

Phase 1 Evaluation Report

UBC Line Rapid Transit Study
February 2010



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A LONG LIST OF OPTIONS

B PRE-SIFT ASSESSMENT RESULTS

C SIFT ASSESSMENT TEMPLATES AND ASSUMPTIONS

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EXECUTIVE SUMMARY

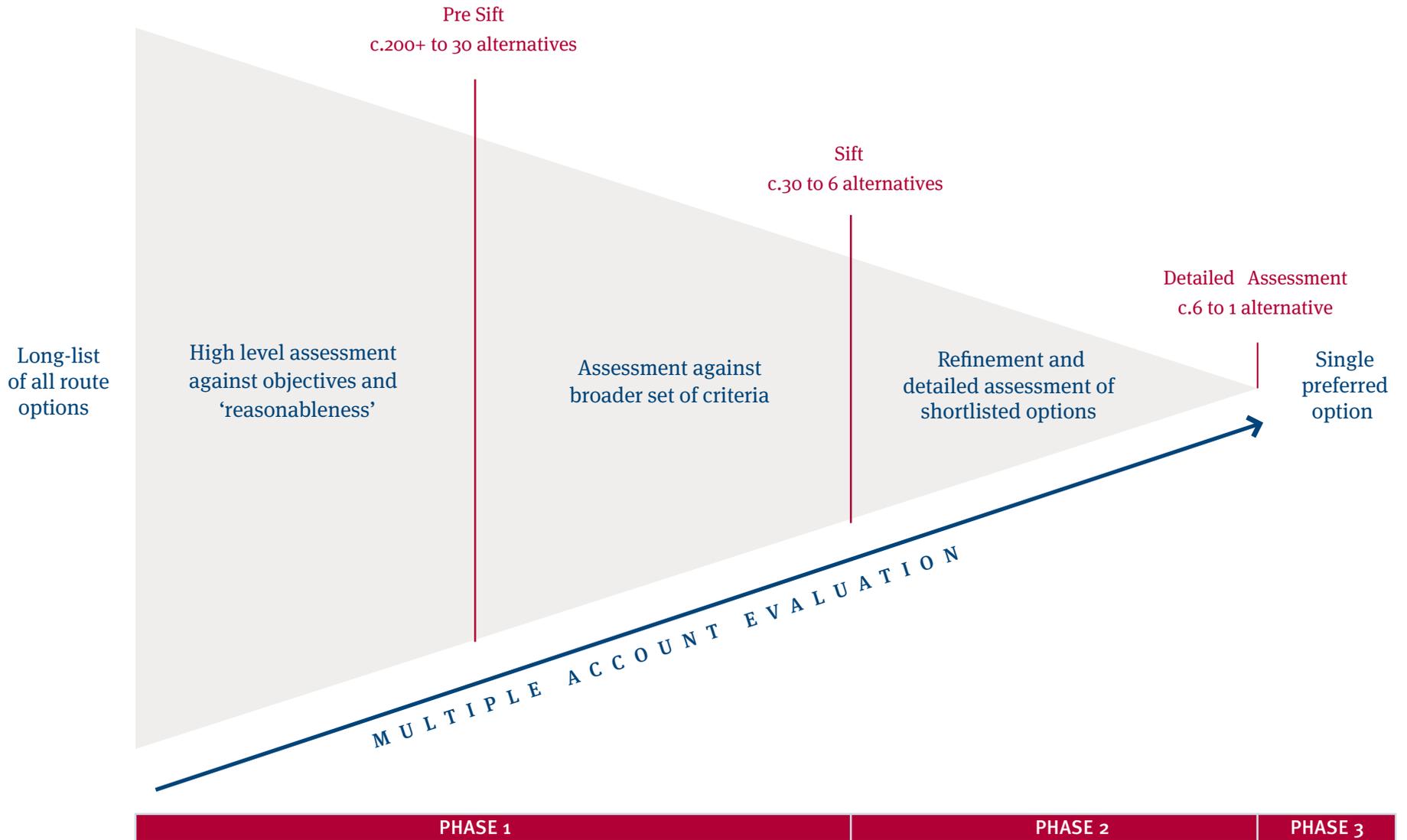
Introduction

- 1.1 In March 2009, Steer Davies Gleave was retained by the South Coast British Columbia Transportation Authority (TransLink) and the BC Ministry of Transportation & Infrastructure (MOTI) (the Project Sponsors) to examine a range of rapid transit technologies and alignment options (together known as ‘alternatives’) to serve the Broadway Corridor.
- 1.2 For reference, while the complete UBC Line Rapid Transit Study is being undertaken in the three phases, the Steer Davies Gleave contract is only for the first two phases. The full project includes:
 - **Phase 1 - Shortlist Identification: technology and alignment options are identified and screened for technical feasibility in order to arrive at a shortlist of plausible alternatives for further development in Phase 2.**
 - **Phase 2 - Alternatives Development and Evaluation: shortlisted alternatives are further developed and evaluated to support a decision on a preferred alternative.**
 - **Phase 3 - Design Development: after selection of a preferred alternative, further design development and costing is undertaken. Phase 3 will establish a budget, timeline and phasing for the project and provide the basis for project definition, securing funding and procurement.**
- 1.3 This Executive Summary and report summarize Phase 1 of the Evaluation process, including the ‘Pre-Sift’ and the ‘Sift’ process. It includes the process and results of the analysis together with recommended alternatives for further study in Phase 2 of the study.

Alternatives Development & Evaluation Process

- 1.4 The evaluation of options and alternatives is not a ‘single step’ process, but rather a tool that is employed on an ongoing basis to assist the shaping and refinement of the options. Figure 1 illustrates the project and option development process that will be used to move from a full set of all possible options through to the identification and definition of a single preferred alternative.
- 1.5 The initial stage considers a long list of potential route options which undergo a series of Assessments (‘sifts’). As the list of route options and then alternatives reduces, the detail in which the options are assessed increases, thereby concentrating analysis on alternatives more likely to be taken forward. At each step, the options and alternatives are assessed using a Multiple Account Evaluation Framework.
 - PHASE 1 – PRE-SIFT ASSESSMENT**
 - 1.6 A high level, strategic Assessment process used to sift or screen out the lowest performing route options.
 - PHASE 1 – SIFT ASSESSMENT**
 - 1.7 Following the elimination of the weaker performing routes at the Pre-Sift stage, a shorter list of alternatives is assessed using a larger set criteria at the Sift stage.
 - 1.8 As with the Pre-Sift, specific criteria are agreed with the Project Sponsors to assess the alternatives and to provide the additional information needed to make a recommendation on the alternatives to progress to Phase 2 of the study.

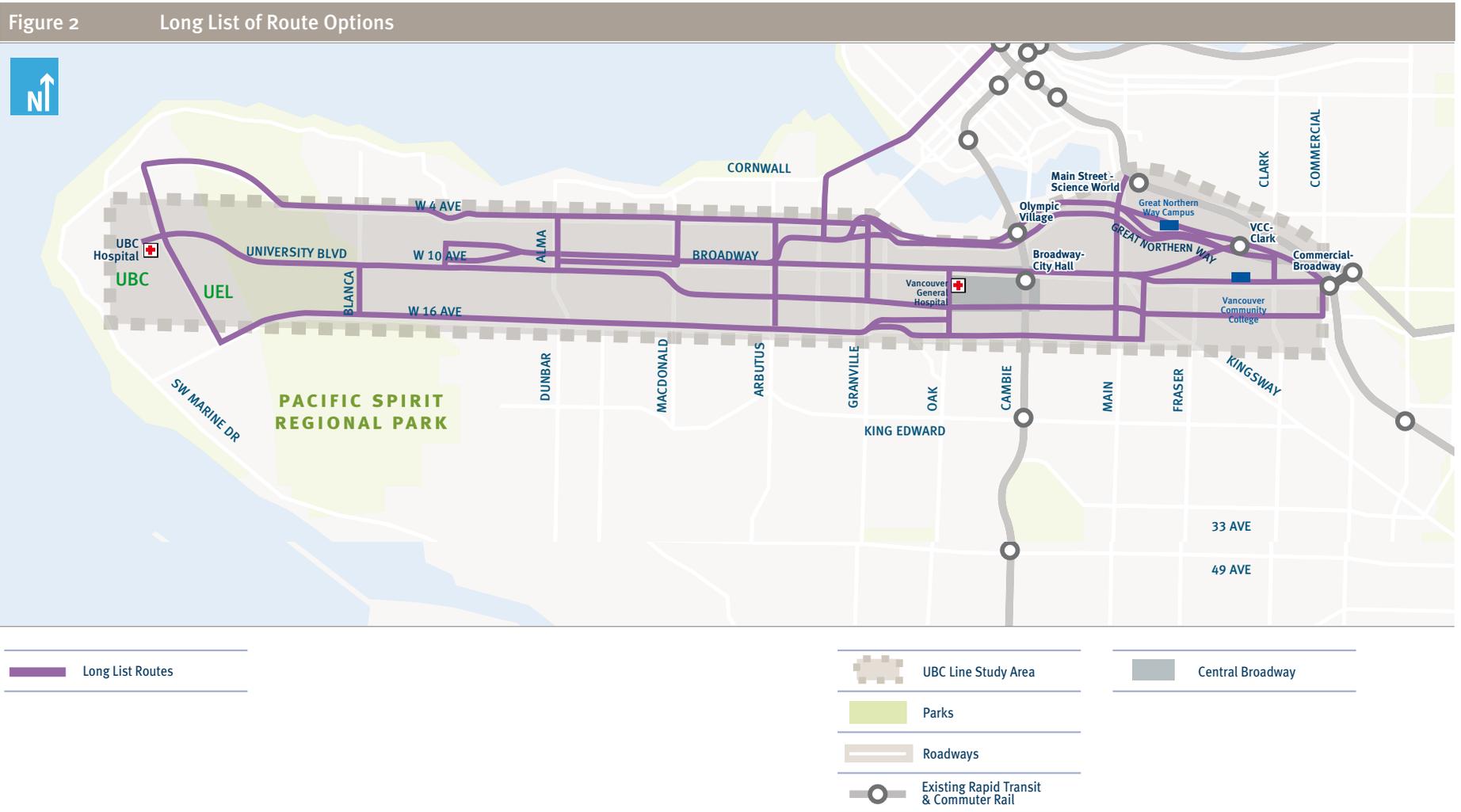
Figure1 Alternative Development and Assessment Process



OPTION DEVELOPMENT

- 1.9 Through consultation with the Project Sponsors and the Partners Agencies (City of Vancouver, University of British Columbia, University Endowment Lands and Metro Vancouver), a long list of potential rapid transit routes was developed that included nearly 200 possible route options

using on-street routes as well as routes using existing and disused rail corridors within the study area. All route options needed to provide a connection from either the Expo or Millennium SkyTrain line to the UBC campus. A map illustrating the full set of route options is included as Figure 2.



MULTIPLE ACCOUNT EVALUATION FRAMEWORK (MAE)

- 1.10 Drawing on a Best Practices Review and a review of the requirements of the likely funding agencies, a Multiple Account Evaluation framework was developed to enable an Assessment of alternatives across a broad range of criteria that are clearly linked to the project objectives.
- 1.11 The resulting framework includes seven accounts that represent the high-level broader public policy goals against which the alternatives will be assessed. The accounts, along with their related project objective are:
- ▶ **Financial - An affordable and cost-effective service**
 - ▶ **Transportation - A fast, reliable and efficient service that meets current and future capacity needs, supports achieving transportation targets and integrates with and strengthens the regional transit network and other modes**
 - ▶ **Environmental - A service that contributes to meeting wider environmental sustainability targets and objectives by attracting new riders, supporting changes to land use and reducing vehicle kilometers travelled**
 - ▶ **Urban Development - A service that supports current and future land use development along the corridor and at UBC and integrates with the surrounding neighbourhoods through high quality urban design**
 - ▶ **Economic Development - A service that encourages economic development by improving access to existing and future major regional destinations and local businesses by transit while continuing to facilitate goods movement**
 - ▶ **Social Community - A safe, secure and accessible service that also improves access to rapid transit for all and brings positive benefit to the surrounding communities, including managing impacts of rapid transit**
 - ▶ **Deliverability - A service that is constructible and operable**

The Pre-Sift Assessment

- 1.12 With nearly 200 route options to evaluate, the following criteria were selected from the full MAE framework for use in the Pre-Sift Assessment:
- ▶ **Transportation Account:**
 - Catchment Analysis - 400m catchment for population and employment (2041)
 - Integration with rapid transit network (number of connections for each option)
 - Route length (as a proxy for journey time)
 - ▶ **Urban Development Account - proximity to existing and planned major activity centres**
 - ▶ **Deliverability Account – constructability and public policy support**
- 1.13 The Pre-Sift Assessment process reduced the list of possible route options down to 11 route options. However, the UBC Line Rapid Transit Study is considering three modes of rapid transit - Bus Rapid Transit (BRT), Light Rail Transit (LRT) and Rail Rapid Transit (RRT). The applicability of each of these technologies was then reviewed against the route options and the resulting alternatives are presented in Table 1. For reference, due to likely capacity constraints, BRT was only tested for a single option, LRT was deemed to be suitable for all options due to its operating flexibility and equally, RRT was tested in all options except for those where it was not viewed as constructible or operationally practical.
- 1.14 Table 1 illustrates that by combining technologies to the remaining routes, the initial set of Pre-Sift route options increases from 11 to 20 rapid transit alternatives.

Table 1 Pre-sift Route and Technology Options

Option	Route	Applicable Technology		
		BRT	LRT	RRT
1	10th Avenue / Alma / Broadway	✓	✓	✓
4	Wesbrook / Chancellor Blvd / 4th Avenue / Alma / Broadway		✓	✓
6	10th Avenue / 12th Avenue / Arbutus / Broadway		✓	
22	10th Avenue / Alma / 4th Avenue /GNW / Broadway		✓	✓
25	10th Avenue / Broadway / Macdonald /4th Avenue / GNW / Broadway		✓	✓
29	10th Avenue / Broadway/ Granville / 4th Avenue / Broadway		✓	
35	10th Avenue / Broadway / rail corridor/ 4th Avenue / GNW / Broadway		✓	✓
40	10th Avenue / 12th Avenue / rail corridor/ 4th Avenue / GNW / Broadway		✓	
62	10th Avenue / Broadway / Granville / 4th Avenue / VCC		✓	✓
100	10th Avenue / Broadway / Quebec (Main)/ 2nd Avenue / Broadway		✓	✓
173	10th Avenue / 12th Avenue / Broadway		✓	✓

MULTIPLE CORRIDORS & MULTIPLE TECHNOLOGIES

1.15 The first phase of the Pre-Sift Assessment assumed that each alternative would be a single technology end-to-end and that it would only operate in a single corridor. However, previous studies examined alternatives that included, for example, short extensions of the SkyTrain into Central Broadway in conjunction with bus-based services. An exercise was therefore undertaken with the Project Sponsors and the Partner Agencies to identify additional alternatives that used either multiple technologies and/ or alternatives that used multiple corridors. This process identified an additional nine alternatives.

CONCLUSIONS OF THE PRE SIFT ASSESSMENT

1.16 The Pre-Sift Assessment reduced the total number of route options from nearly 200 down to a collection of 29 alternatives that were progressed to the Sift Assessment. Further detail on these routes is provide in Appendix D but the route corridors are shown in Figure 3 and include:

- ▶ **Two BRT alternatives;**
- ▶ **12 LRT alternatives;**
- ▶ **Eight RRT alternatives; and**
- ▶ **Seven combination technology alternatives.**

The Sift Assessment

- 1.17 The Sift Assessment was used to further filter the 29 alternatives brought forward from the Pre-Sift Assessment down to a shortlist of alternatives for further development in Phase 2 of the study. The Sift Assessment is designed to be more detailed than the Pre-Sift Assessment by using a larger set of criteria for alternatives analysis.
- 1.18 In the Sift Assessment, all the alternatives were assessed using the MAE framework and within each account, the alternatives were assessed using a combination of quantitative and qualitative measures.
- 1.19 Given the limited level of design completed at this stage, it was difficult to differentiate between the impacts of various alternatives and it was therefore agreed that only a few of the criteria would be used as the ‘differentiating criteria’ to assist in selecting the alternative that should progress to Phase 2. These included:

- ▶ **Financial – Capital Cost**
- ▶ **Transportation – Total Ridership**
- ▶ **Deliverability**

CONCLUSIONS OF THE SIFT ASSESSMENT

- 1.20 Table 2 shows a simplified summary of the results for the 29 alternatives evaluated through the Sift Assessment. To assist in presenting the results of all the alternatives across a broad range of criteria, a series of red shaded boxes were used to highlight which alternatives met specified quality levels for each criteria. For reference, the three primary differentiating criteria are shown in a darker shade of red to highlight the key differentiators between the alternatives.



RRT - Canada Line, Canada



LRT - Dublin, Ireland



BRT - Eugene, USA

Figure 3 Conclusions of the Pre-sift Assessment



Table 2 Sift Assessment Summary

Option	Financial	Transportation								Environment		Urban Development			Social Community				Deliverability			
	Capital Cost	Total Ridership	Peak Load	Travel Time Competitiveness	Avg. Car Journey Time	Road Closures, Traffic, Parking	Population	Employment	Reliability	Network – Wide VKT	Parks and Open Space Impact	Major Activity Centres	Land Use Potential	Property Impacts	Walking & Cycling Connectivity	First Nations	Safety	Visual Intrusion	Heritage Building Impacts	Constructability	Acceptability	Funding
BRT																						
1c - BRT																						
181 - 2 BRT Corridors																						
LRT																						
1a - LRT																						
4a - LRT																						
6a - LRT																						
22a - LRT																						
25a - LRT																						
29a - LRT																						
35a - LRT																						
40a - LRT																						
62a - LRT																						
100a – LRT																						
173a - LRT																						
182 – LRT/ LRT																						

Option	Financial	Transportation							Environment	Urban Development			Social Community				Deliverability					
	Capital Cost	Total Ridership	Peak Load	Travel Time Competitiveness	Avg. Car Journey Time	Road Closures, Traffic, Parking	Population	Employment	Reliability	Network – Wide VKT	Parks and Open Space Impact	Major Activity Centres	Land Use Potential	Property Impacts	Walking & Cycling Connectivity	First Nations	Safety	Visual Intrusion	Heritage Building Impacts	Constructability	Acceptability	Funding
RRT																						
1b - RRT		High	High	High																		
4b - RRT		High	High	High																		
22b - RRT			High	High																		
25b - RRT			High	High									High									
35b - RRT			High	High									High									
62b – RRT		High	High	High									High									
100b - RRT		High	High	High				High					High									
173 - RRT			High	High														High				
Combined Technology Options																						
174 – RRT / LRT		High	High	High									High							High		
176 - RRT / LRT		High	High	High									High							High		
177 - RRT / LRT		High	High	High									High							High		
178 – RRT / LRT		High	High	High									High							High		
179 - RRT / LRT		High	High	High									High							High		
180 - RRT / LRT		High	High	High									High							High		
183 – RRT/ BRT		High	High	High									High							High		

Conclusion of the Phase 1 Evaluation

1.21 The purpose of Phase 1 of the UBC Line Rapid Transit Study was to identify and evaluate alternatives for the corridor in order to define a shortlist of alternatives that would be advanced to Phase 2 Alternatives Development and Evaluation. Throughout Phase 1, all alternatives were assessed using a common Multiple Account Evaluation framework that will continue to be used and developed further in Phase 2 of the study.

PHASE 2 RECOMMENDED ALTERNATIVES

1.22 The results presented in this report were reviewed with staff from both the Project Sponsors (TransLink and the Ministry of Transportation and Infrastructure) and the Partner Agencies (City of Vancouver, University of British Columbia, University Endowment Lands and Metro Vancouver).

1.23 The alternatives presented in the following sections are the recommended alternatives that will be progressed for more detailed design development and evaluation in Phase 2 in order to support a decision on a single preferred alternative for Phase 3 design development and implementation.

1.24 The Phase 2 recommended alternatives were brought forward for Stakeholder and Public consultation. The consultation, documented in an independent report, largely confirmed the shortlist as the starting point for more detailed study in Phase 2 and identified the need to explore options to combine RRT and BRT.

BUS RAPID TRANSIT ALTERNATIVES

1.25 There were two BRT alternatives considered and the single recommended BRT alternative is shown in Figure 4 and can be summarised as:

📍 BRT – UBC, W.10th Ave, Broadway

1.26 It is worth noting that while both BRT alternatives performed well across many of the criteria, it was agreed with the Project Sponsors and Partner Agencies that the



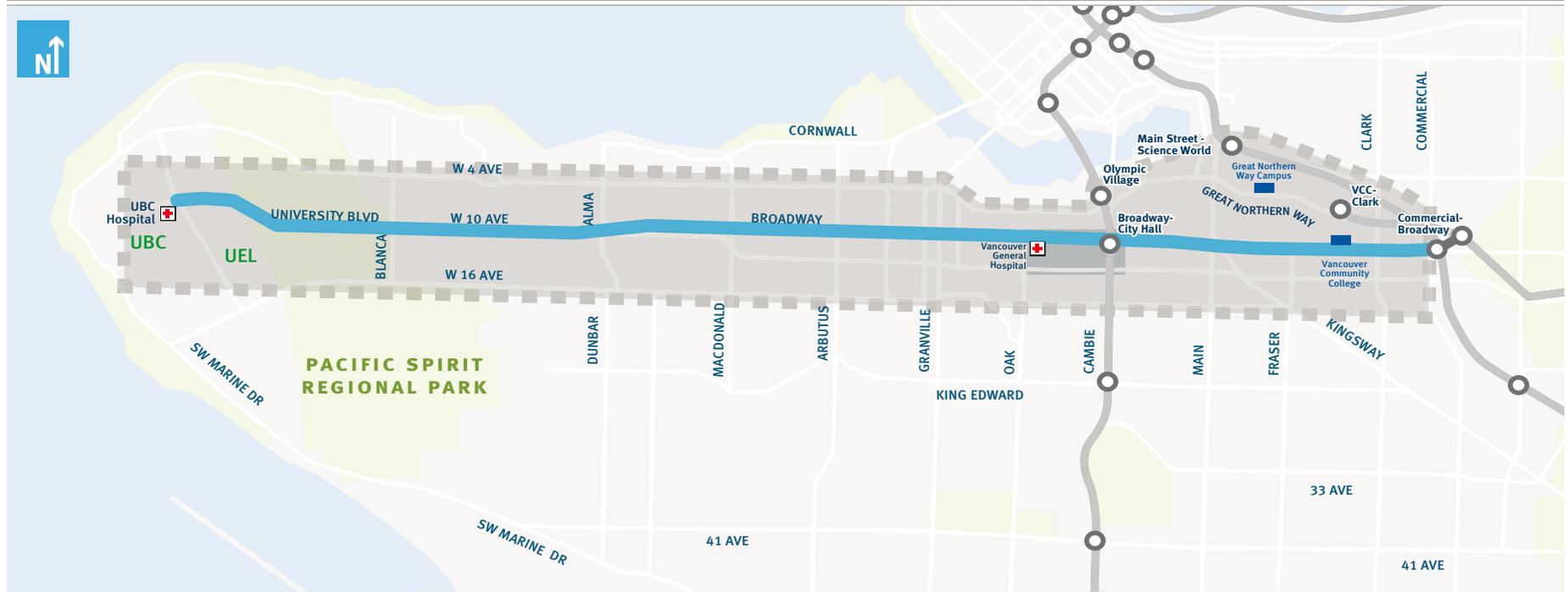
BRT - Eugene, USA

BRT Alternative that included fully segregated routes on both Broadway and 4th should be eliminated from further consideration because:

- Preliminary ridership forecasts predicted only small diversions from the main Broadway route; and

- There were concerns regarding the impacts from constructing and operating parallel, fully segregated routes within such close proximity of each other (five blocks) and that are both truck routes.

Figure 4 Phase 1 - Recommended BRT Alternative



Bus Rapid Transit Alternative

Notes:

1 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

2 Potential station locations will be identified in Phase 2 of the Study.

UBC Line Study Area

Central Broadway

Parks

Roadways

Existing Rapid Transit & Commuter Rail

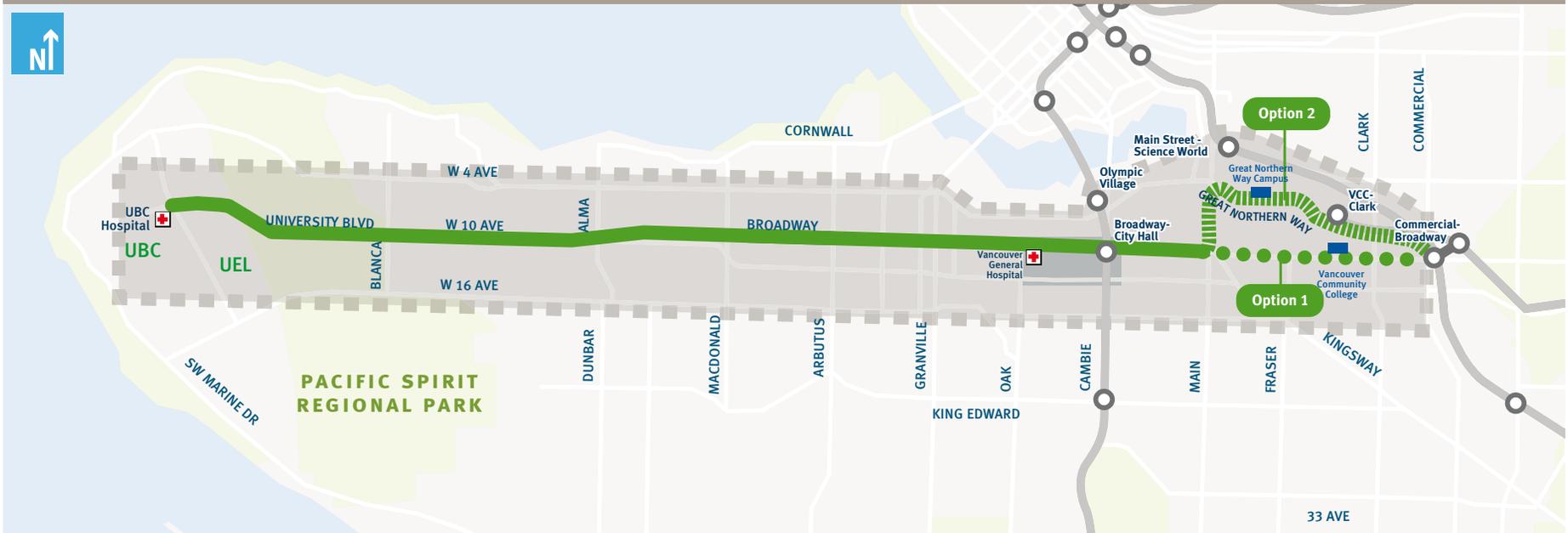
LIGHT RAIL TRANSIT ALTERNATIVES

1.27 There were 12 LRT alternatives considered through the Sift Assessment and two alternatives are recommended for further development and evaluation in Phase 2. Each alternative has 2 options for completing the route in the eastern section. The two alternatives shown in Figures 5 and 6 are:

• LRT Alternative 1- UBC, W.10th Ave, Broadway (to Main), then either:

- Option 1: Broadway to Commercial-Broadway Station; or
- Option 2: Main, Great Northern Way Campus, VCC/Clark, Commercial-Broadway Station;

Figure 5 Recommended LRT Alternative 1



- Light Rail Transit Alternative 1
- Option 1
- Option 2

Notes:

1 This alternative has two potential route options in the eastern section:

Option 1 - connecting to Commercial - Broadway Station along Broadway;

or Option 2 - connecting to Commercial - Broadway Station via Great Northern Way,

These two potential route options will be assessed in detail in Phase 2

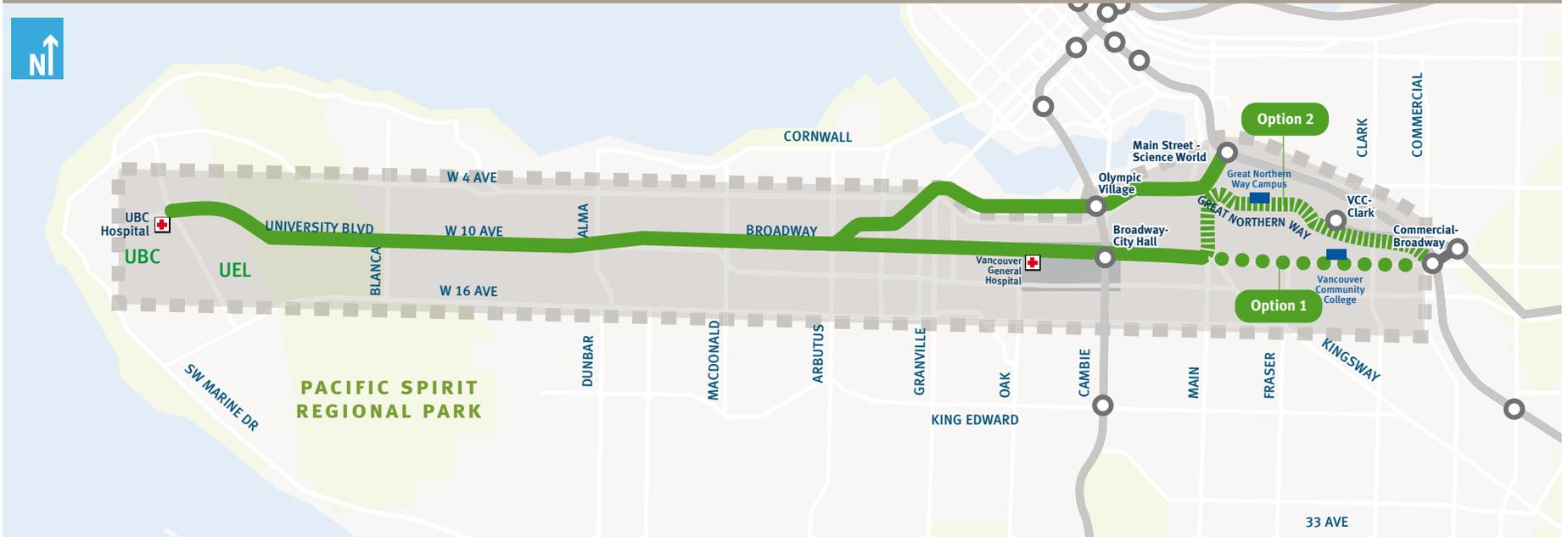
2 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

3 Potential station locations will be identified in Phase 2 of the Study.

- UBC Line Study Area
- Parks
- Roadways
- Existing Rapid Transit & Commuter Rail
- Central Broadway

- LRT Alternative 2 – Same as above with addition of:
 - LRT – Broadway/Arbutus, CP Rail right-of-way, Main Street Station.

Figure 6 Phase 1 – Recommended LRT Alternative 2



<ul style="list-style-type: none"> Light Rail Transit Alternative 2 Option 1 Option 2 	<p>Notes:</p> <p>1 This alternative has two potential route options in the eastern section:</p> <p>Option 1 - connecting to Commercial - Broadway Station along Broadway;</p> <p>or Option 2 - connecting to Commercial - Broadway Station via Great Northern Way,</p> <p>These two potential route options will be assessed in detail in Phase 2</p> <p>2 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).</p> <p>3 Potential station locations will be identified in Phase 2 of the Study.</p>	<ul style="list-style-type: none"> UBC Line Study Area Parks Roadways Existing Rapid Transit & Commuter Rail 	<ul style="list-style-type: none"> Central Broadway
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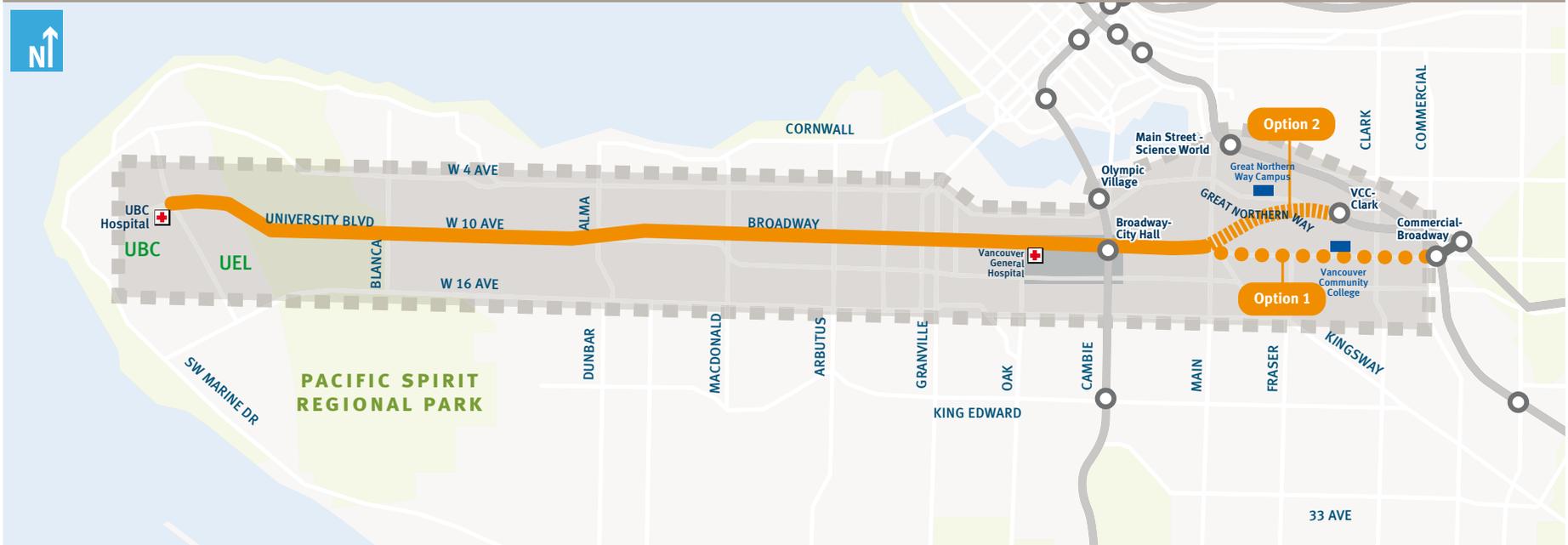
RAIL RAPID TRANSIT ALTERNATIVES

1.28 There were eight RRT alternatives considered through the Sift Assessment and a single alternative is recommended for further development and evaluation in Phase 2. The alternative, as shown in Figure 7, has 2 options for completing the route in the eastern section and can be summarised as:

● RRT - UBC, W.10th Ave, Broadway (to Main), then either:

- Option 1: Broadway to Commercial-Broadway Station; or
- Option 2: to Great Northern Way Campus and VCC/Clark Station;

Figure 7 Phase 1 – Recommended RRT Alternatives



- Rail Rapid Transit Alternative
- ● ● Option 1
- ▤▤▤▤▤ Option 2

Notes:

1 This alternative has two potential route options in the eastern section:

Option 1 ● ● ● - connecting to Commercial - Broadway Station;

or Option 2 ▤▤▤▤▤ - connecting to VCC-Clark Station,

These two potential route options will be assessed in detail in Phase 2.

2 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

3 Potential station locations will be identified in Phase 2 of the Study.

- ▤▤▤▤▤ UBC Line Study Area
- Parks
- ▤▤▤▤▤ Roadways
- Existing Rapid Transit & Commuter Rail
- Central Broadway

1.29 At this stage of design and development, no decisions or recommendations have been made on the horizontal or vertical alignment of any of the alternatives (i.e. BRT or LRT have been assumed to run on-street in segregated lanes but could be centre-running or side-running, while RRT could operate either in tunnel or on an elevated guideway down the centre or along the side of the corridor) nor has a decision or recommendation been made on choice of RRT technology (i.e. SkyTrain or non-SkyTrain RRT).

1.30 Similarly, no decisions or recommendations have been made with respect to station locations. A generic set of station locations has been used for all alternatives to facilitate some aspects of the evaluation, for comparison purposes, but these are only hypothetical. All of these issues will be addressed for each of the recommended alternatives in Phase 2 of the study.

COMBINED TECHNOLOGY ALTERNATIVES

1.31 There were seven combined technology alternatives considered through the Sift Assessment and while all of the combined alternatives showed good levels of ridership and scored well across many criteria, not all of the combined technology alternatives are recommended for further development.

1.32 While two of the alternatives (Option 174 – LRT to Downtown/Waterfront Station and Option 179 – short RRT extension from VCC/Clark to Olympic Station) appear to be candidate rapid transit projects, they do not address the specific problems or issues in the corridor.

1.33 Three of the alternatives (177, 178 and 180) include parallel or duplicative LRT and RRT services that do not appear to generate enough additional benefits when compared to the additional costs.

1.34 Option 183 (RRT from VCC/Clark to Arbutus with BRT from Arbutus to UBC) is not recommended for two reasons:

- ▶ **Approximately half of all westbound transit trips in the corridor are destined for locations west of Arbutus and, by including a mid-corridor transfer, all passengers from either the Expo Line or the Canada Line would be forced to transfer at either Broadway/Commercial or Broadway/Cambie onto the RRT and then again on the BRT at Arbutus;**

- ▶ **Capacity constraints of the BRT service – the preliminary ridership numbers for the BRT portion of the route indicate that a bus-based service would not provide sufficient capacity to meet peak period demand.**

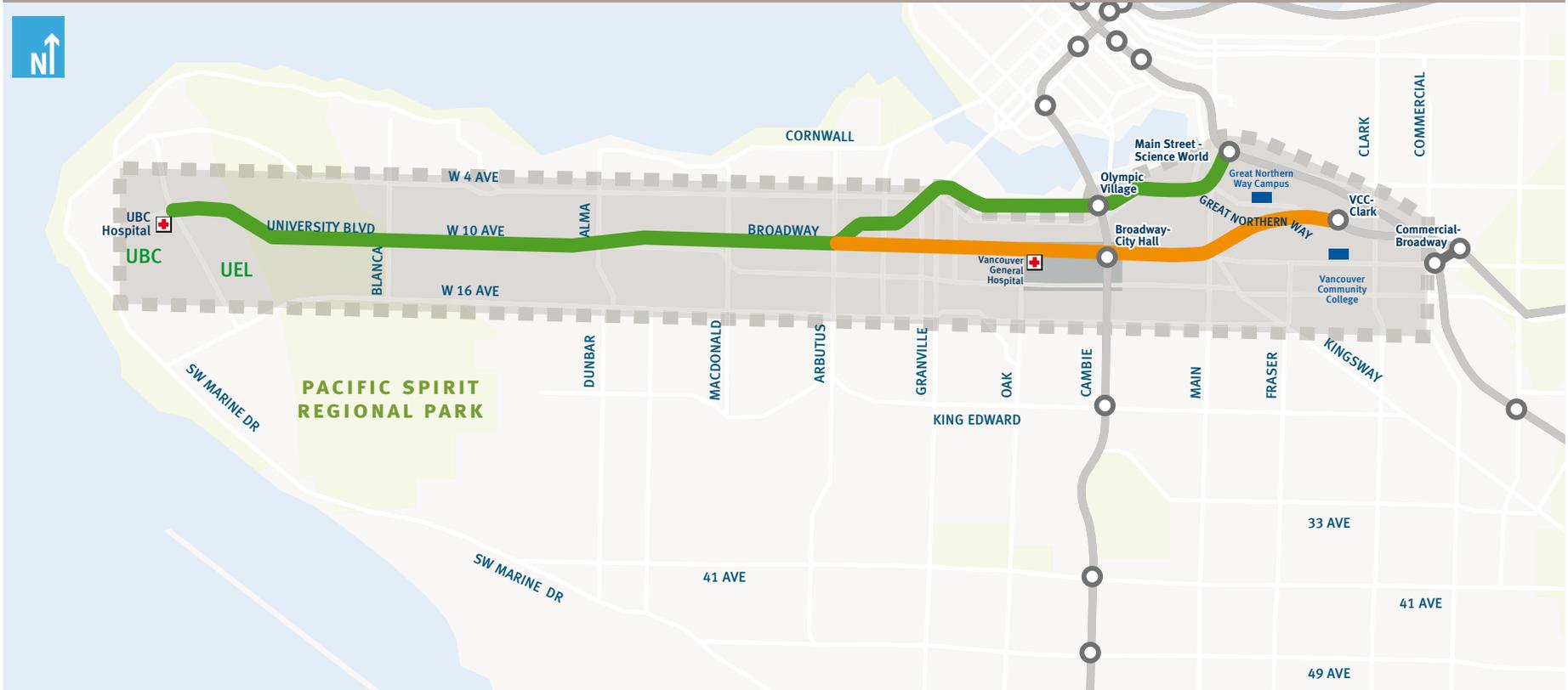
1.35 While Option 183 is therefore not recommended as a long term solution, it can still be considered as a potential phasing option of a full RRT alternative in Phase 2.

1.36 The results of the Sift Assessment therefore show that one alternative (Option 176) should be progressed for further development and evaluation in Phase 2 and is shown in Figure 8.

- ▶ **RRT - Broadway/Arbutus, Broadway, Great Northern Way Campus, VCC/Clark Station, in addition to**

- ▶ **LRT - UBC, W.10th Ave, Broadway/Arbutus, CP Rail right-of-way, Main Street Station.**

Figure 8 Phase 1 – Recommended Combined Technology Alternative



Combination Alternative

- Light Rail Transit
- Rail Rapid Transit

Notes:

1 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

2 Potential station locations will be identified in Phase 2 of the Study.

	UBC Line Study Area		Central Broadway
	Parks		
	Roadways		
	Existing Rapid Transit & Commuter Rail		

Next Steps

This Executive Summary and report conclude the technical evaluation and assessment of alternatives for Phase 1 of the UBC Line Rapid Transit Study. The next step is therefore to develop the Phase 2 alternatives in much greater detail including:

- ▶ Preliminary alignment designs for each alternative including vertical and horizontal alignment design
- ▶ Parking, servicing and access review
- ▶ Detailed station/stop Assessments
- ▶ Urban context Assessments
- ▶ Transit operations and complementary bus network review
- ▶ Capital & operating cost estimates
- ▶ Data collection & analysis
- ▶ Modelling – ridership & traffic
- ▶ Multiple account evaluation of alternatives

THE BEST BUS ALTERNATIVE

- 1.37 Five of the alternatives presented earlier in this Executive Summary represent the range of ‘build’ alternatives. That is, they include significant levels of investment in new, capital infrastructure. However to help inform the final evaluation and to provide a means of assessing the incremental value that the alternatives represent, a low cost alternative will be developed. It will include only limited capital investments for bus priority measures and will include frequency enhancements across a range of corridors to determine the most that could be achieved using buses - **‘the best bus alternative’**.
- 1.38 In addition, the Steer Davies Gleave team will begin to develop ‘Wider Area Solutions’ that will look at the impacts and opportunities created by each alternative outside the direct corridor. This could include, for example, addressing parking issues on side and parallel roads, improving walking and pedestrian routes to provide better access to the stops, and integrating cycling routes and facilities as well as looking at ways to mitigate any displaced traffic.
- 1.39 The shortlisted alternatives identified by the technical assessment and evaluation process completed through Phase 1 was largely confirmed by the public and stakeholder consultation. A key point raised during Phase 1 consultation was to look more closely at opportunities to combine RRT and BRT, which will be considered as part of the more detailed assessment of the alternatives in Phase 2. A detailed Phase 2 consultation plan will be developed to provide these groups with a more active role in future Phases of the project.

1. INTRODUCTION AND OVERVIEW

Report Context

In March 2009, Steer Davies Gleave was retained by the South Coast British Columbia Transportation Authority (TransLink) and the BC Ministry of Transportation & Infrastructure (MOTI) (the Project Sponsors) to examine a range of rapid transit technologies and alignment options (together known as ‘alternatives’) to serve the Broadway Corridor.

For reference, while the complete UBC Line Rapid Transit Study is being undertaken in the three phases, the Steer Davies Gleave contract is only for the first two phases. The full project includes:

- ▶ **Phase 1 - Shortlist Identification: technology and alignment options are identified and screened for technical feasibility in order to arrive at a shortlist of plausible alternatives for further development in Phase 2.**
- ▶ **Phase 2 - Alternatives Development and Evaluation: shortlisted alternatives are further developed and evaluated to support a decision on a preferred alternative.**
- ▶ **Phase 3 - Design Development: after selection of a preferred alternative, further design development and costing is undertaken. Phase 3 will establish a budget, timeline and phasing for the project and provide the basis for project definition, securing funding and procurement.**

A number of reports have been drafted which provide useful background to this report including :

- ▶ **Project Vision, Mission, Objectives and Evaluation Framework” (January 2010)**
- ▶ **Project Context and Background Document Review (January 2010).**

- 1.1 Figure 1.1 illustrates the Broadway corridor, as defined in the context of this study.

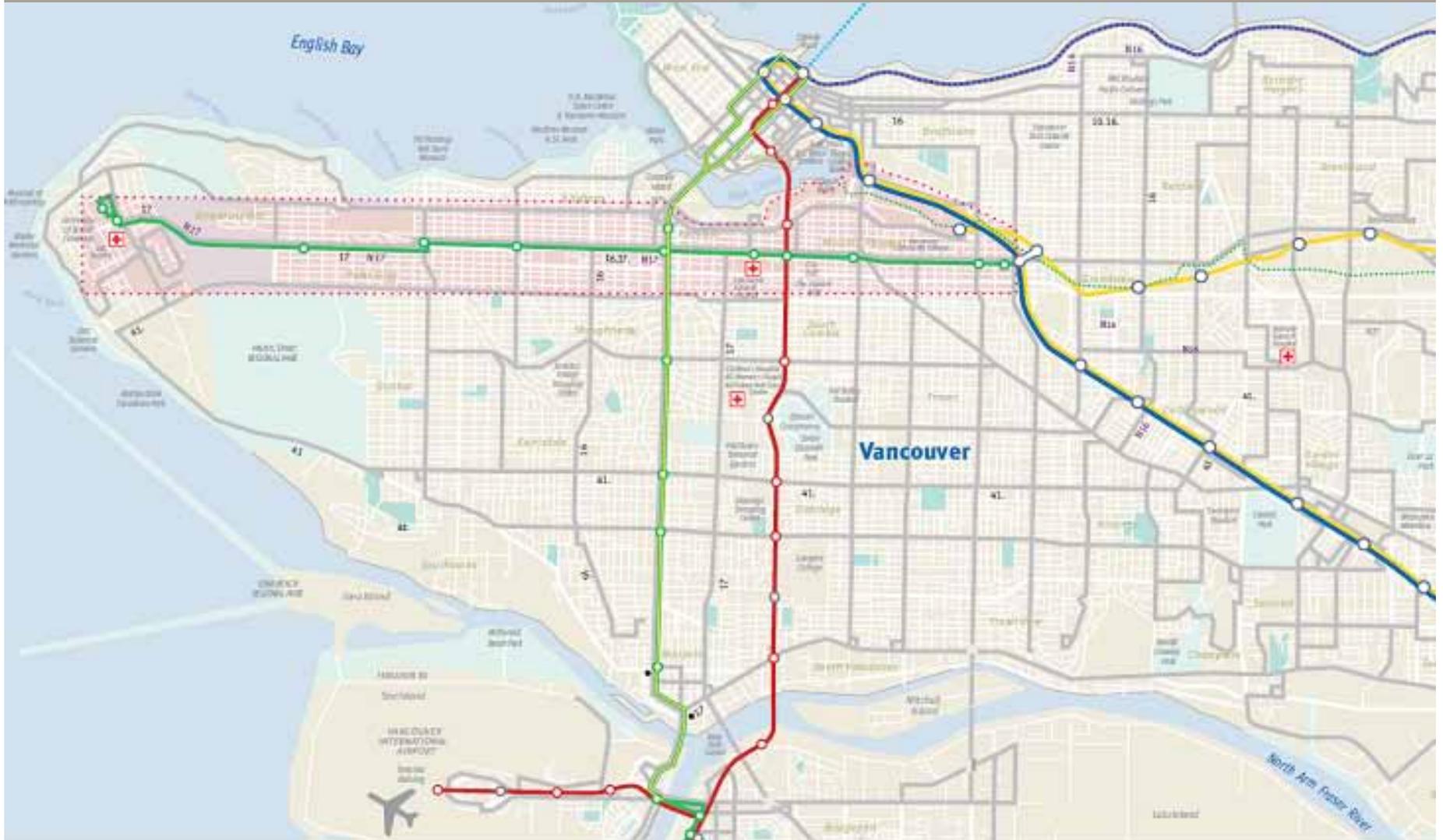
Purpose of the Report

- 1.2 This report summarizes Phase 1 of the Alternative Evaluation process outlined above, including the ‘Pre-Sift’ and the ‘Sift’ process. It includes the process and results of the analysis together with recommendations for alternatives for further study in Phase 2 of the study.

Report Structure

- 1.3 Following this introduction, this report includes the following four chapters:
 - ▶ **Chapter 2 – Development and Evaluation Process**
 - ▶ **Chapter 3 – Pre-Sift Assessment**
 - ▶ **Chapter 4 - Sift Assessment**
 - ▶ **Chapter 5 – Recommendations and Next Steps**
- 1.4 In addition, this report is supported by the following four appendices:
 - ▶ **Appendix A: Long List of Options**
 - ▶ **Appendix B: Pre-Sift Assessment Results**
 - ▶ **Appendix C: Sift Assessment Templates and Assumptions**
 - ▶ **Appendix D: Sift Option Maps**

Figure 1.1 UBC Rapid Transit Context Study Map



2. ALTERNATIVES DEVELOPMENT AND EVALUATION PROCESS

Introduction

- 2.1 Where funding for public transportation is finite, it is important that investment is put into the most effective solutions. It is therefore necessary to consider a wide range of options, and a robust option evaluation process is required to justify the final recommended solution.

Alternatives Evaluation Process

- 2.2 The evaluation of options and alternatives is not a ‘single step’ process, but rather a tool that is employed on an ongoing basis to assist the shaping and refinement of the options. This process supports the consideration of the transit system network effect (currently being studied as part of the parallel Strategic Network Review) by ensuring the definition of individual alternatives does not preclude valuable opportunities for integration and delivering benefits on a regional scale.
- 2.3 Figure 2.1 illustrates the project development process that will be used to move from a full set of all possible alternatives through to the identification and definition of a single preferred alternative.
- 2.4 The initial stage considers a long list of potential alternatives which undergo a series of assessments (‘sifts’). As the list of alternatives reduces, the detail in which the alternatives are assessed increases, thereby concentrating analysis on alternatives more likely to be taken forward. At each step, the alternatives are assessed using a Multiple Account Evaluation Framework.

MULTIPLE ACCOUNT EVALUATION FRAMEWORK (MAE)

The ‘Project Vision, Mission, Objectives and Evaluation Framework’ report provides the full details of the MAE

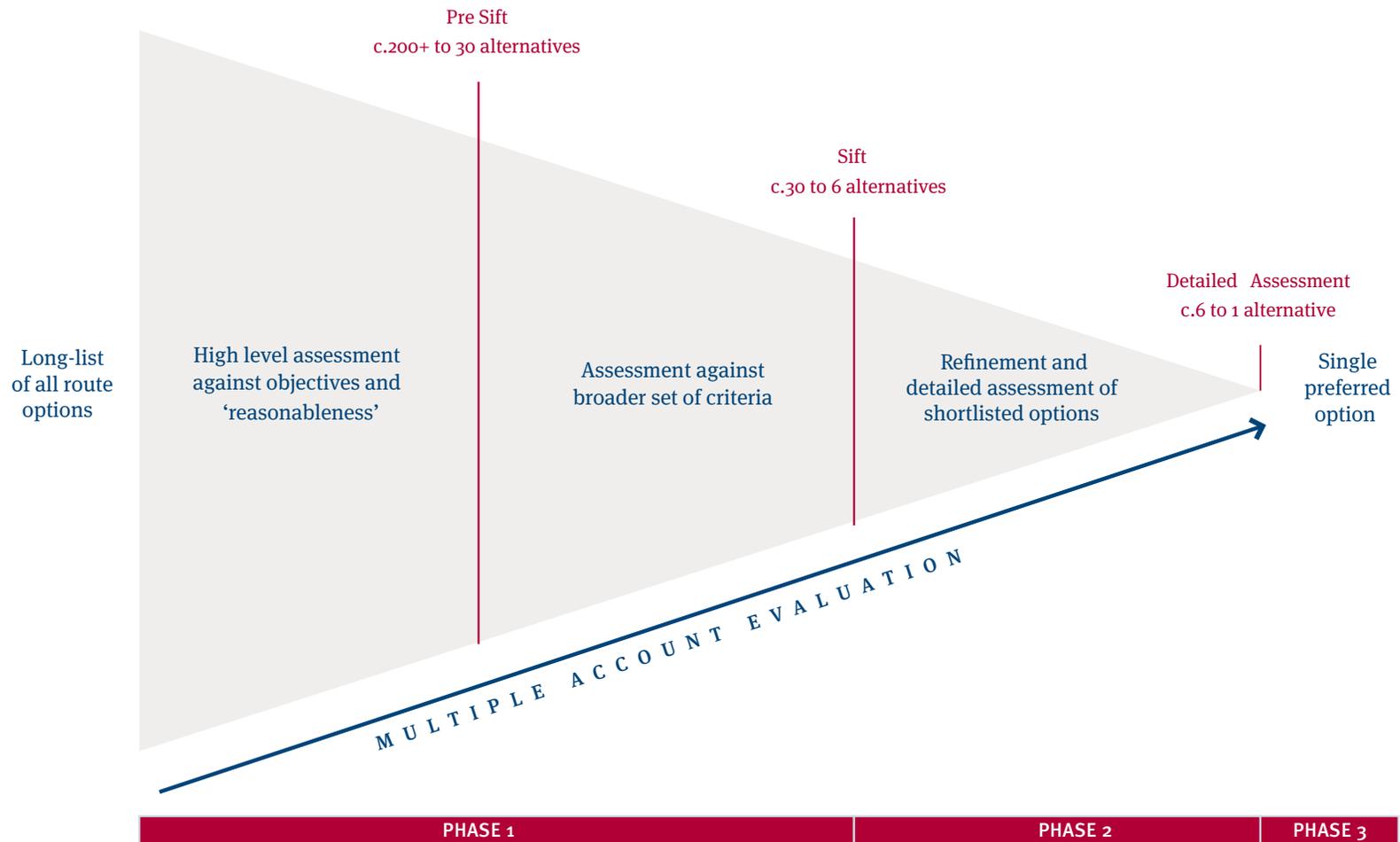
Framework, including the accounts selected and the criteria used in each phase of the evaluation process. However, in summary, the accounts were selected based on a Best Practices Review, the requirements of the likely funding agencies and to provide a clear link from the objectives to the evaluation process.

The resulting framework includes seven accounts that represent the high-level broader public policy goals against which the projects will be assessed and are included, along with the related project objective, in Table 2.1.

Table 2.1 MAE Accounts

Project Objective	Account
An affordable and cost-effective service	Financial
A fast, reliable and efficient service that meets current and future capacity needs, supports achieving transportation targets and integrates with and strengthens the regional transit network and other modes	Transportation
A service that contributes to meeting wider environmental sustainability targets and objectives by attracting new riders, supporting changes to land use and reducing vehicle kilometers travelled	Environmental
A service that supports current and future land use development along the corridor and at UBC and integrates with the surrounding neighbourhoods through high quality urban design	Urban Development
A service that encourages economic development by improving access to existing and future major regional destinations and local businesses by transit while continuing to facilitate goods movement	Economic Development
A safe, secure and accessible service that also improves access to rapid transit for all and brings positive benefit to the surrounding communities, including managing impacts of rapid transit	Social Community
A service that is constructible and operable.	Deliverability

Figure 2.1 Alternative Development and Assessment Process



PHASE 1 EVALUATION

- 2.5 As indicated in Figure 2.1, with a very long list of alternatives at the beginning of Phase 1, the evaluation was split into two steps. The ‘Pre-Sift’ was used to reduce the long list of all possible route options to a manageable set of ‘in scope’ options. This more manageable set of options was then subjected to a more detailed Assessment (the ‘Sift’) to arrive at a recommended short list of alternatives (i.e. routes and technologies) to progress to Phase 2 of the study.

Phase 1 – Pre-Sift Assessment

- 2.6 With a very long list of possible alternatives to review, it would have been both impractical and inefficient to undertake a detailed analysis on all of the alternatives at this stage of evaluation. Therefore, a high level Assessment process was needed to sift or screen out the routes that would likely be the lowest performing.
- 2.7 There is very little guidance provided by any of the local funding agencies or by other international best practice jurisdictions reviewed on how to undertake this process. However, all agencies recommend that the process be:
- ▶ **Well documented;**
 - ▶ **Agreed with the Project Sponsors and**
 - ▶ **That the screening process be done against the defined project objectives as well as a more general test of the ‘reasonableness’ of the options.**

Phase 1 – Sift Assessment

- 2.8 Following the elimination of the weaker performing routes at the Pre-Sift stage, a shorter list of alternatives was assessed using a larger set criteria at the Sift stage.
- 2.9 As with the Pre-Sift, specific criteria were agreed with the Project Sponsors to assess the alternatives and to provide the additional information needed to make a recommendation on the routes to progress to Phase 2 of the study.

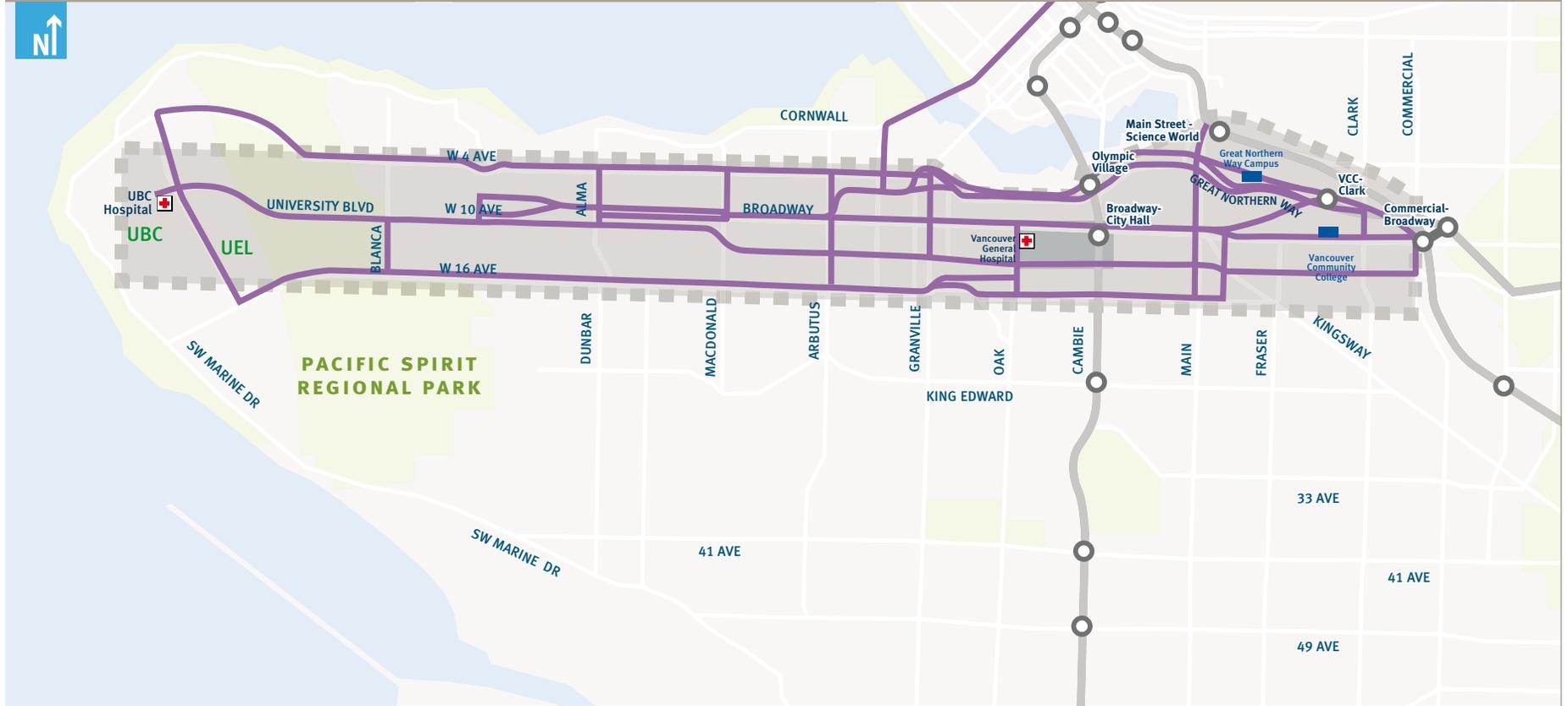
PHASE 2 EVALUATION

- 2.10 The Phase 2 evaluation process will build on the evaluations undertaken through Phase 1 for the remaining shortlisted alternatives. At this stage of development and Assessment, the alternatives will be tested against two baseline scenarios:
- ▶ **Business as Usual: Increases in the service levels of existing routes in accordance with historical and planned service increase trends and without significant fixed infrastructure costs.**
 - ▶ **Best Bus: Improvements in the bus service to deliver the highest-capacity service possible (though not exceeding projected demand) with changes to routes, frequencies and service patterns, and modest investment in fixed infrastructure.**
- 2.11 The roles of these scenarios are complementary in supporting the evaluations of rapid transit alternatives. The Business as Usual scenario will be used to measure the effectiveness of the Best Bus scenario and as a point of reference for comparisons with the rapid transit alternatives. The Best Bus scenario will be the basis of comparison for the relative evaluation of the rapid transit scenarios.
- 2.12 As the alternatives and Assessment tools become available (e.g. new ridership models, microsimulation tools, etc...) they will be used to test the Phase 2 alternatives and provide the key inputs to the detailed Phase 2 evaluation process. This process has been developed so that the Project Sponsors and their consultants can then continue with further detailed Assessment and business case development through Phase 3 of the project.
- 2.13 This report focuses on the Phase 1 Evaluation ('Pre-Sift' and 'Sift' Processes) and summarizes the Assessment process and results. A similar report will be prepared at the conclusion of the Phase 2 process.

Option Development

- 2.14 Through consultation with the Project Sponsors and the Study Partners (City of Vancouver, University of British Columbia, University Endowment Lands and Metro Vancouver), the project team developed a long list of potential rapid transit corridors that included both on-street routes as well as route options using existing and disused rail corridors within the study area. All options needed to provide a connection from either the Expo or Millennium SkyTrain line to the UBC campus.
- 2.15 Routes that were viewed as overly circuitous were not included in the full set of options. The long list is included in Appendix A and is shown in Figure 2.2.

Figure 2.2 Long List of Route Options



3. PRE-SIFT ASSESSMENT

The Pre-Sift Assessment Framework

- 3.1 As noted in Chapter 2, the full details of the Assessment framework and criteria used at each step of the evaluation process are described in the ‘Project Vision, Mission, Objectives and Evaluation Framework Report’, however for reference, the criteria selected for undertaking the Pre-Sift Assessment are provided in Table 3.1.
- 3.2 Each of the criteria is described in the following sections.

Table 3.1 Pre-Sift Assessment Criteria

	Financial	Transportation	Environment	Urban Development	Economic Development	Social Community	Deliverability
Assessment Criteria	Not assessed at this stage	Network Access – Corridor employment & population	Not assessed at this stage	Land Use Integration – Activity Centres	Not assessed at this stage	Not assessed at this stage	Constructability
		Network Access – Connectivity & Integration					
		Transportation Efficiency – Route length					

TRANSPORTATION ACCOUNT

3.3 The Assessment of options against the Transportation Account consisted of the following three criteria:

- ▶ **Catchment Analysis to measure the number of people that are projected to live/work near to a route;**
 - 400m catchment for employment (2041)
 - 400m catchment for population (2041)
- ▶ **Integration with rapid transit network (number of connections for each option);**
 - Expo Line;
 - Millennium Line;
 - Canada Line; and
 - Proposed City of Vancouver streetcar.
- ▶ **Route length (as a proxy for journey time)**

3.4 The projected corridor population and employment densities (based on Metro Vancouver's Draft Regional Growth Strategy) are shown in Figures 3.1 and 3.2. In addition, Figures 3.3 and 3.4 show real population and employment growth. Table 3.2 provides data with respect to these figures. Note that the Traffic Area Zone data used may not capture nodes of very high or very low density (e.g UBC where Pacific Spirit Park has no density and the campus housing areas have medium-high density).

Table 3.2 2041 Population and Employment Forecast

Map Reference	TAZ	Population			Employment		
		2006	2041	Growth	2006	2041	Growth
A	2900	677	1,825	1,148	469	1,119	650
B	2910	2,555	7,141	4,586	16,813	22,383	5,570
C	2922	8,067	11,930	3,863	1,615	2,315	700
D	3000	5,261	7,567	2,306	1,961	2,180	219
E	3010	8,442	10,438	1,996	2,388	2,345	-43
F	3030	5,521	6,406	885	2,434	2,594	160
G	3040	5,785	6,575	790	1,915	2,167	252
H	3060	5,131	5,539	408	2,353	2,987	634
I	3070	5,736	6,136	400	3,896	3,573	-323
J	3080	1,510	3,783	2,273	8,425	8,463	38
K	3090	6,803	8,221	1,418	2,908	3,316	408
L	3100	4,478	4,798	320	3,636	4,753	1,117
M	3130	3,596	3,800	204	5,236	5,583	347
N	3170	7,996	8,876	880	2,995	3,413	418
O	3120	3,508	3,018	-490	843	713	-130
P	3140	2,231	3,582	1,351	6,363	7,267	904
Q	3180	1,151	1,048	-103	13,051	16,068	3,017
R	3190	4,127	4,721	594	872	1,111	239
S	3150	1,530	7,700	6,170	1,607	2,158	551
T	3160	980	7,487	6,507	13,377	16,365	2,988
U	3200	5,572	6,523	951	3,776	4,675	899
V	3460	8,800	9,168	368	6,508	15,978	9,470
W	3590	5,044	7,156	2,112	2,835	3,164	329
X	3640	7,794	9,471	1,677	1,796	2,243	447
Y	3490	6,299	6,657	358	2,104	2,234	130

Figure 3.1 Projected Study Area Population Density (2041)

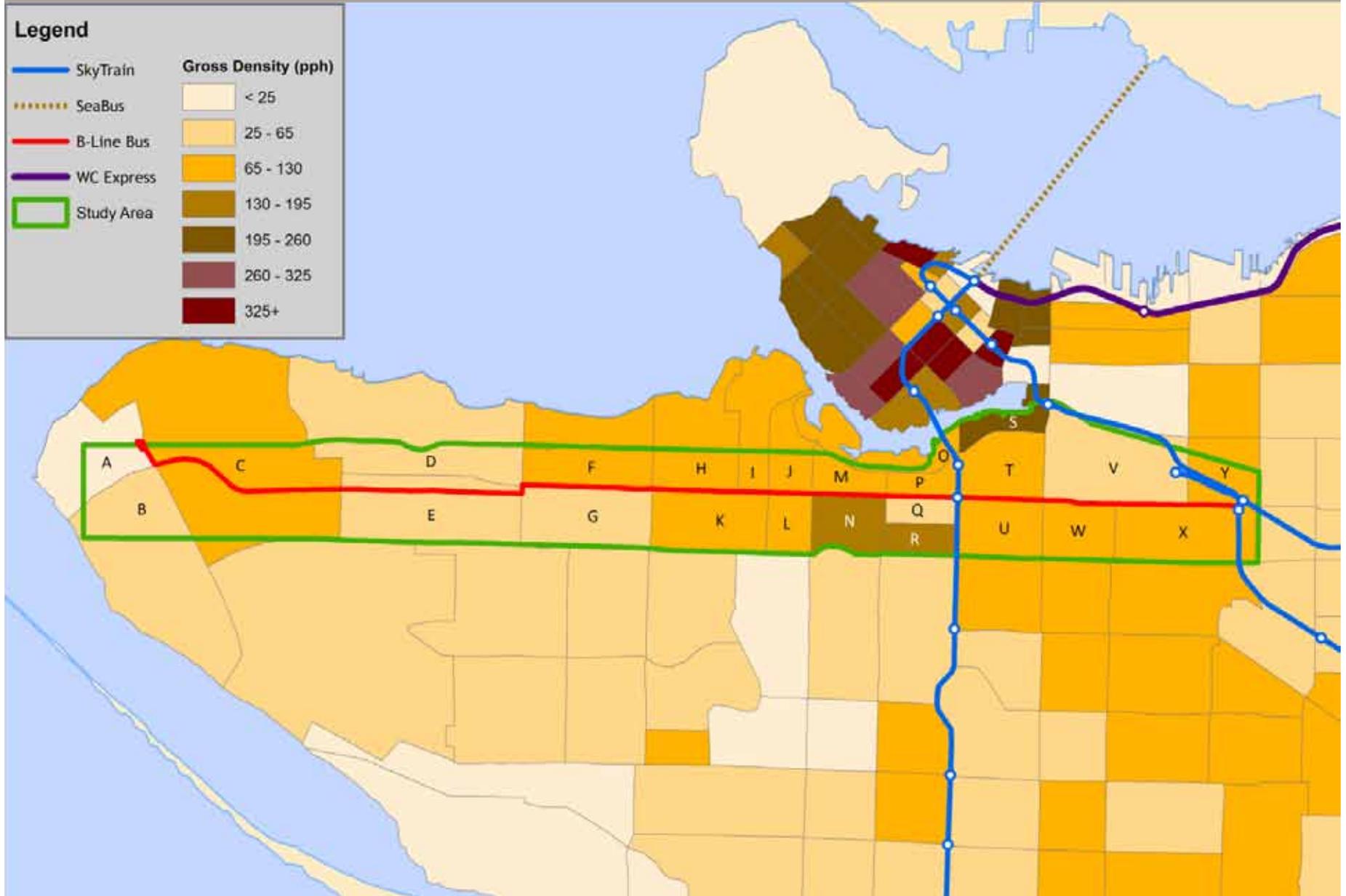


Figure 3.2 Projected Study Area Employment Density (2041)

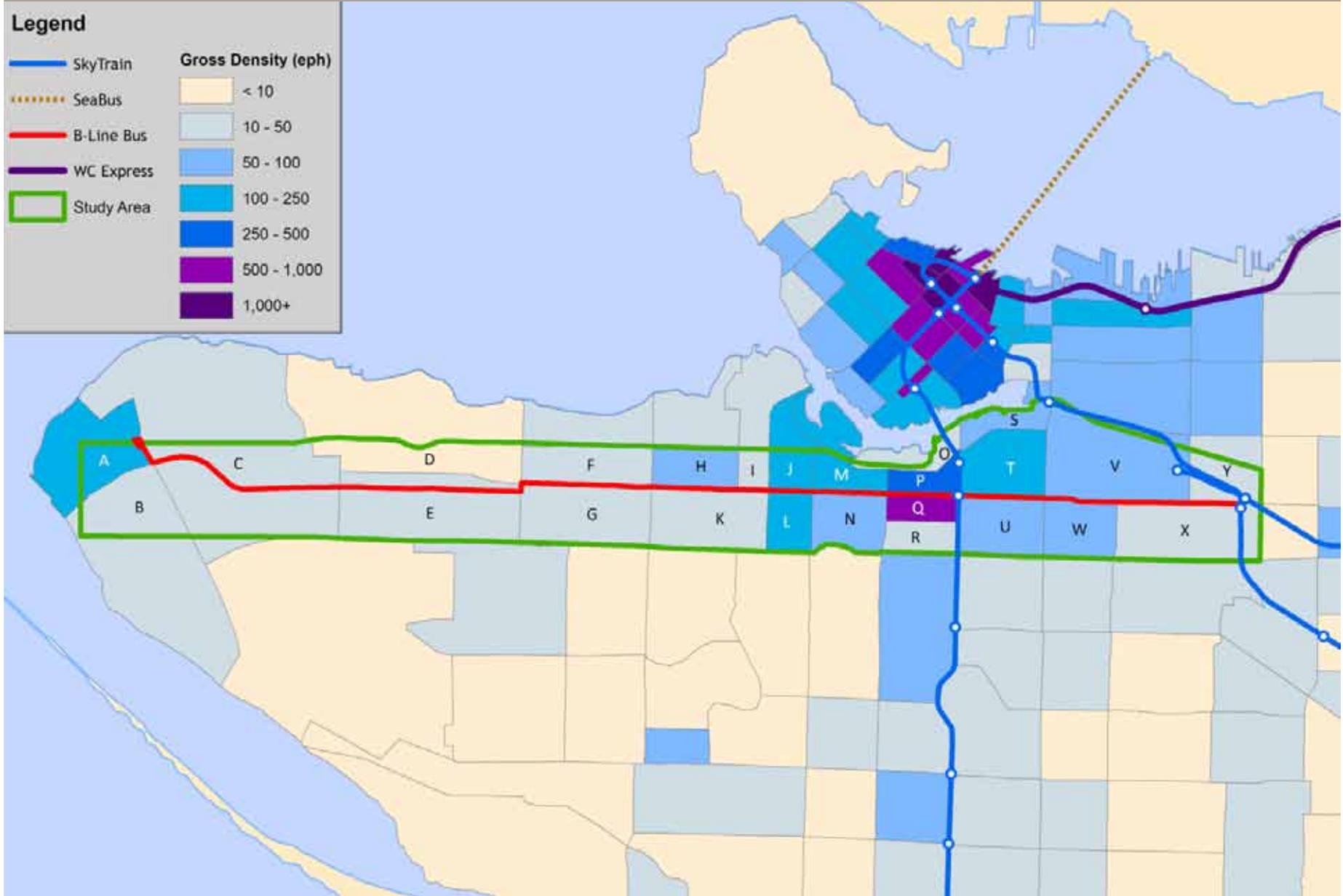


Figure 3.3 Projected Real Population Growth 2006-2041

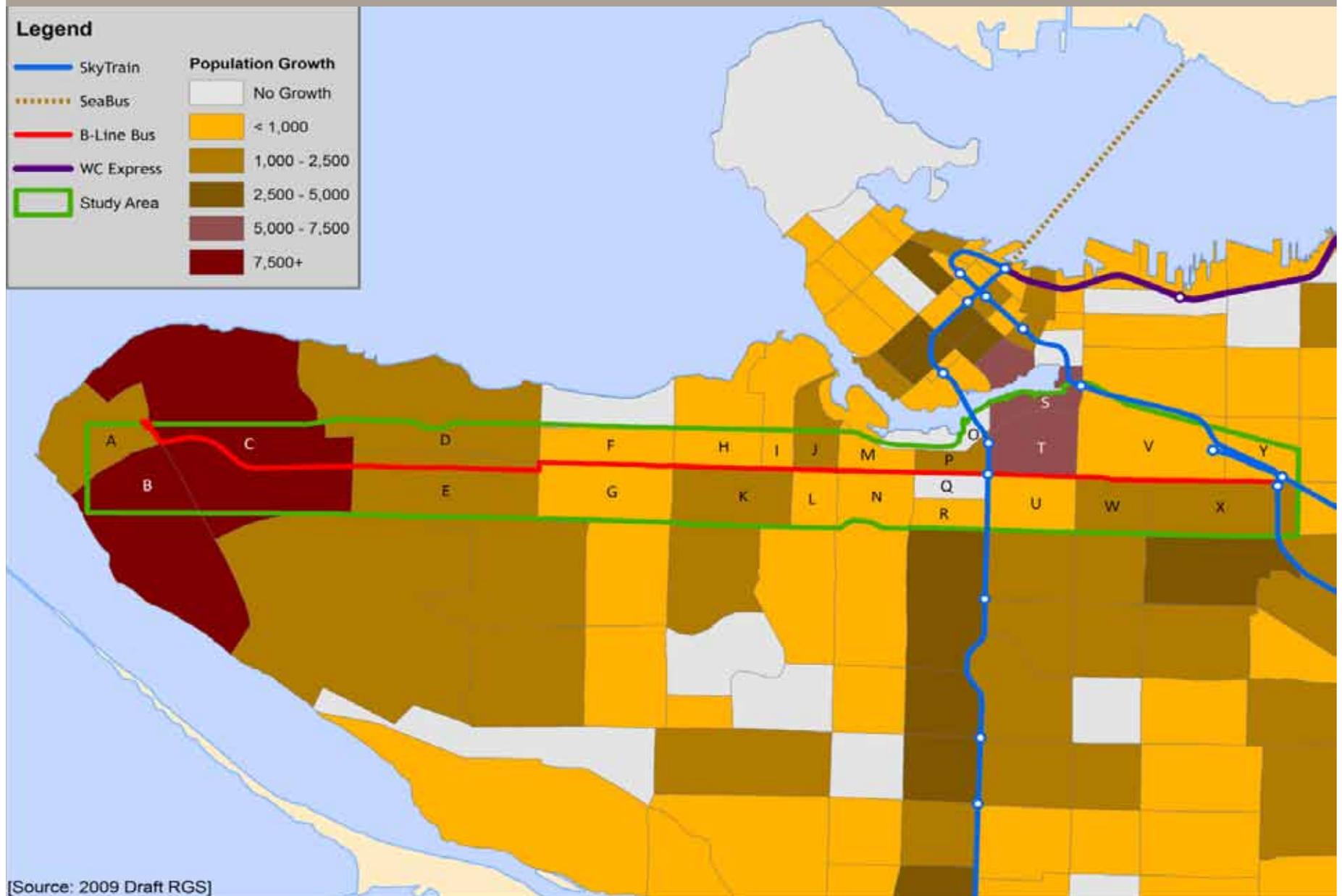
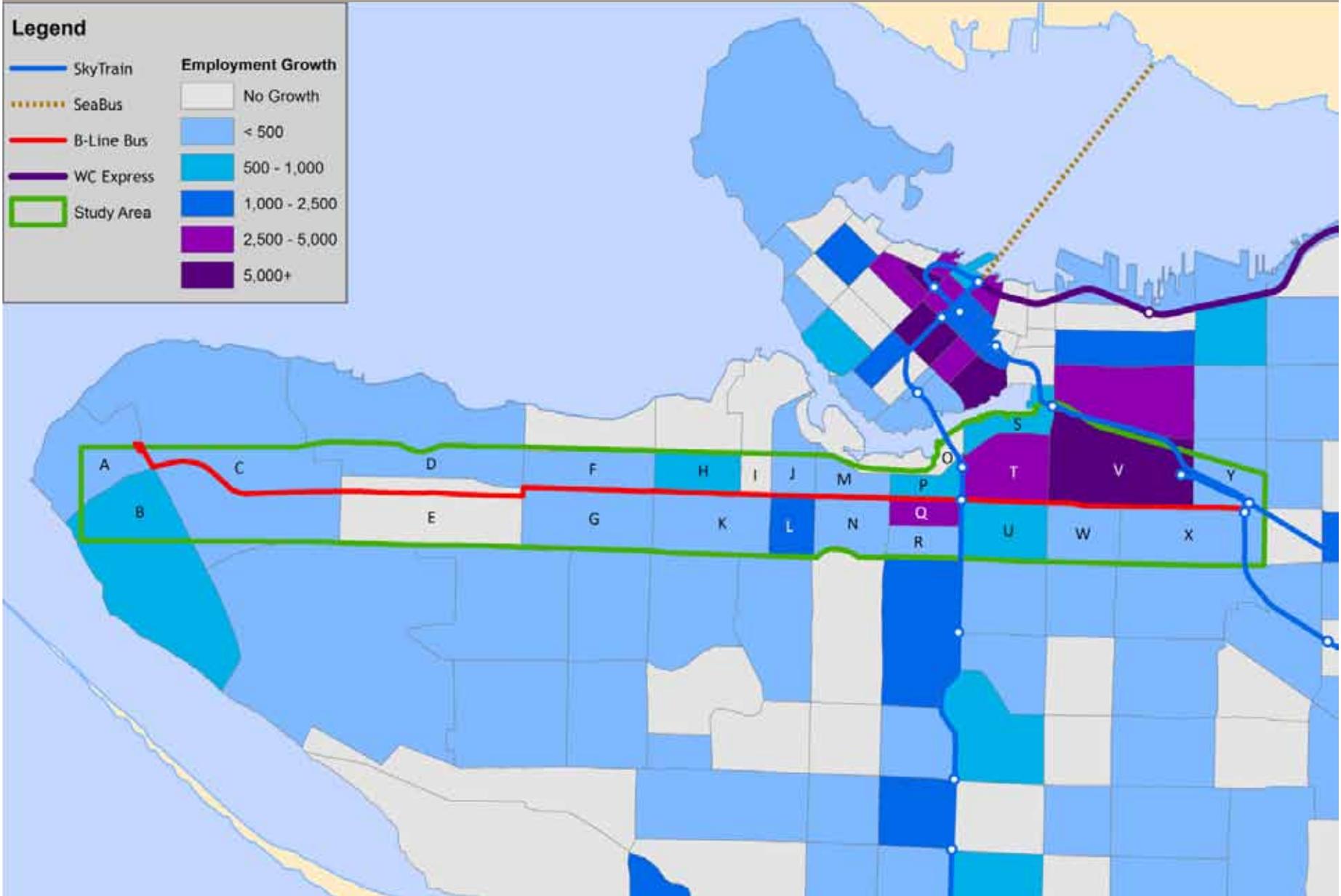


Figure 3.4 Projected Real Employment Growth 2006-2041



URBAN DEVELOPMENT ACCOUNT

3.5 The Assessment of options against the Urban Development Account considered the proximity of the options to the following six major activity centres in the study area:

- ▶ **University of British Columbia;**
- ▶ **Vancouver General Hospital;**
- ▶ **City Hall/City Square;**
- ▶ **Central Broadway;**
- ▶ **Vancouver Community College; and**
- ▶ **Great Northern Way Campus.**

3.6 These represent the largest employment centres and attractors of transit trips in the corridor and were agreed with the Project Sponsors and Partner Agencies. Each are shown in purple in Figure 3.5 and note that the centres were considered in the route catchment if they were within two blocks of the option alignment.

DELIVERABILITY ACCOUNT

The Assessment of options against the Deliverability Account used a pass/fail test to assess the Constructability of the options. With all of the options following existing transportation corridors and with little/no design completed, all options were considered 'Constructible' and none were eliminated due to Deliverability.

Pre Sift Route Assessment Summary

3.7 For each of the criteria, the options were ranked from best to worst and then an overall ranking was calculated by summing the ranking across each criteria.

3.8 Table 3.3 shows the 31 best performing options with scores less than 250 (i.e. those options that scored, on average, in the top 50 across the five categories). Full details of the rankings for each criteria are provided in Appendix B.

3.9 With 31 routes passing the initial Pre-Sifting process, a review was undertaken of the individual routes. This review highlighted that many of the options represented only very minor variations of each other (e.g. Option 1 and 2 are exactly the same except for the section between West Broadway and 10th Avenue where for that one-block stretch, Option 1 uses Alma St where as Option 2 uses Highbury St). It was therefore agreed that these minor variations would be treated as 'Design Options' rather than full, stand alone routes and that they would be reviewed as part of further detailed option development in Phase 2 of the study. Table 3.4 provides a list of the options that were retained and those which will be treated as Design Options (and of which option). By removing these design options, the 31 options were reduced to 11 options.

Figure 3.5 Major Activity Centres

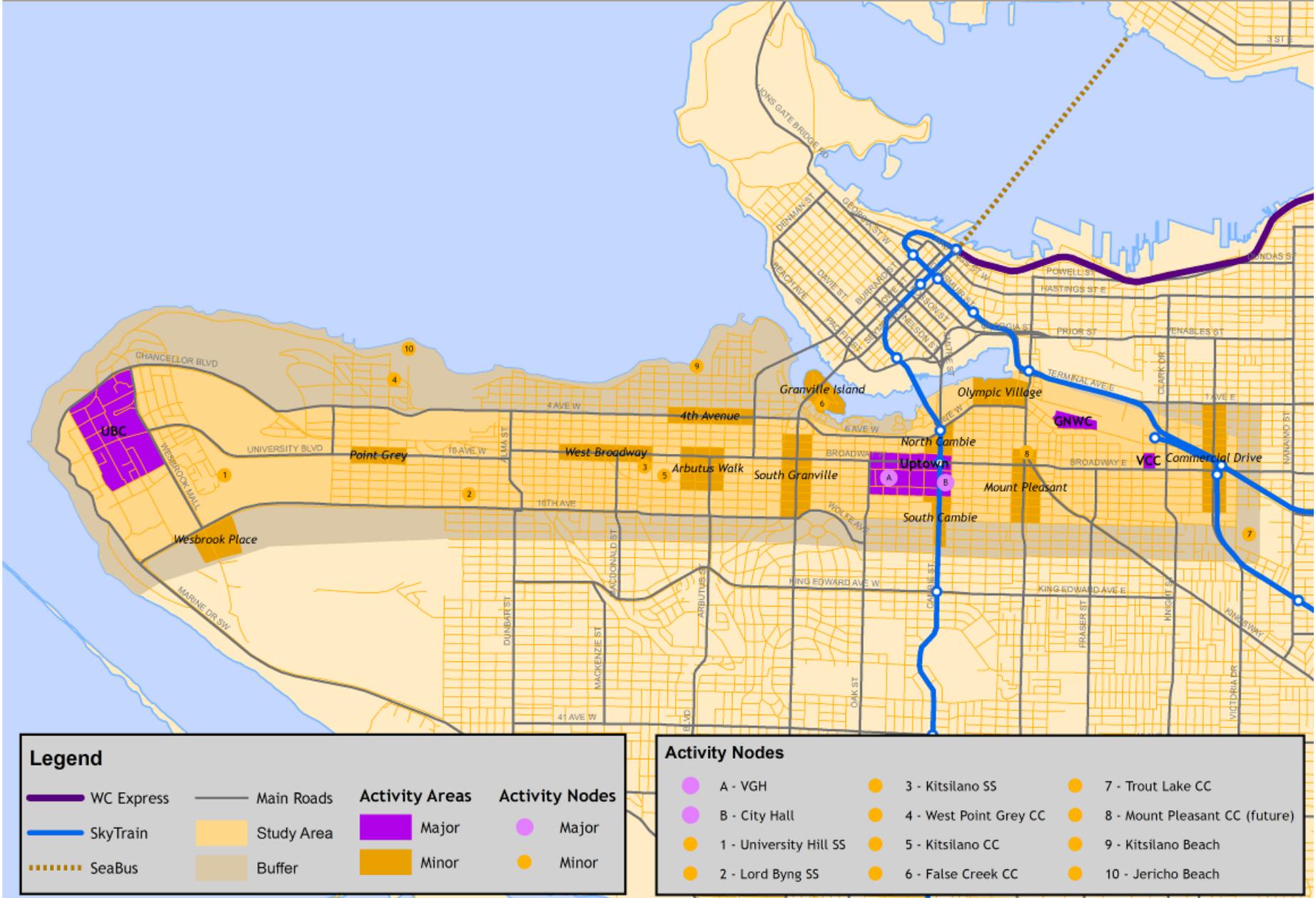


Table 3.3 Pre-Sift Results Summary

Route Options	Route	Ranking					TOTAL
		Route Length	Employment Catchment	Population Catchment	Activity Centres	Integration	
1	10 th / Alma / Broadway	2	8	56	13	23	102
2	10 th / Highbury / Broadway	4	9	57	13	23	106
5	10 th / Macdonald / Broadway	3	12	60	13	23	111
6	10 th / 12 th / Arbutus / Broadway	14	11	51	13	23	112
3	10 th / Discovery / Broadway	8	10	62	13	23	116
22	10 th / Alma / 4 th / 2 nd / GNW / Clark / Broadway	17	37	29	46	1	130
172	10 th / Commercial	1	57	39	13	23	133
35	10 th / Alma / Broadway / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	28	27	45	46	1	147
29	10 th / Alma / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	72	14	19	46	1	152
36	10 th / Highbury / Broadway / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	31	28	47	46	1	153
33	10 th / Macdonald / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	66	18	24	46	1	155
39	10 th / Macdonald / Broadway / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	26	33	52	46	1	158
100	10 th / Alma / Broadway / Underground / VCC	7	2	127	1	23	160
105	10 th / 12 th / Arbutus / Broadway / Underground / VCC	20	5	117	1	23	166
101	10 th / Highbury / Broadway / Underground / VCC	13	3	130	1	23	170
104	10 th / Macdonald / Broadway / Underground / VCC	6	6	135	1	23	171
30	10 th / Highbury / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	89	15	22	46	1	173
37	10 th / Discovery / Broadway / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	50	29	53	46	1	179
25	10 th / Alma / Broadway / Macdonald / 4 th / 2 nd / GNW / Clark / Broadway	73	34	26	46	1	180
102	10 th / Discovery / Broadway / Underground / VCC	16	4	137	1	23	181
34	10 th / 12 th / Arbutus / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	113	17	15	46	1	192
31	10 th / Discovery / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	105	16	25	46	1	193
26	10 th / Highbury / Broadway / Macdonald / 4 th / 2 nd / GNW / Clark / Broadway	90	35	27	46	1	199
23	10 th / Highbury / 4 th / 2 nd / GNW / Clark / Broadway	87	39	31	46	1	204
24	10 th / Discovery / 4 th / 2 nd / GNW / Clark / Broadway	96	40	33	46	1	216
27	10 th / Discovery / Broadway / Macdonald / 4 th / 2 nd / GNW / Clark / Broadway	106	36	32	46	1	221
173	10 th / 12 th / Commercial	5	155	13	33	23	229
40	10 th / 12 th / Arbutus / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	116	31	37	46	1	231
62	10 th / Alma / Broadway / Granville / 4 th / 2 nd / GNW	37	21	73	46	56	233
66	10 th / Macdonald / Broadway / Granville / 4 th / 2 nd / GNW	32	25	79	46	56	238
4	Wesbrook / Chancellor Blvd / 4 th / Alma / Broadway	139	7	58	13	23	240

Table 3.4 Pre-Sift Design Options

Route Options	Route	Retain	Design Option
1	10 th / Alma / Broadway	✓	-
2	10 th / Highbury / Broadway	✓	Route 1
3	10 th / Discovery / Broadway	X	Route 1
4	Wesbrook / Chancellor Blvd / 4 th / Alma / Broadway	✓	
5	10 th / Macdonald / Broadway	X	Route 1
6	10 th / 12 th / Arbutus / Broadway	✓	-
22	10 th / Alma / 4 th / 2 nd / GNW / Clark / Broadway	✓	-
23	10 th / Highbury / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 22
24	10 th / Discovery / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 22
25	10 th / Alma / Broadway / Macdonald / 4 th / 2 nd / GNW / Clark / Broadway	✓	-
26	10 th / Highbury / Broadway / Macdonald / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 25
27	10 th / Discovery / Broadway / Macdonald / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 25
29	10 th / Alma / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	✓	-
30	10 th / Highbury / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 29
31	10 th / Discovery / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 29
33	10 th / Macdonald / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 29
34	10 th / 12 th / Arbutus / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 29
35	10 th / Alma / Broadway / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	✓	-
36	10 th / Highbury / Broadway / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 35
37	10 th / Discovery / Broadway / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 35
39	10 th / Macdonald / Broadway / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	X	Route 35
40	10 th / 12 th / Arbutus / Rail Corridor / 4 th / 2 nd / GNW / Clark / Broadway	✓	-
62	10 th / Alma / Broadway / Granville / 4 th / 2 nd / GNW	✓	-
66	10 th / Macdonald / Broadway / Granville / 4 th / 2 nd / GNW	X	Route 62
100	10 th / Alma / Broadway / Underground / VCC	✓	-
101	10 th / Highbury / Broadway / Underground / VCC	X	Route 100
102	10 th / Discovery / Broadway / Underground / VCC	X	Route 100
104	10 th / Macdonald / Broadway / Underground / VCC	X	Route 100
105	10 th / 12 th / Arbutus / Broadway / Underground / VCC	X	Route 100
172	10 th / Commercial	X	Route 1
173	10 th / 12 th / Commercial	✓	-

CROSS CHECKING THE RESULTS

3.10 In order to ensure that the Pre-Sift Assessment process and the application of rankings was robust, the Pre-Sift criteria were re-applied as a cross check of the results. This included using a pass/fail process to test each option against the following criteria:

► Transportation Account:

- Population & Employment Catchment – options within 10% of highest value
- Integration –three or more points of interchange with the rapid transit network
- Route length – within 10% of existing (B-Line) route length

► Urban Development Account:

- Major activity centres – minimum of three

3.11 This process selected the majority of the same route options and it was therefore agreed with the Project Sponsors that the final 11 route options shown in Table 3.5 be progressed to the Sift Assessment.

Table 3.5 Route Options Progressed to the Sift Assessment

Option	Route
1	10 th / Alma / Broadway
4	Wesbrook / Chancellor Blvd / 4 th / Alma / Broadway
6	10 th / 12 th / Arbutus / Broadway
22	10 th / Alma / 4 th /GNW / Broadway
25	10 th / Broadway / Macdonald /4 th / GNW / Broadway
29	10 th / Alma / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway
35	10 th / Broadway / rail corridor/ 4 th / GNW / Broadway
40	10 th / 12 th Avenue / rail corridor/ 4 th / GNW / Broadway
62	10 th / Broadway / Granville / 4 th / VCC
100	10 th / Broadway / Quebec (Main)/ 2 nd / Broadway
173	10 th / 12 th / Broadway

Technology Assessment

3.12 Once the feasible routes were identified, an assessment was undertaken to generate route and technology combinations.

3.13 The study is considering three modes of rapid transit technologies to serve the corridor. Specific details of the operating characteristics of the vehicles, alignments and typical costs are provided in the ‘Rapid Transit Mode Technical Backgrounder’ report. However for reference, the technology options include:

- ▶ **Bus Rapid Transit (BRT).**
- ▶ **Light Rail Transit (LRT); and**
- ▶ **Rail Rapid Transit (RRT).**

3.14 The appropriateness of each technology was considered for each of the 11 route options in Table 3.5 by:

- ▶ **Applying a common set of guiding principles;**
- ▶ **Reviewing the applicability to each route; and**
- ▶ **Examining options that would use multiple corridors or multiple technologies.**

TECHNOLOGY GUIDING PRINCIPLES

3.15 The following common set of technology guiding principles were developed to assess the technology options:

- ▶ **One interchange only: for all passengers travelling to/from the existing rapid transit network (Expo Line, Millennium Line or Canada Line), a maximum of one interchange is permitted to travel to/from the major transit destinations in the corridor, UBC and Central Broadway;**
- ▶ **The highest capacity technology will be provided at the peak load point (i.e. there could not be a BRT system from Commercial to Granville and then an RRT system from Granville to UBC);**

- ▶ **Stand-alone RRT options: due to high system fixed costs (i.e. an operations and maintenance centre), all RRT option that are not an extension of the SkyTrain system (from VCC/Clark) are assumed to run the entire way to UBC.**
- ▶ **Stand-alone RRT options: unless combined with the Streetcar/LRT system, short sections of RRT are not considered feasible due to the high system fixed costs.**

APPLICATION OF TECHNOLOGIES TO OPTIONS

3.16 As noted in the Problem Statements, the ‘existing transit services do not provide sufficient capacity’ and ‘transit trips and mode share need to increase...for the region to meet its goals’. The ‘Project Vision, Mission, Objectives and Evaluation Framework’ report provides further details that substantiate those statements through an examination of the current transit services and the capacity constraints faced by the existing 99 B-Line service in the corridor.

3.17 Preliminary forecasts suggest demand may be at the upper limit of BRT capacity as assumed for screening purposes and therefore, a bus-based system is unlikely to be able to provide sufficient capacity to meet future long term demand¹.

3.18 While BRT alternatives were therefore not considered as long term solutions to the problems in the corridor, a single BRT alternative was retained as it will continue to provide a low-cost alternative that may meet some of the project objectives and may also provide a phasing option for some of the other higher cost options.

3.19 Table 3.6 shows the results of the Technology Assessment against the 11 options from the Pre-Sift Assessment including the recommended alternatives at the conclusion of the Pre-Sift Assessment.

¹ Preliminary forecasts for BRT service along the Broadway corridor showed peak hour passenger flows per direction between 3,000 and 4,500 passengers for 2021 and 2041 respectively.

3.20 As noted above, Table 3.6 includes the single BRT alternative; it shows that all 11 of the options appear to be viable LRT options and that eight appear to be viable RRT options. The following three options were not considered as stand-alone RRT options:

- ▶ **Route 6 – to be treated as a Design Option of Route 1**
- ▶ **Route 29 – the section from 4th onto Granville and then onto Broadway appears un-constructible (particular if a station is required at 4th/Granville)**
- ▶ **Route 40 - to be treated as a Design Option of Route 35**

MULTIPLE CORRIDORS & MULTIPLE TECHNOLOGIES

3.21 The Assessment completed thus far assumed that each alternative would be a single technology end-to-end and that it would only operate in a single corridor. However, previous studies examined alternatives that included, for example, short extension of the SkyTrain into Central Broadway in conjunction with bus-based services. An exercise was therefore undertaken with the Project Sponsors and the Partner Agencies to identify additional alternatives that used either multiple technologies or alternatives using multiple corridors.

3.22 This process identified the additional nine alternatives presented in Table 3.7.

Table 3.6 Review of Technology Options

Option	Applicable Technology		
	BRT	LRT	RRT
1	✓	✓	✓
4		✓	✓
6		✓	
22		✓	✓
25		✓	✓
29		✓	
35		✓	✓
40		✓	
62		✓	✓
100		✓	✓
173		✓	✓

Table 3.7 Additional Pre-Sift Options

Option	Route
174	RRT (Arbutus / Broadway / VCC) + LRT (10 th Avenue / Broadway / Burrard / Waterfront)
176	RRT (Arbutus / Broadway / VCC) + LRT (10 th Avenue / Broadway / rail corridor / Main)
177	RRT (Cambie/ Broadway / VCC) + LRT (10 th Avenue / Broadway)
178	RRT (Arbutus/ Broadway / VCC) + LRT (10 th Avenue / Broadway)
179	RRT (Olympic / 2 nd Avenue / VCC) + LRT (10 th Avenue / Broadway)
180	RRT (4 th & Arbutus / Broadway / VCC) + LRT (10 th Avenue / Alma / 4 th Avenue / Main)
181	BRT (10 th Avenue & Broadway) + BRT (Chancellor / 4 th Avenue / 2 nd Avenue / VCC)
182	LRT (10 th Avenue & Broadway) + LRT (10 th Avenue & Rail Corridor to Main Street)
183	RRT (Arbutus/ Broadway / VCC) + BRT (10 th Avenue / Broadway / Arbutus)

Conclusions of the Pre Sift Assessment

3.23 Including these nine additional multiple technology or multiple corridor options, a total of 29 alternatives were taken forward to the ‘Sift’ Assessment. The routes are listed in Table 3.8 and shown in Figure 3.6 and include:

- ▶ Two BRT alternatives (1 and 181);
- ▶ 12 LRT alternatives (1, 4, 6, 22, 25, 29, 35, 40, 62, 100, 173 and 182)
- ▶ Eight RRT alternatives (1, 4, 22, 25, 35, 62, 100 and 173)
- ▶ Seven combination technology alternatives (174, 176, 177, 178, 179, 180 and 183).

Table 3.8 Pre Sift Alternatives Taken Forward

Option	Route
1	10th / Alma / Broadway
4	Wesbrook / Chancellor Blvd / 4 th / Alma / Broadway
6	10 th / 12 th / Arbutus / Broadway
22	10 th / Alma / 4 th /GNW / Broadway
25	10 th / Broadway / Macdonald /4 th / GNW / Broadway
29	10 th / Alma / Broadway / Granville / 4 th / 2 nd / GNW / Clark / Broadway
35	10 th / Broadway / rail corridor/ 4 th / GNW / Broadway
40	10 th / 12 th Avenue / rail corridor/ 4 th / GNW / Broadway
62	10 th / Broadway / Granville / 4 th / VCC
100	10 th / Broadway / Quebec (Main)/ 2 nd / Broadway
173	10 th / 12 th / Broadway
174	RRT (Arbutus / Broadway / VCC) + LRT (10 th Avenue / Broadway /Burrard /Waterfront)
176	RRT (Arbutus / Broadway / VCC) + LRT (10 th Avenue / Broadway /rail corridor / Main)
177	RRT (Cambie/ Broadway / VCC) + LRT (10 th Avenue / Broadway)
178	RRT (Arbutus/ Broadway / VCC) + LRT (10 th Avenue / Broadway)
179	RRT (Olympic / 2 nd Avenue / VCC) + LRT (10 th Avenue / Broadway)
180	RRT (4 th & Arbutus / Broadway / VCC) + LRT (10 th Avenue / Alma / 4 th Avenue / Main)
181	BRT (10 th Avenue & Broadway) + BRT (Chancellor / 4 th Avenue / 2 nd Avenue / VCC)
182	LRT (10 th Avenue & Broadway) + LRT (10 th Avenue & Rail Corridor to Main Street)
183	RRT (Arbutus/ Broadway / VCC) + BRT (10 th Avenue / Broadway / Arbutus)

Figure 3.6 Conclusions of the Pre-Sift Assessment



4. SIFT ASSESSMENT

Introduction

- 4.1 The Sift Assessment aims to filter the list of 29 alternatives brought forward from the Pre-Sift Assessment down to a shortlist of approximately four alternatives for further development in Phase 2 of the study. The Sift Assessment is designed to be more detailed than the Pre-Sift Assessment by using a larger set of criteria for analysis.
- 4.2 The assumptions for each alternative (travel time, headways, etc) are provided in Appendix C while Appendix D provides maps of all of the alternatives considered in the Sift Assessment, including alignment and assumed stop locations (used to forecast likely levels of demand).
- 4.3 The Economic Development account was not considered at this stage. The criteria and requirements for Economic Development are largely those of the potential funding agencies (Transport Canada and the BC Ministry of Transportation and Infrastructure) and include, for example, a detailed Assessment of the impacts to the local, regional and national tax base. At this stage of alternative evaluation, with many alternatives still being considered, it was agreed that this level of analysis was neither practical nor would it be a clear differentiating factor between alternatives.

The Sift Assessment Framework

- 4.3 As noted in Chapter 2, the full details of the Assessment framework and criteria used at each step of the evaluation process are described in the ‘Project Vision, Mission, Objectives and Evaluation Framework Report’, however for reference, the criteria selected for undertaking the Sift Assessment are provided in Table 4.1.
- 4.4 In the Sift Assessment, all the alternatives carried forward from the Pre-Sift Assessment were assessed against six of the seven MAE accounts as follows:
- ▶ **Financial;**
 - ▶ **Transportation;**
 - ▶ **Environmental;**
 - ▶ **Urban Development;**
 - ▶ **Social Community; and**
 - ▶ **Deliverability.**

Table 4.1 Sift Assessment Criteria

	Financial	Transportation	Environment	Urban Development	Economic Development	Social Community	Deliverability
Assessment Criteria	Capital cost estimate	Transport Efficiency (Users) – Total ridership, travel time competitiveness	Emissions reductions	Major activity centres within 400m	Not assessed at this stage	Pedestrian, cycle impacts (health)	Constructability
		Transport Efficiency (Non-Users) travel time for road users, street closings, diverted traffic and parking	Impacts on parks and public open space	Impact on urban composition		First Nations Impacts	Acceptability
		Network Access – population and employment within 400m		Property Impacts		(Operating) Safety Assessment	Funding
		Reliability - Assessment based on % of route segregated				Visual intrusion	
						Heritage building impacts	

Sift Assessment Process

- 4.6 Within each account, the alternatives were assessed against each of the criteria using a combination of quantitative and qualitative measures. For the qualitative Assessments, a '7 point scale' ranging from 'XXX' to '✓✓✓' was applied where 'XXX' meant the alternative was viewed as having a significant impact or disbenefit and '✓✓✓' meant a significant benefit or opportunity. The qualitative Assessments were, by their very nature, qualitative and drew on the professional skill, expertise and judgment of qualified professional staff to undertake the Assessments. However, where definitive thresholds between the scores were used, the details of those Assessments are provided in Appendix C.
- 4.7 Given the very high level of design completed at this stage, it was difficult to determine the precise impacts of some of the alternatives (e.g. the likely impacts on private properties). It was therefore agreed with the Project Sponsors that while each of the Assessments in the Sift Assessment Framework should still be completed, that only a few of the criteria would be used as the 'Differentiating criteria'. These included:
- ▶ **Financial – Capital Cost**
 - ▶ **Transportation – Total Ridership**
 - ▶ **Deliverability**
- 4.8 To assist in presenting the results of all the alternatives across a broad range of criteria and to highlight the alternatives that are better performers, a series of shaded boxes has been used in the summary tables. Where applicable, the threshold value (for obtaining a shaded box) has also been included.

Financial Account

4.9 Capital costs were calculated for each alternative using unit rates (per kilometre) based on the route lengths and are presented in Figure 4.1. The costs shown are in millions of Canadian dollars (2009) and include provision for stops, the alignment, vehicles, an allowance for a depot/operations and maintenance facility as well as a 10% property cost allowance. They do not at this time include a detailed assessment of the incremental operating costs/savings. Additionally, the level of precision in costing has been targeted for order of magnitude and comparison purposes only. For reference, the alignment costs per kilometer (i.e. excluding the costs of the vehicles, depot, maintenance facility, property cost and any contingencies) are summarised in Table 4.2:

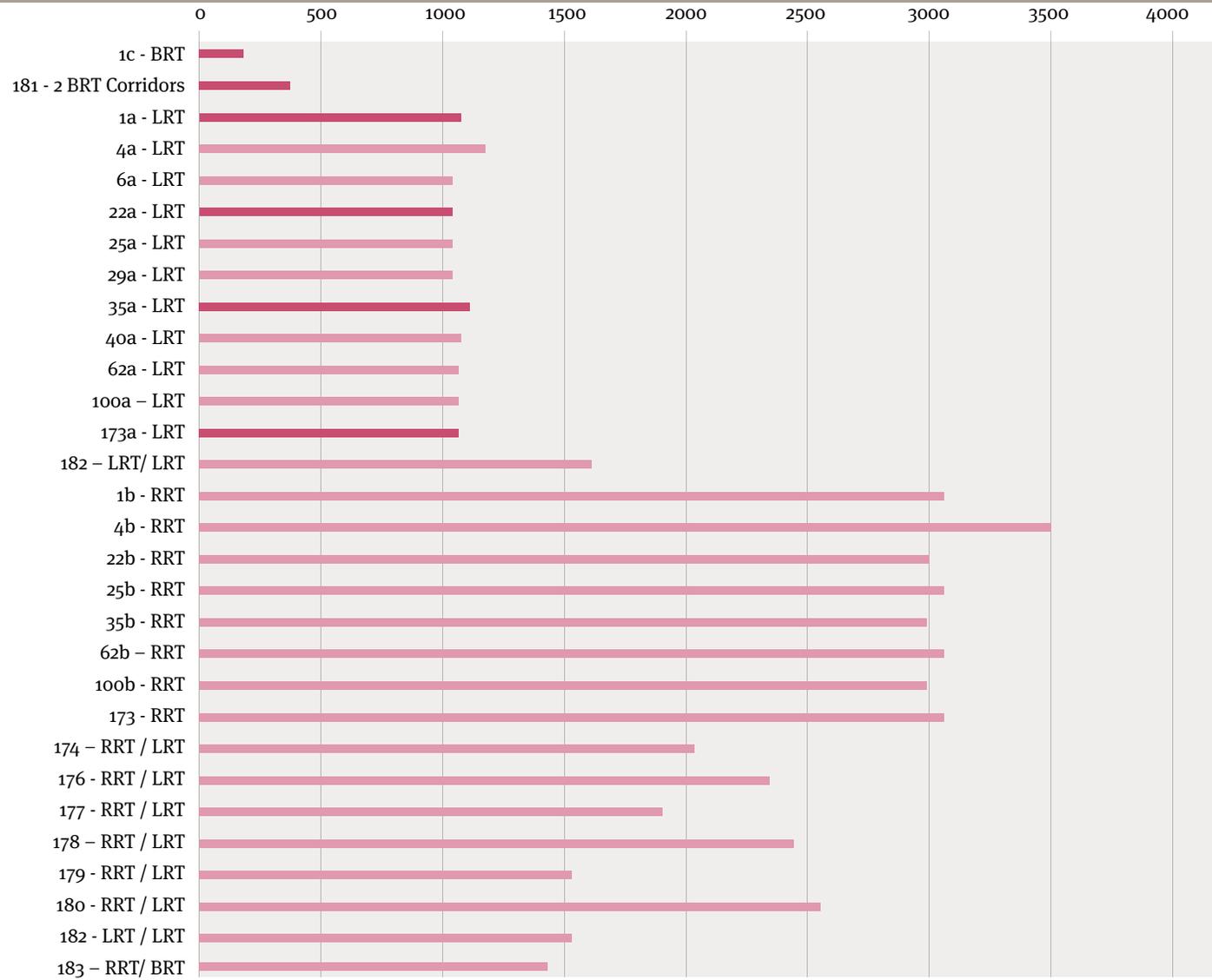
4.10 Figure 4.1 shows that the BRT alternatives have the lowest capital costs (less than half of any other alternative) and that the RRT alternatives have the highest capital cost – typically double that of the capital costs of the LRT alternatives.

4.11 The combined alternatives fall somewhere in between with a lower capital cost than RRT, and a slightly higher capital cost than the LRT (due to their shorter sections of RRT alignment).

Table 4.2 Sift Assessment – Per Kilometer Alignment Cost

Alignment Costs (\$M per route km)	At-Grade	At-Grade in Rail Corridor	Elevated	Tunnelled
BRT	\$6	-	-	-
LRT	\$31	\$22	\$40	\$114
RRT	\$49	-	\$54	\$128

Figure 4.1 Indicative Capital Cost of Alternatives



* Dark red bars less than \$1,100m. BRT Alternatives based on diesel buses. RRT alternatives based on underground track.

Transportation Account

4.12 The following Transportation Account criteria were used in the Sift Assessment:

▶ **Transportation Efficiency (Users)**

- Total boardings (number of AM peak hour boardings)
- Peak load (maximum number of peak hour passengers per direction)
- Travel time competitiveness (transit speed compared to auto speed)

▶ **Transportation Efficiency (Non-Users)**

- Average Car Journey Time (minutes)
- Road Closures, Traffic and Parking - qualitative impacts on street parking, road width and intersections where on-street or alternatives using multiple corridors were viewed as having a greater impact.

▶ **Network Access:**

- Population Catchment (number of people within 400m)
- Employment Catchment (number of employees within 400m)

▶ **Operational Reliability:**

- Qualitative Assessment based on the percentage of the alignment that was assumed to be fully segregated from other traffic where alternatives with more than 25 intersections still open to traffic scoring the worst and alternatives with less than 20 remaining open scored the best.

4.13 The detailed results of the Assessment are presented in Table 4.2 and summarized below:

- ▶ In terms of total boardings (which was identified as a key differentiating criteria), all of the BRT and combined alternatives perform well. The LRT and RRT alternatives have similar ridership values with some exceeding 10,000 boardings per AM peak period. Note that these numbers are preliminary only and that no significant revisions were made to the model. The values should therefore be viewed as appropriate for comparative purposes only and not be used or referenced as absolute values;
- ▶ The RRT and combined alternatives show the highest peak passenger loads with some alternatives peaking at over 7,000 passengers in the peak hour;
- ▶ The majority of alternatives perform well on travel time competitiveness (where the number presented is the speed of a car trip in the corridor compared to a transit trip (i.e. number above 1.0 indicate that transit is faster than the car) with the BRT alternatives performing worst and the combined alternatives performing best;
- ▶ Average car journey times are relatively similar for BRT and LRT alternatives but RRT shows the fastest journey times as there is no (negative) effect on road capacity;
- ▶ All on-street alternatives (BRT and LRT) are likely to generate disbenefits from local road closures, traffic changes and loss of some parking; The combined alternatives and those serving multiple corridors (i.e. 176, 181, 182) generally have the highest population and employment catchments;
- ▶ The RRT alternatives receive the highest scores for reliability (due to grade separation) followed by the LRT alternatives that avoid some of the major intersections.

Table 4.3 Sift Assessment Results - Transportation Account

Alternative	Total Boardings	Peak Load (2041/2021)	Travel Time Competitiveness	Avg. Car Journey Time	Road Closures, Traffic, Parking	Population	Employment Catchment	Reliability
Threshold	>=10,000	>=4,500 (2041)	>= 1.15	Not Used	Not Used	>=55,000	>=60,000	✓✓
BRT								
1c - BRT	10,100	5,000/4,500	1.08	24.8	X	59,000	62,000	✓
181 – 2 BRT Corridors	7,800/4,100	4,000/3,800	1.12	27.8 (4 th Av)	XX	93,000	98,000	✓
LRT								
1a - LRT	10,100	5,000/4,500	1.09	22.7	X	59,000	62,000	✓
4a - LRT	8,900	4,700/4,100	1.14	25.3	X	60,000	62,000	✓
6a - LRT	9,500	4,900/4,400	1.15	23.2	X	61,000	63,000	✓
22a - LRT	9,400	4,200/4,000	1.16	23.4	X	54,000	54,000	✓✓
25a - LRT	9,500	4,300/4,000	1.16	24.2	X	55,000	55,000	✓✓
29a - LRT	9,800	4,300/3,900	1.16	24.2	X	51,000	59,000	✓
35a - LRT	9,600	4,200/4,000	1.16	23.7	X	51,000	58,000	✓✓
40a - LRT	8,900	4,100/3,900	1.15	24.8	X	53,000	59,000	✓✓
62a - LRT	8,200	3,400/3,200	1.15	25.4	X	44,000	57,000	✓✓
100a – LRT	10,700	4,700/4,000	1.16	24.4	X	58,000	79,000	✓
173a - LRT	6,300	3,600/3,400	1.18	22.8	XX	54,000	38,000	✓
182 – LRT/ LRT	8,700/3,800	4,800/4,200	1.16	22.7/20.8	XX	78,000	80,000	✓
RRT								
1b - RRT	11,700	5,700/5,100	1.22	19.8	0	60,000	62,000	✓✓✓
4b - RRT	10,900	5,600/4,900	1.23	22.2	0	60,000	62,000	✓✓✓
22b - RRT	9,600	7,200/5,500	1.21	20.4	0	49,000	52,000	✓✓✓
25b - RRT	9,800	7,200/5,500	1.21	21.2	0	48,000	53,000	✓✓✓
35b - RRT	10,100	7,200/5,500	1.22	20.8	0	46,000	56,000	✓✓✓
62b – RRT	11,000	7,300/5,600	1.21	22.2	0	45,000	57,000	✓✓✓
100b - RRT	11,000	7,500/5,800	1.20	21.3	0	48,000	71,000	✓✓✓
173 - RRT	7,700	4,200/4,000	1.23	20.0	0	54,000	38,000	✓✓✓
Combined Technology Alternatives								
174 – RRT / LRT	6,100/7,000	6,100/4,400	1.23	8.6/19.8		88,000	197,000	✓
176 - RRT / LRT	5,500/6,700	6,000/4,200	1.23	8.6/20.9		66,000	89,000	✓✓
177 - RRT / LRT	2,800/9,000	4,500/4,100	1.26	4.6/22.7		61,000	74,000	✓
178 – RRT / LRT	4,700/7,900	5,200/3,800	1.26	8.6/22.7		61,000	74,000	✓
179 - RRT / LRT	2,400/9,200	4,800/4,400	1.26	4.3/22.7		70,000	82,000	✓
180 - RRT / LRT	5,800/5,700	6,000/4,200	1.25	9.3/20.8		77,000	94,000	✓✓
183 – RRT/ BRT	6,900/3,300	6,700/5,100	1.21	8.6/16.0		48,000	71,000	✓✓✓

4.14 The comparison of alternatives within each technology type illustrated that:

- ▶ **BRT 181 has considerably higher population and employment catchments due to its multiple corridors, but BRT 1c has a higher peak load point due to less competition between corridors;**
- ▶ **LRT 100a has the highest ridership and employment catchment for the single corridor option, while LRT 182 has the highest boardings and population and employment catchments due to its multiple corridor nature. All of the LRT alternatives except 1a have similar travel time competitiveness and the lower population and employment catchment alternatives have better reliability;**
- ▶ **RRT 1b and 4b exceed the thresholds in all utilized assessment categories. RRT 173 performs the poorest in terms of boardings and peak load point. All of the RRT alternatives have excellent reliability;**
- ▶ **Combined Alternatives 176 and 180 exceed the thresholds in all utilized assessment categories though neither have the highest values in any one category. Combined 174 and 178 have the highest boardings with 174 having by far the highest employment catchment. Combined 183 performs best in terms of reliability.**

Environmental Account

4.15 The following Environmental Account criteria were used in the Sift Assessment:

- ▶ **Emissions reductions:**
 - Network-wide annual vehicle kilometres travelled (VKT) as a proxy for the likely reduction in greenhouse gas emissions resulting from fewer vehicles on the road and/or shorter trips being made across the region. It is important to note that as with the other modeling work undertaken, very few changes to the model were made at this stage of assessment (i.e. no changes were made to the complementary bus network) and therefore the results should be viewed as appropriate for comparative purposes but not as absolute values.
- ▶ **Impacts on parks and public open space:**
 - Parks and Open Space Impact (m² of land impacted) where alternatives that impacted more than 17,000m² scored the worse than those impacting less than 17,000m². This assessment refers to the potential impact that certain options might have on the boulevard space along UBC Blvd.

Table 4.4 Sift Assessment Results - Environmental Account

Alternative	Network – Wide VKT (million)	Parks and Open Space Impact
Threshold	Equal or less than 5.319m	Equal or less than 16,960 m2
BRT		
1c - BRT	5.320m	XX
181 – 2 BRT Corridors	5.312m	XX
LRT		
1a - LRT	5.318m	XX
4a - LRT	5.319m	X
6a - LRT	5.320m	XX
22a - LRT	5.319m	XX
25a - LRT	5.319m	XX
29a - LRT	5.319m	XX
35a - LRT	5.319m	XX
40a - LRT	5.321m	XX
62a - LRT	5.320m	XX
100a – LRT	5.318m	XX
173a - LRT	5.320m	XX
182 – LRT/ LRT	5.317m	XX

Alternative	Network – Wide VKT (million)	Parks and Open Space Impact
Threshold	Equal or less than 5.319m	Equal or less than 16,960 m2
RRT		
1b - RRT	5.320m	0
4b - RRT	5.322m	0
22b - RRT	5.316m	0
25b - RRT	5.316m	0
35b - RRT	5.315m	0
62b – RRT	5.315m	0
100b - RRT	5.314m	0
173 - RRT	5.323m	0
Combined Technology Alternatives		
174 – RRT / LRT	5.314m	XX
176 - RRT / LRT	5.316m	XX
177 - RRT / LRT	5.315m	XX
178 – RRT / LRT	5.313m	XX
179 - RRT / LRT	5.315m	XX
180 - RRT / LRT	5.314m	XX
183 – RRT/ BRT	5.318m	XX

4.16 The detailed results of the Assessment were presented in Table 4.4 and summarized below:

- ▶ **While some alternatives have greater reductions in network wide VKT than others – particularly the on-street options that remove vehicle travel lanes - the differences between the best (Option 181 which removes lanes on two parallel corridors) and worst (Option 173 which does not remove any vehicle lanes) performing alternatives is less than 0.2% of the network wide total VKT (in the AM peak period); and**
- ▶ **The RRT alternatives have the least impact on parks and open spaces due to the grade separated alignment. Of the LRT alternatives, Alternative 4a has slightly less impact as the route follows Chancellor Blvd and therefore any likely impacts on the University Blvd boulevard are avoided.**

Urban Development Account

4.17 The following Urban Development Account criteria were used in the Sift Assessment:

- ▶ **Land Use Integration:**
 - Major Activity Centres (see Figure 3.5 for reference of the activity centres considered): number of activity centres within 2 blocks of alignment;
- ▶ **Land Use Potential:**
 - Impact on urban composition based on a summary of compatibility, development opportunities and pedestrian realm;
- ▶ **Property Impacts:**
 - Extent of properties potentially affected (in m² of land impacted) where alternatives that impacted more than 10,300m² scored the worse than those impacting less than 10,300m²

4.18 The detailed results of the Assessment are presented in Table 4.5 and summarized below:

- ▶ **No alternatives serve less than 4 major activity centre and the combined alternatives reach all six major activity centres (as do Alternatives 100, 181 and 182);**
- ▶ **Due to the existing zoning and planned developments along the Broadway corridor and at the Great Northern Way Campus, the routes that served either or both of those areas were viewed as providing the greatest opportunities for integrated development and compatibility with the existing street-uses/pedestrian realm; and**
- ▶ **All alternatives are likely to have some property impacts, however alternatives from VCC/Clark generally perform worse as they would likely have additional property impacts to access Broadway.**

Table 4.5 Sift Assessment Results - Urban Development Account

Alternative	Major Activity Centres	Land Use Potential	Property Impacts
Threshold	5 or More	✓✓✓	Equal or less than 10,300 m2
BRT			
1c - BRT	5	✓✓	X
181 – 2 BRT Corridors	6	✓✓	XX
LRT			
1a - LRT	5	✓✓	X
4a - LRT	5	✓	X
6a - LRT	5	✓	X
22a - LRT	4	✓	XX
25a - LRT	4	✓✓	XX
29a - LRT	4	✓✓	XX
35a - LRT	4	✓✓	XX
40a - LRT	4	✓	XX
62a - LRT	4	✓✓	XX
100a – LRT	6	✓✓✓✓	XX
173a - LRT	4	o	X
182 – LRT/ LRT	6	✓✓	XX

Alternative	Major Activity Centres	Land Use Potential	Property Impacts
Threshold	5 or More	✓✓✓	Equal or less than 10,300 m2
RRT			
1b - RRT	5	✓✓	X
4b - RRT	5	✓	X
22b - RRT	4	✓	X
25b - RRT	4	✓✓	X
35b - RRT	4	✓✓	X
62b – RRT	4	✓✓	X
100b - RRT	6	✓✓✓	X
173 - RRT	4	o	X
Combined Technology Alternatives			
174 – RRT / LRT	6	✓✓✓	XX
176 - RRT / LRT	6	✓✓	XX
177 - RRT / LRT	6	✓✓	X
178 – RRT / LRT	6	✓✓	X
179 - RRT / LRT	6	✓✓	X
180 - RRT / LRT	6	✓✓	X
183 – RRT/ BRT	6	✓✓	X

Social Community Account

4.19 The following Transportation Account criteria were used in the Sift Assessment:

▶ **Health impacts:**

- Integration and connectivity to the Pedestrian and Cycle networks

▶ **First Nations:**

- Impact on land/resources under claim by First Nations (no alternatives were identified as having any greater or less impact and therefore not used)

▶ **Safety:**

- Assessment of the operational safety of each alternative where alternatives that were fully grade separated scored better than alternatives running at-grade/on-street. In the next phase of project design and evaluation, personal safety (of the users) will also be considered.

▶ **Community cohesion:**

- Likely impacts due to visual intrusion from either elevated guideway or from using the disused CP Rail alignment

▶ **Heritage impacts:**

- Number of heritage building impacts (none identified and therefore not used)

4.20 The detailed results of the Assessment are presented in Table 4.6 and summarized below:

- ▶ **At this high level of design, the majority of the alternatives do not have any material impacts on the pedestrian and cycle networks except for those alternatives that provide a stop or access to walk areas of high pedestrian or bicycle activity (e.g. False Creek Seawall – Alternatives 176, 179 and 182);**
- ▶ **The RRT and combined alternatives perform best in terms of safety as they are grade separated and reduce the potential for accidents between rapid transit and pedestrians, cyclists and cars. It is assumed that while all alternatives will be designed to be safe to operate, the on-street alternatives (BRT and LRT) receive slightly lower scores to account for the interaction between rapid transit and other road users; and**
- ▶ **Alternatives that make use of the disused CP Rail alignment (which for large portions is a community garden/amenity) and/or have sections of elevated guideway (e.g. alternatives that connect directly to the existing elevated SkyTrain at VCC/Clark) score worse under Visual Intrusion and Alternative 176 received the lowest score as it uses both of these.**

Table 4.6 Sift Assessment Results – Social Community Account

Alternative	Walking & Cycling Connectivity	First Nations	Safety	Visual Intrusion	Heritage Building Impacts
Threshold	0	Not Used	✓✓	0	Not Used
BRT					
1c - BRT	0	0	✓	0	0
181 – 2 BRT Corridors	0	0	✓	0	0
LRT					
1a - LRT	0	0	✓	0	0
4a - LRT	✓	0	✓	0	0
6a - LRT	✓	0	✓	0	0
22a - LRT	✓	0	✓	0	0
25a - LRT	0	0	✓	0	0
29a - LRT	0	0	✓	0	0
35a - LRT	0	0	✓	X	0
40a - LRT	✓	0	✓	X	0
62a - LRT	0	0	✓	0	0
100a – LRT	0	0	✓	0	0
173a - LRT	0	0	✓	0	0
182 – LRT/ LRT	✓	0	✓✓	0	0

Alternative	Walking & Cycling Connectivity	First Nations	Safety	Visual Intrusion	Heritage Building Impacts
Threshold	0	Not Used	✓✓	0	Not Used
RRT					
1b - RRT	0	0	✓✓	0	0
4b - RRT	0	0	✓✓	0	0
22b - RRT	0	0	✓✓	X	0
25b - RRT	0	0	✓✓	X	0
35b - RRT	0	0	✓✓	X	0
62b – RRT	0	0	✓✓	X	0
100b - RRT	0	0	✓✓	X	0
173 - RRT	0	0	✓✓	0	0
Combined Technology Alternatives					
174 – RRT / LRT	0	0	✓✓/✓	X	0
176 - RRT / LRT	✓	0	✓✓/✓	XX	0
177 - RRT / LRT	0	0	✓✓/✓	X	0
178 – RRT / LRT	0	0	✓✓/✓	X	0
179 - RRT / LRT	✓	0	✓✓/✓	X	0
180 - RRT / LRT	0	0	✓✓/✓	X	0
183 – RRT/ BRT	0	0	✓✓	X	0

Deliverability Account

4.21 Constructability was the only criteria used from the Deliverability Account criteria in the Sift Assessment as there has not yet been a formal public or stakeholder consultation on the route alternatives (Acceptability) nor has any formal Assessment of the affordability of the alternatives been undertaken (Funding).

4.22 The Constructability Assessment used a qualitative Assessment of the engineering difficulty to construct the alternatives (e.g. grades, curves, stop locations, etc.) where the straight, on-street alternatives were generally viewed as the easiest to construct and curving, hilly and/or underground alternatives viewed as the most difficult.

4.23 The detailed results of the Assessment are presented in Table 4.7 and summarized below:

- ▶ **BRT alternatives are considered as the easiest to construct;**
- ▶ **LRT alternatives via VCC/Clark are viewed to be particularly challenging due to grade and cornering issues near VCC/Clark station;**
- ▶ **Alternative 62 (RRT) presents the greatest challenges due to the curves required to serve Granville Island and Granville St.**

Table 4.7 Sift Assessment Results - Deliverability Account

Alternative	Constructability
Threshold	✓
BRT	
1c - BRT	✓✓
181 – 2 BRT Corridors	✓
LRT	
1a - LRT	✓✓
4a - LRT	X
6a - LRT	✓
22a - LRT	X
25a - LRT	X
29a - LRT	X
35a - LRT	X
40a - LRT	X
62a - LRT	✓
100a – LRT	X
173a - LRT	X
182 – LRT/ LRT	✓

Alternative	Constructability
Threshold	✓
RRT	
1b - RRT	0
4b - RRT	0
22b - RRT	0
25b - RRT	0
35b - RRT	0
62b – RRT	XX
100b - RRT	0
173 - RRT	0
Combined Technology Alternatives	
174 – RRT / LRT	✓
176 - RRT / LRT	✓
177 - RRT / LRT	✓
178 – RRT / LRT	✓
179 - RRT / LRT	✓
180 - RRT / LRT	✓
183 – RRT/ BRT	✓

NOTE: * Underground / Elevated costs

Sift Assessment Results Summary

4.24 Table 4.8 shows a simplified summary of the results for the 29 alternatives evaluated through the Sift Assessment. Alternatives that met the threshold scores under each

category are highlighted in red and, for reference, the three primary Differentiating criteria are shown in a darker shade of red to highlight the key differentiators between the alternatives.

Table 4.8 Sift Assessment Results Summary

Option	Financial		Transportation							Environment		Urban Development			Social Community				Deliverability			
	Capital Cost	Total Ridership	Peak Load	Travel Time Competitiveness	Avg. Car Journey Time	Road Closures, Traffic, Parking	Population	Employment	Reliability	Network – Wide VKT	Parks and Open Space Impact	Major Activity Centres	Land Use Potential	Property Impacts	Walking & Cycling Connectivity	First Nations	Safety	Visual Intrusion	Heritage Building Impacts	Constructability	Acceptability	Funding
BRT																						
1c - BRT																						
181 - 2 BRT Corridors																						
LRT																						
1a - LRT																						
4a - LRT																						
6a - LRT																						
22a - LRT																						
25a - LRT																						
29a - LRT																						
35a - LRT																						
40a - LRT																						
62a - LRT																						
100a – LRT																						
173a - LRT																						
182 – LRT/ LRT																						

Option	Financial	Transportation							Environment		Urban Development			Social Community				Deliverability			
	Capital Cost	Total Ridership	Peak Load	Travel Time Competitiveness	Avg. Car Journey Time	Road Closures, Traffic, Parking	Population	Employment	Reliability	Network – Wide VKT	Parks and Open Space Impact	Major Activity Centres	Land Use Potential	Property Impacts	Walking & Cycling Connectivity	First Nations	Safety	Visual Intrusion	Heritage Building Impacts	Constructability	Acceptability
RRT																					
1b - RRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
4b - RRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
22b - RRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
25b - RRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
35b - RRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
62b - RRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
100b - RRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
173 - RRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
Combined Technology Options																					
174 - RRT / LRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
176 - RRT / LRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
177 - RRT / LRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
178 - RRT / LRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
179 - RRT / LRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
180 - RRT / LRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High
183 - RRT/ BRT		High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High	High

5. RECOMMENDATIONS AND NEXT STEPS

Summary

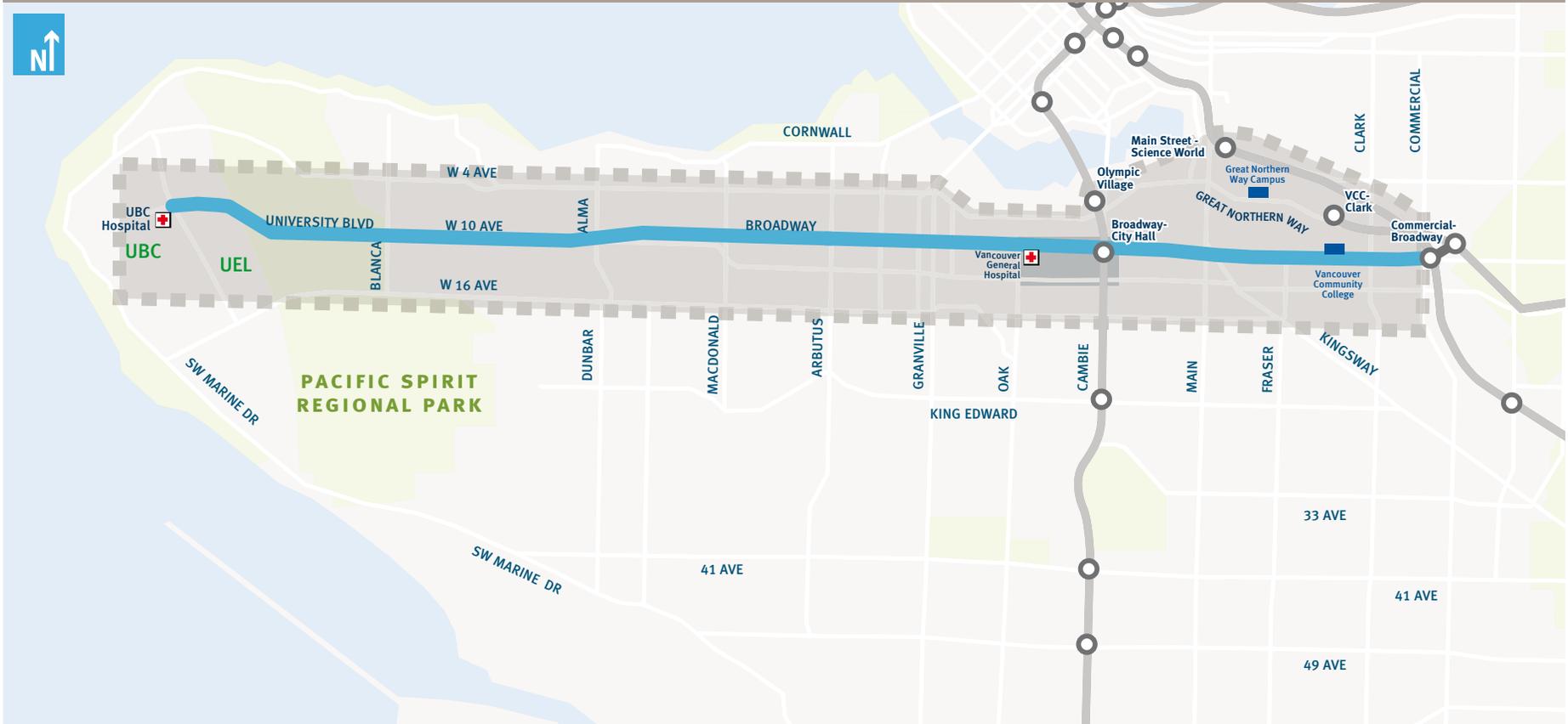
- 5.1 The purpose of Phase 1 of the UBC Line Rapid Transit Study was to identify and evaluate technology and alignment options (alternatives) for the corridor in order to define a shortlist of alternatives that would be advanced to Phase 2 Alternative Development and Evaluation.
- 5.2 With a long list of nearly 200 possible route options, the Phase 1 process was split into two steps – a Pre-Sift and Sift – with a greater level of detail and analysis used at each additional step in order to eliminate the weaker performing alternatives and arrive at a shortlist that are recommended for advancement to Phase 2 of the study. Throughout Phase 1, all alternatives were assessed using a common Multiple Account Evaluation framework that will continue to be used and developed further in Phase 2 of the study.

Phase 1 Recommended Alternatives

- 5.3 The results presented in this report were reviewed with staff from both the Project Sponsors (TransLink and the Ministry of Transportation and Infrastructure) and the Partner Agencies (City of Vancouver, University of British Columbia, University Endowment Lands and Metro Vancouver).
- 5.4 The alternatives presented in the following sections are the recommended alternatives that will be progressed for more detailed design development and evaluation in Phase 2 of the study and, from them, a single preferred alternative will be recommended for Phase 3 Detailed Design Development and Implementation. In summary, the alternatives that performed ‘best’ and are recommended are those that:

- ▶ **Serve the major activity centres in the study area**
- ▶ **Provide connections to the existing rapid transit network**
- ▶ **Serve current and future centres of population and employment**
- ▶ **Provide a direct route, minimizing travel time and cost**

Figure 5.1 Phase 1 – Recommended BRT Alternative



 Bus Rapid Transit Alternative

Notes:

1 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

2 Potential station locations will be identified in Phase 2 of the Study.

 UBC Line Study Area

 Parks

 Roadways

 Existing Rapid Transit & Commuter Rail

 Central Broadway

BUS RAPID TRANSIT ALTERNATIVES

5.5 There were two BRT alternatives considered – Alternative 1c on Broadway following the existing route of the 99 B-Line, and Alternative 181 with BRT services running on parallel corridors (on Broadway as well as on 6th/2nd/ 4th and Chancellor Blvd). While both BRT alternatives performed well across many of the criteria, it was agreed with the Project Sponsors and Partner Agencies that BRT alternative (Alternative 181) should be eliminated from further consideration because:

- **Preliminary ridership forecasts predicted only small diversions from the Broadway route; and**
- **There were concerns regarding the impacts from constructing and operating parallel, fully segregated routes within such close proximity of each other (five blocks) and that are both truck routes.**

5.6 It was also felt that the development of a ‘Best Bus’, low cost alternative would also address a full spectrum of multi-corridor, bus-based alternatives.

5.7 It was noted that it would not (likely) be possible to provide full segregation and intersection priority on multiple parallel corridors and that the 4th Ave service did not attract sufficient demand away from Broadway.

5.8 The single recommended BRT alternative is shown in Figure 5.1 and can be summarized as:

- **BRT – UBC, W.10th Ave, Broadway**

LIGHT RAIL TRANSIT ALTERNATIVES

5.9 There were 12 LRT alternatives (1, 4, 6, 22, 25, 29, 35, 40, 62, 100, 173 and 182) considered through the Sift Assessment and, while many of the alternatives were relatively small variations of each other, one alternative (Alternative 182) provided two LRT routes – one along Broadway (similar to the recommended BRT alternative) and one that would connect UBC to Main Street Station via Broadway/Arbutus and the disused CP Rail right-of-way.

5.10 The results of the Sift Assessment show that three alternatives (Alternatives 1a, 100a and 182) perform comparatively better than the others across a range of the criteria and critically across the three primary Differentiating criteria. By combining these into two alternatives, each with 2 routes options in the east, the recommendations for further development and evaluation in Phase 2 and presented in Figures 5.2 and 5.3 are:

- **LRT Alternative 1 - UBC, W.10th Ave, Broadway (to Main), then either:**

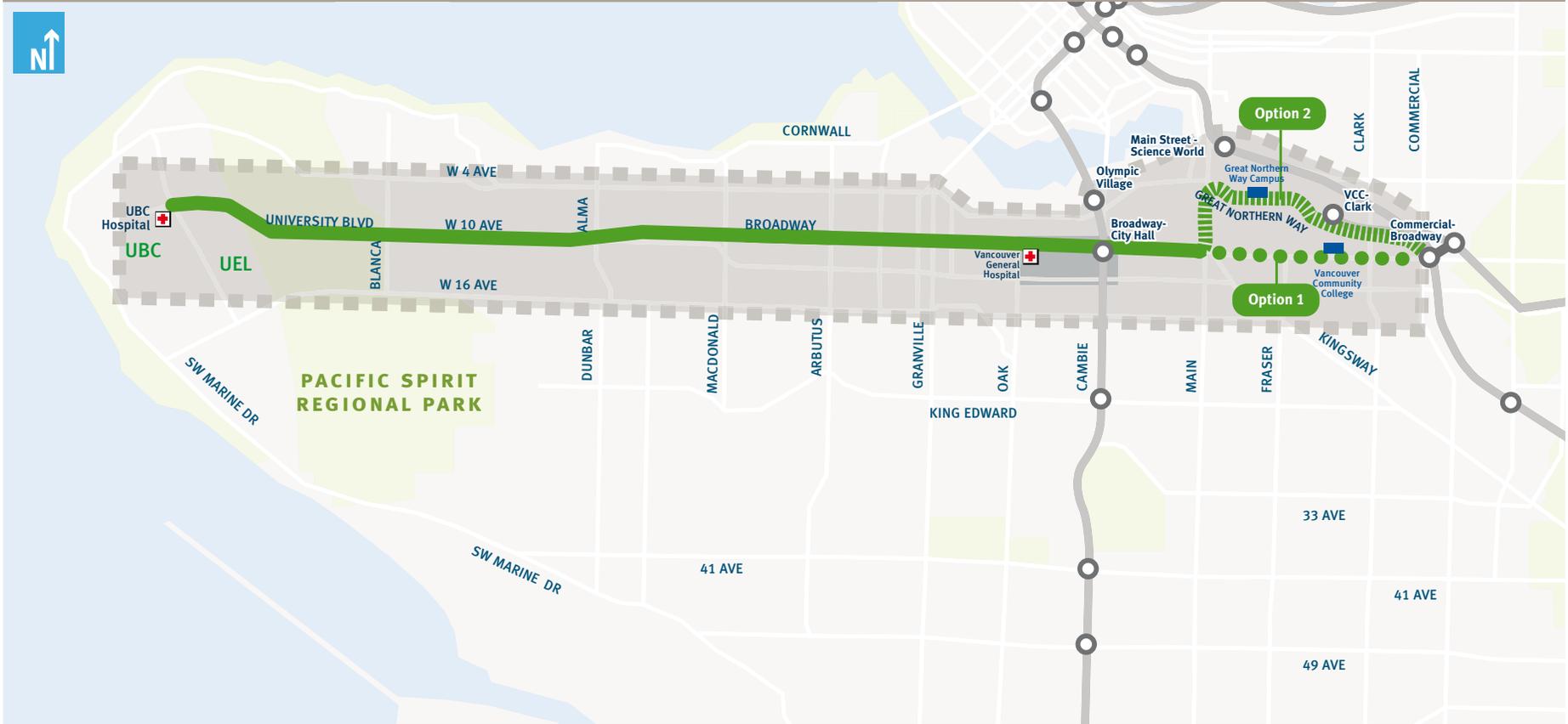
- Option 1: Broadway to Commercial-Broadway Station; or
- Option 2: Main, GNWC, VCC/Clark, Commercial-Broadway Station;

- **LRT Alternative 2 – Same as above with addition of:**

- LRT – Broadway/Arbutus, CP Rail right-of-way, Main Street Station.

5.11 It is worth noting that at this stage of design and assessment, it was assumed that all LRT alternatives would operate fully at grade (i.e. on the street in segregated lanes). Further work will be undertaken in Phase 2 to determine the vertical alignment for each alternative.

Figure 5.2 Phase 1 – Recommended LRT Alternative 1



-  Light Rail Transit Alternative 1
-  Option 1
-  Option 2

Notes:

1 This alternative has two potential route options in the eastern section:

Option 1  - connecting to Commercial - Broadway Station along Broadway;

or Option 2  - connecting to Commercial - Broadway Station via Great Northern Way,

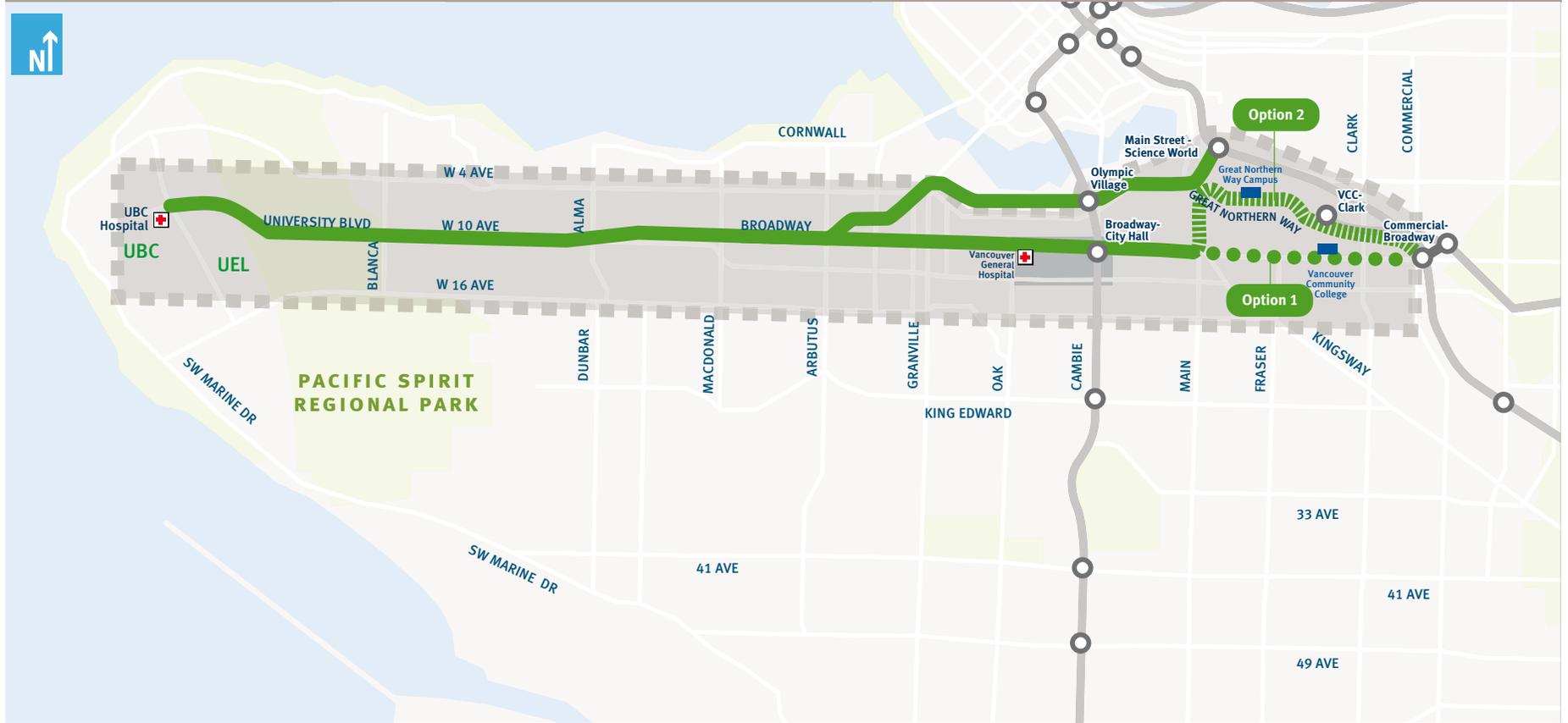
These two potential route options will be assessed in detail in Phase 2

2 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

3 Potential station locations will be identified in Phase 2 of the Study.

-  UBC Line Study Area
-  Parks
-  Roadways
-  Existing Rapid Transit & Commuter Rail
-  Central Broadway

Figure 5.3 Phase 1 – Recommended LRT Alternative 2



-  Light Rail Transit Alternative 2
-  Option 1
-  Option 2

Notes:

1 This alternative has two potential route options in the eastern section:

Option 1  - connecting to Commercial - Broadway Station along Broadway;

or Option 2  - connecting to Commercial - Broadway Station via Great Northern Way,

These two potential route options will be assessed in detail in Phase 2

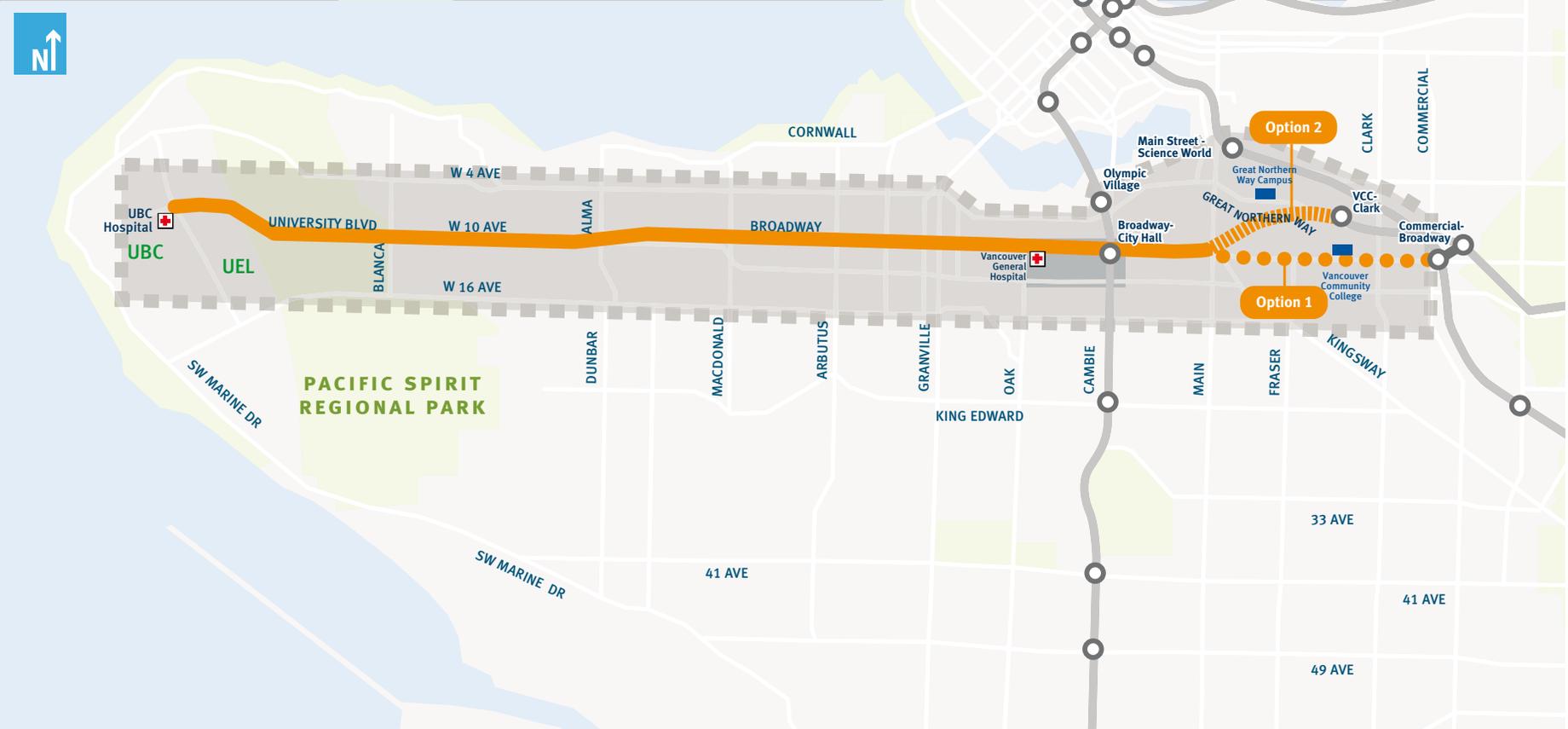
2 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

3 Potential station locations will be identified in Phase 2 of the Study.

-  UBC Line Study Area
-  Parks
-  Roadways
-  Existing Rapid Transit & Commuter Rail

-  Central Broadway

Figure 5.4 Phase 1 – Recommended RRT Alternative



-  Rail Rapid Transit Alternative
-  Option 1
-  Option 2

Notes:

1 This alternative has two potential route options in the eastern section:

Option 1  - connecting to Commercial - Broadway Station;

or Option 2  - connecting to VCC-Clark Station,

These two potential route options will be assessed in detail in Phase 2.

2 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

3 Potential station locations will be identified in Phase 2 of the Study.

-  UBC Line Study Area
-  Parks
-  Roadways
-  Existing Rapid Transit & Commuter Rail
-  Central Broadway

RAIL RAPID TRANSIT ALTERNATIVES

- 5.12 There were eight RRT alternatives (1, 4, 22, 25, 35, 62, 100 and 173) considered through the Sift Assessment. While the preliminary ridership numbers were higher for the RRT alternatives (compared against the BRT and LRT alternatives) so too were the capital costs. The Assessment at this stage was, however, a comparative Assessment and was used to select the best performing RRT alternative(s).
- 5.13 The results of the Sift Assessment therefore show that two alternatives (1b and 100b) perform comparatively better than the others across a range of the criteria and critically across the three primary Differentiating criteria. As much of the route is the same in both alternatives, a single alternative with 2 route options in the east is recommended for further development and evaluation in Phase 2 and presented in Figure 5.4 including:
- **RRT - UBC, W.10th Ave, Broadway (to Main), then either:**
 - Option 1: to Commercial-Broadway Station; or
 - Option 2: to GNWC and VCC/Clark Station;
- 5.14 At this stage of design and development no decisions or recommendations have been made on the vertical alignment of the RRT alternatives (i.e. in tunnel or on elevated guideway) nor has a decision or recommendation been made on choice of RRT technology (i.e. SkyTrain or non-SkyTrain RRT). Both of these issues will be addressed for the two recommended RRT alternatives in Phase 2 of the study.



RRT - Canada

Figure 5.5 Phase 1 – Recommended Combined Technology Alternative



Combination Alternative

- Light Rail Transit
- Rail Rapid Transit

Notes:

1 In Phase 2, designs for each alternative will be developed which will determine the horizontal alignment (positioning of the alternative within the street) and the vertical alignment (whether it is at street level, elevated or underground).

2 Potential station locations will be identified in Phase 2 of the Study.

	UBC Line Study Area		Central Broadway
	Parks		
	Roadways		
	Existing Rapid Transit & Commuter Rail		

COMBINED TECHNOLOGY ALTERNATIVES

- 5.15 There were seven combined technology alternatives (174, 176, 177, 178, 179, 180 and 183) considered through the Sift Assessment.
- 5.16 While all of the combined alternatives showed good levels of ridership and scored well across many criteria, not all of the combined technology alternatives are recommended for further development.
- 5.17 Two of the alternatives, while they appear to be candidate rapid transit projects, do not address the specific problems or issues in the corridor, including the provision of transit service to UBC against current service as well as providing the necessary capacity through Central Broadway. It is therefore recommended that they be reviewed as part of a separate study, rather than continue to be developed as part of the UBC Line Rapid Transit Study.
- ▶ **Alternative 174 – LRT to Downtown/ Waterfront Station; and**
 - ▶ **Alternative 179 – short RRT extension from VCC/Clark to Olympic Station.**
- 5.18 Three of the alternatives (177, 178 and 180) included parallel or duplicative LRT and RRT services and the results of the Sift Assessment show that these alternatives do not generate enough additional benefits when compared to the additional costs or the other stand-alone LRT or RRT alternatives.
- 5.19 Alternative 183 (RRT from VCC/Clark to Arbutus with BRT from Arbutus to UBC) is not recommended for two reasons:
- ▶ **Approximately half of all east-west transit trips in the corridor go west of Arbutus to UBC and, by including a mid-corridor transfer, the service would be worse than the existing 99 B-Line service (i.e. passengers on either the Expo Line or the Canada Line would need to transfer at either Broadway/ Commercial or Broadway/Cambie onto the RRT and then again on the BRT at Arbutus); and**
 - ▶ **Capacity constraints of the BRT service – the preliminary ridership numbers for the BRT portion of the route indicate that a bus-based service would not provide sufficient capacity to meet peak period demand.**
- 5.20 While Alternative 183 is therefore not recommended as a long term solution, it can still be considered as a potential phasing option of a full RRT alternative in Phase 2.
- 5.21 The results of the Sift Assessment therefore show that one alternative (176) performs comparatively better than the others and that it is recommended for further development and evaluation in Phase 2 and is presented in Figure 5.5.
- ▶ **RRT - Broadway/Arbutus, Broadway, Great Northern Way Campus, VCC/Clark, Broadway, in addition to LRT - UBC, W.10th Ave, Broadway/Arbutus, CP Rail right-of-way, Main Street Station.**

Next Steps

5.22 This report concludes the technical evaluation and Assessment of alternatives for Phase 1 of the UBC Line Rapid Transit Study. The information and analysis presented was based on the best information available at the time of the Assessments using very high level assumptions on the alternative design.

5.23 The next step in the project development process is therefore to develop the alternatives presented in this Chapter in much greater detail including:

- ▶ **Preliminary alignment designs for each alternative (including vertical alignments)**
- ▶ **Parking, servicing and access review**
- ▶ **Detailed station/stop Assessments**
- ▶ **Urban context Assessments**
- ▶ **Transit operations and complementary bus network review**
- ▶ **Capital & operating cost estimates**
- ▶ **Data collection & analysis**
- ▶ **Modelling – ridership & traffic**
- ▶ **Multiple account evaluation of alternatives**

The Best Bus Alternative

5.24 All five of the alternatives presented earlier in this Report represent the range of ‘build’ alternatives. That is, they include significant levels of investment in new, capital infrastructure. However to help inform the final evaluation and to provide a means of assessing the incremental value that the alternatives represent, a low cost alternative will be developed. It will include only limited capital investments for bus priority measures and will include frequency

enhancements across a range of corridors to determine the most that could be achieved using buses - ‘the best bus alternative’.

5.25 In addition, the Steer Davies Gleave team, working with the Project Sponsors and Partner Agencies, will begin to develop ‘Wider Area Solutions’ that will look at the impacts and opportunities created by each alternative outside the direct corridor. This could include, for example, addressing parking issues on side and parallel roads, improving walking and pedestrian routes to provide better access to the stops as well as looking at ways to mitigate any displaced traffic. While these are all detailed issues, they are issues that will need to be addressed in Phase 2 to understand the full costs and benefits of each alternative.

5.26 This report documents the technical process undertaken to arrive at Phase 1 recommendations. These recommendations were brought to stakeholder and public consultation in spring 2010 which largely confirmed the shortlist as a reasonable starting point for Phase 2 evaluation and identified the need to further explore combinations of RRT and BRT. This process has been documented in a separate report on the consultation process.