



**Sound Transit Long-Range Plan Update  
Issue Paper E.1.S.2: Rail Convertible Bus Rapid  
Transit (RC BRT) : Supplement to Issue Paper  
E.1: I-90/East King County HCT Analysis**

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## Foreword

This supplemental issue paper provides additional information and analysis about the mode choice for high capacity transit (HCT) in the I-90/East King County Corridor. It continues the format of the series of reports that were used to inform the Sound Transit Board prior to its adoption of the Regional Transit Long-Range Plan (July, 2005). Like those prior reports, this supplemental issue paper provides additional information about a specific element or area of the Long-Range Plan, focusing on issues such as costs, ridership, engineering feasibility and operations.

The environmental impacts of the updated Long-Range Plan and Options, as well as potential mitigation measures, were examined in the Final Supplemental EIS for the Regional Transit Long-Range Plan (June 2005) (“2005 SEIS”). The 2005 SEIS supplements the 1993 EIS prepared on the Regional Transit System Plan and updates relevant information and analysis through the year 2030.

The information in this supplemental issue paper does not substantially change the analysis of significant impacts and alternatives contained in the 2005 SEIS. Additional environmental analysis will be prepared before the Sound Transit Board makes project-specific decisions on routes, locations, facilities, operating characteristics and related matters.

# 1. Introduction

Sound Transit's current Long-Range Plan includes additional High-Capacity Transit (HCT) development along the I-90 corridor between downtown Seattle and the Eastside. In March 2005, Sound Transit prepared an issue paper entitled "*Issue Paper E.1: I-90 Corridor/East King County High Capacity Transit Analysis*," that evaluated and compared different high-capacity transit technologies to address the long-term mobility needs in the I-90 corridor between Seattle and Bellevue. The analysis also included an assessment of HCT along three branches from Bellevue extending to Kirkland, Redmond, and Issaquah. As part of the March 2005 issue paper, the following different technologies were assessed: HOV/Bus Rapid Transit (BRT), Busway/BRT, Light Rail (LRT), Monorail, and Rail-Convertible BRT (RC BRT).

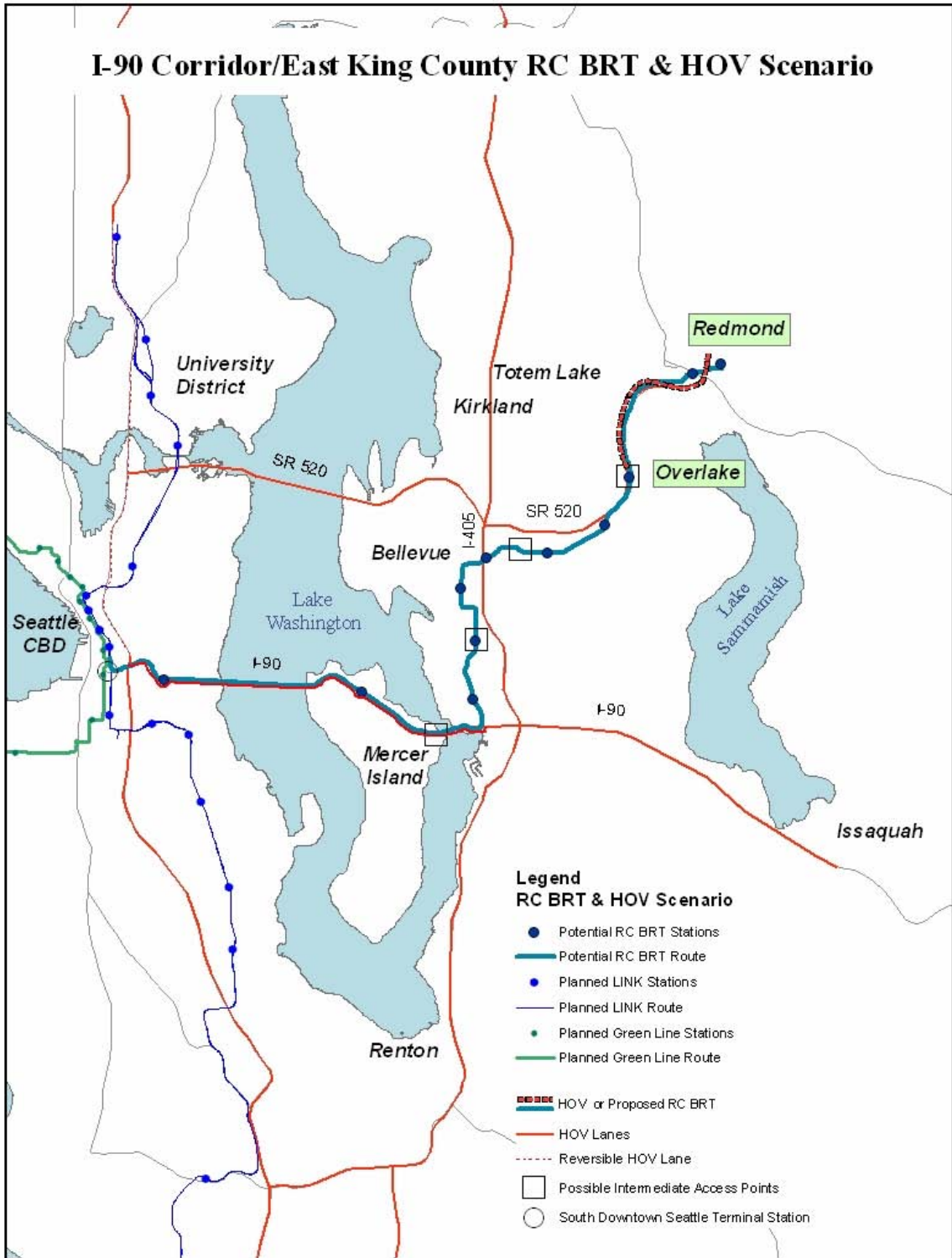
The outcome of the Sound Transit Board review of Issue Paper E.1 was direction to develop various scenarios that combined the best features of two technologies (BRT and Light Rail) and to carry out an objective comparison between the scenarios. A portion of this analysis, an LRT/HOV hybrid, was presented in a supplemental report to Issue Paper E.1, *Issue Paper E.1.S: Hybrid Scenarios Supplement to Issue Paper E.1: I-90/East King County HCT Analysis*, May 2005.

Figure 1 illustrates the RC BRT scenario.

Following the Board's adoption of the Long-Range Plan in July 2005, Sound Transit staff further refined a representative alignment for the light rail and rail convertible BRT systems between Seattle and Redmond. This work was consistent with the Board's decision in the Long-Range Plan to narrow the modal choice to these two options. The comparison of capital and operating costs of LRT and RC BRT will be available in late 2005. For that reason, this paper does not include cost information.

In addition, following adoption of the Long-Range Plan, Sound Transit staff further updated its long-range ridership forecasting model for use in the development of ST2. Ridership estimates will also be available in late 2005.

This paper (1) describes the assumptions of the RC BRT system that have been developed, (2) summarizes key findings, and (3) describes the issues to be considered for conversion of the bus guideway to light rail.



**Figure 1. East King County RC BRT / HOV Scenario**

## 2. Assumptions Underlying the Rail Convertible BRT (RC BRT) option

- **Alignment – Rail convertibility assumes the same alignment for the RC BRT system as the LRT option.** Both options will be analyzed and costed with identical alignments. This alignment is representative only to permit side-by-side comparison; the alignment identified for analysis does not presume that an alignment decision has been made. Project-level work will begin after the Sound Transit Board decides on a preferred transit mode (RC BRT or LRT), in order to develop and evaluate alternative alignments. A final alignment will not be selected until after completion of project-level environmental review.
- **Supporting Bus Service – Buses that feed the RC BRT and LRT options operate in the same manner.** Neither of the options will force transfers onto the RC BRT or LRT system when there are better alternative direct routings for buses. For example, buses serving the University District and downtown Seattle from the north I-405 corridor are assumed to use the SR 520 bridge as they currently operate. Riders are not forced to transfer onto the proposed LRT or RC BRT system. The same is true for the buses traveling between Issaquah and Seattle and Renton and Seattle.
- **Both options will feature a bus or train traveling exclusively on the guideway from end to end, with no interference from other vehicles.** The RC BRT system will operate exactly like a train in the LRT option. The RC BRT system is assumed not to have intermediate access points along the guideway that permit local buses to enter and leave the guideway. Although these access points could be provided (see below), when the RC BRT system is converted to LRT these access points would no longer be needed and would therefore become abandoned investments. Omitting these access points from the analysis will minimize the costs of the RC BRT system. Nevertheless, four possible intermediate access points are described for consideration in this paper.
- **The RC BRT option will terminate at a transfer station in the south end of the Seattle CBD and not travel through the downtown tunnel because the tunnel is expected to be used exclusively by rail.** This paper assumes the LRT system is extended to Northgate over the long term and subsequent train frequencies increase, precluding use of the Downtown Seattle Transit Tunnel by buses. An I-90 RC BRT system would therefore require riders to transfer at a new transfer station located south of the International District Station, and riders would complete their journey into downtown Seattle via light rail or surface buses. When the RC BRT system is converted to LRT, this transfer facility would no longer be needed and would be removed.
- **Design – Rail convertibility assumes the BRT system is engineered and built to LRT design standards.** This assumes the RC BRT guideway is built with curves and grades suitable for trains, and that station platforms will accommodate four-car train lengths.

### 3. Key Findings

- Converting the RC BRT facility to LRT would require shutting down all parts of the guideway for a substantial period of time in order to complete conversion. The length of time required for conversion will vary depending on the scope of the initial investment. For example, the conversion period could be reduced if significant light rail infrastructure was included in the initial construction although this would increase the initial capital costs.
- During the conversion period, bus services would use alternative routes. City arterials would need to be identified for this alternative service operation and will likely require mitigation measures to be instituted similar to the measures completed in downtown Seattle prior to closing the Downtown Seattle Transit Tunnel. On the I-90 floating bridge, bus services could operate on the HOV lanes to be developed on the outer roadway under the I-90 Two-Way Transit and HOV operations project.
- Based on the initial analysis in March 2005, the capital cost for the RC BRT guideway and the LRT guideway is relatively close. However the cost of the RC BRT guideway is dependant on the extent of rail system infrastructure included in the initial RC BRT guideway construction. This also determines the amount of subsequent work needed and the cost required to convert the guideway to LRT operations. Updated analysis of capital and operating costs will be available in late 2005
- *I-90 Traffic Impacts:* As per the Issue Paper E.1, March 2005 and Issue Paper E.1.S, May 2005, both RC BRT and LRT will convert the reversible center lanes to a two-way transit-only system, displacing HOV and Mercer Island traffic to the outer roadway. This would increase the people-moving capacity of the center roadway. This change will result in travel times of about 9-13 minutes between the East Channel Bridge on Mercer Island and Rainier Avenue South in Seattle for general purpose traffic, which is similar to current conditions before implementing an HOV lane in each direction along the outer roadways under the I-90 Two-Way Transit and HOV Operations project.
- *Seattle Street Impacts:* For both RC BRT and LRT options, there would be a decrease of approximately 46 buses/hour (-8.7%) from the Future Baseline condition using the local street network. (Note: The Future Baseline Scenario includes the region's existing transportation system, all projects included in Sound Transit's *Sound Move* Phase 1 plan, and WSDOT projects with committed funding. Please refer to Sound Transit Long-Range Plan Update - *Issue Paper E.1: I-90/East King County High Capacity Transit Analysis* for additional information.) A total of 485 peak hour two-direction bus trips are expected to downtown Seattle. To maintain the decrease in buses under the RC BRT scenario, a transfer station in the Seattle CBD would be required until operations are converted to LRT.
- *Bellevue Street Impacts:* For both RC BRT and LRT options there would be a decrease of approximately 14 buses/hour (-11.2%) from the Future Baseline

condition using the local street network. A total of 111 peak hour trips thorough the Bellevue Transit Center is expected.

- The March 2005 analysis indicated that both RC BRT and LRT scenarios are projected to have the highest ridership on the I-90 bridge between downtown Bellevue and downtown Seattle.
- At the time of this report, there is no known example of a corridor-long conversion from BRT to LRT operations. The closest example is the conversion of the Downtown Seattle Transit Tunnel that is now underway.
- The LRT scenario would be interlined through the Downtown Seattle Transit Tunnel, which means there would be a one-seat ride with no transfers for eastside riders traveling to north Seattle. The RC BRT option requires all bus riders to transfer at a transfer facility located immediately south of the International District Station.
- The transfer required as part of the RC BRT scenario, in part, explains the differences in travel times and ridership between LRT and RC BRT. As indicated in the March 2005 analysis, LRT is expected to have faster travel times and higher ridership than RC BRT. Additional ridership forecasts and travel time information will be available in late 2005.
- The station platform configurations will be established to accommodate LRT requirements. It is envisioned that the LRT system will include both side platform and center platform designs, depending on the location. To avoid platform reconstruction or reconfiguration, it will be necessary to purchase buses with doors on both the right and the left-hand side. These buses will be a special vehicle order.

## 4. Rail-Convertible BRT (RC BRT) Issues

To provide additional information to the Sound Transit Board and other stakeholders, the Board requested that staff further evaluated RC BRT, especially in regard to the following issues:

- Exploration of added intermediate access points to the RC BRT guideway;
- Estimation of how long the conversion from BRT to LRT operation would take;
- Identification of potential impacts during the construction period required to convert the system infrastructure from RC BRT to LRT operation;
- Identification of key issues that differentiate this option from others under consideration; and
- Estimation of the approximate capital cost of conversion from RC BRT to LRT.

The following sections explain the findings of the analysis of the first four items. The last item regarding cost will be described later this year.

### 4.1 Access to the Transit-Only Guideway

The RC BRT system assumes no access points to the transit-only guideway from freeway or arterial general purpose lanes or the HOV lanes in order to maintain service speed and reliability, and to replicate the service attributes of LRT. This means that there are no direct access ramps in the system that would have to be abandoned after conversion to LRT. A BRT service similar to an LRT system can be achieved by minimizing the opportunities for disruption to the BRT system. For this analysis it was assumed that this could be achieved by not allowing buses operating on the transit-only facility to continue beyond the RC BRT corridor and not allowing mid-point connections from the freeway or local road network along the alignment. However, it is a policy decision as to whether this assumption should stand or be changed.

For the purpose of this analysis, the RC BRT scenario was assumed to operate in a similar manner to the LRT scenario discussed in *Issue Paper E.I.S.* Buses utilizing the RC BRT transit-only facility would terminate at a transfer station located immediately south of the International District Station (the western end of the alignment) and either at Overlake Transit Center or Redmond. Buses utilizing the facility would serve the stations on the alignment from Seattle to Overlake and/or Redmond. Mid-point connections to this alignment for riders using local buses would require transferring at a station location.

There are a limited number of intermediate access locations along the alignment where it is possible for buses to connect from the freeway or local streets. Four options are presented in this paper, however, more work needs to be undertaken to verify their actual feasibility.

### **Option 1. Eastern End of Mercer Island**

Connections on I-90 from the HOV lanes to the transit-only guideway can be made at the eastern end of Mercer Island. Following the completion of the I-90 Two-Way Transit and HOV Operations project (R8-A), a connection in the eastbound direction may be made, however reconfiguration of the R8-A eastbound connection would be required. In the westbound direction, an existing slip ramp would be available for connection to the added outer roadway westbound HOV lanes to serve buses from Issaquah. Further investigation is required to determine if the westbound connection can be enforced for transit-only vehicles.

### **Option 2. Wilburton Station (SE 8<sup>th</sup> Street/Bellevue Way Intersection)**

A connection would be possible in the vicinity of the Wilburton Station. This connection would require an aerial structure on SE 8<sup>th</sup> Street, creating an aerial “T” intersection with the transit-only guideway aligned along 112<sup>th</sup> Avenue SE. This connection could serve buses from Totem Lake that run on the HOV lanes along I-405. These buses would depart/connect to I-405 using the existing ramps at the I-405/SE 8<sup>th</sup> Street interchange. However, this connection is not warranted based on the proposed service plan since buses from Totem Lake would use the SR 520 bridge to connect with Seattle and not the I-90 bridge. Construction of this option is feasible; however, costs incurred for this option would be abandoned upon conversion to LRT.

### **Option 3. East of Overlake Hospital (via 124<sup>th</sup> Avenue NE)**

A connection is possible at 124<sup>th</sup> Avenue NE, east of the proposed Overlake Hospital Station. Buses on the I-405 HOV lanes could use the existing I-405/SR 520 interchange to leave I-405, connect to SR 520 and then connect to 124<sup>th</sup> Avenue NE via the existing ramps from SR 520. Buses would travel along 124<sup>th</sup> Avenue NE to a new bus-only, at-grade facility that would provide a connection to the transit-only guideway in the vicinity east of the proposed Overlake Hospital Station. This connection would occur where the transit-only guideway is at grade (possibly near the proposed maintenance yard access). It was assumed that this connection occurs within the City of Bellevue’s proposed transportation corridor. Due to the steep grade along 124<sup>th</sup> Avenue NE there is a possibility that road maintenance requirements on 124<sup>th</sup> Avenue NE would increase. This connection could serve buses to and from Totem Lake. However, as discussed above, buses from Totem Lake would use the SR 520 bridge under the assumed service plan.

### **Option 4. Overlake Transit Center (Intersection of NE 40<sup>th</sup> St/SR 520)**

A connection is possible in the vicinity of the Overlake Transit Center near the intersection of NE 40<sup>th</sup> Street and SR 520. The existing bridge carrying NE 40<sup>th</sup> Street over SR 520 could be rebuilt to include a bus access ramp from the eastern end

of the structure connecting to the aerial station proposed for the transit-only guideway at Overlake Transit Center.

Option 1 provides a direct access to the RC BRT guideway. A reconfiguration of the existing eastbound connection would require WSDOT approval and further work is needed to determine if the westbound connection can be enforced for transit-only vehicles.

Options 2 and 3 provide connections to the transit-exclusive guideway for buses from Totem Lake. However, the optimal route for these buses is to use the SR 520 bridge to connect to downtown Seattle. The current and the proposed service plans both assume that buses from Totem Lake would take advantage of the likely HOV lanes across the SR 520 bridge. Buses utilizing the exclusive guideway are required to transfer at a terminal station in the vicinity of the International District Station, while buses utilizing the SR 520 bridge would have a direct route to downtown Seattle.

Option 2 may require constructing a transit-only direct access ramp from I-405 at SE 8th Street, which would then connect to an aerial guideway structure along or within the SE 8th Street right-of-way. This option would considerably impact SE 8th Street and the surrounding area due to the need for an elevated guideway and connection to the proposed Wilburton Station. Option 3 would require buses to travel through the I-405/SR 520 interchange using the existing ramp system and then operate on 124th Avenue NE to access the proposed RC BRT guideway.

Based on this preliminary analysis, Option 1 and 4 appear to provide the most feasible access point to the transit-only guideway under the RC BRT alternative.

## **4.2 Conversion from RC BRT to LRT Operations**

Converting the RC BRT system to LRT operations will take time, disrupt transit service and affect the performance of nearby roadways.

The extent of the rail infrastructure installed during the RC BRT guideway construction, whether or not the system is at grade, on elevated structure, or in a tunnel and how easy it is to access the guideway and work sites all influence how the rail and supporting infrastructure could be installed during the conversion process. How the LRT conversion project is procured and delivered and whether the contractor is required to maintain access to sections of the guideway for bus operations are additional key issues that influence the duration and amount of disturbance to transit services and adjacent road facilities.

The amount of disruption to the operating BRT transit system during conversion would vary greatly depending on the level of service made available during the conversion period. If the entire alignment is closed, the time and cost to convert is reduced since the contractor carrying out the conversion has complete flexibility in staging the conversion work. It would also allow work to be carried out in several areas along the alignment at the one time. However, the transit system would be redirected to the local streets for the

duration of the conversion process. Partial or staged shutdown of the alignment would result in areas of the alignment still being available for transit use. Sound Transit would need to make a policy decision on service levels during the design stage of the BRT system.

To minimize the conversion time, rail and all ducting for the rail systems (except for the floating bridge segment) would need to be installed during the initial RC BRT guideway construction. Rail would not be installed in the floating bridge segment, because raised rail on the bridge deck would be incompatible with BRT operations. The decision to build light rail systems into the initial construction of the RC BRT guideway should consider the substantial time required to procure and test light rail vehicles prior to operation. If rail infrastructure and systems are included in the RC BRT phase, this will increase the initial capital cost of the RC BRT option. There is a direct tradeoff between the initial capital costs for the RC BRT guideway and the duration of disruption to convert to LRT. This issue also poses a policy issue for the Sound Transit Board.

The length of time between when the RC BRT infrastructure is built and when the system is converted to LRT could be substantial, and within this timeframe, various design codes and vehicle requirements could change. These changes may result in unforeseen costs and delays.

The impacts on the transit network and the local road network that would result from moving buses from the BRT infrastructure onto the local street varies depending on how the conversion process is implemented and the level of service maintained during conversion time.

There is limited opportunity for phased construction of the I-90 corridor between Seattle CBD and Bellevue. The alignment on the existing I-90 bridge would use the reversible express lanes (separate from the general traffic lanes) which are located within a constrained ROW and access to the proposed aerial structure from I-90 to South Bellevue Way is limited. The implementation of the I-90 Two-Way Transit and HOV Operations project would establish new HOV lanes on the outer roadways, but the center roadways would be unavailable for transit service during conversion. These constraints mean that it is not possible for buses using the general purpose lanes on I-90 to safely connect to the RC BRT guideway (or vice versa) during construction to enable staged construction for the conversion process. The nonstandard access from the RC BRT guideway to the future outer roadway HOV lanes discussed above as *Option 1: Eastern End of Mercer Island* could only be used for buses connecting to Issaquah as the HOV lane connection to Bellevue Way would be removed once the transit-exclusive guideway is constructed.

The following assumptions have been made for the purpose of investigation into convertibility of RC BRT to LRT:

- Rail and system installation would not occur within the RC BRT guideway construction phase. Guideway infrastructure (drainage, walkways, structural components etc) constructed during the RC BRT phase would facilitate

- installation of future LRT components, ducting, catenary pole footings and stray current protection (excluding the stray current protection associated with the rail);
- The RC BRT guideway would be closed to transit operations for the duration of the conversion process;
  - Three work sites along the alignment of approximately two acres each would be required for storage of construction equipment during conversion;
  - Surface street upgrades associated with the conversion would be needed;
  - There would be an increase in bus service hours during conversion due to slower bus operations utilizing the local road network. An interim service plan would need to be developed for use during the conversion process;
  - Rail installation for LRT on the I-90 floating bridge can only be constructed during the conversion period. Raised rail is directly fixed on the surface of the bridge deck without the concrete poured in between that would provide a smooth surface for use by buses during the pre-conversion period;
  - Station platforms for LRT operations would be constructed as part of the RC BRT construction since stations along the alignment would include both center and side platform configurations. Buses with doors on both the left and the right side of the vehicle would be required to accommodate bus operations on the transit only guideway. These buses would be a special fleet purchase;
  - LRT vehicle procurement, delivery, testing and acceptance could be achieved during the conversion period. If a shortened conversion period is required, it would be necessary to start LRT vehicle procurement prior to the conversion process;
  - Fire/Life Safety systems and Ventilation facilities constructed in the initial RC BRT phase would have to accommodate the more stringent design criteria for both bus and light rail operations;
  - The bus maintenance facility constructed as part of the RC BRT phase would be a suitable size for converting to LRT operations. Bus maintenance would still be required during the conversion period.