THE TRANSIT PRIORITY PROJECT
When the buses move...everybody moves.

BC Transit

Douglas Street / Highway 1 Transit Priority Study

Final Report

October 14, 2005

IBI GROUP

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1. Executive Summary

The *Travel Choices* strategy developed in conjunction with the Capital Region Growth Strategy defines the long term transit service requirements for the region. In order to achieve the community, transportation and environmental objectives of the Growth Strategy, Travel Choices envisions a network of rapid transit services linking the downtown of Victoria to major regional growth centers in the outer city and the suburbs. Travel Choices calls for development of rapid transit corridors along Douglas Street from downtown Victoria to Langford on the west and to Sidney and Swartz Bay ferry terminal on the northeast, as shown in Exhibit 1.1.

As a first step in implementing meeting the needs of the Regional Growth strategy, BC Transit has been investigating the application of lower cost, bus transit and transit priority measures in this corridor, which could be implemented in advance of LRT. The bus transit service will involve limited stop bus service, incorporating transit priority measures to achieve rapid and on time service performance, The enhanced rapid bus transit services will promote growth in transit ridership in the corridor and strengthen transit linkages between major centers.

The first steps in implementing improved transit services in the western corridor were the development of transit queue jump lanes and transit signal priority northbound on Highway 1 at both McKenzie Avenue and Tillicum Road, efforts which yielded high transit benefits for relatively low cost.

Since then, BC Transit and the City of Victoria have applied and received grants from the federal and provincial governments, and together with BC Transit's contribution, have created a $3 million infrastructure fund to improve transit services in the corridor. The consulting firm IBI Group was retained to assess auto and transit operations on Douglas Street and Highway 1 between Belleville Street in the downtown and Helmcken Road in the District of Saanich and to develop improvement plans to meet these objectives. A number of problems and possible solutions were identified as summarized in Exhibit 1.2.

Exhibit 1.1 Transit Network Development

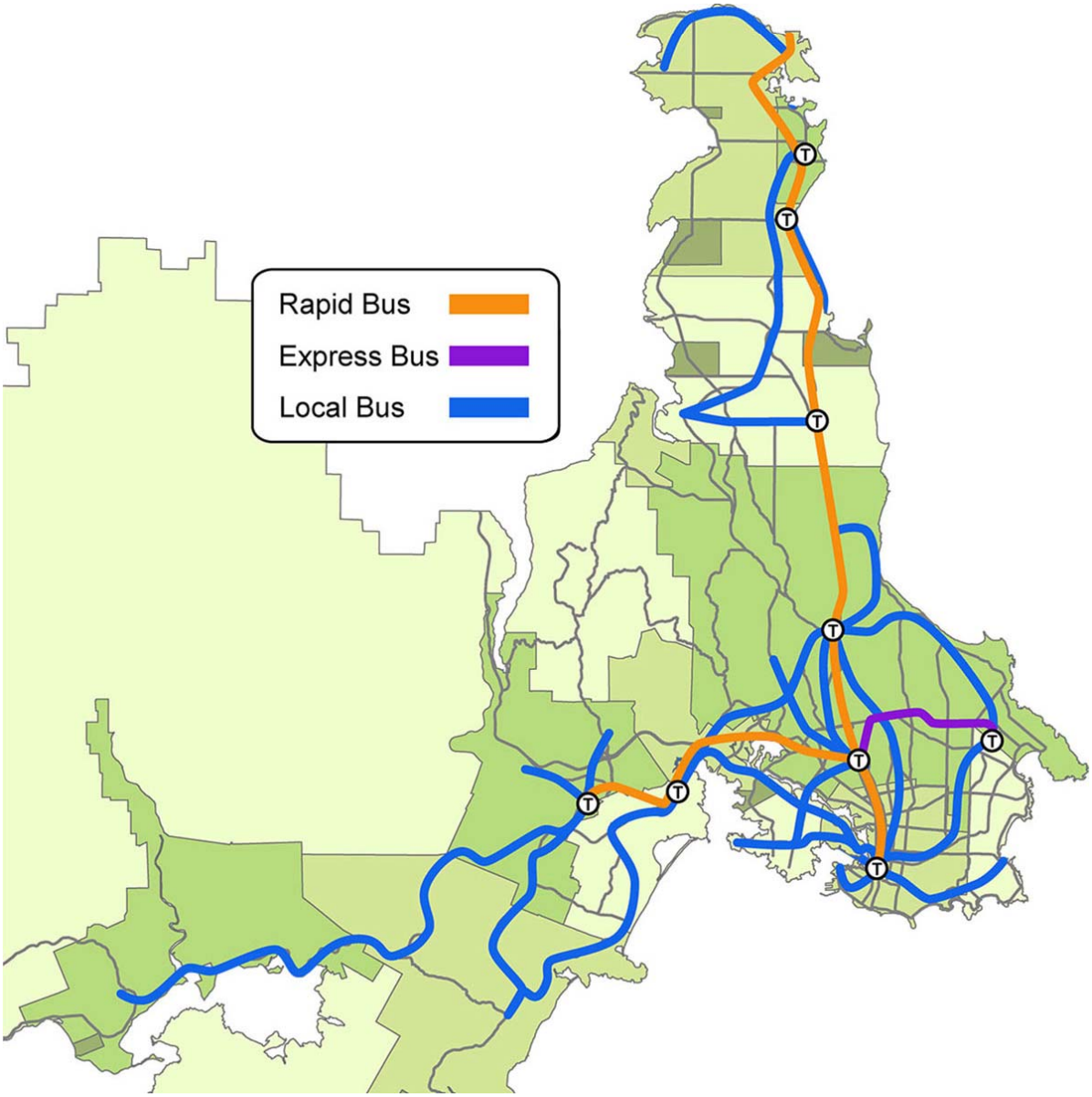


Exhibit 1.2 Transit Service Problems And Solutions

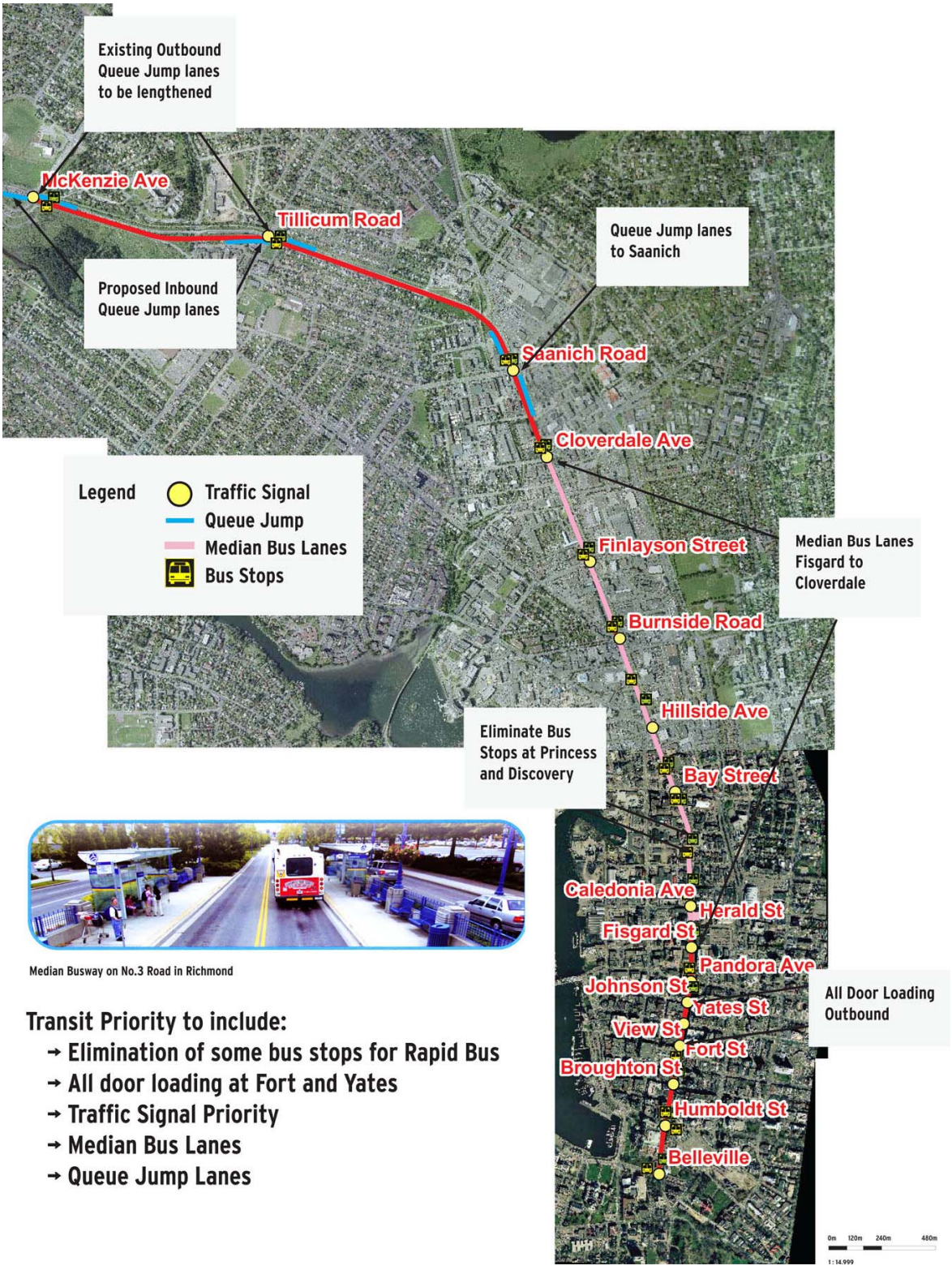
Problems	Possible Solutions
• Some bus stops are very close together resulting in low rider usage at these stops and increased delay stopping and starting.	• It is proposed to introduce limited stop, rapid bus service and eliminate some low usage, closely spaced bus stops for this service.
• Bus layover times at timing points are sometimes very high.	• It is proposed to eliminate mid-route timing points, particularly for regional routes in this portion of the corridor.
• High variances in travel times were observed in the peak direction, particularly in the northbound direction in p.m. peak period.	• Traffic signal priority, bus lanes and queue jump lanes are proposed to improve travel times.
• 95% to 98% of delays are due to traffic signals, with particularly high delays at McKenzie Avenue, Tillicum Road, Finlayson and Hillside in the southbound direction, and Saanich, Cloverdale, Broughton and Hillside in the northbound direction.	• Bus lanes, queue jump lanes and traffic signal priority measures are proposed to address these issues.
• Travel speeds are higher on Blanshard than Douglas	• Blanshard provides another feasible option for operation of some limited stop routes.

The possible solutions were developed further and described on graphs and charts and presented at a public open house on June 29th. Exhibit 1.3 presents the transit priority alternatives. The improvements are categorized into three groups:

- Transit Operations, including elimination of some closely spaced bus stops, eliminate some timing points and provide all door loading at stops where large numbers of passengers are boarding.
- Transit Priority Measures which included improved traffic signal coordination and bus activated traffic signal priority.
- Geometric improvements - two approaches were investigated. One based on queue jump lanes similar to the improvements on Highway 1 northbound, the other using median bus lanes.

The open house was advertised in the media and letters were sent to all property owners along the corridor to solicit input. There was lively discussion of the need for improved transit in the corridor and general support for the measures, particularly the busway, in hope that this would lead to eventual construction of LRT.

Exhibit 1.3 Transit Priority Alternatives



Median Busway on No.3 Road in Richmond

Transit Priority to include:

- → Elimination of some bus stops for Rapid Bus
- → All door loading at Fort and Yates
- → Traffic Signal Priority
- → Median Bus Lanes
- → Queue Jump Lanes

Following the open house meeting, discrete improvement options or scenarios were developed by the consultants and subjected to comprehensive evaluation of benefits and costs, applying the multiple account evaluation (MAE) evaluative process developed by the Province and used by BC Transit and Ministry of Transportation. The MAE process includes the following evaluation criteria or accounts:

- Financial Account, which includes capital and operating and maintenance costs for the improvement over the life of the improvement.
- Customer Service considerations, which include travel time benefits to users, as well as benefits to BC Transit in terms of reduced operating hours.
- Social and Community Benefits, which include property impacts, community severance, cross-street delays, compatibility with the community plans, visual impacts and bicycle and pedestrian impacts.
- Economic Development considerations, which include business access, parking for businesses and land value impacts.
- Environmental considerations, which include land impacts and air quality impacts.

The multiple account evaluation concluded the following:

Scenario 1: Transit Operations Improvement

- this scenario involves elimination of two bus stops in each direction on the route, provision of all door loading, implementation of a rapid bus marketing program, and updating shelters at the rapid bus stops and upgrading rapid bus vehicles.
- capital cost - $800,000.
- these improvements will yield high benefits to users and to BC Transit, totaling $10 million over 10 years.
- this scenario should be implemented immediately.

Scenario 2: Transit Operations and Centralized Traffic Signal Control

- this scenario involves implementation of a centralized traffic signal control system in the corridor to improve both auto and transit flows, and which is responsive to changes in traffic patterns throughout the day and throughout the week.
- incremental capital cost - $1.25 million
- 10 year net benefits - $16 million
- positive benefits in terms of community plan compatibility, land value increase and reductions in fuel consumption and greenhouse gas emissions.

Scenario 3: Transit Operations, Centralized Traffic Control and Traffic Signal Priority

- as well as the transit operations and centralized traffic control system, this scenario would also involve implementation of equipment on the rapid bus fleet and at signalized intersections which would provide priority to transit vehicles to reduce traffic signal delay.
- incremental capital cost – $880,000
- net benefits – $26 million over 10 years.
- higher quality transit service will encourage greater transit usage and be more compatible with the long term transit plan, encourage higher land values and lower auto fuel consumption and greenhouse gas emissions.

Scenario 4: Busway Between Herald Street and Saanich Road

- this improvement would involve construction of two median bus lanes as well as bike lanes between Herald Street and Saanich Road, as well as implementation of the centralized traffic control system.
- incremental capital cost – $3.3 million
- significant benefits to users and to BC Transit, amounting to a net benefit of $32 million over 10 years.
- additional benefits in terms of a stronger statement in support of the long term plan for rapid transit, benefits to bicyclists, enhanced land values and greater reductions in fuel consumption and greenhouse gas emissions.
- some minor disbenefits such as restrictions that pedestrian and traffic crossing must occur at signalized intersections, longer walking distances for pedestrians crossing the wider roadway, some loss of parking and trees, and increased left turn restrictions.

Scenario 5: Busway + Traffic Signal Priority

- this is the same as Scenario 4, but it also includes bus activated traffic signal priority.
- incremental capital cost is approximately $880,000 greater than Scenario 4, i.e. $6.2 million.
- benefits are approximately $6 million greater than Scenario 4, that is $38 million over 10 years.
- greater positive benefits due to higher quality transit service and higher transit usage, and same disbenefits.

These transit improvements clearly fall into two time phases:

- Phase 1 should involve immediate implementation of the transit operational improvements, as well as the centralized traffic control system and the transit priority equipment to be installed on buses operating in the corridor, and at the 19 signalized intersections. This work would amount to a capital expenditure of $2.9 million and would be funded under the $3 million federal / provincial / BC Transit fund. The project should be initiated and funds committed before the end of the fiscal year, March 31, 2006, in order to qualify under the terms of the federal / provincial funding.
- Phase 2 should involve implementation of the busway, with the traffic signal priority system. Work should commence immediately on the development of busway and bikeway designs to mitigate the negative impacts described above, and then undertake a comprehensive stakeholder consultation program to identify implementation problems and find appropriate solutions. Timing of construction would be dependent on availability of the $3.3 million capital investment required for this phase.

The Phase 1 work can commence immediately and the transit improvement systems defined and contractors selected in sufficient time for commitments to be made prior to the fiscal year end, March 31, 2006.

While design of the Phase 1 improvements associated with the traffic control system and transit priority systems proceeds, work can also proceed on the Phase 2 design to ensure compatibility of designs, so that the busway system can be implemented with least loss of initial investment.

2. Introduction, Purpose and Scope

The Douglas Street – Highway 1 corridor in the Greater Victoria Region is the primary transit corridor connecting downtown Victoria and such major residential areas as Saanich, Colwood and Langford, as shown in Exhibit 2.1.

In 1996, BC Transit retained N.D. Lea Consultants to prepare a preliminary concept for future development of LRT within this corridor. It is intended that any transportation improvements in this corridor will be designed to be compatible with eventual implementation of LRT within the corridor.

In the interim, BC Transit wishes to improve bus-based transit services within the corridor. In 1998, BC Transit retained Delcan and IBI Group to identify short term and medium term improvements in the corridor. This included recommendations for a number of transit priority measures, including queue jumpers and traffic signal priority. Some of these improvements have been implemented, specifically outbound queue jumpers at McKenzie Avenue and Tillicum Road.

The City of Victoria has obtained capital funds from the Federal and Provincial Infrastructure Program and from BC Transit in the amount of $3 million and wishes to apply these funds to continue implementation of transit improvement strategies in the corridor. The intent of this project is to develop a comprehensive transit priority – traffic management approach to the corridor and then to identify the specific plans and projects to be implemented through the infrastructure program and beyond. These improvements are to be designed and implemented bearing in mind the longer term objective of developing a fully exclusive right-of-way and high quality bus rapid transit or light rail transit system.

IBI Group has been retained by BC Transit to carry out this transit priority study for the Douglas Street / Highway 1 corridor. This report presents a description of the existing conditions and transit operations in the Douglas Street corridor, identifies current problems, issues and causes of travel time delays, outlines areas and types of operational, transit priority and roadway and bus lane improvements, and associated benefits and costs of the improvements. This information is then used to develop a proposed implementation program, outlining Phase 1 projects to be undertaken within the $3 million grant outlined above, and subsequent, Phase 2 improvements to be carried out in a longer timeframe.

Exhibit 2.1 Greater Victoria Regional Transit System

3. Existing Conditions, Problems and Improvements

The project study area includes Highway 1 and Douglas Street between Helmcken Road and Belleville Street in downtown Victoria, as shown in Exhibit 3.1. The length of this corridor is approximately 6 km.

The Highway 1 portion between McKenzie and Saanich is 2.2 km long and provides two lanes in each direction, with turn lanes at each of the three signalized intersections. At two of these intersections, McKenzie and Tillicum, northbound bus queue jump lanes were constructed following the 1999 study by Delcan / IBI Group, which allow thru routed buses to use the mandatory right turn lane to proceed through the intersection, bypassing the intersection queue. The benefit of the queue jump is sometimes limited when the traffic extends past the turn lane and buses are delayed entering the queue jump / turn lane.

The Douglas Street portion of the corridor extends between Saanich and Belleville Street, a distance of 3.8 km and includes 16 traffic signals. This portion of the corridor is primarily two lanes in each direction plus parking on several sections between Bay Street and Broughton. Sections of Douglas Street between Burnside and Bay Street provide three lanes in each direction.

In the City of Victoria, the signals between Caledonia Avenue and Belleville Street are coordinated and implement time of day signal timing plans. On Highway 1, traffic signals at McKenzie Avenue and Tillicum Road intersections are coordinated, and Saanich and Cloverdale are separately coordinated.

The existing right of way is approximately 30 metres wide through the portion within the City of Victoria, and somewhat wider on the Highway 1 portion through the City of Saanich. The curb to curb width is typically 22 metres in width, with boulevards and sidewalks on both sides, all within the 30 metre cross-section.

Exhibits A1 and A2 in Appendix A present the a.m. and p.m. peak hour traffic volumes by direction and by lane at each of the signalized intersections within the study area. These have been factored to 2005 from earlier years that the counts were obtained, based on 1.5% per annum growth rate. Exhibits A3 and A4 present the a.m. and p.m. signal timing by direction, for each of the signalized intersections within the corridor.

3.1 Current Transit Operations

One of the first tasks in this project was to carry out travel time and delay surveys on Douglas Street / Highway 1 during the morning, midday and afternoon peak periods to identify locations and causes of delays. A similar survey was also undertaken along Blanshard Street, so that the possibility of running transit services on this street could be considered.

An analysis was also undertaken of the transit usage on the major routes along the corridor, including boardings and alightings at each of the stations.

Exhibit 3.2 presents the average travel speeds between intersections along the corridor by direction. The exhibit shows relatively low transit speeds between Fisgard and Saanich due to traffic signal delays and general road congestion delays. The exhibit also shows relatively low speeds in the downtown, south of Fisgard, but this is typical of transit operations in downtown areas where there is frequent pick up and drop off operations.

Exhibit 3.1 Douglas Street / Highway 1 Transit Priority Corridor

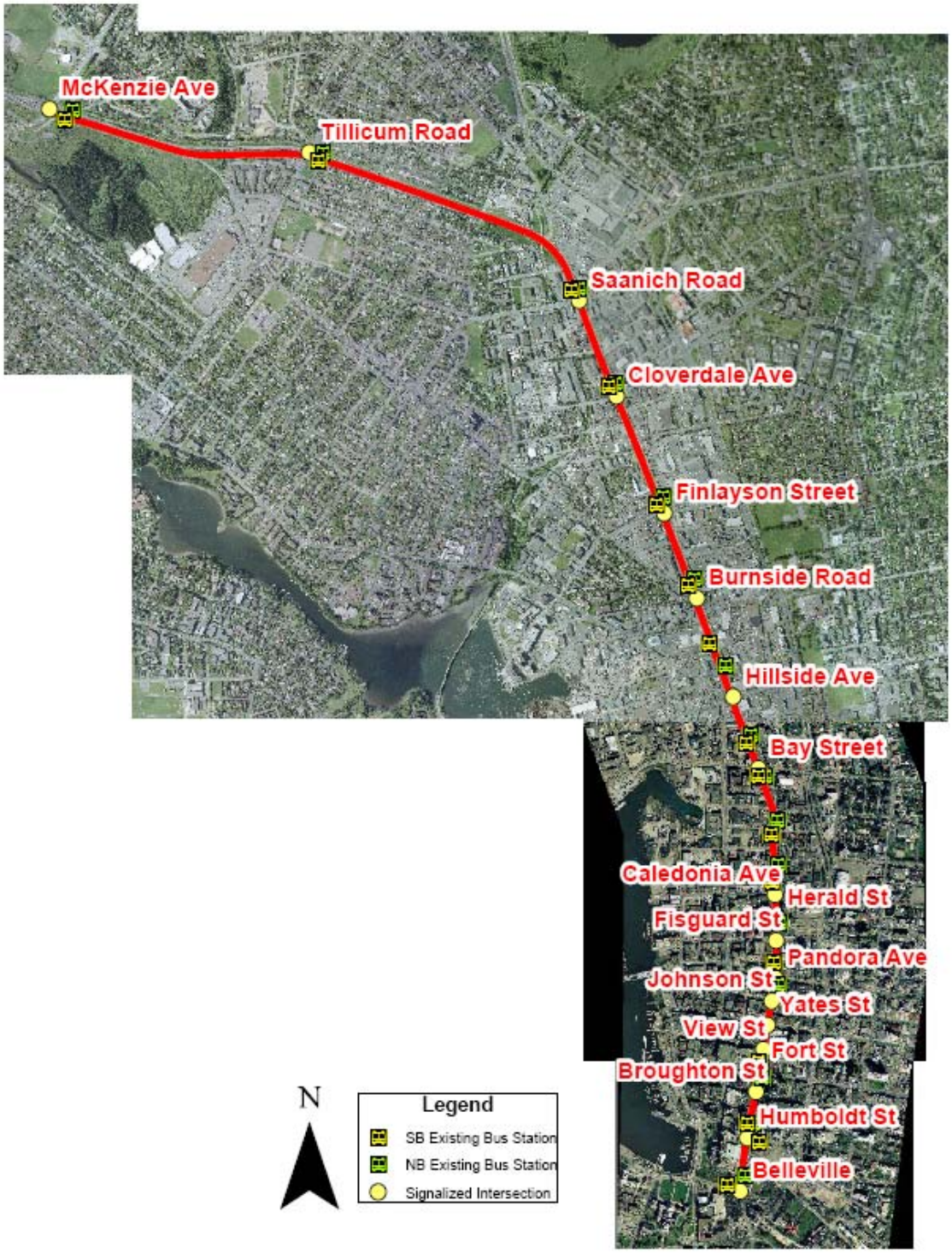
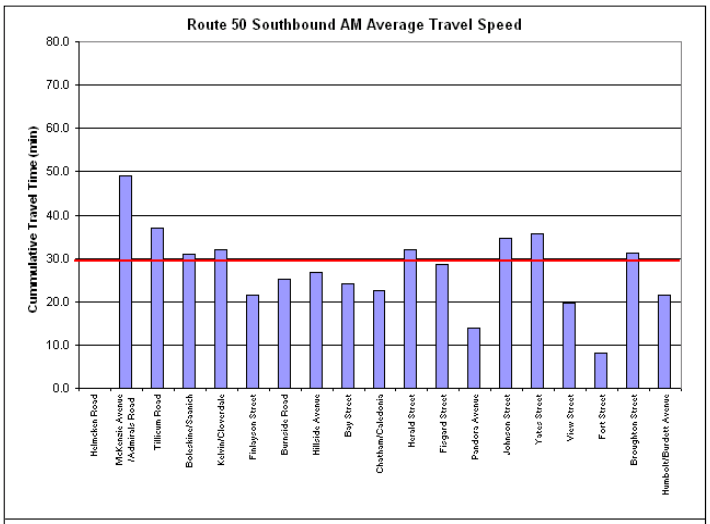
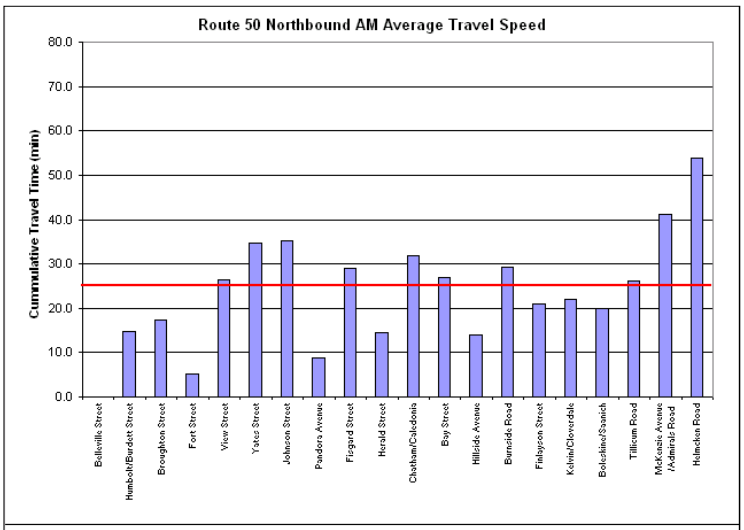
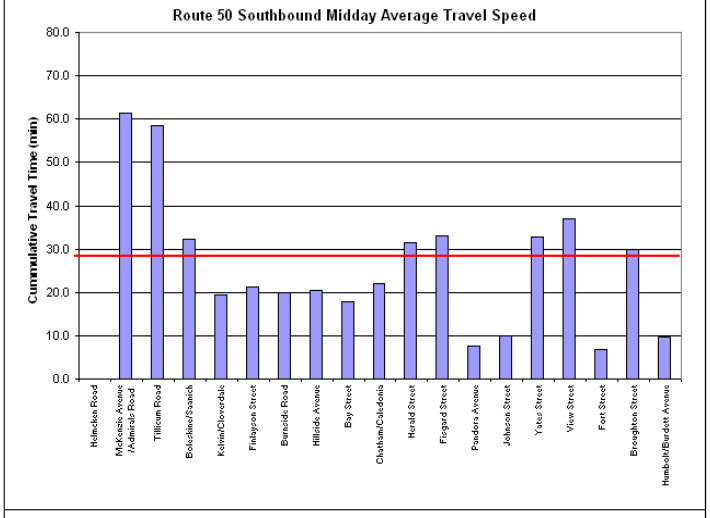
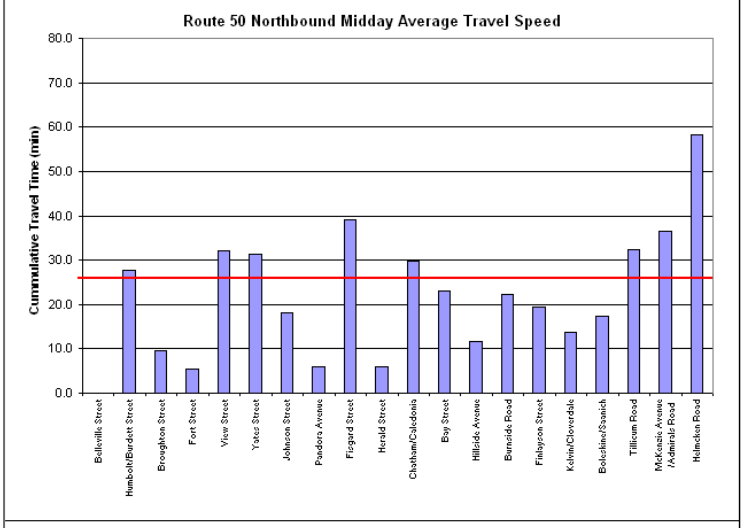


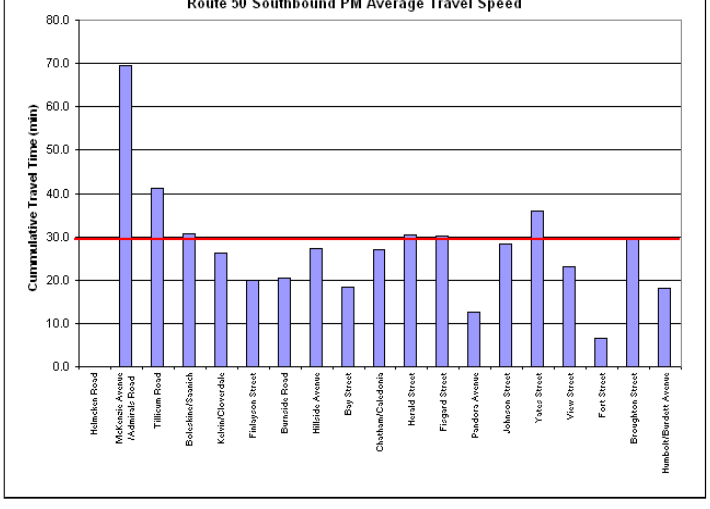
Exhibit 3.2 Route 50 Southbound & Northbound Average Travel Speeds











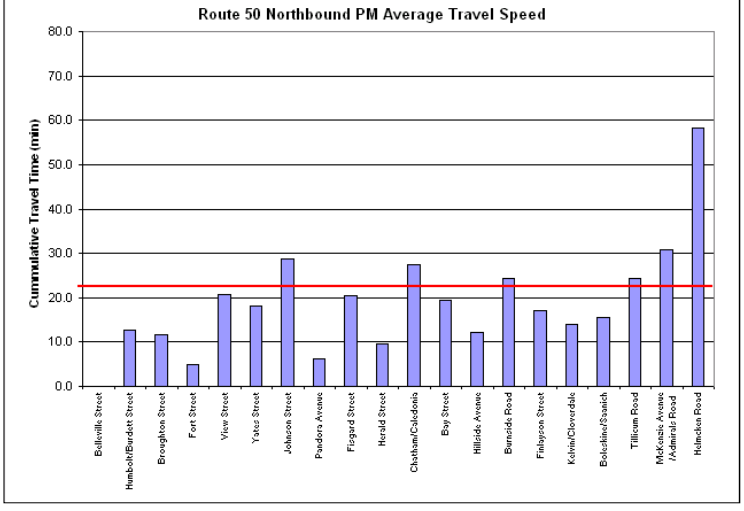


Exhibit 3.3 presents the boardings and alightings at each bus stop for Route 50 through the study area. The exhibit indicates low transit usage stops which should not be served by the rapid bus, such as Princess Street and Discovery Street. The exhibit also shows stations where there are high boardings, where measures to reduce boarding times should be considered, such as all door loading areas. These stops are primarily Fort and Pandora, and to a lesser extent Finlayson and Saanich.

As part of the travel time survey, the dwell time at stations was also recorded. It was noted that dwell times were quite high at timing points, typically 60 – 90 seconds, to allow buses to get back on schedule. These timing points should be deleted for the rapid bus service.

Finally, Exhibit 3.4 presents the location of intersection delays. It is noted that higher than average delays were realized at Hillside Avenue in both directions, Finlayson Street, McKenzie Avenue and Tillicum Road southbound, and Saanich, Cloverdale and Finlayson Street northbound.

The auto travel time surveys on Blanshard indicated that speeds are typically in excess of 30 km per hour, much faster than on Douglas Street. This suggests that Blanshard Street be considered for future rapid bus service from the peninsula.

The transit service problems and possible solutions that emerged from this analysis are outlined in Exhibit 3.5.

Exhibit 3.3 Route 30/31 Southbound & Northbound Average Total Delay

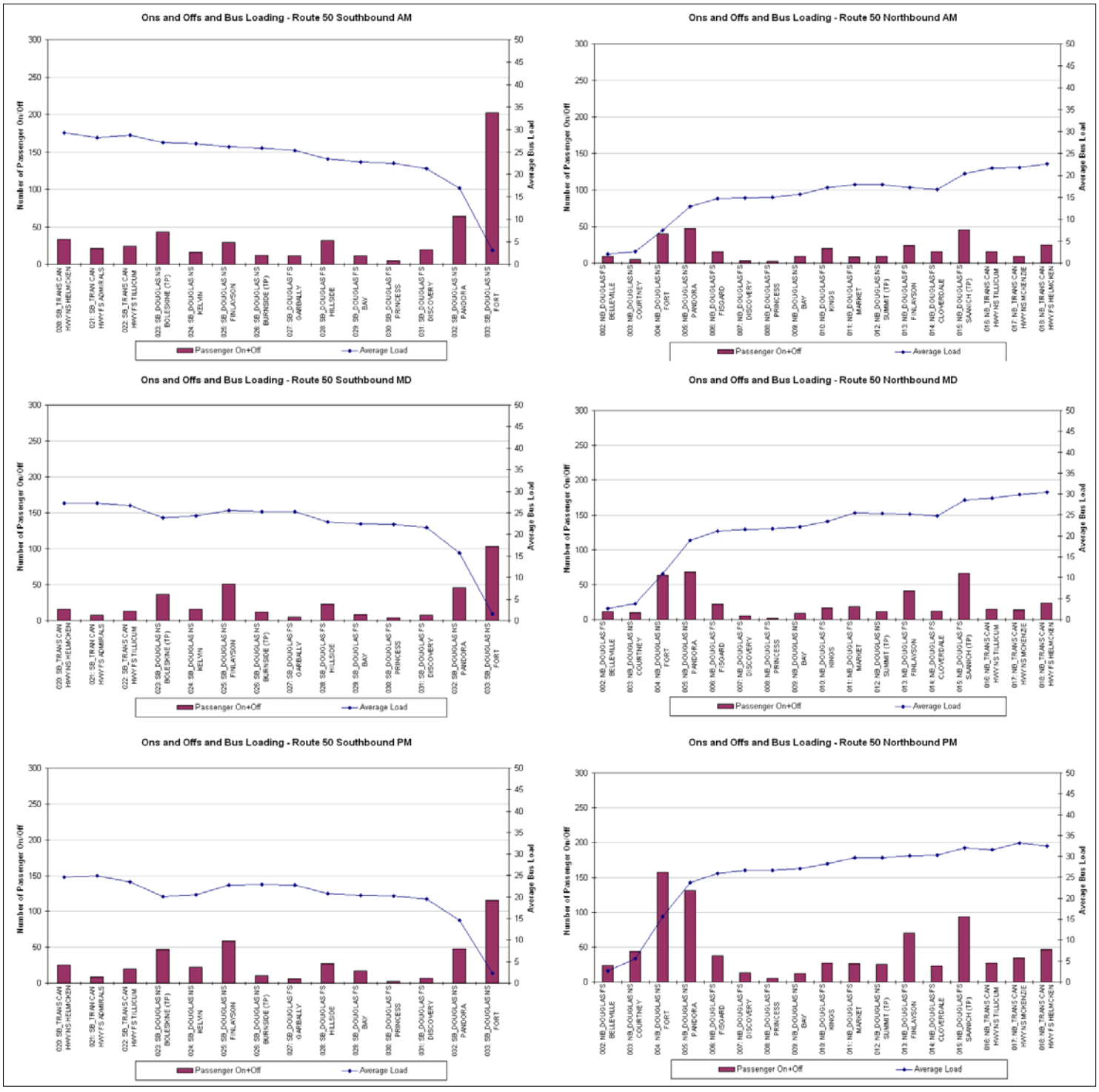
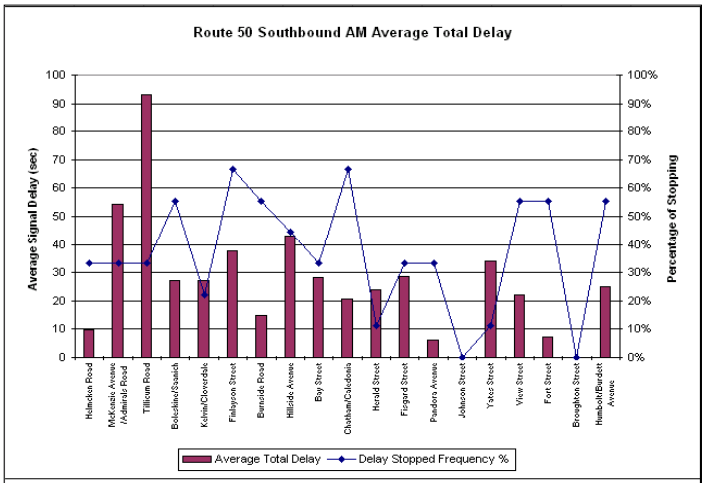
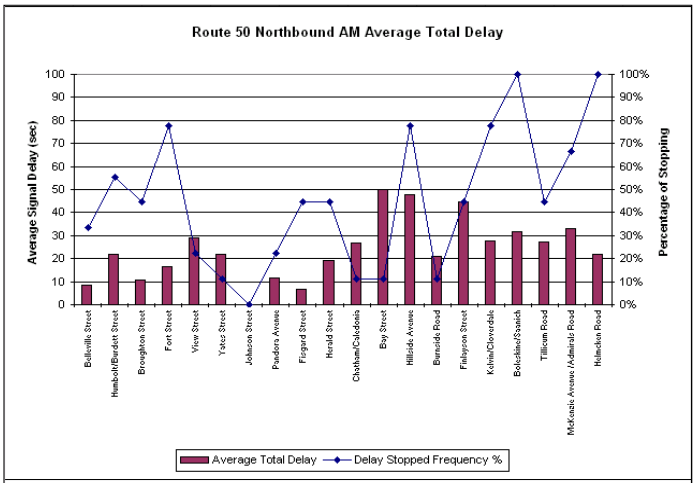
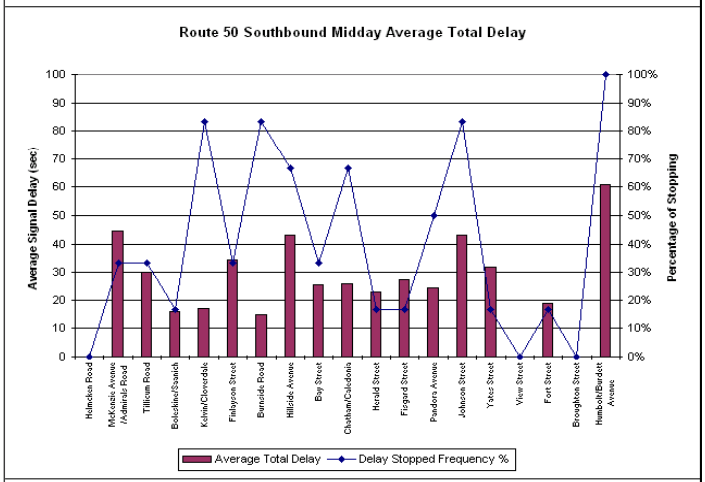
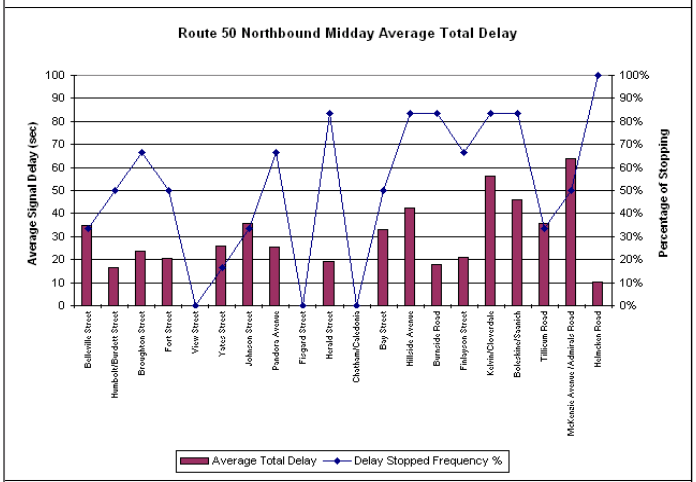


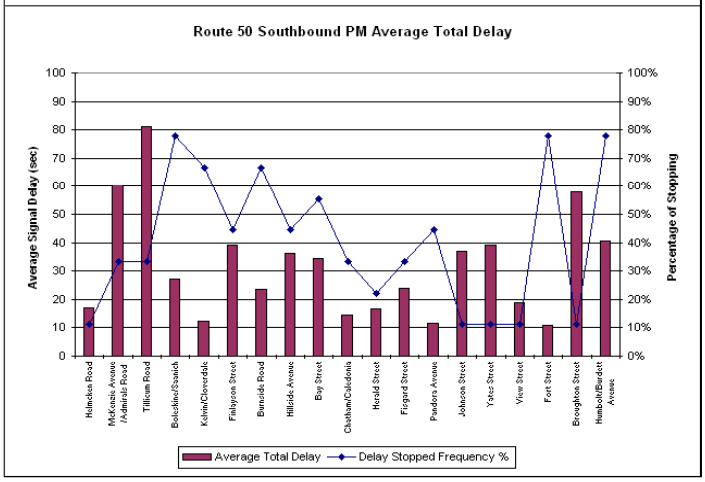
Exhibit 3.4 Route 50 Southbound & Northbound Average Total Delay











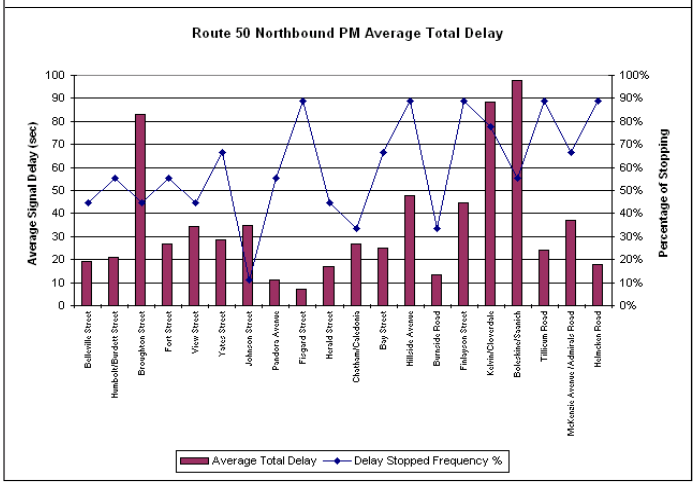


Exhibit 3.5 Transit Service Problems And Solutions

Problems	Possible Solutions
• Some bus stops are very close together resulting in low rider usage at these stops and increased delay stopping and starting.	• It is proposed to introduce limited stop, rapid bus service and eliminate some low usage, closely spaced bus stops for this service.
• Bus layover times at timing points are sometimes very high.	• It is proposed to eliminate mid-route timing points particularly for regional routes in this portion of the corridor.
• High variances in travel times were observed in the peak direction, particularly in the northbound direction in p.m. peak period.	• Traffic signal priority, bus lanes and queue jump lanes are proposed to improve travel times.
• 95% to 98% of delays are due to traffic signals, with particularly high delays at McKenzie Avenue, Tillicum Road, Finlayson and Hillside in the southbound direction, and Saanich, Cloverdale, Broughton and Hillside in the northbound direction.	• Bus lanes, queue jump lanes and traffic signal priority measures are proposed to address these issues.
• Travel speeds are higher on Blanshard than Douglas	• Blanshard provides another feasible option for operation of some limited stop routes.

3.2 Alternative Transit Priority Measures

A number of transit priority measures are proposed to reduce transit delays and improve on time performance. These transit priority measures are grouped into three areas:

- Transit operations
- Traffic signal priority (TSP)
- Geometric transit priority

Exhibit 3.6 presents a compilation of the possible priority measures which can affect bus travel times and schedule performance.

Exhibit 3.6 Alternative Transit Priority Measures

Transit Operations	Transit Signal Priority	Geometrics
• Eliminate 1 – 2 bus stops in each direction. • Limited stop service. • Route express services via Blanshard • Eliminate timing points. • All door loading at Fort and Pandora northbound.	• Passive – optimize signal timing in peak direction. • Active – green extension at all signals in peak direction – early green at Bay and Pandora – transit phase insert at Hillside NB / SB, Tillicum and McKenzie SB in conjunction with queue jump lane	• SB – utilize RT lane at McKenzie as queue jump and extend – construct queue jump to Tillicum – queue jump to Saanich* – extend bus bay through Finlayson and Burnside* – remove some parking to Bay Street • NB – queue jump Pembroke to Market* – queue jump to Hillside* – LT queue jump to Burnside* – queue jump Tolmie to Saanich* – lengthen Tillicum queue jump – lengthen McKenzie queue jump • SB and NB (replaces items marked *) – median bus lanes between Fisgard and Saanich Road

Following is a description of each of the measures which were examined.

3.2.1 TRANSIT OPERATIONS

The transit priority measures within this category include bus stop and routing modifications.

Reduce Number of Bus Stops

Examination of the bus stop usage and bus stop spacing indicates that Princess southbound could be eliminated, Princess and Kings Road northbound could be eliminated and the Market Street stop relocated to farside Hillside for rapid bus service.

Bus passenger usage at Discovery Street in both directions is also quite low, and could also be eliminated.

Elimination of each bus stop could reduce travel times by 0.5 – 1 minute each.

Eliminate Timing Points

It is proposed to eliminate timing points along the routes for the rapid bus service. There is no need for schedule correction points between the downtown terminus and Saanich Road.

This could reduce travel times by 1 – 2 minutes.

All Door Loading

As noted earlier, high bus dwell times were experienced at Fort Street and Pandora Avenue northbound for passenger loading, particularly for Routes 30 / 31. It is proposed that an area within the loading area be designated as a "fare paid" zone, and that all door loading be permitted in order to reduce dwell time at the bus stops. This could reduce travel time by 20 – 30 seconds at each of these stops.

This enhancement should be introduced in conjunction with increased inspections of passenger proof of payment and installation of pass reading equipment at the rear doors on buses identified for regional operations. Rear door pass readers for a fleet of 50 buses dedicated to regional bus operations would cost $100,000.

Route Express Buses via Blanshard

As noted earlier, average delays for general purpose traffic on Blanshard Street are approximately 3 – 4 minutes, compared to 5 – 6 minutes delays experienced on Douglas Street. Lower levels of delay and higher speeds on Blanshard suggests that some buses could be routed via Blanshard to the downtown as they do now, thus saving some travel time, reducing the numbers of buses on Douglas Street and reducing traffic congestion as well. Since Douglas Street is considered the main transit street in downtown Victoria, only express or limited stop services to and from the Saanich peninsula should continue to be routed via Blanshard Street. However, if geometric transit priority investments are made on Douglas Street and improved stations and amenities are developed, use of the rapid transit corridor is preferable.

Rapid Bus Marketing Program

A marketing program should be developed to promote the new service and include upgrades to selected high usage shelters and station areas, as well as development of a distinctive logo for the shelters and the buses. An allowance of $25,000 for each of 10 shelters along Douglas Street, and $5,000 for each of 20 buses, is proposed. Planning and design of shelters and marketing has been estimated at $200,000

Total cost of all of the operations improvements listed above is $800,000.

3.2.2 TRAFFIC SIGNAL PRIORITY

There are two types of traffic signal priority, passive and active.

Passive Transit Priority

Passive transit priority measures involve developing a traffic signal offset plan or "green wave" which minimizes both transit travel times and delays and auto travel times and delays. Since the greatest delays are incurred in the peak direction, the traffic signal offset plan should favour southbound traffic in the a.m. peak and northbound traffic in the p.m. peak. The attractive feature of the passive transit priority measure is that it minimizes bus delays at traffic signals, while minimizing impact on pedestrian and cross-street traffic.

Passive transit priority timing plans are most beneficial in sections where queue jump lanes are utilized or where exclusive bus lanes are provided, both of which reduce variations in travel times and increase the probability that the transit vehicle approaches the traffic signal on a green phase.

Simulations have shown that passive priority measures have provided significant benefits to transit operations and transit riders, with little or no negative impact on auto travel and pedestrian movements.

In order to realize the full benefits of passive traffic signal priority, a centralized traffic control system capable of responding to changes in traffic patterns throughout the day and throughout the week is preferred. Accordingly, an upgrade to the City of Victoria's traffic signal system is proposed, involving installation of a central traffic signal control system and communications to the signals on the Douglas Street corridor initially, and future extension to other signals within the downtown. Also, consideration should be given to tying the MoT signals on Highway 1 north to McKenzie into the system, which will involve replacement of the local controllers of the MoT signals.

The estimated costs for these improvements are as follows:

- Central traffic control system and hardware $500,000
- Traffic signal controller upgrades (City and MOT) $330,000
- Traffic signal communication system $190,000
- Traffic signal timing plans installation $ 38,000
- System design and integration $200,000
- **TOTAL** **$1,258,000**

Active Transit Priority

Active transit priority involves modifying, on a real-time basis, the traffic signal phase to provide a "green phase" for a transit vehicle. Various protocols include extending green time on Douglas Street / Highway 1, reducing cross-street green time, or inserting a "transit only" phase to allow the transit vehicle to pass through the intersection with less delay. Experience from other projects suggests that the green time extension should be up to 14 seconds, while the cross-street green time truncation is limited by the requirement to provide for a minimum pedestrian crossing time. Transit phase insert involves changing the sequence of phases to advance to the phase which permits the transit vehicle to proceed, or inserting a separate "transit only" phase to allow the transit vehicle to advance through the intersection ahead of other vehicles. This latter type of transit priority is currently provided on Highway 1 northbound at McKenzie Avenue and Tillicum Avenue, which has successfully reduced bus delays.

Some possible active transit priority measures to be examined along the Douglas / Highway 1 corridor include:

- Green extension at all signals in the peak direction.
- Early green / red truncation at streets with high cross-street green times, such as Bay Street and Pandora.
- Transit phase insert at multi-phase signals, such as Hillside, McKenzie, Tillicum, Saanich, Cloverdale and Finlayson. Currently there is a transit phase insert at McKenzie Avenue northbound which is 7 seconds duration, allowing buses to advance ahead of general purpose vehicles.

The active traffic signal priority system that is being considered is somewhat similar in performance to the traffic signal priority system installed by TransLink on the 98 B-Line rapid bus service in Vancouver. This system would involve a bus detector at each signalized intersection, either within the right of way or a GPS-based detection methodology which eliminates the need for roadside detectors. The detector would call for an adjustment in the signal phasing at the next intersection to increase the green time available for the bus, thus minimizing the potential for delay to the bus at the signalized intersection. Some limits are established for the amount of green time extension, typically 14 seconds, or early green time to provide sufficient time for pedestrians to clear the cross-street intersection. This transit priority would be available for all of the buses designated as "rapid bus", which will typically be the services destined to the Saanich Peninsula or Western Communities, such as Route 50 and Route 70. Since priority would be granted to all of the designated buses, there is no requirement for an automatic vehicle location monitoring system to determine where the bus is relative to schedule.

The costs of the traffic signal priority system are estimated as follows:

- Bus detection and traffic signal activation system (19 intersections): $380,000
- In-vehicle bus priority system (50 buses): $300,000
- System development and integration: $200,000
- **TOTAL** **$880,000**

These costs are in addition to the central traffic signal control systems costs.

3.2.3 GEOMETRIC TRANSIT PRIORITY MEASURES

Geometric transit priority measures involve a number of roadway revisions and lane re-designations, including:

- Queue jumps.
- Bus only lanes.
- Peak period or full time parking restrictions.
- Intersection improvements.

Following is a description of each of these geometric improvements.

Queue Jumps

Queue jump lanes provide a lane for buses to bypass traffic congestion at signals or other obstructions such as bridges. A low cost but very effective queue jump lane involves allowing buses to bypass queues at intersections using the right turn lane, allowing buses to proceed through the intersection, but requiring vehicles to turn right. Currently, "right turn except buses" queue jump lanes are provided northbound on Highway 1 at McKenzie and at Tillicum Road. However, these existing queue jumps need to be lengthened, as auto queues are longer than the turn lane, prohibiting buses from accessing the priority lane.

Following are some queue jump lanes to be examined, and preliminary cost estimates.

Southbound

- Construct southbound queue jump lane at McKenzie by extending the existing right turn lane – cost $300,000.
- Construct southbound queue jump lane to Tillicum using the existing curb lane and replacing the through lane by converting the second southbound left turn lane to through lane – cost $100,000,
- Construct southbound queue jump lane to Saanich – cost $225,000.
- Extend southbound bus bay through Finlayson and Burnside with transit advance signal – cost $450,000.
- Eliminate parking at Hillside to Bay – cost $10,000.

Northbound

- Construct queue jump lane from Pembroke to Market – cost $1,050,000.
- Construct queue jump lane to Hillside – cost $150,000.
- Construct left turn queue jump at Burnside – cost $45,000.
- Construct northbound queue jump lane from Tolmie to Saanich – cost $900,000.
- Lengthen Tillicum queue jump lane northbound – cost $150,000.
- Lengthen McKenzie queue jump lane northbound – cost $150,000.

Bus Lanes

As an alternative to the large number of queue jump lanes listed above, continuous bus lanes over a portion of the route could be considered.

Bus lanes provide an exclusive transitway for buses, bypassing traffic congestion and queues at signalized intersections. In order to minimize costs, busways are generally at grade and pass through signalized intersections generally with some form of signal priority.

The LRT study undertaken by N.D. Lea on behalf of BC Transit in 1996 identified a preferred LRT alignment along Douglas Street, from the downtown through to the Highway 1 corridor and to the western communities. Within Douglas Street, there is a 7 metre right-of-way designated for a future transitway, extending from Pandora Street to the city limits. It is proposed to utilize this right-of-way for exclusive bus lane operation, prior to implementing LRT. Like the future LRT alignment, the bus transitway would be in the centre of the street, with stations located farside of the intersections, in the shadow of the left turn bays. The roadway would be widened to maintain two lanes of traffic in each direction, which will eliminate some parking and some corner bulges, to be determined.

The busway geometry should be designed to accommodate a future LRT system within the same alignment, thus minimizing costs for subsequent conversion to LRT.

The analysis undertaken in this study indicates that continuous bus lanes are warranted from Herald Street as two lanes to Saanich Road. North of Saanich Road, there are several alternatives for the alignment, that is, in the median, on the shoulder, or adjacent to the Galloping Goose trail. Alternatively, auto travel lanes combined with intersection queue jumpers could be used. An assessment of these alignment options will be the subject of a future planning phase.

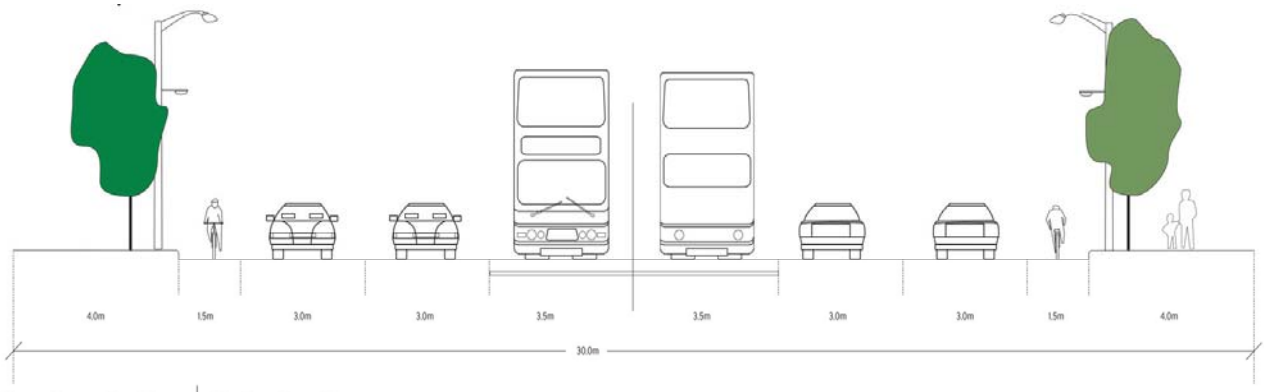
Typical roadway cross-sections showing the location of the busway in the median of Douglas Street, and the adjacent travel lane, bike lanes and sidewalks within the available 30 metre right of way are shown in Exhibit 3.7. The exhibit shows cross-section requirements at locations where stations will be provided and between stations. The cross-section in the City of Victoria allows for two 3.5 metre bus lanes, two 3.0 metre general purpose traffic lanes in each direction, two 1.5 metre bike lanes in each direction, and sidewalks and boulevards in the remaining right of way. At station locations, an additional 3 metres is required for the station, which results in a reduction in the boulevard areas, in order to stay within the 30 metre right of way. In the Saanich portion of the corridor there is additional right-of-way width which would permit wider lanes, walks or boulevards without property acquisition.

Exhibit 3.8 shows possible cross-sections for curb running busway. This cross-section could be applicable on Highway 1 north of Saanich Road.

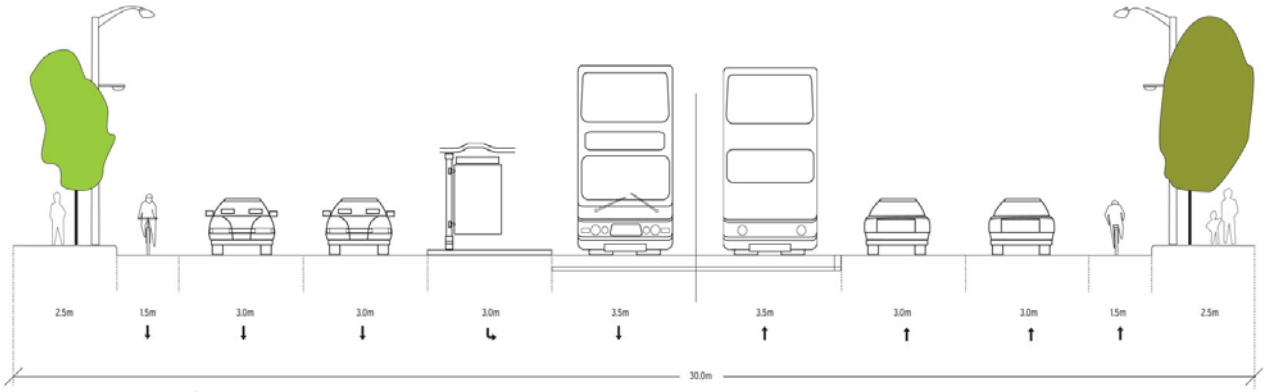
Conceptual layout of the busway and traffic lanes, bike lanes, sidewalks and boulevards are shown in Appendix B for the entire 2.8 km length from Herald Street to Saanich Road. The concept includes three stations between downtown and Highway 1. These concept designs indicate that the curb lines would need to be widened generally throughout the length of the bus lane to accommodate both the bike lanes as well as the bus lanes. If the bike lanes were deferred or relocated to a different corridor, the bus lanes and general purpose traffic lanes would generally fit within the existing curb to curb width and there would be less need to widen the curb line. The detailed design phase of the busway project would assess in detail alternative station locations and right-of-way design issues.

The busway improvements presented in Appendix B, including construction of bus shelters, and relocation of 8 traffic signals, is estimated to cost approximately $3.3 million. The breakdown of this cost estimate is shown in Exhibit 3.9. No allowance is provided for property acquisition, since the busway concept and traffic lanes have been designed to avoid property acquisition.

Exhibit 3.7 Cross-Sections Centre Section

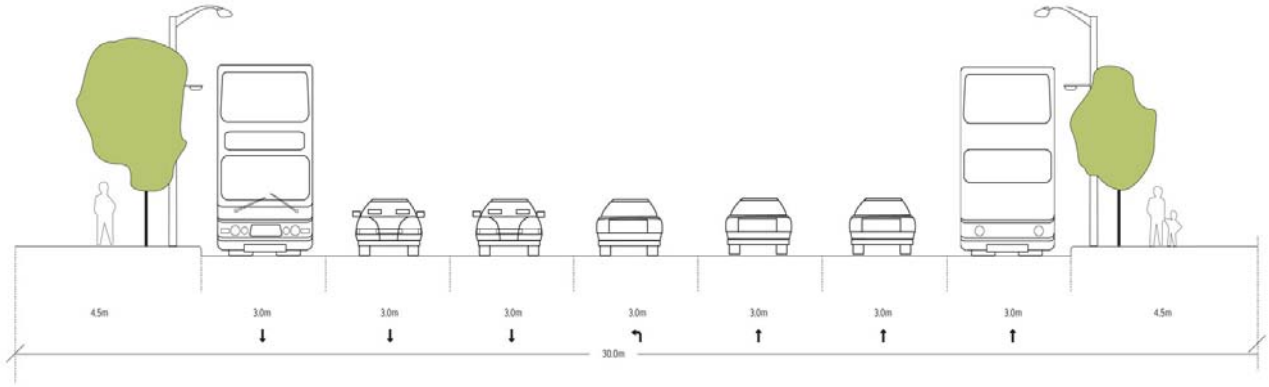


Typical Transitway Cross-Sections | Median Transitway

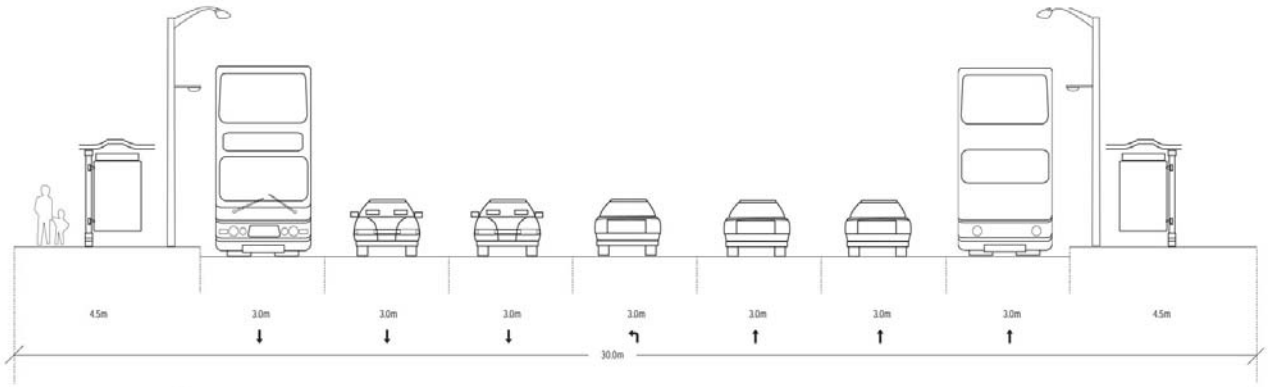


Typical Transitway Cross-Sections | Median Station

Exhibit 3.8 Cross-Sections North Section



Typical Curb Lane, Mixed Traffic | Curb Lane Queue Jump



Typical Curb Lane, Mixed Traffic | Curb Lane Station

Exhibit 3.9 Busway Construction Costs, Herald Street to Saanich Road

Item	Unit	Quantity	Unit Rate	Estimate
Site Works				
Remove Curb	lm	6196	$15	$92,944
Sawcut	lm	2905	$12	$34,860
Eradicate Paintlines	lm	10458	$3	$29,281
Install Curb	lm	5268	$60	$316,050
Widen Lane - 100mm HMAC 250mm Gravels	m^2	6253	$47	$290,759
Concrete Sidewalk	m^2	330	$50	$16,500
Paint Markings				
Line Painting	lm	21518	$1	$21,518
Stimsonite	ea	1165	$2	$2,330
Chevrons	m^2	144	$17	$2,376
Painted Symbols	ea	410	$105	$43,050
Thermoplastic Stop Bars and Crosswalks	m^2	93	$72	$6,696
Utility Relocation				
Relocate Lamp Standards	ea	95	$290	$27,550
Relocate Power Poles	ea	68	$2,000	$136,000
Relocate Parking Meters	ea	45	$80	$3,600
Relocate Signs	ea	58	$75	$4,350
Relocate Trees	ea	75	$200	$15,000
Adjust MH and Catchbasins	ea	75	$250	$18,750
Electrical				
Transit Advance Phasing	ea	4	$20,000	$80,000
Signals Relocate	Intersection	8	$150,000	$1,200,000
Bus Platforms and Shelters				
Bus Pad	m^2	1025	$80	$82,000
Bus Platform	m^2	880	$60	$52,800
Bus Shelter	ea	8	$10,000	$80,000
Sub Total				**$2,556,413**
Contingency - 15%				$383,462
Engineering and Construction Services - 12%				$352,785
Total				**$3,292,660**

3.3 Analyzing Corridor Transit Improvement Options

Corridor transit improvement options or scenarios were developed comprising combinations of transit operations, traffic signal priority and geometric improvements. Five scenarios, in addition to the base, do nothing scenario, were developed as follows:

- Scenario 1, Transit Operations: eliminate some transit stops and timing points, and optimize the traffic signal timing plans.
- Scenario 2, Transit Operations and Central Traffic Control System
- Scenario 3, Transit Operations, Central Control and Traffic Signal Priority
- Scenario 4, Transit Operations, Central Control and Busway.
- Scenario 5, Transit Operations, Central Control, Busway and Traffic Signal Priority

A first level of analysis involved application of Synchro volume/capacity analysis to determine impacts of changes in geometry and timing plans, as well as to determine appropriate signal timing plans.

Then, a detailed microsimulation using the microsimulation model VISSIM was undertaken to examine in greater detail the transit travel times and delays for a number of selected improvement scenarios, as well as to examine the impact on other traffic in the corridor.

The evaluation of these alternatives is presented in the next section.

4. Evaluation of Alternative Improvements

The multiple account evaluation methodology developed by the Province of British Columbia has been used to evaluate the alternative transit priority measures. The multiple account evaluation methodology is a multi-criteria decision matrix tool designed to :

- Provide a balanced view to decision makers, to display the inevitable trade-offs which are required in a decision.
- Compare options within a project.
- Draw comparisons with other projects.
- Facilitate comparison with other program needs.

The MAE methodology has been used by the province, BC Transit and TransLink to evaluate major capital projects, using criteria which are measurable and quantitative, as well as criteria which are not measurable but rely on qualitative descriptions.

4.1 MAE Accounts

The five accounts used in the MAE evaluation include:

- Financial Account;
- Customer Service Account;
- Social / Community Account;
- Economic Account;
- Environmental Account.

The Financial and Customer Service Accounts are typically quantitative, while the other accounts are generally qualitative accounts.

The multiple account evaluation methodology produces estimates of benefits and costs over the life of the project. In this project, we have assumed a 10 year life, that is after 10 years it is assumed that the improvements will either have reached their useful life or will be converted or upgraded to another form of Improvement.

Following is a description of the components of each of the accounts.

4.1.1 FINANCIAL ACCOUNT

The Financial Account includes all of the costs to develop and operate/maintain the facility over its 10 year life. In this project, the capital costs include costs of bus shelters, bus equipment, central traffic control, traffic signal priority equipment, and roadway and infrastructure improvements. Operating and maintenance costs relate to operating and maintaining the improvements, not the operating and maintenance costs of transit service using the corridor.

For the traffic signal priority systems, it is assumed that they have a 10 year life and, after 10 years, will need to be replaced or upgraded.

For the busway improvements, it is assumed that they also have a 10 year life. It is assumed that after 10 years the salvage value of the facilities is 25% of original capital cost. This assumption would be appropriate whether the busway continued in service beyond 10 years, or was converted to LRT.

Infrastructure operating and maintenance costs were assumed to be 10% of the original capital costs, a value which is consistent with other transit priority projects undertaken by the consultant.

4.1.2 CUSTOMER SERVICE ACCOUNT

The Customer Service Account includes both benefits to the transit operator, BC Transit, and to transit users and auto users within the corridor.

Benefits to the transit operator include reduced bus operating hours as a result of the improvements, using an average bus operating cost of $70 per hour. Also, reduced number of vehicles due to higher average operating speeds is also considered a benefit to BC Transit.

Transit user benefits include reduced travel time resulting from the transit priority improvement. "Before and after" improvement in travel times were estimated along the corridor from Belleville to McKenzie Ave, and the travel time savings were multiplied by the average number of users on all buses along the corridor. Travel times were estimated for a.m., midday and p.m. peak periods by direction and applied to the number of passengers. A value of $10 per hour of travel time saved was used for transit passenger travel time savings.

In addition to transit passenger benefits, car driver and car passenger benefits were also estimated along the corridor. In the case of car drivers and passengers traveling on Douglas Street, they were assumed to realize the same benefit that the transit riders realized. However, for car drivers and passengers on cross-streets, there is a potential disbenefit as a result of granting more green time to Douglas Street, causing some delays on the cross-streets. These disbenefits were included in the analysis.

Qualitative measures of benefits to bike riders and pedestrians were also assessed. Benefits to bike riders were assumed to be realized for the alternatives which involved provision of bike lane.

Pedestrians will realize benefits and disbenefits similar to auto passengers, that is pedestrians crossing streets in the same direction of travel as the transit buses will benefit from additional crossing time available, while those pedestrians crossing Douglas Street will experience a disbenefit as a result of the reduced crossing time available. Further, for the options involving construction of the busway, the curb to curb width would be widened by up to 7 metres, depending on existing turns lanes and medians, which could increase the crossing time for pedestrians, and reduce available green time for autos, transit and pedestrians on Douglas Street.

4.1.3 SOCIAL / COMMUNITY ACCOUNT

The Social / Community Account usually includes noise, aesthetics, community disruption, community severance, accessibility, obstruction of views, community intrusion and overshadowing. In this project, the physical construction will be minimal, other than the busway, which is not expected to create aesthetic issues. The following social / community factors were therefore considered:

- Property takings in order to accommodate the transit improvements and associated roadway improvements.
- Community severance to reflect the extent to which the improvement disrupts the flow of traffic within or across the corridor.
- Consistency with community plans, in this case the extent to which the improvement concepts support the Region's transportation plan.
- Visual impact to reflect both new construction and loss of visual amenities such as trees and green space.
- Bicycle and pedestrian impacts to consider availability of bicycle lanes, as well as impacts on pedestrians walking on the sidewalks and crossing the streets.

4.1.4 ECONOMIC DEVELOPMENT ACCOUNT

The Economic Development Account considers the benefits or disbenefits that affect the local, regional and provincial economies. It is not felt that any of the options would affect economic efficiency in the region. However, local economic development impacts considered include:

- Business access reflects the auto accessibility of customers to access businesses along the street, primarily impacts on left turning traffic.
- Business parking, or loss of parking in front of businesses, resulting from widening of the roadway to accommodate the busway.
- Land value reflects the potential change in property values resulting from the substantial investment and effects of significantly improved rapid transit.

4.1.5 ENVIRONMENTAL ACCOUNT

The Environmental Account includes impacts on air, land and watercourse. The impacts considered in this account include:

- Land requirements / park impacts considers loss of green space to paved areas.
- Fuel use considers the potential reduction in auto use and fuel consumption as a result of the improved transit services.
- Carbon monoxide emissions reflects the impact on air quality resulting from reduction in auto use through improved transit services, thus achieving reductions in greenhouse gas emissions.

4.1.6 LIFE CYCLE BENEFITS AND COSTS

In computing the quantitative benefits over the life of the improvements, such as travel time savings and transit operator savings, and comparing these to capital and operating costs, net present value methods were used to convert annual benefits and costs over the 10 year life of the improvements to net present values. A discount rate of 6% per annum was used for calculating discounted net present values. This rate is similar to discount rates used in other major transit investment projects. All costs and benefits are expressed in current (2005) values.

4.2 Results of Multiple Account Evaluation

The multiple account evaluation of each of the transit improvements is summarized in Exhibit 4.1 and described following. The quantitative benefits and costs are compared to the base or 'do nothing' condition, which is the continuation of the current operations. Incremental benefits and costs are presented to show the additional net benefit achieved through additional capital investment.

Exhibit 4.1 Douglas St Transit Improvement Multiple Account Evaluation Summary

Account	Scenario	Scenario 1 Operations Improvements	Scenario 2 TSP-Passive Priority	Scenario 3 TSP-Active Priority	Scenario 4 Busway	Scenario 5 Busway + Active TSP
Financial Account						
	Capital Cost(PV)	$800,000	$2,058,000	$2,938,000	$5,370,500	$6,250,500
	Annual maintenance(PV)	$362,695	$933,032	$1,331,996	$2,434,815	$2,833,779
	Life Cycle Cost(PV)	$1,162,695	$2,991,032	$4,269,996	$7,805,315	$9,084,279
	Incremental Cost	$1,162,695	$1,828,337	$1,278,964	$3,535,319	$1,278,964
Customer Service						
	Travel Time(PV)	$3,014,020	$5,123,728	$8,099,101	$10,594,110	$12,632,547
	Transit Operating Cost(PV)	$8,293,999	$13,695,130	$21,986,161	$28,749,322	$34,140,981
	Total	$11,308,019	$18,818,859	$30,085,262	$39,343,431	$46,773,528
	Incremental Benefit	$11,308,019	$7,510,840	$11,266,403	$9,258,170	$7,430,097
	Net Benefit	$10,145,324	$15,827,826	$25,815,265	$31,538,116	$37,689,248
	Benefit Cost Ratio	9.7	6.3	7.0	5.0	5.1
	Incremental Net Benefit	$10,145,324	$5,682,502	$9,987,439	$5,722,851	$6,151,132
Social/Community						
	Property Takings	No Impact	No Impact	No Impact	Potential Impact	Potential Impact
	Community Severance	No Impact	No Impact	No Impact	Small Disbenefit	Small Disbenefit
	Community Plans Comaptibility	Little Benefit	Some Benefit	Good Benefit	High Benefit	Highest Benefit
	Visual Impact	No Impact	No Impact	No Impact	Some Loss of Medians & Boulevards	Some Loss of Medians & Boulevards
	Bicycle & Pedestrian Impacts	No Impact	No Impact	No Impact	Benefit to Bicyclists, Disbenefit to Peds	Benefit to Bicyclists, Disbenefit to Peds
Economic Development						
	Business Access	No Impact	No Impact	No Impact	Disbenefit Due to Left Turn restrictions	Disbenefit Due to Left Turn restrictions
	Business Parking	No Impact	No Impact	No Impact	Some Loss of Parking	Some Loss of Parking
	Land Value	Little Benefit	Some Benefit	Good Benefit	High Benefit Due to Transit Statement	High Benefit Due to Transit Statement
Environmental						
	Land Requirements/Park Impacts	No Impact	No Impact	No Impact	Some Tree Loss & Land Take	Some Tree Loss & Land Take
	Fuel Use	Little Benefit	Some Benefit	Good Benefit	High Benefit	Highest Benefit
	CO Emmisions	Little Benefit	Some Benefit	Good Benefit	High Benefit	Highest Benefit

4.2.1 SCENARIO 1: TRANSIT OPERATIONS IMPROVEMENTS

This scenario includes operational improvements, that is elimination of some transit stops and timing points, and implementation of all door loading at selected locations, as well upgraded shelters and a marketing program to promote the new rapid bus service.

This option will involve an investment of $800,000 and yield significant user travel time benefits and operator cost savings. The net benefit of this improvement over 10 years is $10 million, and yields a benefit cost ratio of 9.7. Other benefits and disbenefits associated with the other accounts are relatively minor.

This improvement should be pursued as a first priority.

4.2.2 SCENARIO 2: TRANSIT OPERATIONS AND CENTRAL TRAFFIC CONTROL SYSTEM

This scenario assumes that, in addition to the Scenario 1 Operations Improvements, the centralized traffic signal control system will be installed to provide improved traffic signal coordination on Douglas, and be responsive to changing travel patterns throughout the day and throughout the week.

This scenario will involve an additional investment of approximately $1.2 million for the traffic control system. The customer service benefits are significant in terms of travel time savings ($5.1 million), transit operating cost savings ($13.7 million), such that the net benefit is $16 million, and the benefit cost ratio is 6.3.

The incremental benefit relative to Scenario 1 is also significant, providing an additional $5.7 million of net benefit after cost.

The benefits associated with the other accounts are marginally improved relative to Scenario 1.

4.2.3 SCENARIO 3: TRANSIT OPERATIONS, CENTRAL TRAFFIC CONTROL AND ACTIVE TRANSIT PRIORITY

This scenario includes the operations improvements and centralized traffic signal control in Scenarios 1 and 2 described above, as well as active transit priority for each of the rapid buses at each of the traffic signals on Douglas Street and Highway 1 through the study section.

This scenario involves an additional $880,000 capital investment in transit priority equipment and installation, additional $200,000 for maintenance over 10 years less salvage value, for a total of $4.2 million in life cycle costs.

Customer service benefits are significant. User travel time savings are estimated to be $8 million over 10 years, while transit operating cost savings are estimated to be $25.8 million, for a total of $30 million benefits over 10 years. The net benefit after costs is $27.7 million, and the benefit cost ratio is 7.0. The additional incremental net benefit relative to Scenario 2 is $10 million.

In addition to the substantial benefits to users, additional social / community, economic and environmental benefits are expected to be realized. These include:

- Community plans benefit, since the transit system improvements is consistent with the Region's long term rapid transit plan.
- This scenario is a step towards implementing the Region's rapid transit plan, which in turn will likely yield an increase in land values along the corridor resulting from a significant commitment towards rapid transit.
- Environmental benefits in terms of reduced fuel consumption and reduced greenhouse gas emissions will result from higher transit usage which this scenario will encourage.

The high net benefits resulting from this scenario are significant, while total capital costs are within the $3 million available budget.

Scenarios 1, 2 and 3 together should be pursued as Phase 1 of the transit improvement project.

4.2.4 SCENARIO 4: TRANSIT OPERATIONS, CENTRAL TRAFFIC CONTROL AND BUSWAY

This scenario involves construction of the busway between Harold Street and Saanich Road for an expenditure of $3.3 million. This is in addition to the operational improvements and the centralized traffic control system improvements, all of which together will involve an expenditure of $5.4 million. The expenditure for the active transit priority system is not included in this scenario. The total life cycle costs of this scenario are $7.8 million.

The customer service benefits are higher than the benefits associated with the previous alternatives, as is the net benefit which amounts to $32 million over the 10 year period. The benefit cost ratio is estimated to be 5.0. The incremental net benefit is $5.7 million additional to Scenario 3.

The social / community, economic development and environmental impacts are more significant in this alternative, due to the physical construction of the busway in the median and the positive, as well as the negative impacts of this. These impacts include:

Positive Benefits Include:

- The busway, as well as the bike lanes, are most consistent with the regional plan for rapid transit in this corridor.
- There will be positive benefits to bicyclists as a result of provision of the bike lane, but some disbenefit to pedestrians as a result of widening the street which increases walking distance for pedestrians crossing the street.
- Businesses will likely realize a significant land value increase as construction of the busway is a clear commitment to transit in the corridor.
- There will be significant benefits accruing to the environment as a result of increased transit usage and reduced auto usage, reducing fuel consumption and greenhouse gas emissions.

Negative Benefits Include:

- Although the current conceptual design of the busway is designed to minimize property impacts, there may be some minor property conflicts in order to accommodate the busway as well as the bike lanes, walks and boulevards in areas where left turn lanes need to be maintained.
- There is some negative community severance impact as general purpose vehicles, as well as pedestrians, would not be permitted to cross the busway except at signalized intersections.
- There will be some negative visual impacts due to loss of boulevards and trees in order to widen the roadway to accommodate the busway and bike lanes, as well as maintain two lanes in each direction and turn lanes.
- There will be some disbenefit to businesses as a result of the potential left turn restrictions at some streets, unless left turn lanes can be constructed which will then have property impacts as described above.
- There will be some loss of on street parking due to the widening of the roadway in order to maintain two travel lanes in each direction.

There will be some loss of green space and trees as a result of the road widening, requiring a program of tree replacement, which is included in the cost.

This alternative clearly provides significant quantitative and qualitative benefits, but involves greater expenditure than is currently available, and will require comprehensive stakeholder consultation to minimize negative impacts on businesses. This scenario should be considered for later implementation as part of Phase 2 for the transit priority project. The process of preparing designs which mitigate negative impacts and then reviewing these with stakeholders should commence as part of Phase 1.

4.2.5 SCENARIO 5: BUSWAY AND ACTIVE TRAFFIC SIGNAL PRIORITY

This scenario involves the construction of the busway and bike lanes as described in Scenario 4, as well as implementation of the active traffic signal priority, providing transit priority systems at each signalized intersection and for the designated rapid bus fleet, as described in Scenario 3.

This scenario involves an additional expenditure of approximately $880,000 for the transit priority system relative to Scenario 4, but yields a benefit / cost ratio of 5.1 and an additional net benefit of $6.1 million, clearly justifying the additional investment.

The qualitative benefits and disbenefits are similar to Scenario 4, yielding marginally higher positive benefits for Community Plans Compatibility and for positive environmental impacts due to the higher transit usage and lower auto usage that this scenario will likely yield.

In the design of the active traffic signal priority system in Phase 1, the system should be designed to facilitate Phase 2 construction of the busway system with minimal loss of Phase 1 investment.

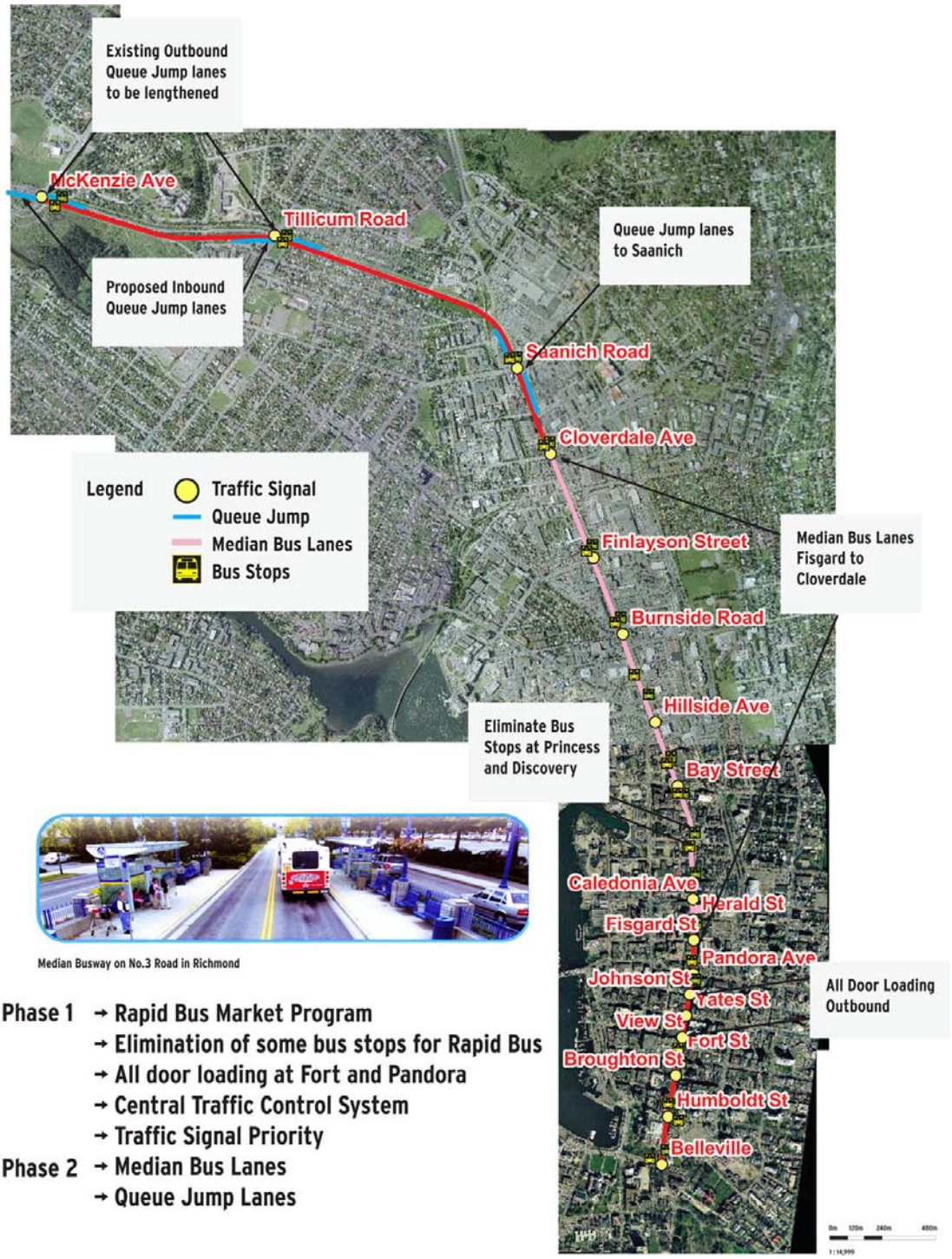
5. SUMMARY OF MAE EVALUATION

This analysis has demonstrated that Scenarios 1 – 3, Transit Operations, Centralized Traffic Control System and Active Signal Priority, yield very high net benefits, for a total capital investment of $2.94 million. In addition to the financial benefits, these improvements yield social/community, economic and environmental benefits to society. It is recommended that these improvements be implemented immediately, and that work be underway and contracts awarded prior to March 31, 2006, in order to quality for the federal/provincial grant.

Construction of the busway will require a further investment of approximately $3.3 million plus any land costs. This improvement will yield significant additional travel time benefits to the users amounting to $5.7 million, as well as additional benefits to the community in terms of social, economic and environmental benefits associated with the much improved rapid bus system. The issues with respect to business impacts and impacts on green spaces, should be examined in more detail and designs prepared to mitigate the impacts. Then a public consultation program to solicit input from all affected stakeholders prior to finalizing the busway design should be carried out. This investigation of the busway option should commence during the Phase 1 program.

The recommended transit priority improvements are shown in Exhibit 5.1.

Exhibit 5.1 Recommended Transit Priority Improvements



Median Busway on No.3 Road in Richmond

Phase 1 → Rapid Bus Market Program
→ Elimination of some bus stops for Rapid Bus
→ All door loading at Fort and Pandora
→ Central Traffic Control System
→ Traffic Signal Priority

Phase 2 → Median Bus Lanes
→ Queue Jump Lanes

APPENDIX A

BUSWAY PRELIMINARY DESIGN