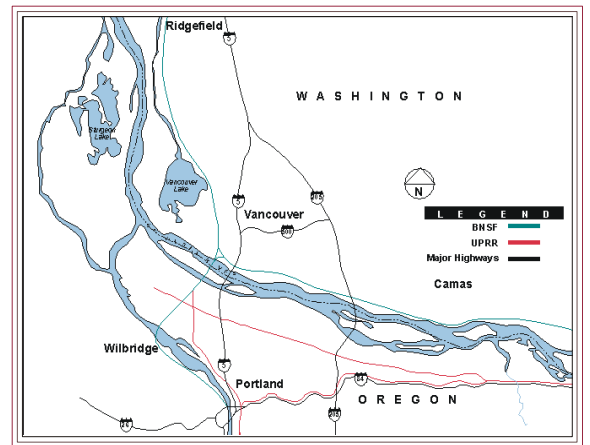


# Commuter Rail Feasibility Study

May, 1999





**Southwest Washington  
Regional Transportation Council**

Commuter Rail Feasibility Study

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May 1999

*Prepared by*

**HDR Engineering, Inc.  
BRW, Inc.**

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# 1. Executive Summary

This study was prepared for the Southwest Washington Regional Transportation Council (RTC) to evaluate the feasibility of operating a commuter rail system between Clark County, Washington and Portland, Oregon. The study focused on the level of commuter rail service, if any, which could be accommodated on the Burlington Northern and Santa Fe (BNSF) Railroad's existing local track system.

## *a. Background*

The Commuter Rail Feasibility Study was initiated as a result of the findings contained in a report by the Transportation Futures Committee. In their assessment of bi-state transportation options, the Committee conducted a preliminary review of the issues associated with the development of commuter rail service between Vancouver and the Portland metropolitan area. The Committee identified commuter rail as a potential low cost option for improving bi-state mobility in the I-5 corridor and determined that it should be studied further.

The purpose of the Commuter Rail Study was to determine the feasibility of commuter service between Vancouver and Portland. The primary focus of the study was a detailed operational analysis to evaluate and identify the capital improvements needed to accommodate both freight and passenger rail service, including an estimate of the capital and operating costs of providing a commuter rail service.

A workshop on this subject was held in November 1997 that resulted in the development of a number of key components of the operating plan for the concept commuter rail system. Workshop participants determined that the service should travel along two lines, one between Rye and Portland's Union Station, and the other between Fisher's Landing and Union Station. In addition to utilizing the Amtrak stations at Vancouver depot and Union Station for commuter rail service, four new station sites were identified: at Andresen Road, Fisher's Landing, Rye and Rye Junction. Workshop participants recommended the following three service alternatives for further analysis:

Low Service - AM and PM peak period service; eight train starts in a single corridor between Rye on the Lewis and Clark Railroad, and Rye Junction to Union Station on the BNSF Railroad.

Medium Service - AM and PM peak period service; 14 train starts in two corridors; six between Rye Station and Union Station, and eight in an additional corridor between 164<sup>th</sup> Avenue and Union Station. The second route includes two "non-revenue" runs between a train storage facility on the Lewis and Clark Railroad and the 164<sup>th</sup> Street terminus on the BNSF Railroad.

High Service - AM and PM peak period service; 22 train starts in two corridors; 10 between Rye Station and Union Station, and 12 between 164<sup>th</sup> Avenue and Union Station. The second route includes two "non-revenue" runs between a train storage facility on the Lewis and Clark line and the 164<sup>th</sup> Street terminus on the BNSF Railroad.

Table 1 summarizes the trips undertaken for each of the service levels.

<b>Table 1- All Day Peak Direction Trips by Service Alternative</b>		
<b>Service</b>	<b>Between Rye and Union Station</b>	<b>Between Fisher's Landing and Union Station</b>
<b>Low Alternative</b>	6	0
<b>Medium Alternative</b>	4	4
<b>High Alternative</b>	6	6

Based on the operating plan developed during the workshop, and the three alternative levels of service developed for this study, the project team and analysts from the BNSF tested the impacts and requirements of a concept commuter rail service on the local railroad system. Analysts examined the impacts to existing freight and passenger service, as well impacts based on projected growth by 2003 and 2018.

**b. Findings**

The proposed service levels were tested to see if they would allow all committed freight and passenger services to operate within a 24 hour period. Specifically, would delays from one day impact the next day's traffic? All of the alternative service levels were found to result in unacceptable train traffic delays by 2003. With relatively minor capacity improvements as mitigation, the "low" and "medium" service levels were found to operate with projected rail freight operations at acceptable levels of delay in 2003, however, by the years 2013 and 2018 available capacity improvements to the existing track would be insufficient to mitigate the impacts of the medium and low service levels respectively.

To provide commuter rail service at the "high" service level in 2003, and for all of the alternative levels beyond 2013, a dedicated track alignment for passenger rail traffic would be required. This dedicated alignment would separate passenger traffic from conflicts with freight, and would greatly increase the ability of the system to handle intercity passenger traffic and increasing freight needs. Infrastructure and operating costs required under the 2003 "low" and "medium" service alternatives, as well as the cost of the dedicated alignment required for all of the alternatives by 2013, are shown in Table 2. In addition to capacity improvements within the mainline corridor, the figures presented in Table 2 include cost estimates for improvements necessary to open the commuter rail line. These additional costs include:

1. Construction of an improved intersection between the BNSF and the Lewis and Clark Railroad at Rye Junction.
2. Facilities associated with the station sites including parking, platforms and other improvements.
3. Improvements to the Lewis and Clark Railroad that would be required for passenger operation.

<b>Table 2: Infrastructure and Operating Costs for Concept Commuter Rail (in \$1998)</b>			
<b>Service Level</b>	<b>Infrastructure Costs<sup>1</sup></b>	<b>Operating Costs<sup>2</sup></b>	<b>Cost per Rider<sup>3</sup></b>
<b>Low Alternative<sup>4</sup></b>	\$36.6 M	\$2.7 M/ year	\$10.02
<b>Medium Alternative<sup>4</sup></b>	\$53.1 M	\$3.3 M/ year	\$11.94
<b>High Alternative<sup>5</sup></b>	\$53.1 M	\$4.1 M/ year	\$13.34
<b>Dedicated Alignment</b>	\$430 M - \$750 M	NA	NA
<sup>1.</sup> Infrastructure costs include the cost for capacity improvements, equipment, and station improvements, etc. <sup>2.</sup> Operating costs include administrative costs, insurance, wages, track and equipment maintenance, etc. <sup>3.</sup> Cost per Rider equals Operating costs/(no. riders per day x 260 working days/year) Ridership figures are 2003 forecasts. <sup>4.</sup> "Low" and "Medium" alternatives require a dedicated alignment by 2013. <sup>5.</sup> "High" alternative requires a dedicated alignment for operation in 2003 and beyond.			

**c. Recommendations**

The findings of this feasibility study indicate that development of a commuter rail system should not be pursued at this time, However, if it is determined that a major rail investment is necessary to support future intercity passenger and freight rail growth in this corridor, then the concept of a commuter rail service should be revisited

The capacity constraints in this corridor need to be discussed further, not only in the context of the concept commuter rail system, but also as they relate to the rapid growth of rail freight traffic in the corridor and plans for greatly increased intercity passenger service. This corridor is severely constrained in terms of how much growth it can support without major capital investment. The commuter rail operations, which triggered the requirement for a dedicated passenger alignment, added a relatively small number of trips to the system. Current plans for intercity passenger and freight growth could trigger the need for major capacity improvements before the 2018 horizon year. RTC called a meeting of regional stakeholders who rely on passenger and freight mobility in this corridor and began the discussion of how the region could respond to this problem. The results of this study have created the awareness of the need to initiate regional discussion about long-term rail capacity issues affecting freight and passenger needs.

## 2. Introduction

Commuter rail has been identified as a mode that could potentially improve mobility between the Vancouver and Portland metropolitan regions. The Transportation Futures Committee, a 28-member citizens committee, conducted a preliminary review of the issues associated with the provision and development of bi-state commuter rail service. The Committee identified commuter rail as having the potential to be a low cost option for improving bi-state mobility and making more effective use of transportation facilities in the I-5 corridor.

The Regional Transportation Council (RTC) initiated this Commuter Rail Feasibility Study to identify critical implementation issues for commuter rail and to present an operational and capital plan for initiation of commuter rail service. Key issues include the following: service reliability, operations, shared use with freight and intercity passenger needs, capital and operating costs, ridership, and transit service objectives. The study examined how commuter rail could be integrated with other components of the transportation system including bus service, transit centers, and park and ride facilities. The study also assessed commuter rail service as a strategy for addressing bi-state travel needs.

## 3. Study Objectives, Scope and Background

The objectives of this feasibility study were focused around the following five basic questions about a commuter rail system:

1. *Do the existing tracks provide adequate capacity for the system to operate?*
2. *What improvements must be made to the existing infrastructure to accommodate this service?*
3. *What are the capital and operating costs associated with these improvements and operations?*
4. *What level of usage could be expected on this system?*
5. *Are there any fatal flaws associated with the introduction of commuter rail service?*

In order to analyze the ability of the existing rail infrastructure to handle the capacity requirements of a commuter rail system, it was first necessary to develop an operating plan. The plan developed for this study included route, station and storage yard locations, and schedule. This plan was then tested to determine its feasibility given existing and projected activity levels for freight and passenger uses on the BNSF lines<sup>1</sup>. Because of capacity limitations on the BNSF lines, the analysis considered alternative levels of service as well as possible mitigation through infrastructure improvements targeted at increasing capacity. The system was tested with a 20-year planning horizon, providing costs, feasibility, and mitigation requirements to the year 2018.

To develop the operating plan used in the capacity analysis, RTC hosted a workshop where local agencies, ports, the BNSF, and others identified many of the essential elements of the operating plan, including the number and general location of the station sites, frequency of service, service alternatives for consideration, equipment type and number, and other

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<sup>1</sup> The BNSF refers to the trackage between the Vancouver Depot and Rye Junction as part of the BNSF Seattle Subdivision, and the trackage between the 164<sup>th</sup> Avenue station site and Union Station as part of the Fallbridge Subdivision.

commuter rail service elements. The project's Study Management Team also traveled to BNSF headquarters in Fort Worth, TX to meet with BNSF representatives to discuss the use of BNSF track for this project and to develop a coordinated approach to completing the capacity analysis. Observations of the dispatching requirements of other commuter rail systems also provided the Study Management Team with a better understanding of the special requirements of a commuter rail system.

The analyses and focus of this study have been guided by a Study Management Team, composed of affected local and regional entities including the City of Vancouver, Clark County, C-TRAN, Washington State Department of Transportation (WSDOT), and the RTC. These entities reviewed drafts of the technical memoranda, and provided direction as the project unfolded. Additional presentations to the RTC Board and the I-5 Trade Corridor Study Group and its Blue Ribbon Committee have provided further opportunities to discuss the findings of the study.

This study did not examine the potential environmental impacts of the concept system. Basic fatal flaw criteria were taken into consideration for development of the operating plan, but many elements such as the public acceptance and environmental effects of station locations and some mitigation opportunities require further analysis.

## **4. Commuter Rail Operating Plan**

To provide the BNSF with adequate information for analysis of the impacts of a commuter rail system on existing and future intercity and freight rail traffic, the operating plan developed for this study required substantial detail. Potential station sites and ridership estimates were developed for this study, however, a more detailed analysis of these and other aspects of the system would need to be undertaken if the commuter rail system is pursued further.

### ***a. Route***

As shown in Figure 1, the main corridor for the commuter rail line would be between Portland's Union Station and the Vancouver Amtrak depot. From Vancouver depot, the service would split along two routes. One route would travel north along the BNSF's Seattle Subdivision to Rye Junction (at approximately Fruit Valley Road and NW 78<sup>th</sup> Street), and then east to Rye on the Lewis and Clark Railroad. The other route would travel east on the BNSF's Fallbridge Subdivision east to a site near Fisher's Landing at 164<sup>th</sup> Avenue and the BNSF mainline. This second line would not be utilized for the lowest service level. The service would use the existing passenger facilities at both Vancouver and Portland, as well as three new stations at Rye, Andresen Road, and Fisher's Landing. A storage facility would also be provided. The route between Union Station and Rye is 17 miles long, the route between Union Station and Fisher's Landing is 19 miles long. Most commuter rail lines operate over 40 to 60 miles of track, making this line relatively short. Commuters traveling between Rye and Union Station would experience travel times of approximately 34 minutes. Travelers between Fisher's Landing and Union Station would have a travel time of approximately 40 minutes.



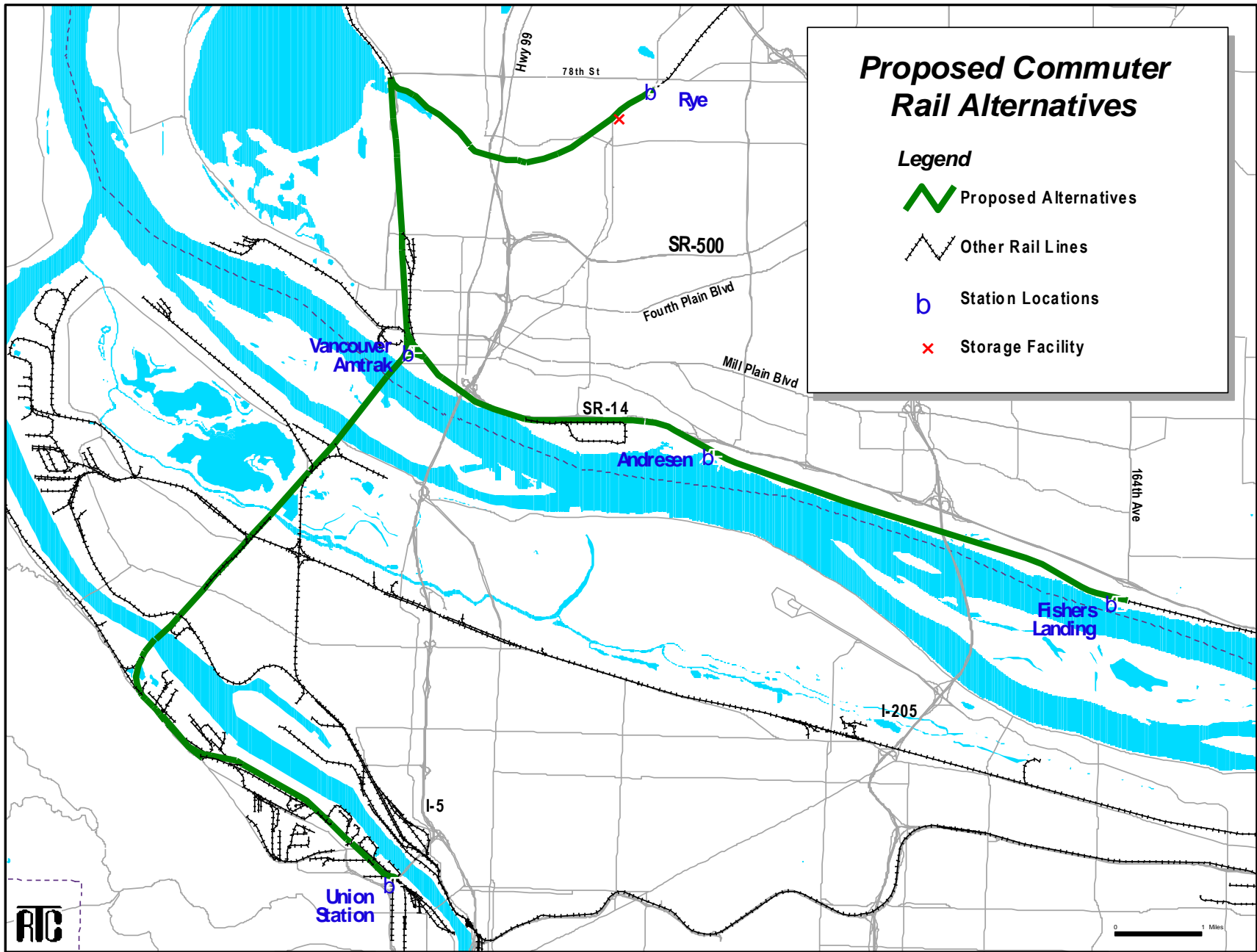


Figure 1- Commuter Rail Route Map

**b. Station Sites**

The selection of station sites was a primary component of the operating plan. While the sites located at the existing rail passenger stations were obvious choices, the three additional sites were chosen based largely on compatible zoning and the existence of relatively large undeveloped or underdeveloped parcels. Many of the station sites, including the improvements suggested for the Vancouver Amtrak Station, pose potential problems with respect to access and parking, as well as other concerns.



If a commuter rail service is pursued, these sites are not likely to be developed as stations for a number of years. In that time, site availability could change dramatically. More detailed analyses of these and other site locations would be necessary before a commuter rail line was fully implemented. The station costs include materials costs for station platforms, parking areas and other infrastructure, land acquisition costs<sup>2</sup>, and ticket vending facilities. These costs are summarized in Table 3.

**Table 3: Summary of Station Costs (in \$1998)**

Station	Cost
Rye	\$1.7 M
Fisher's Landing	\$1.0 M
Andresen	\$1.6 M
Vancouver Depot	\$1.7 M
<b>Total</b>	<b>\$6.0 M</b>

<sup>2</sup> Land acquisition costs were estimated from information provided by the Clark County Tax Assessors Office. The assessed values of these properties do not necessarily reflect their market value which could be significantly higher.

### ***c. Levels of Service***

The operating plan established for the concept system would provide peak-only service with three levels of service under consideration. As shown in Figure 2, under the “low” service alternative, eight train starts each day would provide three peak direction and one off-peak trip between the Rye station and Portland during both the morning and evening peak periods. The “medium” service alternative would expand the number of starts to 14, while at the same time dividing these starts between the Rye and Fisher’s Landing branches of the system. The “high” level of service option would provide 22 train starts each day, again serving passengers along both lines. It is important to note that even the high level of service proposed for this study would provide relatively few trips compared to other comparable commuter rail lines. The West Coast Express in Vancouver, British Columbia, examined for comparison during the course of this analysis, has only about 10 starts each day, however, most lines have between 30 and 40 starts per day, with some providing as many as 90 starts each day.

### ***d. Ridership***

In conjunction with this study, the RTC developed a patronage forecast to estimate the number of riders likely to use the proposed system, and identified the stations where they would likely board. In addition, the forecast identified the effect of the proposed system on the percentage of riders using fixed route transit compared to commuter rail(see Table 4). In general, the estimates indicate that the commuter rail system would have a relatively low ridership in comparison to other commuter rail systems around the country. The ridership estimates completed for the proposed commuter rail system indicate that approximately 1,000 to 1,200 daily riders during the peak period would use a commuter rail system in the year 2003, growing to between 2,000 and 2,400 riders per day during the peak period in 2017. These estimates are based on comparisons of the user costs and travel time associated with the proposed commuter rail mode and competing transportation modes such as bus and automobile. The significant increase in ridership between the 2003 and 2017 model runs reflects the projected increase in traffic congestion, and subsequently longer travel times, for bi-state commuters.

One of the most significant reasons for the relatively low ridership was the low frequency of trips provided by the service. In addition, the commuter rail line serves only one station in the Downtown Portland, which forces commuters to transfer to other bus for destinations away from the station, while the express bus directly serves more extensive destinations throughout the downtown area.

Figure 2 Revised 4/12/1999		Approximate Schedule for Proposed Commuter Rail Service Alternatives									
		Rye - Union Station Route					164th Avenue - Union Station Route				
		Leave	Arrive	Leave	Arrive	Train	Leave	Arrive	Leave	Arrive	Train
Train	Rye	Union Sta.	Union Sta.	Rye	Starts	164th	Union Sta.	Union Sta.	164th	Starts	
"Low" Alternative	1	6:00am	6:34am	6:45am	7:19am	2					
	2	6:45am	7:19am			1					
	1	7:30am	8:04am			1					
	2			4:40pm	5:14pm	1					
	1			5:15pm	5:49pm	1					
	2	5:25pm	6:05pm	6:10pm	6:44pm	2					
						8/day					
"Medium" Alternative	1	5:30am	6:04am	6:15am	6:49am	2					
	1	7:00am	7:34am			1					
	2						6:10am	6:50am	6:55am	7:35am	2
	2						7:40am	8:20am			1
	1			3:55pm	4:29pm	1					
	1	4:40pm	5:14pm	5:40pm	6:14pm	2					
	2								4:20pm	5:00pm	1
	2						5:05pm	5:45pm	5:50pm	6:30pm	2
					6/day					6/day	
"High" Alternative	1	5:30am	6:04am	6:15am	6:49am	2					
	1	7:00am	7:34am			1					
	2						6:03am	6:43am	6:48am	7:28am	2
	2						7:33am	8:13am			1
	1			7:45am	8:19am	1					
	1	8:30am	9:04am			1					
	2								8:18am	8:58am	1
	2						9:03am	9:43am			1
	1			4:00pm	4:34pm	1					
	1	4:45pm	5:19pm	5:40pm	6:14pm	2					
	2								4:20pm	5:00pm	1
	2						5:05pm	5:45pm	5:50pm	6:30pm	2
	1	6:25pm	6:59pm	7:10pm	7:44pm	2					
	2						6:35pm	7:15pm	7:20pm	8:00pm	2
					10/day					10/day	

The forecast developed for this analysis represents a reasonable estimate of commuter rail usage, including the diversion from other modes. The need to maintain adequate levels of service for bi-state commuters during the midday and from Clark County origins with poor access to commuter rail stations was balanced with the service provided by commuter rail. Therefore, the commuter rail service was defined as a replacement for some portion of well-utilized express bus services. In addition, the existing feeder bus system and location of park-and-ride facilities were not altered for this forecast exercise. For these reasons, the introduction of commuter rail would result in a slight decline in transit use between Vancouver and Portland.

The dedicated passenger alignment that was considered for a portion of this concept system would allow for a significant increase in the number of commuter rail trips which could be provided. Any increase in service has the potential to generate additional ridership, and would require further ridership analysis.

Also, in comparison with today's express bus service, the commuter rail stations would require out-of-direction travel for most commuters. Another element that might result in added ridership would be a reconsideration of the of station locations. A comprehensive examination of the existing feeder bus system and location of park-and-ride facilities would also need to be addressed. The orientation of commuter rail service to downtown Portland, and not other destinations in the corridor may also limit ridership opportunities.

<b>Table 4: Peak Period River-Crossing Transit Volumes</b>				
	Bus Only	Low Alt.	Medium Alt.	High Alt.
<b>Year 2003</b>				
<b>Express Bus</b>	2986	1875	1848	1729
<b>Commuter Rail</b>	N/A	1036	1063	1182
<b>Total</b>	2986	2911	2911	2911
<b>% of Peak Period Transit on Commuter Rail</b>	N/A	35.6%	36.5%	40.6%
<b>Year 2017</b>				
<b>Express Bus</b>	5582	3380	3329	3106
<b>Commuter Rail</b>	N/A	2062	2113	2336
<b>Total</b>	5582	5442	5442	5442
<b>% of Peak Period Transit on Commuter Rail</b>	N/A	37.9%	38.8%	42.9%

Source: RTC, January 1999

### e. Equipment Requirements

The number of trips identified in the operating plan could be undertaken with only two trainsets, each consisting of a locomotive and two coach cars; such as the bi-level cars manufactured by Bombardier. In addition, a third trainset would be required to maintain service in the event of an equipment failure by one of the primary trainsets. In each trainset, one of the coach cars would be equipped as a “cab” car allowing operation of the train from either end. This configuration will allow the trainsets to operate without turning around. The total cost for this equipment is estimated to be \$17.4 million.

## 5. Future Conditions and Committed Improvements

As shown in Table 5, train traffic is expected to increase significantly over the course of the study’s 20-year planning horizon, with a particular increase in high-priority Amtrak passenger trains. These increases will make an already congested system even more complicated.





Operator	1998	2003	2013	2018
<b>Amtrak</b>	10	20	26	30
<b>BNSF + Union Pacific</b>	63	71	80	90
<b>Lewis and Clark Railroad</b>	<1	NA	NA	NA
*Trains per day				

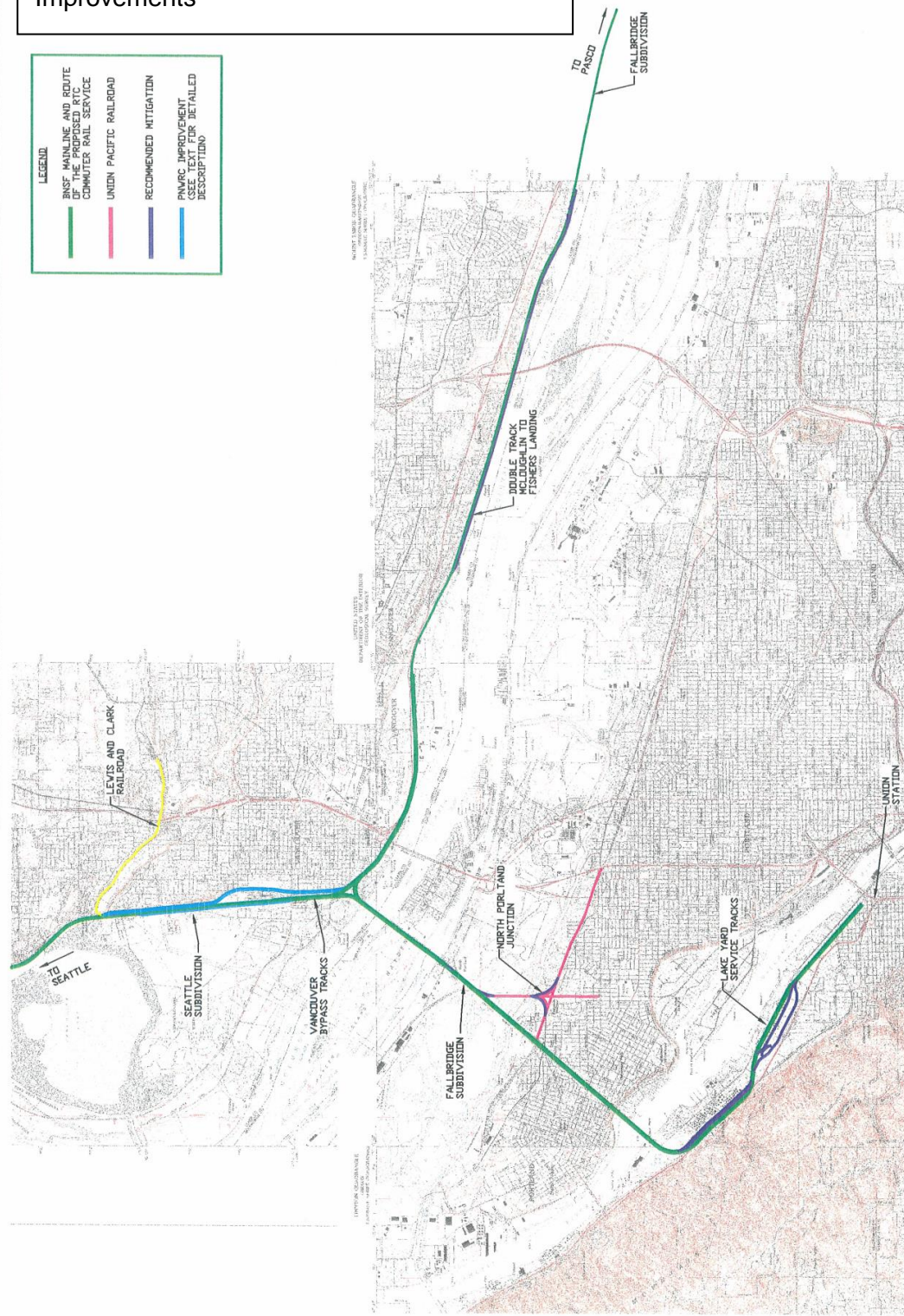
### a. Committed Improvements

In association with planned increases in intercity passenger service on the Seattle and Fallbridge subdivisions, WSDOT has committed funds to a number of significant improvements in the corridor. Since these improvements would directly benefit the commuter rail system, they were included in the capacity analysis based on their scheduled implementation dates. These improvements are shown in Figure 3, and include:

- Vancouver Yard Bypass Tracks - This improvement consists of the construction of two bypass tracks in Vancouver that will allow trains travelling through the corridor to do so without entering the Vancouver Yard. Currently, trains are often delayed at the Vancouver Yard while switching, waiting for a new crew, waiting for other trains, or waiting to cross the Columbia River. In addition, an existing siding west of the mainline tracks will be extended and equipped with power operated switches. These improvements will reduce congestion in the Vancouver Yard area and reduce the number of trains on the mainline track.
- Felida/North Vancouver Universal Crossover - A universal crossover track located south of the Lewis and Clark railroad between the two mainline tracks has been recommended to improve the dispatch of passenger and freight trains north of Vancouver.
- Vancouver Yard to Union Station Speed Improvements - Three improvements have been identified to improve train speeds between Vancouver and Portland: the realignment of a sharp curve near Union Station; the installation of centralized traffic control over a portion of the route; and, power operated switches at the north end of Union Station.

Figure 3- Committed and Proposed Improvements

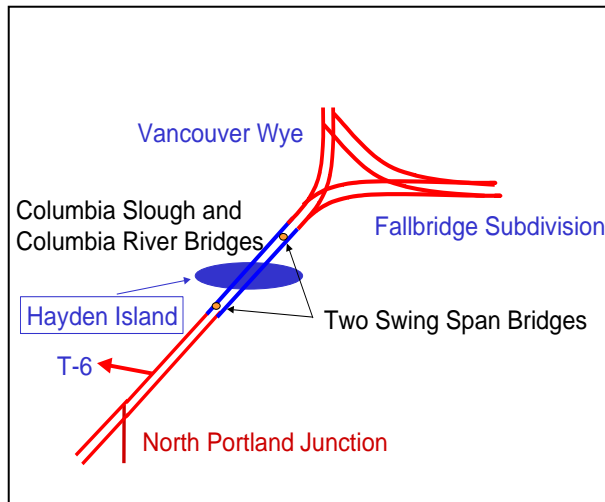
LEGEND	
	BNSF MAINLINE AND ROUTE IMPROVEMENTS FOR RAIL SERVICE
	UNION PACIFIC RAILROAD
	RECOMMENDED MITIGATION
	PNVRC IMPROVEMENT (SEE TEXT FOR DETAILED DESCRIPTIONS)



<b>HDR</b> HDR Engineering, Inc. 1435 SW BEDENBURG ROAD PORTLAND, OR 97223 (503) 788-3710		<b>RTC</b> Southwest Washington Regional Transportation Council		<b>RTC - COMASTER RAIL</b> FEASIBILITY STUDY STUDY AREA MAP FIGURE 3	
No. _____ Date _____	By: _____ Title: _____	Checked By: _____ Date: _____	Approved By: _____ Date: _____	Submitted: _____ Date: _____	Approved: _____ Date: _____
Designed By: _____ Drawn By: _____ Checked By: _____ Approved By: _____	Scale: _____ Reference: _____ Contract No.: _____ Date: _____	Sheet No.: _____ Rev.: _____ Drawing No.: _____			

**b. Corridor Constraints and Capacity Analysis**

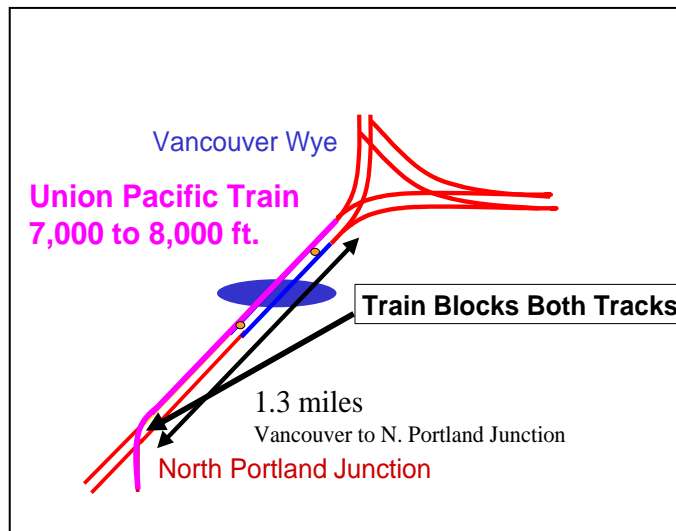
The concept commuter rail system would operate largely on the Fallbridge and Seattle subdivisions of the BNSF. This portion of the BNSF network represents one of the busiest operations in the Pacific Northwest, accommodating the BNSF and Union Pacific (UP) railroads, as well as Amtrak’s intercity passenger trains, and providing access to two major ports. The commuter rail system includes three moveable spans over rivers, three rail yards, numerous industrial leads and sidings tracks, a complex “wye” interchange at the Vancouver depot, and junctions with the UP railroad, Portland & Western Railroad, the Peninsula Terminal Railroad, and the Lewis and Clark Railroad. Proposed improvements by the Port of Portland at West Hayden Island which were included in the projected freight growth estimates for this study would add an additional junction, and even more freight traffic.



*Some of the many elements which complicate the proposed commuter rail corridor*

The junctions, yards, and bridges described above constrain the operation of all train operations, and would also constrain a commuter rail system in this corridor. Traffic generated by the ports and industrial users generates demand for capacity, while the need to safely enter and exit these facilities, including time spent accelerating and decelerating, forces many trains to move slowly through the corridor. Yard moves initiated to position freight cars for transport and for maintenance further tax the capacity of the system. The three moveable spans are an additional constraint, using capacity throughout the day. In addition, relatively dense

development adjacent to the tracks makes it expensive and difficult to make capacity improvements. The objective of the capacity analysis was to determine the extent to which commuter rail would impact this system, and to identify any improvements which could be made to reduce this impact to acceptable levels.



*UP trains entering and exiting the BNSF system at North Portland Junction require significant capacity. Similar delays are caused by trains moving on and off the mainline throughout the corridor.*

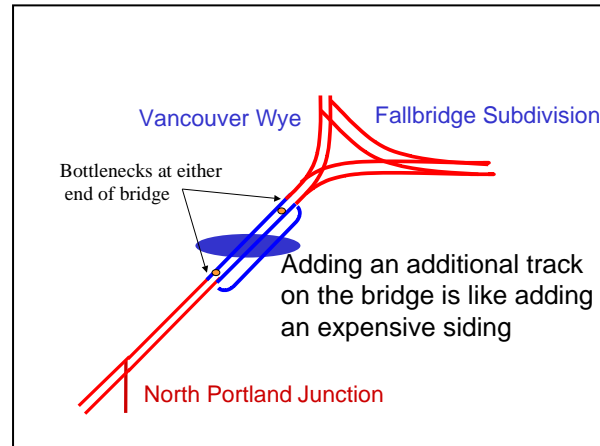
**c. Capacity Analysis Model**

The BNSF used the Dispatch Planning Model (DPM) developed by Berkeley Simulation Software to simulate the operation of commuter rail service in the corridor. This model works by prioritizing all users (passenger trains, intermodal trains, unit trains, freight trains, and yard moves), and then seeking to pass all of the users through the corridor with



acceptable levels of delay based on their prioritization. The model takes into account constraints on speed and operation, and allows the analyst to simulate improvements that may mitigate these considerations. Using the DPM, it was possible to estimate the effect of the concept commuter rail program on the corridor while identifying ways of improving the system's operations and infrastructure to lessen this impact.

An important element of the model is the level of priority it considers for each train type. For example, an intercity passenger train which is extremely time sensitive, and an intermodal train, which also has important schedule reliability requirements, receive very high priority in the set of simulations performed by the DPM software. Similarly, a lifting of the lift span for marine vessels, has a high priority, whereas, local train movements and most unit trains have lower priority in the chain of simulations. These simulations replicate the decisions and protocols used by train dispatchers who organize train movements through rail systems. The degree of priority is tied to the amount of capacity that is absorbed. That is, in order to guarantee the schedule requirements of an Amtrak or intermodal train, the movements of other lower priority trains may be halted to permit them to pass through the system, thus, requiring more system capacity.



## 6. Findings

The results of the DPM analysis indicated that even relatively low levels of commuter rail service would generate unacceptable delay to committed freight and intercity passenger services within the study's 20-year planning horizon. While a number of improvements were identified which could mitigate commuter rail's impacts in the short term (i.e., through the year 2003), the existing BNSF alignment has a finite capacity which could not be expanded to sustain commuter rail service at any level beyond the year 2013. One improvement which was examined during the course of this analysis was the concept of adding a third mainline track across the Columbia River and Oregon Slough bridges. The DPM analysis found that adding additional tracks to the bridges would not provide significant capacity increases. Instead it was found that an additional mainline track on the bridge acted as a standard siding, while pushing bottlenecks to either end of the bridge where trains would be forced to merge back to just two mainlines.

### a. Capacity Analysis Results

The ability of the existing BNSF system to accommodate the needs of the concept commuter rail operation is the central issue in determining the proposal's feasibility. In rail capacity modeling "infeasible" means that there is not enough rail system capacity to dispatch the train demand, which includes freight, intercity passenger, and commuter service, over a twenty-four hour period. Given the constraints imposed on the system by its growing traffic and complex operational requirements, the prospect of adding a significant number of high-priority trips (i.e., more passenger trains) to the corridor must be considered carefully. This study found that all of the concept service alternatives were "infeasible" by the year 2003 without mitigation through capacity improvements. In 2003, the "low" and "medium" service alternatives were "feasible"

with mitigation, however, the 2003 high service level and all of the concept alternatives in 2018 could not be mitigated to feasible delay levels. The delay identified in Table 6 refers to unscheduled dwell time incurred by trains in order to provide a “feasible” model outcome. This can include a rescheduled departure time or time spent waiting at a junction for a higher priority train to pass.

<b>Table 6: Total Accumulated Delay (in hours) - 2003 Analysis</b>			
	<b>No Build Baseline</b>	<b>No Build With Commuter Rail</b>	<b>With Improvements</b>
<b>Low Service</b>	79.84	92.81	81.44
<b>Medium Service</b>	79.84	108.56	73.47
<b>High Service</b>	79.84	121.45	97.58
<u>2003 Base Case – Improvements Already Committed in BNSF 1999-2000 Plan:</u>			
<ol style="list-style-type: none"> <li>1. Double track bypass of Vancouver Yard.</li> <li>2. New siding construction on Fallbridge between Wishram and Vancouver.</li> </ol>			
<u>2003 Low Service – Improvements:</u>			
<ol style="list-style-type: none"> <li>1. Add service track at Lake Yard to reduce light engine moves across river.</li> <li>2. Improvements at No. Portland Junction to increase speeds to 25 mph.</li> </ol>			
<u>2003 Medium Service – Improvements:</u>			
<ol style="list-style-type: none"> <li>1. Add service track at Lake Yard to reduce light engine moves across river.</li> <li>2. Improvements at No. Portland Junction to increase speeds to 25 mph.</li> <li>3. Extend double-track on Fallbridge east from McLoughlin Yard (MP 14.9) to Fisher's Landing (MP 19.7).</li> <li>4. Construct new double crossover at approximately MP 16.6 on Fallbridge.</li> </ol>			
<u>2003 High Service – Improvements:</u>			
<ol style="list-style-type: none"> <li>1. Add service track at Lake Yard to reduce light engine moves across river.</li> <li>2. Improvements at No. Portland Junction to increase speeds to 25 mph.</li> <li>3. Extend double-track on Fallbridge east from McLoughlin Yard (MP 14.9) to Fisher's Landing (MP 19.7).</li> <li>4. Construct new double crossover at approximately MP 16.6 on Fallbridge.</li> <li>5. Reconfiguration of mainline tracks through Wilbridge Yard.</li> </ol>			

**b. Costs of the Low Service Alternative in 2003**

To operate the low service alternative in 2003, several mitigation actions would be required. At Lake Yard, a service track would be added to allow trains to be kept at the Yard, reducing the number of trips made across the Columbia River to the Vancouver fueling station. This improvement is depicted in Figure 3. A second required improvement would be the addition of faster turnouts at North Portland Junction. Every day, long unit trains operated by the UP enter and exit the BNSF system at North Portland Junction. These trains often cross over both mainline tracks during this maneuver, tying up capacity on both tracks while the trains move at 15 mph through the turnout. By increasing the speed allowed at the turnouts, the time taken to accommodate these trains can be greatly reduced (see Figure 3).

As shown in Table 7, the capital costs for the 2003 low service alternative, including station costs, mitigation improvements, trainsets and track repair, are estimated to be \$36.6 million. The yearly operating costs based on an analysis of comparable services elsewhere in the country are estimated to be \$2.7 million per year.

<b>Table 7: Low Service Alternative Total Costs (2003), in \$1998</b>		
	<i>Cost</i>	<i>Cost per Train mile*</i>
<b>Station Facilities</b>		
Storage Facility	\$ 944,000	\$ 26.70
Rye Station	\$ 2,245,000	\$ 63.49
Vancouver Station Improvements	\$ 2,320,000	\$ 65.61
<i>Subtotal</i>	<i>\$ 5,509,000</i>	<i>\$ 155.80</i>
<b>Other Improvements</b>		
Improvements at Rye Junction	\$ 3,714,000	\$ 105.03
Lewis & Clark Railroad Track Improvements	\$ 5,010,000	\$ 141.69
Two Trainsets plus backup	\$ 17,400,000	\$ 492.08
<b>Capacity Improvements</b>		
Lake Yard Service Tracks	\$ 1,170,000	\$ 33.09
North Portland Junction	\$ 3,810,000	\$ 107.75
<i>Subtotal</i>	<i>\$ 4,980,000</i>	<i>\$ 140.84</i>
<b>Total</b>	<b>\$ 36,613,000</b>	<b>\$1,035.43</b>
	<i>Annual Cost</i>	<i>Cost per passenger per day</i>
<b>Operating Costs</b>	<b>\$ 2,700,000</b>	<b>\$ 10.02</b>
<i>*Costs based on revenue generating miles per year (number of trips per day x 260 days per year x distance of each trip).</i>		

### **c. Costs of the Medium Service Alternative in 2003**

In addition to the mitigation measures identified for the low service option discussed above, the medium level of service would require two further improvements. To accommodate the service considered for the Fishers Landing and Andresen Road stations, the mainline on the Fallbridge Subdivision would need to be double-tracked from McLoughlin Yard east to Fisher's Landing (see Figure 3). This would allow freight and other operations to continue activity while the commuter service is in operation. Additionally, a double crossover would have to be installed in the vicinity of Ellsworth Road in order to make the new double tracked section more effective.

As shown in Table 8, the capital costs for the 2003 medium service alternative, including station costs, mitigation improvements, trainsets, and track repair are estimated to be \$53.1 million. The yearly operating costs based on an analysis of comparable services elsewhere in the country are estimated to be \$3.3 million per year.

**Table 8: Medium Service Alternative Total Costs (2003), in \$1998**

	<i>Cost</i>	<i>Cost per Train mile*</i>
<b>Station Facilities</b>		
Storage Facility	\$ 944,000	\$ 16.81
Rye Station	\$ 2,245,000	\$ 39.98
Vancouver Station Improvements	\$ 2,320,000	\$ 41.31
Andresen Station	\$ 2,095,000	\$ 37.30
Fisher's Landing	\$ 1,390,000	\$ 24.75
<i>Subtotal</i>	<i>\$ 8,994,000</i>	<i>\$ 160.15</i>
<b>Other Improvements</b>		
Improvements at Rye Junction	\$ 3,714,000	\$ 66.13
Lewis & Clark Railroad Track Improvements	\$ 5,010,000	\$ 89.21
Two Trainsets plus backup	\$ 17,400,000	\$ 309.83
<b>Capacity Improvements</b>		
Lake Yard Service Tracks	\$ 1,170,000	\$ 20.83
North Portland Junction	\$ 3,810,000	\$ 67.84
Double-track on Fallbridge Subdivision	\$ 11,781,000	\$ 209.78
Double-crossover on Fallbridge Subdivision	\$ 1,309,000	\$ 23.31
<i>Subtotal</i>	<i>\$ 18,070,000</i>	<i>\$ 321.76</i>
<b>Total</b>	<b>\$ 53,188,000</b>	<b>\$ 947.08</b>
	<i>Annual Cost</i>	<i>Cost per passenger per day</i>
<b>Operating Costs</b>	<b>\$ 3,347,000</b>	<b>\$ 12.11</b>
<i>*Costs based on revenue generating miles per year (number of trips per day x 260 days per year x distance of each trip).</i>		

**d. Cost of High Service Alternative in 2003 and Costs of All Service Alternatives in 2018**

The impacts of the 2003 high service alternative cannot be mitigated to acceptable levels of delay within the existing alignment. Increases in traffic would make the impacts of the low and medium service alternatives infeasible in 2018, and possibly as early as 2013. Under these conditions, a separate alignment for passenger rail would be necessary for the commuter rail system to operate with projected freight rail and intercity passenger rail operations. Table 9 identifies the costs associated with these service levels as \$483 million for capital expenditures. The annual operating costs for the high service level are estimated to be \$4.0 million.

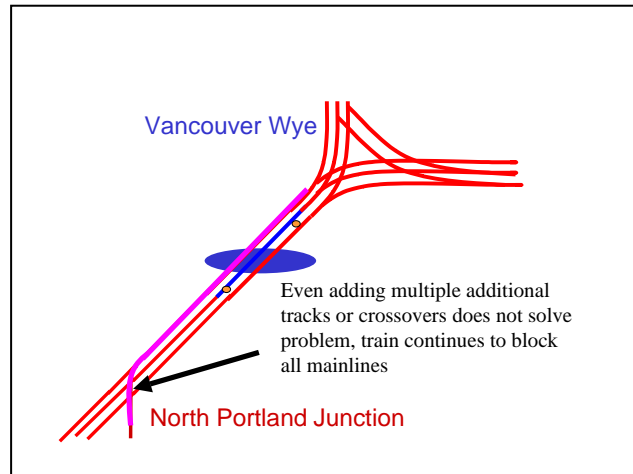
<b>Table 9: High Service Alternative (2003) and All Service Alternatives (2018)</b>		
	<i>Cost</i>	<i>Cost per Train mile*</i>
<b>Station Facilities</b>		
Storage Facility	\$ 944,000	\$ 10.09
Rye Station	\$ 2,245,000	\$ 23.99
Vancouver Station Improvements	\$ 2,320,000	\$ 24.79
Andresen Station	\$ 2,095,000	\$ 22.38
Fisher's Landing	\$ 1,390,000	\$ 14.85
<i>Subtotal</i>	<i>\$ 8,994,000</i>	<i>\$ 96.09</i>
<b>Capacity Improvements</b>		
Lake Yard Service Tracks	\$ 1,170,000	\$ 12.50
North Portland Junction	\$ 3,810,000	\$ 40.71
Double-track on Fallbridge Subdivision	\$ 11,781,000	\$ 125.87
Double-crossover on Fallbridge Subdivision	\$ 1,309,000	\$ 125.87
<i>Subtotal</i>	<i>\$ 18,070,000</i>	<i>\$ 193.06</i>
<b>Other Improvements</b>		
Rye Junction Improvements	\$ 3,714,000	\$ 39.68
Lewis & Clark Railroad Track Improvements	\$ 5,010,000	\$ 53.53
Two Trainsets plus backup	\$ 17,400,000	\$ 185.90
Dedicated Passenger Alignment (Low – High Estimate)	\$ 430,000,000- \$750,000,000	\$4,594.02- \$8,012.82
<b>Total (Low Estimate)</b>	<b>\$ 483,188,000</b>	<b>\$ 5,162.27</b>
<i>2003 High Only</i>	<i>Annual Cost</i>	<i>Cost per passenger per day</i>
<b>Operating Costs</b>	<b>\$ 4,078,000</b>	<b>\$ 13.27</b>
<i>*Costs based on revenue generating miles per year (number of trips per day x 260 days per year x distance of each trip).</i>		

#### **e. Dedicated Alignment**

In many situations, chokepoints can be reduced by simply adding an additional mainline track. This solution is not effective in the subject corridor because of the numerous entrance and exit points result in trains crossing and re-crossing both mainlines to enter and exit the BNSF system. In addition, the two yards and three moveable span bridges present capacity problems which cannot be solved with the simple addition of more mainline track. Improvements were tested where a third mainline was added to large sections of the corridor including the Columbia River and Oregon Slough bridges. To increase the capacity to the point where commuter rail operations would be feasible, the alignment would need to travel either above or below the

points of conflict with existing freight service on the at-grade mainlines between the Vancouver Yard, and at North Portland Junction.

The principal reasons for considering a dedicated passenger alignment are related to separating passenger traffic from chokepoints in the existing network; e.g., Vancouver Yard, the proposed West Hayden Island connection, and North Portland Junction. This separation could be in the form of a raised structure traveling over the conflict areas, or a tunnel located underneath the congested areas.



*The DPM analysis indicates that even with capacity improvements, choke points would still exist in the corridor.*

Conceptual cost estimates for both alternatives were completed as a part of this analysis. To rise above the critical points, track would need to be elevated off both the Fallbridge and Seattle Subdivisions as they approach Vancouver Yard. The tracks would meet approximately 30 feet above the existing track at the Vancouver Amtrak Depot, where raised platforms would allow passengers access to the trains. The trains themselves would require a level platform of approximately 1,000 feet to allow for safe boarding by passengers. After joining at Vancouver Yard and traveling over the existing mainline, the dedicated alignment could drop down to the level of the existing railroad bridge. Both the Columbia River and Oregon Slough swing spans would need to be replaced with lift spans to allow the new alignment to run parallel to the existing bridge. The alignment would likely run on the east side of the existing track to avoid conflicts with trains arriving and departing at the anticipated "Wye" junction to West Hayden Island. The new alignment would then need to be elevated to clear the North Portland Junction. The alignment could then drop down and rejoin the existing track at East St. John's.

The dedicated alignment concept is expensive, however, the alignment needs to be considered in the context of freight and passenger mobility in the corridor. The capacity analysis indicates that the Clark County to Portland mainline rail corridor has a limited capacity for growth. At some point in the future (i.e., according to the DPM analysis, by at least 2013), it will become necessary to identify ways to keep the corridor operating smoothly. At that time, the expense of a dedicated alignment may be more in line with the demands and resources of the providers and users of the system.

The dedicated alignment is estimated to cost roughly \$450 to \$750 million. Two conceptual dedicated alignments were analyzed; an elevated alignment and a tunnel alignment. The elevated alignment first would extend between MP 133.73 on the Seattle Subdivision, north of where the Vancouver Yard ties back into the main line, south to the East St. Johns Depot at MP 6.7 on the Fallbridge Subdivision. The preliminary cost estimate for these facilities, including property acquisition, environmental mitigation, industry relocation, engineering and contingency costs, is approximately \$450 million. These costs include the mitigation projects required for Medium service alternative, as well as reconfiguration of the main line between the Willbridge Yard and Lake Yard.

The underground alignment would include a 2.5-mile long tunnel with a northern terminus at MP 136.01 on the Seattle Subdivision to MP 7.82 on the Fallbridge Subdivision, just south of North Portland Junction. The estimated construction cost for the tunnel alone is projected to be \$275

million. Other cost items include property acquisition, environmental mitigation, industry relocation, track, signals, station platforms and elevators, and a new dedicated track structure over the Oregon Slough. In total, the preliminary low estimate for the underground alternative is \$520 million.

The high estimate of \$750 million accounts for the potential for a much higher cost to reconfigure the main line between Willbridge Yard and Lake Yard; i.e., from \$20 million to \$250 million. A number of potential improvements for this area were proposed during the course of this study. One of these improvements would require relocation of several industrial facilities located near the yards, while another required only realignment of the track and an overpass. The feasibility of either of these options could not be determined sufficiently at this time. Additional engineering feasibility analyses need to be completed for this segment to establish a more accurate cost estimate. Table 10 provides a summary of the costs and improvements associated with the construction of the two river crossing alignment alternatives.

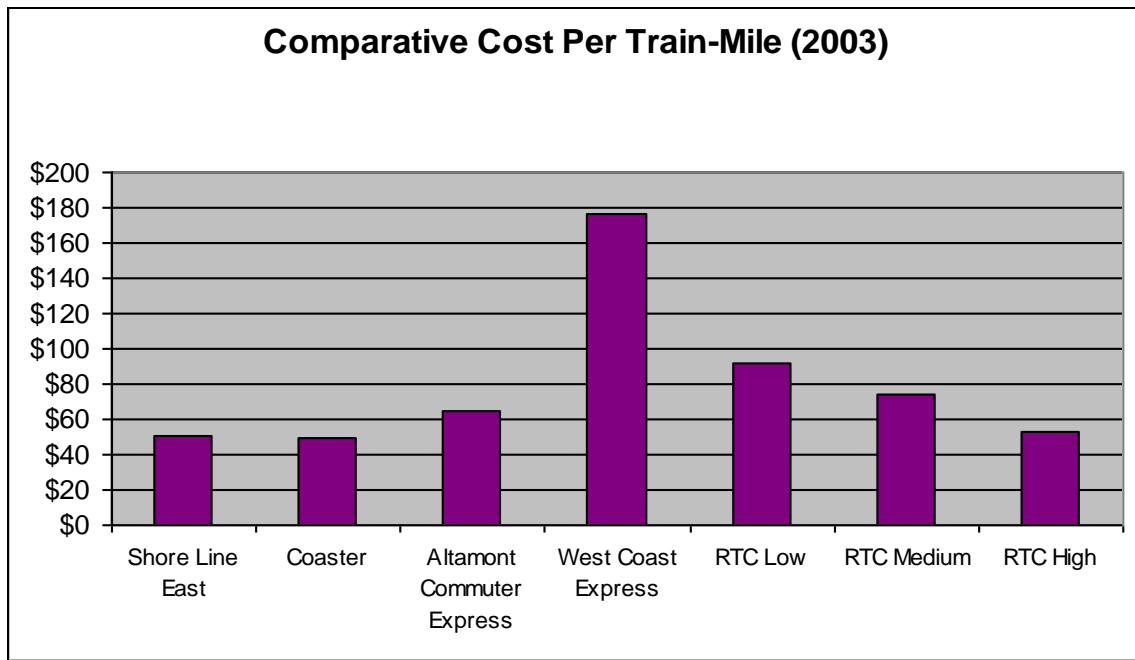
**Table 10: Dedicated Passenger Alignment–Conceptual Level Cost Estimate (in \$1998)**

Bridge Alternative	Cost (in millions of dollars)
Modify Mill Plain Viaduct	\$4
Modify 4 <sup>th</sup> Plain Viaduct	\$4
North Approach to BNSF O'pass	\$10
BNSF Overpass	\$20
Vancouver Station Platform & Elevators	\$5
Replace Columbia River Swing Span w/ Lift Span	\$24
Replace Oregon Slough Br. Swing Span w/ Lift Span	\$16
New Double Track Commuter Bridge Over Columbia	\$70
New Double Track Commuter Bridge Over Oregon Slough	\$40
New Double Track Commuter Bridge Over Columbia Slough	\$5
East Approach to BNSF O'pass	\$10
N. Approach to N. Portland Jct. O'pass	\$5
Bridge over N. Portland Jct.	\$30
S. Approach to N. Portland Jct. O'pass	\$5
Track Construction	\$14
Signal Construction & Modifications	\$10
Right-of-way Acquisition	\$17
Environmental Mitigation	\$10
Industry Relocation Costs	\$20
Engineering & Contingency	\$93
Medium Service Alternative Mitigation	\$18
<b>Total</b>	<b>\$430</b>
<b>Tunnel Alternative</b>	
Construct 2.5 Mile Tunnel	\$275
Modify 4 <sup>th</sup> Plain Viaduct	\$3
Vancouver Station Platform & Elevators	\$14
New Double Track Commuter Bridge Over Columbia Slough	\$5
Track Construction	\$15
Signal Construction & Modifications	\$10
Right-of-way Acquisition	\$10
Environmental Mitigation	\$10
Industry Relocation Costs	\$15
Engineering & Contingency	\$125
Medium Service Alternative Mitigation Projects	\$18
<b>Total</b>	<b>\$500</b>
Track Reconfiguration at Lake Yard	\$20-\$250



**f. Operating Costs**

This study also examined the potential operating costs for the concept system including maintenance, administration, staffing, and other elements. As part of this analysis, projected operating costs for all three service levels were compared to costs incurred by other comparable commuter rail systems around the country. Figure 4 compares the costs per mile of the concept system with the costs of operating similar systems. It should be noted, however, that the systems identified as having similar costs per mile generally have much higher passenger loads, and thus a smaller cost per passenger mile.



*Figure 4: Comparative Cost Per Train-Mile (2003)*

Another finding of the study was that the cost recovery for the operation from fares and concessions would be less than 20% of total operating costs. This figure is substantially less than most comparable services, and would make the system more costly to operate over the long term. The low cost recovery stems from high fixed costs from insurance and administration with a relatively low number of potential riders.

The analysis of operating costs assumed that an agency would be formed to manage the commuter rail system. This in effect provides a worst case scenario of the administrative costs that would be associated with this rail line. If a commuter rail service were to be implemented in Clark County, it is likely that an existing agency would oversee its operations. In this case, administrative costs could be reduced, and the operating costs would also go down.

### **g. Columbia River Bridge**

Some of the more significant sources of delay in the concept commuter rail corridor are the Columbia River and Oregon Slough bridges. These bridges are located between the two points of conflict of North Portland Junction and the Vancouver “wye,” and they generate their own delays through frequent openings for marine traffic. This study examined the bridges based on both increasing their capacity for rail traffic, and improving their operations for marine traffic.



RN BNSF Columbia River Bridge with open swing span

### Capacity Improvements

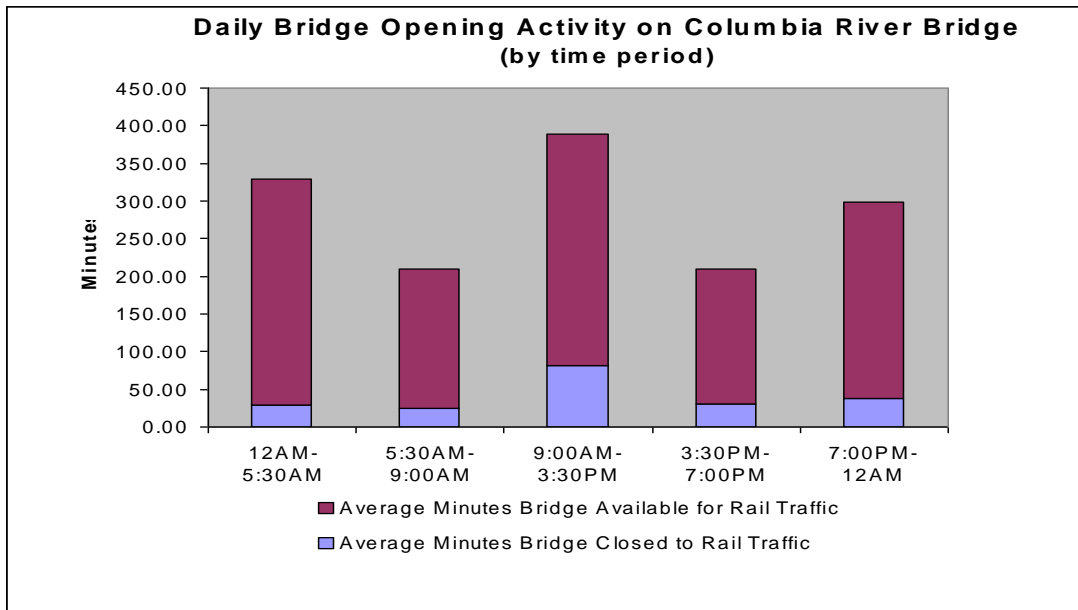
The Columbia River and Oregon Slough bridges are an important link in the movement of freight in the Pacific Northwest. The bridges link the Port of Portland with the BNSF mainline, and are also a critical link for UP trains serving the ports of Seattle, Tacoma, Longview, and Kalama. The bridges are already severely congested, and as shown in Table 5, traffic is expected to increase significantly in the next five to ten years, with a noteworthy jump in high priority passenger trains. Furthermore, proposed development by the Port of Portland of its West Hayden Island site would add a high-traffic junction immediately adjacent to both bridges. In addition, the bridges generate their own delays, opening multiple times every day to accommodate marine traffic (see Figure 5). Under federal law, the railroad is required to open the bridge for marine traffic within a relatively short period of time, or face a fine. As commercial navigation on the Columbia River grows, the bridges will need to be opened more frequently, and conflicts between marine and rail uses will increase in number.



*Both the Columbia River and Oregon Slough swing spans would have to be replaced with lift spans in order to allow the new alignment to run parallel.*

Adding a third mainline to the Columbia River and Oregon Slough bridges is one proposal for dealing with the increased traffic predicted for the corridor. However, the analysis performed for this study suggests that an additional track on the bridges would only serve to push the chokepoints to either end of the bridges where the existing double-track would force trains to merge down to two tracks again. The analysis indicated that adding a third mainline did not increase the capacity in the corridor, but rather operated more like a short train siding. The estimated cost for adding a third mainline to both bridges, including conversion of the swing spans to lift spans was estimated to cost \$100 to \$125 million. The lower cost assumed that existing spans would be retrofitted to include a third mainline. The higher cost option would replace the bridges with a new structure that has three mainlines.

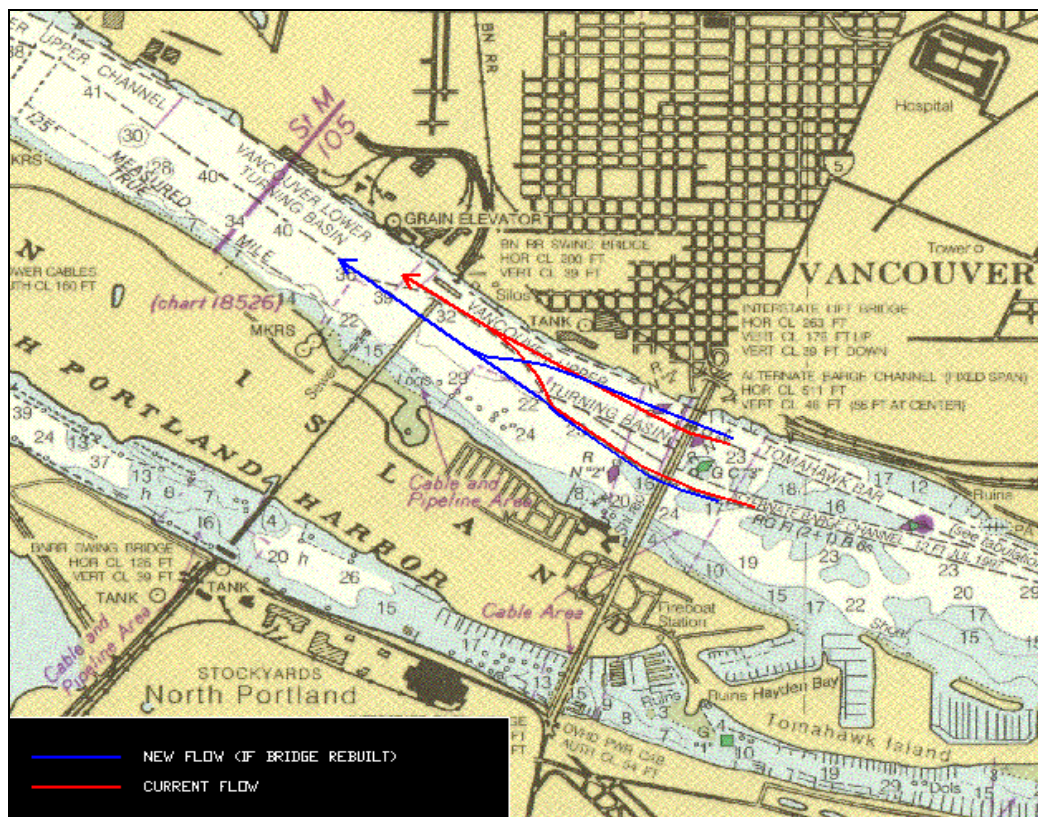
Figure 5.



Marine Navigation Improvements

The Columbia River serves as a major shipping channel for goods traveling between inland ports in Washington, Oregon, and Idaho, and the major transshipment points in Vancouver and Portland. Any changes to the bridges in terms of increasing capacity, or alterations made in association with the construction of a dedicated alignment, should take these maritime users into consideration. As shown in Figure 6, the BNSF railroad bridges are in proximity to the heavily traveled I-5 highway bridge. For most of the year, commercial operators are able to travel downstream through the central “hump” of the Interstate Bridge, before steering towards the Washington side of the river and the swing span of the BNSF Columbia River Bridge. During high water periods, however, the current moves too swiftly to accommodate this operation, and so barge operators are forced to wait until the Interstate Bridge can be opened before passing through. If the existing swing span on the railroad was fixed in place, and a new lift span installed just to the south of the existing swing span, marine traffic would require fewer openings of the Interstate Bridge, with commensurate gains in efficiency for both marine traffic and highway users.

Figure 6: Marine Navigation Past the BNSF and Interstate 5 Bridges



## 7. Recommendations

The findings of this feasibility study indicate that development of a commuter rail system should not be pursued at this time. However, if it is determined that a major rail investment is necessary to support future intercity passenger and freight rail growth in this corridor, then the concept of a commuter rail service should be revisited.

The capacity constraints in this corridor need to be discussed further, not only in the context of the concept commuter rail system, but also as they relate to the rapid growth of rail freight traffic in the corridor and plans for greatly increased intercity passenger service. This corridor is severely constrained in terms of how much growth it can support without major capital investment. The commuter rail operations, which triggered the requirement for a dedicated passenger alignment, added a relatively small number of trips to the system. Current plans for intercity passenger and freight growth could trigger the need for major capacity improvements before the 2018 horizon year. RTC called a meeting of regional stakeholders who rely on passenger and freight mobility in this corridor and began the discussion of how the region could respond to this problem. The results of this study have created the awareness of the need to initiate regional discussion about long-term rail capacity issues affecting freight and passenger needs.

## 8. Guide to the Appendix

- *Technical Memorandum No. 1 - Study Objectives and Evaluation Criteria.* This memorandum describes the objectives for the study as developed during the November, 1997 informational workshop, and the criteria used to guide the analysis.
- *Technical Memorandum No. 2 - Capital Considerations Associated with the Lewis and Clark Railroad.* The Lewis and Clark Railroad would require some improvement before it would be suitable for passenger rail use. This memorandum identifies the necessary improvements and provides a conceptual level cost estimate for these improvements.
- *Technical Memorandum No. 3 - Columbia River and Oregon Slough Rail Bridges.* The Columbia River and Oregon Slough bridges represent some of the essential elements in the examination of a potential commuter rail system. This memorandum discusses the usage of the bridges and the costs of adding capacity in the form of an additional mainline track. Some details are provided regarding the number of openings for marine traffic, and the potential for adding a lift span to the structures in response to requests from commercial barge operators and others.
- *Technical Memorandum No. 4 - Access and Capital Costs of Potential Station Sites and Maintenance Facility.* This memorandum provides details about the parking and station facilities which would be provided as a part of the commuter rail system. Conceptual level cost estimates are provided for each of the station sites, a brief review of land use and access issues for each of the sites is also provided.
- *Technical Memorandum No. 5 - Commuter Rail Connection at Rye Junction.* Rye Junction presented two options for improvement in association with the commuter rail concept. One option would provide a siding for commuter trains to pull onto while changing direction between the BNSF and Lewis and Clark Railroad systems. The second alternative would allow non-stop transfer between the two lines through construction of a new bridge and turnout. These options were presented for a decision by the Management Team.
- *Technical Memorandum No. 6 - Description of Inputs Used for the DPM Model.* This memorandum was prepared by analysts at the BNSF, and describes the data, methodology and findings of their DPM analysis. The report identifies the improvements that were incorporated into their modeling effort, and also includes a stringline diagram showing the output from the modeling effort.
- *Technical Memorandum No. 7 - Evaluation of DPM Model Results.* This memorandum serves as a critique of the BNSF findings detailed in Technical Memorandum No. 6. This memorandum indicates overall support for the findings of the BNSF analysis, while identifying some reservations about the methods.
- *Technical Memorandum No. 8 Recommended Infrastructure Improvements.* Technical Memorandum No. 8 provides conceptual level drawings and cost estimates of the improvements identified in the DPM analysis for operation of the commuter rail system. Included is a description of the dedicated passenger alignment which would be necessary in order for the concept commuter rail system to operate through the 20 year planning horizon.
- *Technical Memorandum No. 9 - Operating Costs.* Prepared by BRW inc. this element of the analysis evaluated commuter rail systems in operation throughout North America, and used

this information to estimate the operating costs for the concept commuter rail system in Clark County. The analysis found that the system would be relatively expensive, and have a low rate of cost recovery.

- *Technical Memorandum No. 10 - Operational and Ridership Considerations.* The RTC completed an analysis of the ridership that the concept system would likely generate. This memorandum describes their methodology and findings. In general it was determined that the concept system would generate few riders, and contribute only slightly to overall bi-state mobility.