

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The **Cheakamus Community Forest** carbon offset project is located adjacent to the Resort Municipality of Whistler, within the traditional territories of the Squamish and Lil'wat Nations. The project retains more carbon in the forest by using ecosystem-based management practices that include increasing protected areas and using lower-impact harvesting techniques.

The forestry, agriculture, and waste sectors also provide biomass for bioproducts that can be used in place of fossil fuels in other sectors. For example, waste products from forestry, agriculture, and landfills can be converted into energy sources such as renewable natural gas. Dedicated crops can be grown as feedstocks for products like bioplastics. Expanding renewable fuel industries represents an opportunity to create new jobs and economic growth across Canada.

BIOMASS-FIRED DISTRICT HEATING:

Prince Edward Island is home to Canada's longest running, biomass-fired district heating system. Operating since the 1980's, the system has expanded to serve over 125 buildings in the downtown core of Charlottetown, including the University of Prince Edward Island and the Queen Elizabeth Hospital, and cleanly burns 66 000 tons of waste materials annually.

Innovative solutions, including clean technologies, are required to reduce emissions from agriculture. Promising new technologies are being developed to reduce emissions from livestock and crop production, including from the use of precision farming and "smart" fertilizers, which time the release to match plant needs, and from feed innovations that reduce methane production in cattle. Actions pertaining to the agriculture sector will be developed collaboratively through Canada's Next Agriculture Policy Framework.

These actions in the forestry, agriculture, and waste sectors, and supporting clean technology businesses, can help to create jobs and build more sustainable communities.

NEW ACTIONS

1. Increasing stored carbon

Federal, provincial, and territorial governments will work together to protect and enhance carbon sinks, including in forests, wetlands, and agricultural lands (e.g. through land-use and conservation measures).

2. Increasing the use of wood for construction

Federal, provincial, and territorial governments will collaborate to encourage the increased use of wood products in construction, including through updated building codes.

3. Generating bioenergy and bioproducts

Federal, provincial, and territorial governments will work together to identify opportunities to produce renewable fuels and bioproducts, for example, generating renewable fuel from waste.

4. Advancing innovation

Federal, provincial, and territorial governments will work together to enhance innovation to advance GHG efficient management practices in forestry and agriculture.

3.6 Government leadership

Governments are directly responsible for a relatively small share of Canada's emissions (about 0.6 percent), but they have an opportunity to lead by example. A number of provinces are already demonstrating leadership, including through carbon neutral policies.

CARBON NEUTRAL GOVERNMENT:
British Columbia's public sector has successfully achieved carbon neutrality each year since 2010. Over the past 6 years, schools, post-secondary institutions, government offices, Crown corporations, and hospitals have reduced a total of 4.3 million tonnes of emissions through improvements to their operations and investments of $51.4 million in offset projects. British Columbia was the first—and continues to be the only—carbon neutral jurisdiction on the continent.

In a low-carbon, clean growth economy, federal, provincial, and territorial governments will be leaders in sustainable, low-emission practices that support the goals of clean growth and address climate change.

Municipalities are also essential partners. How cities develop and operate has an important impact on energy use and therefore GHG emissions.

LEADERSHIP BY CITIES:
The City of Whitehorse's Sustainability Plan outlines 12 community-wide goals in areas such as transportation, buildings, waste, GHG reductions, and resilient, accessible food systems, with associated targets for 2020, 2030, and 2050. For example, Whitehorse has set a target that new buildings will be 30 percent more efficient than the National Energy Code of Canada for Buildings, the National Building Codes, or achievable comparable EnerGuide ratings, while city-owned buildings will be 50 percent more efficient than the National Energy Code.

The public sector can play an important role by setting ambitious emissions reduction targets and by demonstrating the effectiveness of policies to reduce emissions (e.g. from vehicle fleets and buildings).

The approach to government leadership will include (1) setting ambitious targets; (2) cutting emissions from government buildings and fleets; and (3) scaling up clean procurement.

Governments control a significant share of assets like fleets and buildings. By setting targets and implementing policies to make buildings more efficient and to reduce emissions from vehicle fleets, the public sector can help to demonstrate the business case for ambitious action. Governments are also major purchasers and providers of goods and services, and they can help to build demand for low-carbon goods and services through procurement policies. They can also provide a testing ground for new and emerging technologies, creating new opportunities for Canadian firms developing clean technology products, services, and processes.

NEW ACTIONS

1. Setting ambitious targets

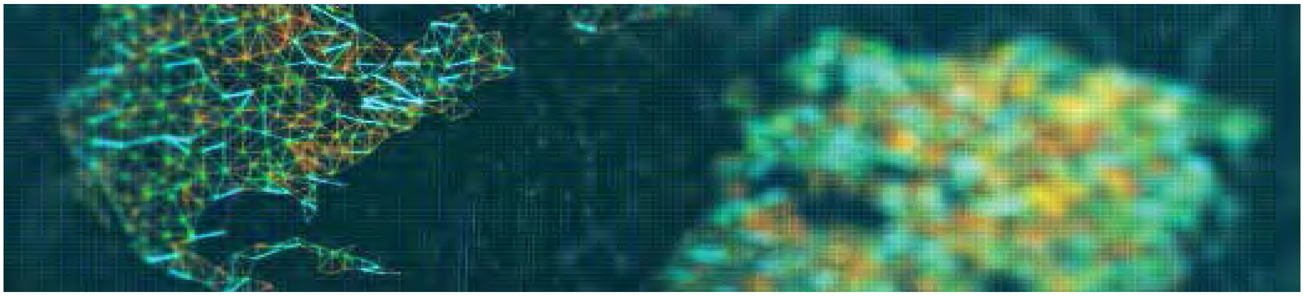
Federal, provincial, and territorial governments will demonstrate leadership through commitments to ambitious targets to reduce emissions from government operations. The federal government is committed to reduce its own GHG emissions to 40 percent below 2005 levels, by 2030 or sooner.

2. Cutting emissions from government buildings and fleets

Federal, provincial, and territorial government will scale up efforts to transition to highly efficient buildings and zero-emission vehicle fleets. The federal government has set a goal of using 100 percent clean power by 2025.

3. Scaling up clean procurement

Federal, provincial, and territorial governments will work together to modernize procurement practices, adopt clean energy and technologies, and prioritize opportunities to help Canadian businesses grow, demonstrate new technologies, and create jobs.



3.7 International leadership

Governments will work with their international partners, including developing countries, to help reduce emissions around the world. The federal government is investing $2.65 billion in climate finance to help developing countries transition to low-carbon economies and build climate resilience.

The priority is to first focus on reduction in emissions within Canada, but part of Canada's approach to climate change could also involve acquiring allowances for emissions reductions in other parts of the world, as a complement to domestic emissions reduction efforts. As recognized under the Paris Agreement (article 6), countries may choose to use emissions reductions that take place outside of their own borders, known as "internationally transferred mitigation outcomes", to meet their targets. Emissions reductions that take place outside of Canada may have lower costs and contribute to investment in sustainable development abroad. Quebec and California already participate in international emissions trading under their linked cap-and-trade system, which Ontario will soon join.

The approach to international leadership will include (1) delivering on Canada's international climate finance commitments; (2) acquiring internationally transferred mitigation outcomes; and (3) engaging in trade and climate policy.

Federal, provincial, and territorial governments will also explore mechanisms and opportunities for provinces and territories to collaborate in international fora, joint missions, and discussions on climate change and energy.

The federal government will continue to engage with and support Indigenous Peoples' action on international climate change issues, including through the United Nations Framework Convention on Climate Change, to formulate a platform for Indigenous Peoples, as agreed to in the Paris decision.

NEW ACTIONS

1. Delivering on Canada's international climate-finance commitments

The federal government will deliver on its historic commitment of $2.65 billion by 2020 to help the poorest and most vulnerable countries mitigate and adapt to the adverse effects of climate change.

2. Acquiring internationally transferred mitigation outcomes

The federal government, in cooperation with provincial and territorial governments and relevant partners, will continue to explore which types of tools related to the acquisition of internationally transferred mitigation outcomes may be beneficial to Canada and will advance a robust approach to the implementation of article 6 of the Paris Agreement. A first priority is ensuring any cross-border transfer of mitigation outcomes is based on rigorous accounting rules, informed by experts, which result in real reductions.

The federal government will work with Ontario, Quebec, and other interested provinces and territories, as well as with international partners, to ensure that allowances acquired through international-emissions trading are counted towards Canada's international target.

3. Engaging in trade and climate policy

The federal government, in cooperation with provincial and territorial governments, will work with its international partners to ensure that trade rules support climate policy.

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ADAPTATION AND CLIMATE RESILIENCE

Overview

The impacts of climate change are already being felt across Canada. These changes are being magnified in Canada's Arctic, where average temperature has increased at a rate of nearly three times the global average. They pose significant risks to communities, health and well-being, the economy, and the natural environment, especially in Canada's northern and coastal regions and for Indigenous Peoples. Indigenous Peoples are among the most vulnerable to climate change due to their remote locations and reliance on wild foods. The changes already being experienced are both dramatic and permanent, with significant social, cultural, ecological, and economic implications.

Taking action to adapt to current and future climate impacts will help protect Canadians from climate change risks, build resilience, reduce costs, and ensure that society thrives in a changing climate.

INUIT AND CLIMATE IMPACTS:
Inuit and Inuit Nunangat, the homeland of Inuit in Canada, are experiencing significant climate change impacts, as highlighted in Inuit Tapiriit Kanatami's recent report on Inuit Priorities for Canada's Climate Strategy. More than 70 per cent of Canada's coastline is located in the Arctic and it is defined by ice. Average sea ice thickness is decreasing and sea ice cover is now dominated by younger, thinner ice. Some models are projecting that summer sea ice cover could be almost completely lost before 2050. These changes are already impacting access to wild foods and contributing to hazards and risks on ice.

Developing adaptation expertise and technology can further contribute to clean growth by creating jobs and spurring innovation. Adaptation is a long-term challenge, and it requires ongoing commitment to action, leadership across all governments, strong governance to assess and sustain progress, adequate funding, and meaningful engagement with, and continued leadership by, Indigenous Peoples. Federal investments (see Annex I) will support key adaptation measures.

Federal, provincial, and territorial governments have identified new actions to build resilience to climate change across Canada in the following areas:

1. Translating scientific information and Traditional Knowledge into action
2. Building climate resilience through infrastructure
3. Protecting and improving human health and well-being
4. Supporting particularly vulnerable regions
5. Reducing climate-related hazards and disaster risks

4.1 Translating scientific information and Traditional Knowledge into action

Canadians need authoritative science and information to understand current and expected changes. This includes changing conditions (e.g., rainfall, temperature, and sea ice) and the impacts of climate change across Canada. Long-term monitoring and local observations are also key. Data, tools, and information need to be widely accessible, equitable, and relevant to different types of decision-makers in different settings.

Translating knowledge into action takes leadership, skilled people, and resources. The Government of Canada's Adaptation Platform supports collaboration among governments, industry, and professional organizations on adaptation priorities. Building regional expertise and capacity for adaptation will improve risk management; support land-use planning; help safeguard investments; and strengthen emergency planning, response, and recovery. Decision-making by all governments will be guided by consideration of scientific and Traditional Knowledge.

INFORMATION AND TOOLS FOR ADAPTATION DECISIONS:
Decision-makers in five Quebec coastal municipalities collaborated with researchers, notably from the Université du Quebec à Rimouski and from Ouranos, a regional climate and adaptation consortium, to explore solutions to repeated damage of coastal infrastructure. Projections of future erosion, studies of sea ice and coastal vulnerability due to climate change, and cost-benefit analyses provided the foundation for the municipalities to make decisions on an adaptation solution.

The approach to information, knowledge, and capacity building will include (1) providing authoritative climate information and (2) building regional adaptation capacity and expertise.

Ensuring Canadians across all regions and sectors have the capacity to make informed decisions and to act on them provides the foundation for advancing adaptation in Canada. Indigenous-led community-based initiatives that combine science and Traditional Knowledge can help guide decision making. Including this information in regional and national impacts and adaptation assessments can further advance understanding of climate change across the country.

NEW ACTIONS

1. Providing authoritative climate information

The federal government will establish a Canadian centre for climate services, to improve access to authoritative, foundational climate science and information. This centre will work with provincial and territorial governments, Indigenous Peoples and other partners to support adaptation decision making across the country.

2. Building regional adaptation capacity and expertise

Governments will work with regional partners, including with Indigenous Peoples through community-based initiatives, to build regional capacity, develop adaptation expertise, respectfully incorporate Traditional Knowledge, and mobilize action. Canada's Adaptation Platform and regional consortia and centres support the sharing of expertise and information among governments, Indigenous Peoples and communities, businesses, and professional organizations and support action on joint priorities.

4.2 Building climate resilience through infrastructure

Climate change is already impacting infrastructure, particularly in vulnerable northern and coastal regions, as well as Indigenous Peoples. Climate-related infrastructure failures can threaten health and safety, interrupt essential services, disrupt economic activity, and incur high costs for recovery and replacement.

The approach to building climate resilience through infrastructure will include (1) investing in infrastructure that strengthens resilience and (2) developing climate-resilient codes and standards.

Traditional built infrastructure (e.g. roads, dykes, seawalls, bridges, and measures to address permafrost thaw) can address specific vulnerabilities. Additionally, living natural infrastructure (e.g. constructed/managed wetlands and urban forests) can build the resilience of communities and ecosystems and deliver additional benefits, such as carbon storage and health benefits.

Considering climate change in long-lived infrastructure investments, including retrofits and upgrades, and investing in traditional and natural adaptation solutions can build resilience, reduce disaster risks, and save costs over the long term.

ADAPTATION INFRASTRUCTURE:
The Red River Floodway was originally constructed in 1968 at a total cost of $63 million. It was recently expanded in 2014, at a cost of $627 million. Since 1968, the Floodway has prevented over $40 billion (in 2011 dollars) in flood-related damages for the City of Winnipeg.

NEW ACTIONS

1. Investing in infrastructure to build climate resilience

Federal, provincial, and territorial governments will partner to invest in infrastructure projects that strengthen climate resilience.

2. Developing climate-resilient codes and standards

Federal, provincial, and territorial governments will work collaboratively to integrate climate resilience into building design guides and codes. The development of revised national building codes for residential, institutional, commercial, and industrial facilities and guidance for the design and rehabilitation of climate-resilient public infrastructure by 2020 will be supported by federal investments.

4.3 Protecting and improving human health and well-being

Climate change is increasingly affecting the health and well-being of Canadians (e.g. extreme heat, air pollution, allergens, diseases carried by ticks and insects, and food security). Indigenous Peoples and northern and remote communities in particular are experiencing unique and growing risks to health and vitality.

The approach to protecting and improving human health and well-being will include (1) taking action to address climate change related health risks and (2) supporting healthy Indigenous communities.

Adaptation actions with an inclusive view of well-being (e.g. social and cultural determinants of health and mental health) will keep Canadians healthy and reduce pressures on the health system.

NEW ACTIONS

1. Addressing climate change-related health risks

Governments will collaborate to prevent illness resulting from extreme heat events and to reduce the risks associated with climate-driven infectious diseases, such as Lyme disease. Federal adaptation investments will support actions including surveillance and monitoring, risk assessments, modelling, laboratory diagnostics, as well as health-professional education and public awareness activities. Efforts will also continue to advance the science and understanding of health risks and best practices to adapt.

2. Supporting healthy Indigenous communities

The federal government will increase support for First Nations and Inuit communities to undertake climate-change and health adaptation projects that protect public health.

The federal government will also work with the Métis Nation on addressing the health effects of climate change.

FOOD SECURITY AND SUSTAINABILITY – PLANNING FOR CLIMATE CHANGE IMPACTS IN ARVIAT, NUNAVUT:
With the goal of promoting and providing access to healthy foods, a community-based project in Arviat, **Nunavut** involved researchers and community youth to monitor and collect data on optimal growing conditions in the community greenhouse and to build capacity for its ongoing operation.

4.4 Supporting particularly vulnerable regions

The Indigenous Peoples of Canada, along with coastal and northern regions are particularly vulnerable and disproportionately affected by the impacts of climate change. Unlike rebuilding after an extreme event like a flood or a fire, once permafrost has thawed, coastlines have eroded, or socio-cultural sites and assets have disappeared, they are lost forever.

The approach to supporting vulnerable regions will include (1) investing in resilient infrastructure to protect vulnerable regions; (2) building climate resilience in the North; (3) supporting community-based monitoring in Indigenous communities; and (4) supporting adaptation in coastal areas.

Action taken to support adaptation in vulnerable regions can help communities, traditional ways of life, and economic sectors endure and thrive in a changing climate. The knowledge, expertise, technologies, and lessons from adaptation actions in vulnerable northern and coastal regions can benefit other vulnerable regions and sectors.

COLLABORATING TO ADDRESS CLIMATE IMPACTS IN THE NORTH:
Nunavut, the Northwest Territories, and Yukon hosted the Pan-Territorial Permafrost Workshop in 2013, which brought together front-line decision makers and permafrost researchers from each territory to share knowledge, form connections, and look at possibilities for adaptation in the future.

NEW ACTIONS

1. Investing in resilient infrastructure to protect vulnerable regions

Federal, provincial, and territorial governments will work together to ensure infrastructure investments help build resilience with Indigenous Peoples as well as in vulnerable coastal and northern regions.

2. Building climate resilience in the North

Federal, territorial, and northern governments and Indigenous Peoples will continue working together to develop and implement a Northern Adaptation Strategy to strengthen northern capacity for climate change adaptation. Federal investments to build resilience in the North and northern Indigenous Peoples will support this work.

3. Supporting community-based monitoring by Indigenous Peoples

The federal government will provide support for Indigenous communities to monitor climate change in their communities and to connect Traditional

Knowledge and science to build a better understanding of impacts and inform adaptation actions.

4. Supporting adaptation in coastal regions

Federal, provincial, and territorial governments will support adaptation efforts in vulnerable coastal and marine areas and Arctic ecosystems. Activities will include science, research, and monitoring to identify climate change impacts and vulnerabilities; the development of adaptation tools for coastal regions; and the improvement of ocean forecasting. This knowledge will help inform adaptation decisions related to fisheries and oceans management and coastal infrastructure. Federal adaptation investments will help advance this work.

SUPPORTING VULNERABLE COASTAL COMMUNITIES:
Through the Atlantic Climate Adaptation Solutions Project, **Newfoundland and Labrador, Nova Scotia, Prince Edward Island,** and **New Brunswick** partner together and with Indigenous communities, regional non-profits, and industry to develop practical tools and resources to help vulnerable coastal communities consider climate change in planning, engineering practices, and water and resource management. Examples include land-use planning tools, best practices, and risk assessments.

4.5 Reducing climate-related hazards and disaster risks

Climate change is impacting the intensity and frequency of events such as floods, wildfires, drought, extreme heat, high winds, and winter road failures. Recognizing this reality, Federal-Provincial-Territorial Ministers Responsible for Emergency Management are updating emergency management in Canada including work to mitigate disasters, review the Disaster Financial Assistance Arrangements, develop build-back better strategies, and collaborate on public alerting. Additionally, the Canadian Council of Forest Ministers is working on the establishment of the Canadian Wildland Fire Strategy, with climate change highlighted as a key challenge.

The approach to reducing climate-related hazards and disaster risks will include (1) investing in infrastructure to reduce disaster risks; (2) advancing efforts to protect against floods; and (3) supporting adaptation for Indigenous Peoples.

Disaster risk-reduction efforts and adaptation measures can reduce the negative impacts of these events, some of which have a disproportionate impact on Indigenous Peoples.

NEW ACTIONS

1. Investing in infrastructure to reduce disaster risks

Federal, provincial, and territorial governments will partner to invest in traditional and natural infrastructure that reduces disaster risks and protects Canadian communities from climate-related hazards such as flooding and wildfires.

2. Advancing efforts to protect against floods

Federal, provincial, and territorial governments will work together through the National Disaster Mitigation Program to develop and modernize flood maps and assess and address flood risks.

3. Supporting adaptation in Indigenous Communities

Governments will work in partnership with Indigenous communities to address climate change impacts, including repeated and severe climate impacts related to flooding, forest fires, and failures of winter roads. The federal government will provide support to Indigenous communities for adaptation.

FLOOD AND DROUGHT PROTECTIONS THROUGH WETLANDS RESTORATION:

Alberta's Watershed Resiliency and Restoration Program provided a grant to Ducks Unlimited to restore approximately 558 hectares of wetlands in the South Saskatchewan River basin for the purposes of water storage for flood and drought protection. Using historical imagery and LiDAR data to identify drained wetlands, project leads then work with and compensate landowners to restore wetlands on private land.

CLEAN TECHNOLOGY, INNOVATION, AND JOBS

Overview

Global demand for clean technologies is significant and increasing. Fostering and encouraging investment in clean technology solutions can facilitate economic growth, long-term job creation, and environmental responsibility and sustainability. Taking action on climate change will help to capture new and emerging economic opportunities, including for Indigenous Peoples and northern and remote communities. The window of opportunity exists for Canada to create the conditions for new clean technology investment and exports and seize growing global markets for clean technology goods, services, and processes.

To effectively compete in the global marketplace and capitalize on current and future economic opportunities, Canada needs a step change in clean technology development, commercialization, and adoption across all industrial sectors. Clarity of purpose, investment, and strong coordination that leverages pan-Canadian regional and provincial/territorial strengths are essential to seizing the economic growth and job-creation opportunities of clean technology. International research, development, and demonstration collaboration is also essential. Governments, Indigenous Peoples, industry, and other stakeholders all have a role to play and must be engaged.

5.1 Building early-stage innovation

To become a leader in the development and deployment of clean technologies, Canada needs a strong flow of innovative ideas.

Government investments in clean technology research, development, and demonstration will create the largest benefit where coordinated and focused in areas that will most effectively help Canada to meet its climate change goals, create economic opportunities, and expand global-market opportunities. Efforts to coordinate and focus investment must go beyond governments and involve the collaboration of industry, stakeholders, academia, and Indigenous Peoples in the innovation process. Canada must leverage its domestic strengths, which vary by region. Developing international partnerships will create new economic opportunities, build areas of shared expertise, and foster stronger bilateral relations.

Sustainable Development Technology Canada (SDTC) provides funding support to companies across Canada to develop, demonstrate, and deploy innovative new clean technologies. SDTC has also launched joint funding opportunities in collaboration with Emissions Reduction Alberta and Alberta Innovates and partners with the Ontario Centres of Excellence to enhance Ontario's Greenhouse Gas Innovation Initiative. SDTC estimates its projects have reduced annual emissions by 6.3 Mt of CO_2e, generated $1.4 billion in annual revenue and, in 2015, supported more than 9200 direct and indirect jobs.

Through its participation in Mission Innovation, the federal government has committed to double its investments in clean energy research and technology development over five years, while encouraging greater levels of private sector investment in transformative clean energy technologies. On November 14, 2016, Canada and 21 other Mission Innovation partners launched seven Innovation Challenges aimed at catalyzing global research efforts in areas that could provide significant benefits in reducing GHG emissions, increasing energy security, and creating new opportunities for clean economic growth.

NEW ACTIONS

1. Supporting early-stage technology development

Governments will support new approaches to early-stage technology development, including breakthrough technologies, to advance research in areas that have the potential to substantially reduce GHG emissions and other pollutants. Innovative partnerships with the private sector will make an important contribution to this effort.

2. Mission-oriented research and development

Governments will encourage new "mission-oriented" research approaches to focus RD&D facilities, programs, and supports on clean technology and environmental performance issues.

5.2 Accelerating commercialization and growth

Given Canada's small domestic market, Canadian firms must look to highly competitive international markets to achieve scale. Succeeding in the globally competitive clean technology marketplace requires globally competitive talent, access to the capital and resources needed to demonstrate the commercial viability of products, and strong international networks that facilitate the cross-border flow of clean technology goods and services.

Canadian clean technology producers and researchers are currently confronted by a myriad of programs and services, at the federal, provincial, and territorial level. Streamlining and integrating access to support programs and services is a priority for businesses and essential to building commercial capacity in this area.

Compared with other technology areas, clean technologies face unique challenges and often take longer to get to market, making access to "patient capital" important to successful commercialization. While federal and provincial governments already have a range of supports in place, key needs exist in terms of accessing venture capital as well as working capital and support for first, large-scale commercial projects or deployments.

20/20 Catalysts Program is a mentorship program that matches Indigenous and non-Indigenous project mentors with Indigenous mentees to promote knowledge sharing that will enable Indigenous communities to drive change towards clean technology business and economic development.

Further development of clean technologies could create new opportunities in Canada's resource sectors, increase the productivity and competitiveness of Canadian businesses, and create new employment opportunities, while also improving environmental performance. Canada will need to be able to access the skills and expertise of talented workers from around the world to enable Canadian businesses to succeed in the global marketplace. It will also be important to ensure a commitment to skills and training to provide Canadian workers with a just and fair transition to opportunities in Canada's clean growth economy.

Indigenous Peoples are leaders of change in the transition to a low-carbon economy. Indigenous governments, organizations, and businesses can play a key role in developing pathways for the adoption and adaptation of clean technology solutions for Indigenous Peoples.

Building stronger businesses and commercial capacity in all of Canada's regions is essential to taking advantage of new market opportunities. Support for new technology start-ups, through incubators and accelerators, is important to this effort. A strong, focused Canadian clean technology export strategy is needed to position Canada in growing and emerging global markets.

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MaRS Cleantech works closely with entrepreneurs and investors to create solutions in energy, water, agri-tech, advanced materials and manufacturing, and smart cities. Industry looks to MaRS Cleantech to assist with company growth and to remove complex technology-adoption barriers. MaRS supports high-impact businesses by connecting innovators with potential partners, customers, investors, talent, and capital. MaRS strives to build globally competitive companies and to drive clean technology innovation.

NEW ACTIONS

1. Access to government programs

Federal, provincial, and territorial governments will work together to create a coordinated "no-wrong door" approach to supporting Canadian clean technology businesses, ensuring full and effective access to the suite of government programs and services available to support their commercial success.

2. Increasing support to advance and commercialize innovative technologies

Governments will collaborate to enable access to capital for clean technology businesses to bring their products and services to market, including at the commercial-scale demonstration and deployment stages. This will include support for clean technology businesses in the natural resource sectors to improve both competitiveness and environmental performance.

3. Strengthening support for skills development and business leadership

Governments will work together to strengthen skills development and business-leadership capacity in support of the transition to a low-carbon economy.

VENTURE CAPITAL:
BDC Capital is launching a new $135 million venture capital fund to support Canadian energy and clean technology start-up businesses with global potential. The Industrial, Clean and Energy Technology (ICE) Venture Fund II will invest in 15 to 20 new high-impact Canadian start-up firms that demonstrate efficiency and strong scalability and will support the transition to a low-carbon economy. Fund II is a follow-on to BDC Capital's highly successful ICE Venture Fund I, which was launched in 2011 with investments of $287 million now under management.

4. Expedite immigration of highly qualified personnel

Governments will work together to enable expedited processing of visas and work permits for global talent, in particular for high-growth Canadian businesses such as those in the clean technology sector. This will attract top international talent and expand Canada's clean growth capacity.

5. Promoting exports of clean technology goods and services

Federal, provincial, and territorial governments will work collaboratively to strengthen clean technology export potential. This will include targeted export missions and the development of better market intelligence, addressing barriers to markets, support for export financing and marketing, and leveraging Canada's Trade Commissioner services.

6. Standards-setting

Governments will work together to exert a strong leadership role in international standards-setting processes for new clean technologies and to ensure that Canada's clean-technology capacity shapes future international standards.

5.3 Fostering adoption

The adoption of clean technology can create economic opportunities and improve environmental outcomes. Canada's performance on clean technology adoption by industry has significant room for improvement. Even amongst Canadian businesses that regularly adopt advanced technologies, clean technologies are the least likely to be adopted.

> **SmartICE** (Sea-ice Monitoring And Real-Time Information for Coastal Environments) is a partnership with community, academic, government, and industry participation. It is developing an integrated system to provide near-real-time information about coastal sea-ice travel and shipping, improving safety and the ability to adapt to changing climate conditions. The pilot program is preparing to expand across the Arctic through a northern social enterprise.

Pricing carbon pollution will send a market signal that can drive innovation among Canadian businesses and, in return, will make them more competitive, including by opening up access to new markets and reducing costs of deploying clean technologies.

There is significant potential for Canadian governments to "lead by example" as early adopters of clean technology serving an essential role as a first or "reference customer" for Canadian clean technology goods, services, and processes. Having a "first sale" in Canada would boost businesses' chances of securing sales abroad. Beyond direct federal, provincial, and territorial government operations, other bodies, such as municipalities and publicly regulated utilities, could become significant markets for and adopters of clean technology.

Done effectively, the adoption of clean technology could be a mechanism for improving environmental circumstances and creating economic opportunity for Indigenous Peoples and northern and remote communities. Effective engagement and partnership with Indigenous Peoples is essential to this effort.

Encouraging dialogue between regulators and industry could improve certainty in clean technology development and allow for more effective and responsible regulation.

NEW ACTIONS

1. Leading by example

Federal, provincial, and territorial governments will develop action plans for greening government operations and encourage utilities and municipalities and other public sector entities to adopt clean technologies to lead by example.

2. Supporting Indigenous Peoples and northern and remote communities to adopt and adapt clean technologies

Federal, provincial, and territorial governments will support Indigenous Peoples and northern and remote communities in adopting and adapting clean technologies, and ensuring business models support community ownership and operation of clean technology solutions.

3. Consumer and industry adoption

Federal, provincial, and territorial governments will work together to promote and encourage effective working relationships between regulators and industry, providing for early dialogue and effective guidance, which can assist in bringing new clean technologies to market quickly and responsibly.

Governments will also support visible and effective certification programs to ensure consumer and business confidence and support green procurement.

5.4 Strengthening collaboration and metrics for success

An effective approach to clean technology development, commercialization, and adoption in Canada requires coherent, collaborative, and focused approaches. This is true within individual governments and between Canadian jurisdictions. A collaborative approach between governments should take into account regional strategies and jurisdictional responsibilities.

Regular and ongoing discussions between federal, provincial, and territorial governments regarding clean technology and clean growth would help eliminate duplication of efforts and identify gaps in support for clean technology development. Engaging Indigenous Peoples, industry, and stakeholders as a routine component of this process would be important.

There is inadequate data on Canada's clean technology capacity and potential. Building better data, and clear metrics for tracing the impact of government activities, would properly focus these activities and ensure that they achieve intended, meaningful results.

NEW ACTIONS

1. Enhance alignment between federal, provincial, and territorial actions

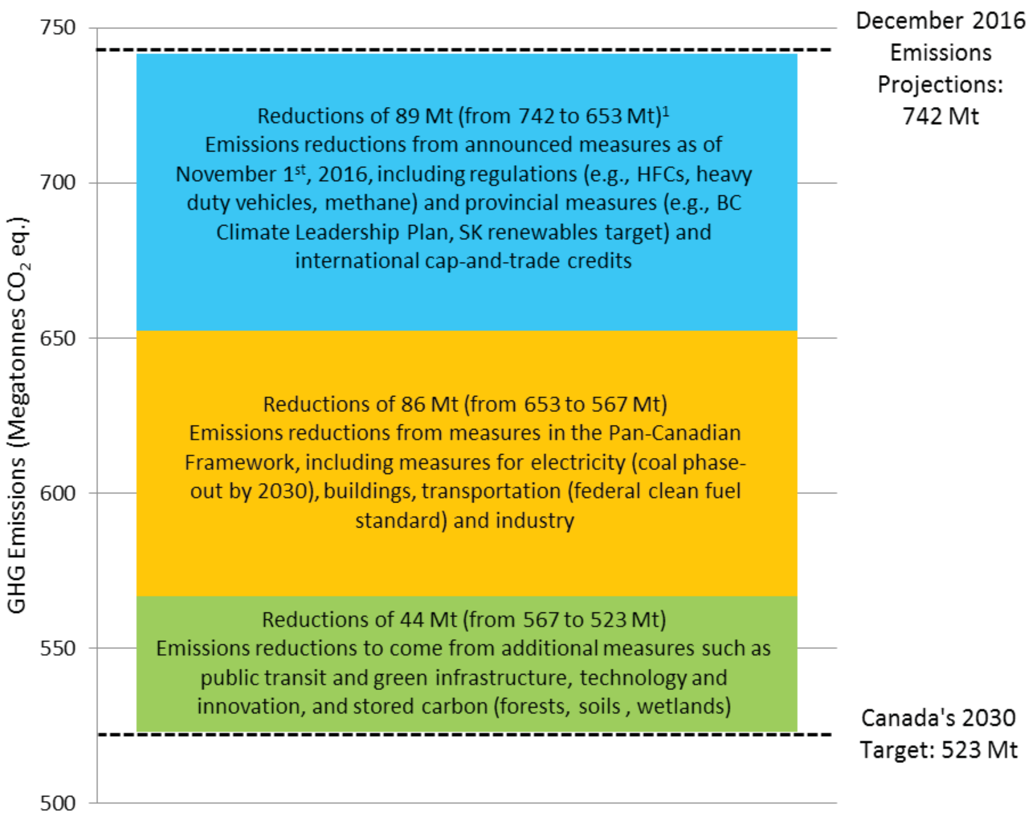
Governments will work together to improve policy and program coordination and sharing of data and best practices, which can sustain intergovernmental momentum and action on clean technology and clean growth. Continued partnership and engagement of Indigenous Peoples, industry, and stakeholders is essential to this effort.

Governments will work together to target and better align clean technology RD&D investments and activities in Canada, including opportunities for co-funding clean technology projects.

2. Establishing a clean technology data strategy

The federal government, working with the provinces and territories, will support the collection and regular publication of comprehensive data on clean technology in Canada to inform future government decision making, to improve knowledge in the private sector and stakeholder community, and to foster innovation.

PATHWAY TO MEETING CANADA'S 2030 TARGET



Note: Reductions from carbon pricing are built into the different elements depending on whether they are implemented, announced, or included in the Pan-Canadian Framework. The path forward on pricing will be determined by the review to be completed by early 2022.

[1] Estimates assume purchase of carbon credits from California by regulated entities under Quebec and Ontario's cap-and-trade system that are or will be linked through the Western Climate Initiative.

REPORTING AND OVERSIGHT

Overview

To help achieve the goals and actions laid out in this Pan-Canadian Framework, the programs and policies put in place will be monitored, results will be measured including impacts on GHG emissions, and actions and performance will be reported on publicly in a way that is transparent and accountable to Canadians. This public reporting will be complemented by ongoing public outreach, including with youth, inviting their contributions to Canada's action on clean growth and climate change. The effectiveness of actions will also be assessed with a view to ensuring continual improvement so as to increase ambition over time, in accordance with the Paris Agreement.

NEW ACTIONS

Measurement and reporting on emissions – Federal, provincial, and territorial governments will continue to collaborate on efforts to track and report GHG emissions in a consistent way across the country, to track progress on the Pan-Canadian Framework, and to support international reporting obligations. This will involve further technical work on measurement to improve emissions inventories and projections, and aligning these where possible. Federal, provincial, and territorial governments will work together through the Canadian Council of Ministers of the Environment (CCME) to examine options for the reporting of emissions and inventories to ensure consistency across provinces and territories, to support Canada's reporting to the UNFCCC, and for a pan-Canadian offset protocol framework and verified carbon credits that can be traded domestically and internationally.

Reporting on implementation – Federal, provincial, and territorial governments will work together to support the coordinated implementation of the Pan-Canadian Framework, engaging with relevant ministerial tables including ministers of environment, energy and mines, transportation, forestry, agriculture, innovation, infrastructure, emergency management, and finance, and with meaningful involvement of Indigenous Peoples. This will include a process to take regular stock of progress achieved, to report to Canadians and, to inform Canada's future national commitments in accordance with the Paris Agreement.

Analysis and advice – Federal, provincial, and territorial governments will engage with external experts to provide informed advice to First Ministers and decision makers; assess the effectiveness of measures, including through the use of modeling; and identify best practices. This will help ensure that actions identified in the Pan-Canadian Framework are open to external, independent review, and are transparent and informed by science and evidence.

Review - Federal, provincial, and territorial governments will work together to establish the approach to the review of carbon pricing, including expert assessment of stringency and effectiveness that compares carbon pricing systems across Canada, which will be completed by early 2022 to provide certainty on the path forward. An interim report will be completed in 2020 which will be reviewed and assessed by First Ministers. As an early deliverable, the review will assess approaches and best practices to address the competitiveness of emissions-intensive trade-exposed sectors.

Federal, provincial, and territorial governments will continue to engage and partner with Indigenous Peoples as actions are implemented and progress is tracked.

LOOKING AHEAD

This Plan provides a foundation for working together to grow the economy, reduce emissions, and strengthen resilience. Ongoing, collaborative action is needed to generate transformational change and to ensure that all Canadians benefit from the transition to a low-carbon economy. First Ministers are tasking their officials to develop an agenda for federal, provincial, and territorial Ministers to implement this Plan. Annual reports to First Ministers will enable governments to take stock of progress and give direction to sustain and enhance efforts.

ANNEX I: FEDERAL INVESTMENTS AND MEASURES TO SUPPORT THE TRANSITION TO A LOW-CARBON ECONOMY

FEDERAL INVESTMENTS

The federal government will help catalyze the transition to a clean growth economy through significant new investments to complement provincial and territorial actions and investments, including investments in infrastructure, the Low-Carbon Economy Fund, and clean technology funding.

- Budget 2016 outlined a number of new federal investments that will support a transition to a low-carbon economy. Some of these investments include
    - $62.5 million to support the deployment of infrastructure for alternative transportation fuels, including charging infrastructure for electric vehicles and natural gas and hydrogen refueling stations as well as demonstration of next generation recharging technologies;
    - $50 million over two years to invest in technologies that will reduce GHG emissions from the oil and gas sector;
    - $82.5 million over two years to support research, development, and demonstration of clean energy technologies with the greatest potential to reduce GHG emissions;
    - $100 million per year from the Regional Development Agencies to support clean technology, representing a doubling of thei existing annual aggregate support;
    - $50 million over four years to Sustainable Development Technology Canada (SDTC) for the SD Tech Fund. These resources will enable SDTC to announce new clean technology projects in 2016 that support the development and demonstration of new technologies that address climate change, air quality, clean water, and clean soil;

THE FEDERAL GOVERNMENT HAS COLLABORATED WITH THE FEDERATION OF CANADIAN MUNICIPALITIES ON THE GREEN MUNICIPAL FUND (GMF) SINCE 2000.

- Budget 2016 provided an additional $125 million over two years including for projects that reduce GHG emissions.
- Recently announced projects under the GMF include a $31.5 million investment for 20 new sustainable municipal projects, such as Canada's first net-zero municipal library and Halifax's ground-breaking Solar City project.

» $40 million over five years to integrate climate resilience into building design guides and codes. The funding will support revised national building codes by 2020 for residential, institutional, commercial, and industrial facilities;
» $129.5 million to implement programming focused on building the science base to inform decision making, protecting the health and well-being of Canadians, building resilience in the North and Indigenous communities, and enhancing competitiveness in key economic sectors; and
» $10.7 million over two years to implement renewable energy projects in off-grid Indigenous and northern communities that rely on diesel and other fossil fuels to generate heat and power.

- Building on the infrastructure investments outlined in Budget 2016, the federal government has announced an additional $81 billion over 11 years for investments in public transit, social infrastructure, transportation that supports trade, Canada's rural and northern communities, smart cities, and green infrastructure.
- Green infrastructure funding will support projects that reduce GHG emissions, enable greater climate change adaptation and resilience, and ensure that more communities can provide clean air and safe drinking water for their citizens. Specific projects could include interprovincial transmission lines that reduce reliance on coal, the development of new low-carbon/renewable power projects, and the expansion of smart grids to make more efficient use of existing power supplies.
- The federal government is proposing the creation of the Canada Infrastructure Bank that will work with provinces, territories, and municipalities to further the reach of government funding directed to infrastructure. The Canada Infrastructure Bank will be responsible for investing at least $35 billion on a cash basis from the federal government into large infrastructure projects that contribute to economic growth through direct investments, loans, loan guarantees, and equity investments.
- Funding under the $2 billion Low Carbon Economy Fund will begin in 2017. This Fund will support new provincial and territorial actions to reduce emissions between now and 2030. Projects will focus on concrete measures that generate new, incremental reductions, while considering cost-effectiveness.
- The Government has also committed more than $1 billion, over four years, to support clean technology including in the forestry, fisheries, mining, energy and agriculture sectors.

FEDERAL CARBON PRICING BENCHMARK

The federal government outlined a benchmark for carbon pricing that reflects the principles proposed by the Working Group on Carbon Pricing Mechanisms and the Vancouver Declaration. Its goal is to ensure that carbon pricing applies to a broad set of emission sources throughout Canada with increasing stringency over time to reduce GHG emissions at lowest cost to business and consumers and to support innovation and clean growth.

The benchmark includes the following elements:

1. Timely introduction.

All jurisdictions will have carbon pricing by 2018.

2. Common scope.

Pricing will be based on GHG emissions and applied to a common and broad set of sources to ensure effectiveness and minimize interprovincial competitiveness impacts. At a minimum, carbon pricing should apply to substantively the same sources as British Columbia's carbon tax.

3. Two systems.

Jurisdictions can implement (i) an explicit price-based system (a carbon tax like British Columbia's or a carbon levy and performance-based emissions system like in Alberta) or (ii) a cap-and-trade system (e.g. Ontario and Quebec).

4. Legislated increases in stringency, based on modelling, to contribute to our national target and provide market certainty.

For jurisdictions with an explicit price-based system, the carbon price should start at a minimum of $10 per tonne in 2018 and rise by $10 per year to $50 per tonne in 2022.

Provinces with cap-and-trade need (i) a 2030 emissions-reduction target equal to or greater than Canada's 30 percent reduction target and (ii) declining (more stringent) annual caps to at least 2022 that correspond, at a minimum, to the projected emissions reductions resulting from the carbon price that year in price-based systems.

5. Revenues remain in the jurisdiction of origin.

Each jurisdiction can use carbon-pricing revenues according to their needs, including to address impacts on vulnerable populations and sectors and to support climate change and clean growth goals.

6. Federal backstop.

The federal government will introduce an explicit price-based carbon pricing system that will apply in jurisdictions that do not meet the benchmark. The federal system will be consistent with the principles and will return revenues to the jurisdiction of origin.

7. Five-year review.

The overall approach will be reviewed by early 2022 to confirm the path forward, including continued increases in stringency. The review will account for progress and for the actions of other countries in response to carbon pricing, as well as recognition of permits or credits imported from other countries.

8. Reporting.

Jurisdictions should provide regular, transparent, and verifiable reports on the outcomes and impacts of carbon pricing policies.

The federal government will work with the territories to address their unique circumstances, including high costs of living, challenges with food security, and emerging economies.

OTHER RECENT FEDERAL MEASURES

The federal government has also recently announced new federal measures, including

- During the North American Leaders Summit in June 2016, the federal government made joint commitments with the United States and Mexico to
  - » phase out fossil fuel subsidies by 2025. The commitment was reaffirmed by G-20 countries in September 2016.
  - » reduce methane emissions from the oil and gas sector by 40 to 45 percent below 2012 levels by 2025.
- On October 15, 2016, Canada signed onto the Kigali Amendment to the Montreal Protocol and committed to propose new regulations to significantly reduce HFC consumption and prohibit the manufacture and import into Canada of certain products containing HFCs. These proposed regulations were published on November 26, 2016. This is additional to measures already introduced to increase the recovery, recycling, and destruction of HFCs in refrigeration and air conditioning equipment and to established regulatory provisions for an HFC reporting system.
- On November 17, 2016, Canada released its Mid-Century Long-Term Low-Greenhouse Gas Development Strategy. The mid-century strategy describes various pathways for innovative and creative solutions. Canada's mid-century strategy is not a blueprint for action nor is it policy prescriptive. It is based on modelling of different scenarios and looks beyond 2030 to start a conversation on the ways we can reduce emissions for a cleaner, more sustainable future by 2050. As a result, it will be a living document.
- On November 21, 2016, the federal government announced that it would be amending its existing coal-fired electricity regulations to accelerate the phase out of traditional coal-fired electricity by 2030. The federal government also announced that, to support the transition away from coal towards cleaner sources of generation, performance standards for natural gas-fired electricity are also being developed.
- On November 25, 2016, the federal government announced that it will consult with provinces and territories, Indigenous Peoples, industries, and non-governmental organizations to develop a clean fuel standard. It is expected that once developed, a clean fuel standard would promote the use of clean technology and lower carbon fuels, and promote alternatives such as electricity, biogas, and hydrogen.

ANNEX II: PROVINCIAL AND TERRITORIAL KEY ACTIONS AND COLLABORATION OPPORTUNITIES WITH THE GOVERNMENT OF CANADA

INTRODUCTION

The Paris Agreement and the Vancouver Declaration have set an ambitious course for low carbon growth and climate action in Canada. The Pan-Canadian Framework on Clean Growth and Climate Change will build on the leadership shown and actions taken by the provinces and territories as well as new policies announced by the federal government.

This annex outlines provincial and territorial accomplishments in reducing greenhouse gas emissions and accelerating clean growth, and presents steps that each jurisdiction has taken or is taking to implement carbon pricing.

The annex also outlines areas where the federal government and each provincial and territorial government will work together to implement the Pan-Canadian Framework in order to spur growth and jobs for Canadians, reduce our emissions and adapt to climate change.

Each province and territory is unique and is responding to the urgency of climate change and the opportunity offered by clean growth in its own way. Effective action will require close collaboration between governments. Each provincial and territorial government has identified multiple areas for potential partnerships with the federal government, adapted to their own priorities, circumstances and strengths. Governments are committed to working together on these priorities to support the implementation of the Pan-Canadian Framework. Governments will also engage the contributions of Indigenous Peoples in advancing shared goals.

This work will be supported by significant new federal investments to drive the transition to a clean growth economy, as outlined in Budget 2016 and the 2016 Fall Economic Statement, including public transit and Green Infrastructure, the Canada Infrastructure Bank, the Low-Carbon Economy Fund, and funding for clean technology and innovation. Federal investments are intended to supplement and accelerate investments by provinces and territories, and will follow applicable program criteria.

BRITISH COLUMBIA

KEY ACTIONS TO DATE

Some of the key actions taken to date or under development in British Columbia include:

British Columbia's Climate Leadership Plan

B.C. has proven that it is possible to reduce emissions while growing the economy and creating jobs and it's important that this balance be maintained. With this in mind, B.C. released its Climate Leadership Plan in the summer of 2016.

Building on the comprehensive foundation established in 2008, the plan lays out a series of targeted, sector-specific actions that will reduce emissions by 25 million tonnes (Mt) of carbon dioxide equivalent (CO_2e) and create 66,000 jobs. The plan will be further strengthened in the months and years ahead, as B.C. continues to work with First Nations, the federal government, communities, industry and others. B.C. is committed to reducing GHG emissions by 80% below 2007 levels by 2050. To read B.C.'s Climate Leadership Plan, visit: http://climate.gov.bc.ca/

Revenue-Neutral Carbon Tax

B.C. has the highest broad-based carbon tax in North America. The carbon tax sets a transparent and predictable price on carbon while returning all revenue to B.C. individuals and businesses. The price signal creates a real incentive to reduce emissions across the economy and is the backbone of B.C.'s approach to climate action.

Forestry

B.C.'s forests offer potential for storing carbon, so the Province is taking further action to rehabilitate up to 300,000 hectares of Mountain Pine Beetle and wildfire impacted forests over the first five years of the program; recover more wood fibre; and avoid emissions from burning slash.

Clean LNG

B.C. has an abundance of natural gas, which is a lower carbon fuel that will play a critical role in transitioning the world economy off of high carbon fuels such as coal. B.C. is developing the resource responsibly, and provincial legislation will make the emerging LNG sector the cleanest in the world. B.C. is also electrifying upstream development of natural gas and will require a 45% reduction in methane emissions by 2025.

100% Clean Electricity

Thanks to significant historical investments, B.C.'s electricity is already 98% clean or renewable and British Columbians have the third-lowest residential rates in North America. Going forward under the Climate Leadership Plan, 100% of the supply of electricity acquired by BC Hydro for the integrated grid must be from clean or renewable sources. The $8.3 billion Site C Clean Energy Project is a major part of B.C.'s clean energy future and will create enough electricity to power 450,000 homes.

Clean Transportation

B.C. is taking real action to reduce emissions from the transportation sector and help British Columbians make greener choices—initiatives include Zero Emissions Vehicles rebates and funding for more charging stations (which have helped BC become the Canadian leader in clean energy vehicle sales per capita); a scrap-it program; low carbon and renewable fuel standards; and historic investments in transit. B.C.'s actions in the transportation sector have already reduced annual emissions by an estimated 2.5 Mt and combined with the new actions, will reduce annual emissions by up to a further 3.4 Mt by 2050.

Adaptation

In 2010, the Province created a comprehensive strategy to address the changes we will see as a result of climate change. It is based on three key strategies: build a strong foundation of knowledge and tools; make adaptation a part of government business; and assess risks and implement priority adaptation actions in key climate sensitive sectors. The Province is now working with the federal government and other Canadian jurisdictions to further improve the management of the risks associated with a changing climate.

These actions provide a strong contribution to a comprehensive pan-Canadian framework.

ACTION ON PRICING CARBON POLLUTION

B.C.'s revenue-neutral carbon tax has been in place since 2008. It is set at $30/tonne and covers approximately 75% of the province's economy. All revenues generated will be returned to tax payers. B.C. will assess the interim study in 2020 and determine a path forward to meet climate change objectives.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

British Columbia and the Government of Canada intend to collaborate in the following domains of priority to address climate change and advance clean growth:

Growing our forests; reducing our emissions

Forests present a unique opportunity to address climate change because trees absorb CO_2 when they grow. British Columbia, the Government of Canada and First Nations will work together to reduce GHG emissions through forestry activities, including reforestation, enhanced silviculture techniques, and the salvaging of unmerchantable trees for processing into dimensional lumber and bioenergy. The initiative is expected to reduce emissions by 12 Mt in 2050 and create 20,000 jobs.

Preparing for and adapting to climate change

British Columbia and the Government of Canada will support projects across the province to make infrastructure more resilient to a changing climate, and to help communities adapt to a changing climate. Flood mitigation will be an area of focus.

Reduce Emissions from Natural Gas Activities

British Columbia and the Government of Canada will work together to bring clean grid electricity to natural gas operations in northeast B.C. They will co-fund the construction of new transmission lines and other public electrification infrastructure that could serve up to 760 megawatts of upstream natural gas processing load and avoid up to 4 Mt of emissions per year.

Electricity Grid Interconnection

British Columbia and the Governments of Canada and Alberta will work together to restore the capability of the existing high-voltage electricity grid interconnection with Alberta. This project will improve access to clean electricity in Alberta and will result in lower GHG emissions and air pollution, and improved grid reliability in both provinces.

Clean Technology Innovation

British Columbia and the Government of Canada will work together to spur the development and commercialization of new technologies that will reduce emissions and create jobs for Canadians.

ALBERTA

KEY ACTIONS TO DATE

Some of the key actions taken to date or under development in Alberta include:

Climate Leadership Plan

The Climate Leadership Plan is a made-in-Alberta climate change strategy, specifically designed for Alberta's unique economy. While details of the final strategy are still being developed, the Alberta government has moved forward on a number of key areas.

Clean Electricity

Alberta will phase-out GHGs from coal-fired power plants and achieve 30% renewable energy by 2030.

Alberta will add 5,000 megawatts of renewable energy capacity by 2030 through the Renewable Electricity Program. To meet this target, investment in Alberta's electricity system will be solicited through a competitive and transparent bidding process, while ensuring projects come online in a way that does not impact grid reliability and is delivered at the lowest possible cost to consumers.

A new provincial agency, Energy Efficiency Alberta, has been created to promote and support energy efficiency and community energy systems for homes, businesses and communities.

Capping Oil Sands Emissions

A legislated maximum emissions limit of 100 Mt in any year, with provisions for cogeneration and new upgrading capacity, will help drive technological progress.

Reducing Methane Emissions

Alberta will reduce methane gas emissions from oil and gas operations by 45% by 2025.

Innovation and Technology

Alberta is investing in innovation and technology to reduce GHGs, encourage a more diversified economy and energy industry, and create new jobs, while improving opportunities to get the province's energy products to new markets. Alberta has created a task force that will make recommendations on a Climate Change Innovation and Technology Framework.

These actions provide a strong contribution to a comprehensive pan-Canadian framework.

ACTION ON PRICING CARBON POLLUTION

A carbon levy to be included in the price of all fuels that emit greenhouse gases when combusted, including transportation and heating fuels such as diesel, gasoline, natural gas and propane. The levy will be applied at a rate of $20/tonne on January 1, 2017 and will increase to $30/tonne one year later.

The Climate Leadership Plan is designed for Alberta's economy. The economic impact of carbon pricing is expected to be small, and every dollar will be reinvested back into the local economy. Reinvesting carbon revenue in our economy will diversify our energy industry by investing in large scale renewable energy, bioenergy initiatives, and transformative innovation and technology. Over the next 5 years:

$6.2 billion will help diversify our energy industry and create new jobs:

- $3.4 billion for large scale renewable energy, bioenergy and technology

- $2.2 billion for green infrastructure like transit
- $645 million for Energy Efficiency Alberta

$3.4 billion will help households, businesses and communities adjust to the carbon levy:

- $2.3 billion for carbon rebates to help low- and middle-income families
- $865 million to pay for a cut in the small business tax rate from 3% to 2%
- $195 million to assist coal communities, Indigenous communities and others with adjustment

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

Alberta and the Government of Canada intend to collaborate in the following domains of priority to address climate change and advance clean growth:

Clean Electricity

Alberta and the federal government will to work together to advance renewable energy, coal to natural gas conversion, and potential hydroelectric projects, including pump storage projects. Alberta is committed to developing incentives for renewable generation in a manner that is compatible with Alberta's unique electricity market.

B.C. – Alberta Intertie

Alberta is working with British Columbia and the federal government to explore new and enhanced interties. The Alberta Electric System Operator is currently working with BC Hydro and industry on a key project, the restoration of the B.C.-Alberta 950 MW intertie to its full path rating (expected completion is in 2020). This restoration would allow imports of 1200 MW on the BC-AB intertie.

Innovation and Technology

Alberta is focused on the opportunity to leverage environmental policies and programs into new manufacturing, innovation, and clean technology businesses. Current opportunities include superclusters, advanced sensor technology for environmental applications including methane monitoring and reductions, and municipal waste diversion. Innovative solutions will result in meaningful GHG reductions across Canada and the export of solutions to promote a lower carbon world.

Disaster Mitigation / Infrastructure

Alberta is undertaking targeted work to address the hazards to which Albertans are vulnerable, including flood, wildfire, heat, drought, landslides, and wind.

While hazards and disaster risks have always been a concern, climate change is driving the need to adapt to more intense and frequent events. Federal support for wildfire mitigation infrastructure will reduce the risk of wildland fires. In addition, flood risk requires immediate mitigation infrastructure such as dykes and dams. Federal partnership on these initiatives will support risk management.

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ONTARIO

KEY ACTIONS TO DATE

Some of the key actions taken to date or under development in Ontario include:

Permanent Closure of Coal-fired Electricity Generating Stations

On April 15, 2014, Ontario became the first jurisdiction in North America to fully eliminate coal as a source of electricity generation. This action is the single largest GHG reduction initiative in North America. On November 23, 2015, Ontario passed the *Ending Coal for Cleaner Air Act*, permanently banning coal-fired electricity generation in the province.

Ontario's Climate Change Strategy and Action Plan

On November 24, 2015, Ontario released its Climate Change Strategy setting the framework for the province to meet its long-term 2050 GHG emissions reduction target. The Strategy highlights five key objectives for transformation:

1. A prosperous low-carbon economy with world-leading innovation, science and technology
2. Government collaboration and leadership
3. A resource-efficient, high-productivity society
4. Reducing GHG emissions across sectors
5. Adapting and thriving in a changing climate

On June 8, 2016, Ontario released its Climate Change Action Plan to implement the strategy over the next five years and put Ontario on the path to achieve its longer term objectives. Policies and programs identified in the Action Plan include:

- Transforming how ultra-low and carbon-free energy technologies are deployed in our homes and workplaces, and how we move people and goods
- Halting rising building-related emissions, with a focus on helping homeowners and small businesses move to low- and zero-carbon energy
- Making available funding for industries and manufacturers proposing to transform their operations and move off carbon-based fuels and peak electricity
- Aligning Ontario's R&D and innovation funding to place a greater emphasis on climate change science and technologies, with a view to making the discoveries that could lead to breakthroughs in zero-carbon technology

Ontario has made measurable progress in reducing GHGs. According to Environment and Climate Change Canada's 2016 National Inventory Report, from 2005 to 2014, Ontario's emissions decreased by 41 Mt (-19%), over the same period, Canada-wide emissions fell by 15 Mt (-2%).

These actions provide a strong contribution to a comprehensive pan-Canadian framework.

ACTION ON PRICING CARBON POLLUTION

On May 18, 2016, Ontario passed its landmark *Climate Change Mitigation and Low-carbon Economy Act,* which creates a long term framework for climate action. The Act creates a robust framework for cap and trade program, ensures transparency and accountability on how any proceeds collected under the program are used and enshrines emission reduction targets in legislation.

Ontario's approach, including its cap and trade program and associated emissions reduction targets, will exceed the standards of the federal carbon pricing benchmark. Ontario's targets are:

- 15% below 1990 levels by 2020;
- 37% below 1990 levels by 2030; and
- 80% below 1990 levels by 2050.

Ontario is a founding member of the Western Climate Initiative (WCI), a not-for-profit organization established in 2008 to help member states and provinces execute their cap and trade programs. In 2017, Ontario will link its cap and trade system with those of WCI members Quebec and California to create the largest cap and trade system in North America.

Ontario will set a cap on total emissions from the covered sectors in 2017 based on the forecast emissions for large final emitters, electricity generation and transportation and heating fuels. Allowances will then be created in an amount equal to the cap and either sold or provided free-of-charge to Ontario emitters.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

Ontario and the Government of Canada intend to collaborate in the following domains of priority to address climate change and advance clean growth:

Invest in Zero Emission Transportation and Infrastructure

Ontario is committed to increase uptake of zero emission passenger and commercial vehicles, both by providing purchasing incentives and by expanding the EV charging network across Ontario. In its 2016 budget, the federal government committed to support the deployment of alternative transportation fuel infrastructure, including electric charging stations. Ontario and the Government of Canada will work together to support the deployment of EV vehicles through enabling infrastructure.

Invest in Other Zero Emission Transportation

Ontario seeks a partnership with the Government of Canada to support enabling infrastructure that will increase the availability and use of lower carbon fuels, including LNG, increase the use of low carbon trucks and buses and increase the availability of LNG fueling infrastructure. Ontario is dedicating significant resources for these additional transportation initiatives. Expected emissions reductions in the transportation sector overall are 2.45 Mt in 2020.

Assist with Building Retrofits, Energy Audits and Technology Deployment

Ontario seeks a partnership with the Government of Canada as the province develops programs for fuel switching and energy efficiency, such as retrofits for existing residential buildings (including targeted initiatives for low-income households), and clean technologies for industries and small and medium enterprises. Partnership would increase investment in this area, allowing acceleration and scaling up of progress.

Ontario Climate Modelling Services Consortium

Ontario seeks a partnership with the Government of Canada to build regional capacity and support adaptation actions. Ontario plans to establish an Ontario Climate Modelling Services Consortium, which would act as a one window source of data to help the public and private sectors make evidence-based decisions.

The Consortium would operate at arm's length from government. Ontario would seek partnerships with other governments, non-governmental organizations and the private sector to ensure the organization's effectiveness and long term success. The Consortium would also be expected to develop service fee revenue streams to contribute to the organization's fiscal sustainability.

Electricity Transmission

Ontario, in collaboration with the Government of Canada, will work with its regional partners to advance opportunities to expand and upgrade electricity transmission infrastructure to support clean hydroelectric power to displace the production of electricity from fossil fuels.

Ontario will also collaborate with the Government of Canada to accelerate access to clean electricity in remote Indigenous communities. This will lessen dependence on expensive diesel fuel and reduce greenhouse gas emissions and air pollution.

QUÉBEC

KEY ACTIONS TO DATE

Some of the key measures taken to date by Québec, which has the lowest greenhouse gas emissions per capita between the provinces in Canada, include:

2013-2020 Action Plan on Climate Change (PACC 2013-2020)

PACC 2013-2020 will reduce GHG emissions by 20% below the 1990 level by 2020. Among its other measures, the action plan offers financial help to the different stakeholders of Québec society so they can reduce their energy consumption, improve their practices, innovate and adjust. The work surrounding the development of the actions of Québec after the 2020 period is underway, in particular to reduce GHG emissions of the province by 37.5 % below the 1990 level by 2030.

2016-2030 Energy Policy

The Energy Policy will favour a transition to a low carbon footprint economy, chiefly by improving energy efficiency by 15%, by reducing petroleum consumption by 40%, and by increasing the production of renewable energies by 25%. Québec is one of the world's main producers of renewable energy, which represents 99.8% of its total electricity production.

2013-2020 Governmental Climate Change Adjustment Strategy

The Strategy will mitigate the impact of climate change on the environment, the economy and the communities, and will strengthen the resiliency of Québec society. The government of Québec has, notably, invested in the Ouranos consortium in order to get a better understanding of the impact of climate change on its territory, and to better inform the decision-making process and the development of solutions.

2015-2020 Transport Electrification Plan

Québec targets 100,000 electric vehicles on the road in 2020 and one million in 2030. The zero-emission vehicle (ZEV) standard adopted in October 2016 will encourage automotive manufacturers to improve their offer of ZEV, and the investments in electrification will allow Québec to build up its available renewable energies, its expertise and its world-class know-how.

These measures represent a major contribution at the Pan-Canadian level.

ACTION ON PRICING CARBON POLLUTION

Pioneer in the use of cap-and-trade systems for greenhouse gas emissions allowances, Québec`s system has been linked to California's since 2014, and will soon be linked to that of Ontario. It represents the largest carbon market in North America, and is often referred to as an example of performance and rigour. Because it is based on hard caps to reduce GHG emissions, it is a robust and efficient tool to achieve the ambitious mitigation goals Québec has set for itself for 2020 and 2030.

Furthermore, auction revenues from its cap-and-trade system are entirely reinvested in measures that will spur the transition of Québec's economy to a more resilient and low-carbon one. This comprehensive approach, tailored to the needs and specificities of Québec, allows Québec to fulfill its leadership role in the fight against climate change in North America and internationally.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

The governments of Québec and Canada intend to collaborate in the following priority areas in order to fight climate change and allow clean economic growth:

Electric and Public Transport

Support the development of the offer and infrastructure of electric and public transport, by completing various projects such as the Metropolitan Electric Network (MEN), the implementation of bus rapid transit (BRT) systems between Montreal and Laval, the extension of the BRT in Gatineau, and the implementation of a BRT in Québec.

Energy Efficiency and Conversion

Speed up the reduction of GHG emissions in Northern communities, as well as on the Lower North Shore and Magdalen Islands, by replacing diesel with renewable energy sources for the electricity supply of their free-standing network.

Promote the implementation of energy performance and efficiency standards for new buildings, as well as for the renovation of existing buildings. Invest in the industrial sector to improve the energy performance of fixed production processes, by providing innovative technologies and reducing the use of gases with high warming potential such as hydrofluorocarbons, which Québec will continue to prioritize.

Recognition of the International Trade of Emission Rights

Contribute to the implementation of Articles 6 and 13 of the Paris Accord, to which the accounting and disclosure principles of the Western Climate Initiative (WCI) can contribute, as well as within a possible agreement between Canada and the United States regarding the accounting and attribution of "internationally transferred mitigation outcomes" as part of the contributions determined at national level (CDN).

Québec will also share with the government of Canada a detailed methodology, developed in collaboration with California and soon Ontario, in order to tabulate in its international reports the emission reductions achieved by Québec thanks to the carbon market.

Innovation and Adjustment to Climate Change

Promote innovation in green technology and GHG emission reduction, and collaborate on increasing the resiliency of the communities affected by climate change, by assessing the vulnerabilities and risks, adjusting land planning and use, and designing sustainable projects.

Québec will provide its expertise to the initiatives of the government of Canada, focusing in particular on joint financing of prevention and protection infrastructure against certain natural disasters linked to climate change.

NEW BRUNSWICK

KEY ACTIONS TO DATE

Some of the key actions taken to date or under development in New Brunswick include:

Transitioning to a Low-Carbon Economy: New Brunswick's Climate Change Action Plan

The Climate Change Action Plan outlines a bold vision for New Brunswick and sets renewed GHG reduction targets: 2030 target of 35% below 1990 levels; and 80% below 2001 levels by 2050. The plan also address other commitments, such as the Canadian Energy Strategy, released by the Council of the Federation in 2015, and contains a Climate Change Adaptation Strategy supported by actions to build resilience into New Brunswick communities, businesses, infrastructures and natural resources.

The Action Plan provides a clear path forward to reduce GHG emissions while promoting economic growth and enhancing current efforts to adapt to the effects of climate change.

Locally-owned Renewable Energy Projects that are Small Scale (LORESS)

In May 2015, the province introduced legislation to allow local entities to develop renewable energy sourced electricity generation in their communities. This will enable universities, non-profit organizations, co-operatives, First Nations and municipalities to contribute to NB Power's renewable energy requirements.

Shifting to renewables in electricity generation

Two fossil fuelled power plants were closed in recent years – one coal and one heavy oil. Also, 300 megawatts of wind energy was installed in the province and biomass fuel use in industry was expanded to displace oil. Solid waste landfills are capturing biogas and some are generating electricity.

These actions are allowing NB Power to achieve the regulated Renewable Portfolio Standard of 40% of in-province sales from renewable energy sources by 2020. This translates to approximately 75% non-emitting by 2020 including nuclear.

Adaptation

The province has developed a progressive Climate Change Adaptation Program including assembling future climate projections, and supporting climate impact vulnerability assessments in communities and for infrastructure. Adaptation projects also focus on solutions building and advanced planning to help reduce or avoid the costs of impacts such as more severe and frequent flooding, coastal erosion and storm events and disease and pest migration.

Several projects are carried out in collaboration with other Atlantic provinces, notably under the Regional Adaptation Collaborative (RAC), which involves federal support, as well as with the Gulf of Maine Council and US partners.

These actions provide a strong contribution to a comprehensive Pan-Canadian Framework.

ACTION ON PRICING CARBON POLLUTION

The province will implement a made-in-New Brunswick carbon pricing mechanism that addresses the requirements of the federal government for implementing a price on carbon emissions by 2018 and that at the same time recognizes New Brunswick's unique economic and social circumstances. The provincial government will take into consideration the impacts on low-income families, trade-exposed and energy-intensive industries, and consumers and businesses, when developing the specific mechanisms and implementation details, including how to reinvest proceeds.

Any carbon pricing policy will strive to maintain competitiveness and minimize carbon leakage (i.e., investments moving to other jurisdictions). Proceeds from carbon emissions pricing will be directed to a dedicated climate change fund.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

The Government of New Brunswick and the Government of Canada intend to collaborate in the following domains of priority to address climate change and advance clean growth:

Enhanced Electricity Generation and Transmission System

New Brunswick will work with the other Atlantic provinces and the Government of Canada to advance opportunities for clean electricity generation, transmission, storage and demand management linkages across the region. This will: improve access to non-emitting electricity; support the phase-out of coal-fired electricity generation; improve grid reliability and energy security; and, consistent with fair market principles, help provinces access export markets for clean, non-emitting electricity.

This will contribute to both the Atlantic Growth Strategy and Canadian Energy Strategy and will build on existing regional coordination efforts, leading to an integrated regional electricity strategy.

Energy Efficiency

The Government of New Brunswick, in partnership with the Government of Canada, will seek to enhance energy efficiency programs by targeting GHG emission reduction opportunities across sectors and fuels.

Examples of possible targeted interventions include programs that help: trucking fleets add aerodynamic and other efficiency measures to existing equipment; small- to medium-size industry improve their compressed air systems, boilers and lighting; commercial and institutional facilities invest in heating, lighting and other retrofits; and families retrofitting their homes to reduce energy costs, with special treatment for low- and fixed-income families.

Industrial Emissions Reductions

The Government of New Brunswick and the Government of Canada will work to support industrial emission reduction initiatives through technology and energy efficiency improvements while maintaining productivity. For example, there are significant opportunities to reduce emissions resulting from industrial production in the Belledune area of New Brunswick.

NOVA SCOTIA

KEY ACTIONS TO DATE

Some of the key actions taken to date or under development in Nova Scotia include:

The Environmental Goals and Sustainable Prosperity Act (2007)

In 2007, Nova Scotia passed legislation outlining principles for sustainable economic growth, including a requirement to reduce GHG emissions in the province to 10% below 1990 levels by 2020. The development and implementation of the Nova Scotia Climate Action Plan led to early action on the electricity sector, the largest source of emissions in the province. As a result, Nova Scotia has not only achieved its target six years early, it has also already met the Canadian 2030 target of 30% below 2005 levels, and is on a track to continue reducing emissions.

Nova Scotia's Greenhouse Gas Emissions Regulations

Nova Scotia was the first province in Canada to place a hard cap on GHG emissions from the electricity sector. These regulations, created in 2009 and enhanced in 2013, required the utility to reduce GHG emissions by 25% by 2020, and 55% by 2030. This is a measured and flexible approach which will enable a transition from coal to clean energy in the province.

Nova Scotia's Renewable Energy Regulations

In addition to the hard cap on GHG emissions, Nova Scotia also has a renewable energy standard for the electricity sector. This standard established requirements for 25% of electricity to be sourced from renewable energy by 2015, and 40% by 2020.

Energy Efficiency

Nova Scotia has Canada's first energy efficiency utility, Efficiency Nova Scotia. This independent organization has achieved an annual reduction in electricity demand of over 1% since its creation. It also administers comprehensive energy efficiency programs for low income and First Nations Nova Scotians. These efforts reduce GHG emissions while supporting the growth of the low carbon economy.

Tidal Energy

The Bay of Fundy and Minas Basin are home to the highest tides in the world- every day, more water flows into this bay than the output from all the rivers in the world combined. Nova Scotia has been supporting the development of these tides as a source of clean, predictable and reliable energy for Nova Scotians and as a clean technology export. The Fundy Ocean Research Centre for Energy (FORCE) now has a grid connected 2MW tidal turbine with plans to install more in the coming years.

Waste Management

Nova Scotia is also making efforts to reduce GHG emissions by diverting organic waste from landfills, recycling and creating a circular economy. Progress on waste diversion is reflected in a 30% reduction in greenhouse emissions from the waste sector since 2002.

These actions are just a snapshot of what Nova Scotians are doing to reduce GHG emissions and provide a strong contribution to a comprehensive pan-Canadian framework.

ACTION ON PRICING CARBON POLLUTION

As part of the pan-Canadian benchmark for carbon pricing, Nova Scotia has committed to implement a cap and trade program in the province that builds on our early action in the electricity sector.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

The Government of Nova Scotia and the Government of Canada intend to collaborate in the following priority domains to address climate change and advance clean growth:

Energy Efficiency

Nova Scotia and the Government of Canada are committed to partnering to enhance the existing provincial energy efficiency programs for homes and businesses with the objective of reducing energy use and saving energy costs. This could include expanded energy efficiency programs, efforts to accelerate the electrification of homes and businesses through heat pumps and smart meters, district energy systems, as well as electric vehicle infrastructure.

Renewable Energy Generation, Transmission and Storage

Nova Scotia, in partnership with the Government of Canada, will work together to advance opportunities for renewable energy generated from sources such as wind, tidal and solar, as well as the enabling transmission and storage infrastructure to ensure growth beyond current technical limits. Research and development capacity will continue to be strengthened.

Planning and Implementing Adaptation Infrastructure

Nova Scotia and the Government of Canada will work together and invest in projects to make infrastructure more resilient to a changing climate, and to help communities increase their capacity to adapt to a changing climate.

Regional Electricity Grid Connections

Nova Scotia will work with the other Atlantic provinces and the Government of Canada to advance opportunities for clean electricity generation, transmission, storage and demand management linkages across the region.

This will: improve access to non-emitting electricity; support the phase-out of coal-fired electricity generation; improve grid reliability and energy security; and, consistent with fair market principles, help provinces access export markets for clean, non-emitting electricity. This will contribute to both the Atlantic Growth Strategy and Canadian Energy Strategy and will build on existing regional coordination efforts, leading to an integrated regional electricity strategy.

PRINCE EDWARD ISLAND

KEY ACTIONS TO DATE

Some of the key actions taken to date or under development in Prince Edward Island include:

Climate Change Policy Framework

Prince Edward Island's primary areas of strategic focus for climate change fall into the themes of built environment, transportation, agriculture, conservation and adaptation. Prince Edward Island is in the process of developing new climate change strategies that will result in further actions and initiatives to reduce GHG emissions across the province, increase our resilience to a changing climate, and advance measures to strengthen and grow a prosperous green economy in the province.

Prince Edward Island does not have a legislated provincial emissions reduction target but does contribute to the regional target set by the Conference of the New England Governors and Eastern Canadian Premiers (NEG-ECP). The targets are 10% reductions from 1990 by 2020, 35% - 45% below 1990 levels by 2030, and 75-85% reduction from 2001 levels by 2050. PEI has realized a 9% reduction in GHG emissions since 2005.

PEI Wind Energy

Prince Edward Island is a world leader in producing clean electricity from wind. Prince Edward Island boasts the highest penetration of wind in Canada and 2nd highest in the world next to Denmark. The Government of Prince Edward Island has demonstrated a long-term commitment and investments of $119 million to wind energy.

The first commercial wind farm in Atlantic Canada was developed by the PEI Energy Corporation at North Cape in 2001. North Cape was expanded in 2003, doubling in size.

In January 2007, the PEI Energy Corporation commissioned its second wind farm at East Point. In 2014, the Island's newest wind farm was commissioned at Hermanville/ Clearspring. As a result, Prince Edward Island now has a total installed wind capacity of 78% of peak load, which supplies almost 25% of the province's total electricity requirements.

Biomass

Prince Edward Island is home to Canada's longest-running, biomass-fired district heating system. Operating since the 1980s, the system has expanded to serve over 125 buildings in the downtown core of Charlottetown, including the University of Prince Edward Island and the Queen Elizabeth Hospital. It has contributed to the establishment of a local waste-wood fuel-supply market. The system burns approximately 66,000 tons of waste materials annually.

Coastal Erosion

Prince Edward Island has partnered with the University of Prince Edward Island (UPEI) Climate Research Lab to study coastal vulnerability, including the award-winning Coastal Impacts Visualization Environment (CLIVE). CLIVE is an innovative 3D platform for visualizing the potential future impacts of coastal erosion and coastal flooding at local community scales, on PEI and elsewhere, using past data and Intergovernmental Panel on Climate Change models.

The province has also invested in UPEI in its development of an expansive, cutting-edge coastal erosion monitoring network. This research includes the use of drone and GIS technology to quantify and assess erosion volume of shoreline disappearance along Prince Edward Island's coastline.

Environmental Awareness in Agriculture

As a key industry for Prince Edward Island, agriculture is of particular consequence for climate change and green growth. In recent years, PEI farmers, watershed groups and the fertilizer industry have been implementing a 4R Nutrient Stewardship program to encourage the efficient use of fertilizer and help reduce related emissions.

Island farmers have been making advances in crop diversification, including testing potato varieties that require less fertilizer and adding nitrogen-fixing pulse crops which improve the environmental sustainability of annual cropping systems. The further use of robotics in dairy farming and food additives in livestock production is being employed to reduce methane emissions.

Prince Edward Island is also the first and only jurisdiction in Canada with a provincially-supported Alternative Land Use Services program. Currently, the program has converted almost 4,000 hectares of marginal land from annual crop production to perennial or permanent cover.

These actions provide a strong contribution to a comprehensive pan-Canadian framework and are helping facilitate the transition to a low-carbon economy.

ACTION ON PRICING CARBON POLLUTION

Prince Edward Island will introduce a made-in-PEI approach to carbon pricing which positively contributes to climate change action while benefitting Prince Edward Islanders and ensures optimal conditions for continued growth of the provincial economy. Prince Edward Island will focus on measures that will meaningfully decrease our GHG emissions and recognize the particular elements of our economy.

Our approach will ensure consistent and competitive alignment with efforts being made across the country, including mitigation and price initiatives in all provinces, especially those in our region. PEI is committed to an approach that will directly enhance provincial adaptation and mitigation efforts.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

Prince Edward Island and the Government of Canada intend to collaborate in the following domains of priority to address climate change and advance clean growth:

Energy Efficiency

Prince Edward Island, in partnership with the Government of Canada, will pursue improved energy efficiency for all sectors in the province as outlined in the 2016 PEI Energy Strategy. The Strategy and forthcoming Climate Change Action Plan are key policy tools in reducing GHGs, driving economic growth and creating jobs locally and in the region.

Prince Edward Island is committed to engaging in incremental actions through solutions for the built environment, including businesses and homes, as well as in new building construction. It has been clearly illustrated by research in the region that investing in efficiency is one of the most effective means of delivering jobs and economic growth widely – across sectors and regions – while reducing emissions and providing savings to consumers.

With a predominantly rural population and some of the highest electricity rates in the country, particular consideration will be given to low-income Island families, and sectors that may find the transition to a lower-carbon environment challenging.

Clean Energy

Energy resilience and security and a move to greater electrification are key priorities for the province. Prince Edward Island, in partnership with the Government of Canada, will work to expand its world-class wind resource, invest in solar, and enable greater integration of renewable energy through storage. Prince Edward Island will work with the other Atlantic Provinces and the Government of Canada to advance opportunities for clean electricity generation, transmission, storage and demand management linkages across the region.

This will: improve access to non-emitting electricity; support the phase-out of coal-fired electricity generation; improve grid reliability and energy security; and, consistent with fair market principles, help provinces access export markets for clean, non-emitting electricity. This will contribute to both the Atlantic Growth Strategy and Canadian Energy Strategy and will build on existing regional coordination efforts leading to an integrated regional electricity strategy.

Adaptation

With its 1100 km of coastline, Prince Edward Island is uniquely vulnerable to climate impacts and is positioned to advance innovative solutions to make infrastructure more resilient to a changing climate.

Prince Edward Island and the Government of Canada will work together to act on findings from disaster risk reduction planning and coastal infrastructure assessment, and to improve decision-making capacity to adapt to climate change through planning, training and monitoring.

Research and Development

Prince Edward Island and the Government of Canada will work together to support research and development on promising practices and innovation in the areas of agriculture, marine industries, and smart grid and micro-grid/ storage. Prince Edward Island provides an ideal demonstration site for development in these areas.

This research will advance better understanding of influences on emissions and opportunities for clean growth in key sectors of the Prince Edward Island economy.

Transportation

Prince Edward Island relies on exports for continued economic growth. The Prince Edward Island economy is heavily reliant on ground transportation for the movement of goods to markets across Canada and around the world, and the movement of people across the province. The province has no rail system, large container ports, or robust public transit. As the most rural province in Canada, mitigation in transportation is a difficult challenge.

Prince Edward Island and the Government of Canada will work together on methods to support an eventual move to greater electrification in transportation, including corresponding work with other jurisdictions in Canada. Proposed specific areas of work include installation of public charging infrastructure across the province and in collaboration regionally where possible.

NEWFOUNDLAND & LABRADOR

KEY ACTIONS TO DATE

Newfoundland and Labrador is making significant investments to increase the use of clean and renewable hydroelectric power in the province. The Muskrat Falls hydroelectric development, with capital costs of over $9 billion, will result in 98% of electricity consumed in the province coming from renewable sources by 2020.

Muskrat Falls will facilitate advancing by more than a decade the decommissioning of the largest thermal oil-fired electricity generation facility in the province, reducing greenhouse gas (GHG) emissions by about 1.2 Mt annually (equivalent to more than 10% of the province's total emissions in 2015), and assisting other jurisdictions to meet their GHG reduction targets.

To focus the province's efforts to tackle climate change, Newfoundland and Labrador has adopted GHG emission reduction targets of 10% below 1990 levels by 2020 and 75-85% below 2001 levels by 2050, and has endorsed, on a regional basis, the Conference of New England Governors and Eastern Canadian Premiers' reduction marker range of at least 35-45% below 1990 levels by 2030.

To make progress towards these targets Newfoundland and Labrador released a Climate Change Action Plan in 2011 identifying 75 actions to reduce GHG emissions and adapt to the adverse impacts of climate change. Building on this work, Newfoundland and Labrador passed the *Management of Greenhouse Gas Act* in June 2016, creating a legislative framework for reducing GHGs from large industry, and has completed public consultations to inform new provincial actions on climate change.

These actions provide a strong contribution to a comprehensive Pan-Canadian Framework.

ACTION ON PRICING CARBON POLLUTION

The Government of Newfoundland and Labrador and the Government of Canada continue to collaborate to ensure that Newfoundland and Labrador's climate change plan, including carbon pricing, is consistent with the goals in the Pan-Canadian Framework to reduce GHG emissions, improves resilience to climate impacts, and accelerates innovation and job creation.

This made-in-Newfoundland and Labrador plan will address the province's particular social, economic, and fiscal realities. This includes sensitivity to the particular circumstances facing Labrador communities, and the need to consider impacts on all remote and isolated communities, vulnerable populations, consumers and trade-exposed industries, as well as the need to take account of the province's reliance on marine transportation and the absence of lower carbon alternatives.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

Newfoundland and Labrador and the Government of Canada intend to explore collaboration in the following priority domains to address climate change and advance clean growth:

Renewable Energy

Newfoundland and Labrador and the Government of Canada intend to jointly explore opportunities to develop renewable energy, including such actions as enhancing hydroelectric capacity, increasing transmission infrastructure, and offsetting diesel use in small-scale off-grid electricity systems.

These efforts will also seek to maximize collaboration with other Atlantic provinces in the electricity sector, contributing to both the Atlantic Growth Strategy and Canadian Energy Strategy, and will build on existing regional coordination efforts, leading to an integrated regional electricity strategy.

Transportation

Newfoundland and Labrador and the Government of Canada intend to jointly explore opportunities to reduce GHG emissions in all parts of the transportation sector, including electric vehicles and associated infrastructure, on- and off-road freight and industrial transportation, marine vessels, and public transit.

Energy Efficiency

Newfoundland and Labrador and the Government of Canada intend to jointly explore opportunities to develop energy efficiency programming, improve energy codes, and support fuel switching in all sectors reliant on fossil fuels.

Adaptation

Newfoundland and Labrador and the Government of Canada intend to jointly explore opportunities to expand climate monitoring and adaptation product and information development, as well as best management practices.

Green Innovation

Newfoundland and Labrador and the Government of Canada intend to jointly explore opportunities in research and development in green technology, including fostering innovation networks and initiation of pilot projects.

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YUKON

KEY ACTIONS TO DATE

Some of the key actions taken to date or under development in Yukon include:

Yukon Government Climate Change Action Plan

The Yukon government *Climate Change Action Plan* has four goals: reducing GHG emissions; addressing the impacts of climate change; leading Yukon action on climate change; and enhancing our knowledge and understanding of climate change.

KEY ACTIONS

Work to date in achieving *Climate Change Action Plan* goals includes:

Reducing GHG emissions (mitigation)

- Setting nine sector-specific targets in the areas of transportation, heating buildings, electricity, and industrial operations.
- Completing a study of Yukon's transportation sector, and launching a Ride Share program in partnership with the City of Whitehorse.
- Supporting Yukon homeowners with the Good Energy Residential Incentives Program, which provides incentives to purchase high efficiency wood stoves, boilers and pellet stoves.
- Carrying out detailed energy audits of seven high-consumption Yukon government buildings.
- A Yukon Biomass Strategy to guide the development of a biomass energy sector in the territory.

Addressing the impacts of climate change (adaptation)

- Completing ten adaptation projects in the areas of permafrost impacts to highways, buildings, hydrological responses, and agricultural capacity; flood risk mapping; forestry implications including the encroachment of mountain pine beetle in lodgepole pine forests; and bioclimate shifts.
- With the Pan-Territorial Adaptation Strategy, territorial governments are collaborating on practical adaptation measures for the north. Permafrost thaw has been a key focus.

Leading Yukon action on climate change

- Participating in international and national climate change efforts that impact Yukon, such as the United Nations Framework Convention on Climate Change Conference of the Parties (COP) meetings, including a developmental opportunity for a Yukon youth ambassador.
- Currently supporting the Yukon College to develop a climate change policy course to be offered by Yukon College.

Enhance our knowledge and understanding of climate change

- Supporting development of the Climate Change Indicators and Key Findings report, an important source of independent information that will guide action and research on climate change in Yukon.
- Provide ongoing funding for the Northern Climate Exchange at Yukon College.

These actions provide a strong contribution to a comprehensive pan-Canadian framework.

ACTION ON PRICING CARBON POLLUTION

The Government of Yukon recognizes the role of carbon pricing in the pan-Canadian Framework for Clean Growth and Climate Change.

Given Yukon's particular circumstances, the Government of Canada and the Government of Yukon will work together to assess the implications of carbon pricing in the territory for its economy, communities and people including energy costs, and to develop solutions together.

The Government of Yukon and the Government of Canada will also work together to assess the implications of carbon pricing in Canada on the cost of living in Yukon. This will be an important consideration for future policy development.

As outlined in the federal government's benchmark, 100% of the revenues from carbon pricing will be retained by Yukon. Yukon government will distribute these revenues back to individual Yukoners and businesses through a rebate.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

Yukon and the Government of Canada intend to collaborate in the following domains of priority to address climate change and advance clean growth:

Advancing Renewable Energy

Yukon government and the Government of Canada will partner in advancing renewable energy projects in Yukon. This will improve the energy infrastructure in Yukon, including developing new renewable energy sources to provide clean energy for current and future electricity needs.

It will also support remote communities in diminishing their reliance on diesel for electricity and will support the expanded use of biomass as a cleaner option for heating in Yukon.

Energy Efficiency

Yukon government, in partnership with the Government of Canada, will support energy efficiency through the retrofitting of existing buildings. Sound investments in retrofits and new energy efficiency projects will be supported by expanding the capacity for collecting, analyzing, and reporting emissions data that will help identify the areas of greatest opportunity for reducing emissions.

Adaptation: Building Resilient Yukon Communities

Canada's Northern jurisdictions and the Government of Canada are working together to develop the Northern Adaptation Strategy. The Government of Canada will partner with Yukon to help build climate-resilient Yukon communities.

Research collaboration will build the knowledge necessary for evidence-based decision-making in community planning. Investments in infrastructure will address known risks such as infrastructure built on thawing permafrost.

Green Innovation and Technology

Yukon government and the Government of Canada will partner on new research and pilot projects that will explore promising areas for climate action in the north, such as seasonal energy storage, cleaner transportation options, and community-level renewable energy generation.

NORTHWEST TERRITORIES

KEY ACTIONS TO DATE

NWT Climate Change Strategic Framework

The Government of the Northwest Territories (GNWT) has committed to develop a climate change strategy that takes northern energy demands and the cost of living into account. It will reflect commitments to reduce greenhouse gas emissions, explore carbon pricing systems and how to develop local alternatives such as hydro, biomass, wind and solar.

NWT Energy Strategy

The GNWT is currently working on a new 10 year Energy Strategy. The Energy Strategy will focus on the affordability, reliability and environmental impacts of energy in the NWT and will promote energy efficiency, renewable and alternative energy in the electricity, heating and transportation sectors.

The GNWT continues to take the following territorial adaptation actions:

- Support adaptation decision-making with knowledge, information collection and sharing
- Build capacity to translate adaptation knowledge into action
- Build climate-resilience through investments in infrastructure
- Invest in land use planning, management plans and building adaptation capacity and expertise
- Support most vulnerable regions, conducting risk assessments and completing hazard mapping
- Reduce climate-related hazards and disaster by developing disaster risk management plans
- Adapt renewable energy options and solutions for cold regions

The GNWT continues to take the following territorial emissions mitigation actions:

- Work with our federal, provincial indigenous partners and others to find solutions to address diesel use in remote off-grid communities including to develop the NWT's hydroelectricity potential to reduce GHG emissions in the electricity sector.
- Implement policies to support the adoption of lower carbon and energy efficient technologies.
- Implement policies to support industry and large emitters in the adoption of lower carbon and energy efficient technologies.
- Continue biomass initiatives and work towards the development of a local forest and wood product industry and develop local wood pellet manufacturing as an alternate local fuel source.
- Addressing energy use and GHG emissions in government buildings and operations.

These actions provide a strong contribution to a comprehensive pan-Canadian framework.

ACTION ON PRICING CARBON POLLUTION

Through the Climate Change Strategic Framework, the GNWT is exploring potential impacts and opportunities that may arise from pursuing different carbon pricing systems in the territory.

The GNWT recognizes the role of carbon pricing in the pan-Canadian Framework for Clean Growth and Climate Change. Given the NWT's particular circumstances, the Government of Canada and the GNWT will work together to assess the

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implications of carbon pricing in the territory for its economy, communities and people including energy costs, and to develop solutions together.

The GNWT and the Government of Canada will also work together to assess the implications of carbon pricing in Canada on the cost of living in the NWT. This will be an important consideration for future policy development.

As outlined in the federal government's benchmark, 100% of the revenues from carbon pricing will be retained by the NWT.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

The NWT will work with the Government of Canada, in collaboration with regional partners, to advance opportunities for clean electricity generation, transmission, storage and demand management linkages across the region.

This will: improve access to non-emitting electricity; support the phase-out of coal-fired electricity generation; improve grid reliability and energy security; and, subject to fair market principles, help the region access export markets for clean, non-emitting electricity.

The NWT and the Government of Canada intend to collaborate in the following priority areas to address climate change and advance clean growth:

Taltson Hydro Expansion and Transmission Links

The proposed Taltson hydro expansion is a small scale run of river hydro project that could be developed with little environmental impact next to the existing power plant, on an already developed river, and combined with a transmission link to provide a green energy corridor to our southern neighbours.

The expansion of the Taltson hydro facility would help reduce Canada's GHG emissions by 360,000 tonnes annually for 50-plus years.

The 60 MW expansion of the Taltson hydro facility could be built in partnership with NWT Indigenous governments, creating economic opportunities for Indigenous-owned businesses across the North. The NWT and Government of Canada will undertake technical and feasibility studies as a first step, including the NWT launching the environment assessment process.

Renewable Solutions for Off-Grid Diesel Communities

The Government of Canada and the GNWT will explore opportunities for reducing reliance on diesel in off-grid communities. For example, the Inuvik Wind Project could produce between 2 and 4 megawatts of wind energy for the Town of Inuvik. The project would reduce GHG emissions by 4,300 tonnes per year and eliminate the need for 1.3 million litres of diesel annually in the largest diesel community in the NWT, and help reduce the cost of living for residents.

For other off-grid diesel powered communities of the NWT, a suite of renewable solutions such as solar and wind in combination with energy storage systems and variable generators could reduce diesel use and emissions by 25 percent, an annual GHG elimination of nearly 3000 tonnes.

All-Weather Road Infrastructure for Adapting to Climate Impacts

The safety and reliability of winter roads is being impacted by climate change. Construction of the Mackenzie Valley Highway from Wrigley to Norman Wells would provide safe, secure, and reliable access into the Sahtu region, helping decrease the high cost of living in communities and support the development of resources in the region.

The Great Bear River is a priority as the seasonal ice crossing is increasingly vulnerable to impacts of climate change. Climate change is also limiting access to existing diamond mining operations in the Slave Geological Province.

Construction of an all-weather Slave Geological Province Access Corridor would reduce costs for industry exploration and development in a region that holds world-class deposits of natural resources and continues to be a major contributor to the Canadian and NWT economy.

NUNAVUT

KEY ACTIONS TO DATE

Some of the key actions taken to date or under development in Nunavut include:

Energy efficiency upgrades

The Nunavut Energy Retrofit Program was piloted in Iqaluit in 2007, and addressed all of the government of Nunavut's Iqaluit Government of Nunavut-owned buildings. The one-time project investment of $12.8 million has led to annual savings in excess of $1.6 million and 1,594 tonnes of GHG reductions.

In combination with the conversion of three of our facilities to residual heat, our GHG reduction is approximately 4,100 tonnes, which is roughly 20% of those buildings' total emissions.

Development of a Climate Change and Adaptation strategy

Upagiaqtavut was developed in 2011 and serves as a guiding document for the impacts of climate change in Nunavut (http://climatechangenunavut.ca/sites/default/files/3154-315_climate_english_reduced_size_1_0.pdf).

Climate change databank

The Government of Nunavut is developing and uses information technology to centralize and increase the access to climate change information, such as permafrost data and landscape hazards maps. The information is used to improve infrastructure planning and help mitigate the effects of climate change across Nunavut.

Climate Change Secretariat

The Government of Nunavut is establishing a Climate Change Secretariat (CCS), which will be the central point within the government to address both climate change adaptation and mitigation issues.

ACTION ON PRICING CARBON POLLUTION

The Government of Nunavut recognizes the role of carbon pricing in the pan-Canadian Framework for Clean Growth and Climate Change. Given Nunavut's particular circumstances, the Government of Canada and the Government of Nunavut will work together to assess the implications of carbon pricing in the territory for its economy, communities and people including energy costs, and to develop solutions together.

The Government of Nunavut and the Government of Canada will also work together to assess the implications of carbon pricing in Canada on the cost of living in Nunavut. This will be an important consideration for future policy development.

As outlined in the federal government's benchmark, 100% of the revenues from carbon pricing will be retained by Nunavut.

COLLABORATION PARTNERSHIP OPPORTUNITIES FOR CLEAN GROWTH AND CLIMATE CHANGE

Nunavut and the Government of Canada intend to collaborate in the following domains of priority to address climate change and advance clean growth:

Nunavut and the Government of Canada will assess the economic and technical feasibility of electrification through hybrid power generation in Nunavut's communities. Hybrid power generation would significantly reduce emissions while at the same time ensure that Nunavut's isolated communities have reliable power.

Nunavut and the Government of Canada will work together to develop a retrofit program to increase the energy efficiency of public and private housing. Investment in safe and energy efficient housing is a key component of building strong resilient communities in the Arctic.

Garden City Conservation Society: Massey Tunnel rationale

Massey Crossing rationale, Garden City Conservation Society, 2017-07-14

Aim: The Massey Crossing, with related transportation systems, will enable efficient, safe, user-friendly transportation of people and goods between its served areas while conserving in a range of ways.

What's known: The bridge options have, in effect, been self-eliminated by their proponents' failure to make a credible case in years of trying. Also, from a conservation standpoint, leaders of all three of the broad conservation groups in Delta/Richmond have determined that the tunnel options are better.

Basic best: From the GMTR Project's five scenarios (Phase 2 Guide, 2013), the simple tunnel option in Scenario 4 (p. 12) could meet the needs with
1) completion of the seismic upgrades for the tunnel and its approaches,
2) refurbishing of the tunnel systems—ventilation, lighting, safety, etc.,
3) new ***2-lane*** tube for transit* + multi-use path, in Massey Corridor,
4) retrofit/replacement of related Hwy 99 bridges/interchanges, and
5) further Hwy 99 corridor improvements—Bridgeport to USA border.

Our graphic at right shows the spacing of the new tube ("Green Tube" because it is ecologically best) from the current tunnel ("Legacy Tube").

*While the Green Tube would *enable* two transit lanes, it might do so *indirectly* (e.g., if *Legacy* lanes are better positioned for Rapid Bus use).

Quality: Since this saves a hefty chunk of $12 billion, doing things well should be feasible. Examples:
1) State-of-the-art seismic upgrade for the Legacy Tube and approaches. Methods have improved in the decade of delay, and there must also be new site-specific knowledge from the bridge studies.
2) Lining of the tunnel walls/ceiling with reflective, easy-to-clean ceramic tile (early intended, never done).
3) Green Tube: Improved ceiling height and lane width. Designed to easily adapt for (possible) light rail.
4) At the new Steveston Interchange, faster and safer entry and exit, as planned a quarter century ago.
5) Facilities for additional efficient Hwy 99 bus entry/exit ramps, sheltered pullouts, easy transfers, etc.

Buses and trucks: Steps to enable (a) early congestion relief, beginning ASAP, and (b) lessons for the future:

- The early need is for the long-overdue influx of energy-efficient Rapid Buses that are reliable (on time, with passenger space), convenient (with Rapid Bus routes or feeder routes reaching people's start/end points) and comfortable (user-friendly throughout trips). High expectations must be set and exceeded.
- Truck traffic to and from the Delta port terminals will need to be spread over far more hours a day, with large trucks banned from the tunnel during the times when they would cause congestion (e.g., rush hour).

Steps: Ideally, the new government's experts will quickly determine how to implement the scenario in seismically sound and practical ways. Action will depend on their advice. For example, re the Green Tube:

- With its current technology to disrupt destructive seismic waves before they reach it, the Green Tube might protect the Legacy Tube. If that applies, it might be placed on the west side of the Massey Corridor.
- If it turns out to be too risky to place the Green Tube within the Massey Corridor (as shown above and in Scenario 4), it could become a new tunnel further east. In the most promising location, it would connect South Fraser Perimeter Rd (with roughly a 76th St route) to Westminster Hwy and Hwy 91 (via Nelson Rd).
- In any case, fast-tracking the Green Tube will allow it to take traffic from the Legacy Tube (usually a pair of lanes of traffic at a time) to enable efficient seismic upgrading and refurbishing of the Legacy Tube.