Washington State

Amtrak *Cascades* Operating and Infrastructure Plan Technical Report

VOLUME 1

Washington State Department of Transportation

February 2006

Prepared by the Freight Systems Division
Washington State Department of Transportation

February 2006

For more information, contact:

- Call the WSDOT State Rail Office at (360) 705-7900 or 1-800-822-2015;
- Write to the WSDOT Rail Office at P.O. Box 47407
  Olympia, WA 98504-7407;
- Fax your comments to (360) 705-6821; or
- E-mail your comments to rail@wsdot.wa.gov

Persons with disabilities may request this information be prepared and supplied in alternate forms by calling the WSDOT ADA Accommodation Hotline collect 206-389-2839. Persons with vision or hearing impairments may access the WA State Telecommunications Relay Service at TT 1-800-833-6388, Tele-Braille 1-800-833-6385, or Voice 1-800-833-6384, and ask to be connected to 360-705-7097.

Amtrak *Cascades* Operating and Infrastructure Plan Technical Report

VOLUME 1

Prepared for the

Washington State Department of Transportation

By

Transit Safety Management, Inc.

in association with

The Resource Group Consultants, Inc.
HDR Engineering, Inc.

February 2006

Washington State
Department of Transportation

Table of Contents

Appendices

List of Exhibits

Chapter One: Introduction

Pacific Northwest Rail Corridor

Washington State is incrementally upgrading Amtrak *Cascades* passenger rail service along the Pacific Northwest Rail Corridor (PNWRC) in western Washington.

Since the late 1980s the Washington State Department of Transportation's (WSDOT) Rail Office has been developing a passenger rail program to meet the state's goal of providing safe, faster, more frequent, and reliable passenger rail service. The plan for the Amtrak *Cascades* service is to provide a reliable transportation choice, year-round, regardless of weather.

The state's vision for passenger rail in the Pacific Northwest extends over a twenty year horizon. The vision is being implemented through a step-by-step approach; service is being increased over time based on state and federal funding and market demand.

What is the purpose of this report?

The purpose of this technical white paper is to provide a revised, detailed operating and capital plan for the Amtrak *Cascades* intercity passenger rail program. This plan has been revised to reflect recent changes and conditions along the BNSF Railway Company's (BNSF) main line corridor (along which the Amtrak *Cascades* service operates). These revisions were necessary in order to maintain the service (operating) goals of the Amtrak *Cascades* program.

The information contained in this report is geared towards the transportation professional and not the general public. The results of the analyses contained in this report are summarized and presented in the *Washington State's Long-Range Plan for Amtrak Cascades*.

Exhibit 1-1
Amtrak *Cascades* Daily Round Trip Trains

Total Roundtrips				
Corridor	1994	2003	2008*	2023
Seattle, WA to Portland, OR	1	3	8	13**
Seattle, WA to Vancouver, BC	0	2***	3	4

**Placeholder year only*
*** Includes three trains that travel north, beyond Seattle, to Vancouver, BC*
****Amtrak Cascades #513/516 travels between Seattle and Bellingham*

Exhibit 1-2
Amtrak *Cascades* Travel Times

Destination	1994	2003	2008*	2023
Portland, OR to Seattle, WA	3:55	3:30	3:00	2:30
Seattle, WA to Vancouver, BC	N/A	3:55**	3:25	2:37
Vancouver, BC to Seattle, WA to Portland, OR	N/A	N/A	6:40	5:22

**Placeholder year only*
** *Travel time for train #510/517.*

What are the service goals for the Amtrak *Cascades* program?

Exhibit 1-1 presents an overview of the number of round-trip passenger trains per day for current and planned service along the PNWRC. **Exhibit 1-2** summarizes passenger train travel times for this service through year 2023.

The travel times and train frequencies presented in this discussion focus on years 2008 and 2023. Year 2023 represents WSDOT's twenty year build-out plan. Year 2008 was chosen as an intermediate year to represent a "mid-point" in service and infrastructure development.

Does the Amtrak *Cascades* operating and capital plan have to be implemented in these specific years?

The operating and capital plan was designed to be implemented within a twenty year timeframe. Although analysis and research data are based on specific years of operation, the purpose of an incremental program is to be able to implement service as funding becomes available. As such, specific years of implementation are irrelevant.

However, in order to meet operating goals without interfering with freight traffic, infrastructure improvements must be implemented in the order in which they are presented in this plan. Each of these improvements was designed to meet a specific need along the corridor, and is a critical component of overall operations.

Why was 2008 chosen as the interim year?

WSDOT selected year 2008 as the interim year based on the assumption that full funding for all projects targeted for implementation between 2003 and 2008 would be available.

Since the initial decision was made to use 2008 as the mid point for this analysis, WSDOT has recognized that funding levels necessary to meet the program's goals will not be available. Therefore, the implementation years identified throughout this operating and capital plan are placeholders. Implementation of projects and equipment purchases could take longer than anticipated, or could feasibly be expedited, depending upon funding availability. From the inception of the Amtrak *Cascades* program, implementation goals have always been based on market demand and well as funding.

When did planning for passenger rail service begin?

Planning for intercity passenger rail along the Pacific Northwest Rail Corridor began in late 1980's with the inception of the Rail Development Commission. This Commission's work eventually led to a number of analyses, projects, and the creation of the WSDOT Rail Office.

What specific studies led to the development of the Amtrak *Cascades* service?

In 1991 the State Legislature passed SHB 1452 which directed WSDOT to develop a comprehensive assessment of the feasibility of developing a high-speed ground transportation system in Washington State as part of a long-term solution to congestion on the state's major transportation corridors.

Several studies were conducted resulting in the *Statewide Rail Passenger Program - Technical Report* (January 1992), the *High-Speed Ground Transportation Study* (October 1992), and the *Washington Statewide Rail Passenger Program (GAP Studies)* (June, September, and December 1992). These studies included analysis of possible rail corridors statewide for items such as: ridership demand, funding sources, possible running speed goals and level of service, and the feasibility and overall costs of constructing new rail alignments versus upgrading existing corridors.

Specific findings of the *High-Speed Ground Transportation Study Final Report* (October 1992) resulted in a decision to pursue a combination of improved conventional rail and tilt body trains. The *Gap Study*, which concentrated on improved conventional rail and tilt body trains, examined combinations of service frequency and travel time against ridership, cost, and revenue. Two scenarios were examined in detail:

- Scenario One:
  - Four daily round trips between Seattle and Vancouver, BC (four hour headway, three hours travel time).
  - Nine daily round trips between Seattle and Portland, OR (headway in multiples of one hour, two hours thirty minutes travel time).

- Scenario Two:
  - Eight daily round trips between Seattle and Vancouver, BC (two hour headway, two hours thirty minutes travel time).
  - Seventeen daily round trips between Seattle and Portland, OR (one hour headway, two hours fifteen minutes travel time).

This information resulted in a decision to pursue an operating plan between the two scenarios studied:

- Four daily round trips between Seattle and Vancouver, BC (four hour headway, travel time two hours and fifty-seven minutes); and
- Thirteen round trips between Seattle and Portland, OR (headway in multiples of one hour, travel time two hours and thirty minutes).

Based on these studies, the 1993 Legislature passed EHB 1617 which was codified in RCW 47.79. This legislation established the high-speed ground transportation program and set goals for top speeds. It directed that the program implement the recommendations of the High-Speed Ground Transportation Steering Committee report of October 15, 1992.

The legislation recognized that the development of public support for high-speed ground transportation was essential, so it mandated that "high-quality intercity passenger rail service shall be developed through incremental upgrading of the existing service." These reports clearly demonstrated that development of a new rail corridor – especially in western Washington – would be extremely costly – both in terms of monetary investment as well as disruption to existing communities and the environment. This would be accomplished through improvements such as: depots, grade crossing improvements or elimination, enhanced signals, revised track geometry or additional tracks, and contracting for new or additional service on the system.

Based on these early analyses, some infrastructure improvements were made to stations and tracks throughout the State.[1] While the program's initial goals were being met, planning continued in an effort to identify the appropriate technology and route for intercity passenger rail in Washington State. The range of technology reviewed included improved conventional rail, tilt body trains, conventional high-speed rail, and maglev.

Further studies were conducted resulting in the *Washington Rail Capacity Analysis* (October 1994) and *Options for Passenger Rail in the Pacific Northwest Rail Corridor* (1995). The modeling included information about the characteristics of the existing rail network such as: grades, curve radii and banking, track and switch classifications, allowable speeds, performance characteristics of the various locomotives and trains using the system, and the schedules for all trains using the corridor. From this, a detailed database was created that could be used to calculate simulated train operations and movements including schedules, meets (conflicts) with other trains, bottleneck locations, and delays due to lack of track capacity and other factors. Future projected freight and passenger traffic levels, desired running speeds and times between locations, desired schedules, and equipment characteristics were run through the model. Through an iterative process, the model identified a particular set of improvements that would safely provide the desired operations.

[1]***Appendix A*** *presents a summary of this work which was implemented and completed throughout the early and mid-1990s.*

Following release of the *Options Report*, more detailed analysis began. Throughout the mid- and late-1990s, WSDOT prepared and released the *Pacific Northwest Rail Corridor Intercity Passenger Rail Plan for Washington State, 1997-2020* (December 1997, revised December 1998, and April 2000[2]. In addition, a programmatic, corridor-wide environmental analysis[3] was produced in 1998 to ensure that corridor operations would not adversely affect communities and the environment along the BNSF main line.

This *Operating and Capital Plan* is one component of a revised Amtrak *Cascades* Long-Range Plan.

Has WSDOT coordinated with other agencies while developing these plans?

Beginning with the first planning study for intercity passenger rail service along the Pacific Northwest Rail Corridor, WSDOT has been working closely with Amtrak, BNSF Railway Company (BNSF), the state of Oregon, the province of British Columbia, local and regional agencies, ports, and Sound Transit.[4]

How has Sound Transit's *Sounder* commuter rail program been integrated into this planning effort?

Infrastructure and operation planning for *Sounder* was integrated with Amtrak *Cascades* planning, beginning in 1991. This early coordination and planning ensured the most economical use of infrastructure. It also ensured the absence of conflict between the two passenger rail services.

Development of the *Sounder* program has continued independently of PNWRC development since 1996. However the infrastructure plan remains similar to the original integrated plan, and WSDOT's operation planning continues to integrate the *Sounder* and Amtrak *Cascades* services.

---

[2]*Supporting documents included the Pacific Northwest Rail Corridor Operating Plan 2003 and 2018 (December 1997) and the Pacific Northwest Rail Corridor Economic Analysis for the Intercity Passenger Rail Program for Washington State 1998-2020 (September 1998).*

[3]*Pacific Northwest Rail Corridor Environmental Overview for the Intercity Passenger Rail Plan for Washington State 1998-2018, December 1998.*

[4]*Sound Transit, the regional transit provider in the Puget Sound area, is developing commuter rail service (Sounder) between Everett and Lakewood. This service shares rail right of way with Amtrak Cascades service.*

What is WSDOT's relationship with the state of Oregon and the province of British Columbia?

The Pacific Northwest Rail Corridor was developed around three levels of service:

- between Eugene, OR and Portland, OR;
- between Portland, OR and Seattle; and
- between Seattle and Vancouver, BC.

The state of Oregon participated in the early planning work for the corridor, concentrating on the Eugene, OR to Portland, OR segment. Although it begins in Oregon, the Portland, OR to Vancouver, WA segment is associated with the Portland, OR to Seattle segment. As such, most of the planning work for this segment has been conducted by WSDOT.

Approximately one-fourth of the Seattle to Vancouver, BC segment is located in British Columbia. The province of British Columbia participated in some of the planning work before 1995, but most of the program development has been conducted by WSDOT.

WSDOT has taken on the responsibility of planning passenger rail service in parts of Oregon and British Columbia because both fall within a service segment which lies predominately in Washington. The lack of detailed plans for the segments outside of Washington would result in the inability to continue Amtrak *Cascades* program development in Washington.

Does this operating and capital plan consider the segment between Portland and Eugene, OR?

Passenger rail service between Eugene, OR and Portland, OR can be considered separately. Planning for this segment was not carefully integrated with this infrastructure plan. As of this writing, the future of the Oregon portion of the program is unclear. Assuming that some service will be operated, service may be extensions of any of the Portland, OR to Seattle service, with Oregon supplying additional train equipment as needed.

What is contained in this document?

This document contains an explanation of the methodology used to develop this operating and capital plan. In addition, an overview of existing corridor conditions is presented. The operating plan contains service goals, timetables, crew and equipment plans, and track charts. The capital plan outlines the projects which will be necessary to achieve the identified service goals. Equipment, which will be required to operate the Amtrak *Cascades* service, is also presented.

This page intentionally left blank.

Chapter Two: Methodology

This chapter presents the detailed assumptions, data and methodology that were used to identify the capital improvements necessary to meet the Amtrak *Cascades* service goals - while not negatively impacting the ability to move freight. By iteratively analyzing rail operations and infrastructure, the original service goals (developed during previous planning efforts) were reconfirmed, and other service options were also identified.

The steps required for revising this operations and capital plan included:

1. Identification of existing conditions - physical, operational, and institutional;
2. Development of assumptions based on existing conditions;
3. Identification of appropriate methodology for developing the operating and capital plan;
4. Iterative process of operations and infrastructure development; and
5. Refinement of timetables, crew and equipment plans, and capital projects.

This chapter focuses on the first three steps of this process.

What are the current physical conditions along the rail line?

Amtrak *Cascades* service operates along the Pacific Northwest Rail Corridor (PNWRC). This corridor extends from Vancouver, BC to Portland, OR along the BNSF Railway Company's (BNSF) north-south main line.

There are three short exceptions to BNSF ownership of the route. Pacific Central Station in Vancouver, BC is owned by VIA Rail Canada. The Fraser River Bridge is owned by the government of Canada and operated by Canadian National Railway. Portland's Union Station is owned by the Portland Terminal Railroad, which is owned jointly by Union Pacific (UP) and BNSF. Most of the rail operation along the corridor is controlled by BNSF.

BNSF's predecessors — the Great Northern Railway, Northern Pacific Railroad and the Spokane, Portland and Seattle Railroad — originally constructed the Pacific Northwest Rail Corridor route as several different routes. The oldest part of the line was constructed in 1872, the newest in 1914. In the intervening years, many sections of the rail line were constructed, including some that replaced part of the original track.[1]

[1] *Generally the sections of line that were relocated had relatively steep grades.*

Improvements since 1914 have generally consisted of improved signal and traffic control systems, and tracks leading into or supporting industrial zones (that were built after 1914).

In addition to BNSF's rail traffic, the rail line also has several tenants:

- Canadian National Railroad between Townsend and Vancouver Junction;
- VIA Rail Canada and Rocky Mountain Railtours passenger trains between Fraser River Junction and Pacific Central Station;
- West Coast Express between CP Junction and Vancouver Junction;
- Canadian Pacific Railroad between Townsend and CP Junction;
- Canadian National Railroad and Canadian Pacific (operating on a line of BC Rail) at Colebrook;
- Sound Transit between Lakewood and Pacific Avenue;
- Union Pacific between Portland, OR and Interbay (Seattle); and
- Amtrak (including the Amtrak *Cascades*) between Portland, OR and Vancouver Junction, BC.

The current rail line consists of two tracks between Portland, OR and Seattle except for a one and one half mile single track section between the Nelson Bennett Tunnel and Ruston, south of Tacoma.

Between Seattle, WA and Everett, WA, the line alternates between single track and two tracks. Beginning in Seattle, there are 3.3 miles of two tracks, 2.1 miles of single track, two miles of two tracks, 0.3 miles of single track, 8.2 miles two tracks, 1.9 miles single track, 9.2 miles two tracks, 0.8 miles single track, and 4.3 miles of two tracks. The remainder of the line is single track except for 9.5 miles of two tracks between New Westminster and Still Creek in the Vancouver terminal area.[2]

What are the current traffic conditions along the rail line?

The amount and type of rail traffic affects infrastructure requirements. A section of rail line with only through-train movements, and a section of rail line with through-train movements and a great amount of local industry switching, require very different infrastructure arrangements. A section of line with great speed differential, not just between passenger and freight trains but also among types of freight trains, also requires different consideration. Traffic on the corridor varies from day to day, and season to season, however patterns in the traffic are typical. The movements are discussed in only

[2] *More information about the current rail line, its characteristics, and its facilities can be found in **Appendix B** of this document.*

general terms, but infrastructure planning considered every through and local freight movement in detail.

The following discussion presents traffic information from south to north along the corridor.

Portland, OR to Vancouver, WA

- Fifty through train movements including trains that originate or terminate at Lake Yard, Port of Portland Terminal 6, and Vancouver, WA;
- UP trains entering or leaving the line at North Portland Junction, and BNSF trains on the Pasco to Seattle route operating through Vancouver , WA;
- Sixty yard and transfer movements in the Vancouver yard area and between Portland, OR and Vancouver, WA with stops or initial/final stations of Lake Yard, Willbridge, East St. Johns, North Portland Junction (Port of Portland Terminal 6), and Vancouver, WA; and
- Four long distance Amtrak trains and six Amtrak *Cascades* trains per day.

Vancouver, WA to Rocky Point, WA

- Forty-four through train movements between Vancouver, WA and Rocky Point, many of which originate, terminate, or stop for work at Kalama or Longview Junction. The typical speed varies between thirty-five mph and sixty mph because of power to weight ratio;
- Two local freight movements between Longview Junction and Rocky Point, and two local freight movements between Kalama and Woodland. Main One at Kalama is typically occupied by local freight switching for six or more hours per day; and
- Two long distance Amtrak trains and six Amtrak *Cascades* trains.

Rocky Point, WA to Tacoma, WA

- Forty-four through train movements between Rocky Point and Tacoma. The typical speed varies between thirty-five mph and fifty mph because of power to weight ratio;
- Two round-trip local freight movements between Centralia and Napavine, one between Centralia and Chehalis, two between Tacoma and East Olympia; and
- Two long distance Amtrak trains and six Amtrak *Cascades* trains.

Tacoma, WA to Seattle, WA

- Twenty through train movements between Tacoma and Seattle. The typical speed varies between thirty-five mph and fifty mph because of power to weight ratio;
- Two local freight movements between Tacoma and Auburn, one between Kent and Thomas, two between South Seattle and Kent. Local freight service occupies the northward track at Orillia for three or more hours per day;
- Between Tukwila and Seattle, there are an additional one hundred or more movements per day including through trains operating between South Seattle or Seattle and Everett or Wenatchee, light engines moving between yards and the Interbay locomotive service facility, switching movements, and Union Pacific through trains on the shared trackage between Tukwila and Argo; and
- Two long distance Amtrak trains, six *Sounder* commuter trains, and six Amtrak *Cascades* trains per day.

Seattle, WA to Everett, WA

- Thirty through train movements between Seattle and Everett;
- Thirty local movements between Seattle and Interbay including trains between south of Seattle and Interbay, yard switching, and locomotives moving to and from the Interbay locomotive service facility; one or more local freight movements between Everett and Mukilteo for the Boeing plant. One or more times per week the Boeing movements handle wide loads that cannot pass other rail equipment on an adjacent track; and
- Two long distance Amtrak trains and four Amtrak *Cascades* trains per day.

Everett, WA to New Westminster, BC

- Two through trains per day between Everett and Burlington for movement to and from Sumas and six through freight trains between Everett and Brownsville or New Westminster, BC. There are occasional through train movements between Everett and Colebrook, which continue to Roberts Bank, a rotary coal dumper facility, or Delta port, an intermodal facility;
- One round trip local freight train per day between Everett and Burlington, one local freight train that works at Burlington about six hours per day then operates on the Anacortes branch, one local freight train between Everett and Bellingham, one local freight train between Bellingham and New Westminster, BC two local freight trains between Bellingham and the Cherry Point spur at Intalco, two local freight trains between New Westminster, BC and the Tilbury Island spur at Townsend; and

- Two Amtrak *Cascades* trains between Everett and New Westminster, BC and two between Everett and Bellingham.

New Westminster, BC to Vancouver, BC

- Forty Canadian National Railroad (CN) through freight trains per day between the Fraser River Bridge and Willingdon Junction or Vancouver, BC. Ten other freight movements use the Fraser River Bridge between Fraser River Junction and the junction at the north end of the bridge, to the Southern Railway and CN facilities in New Westminster, BC;
- At Vancouver, BC there are a large number of CN freight movements between the main yard and the waterfront yards. At Vancouver Junction, these movements cross the route used by passenger trains entering and leaving the Vancouver, BC station; and
- Two Amtrak *Cascades* trains per day and four non-daily passenger trains operated by VIA Canada and Rocky Mountain Rail Tours.

What assumptions were used as the basis for this operations analysis?

Prior to developing this (as well as the previous) operating and capital plans for the Amtrak *Cascades* program, a number of general and specific assumptions were made based on existing conditions along the corridor, as well as policies that were in place at the time. As mentioned previously, some of these conditions changed since the early operating plans were developed. **Appendix C** of this document presents:

- the general and specific assumptions that were used to develop the initial operating and capital plans;
- changes in policy and existing corridor conditions that affect these assumptions; and
- revised assumptions based on new conditions.

What was the general methodology for this analysis?

Once the existing conditions are identified and assumptions are developed, the planning method for analysis needs to be chosen. Following selection of the planning method, critical concepts need to be incorporated, allocation of responsibility needs to be clarified, and then the analysis is performed. Initial findings help lay the foundation for the iterative process between operations and infrastructure. The following discussion outlines this process.

Planning Methods

Freight and passenger rail operations can be analyzed in one of two ways: analytical methods and simulation.

Analytical Methods

Analytical methods were the accepted means of rail infrastructure and traffic planning until the widespread use of computer simulation software beginning in the 1980s. They involve detailed examination of the infrastructure characteristics, the traffic as individual trains and as traffic flow, and the interaction between the traffic and the infrastructure. Analytical methods provide excellent results, but may be time consuming or impractical in complex infrastructure networks because of the need to evaluate segments of the infrastructure individually rather than as a system.

Simulation

Simulation uses the experimental methods of natural science. The experiments are conducted by changing the traffic or infrastructure represented by special computer simulation software that is used only for railroad operation simulation.

The software simulates all partial processes of railroad operation in a specified infrastructure network. The infrastructure, and the physical characteristics and schedule of each train are represented in detail in a data table. The software includes a Train Performance Calculator (TPC), which includes the effects of signal and traffic control system requirements on the trains. The TPC calculates the movement of each train, and other portions of the software act as the traffic control system, providing movement instructions for the trains in accordance with a set of traffic control principles. Often, simulations are called “Train Dispatching Simulation” because they simulate the actions of a Train Dispatcher as well as the movement of the trains.

The simulation method used alone may also involve some degree of hypothesis in deciding what infrastructure and traffic arrangements to establish as the experiment. The experiments (track and/or traffic arrangement to test) are generally determined by an assessment of a reasonably expected solution to the apparent problem. This is why the use of simulation in planning is sometimes called a heuristic (trial and error) method.

The simulation software records track usage, travel time, scheduled station dwell, delay, and adherence to schedule.

Once the simulation is performed, analysis of the output is required. Two analysis approaches are typically utilized:

Statistical Analysis
Evaluation of the simulation generally consists of comparing a statistical analysis of delays and travel time in the new and original situations. The generally used statistic is Delay Ratio, which is the ratio of delay to elapsed time. If a train arrives at its final station one hundred minutes after leaving its initial station and was delayed en route ten minutes, the delay ratio is ten percent. The measurement used in comparison is sometimes delay per one hundred train miles. The delay statistics can indicate the traffic condition, but cannot indicate why the condition exists. Conclusions generally assume that delay and capacity are related. Analytical methods can demonstrate that there is not necessarily a simple and direct relationship between capacity and delay. Thus, simulation and statistical analysis, used exclusively, may not produce accurate results.

Root Cause Analysis
Root cause analysis of simulation output is the basis of a more effective means of evaluating simulation output than statistical analysis. Delays, in addition to having an inconsistent relationship with capacity, may occur at places distant from the cause of the delay. The train dispatching portion of the simulation may hold a train at some distant place where it can be passed by other traffic rather than let the train move to the point at which it can go no further. If a number of delays occur at a station, it may be that it is the only station that has adequate trackage rather than the only one that has not. Knowing where trains are delayed and for how long is often insufficient information. Since simulation programs often do not record the reason for delays, root cause analysis involves a time-consuming process of checking the output reports for each delayed train and comparing that train with other traffic to determine the cause of delay.

Root Cause Analysis can be followed by analytical methods research to determine the nature of the constraint. This research provides the revised infrastructure or traffic arrangement to be tested by simulation.

Critical Concepts

An understanding and application of some key concepts also provides a strong foundation for rail operations analysis. These key concepts are capacity and delay, and travel time.

Capacity and Delay

Capacity is the central element of infrastructure planning. Capacity depends not only on the infrastructure, but also on the traffic. The capacity for short trains moving at a uniform speed is different from the capacity for long trains moving at a uniform speed, which is different from the capacity for trains of different lengths moving at different speeds.

Capacity is often discussed in terms of trains per day, but that is not necessarily a practical measure. Freight and passenger traffic both have specific commercial requirements that include the time that trains are operated. There is a greater demand for commuter trains during the two “rush hours” than at any other time of the day. There is a greater demand for corridor passenger trains during the day than at night. There are also demand periods for freight trains. Freight customers generally ship a day’s production at the end of the workday or at the end of a shift. They generally want material and empty cars for loading ready when they open, or at the beginning of a shift. The effect is less pronounced with intermodal shipments, but it is similar.

The effect is also less pronounced with arriving trains than leaving trains. At the close of business, cars in Seattle, for example, may be arranged into trains for Birmingham, Chicago, Kansas City, Minneapolis, Denver, and Spokane. There is some deviation in leaving time because of yard capacity and differing travel times, but the trains generally leave within a period of a few hours. The arrival of trains is affected by the travel time from the initial station. A train for Seattle may be one of the many trains leaving Birmingham, Chicago, Kansas City, Minneapolis, Denver, and Spokane during each business demand time. Each will have a different travel time and thus arrive at Seattle at a different time.

Freight trains can no more be arranged for a time convenient for passenger trains than passenger trains can be arranged for a time convenient to freight trains. It is not commercially feasible. The ability to accommodate traffic when it meets the commercial requirements is “commercial capacity.” A railroad with a capacity of fifty trains per day (two trains per hour) may have insufficient capacity for twenty trains per day because the commercial capacity requirement is three trains per hour during some part of the day. Planning activity must consider capacity in smaller units than a day. Examination in trains per hour is generally sufficient, although it may yield amounts that have a strange appearance, such as 0.75 trains per hour, meaning that in a period of four hours, the capacity is three trains.

Delay occurs when there is more traffic than there is capacity. The delay will end when there is sufficient capacity for the train that was delayed. Reliable service is the absence of unexpected delays. Thus, capacity and reliability are related. The closer the volume of traffic is to the actual capacity of the line, the greater the probability that it will, at times, exceed capacity and delay will occur. Ensuring reliable operation requires ensuring sufficient capacity at the time it is needed, or in some cases, that the times of insufficient capacity are predictable. An example of the latter is the location of sidings on a single track line. This is a relatively straightforward task on tracks intended for the exclusive use of passenger trains. It is more difficult when unscheduled/improvised freight trains must be considered. In that case, capacity must be configured to the expected traffic, the maximum capacity of the element with least capacity. For example, the yard at Longview Junction has a single lead at each end. The maximum capacity required at Longview Junction is two trains; the number of trains that may use the yard simultaneously. If the normal traffic pattern involves more than two trains attempting to use the yard at Longview Junction simultaneously, the excess may be held at another location, where track construction to accommodate them may be more practical.

Travel Time

One of the most important elements of infrastructure and traffic planning is travel time. Detailed information for train speed, acceleration rate, braking rate, the effect of differing combinations of cars and locomotives, the effect of grades, and other related information is the basis for almost every infrastructure and traffic decision. The required information may be obtained through determination of the propulsive and resistive forces acting upon the train, and calculation of equations that provide speed and acceleration. Each determination and calculation is applicable only to a specific point in time. The calculation must be repeated to describe the movement of the train from place to place.

TPC software, which was discussed earlier in this chapter, describes the movement of trains by making the determination of forces and the calculations at frequent intervals (such as one second) throughout the movement of the train. Many forces acting upon a train change with speed or location, so the result from each calculation becomes the basis for determining the forces used in the next calculation.

In addition to the forces acting upon the train, the TPC must consider the speed limit and schedule, ensuring that a calculation does not result in exceeding the speed limit or overrunning a scheduled stop. Some TPC software calculates the exact amount of propulsive or resistive force required to achieve the goal speed and to stop at schedule locations. Many trains, however, have controls with several discrete positions of power and/or braking, and certain restrictions on the application of either. The method of calculating the exact amounts of force required may be significantly inaccurate. As part of determining the forces acting upon the train, the TPC software used for planning PNWRC traffic and infrastructure considers the positions discrete of power and braking controls and the restrictions on their application.

Evaluation of Responsibility

Railroad traffic operates in a closed system of infrastructure in which any element can affect many other elements. This characteristic can make evaluation of the responsibility for capital projects difficult. Generally, a passenger program must "keep the railroad whole." The concept is also called "maintaining the level of utility." Whole is difficult to define and difficult to achieve. The railroad industry in general has difficulty in obtaining sufficient capital for its requirements. Therefore, railroad operation is often not optimal. "Keeping the railroad whole" appears to mean operating the new service while retaining the same sub-optimal freight operation. That is not practical.

A project may be essential to passenger service and have unintended benefit for freight service. A project associated with a passenger program may involve construction of facilities which address an existing freight traffic problem which the railroad does not consider severe enough to solve system wide, but is essential to the passenger service. The only way in which an element of infrastructure may benefit only one user is to dedicate the use of that element to only one user. This type of separation is generally not a practical use of rail right of way and facilities.

The degree of the unintended benefit may not pass the 'recovery of cost' test of the railroad. The degree of intended benefit, in the case of projects that address existing freight traffic problems, may also not pass the cost recovery test of the railroad. A series of passenger projects may produce an aggregate benefit that would pass the cost recovery test, however. Cost-sharing of projects is a matter for negotiation, which can be facilitated by an objective evaluation of benefit as a basis for discussion.

Simulation can provide an objective basis for discussion. The output may be used for statistical analysis, or for a detailed evaluation of operating cost. However, because a simple change in the order or schedule time of trains can change the amount of delay significantly, all of the simulations must address only one variable. Thus, objective evaluation requires a carefully constructed schedule of simulations that may take weeks or months to conduct. **Appendix D** provides more detailed information.

Which analysis technique was used for this operating plan?

The best planning result comes from a combination of analytical methods and simulation, taking advantage of the capabilities of each. All Amtrak *Cascades* service planning was conducted by using analytical methods to determine infrastructure requirements, testing with simulation, and evaluating the simulation output with root cause analysis and analytical methods, as well as statistical analysis.

The initial feasibility study generated the commercially required running time and service frequency. All subsequent activity was directed at achieving that goal in the most economical manner. The long-term approach was to determine what changes would be required for the proposed traffic speed and density without regard to division of benefit and responsibility, leaving those considerations to subsequent negotiation.

Specific signaling solutions beyond the need for centralized traffic control (CTC), the ability to operate at relatively short headway, and the need for some type of cab signal/automatic train stop to allow high-speed were not identified. The long-term result was simulated assuming that separate analysis would generate the signal system required to provide the desired transportation result.

This procedure was applied twice. The first was during the initial design process. The second was after changing conditions made plan revision necessary (see **Appendix C**). The description of the steps in the process includes the assumptions of the first application of the procedure.

Step One: Existing Congestion

The first step was to identify solutions for existing congestion that limited any increased passenger service or caused reliability problems for existing service. These areas would require correction regardless of the long term goal. This involved analysis of the activities generating the congestion such as trains stopping on main tracks to set out, pick up or switch, trains bunching because of congestion at other locations, and crew changes. Generally, these solutions turned out to be rather straightforward: If trains stopping for these activities could do so clear of the main tracks, capacity would increase greatly. Each solution was designed to accommodate the traffic expected in thirty years, ten years after full development of the program.

Step Two: Running Time Goal

The second step involved determining the changes necessary to achieve the running time goal. This part of the program development used the assumption that in terminal areas, passenger trains would operate at conventional speed in order to reduce the need for capacity that is caused by a great differential between passenger train speed and freight train speed. In some cases this involved limiting passenger train speed to less than could be achieved, for example fifty mph instead of sixty-five mph, because track geometry limited freight train speed to thirty-five mph, which could not be increased. A Train Performance Calculator was used to determine the running time using a maximum speed of 125 mph and also a maximum speed of 110 mph outside of the terminal areas. One line change, the Point Defiance Bypass between Reservation and Nisqually (near Tacoma), was assumed. The Point Defiance Bypass is shorter than the current route and can support significantly higher train speed than the current route. The running time difference between 110 mph and 125 mph outside of the terminal areas was just under three minutes. Since the goal transit time was achievable at a maximum speed of 110 mph, the cost of highway grade separations and additional curve realignment required for 125 mph prompted the decision to make the maximum speed 110 mph. This step also demonstrated the need for the White Rock Bypass (in British Columbia), which was added to the assumptions for the corridor.

Step Three: Track Geometry Changes

After the initial running time determination, the route was examined for the track geometry changes required for 110 mph. Realignments and line changes required to support 110 mph that were in environmentally sensitive or difficult to construct areas were eliminated. In doing so, the speed limit in each of these areas was assumed to be ninety mph. Ninety mph was chosen to allow freight trains to operate at sixty mph on the entire line. The existing freight train speed limits ranged from forty mph to sixty mph. Where tracks might be shared because a third track was not necessary merely to support speed, the speed differential would be kept to no more than the same thirty mph (passenger seventy-nine mph, freight fifty mph). Tests with the TPC showed that freight trains could achieve sixty mph over most of the line using the normally assigned power and that a fuel savings resulted from the sixty mph speed limit. The saving was a result of the effect of momentum on ascending grades and the uniform speed limit. After each change, the running time was tested with the Train Performance Calculator.

Elimination of 110 mph trackage continued for each difficult location in reverse order of probable magnitude of difficulty as long as the goal transit time could be reached.

Step Four: Infrastructure Examined

Once the location of the necessary 110 mph track was determined, the infrastructure required for passenger train operation was examined. Operation was assumed to be a single track, passenger train only line. Northward and

Southward trains at the service goal of one hour interval were drawn on separate overlay layers of a stringline. Trains in one direction were left stationary and trains in the opposite direction were time-shifted. The points at which opposing passenger trains met were examined. Meeting points in terminals or other congested areas were avoided to the extent possible. Meeting points where the speed was to be 110 mph were also avoided, since that would require a second high-speed track. Time-shifting continued until the best set of meeting points were found. At any meeting point, the need for a third main track was assumed, leaving one main track available for freight service at meeting points. At all points where a third main track ended, crossovers allowing simultaneous movement on any combination of two of the three main tracks were assumed.

Step Five: Simulation Testing

Once this entire process was completed, simulation testing of freight and passenger traffic together was begun.[3] Freight traffic was assumed to be that expected in thirty years, ten years after full program development. From this testing, the need for additional infrastructure to support the freight-passenger combination was determined. After determining the infrastructure required for the entire project, phases in which capital projects could be matched to specific increases in service or reduction in transit time were determined. Each capital project was assumed to be a complete portion of the final project so that no work in any phase would be rendered obsolete and be removed by work in a future phase. A project enabling the addition of only two new schedules would have the ability, in isolation, to support hourly 110 mph service and the freight traffic anticipated in thirty years.

What were the initial findings?

The initial result of the analysis was an arrangement of high-speed and shared track along the corridor, with less high-speed than shared track. Shared segments required two or three tracks, except portions of the single track line

[3]Passenger service was arranged to meet the service goal with the least possible infrastructure. Once the optimal pattern was found, the pattern could be moved through time, e.g. trains leave Seattle on the hour or five minutes after or fifteen minutes after, etc.

Long distance service is not as predictable as corridor (Amtrak Cascades) service. Schedules must accommodate the commercial and operating requirements of a number of distant places. Long distance trains travel great distances over rail lines that often have insufficient capacity, resulting in delay to the passenger trains. These characteristics make long distance trains as unpredictable as freight trains for the purpose of infrastructure design.

Freight service was assumed to operate at no more than the maximum capacity of terminals and connecting lines that supply and absorb the traffic. Burlington Northern [later Burlington Northern Santa Fe] provided transportation schedules from which "typical" traffic days were developed. When the traffic provided exceeded the capacity of the freight facilities, the delay was not considered as an effect of the PNWRC program.

north of Everett, WA. High-speed segments were single track throughout (in addition to the existing double track south of Tacoma, WA). The line between Everett and Blaine, WA was an exception, with freight and high-speed trains sharing a generally double track line with sidings. Examples of this methodology and initial results can be found in **Appendices D and E** of this document.

The analysis also concluded that the needed capital improvements could be implemented incrementally in order to achieve increased service goals.

When working forward, it is easy to identify a service level and construct infrastructure specifically for that service level. When another service level becomes appropriate, crossovers or sidings constructed for the previous level may be in the wrong place to support the new schedule. By eliminating restrictions of the same "size" with infrastructure that supports the fully developed plan, and designing the improved service to the infrastructure, no project is made obsolete by a future project. Scheduling is more difficult "working backward" than "working forward," but the product is more cost-effective.

"Working backward" also provides the advantage of knowing the future requirements and approaching economy in a second way. Each project is designed to accommodate full development of the program so that no project needs to be modified after construction.

Chapter Three: Operating Plan

This chapter presents the operational components of the Amtrak *Cascades*' twenty year operating and capital plan. As discussed earlier in this document, service south of Portland, OR was not analyzed nor is it discussed in this plan. The ridership projections for the Amtrak *Cascades* operating plan assume there will be connecting service in Portland, OR to Oregon stations currently served by Amtrak *Cascades* trains. The service may be rail, bus, or a combination. Through-trains between Seattle and Eugene, OR were not assumed.

The Amtrak *Cascades'* train schedules have been developed using principles and methods that are common in Europe and were once common in the United States. These principles and methods are necessary for efficient and reliable service. They include the detailed consideration of infrastructure, detailed consideration of the interaction between trains, and the allocation of infrastructure to schedules. The degree of sophistication expected in daily operation will require the Pacific Northwest Rail Corridor (PNWRC) program to take an unusual (for U.S. passenger rail service) approach to some of the elements of operation.

This approach has been broken down into four components. These components are:

- scheduling;
- timetables, crew and equipment plans;
- train dispatching; and
- operations management.

Each of these components is discussed below.

How were Amtrak *Cascades*' schedules developed?

The Amtrak *Cascades* program has six levels of incremental implementation. Each level of implementation is the result of capital projects that eliminate the greatest capacity limitation(s) of the corridor.[1] Each of the service and operating plans for the six increments generally reflects the greatest amount of

[1] *Although these projects together provide the foundation for the specified service level, each project was carefully developed to ensure that it solves a specific problem within the immediate geographic area. The projects were developed with this independence to ensure that taxpayer's money would not be wasted if all projects were not completed. Each project alone contributes to the incremental development of the overall passenger rail system.*

passenger traffic that can be reliably operated after completion of the infrastructure projects associated with that level of service.

Scheduling techniques include a consideration of service requirements, detailed planning, and general operations.

Service Requirements

For each incremental improvement, the service plan distributes the available number of trains evenly throughout the service day. Intercity passenger service does not generally have the defined peak and off peak periods of commuter service. To the extent possible, the service allows a day trip between any of the three large cities on the route, and the ability to travel to one of the cities during the day and return in the early evening. The last schedule of the day from each terminal is not late enough for return from most music, theater, or evening sports events, however.

Detailed Planning

All of the scheduling has been performed by manual methods, using running times generated by Train Performance Calculator (TPC) computer software. The procedure is generally the same as standard practice in Europe before the availability of sophisticated scheduling software. As traffic density increases, scheduling needs will become dynamic -- accommodating service disruptions, Amtrak long distance trains, and special event trains. Sophisticated schedule planning software that considers all details of infrastructure and train operation will be necessary.

Developing an operating plan involves iteration among scheduling, crew planning, and equipment planning. The service plan demonstrates the approximate service that is required. Transformation to an operating plan involves the operation of trains within the limitations of the infrastructure with the minimum possible amount of crew and equipment costs for the desired service.

Before implementation, especially in later stages when the margin for error decreases, the exact procedures at station stops should be implemented. Passengers should know ahead of time where they must be on the platform. The same cars should always open at each station to eliminate passenger confusion and ensure that trains need not wait while out-of-position passengers walk to the appropriate car. The narrow doors of Talgo cars and the luggage space near the doorways increase the importance of efficient boarding procedures. Efficient station procedures can reduce travel time at no cost. Station dwell times for Amtrak *Cascades* schedules is one to three minutes.[2] For comparison, dwell time for trains in Hamburg, Germany (similar in size to Seattle) is four minutes. Timetables are presented in **Appendix F** of this document.

General Operations

When developing schedules for the Amtrak *Cascades* service, three critical components of the overall operations along the corridor were considered and included in schedule development: reliability, freight operations, and passenger operations.

Reliability

Reliability is essential to a successful transportation service. The Amtrak *Cascades* plan was developed assuming a high degree of reliability. There are two elements of reliability; planning and execution. The operating plan considers both elements and includes operating procedure recommendations as well as infrastructure plans.

An important element in reliable Amtrak *Cascades* service is the service in Oregon. In current operation, only one train runs through from Eugene, OR to Seattle, WA. This train does not have a high degree of reliability; however, when it is late it does not affect other Amtrak *Cascades* service. This train has unusually long dwell time at Portland, OR to mitigate the effect of the unreliable service. The other Eugene, OR to Seattle, WA service requires a change of train at Portland, OR. The equipment leaves Portland, OR on the subsequent schedule to ensure that unreliable service in Oregon does not affect other Portland, OR to Seattle service.

Timetables A and B allow continued Eugene, OR to Portland, OR service using equipment dedicated to Portland, OR to Seattle to Vancouver, BC service. The current arrangement continues. The first train operates through, with an extended dwell at Portland, OR and the second train makes a passenger connection and remains in Portland, OR for the next schedule.

If through service between Seattle and Eugene, OR is operated in Timetables C through F, reliability will be essential. The equipment turnaround times and the single track meeting points cannot accommodate unreliable connections at Portland, OR. Detailed planning must be undertaken in Oregon to address not only general capacity problems and running time reduction, but the exact combination of infrastructure and operation needed for reliable operation.

---

[2] *Except fifteen minutes at Seattle in Timetables C through F (twenty-five minutes in Timetables A and B).*

As the capacity of the infrastructure increases during the program, the dwell time of through trains at Seattle and the turnaround times at Seattle and Portland, OR diminish. In Timetable F, terminal turnaround times are as little as twenty-six minutes. Such times are not common in U.S. operation; however, they regularly occur in Europe. This can be accomplished with careful attention to the schedules and ongoing operation. Careful attention to ongoing operation includes attention to the management of freight traffic.

Freight Operation

The infrastructure arrangement for the PNWRC program generally separates the passenger service from freight service except in terminal areas. In these areas, urban development and geographical constraints make separation impractical. Separation is also not necessary. In these areas, the Amtrak *Cascades* trains operate at conventional speeds and are operationally no different than conventional passenger trains. The infrastructure plan for the areas of shared operation allows the greater flexibility and capacity of main tracks and access to yards than is typical for freight railroads.

The Amtrak *Cascades* trains operate on a detailed schedule developed with the greatest possible accuracy. Freight service is typically improvised. In areas that are shared with freight service, the schedule is effectively a reservation for specific elements of track at specific times. In general, the capacity that has been provided for freight service is greater than the existing capacity, allowing Amtrak *Cascades* trains to move as scheduled without deteriorating freight service. Therefore, the operating plan assumes that the required trackage will be available to the Amtrak *Cascades* trains as scheduled. At Centralia, Kelso, and Vancouver, WA passenger trains may use either of two tracks approaching the station without running time penalty. This arrangement allows greater flexibility and greater opportunity for freight movement without delay.

Schedules are arranged to avoid operation of more than one Amtrak *Cascades* train between Portland, OR and Vancouver, WA simultaneously. The infrastructure arrangement provides two segments, Portland to East St. Johns, OR and East St. Johns to Vancouver, WA with crossovers between the segments that allow Amtrak *Cascades* trains to use a different track in each segment without running time penalty. This provides significant flexibility to maintain freight operation.

Entirely improvised freight operation cannot be expected to continue as the program develops. Some degree of freight service planning is necessary. This is not a deterioration of the existing condition, as current improvised freight operation has some significant deficiencies. The most important element of freight operation in the shared terminal areas is holding trains out of yards on main tracks, blocking the flow of through traffic. Sidings have been provided in the infrastructure plan that can be used to accommodate trains that are to be held out of yards at some subsequent point. More important than trackage for holding trains is increased planning and flow control ability. The same tactical planning ability that is essential to sophisticated passenger operation is also essential to achieving reliable freight operation. The scheduling software used for tactical planning must be capable of accommodating all operation on the line.

Passenger Operation

Passenger rail service, in addition to the Amtrak *Cascades*, plays a critical component in program planning.

Amtrak *Cascades*

The operation of Amtrak *Cascades* trains, especially in the later stages (Timetables E and F) involves short turnaround times at terminals. Scheduled operation must be maintained at all times. The Amtrak *Cascades* schedules were developed with five minute schedule tolerance, meaning that a train which is five minutes late is considered on time for the purpose of service measurement and operation. A train which is five minutes late may operate as if it is on time without causing other Amtrak *Cascades* trains to be delayed. An Amtrak *Cascades* train that is late by the amount of recovery time (in Timetable F, eleven minutes between Portland, OR and Seattle and twelve minutes between Seattle and Vancouver, BC), can leave the next terminal on time and will not cause any other Amtrak *Cascades* train to become late more than recovery time.

Sounder

Sounder and Amtrak *Cascades* trains share the crowded Everett to Lakewood corridor. Capacity is limited, and throughout most of the corridor the line is also shared with freight service. It is necessary for *Sounder* trains to operate on a detailed schedule executed with precision just as the Amtrak *Cascades* trains, in order to insure that neither service disrupts the other. This is further described in the section on Amtrak *Cascades-Sounder* integration located in **Appendix G**.

Amtrak Long Distance Trains

Amtrak long distance trains cannot be operated with the degree of precision that applies to Amtrak *Cascades* and *Sounder* trains. Although originating trains generally operate on time, they are dependent upon equipment from trains that may not be on time. Arriving trains are typically subject to delays while traveling over long distances on rail lines that have insufficient capacity. Therefore the movement of the Amtrak long distance trains must be improvised to some degree. However, once the Amtrak long distance trains arrive on the PNWRC line, their movement is predictable.

Proper handling of Amtrak long distance trains will require the same tactical planning ability needed for other services on the line. Wherever the high-speed tracks of the PNWRC are not needed for Amtrak *Cascades* trains, they may be used by Amtrak long distance trains. Where the Amtrak *Cascades'* schedule does not allow the movement of long distance trains on the high-speed tracks, the long distance trains will operate on the nominally freight tracks, which will still be shared use tracks under some conditions.

Service in Oregon

The Oregon portion of the PNWRC corridor has not undergone extensive planning. There is a general plan to operate Amtrak *Cascades* service through Portland, OR. Currently two trains per day operate through Portland, OR.

As of this writing, the future of the Oregon program is somewhat unclear. Therefore, in developing the Amtrak *Cascades* operating plan, only Timetables A and B provide for continued Seattle to Eugene, OR through train service. In Timetables A and B, Seattle to Vancouver, Amtrak *Cascades* service is not dependent upon decisions made in Oregon as long as the schedule times at Portland match those of the Seattle – Portland timetables. Timetables C through F have no provision for through train service between Seattle and Eugene, OR. If the Oregon program is further developed and trains will continue to operate through between Seattle and Eugene, OR it will be necessary for Oregon to provide sufficient equipment for the additional service. It will also be necessary for the Oregon service timetables to match the Amtrak *Cascades* timetables at Portland. The infrastructure constraints that have been designed into the Amtrak *Cascades* incremental program do not allow service south of Portland, OR to be accommodated by changes in service north of Portland. The same principles and methods that have been applied to PNWRC planning between Portland, OR and Vancouver, BC should be extended to include planning between Eugene and Portland, OR.

Other Passenger Services

Other passenger services include special trains for sporting or other events, extra service during peak holiday periods, and excursion trains. These trains cannot be planned in advance in the manner of the Amtrak *Cascades* and *Sounder* timetables. However; in order to integrate with other passenger operation on the corridor, a detailed schedule of each of these services will be necessary. These trains, like Amtrak long distance trains, may use the high-speed tracks when they are available; however, in some segments they may need to use the freight tracks in shared operation.

How were crew and equipment plans developed?

A crew and equipment plan has been developed for each of the six incremental timetables, demonstrating crew requirements, equipment requirements, and scheduling considerations associated with each timetable.

Each of the timetables is a result of adjusting the service plan for that increment until practical schedules could be achieved, and crews and equipment could be distributed as economically as possible. One of the equipment planning requirements is availability of all trainsets at the maintenance shop in Seattle on a regular basis. The current Talgo maintenance agreement requires trains to be available at the maintenance shop at no greater than 3,150 mile intervals. Greater frequency is preferred in order to maintain cars to the standards that customers will expect.

General Requirements

General requirements for crew and equipment plans are:

- Through operation between Vancouver BC (Bellingham in Timetable A) and Portland, OR;
- Avoid significant change to other established service;
- Avoid conflict with *Sounder* commuter service;
- Ensure that all equipment can be at Seattle as needed for maintenance;
- Ensure that mileage is equalized among the trainsets;
- Best possible commercial arrangement of schedules;
- Minimum crew requirement;
- Avoid Crew Workday of more than ten hours;
- Avoid Layover Time of less than one hour;
- Minimize risk of hours of service tieup resulting from delay; and
- Provide greatest possible reliability and recoverability.

Crew Workday

Each crew plan includes two relative efficiency measurements:

Crew Workday: the time between leaving the initial station of the workday and arriving at the final station of the workday plus one hour (thirty minutes before and after the scheduled trip) for preparation and administrative time and possible movement of the trainset into position for loading at the initial station or storage at the final station. The Crew Workday includes Layover Time.

Layover Time: the time between schedule arrival and schedule leaving time at the layover station. Not all of the layover time will be available to the crew for off-duty activity or rest, assuming the crew is responsible for the train until the passengers are unloaded and after passenger loading begins. The layover station is where the crew is not operating a train on a schedule during the Crew Workday.

Train and engine crews are paid a basic eight hour workday. Time in excess of eight hours during a Crew Workday is paid at overtime rate. It may be possible to negotiate agreements that consider overtime as time after forty hours in a workweek by constructing assignments that work a combination of long and short schedules during a work week, or establishing four day assignments that work forty hours or less in four days.

Train and engine crews (not onboard service personnel) are limited by federal regulation to twelve hours on duty in any period of twenty four hours. Layover Time is counted as on duty time unless the layover is of sufficient length to relieve the crew of all responsibility for four hours or more. For Layover Time of four or more hours to be considered a rest period rather than on duty time, the crew must be furnished with accommodations consistent with a rest period. The crew workday must be given some "reality check" consideration. In the urban areas of the two headquarters stations, Seattle and Portland, OR crews may commute more than one hour to and from the on duty point. A workday of sixteen hours (with the required interim off duty time) may leave less than six hours between workdays, outside of commuting time. A workday of eight hours is preferred for both economic and personnel reasons. A workday of more than ten hours should be avoided. The workweek for train and engine crews should have any workday of more than ten hours followed by another assignment of shorter duration and beginning late enough in the day to allow at least eight hours at home.

A continuous period of responsibility of more than six hours for a locomotive engineer may have some hazards associated with fatigue. Typically, a long workday for a freight service locomotive engineer includes long periods when the train is not moving and the engineer's responsibility is relaxed. Passenger train engineers do not have such periods, nor do they have the ability to turn most responsibility over to automatic systems as do commercial aircraft pilots. Regardless of automation and safety systems, the passenger train engineer must keep a constant lookout for conditions that are not detected by the automated systems. High-speed operation increases the fatigue hazard and reduces the practical length of a period of continuous train operation. For example, the engineer of a German high-speed train typically has a substantial layover after about three hours of train operation.

At full development, some of the crews have as little as a twenty-four minute layover. Although the workday for these crews is less than seven hours, the time at the controls of a high-speed train without a substantial break may be excessive. There is more than one way to address this situation. It is possible to have the conductor and engineer of the train interchangeable, both qualified locomotive engineers. Each crew member would work a one-way trip as locomotive engineer and a one-way trip as conductor. This still presents a workday of almost seven hours with a break of less than twenty-four minutes for some crews. It is possible to also improve this situation by using more crews and having some work only one way for a full day's work, which increases costs. Alternatively more trains can be operated providing the even distribution of trains which allows each crew to skip one departure and have a break of more than one hour between trips while remaining within an eight hour workday.

Crew Headquarters

The operating plan assumes two crew headquarters: Portland, OR and Seattle. If the necessary arrangements can be made, there may be some economic advantage to a crew headquarters in Vancouver, BC. A Vancouver, BC crew headquarters could eliminate the one-way crew trips and short Crew Workdays between Seattle and Vancouver, BC. It may also be useful in eliminating some of the long Vancouver, BC Layover Time and the associated long Crew Workdays.

No additional facilities would be required at Vancouver, BC, since it is already a crew terminal. The arrangements required would include at least Canada and U.S. Customs and Immigration, and the unions representing Amtrak train and engine service employees.

Equipment Plans

Each equipment plan has several equipment assignments. There is one assignment for each trainset needed for service each day. The equipment plan assumes that all trainsets are identical, or sufficiently similar to maintain the same schedule and have common passenger accommodations and amenities. Each plan has a rotation order for the assignments. Each trainset rotates through all assignments, one day on each assignment (except in Timetable B), in the same order, equalizing the mileage and maintenance of all trainsets.

Several terms specific to these measurements are used:

- Schedule Day: the time between the leaving time at the initial station of the first schedule of the day and the arriving time at the final station of the last schedule of the day;
- Calendar Day: twenty-four hours beginning at midnight;
- Layover Time: all time between schedules from the arriving time at the final station of a schedule until the leaving time at the initial station of the next schedule. Time not in service outside of the schedule day is not Layover Time for this measurement;
- Time in Service: Schedule Day minus Layover Time; and
- Seattle Time: the time a trainset is available to the maintenance shop, between the arriving time at Seattle and the leaving time at Seattle on the next schedule.

Each equipment plan includes some relative efficiency measurements:

- Time in Service: the amount of the schedule day that the equipment is producing revenue;
- Layover Time: the amount of the schedule day the equipment is not producing revenue; and
- Total Time: the amount of a Calendar Day occupied by the Schedule Day for that assignment.

Efficiency

A low percentage of Time in Service or Total Time, Crew Workdays in excess of eight hours, or Layover Time of less than one hour indicates that the service plan and the operating plan may not be completely integrated. In many cases better integration is not possible. Before full development, each of the Amtrak *Cascades* schedules provides the maximum amount of service allowed by the infrastructure. For Timetables A through E, the incremental improvements before full implementation, a service plan dependent upon the best operating plan would probably not meet commercial requirements. Thus, the operating plan is dependent upon the service plan.

As the number of trains increase and headway decreases, it becomes more difficult to match crew workdays with train service. Some of the crew plans include crew workdays in excess of ten hours and layovers of less than one hour. Some of the equipment plans do not have good equipment utilization for the same reason.

As the headway becomes shorter, the layover times for some crews may become shorter. When there are few trains, crews may have a very long work day which is broken by a long layover. In the intermediate stages of the program, the number of trains is based on the capacity that is made available by the projects for that increment of service. Inefficient distribution of crews or train equipment is generally a manifestation of the limitation on the number of trains by capacity. This assumes that at least as much service as the capacity allows is required or justifiable. At full development more consideration should be given to the ideal combination of service, crew distribution, and train equipment distribution.

In the early stages of the program, when long days are accompanied with long layovers, the consideration is cost. Since the amount of service is limited by the capacity and the distribution of service is limited by commercial requirement, the cost must be reduced as much as possible; but regardless of the cost reduction effort, the service will probably be inefficient. At full development, modification of the service is possible within the designed pattern. Therefore, at full development additional examination should compare operating cost and efficiency of the number of trains and the service requirement in order to optimize cost/service ratio.

There are several ways of addressing crew workday conditions in Timetables A through E, none of which are addressed by the example plans. It may be necessary to use assignment rotation, reduced administrative time at the beginning and end of the workday, or perhaps additional crews that may be less productive but would not be subject to fatigue hazard.

Inefficiency and fatigue hazard at full development (Timetable F) indicates that a careful ridership and cost analysis should be made to determine if a more efficient operation (increased crew and equipment utilization by either reduction or increase in service to match the capabilities of operation) is possible. The process involves iteration of service plan, operating plan, ridership projection, and cost analysis. One iteration of the analysis has been performed on Timetable F, the results of which are discussed in the section on 2023 Timetable Revision A.

Recovery

Unrecoverable schedules should be rare. If a train is recoverably late, it can leave the next terminal on time. Trains it meets will be made no more than recoverably late, and will also leave the next terminal on time. Delay beyond the amount of recovery time requires some situation-specific tactical planning to develop the appropriate means of recovery.

Sidings at appropriate locations (not discussed in the infrastructure plan) may be constructed to allow a train that is late by more than recovery time to continue operation without affecting on time trains; however, with turnaround times as short as twenty-four minutes, allowing an unrecoverably late train to continue may not be desirable. Sidings at appropriate places on the high-speed tracks may also allow less reliance on the freight tracks for Amtrak intercity trains and additional service.

Recovery, especially between Seattle and Portland, OR should generally involve turning a late train back at a given point so it can get back on schedule, if the delay occurs on the trip away from Seattle. If the delay occurs on the trip toward Seattle, one spare set of equipment will be available at Seattle (Timetable C and after) to start a schedule for which the arriving equipment is late. The late arriving equipment will then become the spare equipment. A service recovery plan should use the option that is appropriate to the situation.

Spare Equipment

The current Amtrak *Cascades* service has operated with no spare equipment for over five years. In that time, equipment has been available about ninety-eight percent of the time. This is the result of Talgo's aggressive preventive maintenance program. A grade crossing collision can remove a set from service for an extended time. Thus far, collisions have affected only the locomotive, which is more easily substituted than the specialized Talgo trainset. No later than the Timetable C, consideration should be given to one spare Talgo train set to ensure a continuation of normal service if a trainset is damaged.

As service becomes more intense, more than one spare set should be considered. By Timetable C, one spare Talgo train set should also be maintained in Seattle to provide service recovery from an unrecoverable schedule. By Timetable F, a total of three spare sets will provide a set for service recovery in the event of substantial delay, a set for service continuation in the event of damage, and one set for service continuation during maintenance that cannot be completed during a scheduled servicing layover between trips.

Extra Service

Extra or special service can be operated with spare sets as needed. The infrastructure plan will allow two Talgo trains on five minute headway, the first on time the second five minutes behind, without affecting service in the opposite direction. Other additional trains can be operated, but on a longer schedule, either using additional sidings constructed for late and extra trains, or by using the nominally freight tracks.

What are the specifics for each timetable?

The following presents the specific elements of each timetable regarding scheduling requirements, crews and equipment. **Appendix H** provides more detailed information regarding timetables, crews and equipment.

Timetable A

Requirements:

- Twenty-five minute Seattle dwell on Bellingham to Portland, OR trains to act as a delay buffer because of infrastructure deficiencies;
- Avoid the use of South Bellingham or Bow for passenger train meets because of freight service requirements;
- No scheduled passenger train meets between Reservation and 21st because of single track Tacoma station;
- Avoid scheduled passenger train meets between Portland, OR and Vancouver Junction North (in Washington) and between Woodland and Ostrander because of capacity limitation;
- Use only the five existing Talgo sets;
- Provide for the current level of Oregon Amtrak *Cascades* service; and
- Minimize sensitivity to late arrival of northward Oregon Amtrak *Cascades* service at Portland, OR.

Timetable A uses six crews and five trainsets per day.

Crews:

- One Crew Workday of fifteen hours with a five hour thirty minute Layover Time;
- One Crew Workday of fifteen hours twenty minutes with a seven hour thirty minute Layover Time;
- One Crew Workday of ten hours fifteen minutes with a two hour fifteen minute Layover Time; and
- Two Crew Workdays of four hours twenty five minutes

Equipment:

- One set operates between Seattle and Vancouver, BC exclusively. It operates 312 miles between availability for maintenance in Seattle, and is available for maintenance in Seattle daily for nine hours fifty minutes;
- Four trainsets rotate through four assignments. Each set is in service four days (1,688 miles) between availability for maintenance in Seattle and is available for maintenance in Seattle for ten hours;

- Three of the trainsets are in service for fifty percent of the calendar day or more. Maximum utilization is sixty percent of the calendar day; minimum utilization is twenty-six percent of the calendar day; and
- A maximum of two trainsets are in Portland, OR simultaneously during the schedule day and at night.

Timetable B

Requirements:

- Avoid the use of South Bellingham or Bow for passenger train meets because of freight service requirements;
- Twenty-five minute Seattle dwell on Vancouver, BC to Portland, OR trains to act as a delay buffer because of infrastructure deficiencies;
- No scheduled passenger train meets between Reservation and 21st Street because of single track Tacoma station;
- Avoid scheduled meets between passenger trains between Portland, OR and Vancouver, WA because of capacity limitation;
- Provide for the current level of Oregon Amtrak *Cascades* service; and
- Minimize sensitivity to late arrival of northward Oregon Amtrak *Cascades* service at Portland, OR.

The capacity improvement for Timetable B eliminates the restriction against meeting Amtrak *Cascades* trains between Woodland and Ostrander. The additional frequency and redistribution of schedules places all Amtrak *Cascades* meets, except for one, outside of this area without an attempt to do so. The meet between Seattle to Vancouver, BC trains is established at Mount Vernon for both the morning and evening. The Mount Vernon meeting point allows the use of a siding which has not been extended for freight train use, and allows the possibility of moving the meet between passenger trains to an adjacent siding if one train is late.

Timetable B allows Amtrak *Cascades* sets to operate between Portland, OR and Eugene, OR. Some adjustment in the schedules was necessary to accommodate an equipment rotation that would make all trainsets available to the maintenance facility. One set in the equipment plan lays over in Portland, OR at night; however it is in Seattle nine hours during each service day. To ensure that all equipment is rotated among the services and is stationed overnight in Seattle periodically to insure a high level of maintenance, the equipment plan has an eight day cycle which involves exchanging equipment between trains at Seattle during a schedule day twice during the cycle. This arrangement also equalizes mileage on all trainsets.

Timetable B uses eight crews and six trainsets per day.

Crews:

- One Crew Workday of fourteen hours thirty-five minutes with a six hour thirty-five minute Layover Time;
- One Crew Workday of twelve hours fifty-five minutes with a five hour fifteen minute Layover Time;
- Two Crew Workdays of four hours twenty five minutes; and
- The other Crew Workdays are eight to nine hours.

Equipment:

- One set operates between Seattle and Vancouver, BC exclusively. It operates 312 miles between availability for maintenance in Seattle and is available for maintenance in Seattle daily for ten hours twenty-five minutes;
- Five trainsets rotate through five assignments. The arrangement of schedules for the best service plan makes equipment rotation for equalization and availability for maintenance difficult. The rotation schedule is eight days, during which some assignments are repeated, and some assignments are exchanged during the schedule day after partial completion of an assignment. Each trainset is available for maintenance in Seattle four times in eight days. The maximum time between availability is four days (1,434 miles). The amount of time available is seven hours twenty-five minutes to nine hours fifty-five minutes;
- Four of the trainsets are in service for fifty percent of the calendar day or more. Maximum utilization is sixty-seven percent of the calendar day; minimum utilization is thirty percent of the calendar day; and
- A maximum of two trainsets are in Portland, OR simultaneously during the schedule day and three at night.

Timetable C

Requirements:

- Fifteen minute Seattle dwell on Vancouver, BC to Portland, OR trains for minor restocking, servicing, and repair as necessary to maintain service and equipment to the level of customer expectations;
- No scheduled passenger train meets between Lakeview and Nisqually because of single track;
- Avoid scheduled meets between passenger trains between Portland and Vancouver because of capacity limitation; and
- Mount Vernon is the preferred passenger train meeting location; Bow-Samish is the preferred alternative because of freight service requirements.

The first substantial section of single track between Portland, OR and Seattle, the portion of the Point Defiance Bypass between Lakeview and Nisqually, is introduced in Timetable C. This constraint has some undesirable, but unavoidable, effects on scheduling. This arrangement is necessary because there will be no scheduled meets occurring on this section after full development.

Three meets occur between Seattle and Vancouver, BC. One occurs on the extended Samish Siding, one occurs at English, and one occurs at South Bellingham. The freight traffic pattern in the early afternoon generally involves no trains near English so that the meet occurring at English will not prove to be a difficulty. The meet at South Bellingham is not at a desirable location; however, it is necessary to maintain a reasonable service plan. The effect is mitigated by the crossover north of the station at South Bellingham. The crossover allows the meet to occur in the south section of the siding, which will typically not hold a freight train because of street crossings at the station, while a freight train uses the north section of the siding.

Timetable C uses twelve crews and six trainsets per day.

Crews:

- One Crew Workday of twelve hours twenty minutes with a five hour twenty minute Layover Time;
- Two Crew Workdays of four hours twenty-five minutes;
- Four crew workdays are between seven hours thirty-five minutes and seven hours fifty-five minutes but have a Layover Time of thirty-five to fifty-five minutes. These workdays may be acceptable under the conditions that prevail at that time. If not, additional crews and perhaps Crew Workdays consisting of one-way trips and an overnight layover away from home may be necessary.
- The other Crew Workdays are seven hours forty-five minutes to nine hours thirty minutes; and

Equipment:

- Six trainsets rotate through six assignments. Each trainset is available for maintenance in Seattle three times in six days. The maximum time between availability is four days (2,464 miles). The amount of time available is nine hours fifteen minutes to ten hours ten minutes;
- All of the trainsets are in service for fifty-two percent of the calendar day or more. Maximum utilization is sixty-three percent of the calendar day; minimum utilization is fifty-two percent of the calendar day; and
- A maximum of two trainsets are in Portland, OR simultaneously during the schedule day and at night.

Timetable D

Requirements:

- Fifteen minute Seattle dwell on Vancouver BC to Portland, OR trains for minor restocking, servicing, and repair as necessary to maintain service and equipment to the level of customer expectations;
- No scheduled Amtrak *Cascades* train meets between Winlock and Centralia because of single track;
- No scheduled passenger train meets between Nisqually and Lakeview because of single track;
- Avoid scheduled meets between passenger trains between Portland, OR and Vancouver, WA because of capacity limitation; and
- Mt. Vernon is the preferred passenger train meeting location; Bow-Samish is the preferred alternative because of freight service requirements.

Scheduling the service is somewhat more difficult because a second section of single track, between Centralia and Winlock is introduced in this timetable. This second section of high-speed line has no meets in the full development plan therefore has no accommodation for meets in the interim.

Two of the three meets between Seattle and Vancouver, BC occur at Samish, and the third at Mount Vernon. This arrangement is made possible by the increased frequency between Seattle and Portland, OR which moves the through trains between Portland and Vancouver, BC to more convenient times.

One short turnaround at Portland, OR causes one equipment set to remain at Portland until the next scheduled trainset arrives. This avoids returning the set to Vancouver, BC, which would result in a continuous rotation between Portland, OR and Vancouver, BC without opportunity for movement to the maintenance shop in Seattle.

Timetable D uses fourteen crews and eight trainsets per day.

Crews:

- One Crew Workday of ten hours fifteen minutes with a two hour twenty-five minute Layover Time;
- Two Crew Workdays of four hours twenty five minutes;
- Five crew workdays are between seven and eight hours but have a Layover Time of thirty to fifty five minutes. These workdays may be acceptable under the conditions that prevail at that time. If not, additional crews and perhaps Crew Workdays consisting of one-way trips and an overnight layover away from home may be necessary.

- The other Crew Workdays are seven hours twenty minutes to nine hours forty minutes; and

Equipment:

- Eight trainsets rotate through eight assignments. Each trainset is available for maintenance in Seattle four times in eight days. The maximum time between availability is three days (1,744 miles). The amount of time available is nine hours twenty minutes to thirteen hours five minutes;
- Six of the trainsets are in service for fifty percent of the calendar day or more. Maximum utilization is sixty-six percent of the calendar day; minimum utilization is forty-seven percent of the calendar day; and
- A maximum of two trainsets are in Portland, OR simultaneously during the schedule day and three at night.

Timetable E

Requirements:

- Fifteen minute Seattle dwell on Vancouver, BC to Portland, OR trains for minor restocking, servicing, and repair as necessary to maintain service and equipment to the level of customer expectations;
- No scheduled Amtrak *Cascades* train meets between Riverlake and Centralia because of single track;
- No scheduled passenger train meets between Nisqually and Lakeview because of single track;
- Avoid scheduled meets between passenger trains between Portland, OR and Vancouver, BC because of capacity limitation; and
- Mt. Vernon is the preferred passenger train meeting location; Bow-Samish is the preferred alternative because of freight service requirements.

In timetable E, the length of single track operation has increased to include between Winlock and Riverlake (near milepost 82). No meets between Amtrak *Cascades* trains may occur between Lakeview and Nisqually and between Centralia and Riverlake. This situation limits the scheduling flexibility of the *Cascades* service, which increases the dependence of the service plan on the operating plan.

Of the three meets that occur between Seattle and Vancouver, BC; two occur at Samish and one at Mount Vernon.

During the course of the day some equipment lays over in Portland, OR until the second or third departure after arrival because of short turnaround time, or to ensure that a set that arrives from Vancouver, BC will not leave again on a train for Vancouver, BC and be in a cycle that cannot be exchanged for equipment rotating through the Seattle maintenance facility.

Timetable E uses sixteen crews and nine trainsets per day.

Crews:

- One Crew Workday of twelve hours with a five hour thirty minute Layover Time;
- One Crew Workday of ten hours ten minutes with a three hour fifty minute Layover Time;
- Two Crew Workdays of four hours twenty five minutes;
- Six crew workdays are between seven hours five minutes and seven hours twenty minutes but have a Layover Time of thirty-five to fifty minutes. These workdays may be acceptable under the conditions that prevail at that time. If not, additional crews and perhaps Crew Workdays consisting of one-way trips and an overnight layover away from home may be necessary.
- The other Crew Workdays are seven hours five minutes to nine hours thirty minutes; and

Equipment:

- Nine trainsets rotate through nine assignments. Each trainset is available for maintenance in Seattle four times in nine days. The maximum time between availability is four days (2,460 miles). The amount of time available is nine hours thirty minutes to thirteen hours;
- Seven of the trainsets are in service for fifty percent of the calendar day or more. Maximum utilization is sixty-four percent of the calendar day; minimum utilization is forty-six percent of the calendar day; and
- A maximum of three trainsets are in Portland, OR simultaneously during the schedule day and four at night.

Timetable F

Requirements:

- Fifteen minute Seattle dwell on Vancouver, BC to Portland, OR trains for minor restocking, servicing, and repair as necessary to maintain service and equipment to the level of customer expectations;
- No scheduled Amtrak *Cascades* train meets between Felida and Rocky Point, between Riverlake and Hannaford, between Everett and English, between Silvana and South Bellingham, and between South Bellingham and Surrey because of single track;
- No scheduled passenger train meets between Nisqually and Lakeview because of single track; and
- Avoid scheduled meets between passenger trains between Portland, OR and Vancouver, BC because of capacity limitation.

In timetable F train schedules and service plan match the infrastructure design. Between Seattle and Portland, OR trains operate at one hour headway or multiples of one hour headway and between Seattle and Vancouver, BC trains operate at two hour headway or multiples of two hour headway. Equipment turnaround is generally short, as short as twenty-four minutes in Portland, OR and thirty-six minutes in Seattle. At Portland, some of the equipment is assigned to the second or third train leaving after arrival in order to create equipment assignments that can be rotated through the Seattle maintenance headquarters on a regular basis and to avoid equipment sets arriving from Vancouver, BC and making an immediate return trip to Vancouver, BC.

At timetable F, the infrastructure has the ability to accommodate hourly service between Seattle and Portland, OR and bi-hourly service between Seattle and Vancouver, BC. The final service plan was established using an estimate of cost and ridership. Establishing the final service on such an estimate can be counterproductive because the service may not match the requirements of efficient crew and equipment distribution. An example is the full development service plan of thirteen round trips between Seattle and Portland, OR and four round trips between Seattle and Vancouver, BC. Ten sets of equipment are required for the service. Of those sets one is in use only forty-three percent of the calendar day, one is in use forty-eight percent of the calendar day, and one is in use only ten percent of the calendar day, making a single trip between Seattle and Portland. The effect of the service plan is not quite as profound on crew management; however, because of unused intervals in the one-hour pattern, one crew has an eight hour thirty-six minute workday and Seattle to Vancouver, BC crews all have workdays of over eight hours. One crew in the example plan works continuously between Portland, OR and Vancouver, BC, which would require an alternative arrangement such as two engine crews and one train crew, or exchanging the train and engine crews at Seattle.

Timetable F uses seventeen crews and ten trainsets per day.

Crews:

- One Crew Workday of ten hours five minutes with a two hour forty-seven minute Layover Time;
- Three Crew Workdays of six hours twenty-four minutes with a twenty-four minute Layover Time;
- Two Crew Workdays of six hours twenty seven minutes with a fifteen minute station stop en route;
- Four Crew Workdays of six hours thirty-six minutes with a thirty-six minute Layover Time; and

- The other Crew Workdays are seven hours twenty-four minutes to eight hours thirty-six minutes.

The short Layover Times will not be acceptable under the conditions that will prevail at the time; however no detailed plan for increase of layover time has been developed. This situation should be addressed by an economic assessment of train service against cost. Among the possible conclusions are maintain the service as planned and increase crew cost to eliminate the fatigue hazard, increase train service until the hazard is eliminated, or a combination of the two.

Service reduction to eliminate the condition would result in a level of service far lower than the goal. Reduction of the service to achieve a more efficient use of crews may not be effective; creating a condition in which cost is increased in order to provide a desirable level of service with the available number of schedules.

Equipment:

- Ten trainsets rotate through ten assignments. Each trainset is available for maintenance in Seattle five times in ten days. The maximum time between availability is four days (2,170 miles). The amount of time available is seven hours fifty-five minutes to eighteen hours thirty-six minutes;
- Seven of the trainsets are in service for fifty percent of the calendar day or more. Maximum utilization is sixty-nine percent of the calendar day; minimum utilization is ten percent of the calendar day; and
- A maximum of three trainsets are in Portland, OR simultaneously during the schedule day and four at night.

Timetable F Revision A

The ridership and economic data for Timetable F indicated that increased service could potentially improve operating efficiency. One iteration of the planning work needed to assess the full development service plan was performed, adding one Portland, OR to Vancouver BC schedule to Timetable F. The analysis indicated that ridership and profit increased with the addition of one Portland, OR to Vancouver, BC schedule. The additional schedule also demonstrated greater efficiency. More service is provided with one less trainset. Crew planning was conducted using the same procedure used for Timetable F, to allow direct comparison. Overtime pay increased by one hour per day (due to schedule distribution of Portland, OR to Vancouver, BC service), and the number of unacceptable Layover Times increased from seven to nine. However, a cursory examination shows that the ideal number of Seattle to Portland, OR schedules for the purpose of crew distribution is sixteen. Sixteen trains on one hour headway can be assigned to eight crews that each have more than one hour Layover Time and a Crew Workday of eight hours or less. Because trainsets operate through Seattle and crews generally do not (as demonstrated by the assignment of a Portland, OR to Vancouver, BC crew in Timetables F and F Revision A, and the discussion of fatigue hazard in the Operations appendix), the ideal arrangement for trainsets will be dependent upon the arrangement of the Portland, OR to Vancouver, BC and Portland, OR to Seattle service. Timetable F Revision A is the first step in the required analysis, and demonstrates the process.

Timetable F Revision A uses nineteen crews and nine trainsets per day. **Appendix I** presents crew and equipment requirements and other considerations for this revised timetable.

How will train dispatching play a role in Amtrak *Cascades* service?

The Amtrak *Cascades* service corridor will have about 180 miles of track used exclusively by passenger trains. This trackage should be handled by the same train dispatchers that handle the adjacent freight/shared use tracks. Tactical planning for the high-speed passenger lines and the seven shared terminal sections must be completely integrated. There is also a safety deficiency in adjacent tracks being handled by different train dispatchers. Valuable time may be lost in communication between train dispatchers for adjacent tracks if an incident on one line affects the other.

The quality of train dispatching affects the ability to operate with the precision that is needed for the Amtrak *Cascades* service. Typically in the U.S. railroad industry, train dispatching positions have a workload so great that it is not possible to plan traffic appropriately or attend to details of operation. Train dispatcher training is also generally limited to basic principles. Neither situation is appropriate to Amtrak *Cascades* operation. Therefore, it will be necessary for the Amtrak *Cascades* program to include the cost of training and maintaining a pool of trained dispatchers who are qualified to handle the traffic in normal passenger rail operation. The Amtrak *Cascades* payment for a greater level of train dispatching quality and service is a supplement for wage differential and training cost, not for the employment of train dispatchers. The train dispatchers remain employees of BNSF.

The quality of train dispatching will also be affected by the tools that are available. Current control system installations have no traffic planning capability and have cumbersome record maintenance functions. At some point later in development, at Timetable C or after, a sophisticated control system that provides easy record keeping and access and has sophisticated planning capabilities will be necessary.

Three essential elements of train dispatching for the Amtrak *Cascades* program are: qualification, training, and workload. The Amtrak *Cascades* program has been developed around several assumptions which focus on these essential elements. These assumptions are as follows:

Qualification

Train dispatchers must be examined and demonstrate proficiency in the following areas before assuming responsibility for train operations on Amtrak *Cascades*, and each two years thereafter:

- Operating rules;
- Hazardous material handling;
- Passenger train operation and safety;
- Emergency response;
- Route knowledge;
- Planning train movements; and
- Use of planning, control, and communications equipment.

Training

After initial qualification, train dispatchers must receive refresher training in each of the areas of qualification annually. They must also receive training in any of the areas of qualification to which significant changes are made. Training may include classroom, simulation, road familiarization trips, and printed, audio-video, or electronic media technical information and printed training material. Train dispatchers must have handled traffic on a district, either with responsibility or in training, within thirty days to be responsible for train movements on that district. Train dispatchers must have handled traffic on a specific shift on a district within ninety days, either with responsibility or in training, to be responsible for train movements on that shift on that district.

Number of Train Dispatcher Positions and Workload

A sufficient number of qualified train dispatchers will be maintained to ensure:

- train dispatchers receive the required training and examinations;
- train dispatchers are relieved for regular days off and vacations;
- all reasonable requests for relief due to illness, injury, family emergency, etc. can be accommodated; and
- all train dispatching positions are filled at all times with competent train dispatchers.

The workload must be regulated sufficiently to enable all train dispatchers to:

- monitor the movement of all traffic on the territory;
- plan traffic movements;
- respond to unusual situations and emergencies;
- communicate with supervisors and with terminals and dispatchers on adjacent districts about train movements;
- communicate with the passenger service manager about late trains and other conditions affecting passenger service; and
- maintain all required records.

What will be needed for operations management?

The Amtrak *Cascades* program will also require control center management services associated with the train dispatching office. BNSF already provides control center services for Amtrak and the commuter agencies that use BNSF lines, but as with the train dispatching requirements, the control center requirements will be greater than current practice. The services include:

- Ensure that the passenger services are handled in the prescribed manner;
- Monitor all passenger trains for schedule performance;
- Ensure that train dispatchers are aware of the development of unusual situations that can affect tactical decisions;
- Develop strategic plans for service interruption or unrecoverable lateness of a train, including schedule changes and resulting crew and equipment assignment changes;
- Provide instruction on passenger train handling to BNSF for implementation when trains are not operating within schedule tolerance;
- Communicate all planned changes of timetable operation to passenger service field officers;
- Handle all emergency situations involving passenger trains;
- Handle all alternative transportation requirements;
- Provide customer service information on current operation to stations and information services; and
- Provide customer service announcements to all stations on the PNWRC including train arrival platform announcements and service change announcements if necessary.

The control center services must provide a single decision source for all Amtrak *Cascades* passenger operations. A manager in this position must be qualified on all contracts and service requirements for Amtrak *Cascades* passenger service, and should have a train dispatching background.

Chapter Four: Capital Plan

The incremental program was not developed by designing infrastructure towards service levels, but rather by designing service levels that could be accommodated by the infrastructure.

The first step was to identify solutions for existing congestion that limited any increased passenger service or caused reliability problems for existing service. These areas would require correction regardless of the long term goal. This involved analysis of the activities generating the congestion such as trains stopping on main tracks to set out, pick up or switch, trains bunching because of congestion at other locations, and crew changes. Generally, these solutions turned out to be rather straightforward: If trains stopping for these activities could do so clear of the main tracks, capacity would increase greatly. Each solution was designed to accommodate the traffic expected in thirty years, ten years after full development of the program.

The early stages of Pacific Northwest Rail Corridor (PNWRC) planning evaluated capacity limitations throughout the corridor. The limitations were grouped by similarity to ensure that the greatest constraints throughout the corridor were eliminated simultaneously. Each of the incremental improvement phases eliminates all sections of the greatest constraint and allows the additional Amtrak *Cascades* trains that can be accommodated by the next greater constraint on the corridor. The Amtrak *Cascades* infrastructure plan requires a large amount of high-speed track. The construction order of high-speed track was chosen in the same way as the order of projects directed at only capacity limitation relief. Where high-speed track is required in the same area as a capacity limitation, the high-speed track construction was scheduled to be concurrent with the need for elimination of the capacity constraint.

The final level of Seattle, WA to Vancouver, BC service is much less than the final level of Portland, OR to Seattle, WA service, so there are fewer incremental stages to the complete project.

What infrastructure improvements are necessary to meet the service goals?

As discussed in Chapter Three of this report, six incremental levels of service are planned for the Amtrak *Cascades* program. These service levels were discussed as timetables, each of which provides goals related to travel time and frequency. The infrastructure improvements discussed in this chapter are grouped by timetable (service levels). Projects presented include identified infrastructure needs in Washington, Oregon, and British Columbia. In addition, since the Portland, OR to Seattle service and the Seattle to Vancouver, BC service are somewhat independent, projects associated with each are discussed separately.

Although great effort and analysis has gone into the identification, development and design of these infrastructure improvements, specific needs for the Amtrak *Cascades* program could change over time based on changing railroad requirements and/or other changed conditions in the corridor. Therefore each of the identified projects discussed in this chapter will be revisited and refined prior to design and implementation.

In addition, each of these projects will likely be required to follow federal and state environmental policies. As such, as part of an environmental process, alternative designs and/or locations (of the proposed project) are typically required. Depending upon the outcome of the environmental process – and the expected impacts to the natural and built environment – other solutions may surface which meet and solve the same need of the original project. Therefore, the projects listed and discussed in this chapter represent our best solutions – without the benefit of environmental analysis or our ability to foresee changing conditions – to meet current and projected rail service needs.

What projects are necessary for implementation of the Amtrak *Cascades* program?

For each of the six timetables discussed in Chapter Three of this document, a number of infrastructure improvements need to be in place in order to meet the identified service goals. The following discussion presents these improvements. All locations are in Washington State, unless otherwise noted. Track charts for each of these improvements are included in **Appendix J**. Some of the project descriptions indicate locations where a new alignment may be required along the corridor - **Appendix K** illustrates the major projects where this may occur.

Timetable A

The following list of projects are required for implementation of Timetable A. **Exhibit 4-1** shows the general location of these projects.

Felida, Woodland, Titlow, and Ruston Crossovers

These four projects are simple Centralized Traffic Control (CTC) crossovers located to provide quick relief from large capacity limitations. There is regularly a queue of freight trains southward between Kalama and Vancouver, WA awaiting accommodation at Vancouver, WA and northward between Kalama and Vancouver awaiting accommodation at Kalama or Longview

Exhibit 4-1

Timetable A: Project Locations

Junction. The section between Vancouver Junction North and milepost 111 is divided into only two sections by the crossovers at Ridgefield South. If a queue of trains is waiting for accommodation at both Vancouver, WA and Kalama/Longview Junction, there can be single track operation for the entire distance between Vancouver and Kalama. The Felida and Woodland crossovers create four sections of the current two, allowing two sections to be occupied by a train, and to remain as double track operation to significantly improving capacity.

The Titlow and Ruston Crossovers serve the same purpose for congestion that occurs in the vicinity of Tacoma. Single track operation between Reservation and Ruston is not uncommon because of the need to stop freight trains on Main One to work at Tacoma Yard, and the need to handle traffic to and from the Tacoma grain terminal on Main One. It is not unusual, especially in late afternoon, for a queue of northward freight trains to form south of the Nelson Bennett tunnel, awaiting accommodation at Tacoma or a path through Tacoma. The Titlow and Ruston Crossovers will introduce two new sections that may continue to operate as a double track while the current yard operation on Main One at Tacoma and associated queuing continues.

These crossovers do not cure the root congestion problem; however, they present a sufficient capacity increase to allow one more Seattle to Portland, OR train. As traffic continues to grow, shorter than current distances between crossovers will become increasingly important; reducing the length of single track operation when it is necessary for one train to overtake another or to remove one track from service for maintenance.

Sound Transit Phase 1 and 2

Sound Transit Phase 1 and 2 consist of a number of significant projects intended to increase the capacity between Lakewood and Seattle sufficiently to accommodate *Sounder* commuter train service and Amtrak *Cascades* service as well as anticipated freight traffic growth. Projects identified as part of these phases include:

- **Tacoma to Seattle CTC**
  The line between Tacoma and Seattle is double track ABS. Most of the line is Track Warrant Control; however, there is also a significant amount of direct voice control of traffic associated with Yard Limit territory. There is no provision for overtaking between Black River and Tacoma, and no provision for convenient single track operation when track maintenance is necessary. The problem is exacerbated by trains awaiting accommodation at Tacoma or occupying one of the tracks at Reservation while switching at Tacoma, trains occupying the northward main track at Auburn while working, trains occupying the main tracks at Orillia while

working, and trains occupying main tracks between Black River and Seattle while working. There are over twenty miles of yard limit operation, which simplifies traffic control procedures for the congested areas by allowing for verbal traffic control; however, it reduces capacity by limiting train speeds if the track ahead of a train is not clear for a great distance.

The CTC installation increases normal operation capacity of the line by eliminating the Yard Limit operation necessary for voice traffic control and eliminating the time-consuming Track Warrant Control procedures. Under unusual circumstances such as overtaking or sections of track out of service for maintenance, short distances between crossovers increase capacity by limiting the length of single track operation.

- **Tacoma Third Main Track**

  Tacoma Yard is not long enough to accommodate a typical freight train. Trains with cars to set out or pick up at Tacoma occupy Main One adjacent to the yard, and also Main One either south or north of the yard depending upon the direction of movement. The track arrangement at the grain elevator south of Tacoma Yard often requires Main One to be occupied by a switch engine for periods of an hour or more while working at the elevator. The third main track between McCarver Street and Reservation allows Main One to be occupied at Tacoma Yard and also at the Tacoma grain terminal while allowing two tracks for through movement. The third main track reduces the need for queuing north and south of Tacoma to trains that cannot be accommodated in the yard; through movements no longer need to wait to be accommodated. In conjunction with the third main track, the passenger station will be located on a main track instead of a low speed secondary track, which will result in reduced running time for Amtrak *Cascades* service. The project will also reduce the curvature at Head of Bay curve, also known as Thea Foss curve, and allow a speed increase to thirty-nine mph for Talgo trains and thirty mph for other trains from the current twenty mph for Talgo trains and ten mph for other trains.

  The project includes CTC between Nelson Bennett and Reservation where the signal and traffic control system is currently ABS and Yard Limits with voice traffic control of some movements. In such a congested area, this arrangement greatly reduces capacity by requiring trains to move at very low speed unless the track is clear for a great distance ahead. The signals and associated operating rules for the CTC operation allow trains to move as the traffic condition allows, generally allowing higher speed than yard limit operation.

- **Lakewood to Reservation**

  The Lakewood to Reservation project consists generally of improving the BNSF Lakeview subdivision for sixty mph passenger train speed, relocating some industry tracks, and installing CTC. The line is currently a secondary line generally used only for industrial switching. Occasionally the U.S. Army operates trains of military equipment on the Lakeview subdivision between Mobase at the eastern edge of Fort Lewis and the BNSF main line for movement to training or combat. These movements generally occur as one or more 4,000 to 6,000 ton freight trains. The military trains generally operated directly between Mobase and the main line connection at 11th Street in Tacoma; however, the line has been severed in Tacoma to provide for light rail operation. Military train movements must now change direction at Lakeview and connect to the BNSF main line at Nisqually.

  The project also includes creating a new connection between the Lakeview subdivision and the Seattle Subdivision. A new line will be constructed between approximately rail milepost 2 on the Lakeview subdivision and the Tacoma Rail Mountain Division (TR) line near D Street. This connection will be constructed through an area of urban development, involving some commercial property acquisition and new grade crossings with arterial streets. It will include a grade of over three percent ascending southward for a short distance. A new line will also be constructed between the TR line near Portland Avenue and the BNSF line at Reservation. This connection is located adjacent to a highway and involves no significant off right of way construction, except for the closure of Bay Street and extension of Q Street to provide alternative access. This piece of line will be used jointly by TR, Sound Transit, and the Amtrak *Cascades*.

  Between the two connections, the TR line will be improved to accommodate the commuter train service. A second track will be constructed between Portland Avenue and L Street and between G Street and C Street to accommodate the commuter service. The Tacoma Rail Mountain division line has a speed limit of ten mph and has no signal system. The project will include CTC for both new connections and the Tacoma Rail Mountain Division line between the new connections.

  The flows of *Sounder* commuter trains and TR freight trains cross in the joint section. South of C street, TR is east of the new connection and the BNSF Lakeview subdivision. At Portland Avenue the TR line is west of the connection to BNSF. Traffic on the Tacoma Rail line is not heavy; however, when trains operate they may be up to 6,000 feet long. South of C Street, the TR grade exceeds three percent ascending southward. Northward trains are difficult to control on this grade. Once stopped for passenger train traffic at C Street they would have a lengthy delay in releasing the air brakes because of the need to first secure the train with hand brakes. The second track between C Street and G Street moves the conflict between freight and commuter trains away from the steep grade so that stopping does not pose a problem. There is a junction with Union Pacific at Fife on Tacoma Rail, about 3,000 feet from Portland Avenue. Once a northward freight train movement begins crossing the commuter train route at Portland Avenue, it blocks the passage of commuter trains until it is accepted onto the UP line at Fife.

Amtrak *Cascades* trains will not use this line for timetables A and B; however, its completion is necessary to allow *Sounder* commuter trains to discontinue the use of the Tacoma Station used by Amtrak *Cascades* trains. The station and the track leading to the station do not have sufficient capacity to accommodate the increased Amtrak *Cascades* and *Sounder* traffic.

- **Auburn Siding**

  Auburn is the location of a yard generally used for storage, and the junction of the Stampede Subdivision. Trains setting out or picking up at Auburn frequently occupy Main Two while working. The Stampede Subdivision is single track, with the first meeting point located at Ravensdale, about thirty minutes east of Auburn. The project consists of a siding east of Main Two that extends between the south end and the north end of Auburn yard. The north end of the siding has direct connection to the Seattle and Stampede subdivisions. The train working at Auburn may clear Main Two by using the siding, allowing other traffic to pass. A northward train en route to the Stampede subdivision that cannot be accommodated because of opposing traffic may also wait on the siding, allowing other traffic to pass. The siding can also be used to hold a southward freight train that cannot be accommodated at Tacoma, to avoid queuing on the main tracks at Reservation.

  The Auburn Siding provides a location for a slower train to be overtaken, such as a passenger train overtaking a freight train, or a through freight train overtaking a local freight train.

- **Orillia Siding**

  Orillia is the location of an industrial area and a support yard. Several trains per day stop on the main tracks at Orillia to set out or pick up cars, and an industrial switching engine works on the main track at Orillia frequently. The Orillia siding extends between Kent and Glacier Park near rail milepost 12, generally using the Kent industrial lead and Glacier Park runaround track alignment, and relocating the existing Orillia Siding from between the main tracks to east of the main tracks. This Siding provides a track clear of the main tracks for the industrial switch engine to work from, allows those freight trains setting out or picking up cars to do so clear of the main tracks, and provides a track in which trains that cannot be accommodated in Seattle may be held in lieu of queuing on a main track in Seattle.

Crossovers near rail milepost 13 between the siding and Main Two divide the siding into segments, allowing one train to work at the Orillia yard while a second is waiting, or is being held awaiting accommodation in Seattle. The south section of the siding has two street crossings which prevent a train from being held for an extended period of time; however, the crossing at South 228th Street is scheduled to be grade separated (design begins in 2005), which will allow a train of about 7,000 feet to be held.

- **Tukwila to Seattle Third Main Track**
  Freight trains stopping on Main One between Seattle and Tukwila to set out, pickup, or double together; and entering and leaving the main tracks at ten mph at the Coach Wye, Argo, and South Seattle pose a significant capacity limitation. A third main track between Seattle and Tukwila provides one track for slow moving or stopped freight trains while leaving two tracks open for through traffic, significantly increasing capacity. Main One, the west track, is adjacent to the yards and yard connections and is thus the local freight track. Main Two and Main Three are used for through train movements.

- **Seattle Maintenance Facility and Line Relocation**
  A joint WSDOT and Amtrak project is constructing a new maintenance yard and associated facilities on the location of the existing yard. In conjunction with this project, the main tracks are being relocated from west of the yard to east of the yard as part of Sound Transit Phase 2. Because the yard is currently on the opposite side of the main tracks from King Street Station, passenger switching movements must frequently cross the flow of traffic between the station and the yard. Main track relocation will allow all passenger movements to remain on the same side of the main tracks allowing through movements to occur uninterrupted.

Mount Vernon Siding

Currently southbound morning trains leaving Bellingham must wait for the northbound trains to pass them before they can begin their run. The siding upgrades will allow those trains to pass each other in Mount Vernon, eliminating the southbound train's wait time in Bellingham.

This upgrade will allow an earlier departure from Bellingham and better Portland connections in Seattle. Because of this change in schedule, the trainset will be available to accommodate an additional Amtrak *Cascades* roundtrip between Seattle and Portland, OR in mid-2006.

Timetable B

The projects discussed in this section each solve independent problems associated with the main line. However, once all of the projects are completed (in this section), the goals outlined in timetable B can be achieved. **Exhibit 4-2** presents the general location of these projects.

Vancouver Rail Project

Vancouver is the junction between the Portland, OR to Seattle and the Portland, OR to Pasco routes and is also the location of a major yard. The junction, at its construction almost one hundred years ago, was intended for those two major routes. Traffic continued to flow in that manner until the early 1970's, after the Great Northern, Northern Pacific (NP), and Spokane, Portland and Seattle (SP&S) were merged into Burlington Northern. This began a flow of traffic moving between Pasco and the Seattle area without an intermediate stop in Vancouver, where cars were formerly exchanged among the railroads. The connection for the new traffic pattern consisted of operation over yard tracks between the SP&S line at Eighth Street in Vancouver and the NP line adjacent to the Vancouver passenger station. Trains move at ten mph on this connection.   All trains must also stop to exchange crews. This arrangement worked acceptably at the much lower traffic levels of thirty years ago; however, the traffic operating between the Pasco route and the Seattle route north of Vancouver has increased significantly.

Trains regularly queue north of Vancouver on the Seattle route and east of Vancouver on the Pasco route waiting to use the connection between the routes. When trains are moving on this connection it interferes with yard operation, so in addition to waiting for opposing traffic, the trains moving via the Pasco to Seattle route must periodically wait for yard operation. This arrangement is responsible for traffic congestion that greatly affects the reliability of passenger trains. Although the Felida Crossovers have relieved the situation somewhat, the queue of trains north of Vancouver and the resulting single track operation are a significant capacity constraint. This constraint is aggravated by openings of the Columbia River Bridge, which interrupts traffic flow on the already constrained route. Also, the longest tracks in the Vancouver receiving/departure yard, B yard, located immediately south of Vancouver Junction, cannot accommodate a typical freight train. Trains must double in or out of the yard, occupying Main Two for an extended time during the process.

Exhibit 4-2

Timetable B: Project Locations

The Vancouver Rail Project consists of two significant elements. A new double track main line extends around the east side of Vancouver yard between Vancouver Junction on the Seattle route and Eighth Street on the Pasco route. This bypass route serves two purposes: it allows Pasco to Seattle route trains to enter and leave the through route at the same speed as surrounding traffic, thus occupying no additional capacity, and allows trains to stop to exchange crews without blocking either the Portland, OR to Seattle or the Portland, OR to Pasco route. This results in a significant capacity increase for the main tracks of both the Portland, OR to Seattle and Portland, OR to Pasco routes and an increase in the yard capability because yard operation is not interrupted by through freight trains. Passenger train operation receives the benefit of increased reliability because of the elimination of single track operation near Vancouver on the Portland, OR to Seattle route.

The second significant element is a siding adjacent to Main One extending between 39th Street and Vancouver Junction North. This Siding has fifty mph turnouts and allows two significant changes in operations that result in increased capacity. First, southward freight trains that cannot be immediately accommodated at the Columbia River may be placed in the siding to be overtaken by a closely following passenger train. In the current arrangement either the freight train must be held back at some distance, if the bridge opening is known ahead of time, or the passenger train will be delayed following the freight train that has been stopped for the bridge. The arrangement of turnouts at both ends of the siding allows the siding to be one of the tracks available when a freight train is occupying Main Two at the north end of the yard. Effectively, the siding is used as a fifty mph main track under these conditions. This project also includes connections between the new Pasco route main tracks and Vancouver yard to allow through trains to set out and pick up cars without blocking one of the Portland, OR to Seattle main tracks. It also includes power turnouts for movements between the Main and B yards on the west side of the Portland, OR to Seattle line and the NP yard and Port of Vancouver tracks on the west side.

Kelso to Martin's Bluff Rail Project

The section of line between rail milepost 111 and Ostrander is the most congested section of the line between Vancouver and Tacoma. For part of most days, it is the most congested section of line between Portland, OR and Seattle. The capacity deficiency is so severe that single track operation of between sixteen and thirty-eight miles is common because of trains working on one main track or queued waiting for a turn to work. The Woodland crossovers reduce the extreme to only thirty-three miles, which provides marginal relief.

The condition is generally caused by numerous yards and industrial facilities at Kalama, Longview Junction, and Rocky Point that cannot accommodate trains clear of the main track or can only at a very low speed of entry and exit. The situation is aggravated by insufficient storage capacity for grain shipments arriving for the Port of Kalama grain terminals. Arriving grain shipments are stored on tracks at Ridgefield, Kelso, Rocky Point, Castle Rock and Vader. Trains shuttling cars between these points and Kalama add to the already excess-for-capacity traffic. Sufficient capacity for the traffic requires two main tracks for through trains. To achieve this, a third main track extends between rail milepost 114 and milepost 95. Between rail milepost 114 and milepost 105, the east track is a 110 mph passenger track; part of the high-speed track needed to achieve the goal running time between Portland, OR and Seattle. Between rail milepost 105 and milepost 95, the two east main tracks are for use by through traffic; freight and passenger. The west track is for use by freight trains that are stopped to work, moving slowly approaching a stop, or awaiting accommodation at one of the facilities. Crossovers at about one-train length intervals provide the ability to remove or insert a train into any point in the queue as needed, and allow great flexibility in providing track occupancy for maintenance.

Two sidings are provided at Longview Junction, allowing two trains to work at the yard simultaneously. This arrangement minimizes queuing for Longview Junction. A siding is also provided at Kalama, extending between rail milepost 111 and milepost 105. Since only two of the main tracks south of rail milepost 105 are intended for mixed traffic operation, the siding is necessary to accommodate trains stopped for work at one of the Kalama industries. The speed limit of the siding is thirty-five mph to minimize the main track capacity occupied by trains entering and leaving the siding. Crossovers are located in several places to allow several trains access to different sections of the siding simultaneously.

A separate industrial switching lead extends between rail milepost 109 and milepost 103, allowing industrial switching to continue while through trains pass or stop for work.

There are two grain train storage yards. Part of the storage capacity offsets the use of tracks at Ridgefield, Kelso, Castle Rock, and Vader. Part of the storage capacity offsets the current use of the industrial switching lead as a grain storage track. The remainder provides for growth of grain traffic at the Port of Kalama without a return to the current situation.

Centennial Crossovers (Leary Crossover and Pattison Crossover)

Leary and Pattison crossovers work as a pair. At full development, the Centennial station will have platforms only on the high-speed main track and a new track only for the purpose of a second station track. In the short term, the Leary and Pattison Crossovers will allow passenger trains operating on Main One access to Main Two, the station side, at Centennial. This will serve two functions: the Main Two platform is longer and easier for the engineer to spot the train which results in less lost time moving slowly attempting to stop the train the correct position, and eliminates the need for passengers to cross Main Two when boarding or alighting a train on Main One. This eliminates a rather significant hazard. In the days of (freight) timetable operation, all trains knew the scheduled locations of passenger trains, and often the actual location of the trains. It was the responsibility of the crew of an approaching train to not pass a station where a passenger train was due on the opposite track until it was known that it would not be passing between the stopped passenger train and the station. Schedules are no longer published to train crews, and operation can change from day to day, making it difficult for a crew to know what to expect. Train dispatchers may inform crews by radio of the need to stop short of a passenger train; however, it is not a foolproof system. Under current operating rules, the best way to protect a passenger train that is stopped on the track not adjacent to the station is by the use of CTC signals. The Pattison and Leary crossover control points provide not only the means of moving a passenger train adjacent to the station, but also the means of displaying a stop signal at each end of the station should a passenger train need to stop on Main One.

Ketron Crossovers and Tenino Crossovers

The distance between crossovers is related to capacity whenever one train overtakes another or one track is out of service for maintenance. In these situations, normal traffic can temporarily exceed capacity, resulting in delays. The Ketron and Tenino crossovers increase reliability by introducing new crossover locations between existing locations, thereby reducing the distance between crossovers.

Winlock Crossover

The distance between crossovers is related to capacity whenever one train overtakes another or one track is out of service for maintenance. In this situation, normal traffic can temporarily exceed capacity, resulting in delays. The Winlock crossover increases reliability by introducing new crossover locations between existing locations, thereby reducing the distance between crossovers. This crossover is the endpoints for two third main line projects.

North Portland Junction to Kenton

This project is located in Oregon along the main line. Low speed and single track operation on the UP line between North Portland Junction and Kenton creates a significant capacity problem on the BNSF line. The speed limit through crossovers at North Portland Junction and onto the UP connection is ten mph. The line is single track between North Portland Junction and Pen Junction, about five thousand feet away. At Pen Junction, UP trains may take one of three routes: to Barnes Yard, to Albina Yard, and to the east beyond Kenton Yard to Troutdale and the route toward Salt Lake City. All three routes are single track. There is a significant volume of traffic on the Seattle to Albina route and the Kenton to Albina route. Although these routes are on the UP line, they have a significant capacity effect on the BNSF route. Trains are often held on the BNSF route awaiting opposing traffic on the UP line. This can result in additional single track operation on the BNSF line. The ten mph crossovers and connections at North Portland Junction are also a significant capacity constraint.

The *Portland I-5 Study* (2002) completed by the Oregon Department of Transportation indicates that the North Portland Junction to Kenton project is one of the most important capacity projects in the Portland terminal area. The project consists of high-speed crossovers and connections at North Portland Junction including parallel route crossovers to allow movement between the two BNSF main tracks simultaneously with a movement to or from the UP route, and also simultaneous movement of two UP trains. A second main track will be constructed between North Portland Junction and the west end of the Champ siding, near Kenton, to eliminate the twenty minute long single track operation between North Portland Junction and Champ.

A second capacity limitation caused by low speed operation is not as easy to address. The north wye connection to Portland Terminal 6 has a ten mph speed limit. Changing the track geometry is difficult; however, engineering will be undertaken to determine if there is any way to increase the speed limit for movements between north of North Portland Junction and Port of Portland Terminal 6. An increase of five mph is effectively a fifty percent capacity increase, so any small amount that can be arranged in the constrained location of this connection will be helpful.

Swift Customs Facility (rail milepost 114.6 to 118.3)

Congestion on the tracks south of Blaine, near the U.S. Customs and Border Protection facility, can cause delays for Amtrak *Cascades* passenger trains traveling between Seattle and Vancouver, BC.

The siding and associated tracks will allow freight train inspections to occur off the main line, helping to ensure that passenger trains operate on time. A siding is track located next to a main line that allows a train to move out of the way of an oncoming train. Sidings are also used to store trains or to add/subtract rail cars.

Bellingham GP Upgrade (rail milepost 96 to 97)

The existing main line located at the Georgia Pacific plant in Bellingham will be rehabilitated. The purpose of this rehabilitation is to improve the track so that it can handle higher speeds. This improvement is needed because the current condition of the existing track does not meet Federal Railroad Administration (FRA) standards for increased speeds. This project will result in increased passenger and freight rail speeds, which will improve service and increase capacity and reliability.

PA Junction/Delta Junction Improvements

Yard tracks must be constructed to mitigate the use of the main track by passenger trains. After the discontinuance of the previous Amtrak service, increasing freight traffic made it necessary for BN to begin using the main track for additional yard capacity. The return of passenger trains has limited the ability to use the main track for freight trains; a situation has been a source of congestion and delay. This project allows for the continued operation of the Seattle to Bellingham train as well as the continued operation of the Seattle to Bellingham train (planned for extension to Vancouver BC). More refined cost estimates will be negotiated with BNSF before construction is initiated. In addition, the current track condition and geometry in this area restricts Amtrak *Cascades* trains to a speed of 10 to 43 mph and freight trains to a speed of 10 to 15 mph. The project will improve the main track, and in some places, construct new track to allow Amtrak *Cascades*' speeds of 35 to 50 mph and freight train speeds of 30 to 35 mph. The project will also provide a new siding to allow overtaking and opposing trains to pass. These improvements will increase capacity and reliability and reduce the running time of the Amtrak *Cascades* trains.

Stanwood Siding

The Stanwood siding is correctly located for the required capacity; however, it is not long enough to accommodate a typical freight train. A siding of approximately nine thousand feet is required, but the extended siding will be longer to allow the end of the siding to be located on a tangent track. The Stanwood siding extension is not required for the second Seattle - Vancouver train (timetables A and B); however, it is required for the third train. It will increase the reliability of the second train, however, and is thus included in the timetable A and B projects.

Colebrook Siding

There are no meeting points between Swift and Brownsville. Depending upon whether U.S. and/or Canadian customs stops a freight train on the main track at Blaine or White Rock (which is not predictable) for inspection, the running time between Swift and Brownsville is between forty-five minutes and two hours. This is a severe capacity limitation. A nine thousand foot siding at Colebrook reduces this running time by fifteen minutes, which is significant but still quite restrictive. There is no suitable place between White Rock and Colebrook to construct a siding.

Timetable C

The projects discussed in this section each solve independent problems associated with the main line. However, once all of the projects are completed (in this section), the goals outlined in timetable C can be achieved. **Exhibit 4-3** illustrates the general locations of these projects.

Point Defiance Bypass

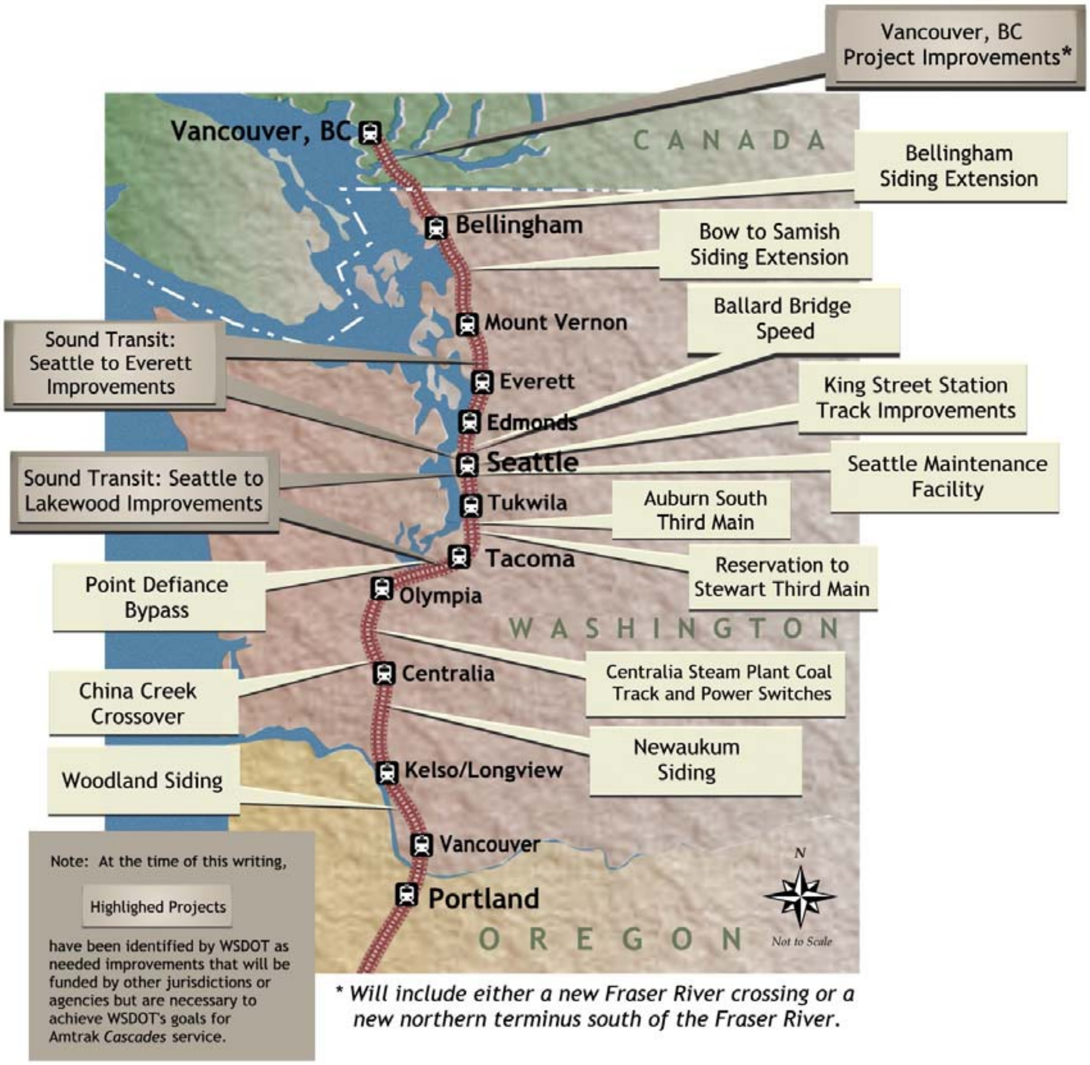
The BNSF Lakeview subdivision was the original rail line in Tacoma. It connected with the current Tacoma to Portland, OR route at Tenino, about thirty miles south of Tacoma. This route was known officially and later unofficially as the Prairie Line. Later, a line was constructed between Lakeview, on the Prairie Line, and Olympia. This line, known until recently as the American Lake Line or the Fort Lewis Line, is now known as the Lakeview subdivision spur. The steep grade between Tacoma and South Tacoma made the Lakeview subdivision an undesirable route. A new line between Tenino and Tacoma was built in 1914, extending along the shoreline of Puget Sound between Nisqually and Tacoma and passing through Point Defiance (through the Nelson Bennett and Ruston tunnels), west of Tacoma, through two tunnels. This route is about six miles longer between Nisqually and Tacoma than the American Lake/Lakeview subdivision route, however it is very slight gradient for the entire distance. This arrangement was preferable for all trains at the time it was constructed and is still preferable for freight trains; however, the extra distance and many relatively sharp curves make it undesirable for fast passenger train service.

The original conceptual planning work for PNWRC identified a combination of the Prairie Line and American Lake Line as a desirable alternative to the Point Defiance Line. The distance is shorter, the curvature is not as severe, and virtually no other traffic uses the line. Any significant increase in passenger train operation on the Point Defiance Line would require very expensive and difficult construction for increased capacity, generally due to the speed differential between the freight and passenger trains. The combination of the Prairie Line and American Lake Line between Nisqually and Tacoma (by way of Lakeview) is known as the Point Defiance Bypass. The Point Defiance Bypass makes use of existing rail lines except at Nisqually and at Tacoma, where new connections suitable for passenger train service must be constructed.

The Sound Transit construction for the Lakewood to Reservation route provides a portion of the construction required for the Point Defiance Bypass. In order to accommodate the frequent passenger train service, including *Sounder* commuter trains, the Amtrak *Cascades* trains, and Amtrak long distance trains, a second main track must be constructed between Lakewood

Exhibit 4-3

Timetable C: Project Locations



and Reservation. To make the route constructed by Sound Transit suitable for Amtrak *Cascades* service, the conflict between Tacoma Rail (TR) freight traffic and passenger trains between G Street and Portland Avenue must also be eliminated. The additional construction undertaken to make the line constructed by Sound Transit suitable for the Amtrak *Cascades* service will include a grade-separated crossing of TR and the passenger route between the Tacoma (Freighthouse Square/ Tacoma Dome) station and Reservation. The TR route crosses between two high points of land between G Street and L Street on a long (1,500 feet) trestle. A new structure will carry the passenger trains along the current TR route. The TR line will descend from G Street to the low ground level near M Street, pass under the passenger route, and ascend to the level of the passenger line near Portland Avenue.

Between Nisqually and Lakewood, only a single track is needed for the Amtrak *Cascades* service. The speed limit on this section of the line will be 110 mph, requiring rehabilitation, some curve flattening, and Advanced Signal and Control Systems. The current connection between the Point Defiance Line and the American Lake Line includes unsuitable sharp curvature. A new connection, largely on structure because of differences in elevation, with a speed limit of one hundred mph will be required. The current connection will be modified to eliminate traffic conflicts and will remain for use as a siding, should it be necessary for Amtrak long distance trains or extra passenger trains to meet or be overtaken by Amtrak *Cascades* train, and for freight service if necessary. The new high-speed connection at Nisqually will extend as a second track to a point just north of Fort Lewis. The U.S. Army currently does not make extensive use of the rail facilities at Fort Lewis; most of the traffic uses the Mobase facility on the Prairie line. Extending the high-speed Nisqually connection to just north of Fort Lewis allows uninterrupted freight service to Fort Lewis should that become necessary. The extension of the Nisqually connection to Fort Lewis also provides a suitable route for freight service on the steep grade between Nisqually and Fort Lewis. However, the high-speed connection will have superelevation suitable for the Talgo trains at one hundred mph, which will be excessive for heavily loaded freight cars at low speed. Movement of ascending freight trains with the minimum amount of power for the tonnage is also inconsistent with the track condition required for the one hundred to 110 mph Talgo trains.

Regular BNSF freight service consists only of one local freight train per day. The trains are typically short; however, some heavy commodities such as grain are handled on the line, making the effect of the freight trains on the high-speed connection at Nisqually a valid concern. With the closure of the Lakeview subdivision at Tacoma, the Point Defiance Bypass route has become unsuitable for reliable operation of large military trains. The trains can no longer proceed directly north from Mobase to Tacoma and further movement on the Point Defiance Line. They must pull north to a point north of Lakeview and run the engine around the train to the opposite End before proceeding to Nisqually. A mobilization consisting of several trains can produce a difficult traffic situation. If military trains are to be moved promptly when ready, they may disrupt passenger service. Also, recent mobilizations have included movement to the Port of Tacoma, which is only accessible by reversing direction at Lakeview and again at Nisqually. This arrangement causes a severe capacity limitation. The preferred alternative is to construct a connection between the Prairie Line and TR south of the city of Roy, where the two lines are roughly parallel for a short distance. This and the appropriate rehabilitation of the TR between Roy and Chehalis will allow direct movement of military trains between Mobase and the BNSF line at Chehalis, and between Mobase and the Port of Tacoma, without conflicting with passenger train operation.

The Sound Transit EIS for the Tacoma to Lakewood service provides for a commuter train layover yard at Camp Murray, between Fort Lewis and Lakeview. An alternative location may be selected before construction begins. Should final construction include the Camp Murray location, it will be necessary for Sound Transit trains to use the improved high-speed line between Lakewood and Camp Murray. It may be necessary to equip Sound Transit trains for the Advanced Signal and Control System that will be in use. The locomotives of the BNSF local freight train that uses the line will also require the Advanced Signal and Control System equipment.

Between Lakewood and Lakeview, the two tracks pass through a non-concentric curve. The inner track of the curve will be suitable for Talgo train operation at eighty mph and will be used by all Amtrak *Cascades* trains. The curvature of the outer track of the curve will be determined by the length of the Sound Transit platform at Lakewood. Typically, *Sounder* trains will use the outer track and the east platform at Lakewood; however, a second platform will be constructed on the west track to allow Sound Transit trains to use the west track between Lakeview and Lakewood when traffic conditions require.

Between Lakeview and Reservation the traffic control system will be CTC, allowing trains use either track in either direction, however the normal flow of traffic will be all trains keeping to the right. A second Sound Transit platform will be constructed at South Tacoma, on the west track, to allow double track operation of *Sounder* trains. The construction of the second platform at Lakewood and South Tacoma will include grade separated pedestrian access between the platforms.

The speed limit for all passenger trains between Lakeview and the top of the South Tacoma hill near Lakeview Subdivision rail milepost 3 will be seventy-nine mph, and between that point and Reservation thirty-five mph. Track geometry can support higher speeds for Talgo trains on this section; however, the speed limit for Talgo trains is being limited to that of conventional trains to limit the speed differential between Amtrak *Cascades* and *Sounder* trains, and limit the circumstances under which overtaking may be necessary.

Throughout the corridor, PNWRC improvements generally supplement existing facilities and will be constructed without disrupting existing freight and passenger service beyond the slow order delays and short work windows common to such construction. Portions of the Point Defiance Bypass project may require extensive relocation of trackage being used by *Sounder* commuter train service and TR freight service, however. All new construction and line relocation will be conducted without disruption to the existing service to the extent allowed by the methods and location chosen for the commuter service improvements.

Reservation to Stewart Third Main Track

Tacoma Yard is not long enough to accommodate a typical freight train. Northward trains with cars to set out or pick up at Tacoma occupy Main One (if traffic allows, otherwise Main Two) north of Reservation while working. Northward trains doubling out (assembling the train from cars on two or more shorter tracks) may occupy one (or both) of the main tracks north of Reservation for an extended time. Some southward trains doubling in (breaking a long train to place the cars on two or more tracks shorter than the train) also occupy one of the main tracks north of Reservation for an extended time. If the a southward train must wait for a northward train to leave before entering the yard at Reservation, both tracks are blocked for an extended time, preventing the movement of through trains.

When a train occupies one of the main tracks north of Reservation while setting out, picking up, or doubling at Tacoma yard, the resulting single track operation between Reservation and the crossovers at Stewart (rail milepost 34) has significantly less capacity and reliability than when all trains on both tracks are moving. The capacity of the line is reduced to almost zero during the time a train must occupy both main tracks at Reservation while entering, leaving, or stopping at the yard. In addition, trains entering and leaving the yard at Reservation move at ten mph. Each train entering or leaving the yard causes a significant reduction in the capacity of the two track line north of Reservation (about thirty percent if it does not stop while entering or leaving; more if it does).

The third main track between Reservation and Stewart provides a track on which trains entering or leaving the main track at Reservation may move slowly or stop without interfering with through traffic. The length of this track, about four miles, allows freight trains to enter or leave the flow of traffic at the north end of the third track at the same speed as through freight traffic. This minimizes the effect on through traffic of the low speed operation or stop at Reservation. If a southward train must wait for a northward train to leave before entering the yard at Reservation, two tracks are blocked for an extended period of time, but one main track remains available for through movement.

Centralia Steam Plant Coal Track and Power Switches North End of Centralia Yard

The Centralia steam power generating station is located about five miles northeast of Centralia on a spur that connects to Main Two north of the north end of Centralia Yard. The plant receives part of its coal by train from Wyoming and part from local mines associated with the power plant. The local coal is low quality and, in the future, additional Wyoming coal may be required. An arriving coal train cannot be taken directly into the power plant, which is not configured for processing of complete unit trains. Coal trains arrive at Centralia and are left on the siding east of Main Two while the train is being processed in short sections. The siding east of Main Two cannot accommodate an entire coal train, so on arrival the front section of the train is taken to the power plant. As the train is processed, the engine travels from Centralia to the power plant, removes the empty cars, and brings loaded cars from the siding. Coal train handling requires occupation of Main Two north of Centralia for an extended period of time, and sometimes occupation of both tracks as empty cars are moved from the power plant spur to the yard.

A new track adjacent to the power plant spur, just north of the connection with Main Two, will accommodate an entire coal train and remove the process of handling the short sections of loaded and empty cars from the main tracks. This arrangement will eliminate the limitation imposed by coal train handling. The project will include signaling and traffic control on the power plant spur between the main track connection and the south end of the coal train track, and a thirty-five mph turnout to the main track. Coal trains may then enter and leave the main track with a minimum occupancy time and capacity limitation. The project also includes a power crossover at the north end of Centralia Yard to allow direct movement between the yard and the power plant spur. The crossover is designed for only ten mph; however, extensive use by long trains is not anticipated.

China Creek Crossover

Centralia is the only passenger station between Tacoma and Portland, OR that is located on the west side of the line. When a southward passenger train is operating between Nelson Bennett Tunnel and Vancouver, it is often possible to reverse the normal flow of traffic, keeping the southward passenger train and other southward traffic on the east track adjacent to most of the stations, and operating northward trains on the west track. When passenger trains use Main Two at Centralia, passengers must cross Main One between the train and the station. Crossing passenger trains over between Main Two and Main One at each end of Centralia involves some running time loss because the crossovers are distant from the station and are restricted to thirty-five mph. Movement of northward trains in and out of the southward flow of traffic for an extended distance can also cause the capacity limitation. The China Creek Crossover is located immediately north of the station at Centralia. Unlike many CTC Crossover installations it consists only of the right hand crossover, intended for movement between the station platform on Main One and Main Two north of Centralia. The crossover is a fifty mph crossover located at approximately the distance from the station at which a stopping Talgo train is moving at fifty mph, eliminating the possibility of delay due to crossing over to the platform adjacent to the station.

Woodland Siding

Part of the industrial activity at Woodland is located east of the line. Currently the industrial tracks connect directly to the main tracks. Local freight trains working at Woodland generally occupy one of the main tracks while working, causing a capacity limitation. When the high-speed track is constructed east of Main Two, direct connection of the Industrial tracks to the high-speed track and use of the high-speed track for switching will not be suitable. The Woodland siding will extend approximately 1.5 miles along the east side of the high-speed track, with crossovers between the high-speed track and Main Two at both ends, to allow local freight service to pull into the siding and remain, while switching the industrial tracks. The siding is being constructed before the high-speed track, so it will be located a sufficient distance from Main Two to allow construction of the high-speed track at the appropriate time.

There are two road crossings, about four thousand feet apart, within the length of the siding. Currently, local freight trains are free to leave cars on Main Two north or south of Woodland while working, so the crossings have little effect on switching. When constrained by the length of the siding, switching cars at Woodland may be made difficult by the crossings. It may be necessary to grade separate one or both of the crossings to allow sufficient room for local trains to perform the work.

Newaukum Crossover

Construction of this crossover provides flexibility for trains to move between tracks. This project will provide increased reliability and capacity.

Seattle Maintenance Facility

A new Amtrak maintenance facility is being constructed south of downtown Seattle, near Safeco Field. This facility will be the primary maintenance and repair site for current and future *Sounder* commuter trains, Amtrak *Cascades* trains, and Amtrak's long-distance *Empire Builder* and *Coast Starlight* trains.

The Seattle Maintenance Facility is being constructed in phases. The first phase, completed in 2002, includes a new rail car washer and a wheel maintenance building. The second phase, scheduled to begin in 2005 if funding is available, will include construction of the main service and inspection facility.

King Street Station Track Improvements

As the amount of Amtrak *Cascades* and *Sounder* service increases, the arrangement of tracks and platforms at King Street Station becomes inadequate. The station is arranged with three tracks that open at either end, and four tracks that open only at the south end. Tracks one and two, the two east tracks in the station, are arranged for Sound Transit service, with direct access to the street and no direct access to the King Street Station building. Track three is the only north opening track available for Amtrak *Cascades* and long distance Amtrak service. Track two and three have access only to Main One at the north end of the station, requiring movement against the flow of traffic between South Portal and North Portal when a northward train is operating. At the north end of the station, there is one pair of routes that allows simultaneous movement. At the south end of the station there are no routes that allow simultaneous movement. **Appendix G** discusses several conflicts between schedules at the south end of King Street Station. In Timetable C, Amtrak *Cascades* service between Seattle and Vancouver, BC is not yet frequent enough to find consistent difficulties in the arrangement at the north end of King Street Station. As traffic increases, the same difficulties that occur at the south end of King Street Station are also found at the north end of King Street Station. There is also inadequate trackage to accommodate all of the trains. Through Timetables D and E, track resources at the station become more difficult to manage if the arrangement is not changed. At Timetable F, it is no longer possible to operate all of the scheduled passenger train traffic with the current track arrangement. At timetables D and E, the availability of track for Amtrak long distance service and other passenger service such as the American Orient Express is increasingly limited. Scheduling these services for times when track is available will be very difficult at timetables D and E with the current track arrangement and impossible at timetable F.

A station diagram of the traffic at timetable F shows that a minimum of five double ended station tracks are necessary. An arrangement of five tracks does not allow for extra service such as that for sports events or the American Orient Express trains, nor does it provide for any failure or maintenance of the track. An arrangement of six through tracks provides sufficient trackage and platform space for all of the anticipated service plus a contingency at most times. There is insufficient room between the King Street Station building and the obstructions east of the current main tracks (the Fourth Avenue viaduct, the retaining wall under Fourth Avenue, and the freeway interchange at the south end of the station), to accommodate all of the required trackage and the track geometry needed for main track operation at the required speed.

The alternative is construction of the six required tracks and associated connections to the main tracks at either end west of the existing main tracks. This will require that some of the station tracks and platforms extend through the existing building. There is still some difficulty in locating all of the required facilities even if this alternative is pursued. The station passenger facilities will be located above the tracks in the second floor of the existing building and in new structures adjacent to it. The concourse will be located above the platform tracks with the appropriate stairways and elevators leading to the platforms. Because of the limited platform space, baggage handling facilities will also be located overhead. Development plans include consolidation of transit facilities including light rail, waterfront street car, transit bus service, monorail, and intercity bus service into the King Street Station facility. The non-railroad modes would generally be located above the tracks as well. After the trackage has been constructed, commercial development may be constructed on the air rights above the track at both ends of the station.

Auburn South Third Main Track

Sound Transit Phase 2 constructed a third main track between Auburn and Thomas. This configuration is useful for eliminating certain freight-passenger conflicts, but has limited usefulness for other freight-freight conflicts or passenger-passenger conflicts such as an Amtrak *Cascades* train overtaking a *Sounder* commuter train. Extending the third main track to the south end of Auburn Yard provides a configuration that allows movement from either track of the two track sections to two of the three tracks without reducing speed.

Sound Transit Phase 3

The track arrangement between Tukwila and Argo is a remnant of the original configuration, when four separate railroads approached Seattle in this corridor. Two railroads remain and have developed separate facilities on opposite sides of the right of way. South of Tukwila, Union Pacific is located west of BNSF. Between Tukwila and Argo, UP is located east of BNSF. North of Argo, UP is located west of BNSF. BNSF has an intermodal yard located west of the line at South Seattle and storage tracks east of the BNSF line (between the BNSF and UP main tracks) at South Seattle and between South Seattle and Argo. UP has two freight yards and a car storage track east of the UP main track between Tukwila and Argo. Sound Transit Phase One addresses part of the conflict built into this arrangement by constructing a third main track on the BNSF line and improving connections between the BNSF and UP lines at Tukwila and just north of South Seattle. This allows limited joint operation between Tukwila and Argo, eliminating some of the conflict built into the arrangement of freight facilities.

As passenger and freight traffic increase, the limited joint operation arrangement will no longer provide sufficient capacity for all of the traffic. Sound Transit Phase 3 will rearrange the facilities between Tukwila and Argo to provide three main tracks for through movement, all located east of the freight facilities. This arrangement will eliminate conflicts between through trains and trains working at any of the freight facilities. In addition, running tracks (higher speed yard tracks used for movement between different areas of a yard) will be provided; one for BNSF movements between Black River and Argo, and one for UP movements between Rhodes and Argo. These two tracks will allow switching operations, set out, and pick up without interfering with through trains. The west main track, Main One, will generally be used by `freight traffic that is moving slowly entering or leaving the various freight facilities west of the main tracks. Projects identified as part of Phase 3 include:

- **Auburn Third Main Track**

  The Auburn Third Main Track extends along the west side of Main One between Auburn and Thomas, near rail milepost 18. This section of three main tracks allows a southward freight train to wait at Auburn until it can be accommodated on the Stampede subdivision, while allowing two tracks for through trains.

  The Auburn Third Main Track provides a location for a slower train to be overtaken, such as a passenger train overtaking a freight train, or a through freight train overtaking a local freight train.

Sound Transit

There are five sections of single track between Seattle and the Everett passenger station at PA Junction. The length of the single track sections, and the running time between the double track sections, is not uniform. This combination of conditions poses a significant capacity limitation. The final configuration details have not yet been determined; however, the Sound Transit project will include constructing a second main track on four of the five sections:

- Galer Street to rail milepost 5.4;
- Rail milepost 7 to rail milepost 8;
- Rail milepost 16 to rail milepost 18; and
- Rail milepost 27 to rail milepost 28.

Bow to Samish Siding Extension

The capacity of the line between Everett and New Westminster, BC is generally limited by the extreme distance and running time between sidings. In some locations, such as English, Stanwood, and Bow, the existing sidings are in the correct location to allow sufficient capacity but are too short to accommodate typical freight trains. A siding extension is sufficient in these locations.

The Bow Siding was extended to about nine thousand feet to accommodate the first Seattle to Vancouver, BC Amtrak *Cascades* service in 1995. This siding allows freight trains to meet or be passed by the current Amtrak *Cascades* trains. In the existing configuration, the next location north of Bow which is available for a siding long enough to accommodate a freight train, is South Bellingham, after it has been significantly extended. The distance and running time between Bow and South Bellingham is not sufficient for the required capacity. In addition as Amtrak *Cascades* service is added it becomes necessary to meet Amtrak *Cascades* trains at or near Bow in order to fit them with the required traffic pattern between Portland, OR and Seattle. If two passenger trains must use the Bow siding to meet, it then recreates some of the initial capacity problem: a lack of places for freight trains to clear for passenger trains.

To overcome these limitations, the short siding at Samish, which has not been used for meeting trains for almost forty years because of its length, is extended south to connect with the siding at Bow. Two crossovers will be constructed at the north end of the Bow siding to allow Bow to Samish to be used as one continuous siding or as two individual sidings. When used as individual sidings, a freight train may use the section at Bow to be overtaken by the two passenger trains that meet at Samish. For instances in which passenger trains are not using the Bow or Samish section of the siding to meet, opposing freight trains may use the two sidings to meet and be overtaken by one of the Amtrak *Cascades* trains.

Bellingham Siding Extension

Extending the Samish siding to allow it to accommodate a typical freight train improves the excessive single track running time between Bow and South Bellingham; however, it is also necessary to extend South Bellingham to accommodate a typical freight train. Extending the siding is difficult, but a new siding north of Bellingham does not meet the capacity requirement. It would extend the running time between meeting points (Samish and a new siding north of Bellingham) so they are similar to the current single track running time between Bow and South Bellingham, providing no capacity improvement.

Two street crossings at South Bellingham, one on either side of the passenger station, prevent the use of the existing siding as part of the extended siding to accommodate a freight train. The South Bellingham siding must be extended north from the current north switch sufficiently to accommodate a typical freight train between the street crossing north of the passenger station and the north switch. The north switch of the extended siding would be located just south of the street crossing near rail milepost 97. There are three street crossings within the length of the extended siding. These crossings would require grade separation in order to allow a freight train to stop on the siding to meet the opposing traffic or be passed.

Two of the street crossings are relatively easy to grade separate. The third crossing, at Boulevard Park, is more difficult. The crossing provides access to a parking lot within the park. It may be necessary to provide alternative parking and improved pedestrian access in lieu of providing a grade separation that can be used by motor vehicles. The siding extension would require that a second track be constructed through the park area. Two sidings, one extending the existing South Bellingham siding southward and a new siding extending north from the north end of Bellingham yard would also provide the required capacity; however, it would require a new or expanded tunnel at the south end of the current South Bellingham siding, a causeway and bridge crossing Chuckanut Bay, and some extensive bridge and embankment construction north of Bellingham yard.

A switching lead for the north end of Bellingham yard extends between the north end of the yard and the bridge south of rail milepost 99, eliminating conflict between switching and through traffic.

Ballard Bridge Speed Increase

The current speed limit over the Ballard Bridge is twenty mph for all trains. This restriction is approximately half of the speed limit for trackage either side of the bridge. This poses a capacity limitation, and also excessive travel time for passenger trains. An engineering assessment of the bridge will be made and the bridge will be modified appropriately for a speed limit for Talgo trains of forty-five mph and thirty mph for freight trains.

Scott Road Station or Capacity Projects North of Brownsville

This is discussed in detail in the Greater Vancouver Terminal **Appendix L**.

Timetable D

The projects discussed in this section each solve independent problems associated with the main line. However, once all of the projects are completed (in this section), the goals outlined in timetable D can be achieved. **Exhibit 4-4** illustrates the general location of these improvements.

Winlock to Chehalis Third Main Track

Napavine Hill, between Vader and Chehalis, is the ruling grade between Portland, OR and Seattle. The Hill is roughly symmetrical with a grade of about 0.9 percent ascending northward and 1.1 percent ascending southward. Freight trains ascending this hill are often reduced to about twenty five mph before reaching the top. This increases the speed differential between freight trains and passenger train significantly and poses a capacity limitation. This section also has a severe curvature at Napavine. An additional track for passenger trains is needed to eliminate the problem of speed differential and is also needed to provide the high-speed operation necessary to maintain the goal running time. Construction of a high-speed track adjacent to the two existing tracks for the entire distance is not practical because of the severe curvature through the city of Napavine. Reduction of this curvature to allow high-speed operation, even considering the tilting capability of Talgo trains, would require relocation of the line into the developed areas either side of the existing tracks.

The need to increase capacity on Napavine Hill and provide high-speed track without effect to the city of Napavine is achieved by constructing a high-speed track between Winlock and Chehalis which is generally adjacent to the existing tracks between Winlock and rail milepost 68 and on a new alignment between rail milepost 68 and Chehalis Junction. This line extends through generally rural areas, and has a maximum grade of about 2.5 percent. This gradient does not pose any difficulty to the operation of the Amtrak *Cascades* trains and can be negotiated by a typical Amtrak long distance train.

The high-speed track is east of the current main tracks between Vancouver and Nisqually except on the Napavine Bypass. The length of an alignment east of the current alignment; however, overcomes the advantage of high-speed operation. Flyover grade separations near rail milepost 68 and just south of Chehalis Junction move the high-speed alignment from the east side to the west side of the current tracks.

Chehalis Siding

The situation at Chehalis is the same as Woodland. The high-speed track east of Main Two intervenes between the freight tracks and the industrial tracks. A siding east of the high-speed track alignment with crossovers between the high-speed track and the current Main Two at either end allows freight service

Exhibit 4-4

Timetable D: Project Locations

to the industrial tracks on the east side at Chehalis without conflict with passenger trains.

Chehalis Junction Crossover

Currently passenger trains can be delayed as long as fifteen minutes while they wait for freight trains to pass in this area. A crossover is a set of turnouts connecting multiple tracks. They allow trains to move from one track to another. The new set of crossovers in Chehalis will allow faster Amtrak *Cascades* trains to move around slower freight trains, at speeds up to 50 mph. Typical main line crossovers limit speeds to 35 mph or less. This project will provide improved Amtrak *Cascades* on-time performance and faster, more frequent Amtrak *Cascades* service.

East St. Johns Siding and Main Track Relocation

This project is located in the state of Oregon. The East St. Johns yard is used for interchange of traffic between BNSF and UP. The yard is arranged for the original arrangement of main track operation with the current of traffic at all times. Some of the tracks are east of the line for use by northward trains and some of the tracks are west of the line for use by southward trains. One of the main tracks must generally be occupied during switching. A train setting out or picking up at East St. Johns must occupy one of the main tracks while working. Also, there is no track in the Portland terminal in which a train may be held clear of the main tracks while it is waiting to be accommodated in one of the yards.

The track arrangement at East St. Johns may be modified to improve yard operation and also provide a siding in which freight trains may wait to be accommodated in one of the yards on the terminal. The tracks are rearranged to place the main tracks east of all of the yard tracks. One track west of the main tracks is extended from East St. Johns to North Portland Junction, where it connects with the main tracks through crossovers, and also directly with the south wye to terminal six. This arrangement allows switching at East St. Johns clear of the main tracks and also provides a siding in which a freight train can be held until they can be accommodated at one of the yards in the terminal.

Lake Yard North Leads

This project is located in the state of Oregon. Trains arriving and leaving at the north end of Lake Yard move at ten mph, generally moving directly between the main tracks and the yard track. Extending the north leads of Lake Yard and changing the turnout configuration allows freight trains to enter and leave the main tracks without significant speed reduction, thus reducing the time required to enter and leave the yard which in turn increases capacity and reliability.

Portland Union Station

This project is located in the state of Oregon. Portland Union Station has four platform tracks: numbers two, three, four, and five. Tracks four and five are the main tracks and pass straight through the station. Tracks two and three diverge from the main tracks through ten mph turnouts. The speed limit at the north end of the station will be thirty mph. Movement through the ten mph turnout at the north end of the station to track three will cause a significant loss of time for Amtrak *Cascades* trains.

The track arrangement is sufficient for current use through timetable C. After timetable C, as many as four Amtrak *Cascades* trains will be in the station simultaneously. A new freight main track between the south end and north end of the station will eliminate the need to reserve track four or track five for freight movement, allowing them to be dedicated to passenger service. Tracks four and five will each accommodate two Amtrak *Cascades* trains, although track four can only accommodate one and still allow passengers to reach the platform at the crossing in front of the Station building. Dedicating tracks four and five to passenger service should provide sufficient trackage and platform capacity for the Amtrak *Cascades* and Amtrak long distance train requirements, although at some times it may be necessary to move Amtrak *Cascades* trains from one track to another - after arriving or before leaving - in order to ensure that platform space is available for Amtrak long distance trains when they arrive. Dedicating tracks four and five to passenger service also eliminates the need to access track three at ten mph in revenue service.

Advanced Signal System

An Advanced Signal System that provides at least cab signal indications, and as much enforcement of compliance with cab signal indications is required by federal regulation for a speed of more than seventy-nine mph. Several systems are being developed that include elements of positive train separation or positive train control systems, which not only provide cab signal indications but also will control a train to prevent overrunning speed restrictions or movement authority. None of the systems being developed are ready for evaluation for use on the PNWRC.

Timetable E

The projects discussed in this section each solve independent problems associated with the main line. However, once all of the projects are completed (in this section), the goals outlined in timetable E can be achieved. **Exhibit 4-5** presents the general location of these improvements.

Chehalis to Hannaford Third Main Track

Industrial switching at Chehalis, and through trains setting out and picking up at Centralia, can cause single track operation. After coal train operation is

Exhibit 4-5

Timetable E: Project Locations

changed to allow direct movement to the steam plant spur, coal trains will no longer occupy Main Two for an extended period of time during processing; however, they will move to and from the steam plant spur at thirty mph, significantly less than the speed of other traffic.

A third main track between Chehalis and Hannaford provides alternatives for two main track operation of through trains at all times. The passenger station at Centralia is west of the main tracks, however the platform on Main Three east of the main tracks will generally be the platform used by passenger trains in either direction. Overhead or under-grade access between the west side and east side platforms will be constructed. In some traffic situations, there can be an advantage to using the west platform for a passenger train stop. To allow this without loss of running time, the crossovers at Centralia south have been moved to just south of the station. These crossovers and the crossovers at the opposite end of the station at China Creek are located such that an Amtrak *Cascades* train stopping at Centralia will be moving fifty mph as it passes the location of these Crossovers.

Ostrander to Winlock Third and Fourth Main Track

The generally ascending grade northward between Castle Rock and Winlock limits the speed of many freight trains and increases the likelihood of being overtaken by a passenger train. In addition, numerous curves of more than two degrees limit the speed of Amtrak *Cascades* trains. At timetable E, this is the most capacity limited area between Portland, OR and Seattle. Constructing the high-speed track between Ostrander and Winlock provides part of the high-speed operation needed to accomplish the goal running time. In addition, it eliminates the capacity limitation for passenger train operation. A second high-speed track between Ostrander and rail milepost 82 allows meets between Amtrak *Cascades* trains at 110 mph, and is located for the final pattern of Amtrak *Cascades* trains in timetable F.

Timetable F

The projects discussed in this section each solve independent problems associated with the main line. However, once all of the projects are completed (in this section), the goals outlined in timetable F can be achieved. **Exhibit 4-6** presents the general location of these improvements.

Felida to MP 114 Third Main Track and Hannaford to Nisqually Third and Fourth Main Track

The two sections between Felida and rail milepost 114 and between Hannaford and Nisqually are the least capacity limited between Portland, OR and Seattle. Thus, these sections of high-speed track are the last to be constructed. The high-speed track is needed to accomplish the goal running time. The second high-speed track north of Hannaford allows meets between Amtrak *Cascades* trains at 110 mph.

Exhibit 4-6

Timetable F: Project Locations

Columbia River Bridge

This will be a joint project between the states of Washington and Oregon. The two main tracks of the Columbia River Bridge have a great capacity. At the current speed limits; however, train movements between Pasco and Portland. OR are restricted to ten mph because of track geometry, which reduces the capacity whenever a Pasco to Portland, OR train is using the bridge. Further, the movable span of the Columbia River Bridge is not directly in line with the high span of the adjacent Interstate 5 bridge. Opening of the movable span of Interstate 5 bridge is restricted, and most navigation uses the high span channel. Navigating between the high span channel and the movable span channel of the railroad bridge can be difficult, extending the amount of time of the bridge opening. The movable span of the railroad bridge is a swing span which is closed and prepared for railroad operation more slowly than a lift or bascule bridge. Low speed movement of trains to and from the Port of Portland at North Portland Junction also limits the capacity between North Portland Junction and Vancouver.

The low speed operation at both ends of the Columbia River Bridge, and the openings for navigation create significant capacity limitation. A second Columbia River Bridge with at least one additional main track (a detailed investigation might indicate that two additional tracks are necessary) will provide a capacity increase to levels similar to the lines leading up to it at either end. The east track, and both tracks of the current bridge if a new bridge has two tracks, would be dedicated to movement between Pasco and Portland, OR. The track or tracks on the new bridge would be dedicated to movement between Seattle and Portland, OR. The arrangement of crossovers at the south end of the new bridge would allow the movement between any combination of main tracks. The movable span of the current Columbia River Bridge would be moved to align with the high span of the Interstate 5 bridge and would be constructed as a vertical lift bridge. The movable span of the new bridge would be a vertical lift bridge. This arrangement will minimize the amount of time the bridges are open for navigation.

Advanced Signal System

An Advanced Signal System that provides at least cab signal indications, and as much as enforcement of compliance with cab signal indications is required by federal regulation for a speed of more than seventy-nine mph. Several systems are being developed that include elements of positive train separation or positive train control systems, which not only provide cab signal indications but also will control a train to prevent overrunning speed restrictions or movement authority. None of the systems being developed are ready for evaluation for use on the PNWRC.

Marysville to Mount Vernon High-speed Track

The scheduled meeting point for Amtrak *Cascades* trains in timetable F is at English. The south end of the meeting zone, the meeting point if one train is five minutes late, is Marysville. The south end of the Marysville to Mount Vernon high-speed section is at English. Between Marysville and English, the existing track and the new track have a seventy-nine mph speed limit for passenger trains. This section of high-speed track is required to achieve the desired Seattle to Vancouver, BC schedule running time. A second high-speed track between English and Silvana allows opposing Amtrak *Cascades* trains to meet at 110 mph. South of the south switch at English, the two Amtrak *Cascades* trains will use Main One and Main Two. North of the south switch at English, the Amtrak *Cascades* trains will use the two high-speed tracks.

Burlington to Bellingham High-Speed Track

The high-speed track between Burlington and Bellingham is required to achieve the desired Seattle, WA to Vancouver, BC schedule running time. Only seven miles between Burlington and Bellingham has an alignment suitable for construction of a 110 mph track adjacent to the existing track. With one significant curve relocation, there are ten miles. The Talgo speed limit at the south end of this segment is sixty-five mph and at the north end fifty mph, both due to curvature. With those limitations, this segment of high-speed operation has little benefit. However, because much of the line presents geographical limitations, the amount of high-speed track needed to achieve the goal running time is difficult to obtain.

A speed limit of 110 mph between Burlington and rail milepost 85 would have a significant effect on running time, about ten minutes. It would require constructing a trestle across the adjacent tideflats between rail milepost 82 and milepost 85. There is precedent for this construction. An interurban railroad was constructed in 1911 on a 4.2 mile trestle across the tideflats adjacent to the railroad between about rail milepost 82.2 and milepost 86.4. The interurban railroad went bankrupt in 1930, the line was abandoned and the trestle was removed. Evidence of the trestle is visible at low tide. Research on the history of the line indicates that severe weather conditions did not interfere with rail operations. Reconstruction was necessary after about ten years because the timber in the original structure was untreated and was attacked by shipworms.

Bellingham to Blaine High-Speed Track

The Bellingham to Blaine high-speed track is required to achieve the desired Seattle, WA to Vancouver, BC scheduled running time. Because of curvature, the track requires a new alignment between rail milepost 100 and milepost 103. It appears that the new alignment must be west of the existing track to avoid the industrial facility at rail milepost 102 and/or minimize the effect on residential development east of the current alignment. The high-speed alignment also requires the significant flattening of the curve at Ferndale. Otherwise, the high-speed track is located adjacent to the existing main track.

The current line extends along the top of a bluff near rail milepost 100. The bluff is subject to earth movement and is protected with vertical motion detectors. Significant movement that would interrupt service for extended time is possible. An alternate route is available that could have a secondary advantage. The passenger line could diverge from the existing route near rail milepost 99, extend north past Bellingham airport, curve towards the northwest around the north end of the airport adjacent to Interstate 5, and return to the current alignment near milepost 103. This route would need a tunnel below the airport terminal facility. At the north end of the airport it would be at an elevation similar to the adjacent Interstate 5 so that it would not be a hazard aircraft. The secondary advantage is the possibility of a station at the Bellingham airport with direct connection to the airport terminal.

Everett Junction to Everett Second Main Track

The single track between Everett Junction and PA Junction is a significant capacity limitation for the amount of traffic to be handled. The Sound Transit commuter service program will extend the Lowell siding from PA Junction to the east portal of the Everett tunnel. This will improve the situation; however, additional improvement is necessary to allow reliable operation of Amtrak *Cascades* trains. A second main track will be constructed between Everett Junction and the west portal of the Everett Tunnel, minimizing the amount of single track and providing the greatest amount of capacity.

White Rock Bypass

The BNSF route between Blaine, at the U.S./Canadian border and Vancouver, BC is indirect and slow. Tilting trains alone cannot overcome the obstacles to practical running time. In 1995, the Pacific Northwest Rail Corridor Technical Oversight Committee explored rail options for the Eugene, OR to Vancouver, BC corridor.

Among the options explored was a new alignment north of Blaine, to eliminate at least part of the obstacles to practical running time presented by the slow and indirect current route. The most suitable option developed was a new alignment, “White Rock Bypass” between Blaine and Colebrook. The White Rock Bypass is relatively direct, about two miles shorter than the existing route. It allows 110 mph operation, reducing the running time by about thirteen minutes. The 1995 report discussed a line suitable for freight trains, with a moderate grade and extensive tunneling. This arrangement is not consistent with the operation of high-speed trains. Leaving the freight trains on the existing route, the White Rock Bypass can be constructed with much more severe grades, eliminating the need for extensive tunneling. Also, the track condition of a moderate grade used by heavy freight trains is not consistent with the operation of passenger trains operating at 110 mph without an extreme degree of maintenance. As the line is proposed in the 1995 report, the combination of low speed operation of freight trains on the grades and the distance between sidings could also result in limited capacity that would be manifested in significant delays.

The bi-hourly pattern of schedules requires a section of two high-speed tracks, part of which is on the White Rock Bypass south of Colebrook, to allow Amtrak *Cascades* trains to meet at 110 mph.

The White Rock Bypass is an essential part of the infrastructure arrangement needed achieve the schedule running time consistent with viable Vancouver, BC service.

Colebrook – Brownsville High-speed Tracks

The BNSF route crosses the BC Rail route to Deltaport and Roberts Bank at grade at Colebrook. The heavy freight traffic on the route, undisciplined operation typical of North American railroads, and control of the route by BC Railway is not consistent with reliable operation of Amtrak *Cascades* trains. The Options Report issued in 1995 does not address the traffic conflict at Colebrook. The White Rock Bypass should cross the BC Rail route via a grade separation at Colebrook to avoid the freight-passenger conflict.

The BNSF route between Colebrook and the Fraser River Bridge is about three miles longer than a direct route. Urban development makes a direct route impractical. The subgrade conditions between Colebrook and the Fraser River are poor. The speed limit does not exceed sixty mph. It is as low as forty mph on tangent track that cannot be maintained for higher speed. Two separate passenger tracks, constructed specifically for high-speed, adjacent to the BNSF track between Colebrook and Brownsville are an essential part of the infrastructure arrangement needed achieve the schedule running time consistent with viable Vancouver, BC service. Two high-speed tracks are required for meeting Amtrak *Cascades* trains at 110 mph in the bi-hourly schedule pattern of timetable F.

What projects will be undertaken by other agencies?

As part of WSDOT's ongoing relationship with Sound Transit, the province of British Columbia, and the state of Oregon, a number of projects that will benefit Amtrak *Cascades* service need to be implemented by these agencies over the next twenty years. Without implementation of these projects, the build-out of the passenger rail program could not be achieved. These projects are listed in **Exhibit 4-7**, on the following page, by jurisdiction/agency. Although WSDOT cannot define projects that Oregon or British Columbia

Exhibit 4-7
Projects to be Implemented by Other Agencies and Organizations

Jurisdiction/Agency	General Location	Project/Estimated Cost (2003 Dollars)
	[1]Greater Vancouver Terminal (Scott Road Station)	Construct new passenger rail station/$75.0 million
British Columbia	[2]Vancouver Terminal Control System	Installation of new traffic control system/$6.7 million
	[2]Still Creek to CN Junction	New siding/$15 million
	[2]Sperling-Willingdon Junction Siding	New siding/$10.4 million
	[2]Willingdon Junction	Grade separation/$14.7 million
	[2]Brunette-Piper Siding	New siding/$25.5 million
	[2]Fraser River Bridge	Replace or improve existing bridge/$500.0 million
	Colebrook to Brownsville High-Speed Tracks (north of White Rock)	High speed track, continuation of White Rock bypass/$89.9 million
	Colebrook Siding	New siding/$11.3 million
	White Rock Bypass	High speed rail bypass/$312.6 million
Sound Transit	Seattle to Everett	Various capacity improvements/$180.0 million
	Seattle to Tacoma to Lakewood	Installation of Centralized Traffic Control (CTC) system and additional trackage/$403.0 million
	Argo to Black River (south Seattle)	Reconfiguration of existing yard and main line tracks/Costs included above
Oregon	Columbia River Bridge (joint Washington and Oregon project)	New bridge/$500.0 million. It is anticipated that funds for this project will be shared between the states of Washington and Oregon, as well as other funding partners.
	North Portland Junction to Kenton (north of Portland's Union Station)	Reconfiguration of existing tracks and new second main line/$51.6 million
	East St. Johns Siding and Main Track Relocation	Construction of a new siding and change in configuration of yard tracks/$59.7 million
	Lake Yard North Leads	Install high speed yard leads/$19.5 million
	Portland Union Station	Construct new turnouts and construct new main line/$6.1 million

** Two alternatives. Depending on the Amtrak Cascades' northern terminus in Vancouver, BC these projects may not be needed. **Appendix L** of this report discusses the possibility of terminating service at Scott Road in Vancouver. WSDOT will continue to work with Province officials to identify the potential benefits and losses that could result from such a change in service.*

will construct, any alternative that is designed by Oregon or British Columbia must be consistent with the planning that has been developed by Washington for successful implementation.

WSDOT identified these potential improvements through their continuous evaluation of the existing rail corridor and the ongoing operational analysis for the Amtrak *Cascades* program. The state of Oregon and the province of British Columbia did not participate in the development of these projects. WSDOT recognizes that it will be each of these jurisdictions responsibility to review WSDOT's findings and perform their own research to solve the given problems along the rail line in Oregon and British Columbia.

When will these projects be built and how will they affect future service?

As discussed earlier, each project improvement was designed to independently solve an operational problem along the Amtrak *Cascades* service corridor. In addition to their ability to solve the specific problems identified, coupled together, incremental service goals could also be achieved – specifically, additional daily round trips along the corridor.

The chronology of these projects was determined by first addressing the service goals of the fully developed program. Once the infrastructure for the fully developed program was developed, all of the projects were examined for their comparative effect on the system. Project improvements were then prioritized[1] by the degree in which each addresses:

1. The constraint on reliable current operation. Can this project, by itself, solve a reliability problem along the corridor?
2. The constraint on increased service. Can this project, by itself, solve a capacity issue at an identified chokepoint along the corridor?
3. The requirements for the service goals. Can this project increase speed and safety within the corridor?

Ordering projects in this manner ensures that each project has immediate utility regardless of future service improvements. **Exhibits 4-8** and **4-9**, on the following pages, show the chronological relationship between the projects and service improvement. The completion year of these projects as well as the service provided is dependent upon funding and the length and complexity of the project's environmental process and permitting.

[1]*This reverse process ensures that no project is constructed for a near term goal then made obsolete by a subsequent project.*

Exhibit 4-8
Timetable and Relationship to Amtrak *Cascades* Service Goals
Seattle to Vancouver, BC

Seattle to Vancouver, BC Project Improvement	Timetable (Completion Year)	Service Goals: Additional Daily Round Trip Trains	Service Goals: Total Daily Round Trip Trains	Service Goals: Schedule Running Time
Mount Vernon Siding	A	1	2	3:55
Swift Customs Facility Stanwood Siding PA Junction/Delta Junction Improvements Bellingham GP Improvements Colebrook Siding	B	1	2	3:55
Sound Transit: Seattle to Everett Improvements Bow to Samish Siding Extension Bellingham Siding Extension Ballard Bridge Speed Sperling to CN Junction Vancouver, BC Project Improvements (see Exhibit 5-14 and accompanying text)	C (Mid-point service)	1	3	3:25
Marysville to Mount Vernon High-Speed Track Burlington to Bellingham High -Speed Track Bellingham to Blaine High-Speed Track Everett Junction to Everett Second Main Track Advanced Signal System - 110 mph White Rock Bypass Colebrook to Brownsville High-Speed Track	F (2023)	1	4	2:37

NOTE: At the time of this writing, the implementation of "gray shaded projects" have been identified by WSDOT as needed improvements in other jurisdictions or other agencies in order to meet the Amtrak Cascades service goals.

The completion year is based solely on the operations and infrastructure plan presented in this report. State and federal funding will dictate actual completion years – if funding becomes available sooner, service goals can be achieved sooner. If funding is not available, or targeted for a future date, then service goals will not be achieved within the identified twenty year time frame.

In addition to funding, Amtrak *Cascades*' service goals are also dependent upon the completion of projects located outside of WSDOT's jurisdiction.

Exhibit 4-9
Timetable and Relationship to Amtrak *Cascades* Service Goals
Seattle to Portland, OR

Seattle to Portland, OR Project Improvement	Timetable (Completion Year)	Service Goals: Additional Daily Round Trip Trains	Service Goals: Total Daily Round Trip Trains	Service Goals: Schedule Running Time
Felida Crossover Woodland Crossover Titlow Crossover Ruston Crossover Sound Transit: Seattle to Lakewood Improvements	A	1	4	3:25
Vancouver Rail Project Kelso to Martin's Bluff Rail Project Centennial Crossovers (Leary and Pattison) Winlock Crossover Tenino Crossover Ketron Crossover North Portland Junction to Kenton	B	1	5	3:20
Point Defiance Bypass Reservation to Stewart Third Main Track Centralia Steam Plant Coal Track and Power Switches Woodland Siding Newaukum Siding King Street Station Track Improvements China Creek Crossover Auburn South Third Main Track Amtrak Maintenance Facility Sound Transit: Seattle to Lakewood Improvements	C (Mid-point service)	3	8	3:00
Winlock to Chehalis Third Main Track Chehalis Siding Chehalis Junction Crossover East St. Johns Siding and Main Track Relocation Lake Yard North Leads Portland Union Station Advanced Signal System - 110 mph	D	2	10	2:55
Chehalis to Hannaford Third Main Track Ostrander to Winlock Third and Fourth Main Track	E	2	12	2:45
Felida to MP 114 Third Main Track Hannaford to Nisqually Third Main Track Columbia River Bridge (Washington/Oregon project)	F (2023)	1	13	2:30

Note: At the time of this writing, the implementation of "gray shaded projects" have been identified by WSDOT as needed improvements that will be funded by other jurisdictions or agencies but are necessary to achieve WSDOT's goals for Amtrak Cascades service.

As discussed earlier, responsible parties include Sound Transit, the state of Oregon, and the province of British Columbia. For those projects located outside of Washington State, WSDOT has only identified these necessary improvements – Oregon and British Columbia have not yet researched, designed or funded these projects. Without implementation of these projects, Amtrak *Cascades* goals as presented in this report can not be realized.

Another critical decision outside of WSDOT's jurisdiction centers on the terminus of the Amtrak *Cascades* service in British Columbia. Currently service terminates/begins at Vancouver's Pacific Central Station. However, in order to increase service to this facility, major infrastructure projects would be required.

What would be required in order to continue service to Vancouver's Pacific Central Station?

Due to the topography, condition of the existing rail line, and the environmental constraints in British Columbia, it is going to be very difficult to meet the Amtrak *Cascades* service goals without implementing a number of project improvements.

As presented in **Exhibit 4-10** the estimated cost of implementing these improvements could be over as $530 million.

Exhibit 4-10
British Columbia Infrastructure
Requirements Needed Before Service Midpoint

Infrastructure Improvement	Estimated Cost
Alternative 1: Vancouver Central Station Terminus	
Fraser River Bridge Improvement	$500.0 million
Brunette to Piper Siding	$25.5 million
Sperling to Willingdon Junction	$10.4 million
Still Creek to CN Junction	$12.9 million
Vancouver Control System	$6.7 million
Willingdon Junction	$14.7 million
Alternative 2: Scott Road Terminus	
Scott Road Station	$75.0 million

*Estimated costs are in 2003 U.S. dollars.

Is there another option for a Greater Vancouver, BC terminus?

WSDOT and other agencies along the Pacific Northwest Rail Corridor have studied the possibility of terminating service at Scott Road, which is located about ten miles south of Pacific Central Station. If service were terminated at this location, passengers would be able to travel to downtown Vancouver, BC via integrated service on Skytrain from the Amtrak *Cascades* station at Scott Road. By terminating service at this station, infrastructure improvement costs could feasibly be reduced by just over $455 million.

When does a decision have to be made?

As indicated in **Exhibit 4-2**, before WSDOT can implement Timetable C, these infrastructure improvements must be completed. Without a decision regarding the northern terminus, as well as funding to implement the necessary improvements, Amtrak *Cascades* service to British Columbia can not be increased beyond its current level (including extension to Vancouver of the service currently originating-terminating at Bellingham).

What other capital improvements will be required to fully implement the Amtrak *Cascades* program?

The Pacific Northwest Rail Corridor capital program includes acquisition of trainsets (locomotives and cars) in addition to infrastructure construction. The current Talgo trains are fully allocated -- there is no spare equipment. No new service beyond Timetable A may occur until additional equipment is acquired.

Continued use of the current equipment

Passenger vehicles

The five Talgo trainsets used in Amtrak *Cascades* service were purchased with the intention of continued use for their expected lifecycle, well beyond the full development of the program. However, the Amtrak *Cascades* Talgo trains do not meet Federal Railroad Administration (FRA) requirements which were put into effect after the trains were purchased. However, FRA allows this equipment to operate as the result of a “grandfathering” process. The “grandfathering” document contains several restrictions which affect the future usefulness of the existing Talgo trainsets. Most significantly, the trains may not be operated at speeds over seventy-nine miles-per-hour (mph) and can only be used on the Pacific Northwest Rail Corridor (on existing BNSF and Union Pacific tracks). It may be possible to ease or remove the restrictions in the future, but there is no certainty.

The Talgo trains have important characteristics (tilting, low weight and axle loading, low center of gravity) that are essential to low cost, reliable, high-speed passenger train service. These characteristics are possible within the limitations of the FRA regulations. For example, after the regulations restricting the use of the Amtrak *Cascades* Talgo trains came into effect, Talgo revised the design to be able to produce equipment that complies with the regulations and is almost identical to the Amtrak *Cascades* equipment.

Since the continued usefulness of the current Talgo trains is not ensured, the capital plan assumes that all trains must be replaced before the advent of 110 mph operation. Also, since FRA restricts the use of these trains to the current Amtrak *Cascades* service, there is currently no future value of these trains in the United States. The resale value of these trains outside of the U.S. is unknown.

Passenger train cars of any type, including high-speed trains, are not readily available in the United States. The Northeast Corridor (located between Washington, DC and Boston, MA) is the only other high-speed corridor in the country. This service has significantly different characteristics from any of the other potential high-speed rail corridor in the United States, including the Amtrak *Cascades* route. Thus, there is no mass production and readily available high-speed train equipment in this country. Unfortunately, European mass produced trains cannot be used in the United States because of FRA regulations. The high-speed trains used on the Northeast Corridor and the Amtrak *Cascades* Talgo trains were custom-constructed in facilities that existed only for the construction of that particular order.

If high-speed rail projects are funded throughout the United States, there would likely be a sufficient market for equipment. As a result, mass production could occur and it would be possible to buy equipment as needed. If the Washington State program is alone in ordering high-speed train equipment, the price will be significantly affected by the size of the order. Even an order for five trains (the size of the order for the current Amtrak *Cascades* trains), can be considered inconsequential if a production facility (in the U.S.) needs to be established specifically for the order. An order for one train would likely receive no bidders.

Based on these market conditions, as well as existing federal regulations, the equipment plan assumes that:

- the currently used Talgo trains cannot be used for Amtrak *Cascades* service once 110 mph operation begins (Timetable D);
- a single train cannot be purchased for the implementation of Timetable B;

- an order of six trains can be purchased for the implementation of Timetable B,
- the currently used Talgo trains will have no resale value when the trains for the implementation of Timetable B are purchased; and
- High-speed rail service throughout the U.S. will be common by the time Timetable C is implemented. As such, it will be possible to order trains as needed.

Locomotives

The locomotives used on the Amtrak *Cascades* Talgo trains are standard North American passenger train locomotives owned by Amtrak. They are designed to pull very heavy (by worldwide standards) North American passenger cars at moderate (by worldwide standards) speed over track used by very heavy freight trains. They are capable of operating at 110 mph, but because of their high weight and axle loading (130 tons, 32.5 tons per axle -- about sixty percent greater than locomotives on high-speed trains throughout the world) they can cause damage to track designed for high-speed train operation, resulting in increased maintenance cost and reduced asset lifetime. Such locomotives are not suitable for future Amtrak *Cascades* service.

As with high-speed passenger train equipment, suitable locomotives are not available in the United States. The Washington State Department of Transportation has been providing performance requirements (for future locomotives) to numerous locomotive manufacturers. It is hoped that such locomotives will be available when WSDOT wishes to purchase such equipment.

Amtrak *Cascades* trains operate in a "push-pull" configuration. Because of this, the trains do not have to be turned around at terminals. This eliminates the need for special tracks (for turning the trains) and the associated cost involved in the process. The train configuration for this "push-pull" movement is: a locomotive on one end and a cab car on the other.

The cab car has a complete set of locomotive controls, which control the locomotive at the opposite end of the train by the use of electric cables that run the length of the train. The cab cars are actually obsolete Amtrak locomotives which had their propulsion system (diesel engine, generator, electric motors) removed. The cab cars weigh as much as two-thirds of the Talgo train, thus affecting acceleration and fuel economy. They are not suitable for continued use when new trains are purchased. When new passenger equipment is acquired, Amtrak *Cascades* trains will operate with a locomotive at each end of the train.

The equipment capital plan for future locomotives for the Amtrak *Cascades* service assumes that:

- the currently used locomotives and cab cars cannot be used for Amtrak *Cascades* service once 110 mph operation begins (Timetable D);
- an order of twelve locomotives can be purchased for Timetable B (at the same time new trains are purchased);
- High-speed rail service throughout the U.S. will be common by the time Timetable C is implemented. As such, it will be possible to order locomotives as needed.

Equipment Acquisition

Equipment acquisition cost assumes passenger vehicle sets at twenty million dollars and locomotives at five million dollars each for a total of thirty million dollars per trainset. **Exhibit 4-11** provides a summary of the equipment which will be necessary for the implementation of the Amtrak *Cascades* service through Timetable F.

Exhibit 4-11
Amtrak *Cascades* Equipment Needs
(Costs are in U.S. 2003 Dollars)

Timetable	New Trainsets*	Acquisition Cost (in millions)	Trainsets in Service	Remarks
A	1	$7.5	5	Acquisition in November 2003 of only one Talgo trainset (no locomotives) formerly leased for use in Amtrak *Cascades* service.
B	6	$180	6	Complete replacement of all Amtrak *Cascades* equipment.
C	1	$30	7	
D	2	$60	9	
E	2	$60	11	
F	2	$60	13	
F (Revision A)			12	Timetable F Revision A requires one less trainset than Timetable F (See Appendix I).
Total Equipment (Timetables A through F)				
		$397.5	13	
Total Equipment (Timetables A through F Revision A)				
		$367.5	12	

**One trainset and two locomotives*

This page intentionally left blank.

Appendices

Appendix A
Initial Improvements and Previous Studies

Initial Improvements

The first initial improvements along the corridor included a number of inexpensive changes that could improve service immediately and remain useful through development of the twenty year program. These changes were:

Improved Service between Seattle, WA and Portland, OR

The Seattle, WA to Portland, OR segment of the corridor had existing passenger rail service. The first phase of development was a short-term plan to improve the existing service and restore the discontinued service.

Improvement of the existing service was accomplished by reducing the running time for passenger trains along the corridor. There were numerous municipal speed restrictions along the line. Each was eliminated through a process that involved the cooperation of the Washington State Department of Transportation (WSDOT), Washington Utilities and Transportation Commission, Burlington Northern and Santa Fe Railway Company (BNSF) and Amtrak. Some of the restrictions had previously been eased only for Amtrak trains through a process involving only Amtrak. The process associated with the project was directed at elimination of restrictions for freight as well as passenger service. The explanation used at hearings included Federal preemption, as well as the need to minimize the speed differential between trains as much as possible to reduce the possibility that the public would assume that the approaching train was moving slowly. Reduction of the speed differential has the added benefit of increased capacity. The elimination of some restrictions was contingent on such safety measures as fencing, barriers between the track and closely adjoining roadways, and traffic signal improvements at intersections adjacent to crossings.

Concurrent with the process to eliminate the municipal speed restrictions, public crossings between Vancouver, WA and Sumner, WA (with a few exceptions) were equipped with automatic signals and gates with constant warning detection. Crossings already equipped with automatic signals and gates were upgraded to constant warning equipment. The detection speed for all crossings was set to 79 miles per hour (mph) regardless of track geometry restrictions, anticipating yet undecided tilt train equipment. Curve super-elevation was adjusted to achieve the maximum possible speed for conventional passenger equipment, assuming the acceleration of conventional equipment.

This first set of improvements yielded a five minute reduction in Seattle, WA to Portland, OR passenger train running time, thus providing visible improvement resulting from the expenditure.

A second part of this phase developed a program of eliminating speed restrictions related to local conditions, or increasing the restriction speed. This program included improvements such as CTC in lieu of yard limits/ABS, improved bridge/rail locks on drawbridges and improved drainage at problem areas. WSDOT and Amtrak also decided upon, and purchased, Talgo tilt train equipment. This equipment allowed travel time reduction without infrastructure investment. New speed limits were established for this equipment, making best use of the tilt capabilities as well as the faster acceleration and braking of this much lighter equipment. Speed limits were rounded to the nearest one mph instead of the customary multiple of five mph. This, combined with the faster acceleration and braking increased the number of curve speed restrictions but reduced the impact of the restrictions. For example, a two mile zone of seventy mph for conventional passenger train equipment might be, for a Talgo train, two short zones of 74 mph separated by a 77 mph zone. Because of the large number of curves, this method of establishing speed limit zones reduced the running time by about six minutes over the multiple of five mph method.

One additional round trip train was added to the existing service in conjunction with these changes. The additional schedule was designed to best serve the commercial requirement of the passenger service, yet operate to the extent possible during the least congested period of time. The ability to operate the additional pair of schedules at the chosen time was approved by train dispatchers and operating officers without the use of simulation testing.

New Service between Seattle, WA and Vancouver, BC

The new Seattle, WA to Vancouver, BC service, mostly on a single track line, involved developing a schedule that fit, to the extent possible, with the existing freight operation in order to limit capital expenditure to the available amount. Freight service on the line was already somewhat structured because of the distance between sidings and the length of sidings and yard tracks, so the new passenger service could be introduced without degrading freight service. As with the improved Seattle, WA to Portland, OR service, a program of municipal speed restriction elimination, track condition speed restriction elimination and automatic grade crossing signal installation was undertaken.

Exhibit A-1 on the following page presents a listing of projects (and their costs) which have been completed along the corridor. This exhibit represents significant capital improvements made for the Amtrak

Cascades service. It is not a comprehensive list of all expenditures made since the beginning of program planning in 1991. Generally expenditures for projects that are not yet in service are not included. Expenditures for the King Street (Seattle) maintenance facility, which is not complete but is partially in service, are included. In Oregon, only expenditures made by Oregon for the Seattle, WA to Portland, OR service are shown.

Exhibit A-1
Capital Funding for Amtrak *Cascades*: 1993-2003

The Portland-Seattle-Vancouver, BC segment of the Pacific Northwest Rail Corridor

Project	**Description**	**Cost** (through December 2003)
Seattle - Vancouver, BC engineering and construction	Projects to restore rail service between Seattle and Vancouver, BC after a 14-year hiatus; additional projects to support Seattle-Bellingham service that began in 1999.	$53.0 Million
Seattle - Portland environmental work, engineering and construction	Includes Sound Transit funds for track improvements between Seattle and Tacoma; also includes track and signal work between Portland's Union Station and the Columbia River.	$160.6 Million
Station construction, renovations and upgrades	Total capital costs for the 13 stations served by Amtrak *Cascades* - Portland to Vancouver, BC.	$82.6 Million
Trainsets, locomotives, cab control cars	Includes 5 Talgo trainsets, 6 locomotives, and 6 cab control cars; also includes Talgo equipment lease (1994 -1996)	$74.0 Million
Seattle Maintenance Facility	The new maintenance facility, currently under construction, will be used by both Amtrak and Sound Transit	$48.7 Million
Grade crossing safety improvements	Includes median separators, circuitry upgrades and safety studies	$8.6 Million
	Total Capital Investment	**$427.5 Million**

This page intentionally left blank.

PNWRC History and Past Studies

Washington State's Long Range Plan for Amtrak Cascades represents the summary of the planning work to date. European experience for a project of this magnitude is a planning period of ten or more years. Switzerland has recently implemented a railway improvement project for which the initial work commenced in 1982. The same principle applies to the Pacific Northwest Rail Corridor. Research represented by several previous reports is incorporated into this document. Thus, there may be an appearance that some important information was not considered or that assumptions were made without basis. The research represented by this set of documents, in the manner of those preceding it, starts with the level of research documented in the previous report and examines greater detail. The research represented in each also considers the change in conditions that has occurred since the last research was concluded. For example, highway congestion and automotive fuel cost were different in 1984, when the initial economic feasibility study was conducted, than in 1992, when the High Speed Ground Transportation study was concluded. In 2005, those conditions and others are different from those considered in 1992.

The changes considered in the ongoing planning have not resulted in a change of course. They have rather corroborated the concern of the 1983 legislature that began this process. Highway and air transport congestion have accelerated at a rate not imagined when this work began and rail freight traffic has increased dramatically with growth not considered reasonable for planning projections only a few years ago. The weight of railway freight cars has increased and continues to increase. This change affects not only the track and bridges of shortline railroads, the usual concern; it also affects the reasonableness of high speed trains sharing the same track as freight trains, one of the early assumptions made in the planning process.

A bibliography of the components of this plan represents a number of titles that are no longer generally available and may seem to be irrelevant because of age. They are all relevant and important, however. Since they represent volumes of a complete body of work that has continued for many years but are not generally available, the following abstract represents their content. It is important to note that this bibliography/ abstract does not represent a series of disconnected reports and new studies but rather volumes in a comprehensive program of research and development of the Pacific Northwest Rail Corridor plan. Some of the documents cited are working papers and reports not published for general distribution; however, their content is represented in *Washington State's Long Range Plan for Amtrak Cascades*. Working papers the contents of which are represented directly in the content of *Washington State's Long Range Plan for Amtrak Cascades* are not represented in this abstract.

The work has not been conducted in isolation, nor by a single consultant or consulting team. The list of participants, advisors and consultants is comprehensive, represented in a listing following the abstracts of the published work. The railroad operations research contributing to the planning process and to this document includes a large body of work that consists of research conducted by or for stakeholders and research conducted by or for WSDOT as conditions change. Much of this work is not represented in separate published reports. This continuing research ensures that all projects included in the program remain appropriate and capable of serving the intended function as a component of the full program plan. A summary of this work also follows the abstracts of the published work.

December 1984 Economic Feasibility Study

During the 1983-1985 Biennium, the Washington State Legislature commissioned a study of the economic feasibility study of the Portland OR – Vancouver BC corridor. The study, *High Speed Rail Passenger Service Western Washington Corridor Economic Feasibility Study*, was completed in December 1984.

Scope and Methodology

- Socio-economic characteristics of the corridor
- Existing and forecasted intercity travel market
- State of development of high speed rail technologies in the US and abroad
- Potential system alternatives combining candidate technologies and alternative alignments
- Potential ridership and revenue for the alternatives
- Preliminary capital and operating cost for each alternative
- Financial feasibility of the alternatives
- Other economic benefits that might be associated with a high speed passenger rail system
- Develop findings based upon existing data using a 20 year forecast

The work was extensive and detailed. There was no recommendation but rather a summary of performance. The evaluation addressed only three alternatives, Improved Amtrak service, High Speed Rail (TGV-type 150 mph), and Super Speed (maglev).

- Improved Amtrak: Assuming bi-hourly service, has the lowest capital cost ($670 million), lowest capital cost per passenger mile, lowest operating cost but highest operating cost per passenger mile, and the lowest ridership (2 million). Revenue would cover sixty percent of operating cost and thirty-three percent of the combined operating and capital cost. The greatest advantages were found to be reliable and established technology, proven systems in operation, and availability of suitable right of way. The only listed disadvantage was major construction problems.

- High Speed: Assuming hourly service, the capital cost was expected to be 1380% of the cost of improved Amtrak service. The operating cost per passenger mile would be fifty-five percent of the Improved Amtrak cost for ridership 245 percent higher than Improved Amtrak. Revenue would cover 139 percent of operating cost and twenty-six percent of the combined operating and capital cost. The greatest advantages were found to be quality of ride, amenities, relaxation, and frequency of service. Disadvantages were construction problems and difficulty of finding and acquiring suitable right of way
- Super Speed: Assuming hourly service, the capital cost was expected to be 1803 percent of the capital cost of Improved Amtrak. The operating cost per passenger mile would be fifty-five percent of Improved Amtrak (the same as High Speed) for ridership 400 percent greater than Improved Amtrak. Revenue would cover 139 percent of operating cost and fifteen percent of the combined operating and capital cost. The only advantages, considered significant advantages, were found to be quality of ride, amenities, relaxation, and frequency of service. Major disadvantages were found to be major construction problems and required right of way characteristics; other disadvantages were found to be not a reliable established technology, no proven systems in operation, and right of way availability.

The evaluation was made after study of the following:

Corridor Characteristics

Population and Employment

- Population and Employment Growth
- Population Density Growth
- Intercity Travel (Total Trips, Trip Lengths, Trips by zone, Highway Travel Growth, Modal Share)
- Existing Transportation Service Characteristics
- Rail, bus, and air by number of trips, one way fare, and average travel time

COMPARISON WITH ESTABLISHED INTERCITY RAIL CORRIDORS

Compare Portland-Vancouver BC with

- Tokyo-Osaka
- Paris-Lyon
- Boston-Washington
- Philadelphia-Pittsburgh

Characteristics compared

- Population
- Population density
- Rail passengers
- Rail passengers per year per 100 population
- Auto ownership per 100 population

HIGH SPEED RAIL TECHNOLOGIES

TECHNOLOGIES

- Guided buses (35 mph – 50 mph) -Eliminated from consideration because of suitability for urban rather than intercity trips
- Rapid Rail Service (60 mph – 125 mph) (Amtrak NEC, British HST, Canadian LRC) -100 mph on upgraded existing trackage with improved signaling, grade crossing protection, and improved trackage arrangement for shared use with freight service.
- High Speed Rail Systems (125 mph to 180 mph) (JNR Shinkansen, French TGV) - New dedicated right of way, electric propulsion, incompatibility with conventional North American rail equipment
- Super Speed Rail Systems (180 mph +) (German Maglev, Japanese Maglev) - Limited information available because still in development. Experience may be similar to American SuperSonic Transport program. Economic viability and actual construction costs unknown.

ALIGNMENT-TECHNOLOGY COMBINATIONS

RAPID RAIL

- Canadian LRC example (Diesel propulsion, tilt, low curve superelevation for freight compatibility)
- Track and signal changes and minor realignment
- Minimum right of way acquisition
- Potential problems of shared use with freight

HIGH SPEED RAIL

- French TGV-PSE trainset example (New Alignment, Sustained high speed, Direct service, Eliminates passenger/freight conflict, Speed increases ridership and allows higher fare)
- Alternative alignments (Traditional central city route, Optimal alignment east of Lake Washington. Possible use of abandoned rights of way, Completely grade separated)
- Tunnel through urban centers where new right of way not available

- New stations

SUPER SPEED RAIL

- Transrapid prototype (Studied for Chicago-Milwaukee and Los Angeles-Las Vegas, Chosen for Western Washington Corridor study because of larger body of information available)
- Little alignment flexibility
- Use of present right of way limited
- Extensive tunneling through urban areas
- Potential environmental impact
- 250 mph speed provides 1 hour 3 minute Seattle-Portland time

MEANS OF ACHIEVING TRAVEL TIME IMPROVEMENTS

- Track (higher FRA track class, Increased superelevation up to six inches, designate passenger tracks, curve straightening, route realignment, new alignment)
- Vehicles (increased power [horsepower per ton], increased cant deficiency [tilting vehicles], electrification, advanced technology [maglev]

JANUARY 1992 Statewide Rail Program Technical Report

This report consists of a description of existing rail facilities and service (freight and passenger), a description of potential speed increases and service enhancements, and a description of rail rights of way that may be useful public transportation corridors in the future. The report provides several passenger service alternatives that could be examined individually in greater detail.

The alternatives were developed through a process that included:

DESCRIPTION OF EXISTING SERVICES

- Rail Facilities Inventory - (Seattle – Portland, Seattle – Spokane, Portland – Spokane, Everett – Vancouver BC, Stampede Pass) including track alignment and configuration, locations and lengths of double track segments and sidings, weight-age-condition of rail, curve superelevation, signal system, speed capabilities of turnouts and crossovers, grade crossing locations and type of protection, maximum authorized speed and reason
- Amtrak Service Inventory – History and overview of intercity rail passenger service, Amtrak service history, current Amtrak services, competing services, running times and schedule adherence, existing stations, existing Washington Amtrak stations, and stations not currently used for passenger trains
- Amtrak Passenger Traffic Inventory – Total boardings and alightings, Amtrak passenger growth trend, monthly and daily variations in Amtrak traffic, Amtrak traffic by route, origin/destination patterns, major traffic movements served by each route, traffic on dedicated Amtrak Thruway bus connections

- Freight traffic – Freight constraints on engineering improvements, freight constraints on passenger train frequency improvements, existing rail freight traffic, and local freight operations

POTENTIAL TRAIN SPEED INCREASES

The potential train speed increases considered locomotive power and number of cars, horizontal and vertical alignment (curves) and grade, speed restrictions due to ordinances/track conditions/road crossings and other speed-affecting conditions, other trains on the same or parallel tracks, number and location of station stops. The projects were grouped as grade crossing improvements, operations change, track and roadbed improvement, rolling stock, right of way fencing or other barriers, signal improvements, and track realignment or new trackage. The projects were tested using Train Performance Calculator software. The resulting comprehensive list of projects included a description of each, expected time savings, and a conceptual estimate of the cost.

SERVICE ENHANCEMENT ANALYSIS

- Alternative Service Analysis - station improvements, marketing, intermodal connections, and additional schedule frequencies
- Project Evaluation and Prioritization – appropriate staging of speed-related and service enhancement projects given institutional and physical considerations such as funding and project lead times
- Ridership Analysis – potential ridership increases to year 2000 on existing and new corridors resulting from service and speed improvement projects
- Economic Development Impact – potential development activities and impacts at Amtrak stations including review of applicable comprehensive plans and zoning ordinances, redevelopment opportunities and determination of local interest
- Funding Alternatives for Service Enhancements – federal, state, local, private, and bi-state/provincial cooperation

RIGHTS OF WAY IDENTIFICATION

- Identification and description of nine non-Amtrak/non-main line routes that may be required for commuter rail or public transit use

JUNE 1992 Statewide Rail Passenger Program Working Paper 1 ("GAP" Study)

Using the January 1992 technical report as the point of departure, identify practical opportunities to increase passenger train speeds between Portland OR and Vancouver BC if the capabilities of the existing right of way could be enhanced to allow 90 mph or 125 mph operation.

ENGINEERING STANDARDS

A detailed review of the alignment with inventory of curves and associated speed restrictions:

- Rolling stock alternatives
- conventional vs. "high tech" rolling stock, tilting suspension systems
- Line Segments Capable of Higher Speeds – examination of running times for maximum speed of 79, 90, 110, and 125 mph for conventional and "high tech" equipment with unbalance of 3, 6, and 9 inches with curvature eased in specified places and a discussion of an alternative route to avoid the curvature near Napavine

SEPTEMBER 1992 Statewide Rail Passenger Program Working Paper 2 ("GAP" Study)

This is a continuation of the work started in Working Paper 1. A route change, the Point Defiance Bypass, is suggested and discussed.

TRAIN SPEEDS AND TRIP TIMES

Description of the TPC software, TPC results for the scenarios described in Working Paper 1:

- Choice of maximum speed (79, 90, 110, 125 mph) less important than choice of rolling stock and general upgrading of the route
- Tilt suspension systems have a beneficial impact on running time
- A Lightweight high-horsepower locomotive is needed to get the best out of both the tilt suspension system trains and the engineering improvements
- Electrification does not necessarily have a performance benefit over the theoretical benefit of a good self-propelled alternative but high performance electric locomotives exist and high performance diesel or turbine locomotives do not

TRACK ENGINEERING COST ESTIMATES

- Specific Engineering Projects (15 line changes or realignments, 5 track expansion projects, 1 tunnel project, 7 bridge projects [all identified in the January 1992 report] and new projects intended to raise speeds to more than 90 mph
- General Upgrading – Upgrade entire corridor to Class 6 track; no significant cost benefit found to increasing to Class 5 and limiting speed to 90 mph
- Third Main Track – 138 miles of third main track between Tacoma and Vancouver, assumes two Class 6 tracks and one Class 4 track

SIGNAL COST ESTIMATES

- Signals in the Northeast Corridor
- Signal requirements
- Grade crossings
- Impact on the existing signal system

- Stopping distances
- New signal technology
- Cost assumptions
- Signal cost table (cost per specified segment)

TRAIN SCHEDULES AND ROLLING STOCK ESTIMATES

Describes the schedules and equipment requirement/cost for two examples

- 8 Seattle – Vancouver BC round trip bi-hourly, 17 Portland – Seattle round trip hourly
- 4 Seattle – Vancouver BC round trip quadri-hourly, 9 Portland – Seattle round trips part hourly part bi-hourly

SUMMARY OF CAPITAL COSTS

OCTOBER 1992 High Speed Ground Transportation Study Final Report

In the spring of 1991, the Washington State legislature directed that a comprehensive assessment be made of the feasibility of developing a high speed ground transportation system in the state of Washington. The minimum speed to be considered was 150 mph.

TECHNOLOGY ASSESSMENT

- Candidate technologies – Improved conventional rail, tilt body trains, conventional high speed rail, maglev
- Safety
- Construction cost

CORRIDOR ANALYSIS

- Inventory and evaluation of candidate HSGT corridors (Portland-Seattle-Vancouver BC, Oroville-Wenatchee-Yakima-Goldendale, Kettle Falls-Spokane-Pullman-Clarkston, Seattle-Moses Lake-Spokane, Seattle-Yakima-Pasco-Spokane, Seattle-Yakima-Pasco-Walla Walla)
- Corridor selection (Portland-Seattle-British Columbia, Seattle-Moses Lake-Spokane) and discussion of alignment alternatives on each corridor
- Corridor travel times
- Corridor length by guideway type
- Service assumptions (12 round trips per day each corridor-mixed 1 hour/2 hour headway)

DEMAND AND RIDERSHIP

This work included travel surveys and related travel data, developing travel demand models expressing choices in terms of travel time/cost/other key variables, prepare forecasts of travel demand/HSGTS ridership and revenue under a variety of conditions and service characteristics. The scope of the study allowed research for the major market segments of Portland-Seattle-Vancouver BC and Seattle-Spokane but not identified secondary markets of Portland-Olympia, Bellingham-Vancouver BC, Ellensburg-Spokane, Seattle Tacoma International Airport transfers, and freight such as mail and package express.

RIGHT OF WAY

- HSGT Right of way requirements
- HSGT right of way types
- General right of way acquisition process
- Applying the generally acquisition process to the right of way types
- Recommendations (100 foot right of way, right of way for performance rather than cost, right of way acquisition process in State law RCW 8.25 and 8.26, property acquired by WSDOT)

COST ESTIMATES

- Definition of alternatives
- Capital cost estimates
- Operating cost estimates

ECONOMIC AND ENVIRONMENTAL IMPACTS

- Economic impact analysis
- Environmental impact analysis
- Plans, growth management, and land use analysis
- Regional transportation planning impact analysis

FINANCIAL ANALYSIS

- Public policy cash flow analysis
- Inventory of domestic and foreign experience
- Washington State capacity to fund
- Quantification of debt

INSTITUTIONAL ANALYSIS

- Institutional considerations
- HSGT in Europe
- HSGT in the United States
- Conclusions from other attempts to implement HSGT
- Federal government’s role in HSGT development
- Types of public-private partnerships
- Impacts on governance, planning, and growth management
- Washington’s options and constraints
- Some possible models for governance

FINDINGS AND RECOMMENDATIONS

European countries provide the best guidance for development of HSGT but the difference in situation must be recognized. European nations have greater population density and greater rail ridership in place. HSGT is not a new mode of transport being introduced. In Germany, Sweden, and France the driving force behind HSGT was highway congestion and the need to maintain the competitiveness of intercity rail with highway and air transport. In France, rail congestion was also a factor in the Paris-Lyon TGV line. Intermodalism already exists in Europe, with an extensive network of local and regional transport already in place.

Washington does not have any of these characteristics. HSGT will be a new mode of transport that is needed because highway and air transport are reaching serious levels of congestion. It merits consideration because of the financial and environmental cost of expanding highway and air transport. The potential benefits are great but without an existing ridership base, coordinated urban and regional transport systems and intercity lines, and a culture attuned to the use of high quality rail travel, a patient and measured approach to achieving ridership and funding is necessary.

The states of Washington and Oregon and the Province of British Columbia should take immediate steps to upgrade Amtrak service, demonstrate integration with other transport modes, and take further action to begin building support for HSGT. 150 mph HSGT should be implemented between Portland and Everett by 2020, and development of HSGT between Everett and Vancouver BC and between Seattle and Spokane should be pursued concurrently.

- A phased approach should be used that makes maximum use of the existing rail right of way with a priority plan for constructing high speed segments.
- Grade crossings should be eliminated.
- Freight and passenger conflicts should be eliminated through the development of integrated freight and passenger timetables.
- High quality non-electrified technology should be used for the first phase with an ultimate goal of electrification of the corridor.
- Purchased right of way must be compatible with future HSGT requirements.
- Examine potential for private funding support.
- It is imperative that passengers be offered through joint ticketing and scheduling for a seamless trip start to finish as can be had using an automobile.
- Intercity and commuter rail service between Olympia and Everett should be coordinated.
- A financing plan that puts intercity rail on the same footing with comparable highway investments.
- Draft legislation should be produced that creates a public entity or empowers an existing public entity to carry out the project

and establishes the revenue mechanisms necessary for HSGT funding.

DECEMBER 1992 Statewide Rail Passenger Program Working Paper 3 ("GAP" Study)

Working Paper 3 continues the work described in Working Paper 2.

OPERATING ANALYSIS

General discussion of freight/passenger conflicts, detailed description of existing freight operations, analytic capacity research.

RIDERSHIP ANALYSIS

The approach included

- Analysis of known and documented changes resulting from similar changes in speed, service level, schedule changes on other Amtrak corridors.
- Consideration of historical patronage response to incremental improvements of the type related to the Pacific Northwest Rail Corridor.
- Station area analysis including statistical analysis of population and employment within a constant distance of each station and correlated with station usage.
- Use of models developed from prior intercity passenger rail studies of the incremental effects of travel time reductions on ridership.
- Use of data from recent Amtrak service enhancements and feeder bus experience in other states.
- Application of an incremental approach using existing ridership as the base case for the two service scenarios described in Working Paper 2. It considered corridor population and economic growth, quality of competitive services, gasoline prices and fares, frequency of service, speed, system accessibility, service schedule, schedule reliability, passenger amenities, and marketing/fare policy.

LOCAL AND REGIONAL IMPACTS

In general the local jurisdictions have not considered rail transportation in their planning. Their only contact with rail transportation is rail freight transportation, over which they have some significant concern. Any approach to improving rail passenger service will be linked to resolving community concerns with freight service.

DECEMBER 1992 Statewide Rail Passenger Program Restoration of Passenger Service between Seattle, Washington and Vancouver BC

This paper considers only the implementation of a single Seattle – Vancouver BC round trip passenger service that would occur immediately, before the beginning of a program of corridor-wide improvement.

ASSUMPTIONS, TRACK SPEEDS, AND SCHEDULE TIMES

- Seattle-Vancouver BC elapsed times approximately 3.5 hours
- Investment program provide for at least two daily round trips in "daylight" hours without degrading BN freight operation
- Investment should recognize shortage of funds and emphasize "smart" selective investment
- Dollars spent to improve reliability are as important as the dollars spent to increase speed

SPECIFIC IMPROVEMENTS WITH COST ESTIMATES

BURLINGTON NORTHERN COMMENTS

Comments included extension of sidings to 9,000 feet, interlockings at GN Jct. and C Line Jct., future extension of the English siding to connect with the Marysville siding (6 miles), a ten track yard and 7,000 foot siding near Conway (MP 63) to support Burlington, Bellingham, Ferndale, and Intalco, relieving congestion at those points, a controlled signal either side of Bellingham as part of the CTC installation, power switch at the south end of Burlington and the middle crossovers at Burlington and the Anacortes line switch.

OCTOBER 1994 Washington Rail Capacity Analysis

The research was a simulation of traffic on all of the state's main line rail routes under a variety of traffic conditions including the introduction of passenger service between Seattle and Vancouver BC, Everett-Tacoma commuter service, and additional passenger service between Seattle/Portland and Spokane. It included evaluation of the detailed planning that had been done for restoration of service between Seattle and Vancouver BC as described in Working Paper 4 of 1992. Recommendations included storage tracks at Cherry Point, extend the Bow, Ferndale, and Blaine sidings to 9,000 feet, CTC between South Bellingham and Blaine, electric lock switches at Burlington, three yard tracks (total 13,000 feet) at Delta yard, extend sidings at English and Stanwood to 9,000 feet, construct 8,000 foot Roger siding, reconstruct the (removed) Short Pass at PA Jct., modify rail locks on Bridge 4 for increased speed and construct second main track between MP 7 and MP 8, and that when comparing the results for south of Seattle and North of Seattle, the immediate need was north of Seattle.

1995 Options for Passenger Rail in the Pacific Northwest Rail Corridor

The introduction cites the objectives of "collect and summarize the plans developed into a single document which can serve as the basis for conduction the environmental impact reviews necessary prior to designing and constructing further improvements" and "lay out the priorities, timing, and financial demands of the long-run strategy so that all concerned can see the architecture of the system as it develops." The scope of the work also included new research and planning, using the work since the publication of the

"GAP" study as the departure point. The introduction also contained a discussion of the logic and history of the incremental approach. The report represents the combined planning for the entire Eugene-Vancouver BC corridor including earlier work performed by Oregon and British Columbia. The research represented in the report included:

TRAIN OPERATIONS, COSTS, AND REVENUES

- Relevant experience in California corridors
- Pacific Northwest Corridor profile
- Improved running times and service levels
- Patronage projections
- Operating costs and revenues
- Fare levels and revenue

PROPOSED IMPROVEMENTS TO RAILROAD INFRASTRUCTURE

- List of proposed improvements (54 projects of magnitude ranging from signal and traffic control system changes to significant deviation from the existing alignment)
- Alternative routes in Oregon and Washington (discussion of the Harrisburg OR bypass route and the Point Defiance Bypass route between Reservation (Tacoma) and Nisqually
- Alternative routes in British Columbia (discussion of the White Rock bypass)
- Ranking of improvements in order of overall benefit
- Intermodal facility/station improvements
- Maintenance/servicing facility
- Land acquisition costs
- Summary of capital costs

ENVIRONMENTAL CONDITIONS AND IMPACTS

This section provided a general overview of environmental conditions and impacts to ensure that "the Pacific Northwest Rail Corridor Report does not gravely impact the natural and built environment" and any environmental features that may constrain the location of alternative rail alignments is identified," preliminary to a comprehensive review under the National Environmental Policy Act (NEPA). The work consisted of collection and review of existing data, field trips to the three bypass areas and to specific improvement sites, and the collection of additional environmental data as necessary.

INSTITUTIONAL AND COMMUNITY INVOLVEMENT PLAN

This section discussed the goal, development, approach, philosophy, issues, and legal requirements of the public involvement plan.

FINANCIAL PROGRAM

This section discussed the financial program in detail including system development and operations, system management and governance, cost sharing responsibility, and funding strategies.

DECEMBER 1997 Pacific Northwest Rail Corridor Operating Plan Years 2003 and 2018

This document develops additional detail using the 1995 Options Report as the departure point.

TRAIN OPERATING SCENARIOS

- Current corridor services
- Rolling stock
- Running times
- Service frequency
- Train operating scenarios

RIDERSHIP AND REVENUE FORECASTS

Forecasts and discussion of forecasting methodology

OPERATING COSTS

- Analysis methodology
- State/Amtrak operating support
- Analysis of operating costs
- Financial performance
- Year 2003 and 2018 schedules

JUNE 1998 Running Time Reduction for Seattle – Portland Amtrak Schedules

This document describes the development of the three hour thirty minute Seattle – Portland schedules through the use of five inch unbalance speeds in curves.

- Developing the 3 hour 30 minute schedule
- Description and results
  - The substantial difference between 3 and 5 inch cant deficiency
  - Determining speed limit zones (track geometry information, existing conditions, curve 133, changes in sped due to changes in cant deficiency
- Testing train speed and running time
- Results (general result of comparison, specific areas of note)
- Curves affecting train speed at various cant deficiencies
- Speed limit zones
- Train Performance Calculator output graphs

- Train Performance Calculator description (calculation, track description, train description, train handling, speed restrictions and stopping, output)
- Effect of cab cars on running time
- 5 inch cant deficiency speeds and operation (restricted curves, other restrictions, revised speed limit zones, operation using a separate set of speed limits, separate speed zones as well as speed limits for Talgo trains, advance warning signs for permanent speed restrictions, example general order implementing Talgo train speeds, unprotected crossings)
- Test trains and final speed limit zones (speed limit zones, superelevation, track conditions Puyallup/Bucoda/Ridgefield/Vancouver, April 22 test train, May 6 test train, implementation)
- FRA Waiver RST-97-4
- BNSF speed limit zone proposal
- April 22 test train
- Running time detail
- Summary of testing
- Implementing general orders

DECEMBER 1998 Revised Intercity Passenger Rail Plan for Washington State 1998-2018

This document is a synopsis of the planning work to date in a user friendly and not-too-technical format intended for the general public, including:

INTRODUCTION

- Where do the trains run?
- Who are the program partners?
- What work has already been done or is underway?

PURPOSE OF THE PROGRAM

- Why do we need this plan?
- Why can't we just increase train speeds and put more trains on the track now?
- What else is going on in the corridor?
- How will these activities affect WSDOT's corridor program?

WSDOT'S VISION FOR PASSENGER RAIL

- What type of passenger rail service do we have today
- What type of service is WSDOT planning?
- How many people will ride the train?

PNWRC PROGRAM COMPONENTS

- Grade crossing upgrades
- Speed increases
- Enhanced train signals and communication
- Improved tracks and facilities
- Potential improvements
- Service level one (five year) projects
- European-style trains
- Stations serving neighborhood communities

ENVIRONMENTAL AND COMMUNITY CONSIDERATIONS

- Environmental areas reviewed
- Potential impacts
- Areas of concern
- Long term impacts

FINANCIAL AND INSTITUTIONAL FRAMEWORK

- What types of costs will be required to meet WSDOT's vision?
- What will the total system cost?
- Capital investments
- Operating costs
- Who's going to pay for it?
- Cost allocation
- Past and future funding sources
- Is it worth the investment?

IMPLEMENTATION

- How will future expansion of passenger rail service be implemented?

DECEMBER 1998 Environmental Overview for the Intercity Passenger Rail Plan for Washington State 1998-2018

Extensive discussion with FRA, FHWA and the State Attorney General's staff (for SEPA) led to WSDOT's environmental approach. It was determined that given the limitations imposed by conflicting policy and planning practices between the state of Washington and BNSF, it was difficult and impractical to analyze a twenty year program at the level of detail required by an EIS. To ensure that environmental resources along the corridor were considered, the environmental overview was developed. The environmental overview was developed to be incorporated in the program plan as an appendix. This approach was determined to fulfill the intent of NEPA while giving the state the flexibility to design the service using an incremental approach. This document is included in *Washington State's Long Range Plan for Amtrak Cascades* as a technical appendix. The discussion included:

THE AFFECTED ENVIRONMENT

- Waterways and hydrological systems (surface water, ground water, floodplains)
- Hazardous materials
- Biological resources/ecology (wetlands, vegetation/fisheries/wildlife including threatened and endangered species)
- Air quality
- Soils and geology
- Land use
- Farmlands
- Parks and cultural resources
- Social and economic (community cohesion and safety, relocation, environmental justice)
- Visual quality
- Energy
- Noise and vibration

IMPACTS AND MITIGATION

Discussion of potential impacts, construction impacts, mitigation, secondary and cumulative impacts:

- Waterways and hydrological systems
- Hazardous materials
- Biological resources/ecology
- Air quality
- Soils and geology
- Land use
- Farmlands
- Parks and cultural resources
- Social and economic
- Visual quality
- Energy
- Noise and vibration

MAPPING (VOLUME 2)

- Hydrology, hazardous sites, floodzones
- Wetlands, threatened and endangered species
- Air quality
- Generalized slope stability
- Parks and cultural resources
- GMA urban growth areas

DECEMBER 1998 Economic Analysis for the Intercity Passenger Rail Plan for Washington State 1998-2018

This volume is a complete economic analysis of the PNWRC Intercity Passenger Rail Program (Amtrak *Cascades*) including a cross-modal analysis. It includes:

WHY INVEST IN PASSENGER RAIL?

This section is a cross modal analysis of highway, air, and passenger rail transport. "Transportation planners and economists use a technique known as cross-modal analysis to compare different types (modes) of transportation systems and identify their operational and societal costs (impacts). When these methods are applied to intercity passenger in the Pacific Northwest Rail Corridor, results reveal that passenger rail is comparable to both highway and air travel." The analysis included:

- Comparison of direct operating cost
- Comparison of travel time (developing time costs by mode, work related vs. leisure related travel time, estimated opportunity cost of travel, assumptions used for travel time estimates, methodology discussion)
- Comparison of external costs (discussion of methodology, air pollution, noise pollution, water pollution, waste disposal, accidents, final external cost estimates)

HOW MUCH WILL IT COST?

- Operational and capital costs
- Capital cost sharing
- Capital investments and cost allocation
- Operating costs
- Passenger rail viewed within the context of the overall transportation system (adding capital costs to the cross-modal comparison, estimating capital costs, final capital cost estimates)

HOW WILL WE PAY FOR IT?

- Cost allocation
- Past and future partnerships
- Washington's commitment
- Other potential funding sources-partnerships/discretionary federal and state transportation funds

JANUARY 1999 Pacific Northwest Rail Corridor Continuing Program of Reduced Running Times, Increased Schedule Frequencies

This collection of working papers discusses recent work on running time reduction and increased service including:

- Seattle-Portland running time reductions
- Seattle-Vancouver running time reductions including eased curvature between Everett and GN Jct. and a new higher speed alignment between GN Jct. and Delta Jct.
- July 1999 Seattle-Vancouver additional service
- Example schedules year 2003
- Phase 4 infrastructure, running time, and schedule examples

SEPTEMBER 1999 Conceptual Engineering Assessment Pacific Northwest Rail Corridor Point Defiance Bypass Project

This document discusses the treatment of grade crossings between Lakewood and Nisqually, track rehabilitation and eased curves, and alternatives for a new connection at Nisqually.

APRIL 2000 Amtrak *Cascades* Plan for Washington State 1998-2018 Update

This document is essentially the same as the 1998 document with the exception of the identification of the service as Amtrak *Cascades* and reference to some capital projects funded by Amtrak instead of Washington State.

OCTOBER 2000 Alternatives for Alignment Change and Speed Increases for Talgo Trains on Curve 0 at Lakeview on BNSF Lakeview Subdivision

This document describes the running time and fuel consumption effects of the exiting track geometry of Curve 0 and explores alternatives to allow higher speed.

SEPTEMBER 2001 WSDOT Projects Simulation Analysis

BNSF conducted a simulation of the Tacoma-Vancouver segment of the PNWRC infrastructure plan. WSDOT and BNSF constructed all input data jointly, BNSF operated the simulation, and BNSF and WSDOT conducted independent analyses of the simulation output. This document represents the BNSF analysis report and the separate WSDOT analysis of the simulation output.

- Background
- Delay
- Simulation and analysis (simulation process, simulation procedure, measurement, general statistical analysis, detailed statistical analysis, root cause analysis, the analysis process, using the result)
- Description of the simulation
- Summary results
    - Software output

    - BNSF statistical analysis
    - Additional ways to look at the data
    - Measurements used for evaluation
    - Direct measurement
    - Measurements not used for evaluation
    - Measurements used for evaluation
    - Equivalent measurements
    - Evaluation process
    - Comparisons to be made
    - Base case to 2004 base case
    - Comparison to base case
    - Comparison to 2004 base case
    - Scoring the results (all trains, all freight trains, through freight trains, passenger , merchandise, intermodal, grain and other unit, yard and local)
- Detailed analysis of the simulation (delays by length and location, delays by length/location/train type, delays by time of day and location, delays by time showing passenger trains, freight schedule, details of delays by length/location/train type)
- Root cause analysis (extended delays, the analysis process, delays of more than ten minutes, delays by cause, delays caused by freight, delays caused by passenger, avoidability, revised statistical analysis)
- Conclusions
- Appendix of train schedules used in the simulations

FEBRUARY 2003 Kelso to Martin's Bluff Project Operation

This document provides a detailed description of current train operation in the Kelso to Martin's Bluff project area and operation when the project is complete.

- Current arrangement
    - Infrastructure (Rocky Point, Kelso, Longview Jct., Kalama, MP 111)
    - Operation (passenger trains, Rocky Point, Longview Jct., Kalama, grain storage, maintenance of way)
    - Capacity (theoretical and practical capacity, yard and terminal capacity, blocking time analysis, freight trains, passenger trains)
- Planned arrangement
    - Infrastructure (Rocky Point, Kelso, Longview Jct., Kalama, MP 111)
    - Operation (passenger trains, Rocky Point, Longview Jct., Kalama, grain storage, maintenance of way)
- Full program development
- Capacity (freight trains, passenger trains)

APRIL 2004 Everett Speed Improvement Project Conceptual Engineering Report

This document provides conceptual engineering information for the PA Jct. – Delta Jct. speed improvement project including a general description of the project, related Sound Transit, city of Everett, and BNSF projects, and modifications to Bridge 37.0 to allow increased train speed.

DECEMBER 2004 Bellingham-Brownsville Congestion

This document describes research into new congestion conditions between Everett and Vancouver BC caused by increased freight traffic, changes in freight traffic patterns, and changes in procedures at the USA/Canada border.

- Summary
- Background (conditions existing before 1995, conditions at initiation of passenger service)
- Capacity, congestion, predictability, delay, reliability
- Current conditions (traffic, USA/Canada border-Swift-Blaine-White Rock, Colebrook, Brownsville)
- Restoration of reliable service (USA/Canada border-infrastructure and procedures, Colebrook, traffic control, Brownsville, Brownsville-Thornton lead, Bridge 69)
- Developing and implementing solutions

JULY 2005 Compiled Working Papers on King Street Station Capacity, Operation, and Infrastructure Design

King Street Station, as constructed, does not have the capacity needed to accommodate the planned passenger train traffic. Research and plan development began in 2001 and was completed in 2005.

PLANNING CONDUCTED BY OTHER AGENCIES IN CONJUNCTION WITH AND INCORPORATED INTO THE PACIFIC NORTHWEST RAIL CORRIDOR PLAN

Agencies other than WSDOT have contributed detailed research for the development of the Pacific Northwest Rail Corridor plan.

FEBRUARY 1995 Regional Transit System Commuter Rail Infrastructure Program and Capital cost Estimates (Puget Sound Regional Transit Authority)

This work represents the base plan developed for Lakewood-Everett commuter rail, using the PNWRC development work to date as the departure point. It includes:

- Brief chronological history of the region's commuter rail development process
- Commuter rail system operating scenarios, line characteristics, service schedules, fleet requirements, operating statistics, and fuel consumption estimates
- Commuter rail infrastructure program development process
- Projects comprising baseline capital program
- Projects not currently scheduled in capital program
- Track chart graphics
- Schedules and cash flows

APRIL 1996 King Street Yard-Conceptual Program for Storage Yard and Maintenance Facility (Amtrak)

This document presents five alternative yard layouts, a conceptual building layout, and a two phase implementation plan. The discussion includes:

- Project approach
- Building description
- Conceptual operation plan
- Cost estimates
- Technical analysis
    - Train consists to be serviced and maintained
    - Service and inspection tracks
    - Heavy passenger car repair and wheel truing track
    - Locomotive repair tracks, drop table, heavy repair and scheduled inspections
    - Locomotive running repair and daily inspections
    - Locomotive sanding and fueling tracks
    - Train washer
    - Train storage yard
    - Vehicle maintenance related support facilities (battery charging room, lubrication storage room and distribution pumps, miscellaneous workbench area, tool lockup area, special tool and instrument room, passenger locomotive wheelset storage)
    - General support areas and special activities (materials and commissary unloading dock, material storage control center, commissary storage and control, maintenance facility administrative offices/supervision and workforce welfare facilities)
    - Discussion of philosophy used when assigning workforce/areas of concern
    - Staffing requirements

MAY 1998 Tacoma Area Rail Access & Capacity Improvement Plan (Port of Tacoma)

This work is a development of previous work, *Port of Tacoma Tideflats Circulation Study* (1996), which identified a system of rail and road improvements that could be implemented over a period of twenty years. This work was initiated to “improve main line capacity through the City of Tacoma that will accommodate freight, commuter, and intercity passenger growth through the year 2005” and “provide improved access to and from the Port of Tacoma tideflats.” It included:

- Project improvement alternatives
- Freight mobility: Thea Foss Curve realignment and third main track
- Commuter and intercity passenger rail: RTA/Amtrak Tacoma to Lakewood connection
- Port of Tacoma direct access improvements: BNSF north wye and UPRR bypass
- Steps toward implementation
- Bridge inspection report
- Train performance graphs
- Rail operations/simulation report
- Detailed cost estimates
- Plans

JUNE 1998 Vancouver Rail Passenger Terminal Alternatives (British Columbia Transportation Financing Authority)

Amtrak *Cascades* service in British Columbia was initiated with very little infrastructure investment. Knowing that significant infrastructure investment would be needed in support of additional trains, the British Columbia government initiated a study of alternatives to the current station location in Vancouver. This research included:

- The intercity passenger service goals (one or two additional trains, running time reduction, bi-hourly service)
- The importance of current decisions to future goals
- Relocation of the BNSF barge operation from Vancouver
- The Roberts Bank deep water port
- Further development of the North Shore terminals
- The passenger service market (business, entertainment, recreation, tourism, personal)
- Intermodality
- Skytrain
- Automobile Access
- Customs inspection (preclearance, facility, equipment isolation, multiple stops within Canada)
- The alternative station locations
    - Station location

        - Single or multiple stations (Chicago, New York City, Boston, Philadelphia, San Francisco)
        - The Vancouver terminal alternatives (Pacific Central Station, Waterfront Station, Burrard Street Station, Scott Road ALRT station, Rupert Street Vicinity Station, New Westminster, South Coquitlam)
        - The airport location and the rail advantage of station location
    - Achieving the goal schedule run time
    - A new passenger terminal
    - The BNSF route
    - Traffic conflict in the Vancouver terminal
    - Railbanking
    - Option 1: New Westminster – Coquitlam – Vancouver (CP/Waterfront)
    - Option 2: Willingdon Jct – Second Narrows tunnel (as a passenger route, as a freight route)
    - Option 3: Scott Road (CNR/SRY route, new alignment)
    - Option 4: Arbutus corridor
    - Option 5: Additional tracks at Douglas Road
    - Option 6: Vancouver Jct. – Heatley – Vancouver (Glen Drive)
    - Option 7: Shared right of way with ALRT between Still Creek and Commercial Drive
    - Option 8: Shared right of way with ALRT between the Fraser River Bridge and Brunette
    - Option 9: Other options (Renfrew street vicinity station, New Westminster station, South Coquitlam station)
    - Fraser River Crossing
    - Project cost

JUNE 1998 Vancouver BC Amtrak Service: Infrastructure and Operating Changes for Additional Trains (Amtrak, British Columbia Transportation Financing Authority, Burlington Northern Santa Fe Railway, Canadian National)

Research included:

- Description of previous work
- Level of utility discussion
- Description of the line
- Description of traffic
- General effect of passenger trains on freight operation
- Specific areas of concern (Fraser River Bridge, CP connection between CP Jct. and Sapperton, North Shore connection at Willingdon Jct., Vancouver yard/terminal area)

- Infrastructure improvements and additional trains (one pair of additional trains, second par of additional trains)
- Shared benefits (Amtrak, BNSF, CN)
- Recommended operating practice changes
- Hazardous roadway crossings
- Fraser River Bridge
- Estimating project cost

FEBRUARY 2003 I-5 Rail Capacity Study (Portland/Vancouver I-5 Transportation and Trade Partnership)

This study was initiated jointly by Washington and Oregon to answer several important questions:

- What is the capacity of the Portland/Vancouver rail network to meet present and future freight and passenger needs?
- Is there sufficient capacity to support the ports of Portland and Vancouver?
- Will there be sufficient capacity to support increased intercity passenger service from Eugene to Portland to Seattle?
- What improvements are needed in the rail network now and in the future?
- What happens if rail capacity does not increase?

The research included a detailed ten year freight traffic forecast, analytic and simulation capacity research, a ten year and twenty year planning horizon, and sensitivity tests. It resulted in a set of conclusions including specific rail infrastructure projects that have been included in *Washington State's Long Range Plan for Amtrak Cascades.* Results of the sensitivity testing suggested that freight traffic congestion in the Portland-Vancouver terminal is related to freight operation in the terminal; passenger trains and external causes are not significant contributors to the Portland/Vancouver terminal area freight congestion.

NOVEMBER 2004 Verification of Conceptual Engineering and Facility Programming Requirements-Amtrak Maintenance Facility, King Street Yard, Seattle WA (Amtrak)

This document represents continued development of the Seattle Maintenance facility including discussion of:

- Key programming and design considerations
- Design fleet and yard operations
- Maintenance requirements
- Industrial design criteria
- Civil engineering – roadway, drainage and grading, utilities
- Trackwork – yard and shop
- Architectural design
- Structural design
- Mechanical, plumbing, and fire protection design
- Fuel system design

- Electrical design
- Construction phasing
- Year 2015 *Sounder* and *Cascades* service plan data
- Site plan and yard track layout
- Construction staging plans
- Yard occupancy at peak times
- Amtrak space and staffing requirements
- Rolling stock diagrams
- Floor plans

OPERATIONS RESEARCH CONDUCTED FOR PLAN DEVELOPMENT AND VERIFICATION

Pacific Northwest Rail Corridor planning has included a large body of railroad operations research. This work represents research conducted in the course of infrastructure design and work conducted as validation of the infrastructure design. This work has been conducted by several entities involved in or affected by the Pacific Northwest Rail Corridor plan. The following table represents the research. Much of this work is not represented by published documents but is rather research conducted during the planning process, the results of which are represented in the infrastructure and operations parts of *Washington State's Long Range Plan for Amtrak Cascades.*

Year	Conducted By	Segment and Method
1990	BN	Tacoma - Seattle simulation
1990	WSA for WSDOT	Portland – Vancouver BC analytic
1991	BN	Tacoma - Seattle analytic and simulation
1991	BN	Seattle - Vancouver BC analytic Tacoma – Seattle simulation
1993	BN/WSA for WSDOT	Portland – Vancouver BC analytic and simulation
1994	BN	Portland – Vancouver BC analytic and simulation
1994	WSA for WSDOT	Statewide freight capacity
1995	BN/WSA for WSDOT	Portland – Vancouver BC simulation
1995	BN	Tacoma – Everett simulation
1996	BNSF	Portland – Vancouver BC simulation
1997	WSA for Clark County	Portland – Vancouver simulation
1998	TSM for BCTFA	Brownsville – Vancouver BC analytic

Year	Conducted By	Segment and Method
1998	BNSF	Tacoma – Everett simulation
1999	MLM for ST	Tacoma - Seattle simulation
2000	TSM for WSDOT	Chehalis – Tacoma analytic
2000	MK/TSM for WSDOT	Tacoma – Seattle simulation
2001	BNSF/TSM	Portland – Tacoma simulation
2001	WSA for Whatcom Council of Governments	Burlington – Vancouver BC simulation
2001	TSM for WSDOT	Auburn – Spokane analytic
2002	TSM for WSDOT	Portland – Vancouver BC analytic
2003	WFK/HDR/TSM	Portland – Tacoma analytic and simulation
2003	WFK/TSM for BNSF	Titlow – Auburn and Port of Tacoma analytic and simulation
2003	MLM for WSDOT	Tacoma-Black River simulation
2003	BNSF	Tacoma – Vancouver BC simulation
2003	HDR for WSDOT	Everett – Blaine analytic and simulation
2003	TSM	Seattle – Everett analytic
2004	MLM for Port of Tacoma	Portland – Tacoma analytic
2004	TSM for WSDOT	Everett – New Westminster analytic
2004	HMM For Greater Vancouver Gateway Council	Blaine – Vancouver simulation
2005	TSM for WSDOT	Everett – Stanwood analytic
2005	BNSF	Everett – New Westminster simulation
2005	WSA for Whatcom Council of Governments	Everett – Blaine analytic
2005	MLM for Port of Vancouver	Vancouver and Port of Vancouver simulation
2005	WFK/TSM for Port of Tacoma	Titlow – Auburn and Port of Tacoma simulation
2005	WSA/TSM for Port of Seattle	Black River – Seattle and Port of Seattle area analytic and simulation

PLANNING PARTICIPANTS

The Pacific Northwest Rail Corridor plan has been developed by an extensive list of participants, advisors, and consultants. The list of consultants is lengthy, but represents those chosen for specific expertise in individual elements of the planning process. Those cited in planning documents include:

PLANNING PARTICIPANTS

- Washington State Department of Transportation (WSDOT)
- Washington State Transportation Center
- Clark County
- Foster, Pepper & Shefelman, Attorneys at Law
- City of Spokane
- Snohomish County
- Pierce Transit
- Burlington Northern Railroad (BN, now BNSF)
- Port of Seattle
- Federal Railroad Administration (FRA)
- Federal Highway Administration (FHWA)
- Manson Construction and Engineering
- City of Renton
- Washington Transportation Policy Institute
- Sound Finance Group
- British Columbia Ministry of Employment and Investment
- National Railroad Passenger Corporation (Amtrak)
- Southern Pacific Lines (now Union Pacific)
- British Columbia Transportation Financing Authority
- Central Puget Sound Regional Transit Authority (now Sound Transit)
- Tacoma Municipal Belt Line Railway
- Union Pacific Railroad Company
- Pacific Rail Services
- Puyallup International
- CEECO
- Port of Portland
- Metro (Portland area metropolitan service district)
- City of Portland
- Port of Vancouver (Washington)
- Southwest Washington Regional Transportation Council
- City of Vancouver (Washington)

PLANNING ADVISORS AND INFORMATION CONTACTS

- Members and staff of the Legislative Transportation Committee
- Members of the Senate and House Subcommittees on Public Transportation
- Greyhound Lines, Inc.

- Washington State Utilities and Transportation Commission
- Washington State Office of Fiscal Management
- Washington State Employment Security Department
- Bonneville Power Administration
- Puget Sound Council of Governments
- Municipality of Metropolitan Seattle (Metro)
- Thurston Regional Planning Council
- Portland Municipal Service District
- Greater Vancouver Regional Planning District
- Oregon State Public Utilities Commission
- City of Bellingham
- City of Blaine
- City of Centralia
- City of Edmonds
- City of Everett
- Snohomish County Transportation Authority (SNO-TRAN)
- City of Kelso
- City of Mt. Vernon
- City of Lacy
- City of Seattle
- Washington Association of Rail Passengers
- Olympia Amtrak Depot Committee
- Wisconsin Department of Transportation
- Oregon Department of Transportation
- British Columbia Ministry of Transportation and Highways

CONSULTANTS

- Parsons Brinkerhoff Quade & Douglas, Inc.
- Wilbur Smith Associates (WSA)
- Molyneaux Associates, Inc.
- Stanton-Masten Associates, Inc.
- Ross-Clarke Associates
- Raj Joshi and Associates
- Gannett Fleming, Inc.
- KPMG Peat Marwick
- First Boston
- DKS Associates
- Triangle Associates
- Morrison Knudsen Corporation (now Washington Infrastructure Services)
- HDR Engineering, Inc. (HDR)
- Morrison Hershfield, Ltd.
- Infrastructure Consulting Corporation
- Berk & Associates, Inc.
- Parametrix, Inc.

- Trans-Actions, Inc.
- Volpe Transportation Systems Center
- The Resource Group Consultants, Inc.
- Transit Safety Management, Inc. (TSM)
- TransSystem Corp.
- Willard Keeney Associates (WFK)
- Kaiser Engineers
- Frederic R. Harris, Inc.
- STV Incorporated
- Mainline Management, Inc. (MLM)
- Hatch Mott MacDonald, Inc. (HMM)

Appendix B
Description of Current Rail Line

Appendix B: Description of Current Rail Line

The following discussion describes the existing rail infrastructure and traffic along the Burlington Northern and Santa Fe Railway Company's (BNSF) main line from south to north. Location names are those used in the BNSF timetable (with some exceptions for locations that no longer have a station name in the timetable). Directions in the description are North: Portland, OR to Vancouver BC, South: Vancouver BC to Portland, OR. The railroad timetable directions vary along the line, with East and North being the same general direction depending upon the subdivision. Where distances and mileposts are shown, distance is the distance from Portland, OR measured continuously, and the milepost is the timetable milepost location. Because the route consists of many segments of lines that were constructed separately and were often separate railroads, the milepost numbering is not consistent.

In some places, the physical features and traffic on a connecting route are an important consideration for the Pacific Northwest Rail Corridor's (PNWRC) configuration and traffic. The discussion includes portions of connecting routes that affect the PNWRC.

Signals and Traffic Control

United States

The track between the switches at the north and south ends of Portland Union Station is Yard Limits with no signal system, controlled verbally by the Portland Terminal Railroad Yardmaster at Lake Yard.

The signal and control system is Centralized Traffic Control (CTC) between Portland and Tacoma. There are seven miles of Yard Limits with two track Automated Block Signals (ABS) with signals for movement on either direction on either track through Tacoma between Ruston and Reservation. Sixteen miles of two track line have been recently equipped with CTC between Reservation and Auburn. Twenty-one miles of two track line between Auburn and Seattle are Yard Limits and block signals for movement with the current of traffic, but CTC installation is in progress.

There are eight miles of Yard Limits and ABS between Seattle and rail milepost 8. The two track portions have block signals for movement in either direction on either track, however the signal indications in some places are more restrictive for left hand operation than for right hand operation. In the Tacoma and Seattle Yard Limits sections, the train dispatcher has absolute control over all main track movements using Occupancy Control System (OCS).

There are twenty-six miles of CTC between rail milepost 8, north of Seattle, and PA Junction in Everett. Three and one half miles of single track between PA Junction and Delta Junction in the Everett terminal have ABS and Yard Limits, but no traffic control. All main track movements are made as allowed by Yard Limit rules.

There are 56.5 miles of CTC between Delta Junction and South Bellingham. The single track between South Bellingham and rail milepost 98.6, about three miles, is Yard Limits ABS with OCS traffic control. There are eighteen miles of CTC between Bellingham and Swift, and three miles of Yard Limits ABS with OCS between Swift and the U.S./Canada border.

Traffic in the U.S. is handled by Train Dispatchers in the Network Control Center in Ft. Worth, TX. Train Dispatcher territories are:

- Portland, OR to Vancouver, WA: ten miles (a portion of a twenty-nine mile district);
- Vancouver, WA to Wabash, WA: eighty-seven miles;
- Wabash to Tukwila, WA: seventy-nine miles;
- Tukwila to rail milepost 8 north of Ballard, WA: eighteen miles
- Rail milepost 8 to PA Junction, WA: twenty-six miles (a portion of a 323 mile district); and
- PA Junction to the U.S./Canadian border: eighty-six miles (a portion of a district of 314 miles of main line and several branches).

Canada

There are seventeen miles of ABS with OCS between the U.S/Canadian border and Townsend, except for 0.7 miles of CTC between switches at Colebrook. The Canadian Operating Rules OCS and the BNSF OCS used in the U.S. are different systems of form-based traffic control.

There are 14.7 miles of CTC between Townsend and Still Creek. 1.7 miles between Still Creek and CN Junction is Yard Limits ABS, controlled by verbal instructions of the Rail Traffic Controller.

The main track ends at CN Junction. There is 1.3 miles of yard track with no signal system between CN Junction and the Vancouver passenger station. There is no traffic control in the 0.4 miles between CN Junction and Vancouver Junction. The VIA Rail Controller controls traffic between Vancouver Junction and the Vancouver passenger station by verbal instructions.

Except for the section controlled by the VIA Rail controller in Vancouver, 0.4 miles between CN Junction and Vancouver Junction with no traffic control, and the 0.7 mile section at Colebrook controlled by the BC Rail RTC, traffic control in Canada, thirty-three miles, is handled by the BNSF Rail Traffic Controller in New Westminster.

Track and Facilities

The following discussion begins at the southern end of the corridor in Portland, OR. It provides an overview of key rail locations along with distance and rail milepost. **Exhibit B-1** illustrates the order in which rail mileposts are labeled.

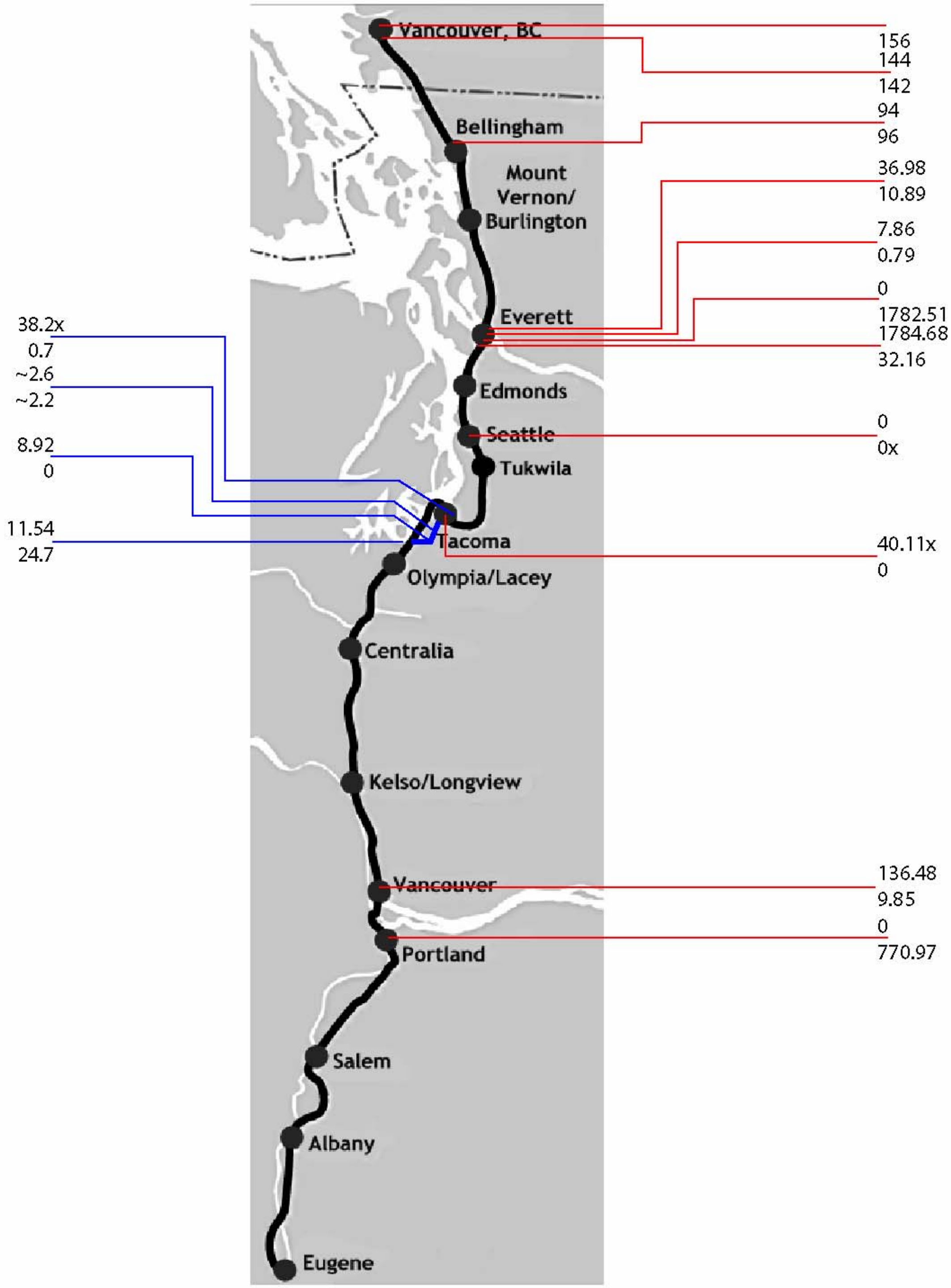
Portland (Distance 0 Rail Milepost 0)

Portland Terminal Railroad (PTR), which is owned by the Union Pacific Railroad (UP) and the BNSF, owns Portland Union Station and the main tracks between the station and rail milepost 0.9. There are five platform tracks. Tracks 4 and 5 are the main tracks. Track 1 opens only south. The building is on the west side of the line. All passenger access to the tracks from the building is at grade. Gates on the concourse control access to the tracks. The speed limit on the main tracks is ten miles per hour. PTR has agreed to increasing the speed limit to twenty miles per hour for passenger trains after rail relay and surfacing. The speed limit on Steel Bridge, a vertical lift bridge over the Willamette River immediately south of the south CTC control point, is six miles per hour.

South of Steel Bridge, a junction (East Portland) of three Union Pacific (UP) routes forms a wye that may be used for turning equipment. The speed limits of the routes through East Portland is six miles per hour.

A CTC control point at the south end of the station, operated by a Union Pacific train dispatcher in Omaha, controls access to tracks two through five. At the north end of the station, tracks one through three have power switches and switch indicators but no signal system protection. The CTC control point at the north end of the station, operated by a BNSF train dispatcher in Fort Worth, is the south end of CTC and controls only the crossovers. There is no signal system between the north and south interlocking. All movements are made at restricted speed. The Portland Terminal Railroad yardmaster at Lake Yard controls the use of all tracks between the north and south CTC control points.

Exhibit B-1
Sequence and Location of Rail Mileposts along the Pacific Northwest Rail Corridor



The tracks and all passenger facilities at the Portland station are at street level. Passenger platforms 2-3 and 4-5 have umbrella sheds and there is a completely covered area in front of the headhouse where passengers cross from the concourse to the platform tracks.
Between the north end of the station and Willbridge, the line passes through generally heavy industrial area.

An industry switching lead, called Oceanic, is parallel to and east of Main Two between rail milepost 1.2 and Willbridge yard. Several industrial spurs connect to Oceanic.

Lake Yard (Distance 2 Rail Milepost 2)
Lake Yard, on the west side of the line between rail milepost 1.6 and rail milepost 3, is owned by PTR and used by both BNSF and UP. Access is through hand throw switches at the middle and both ends of the yard. BNSF also has an intermodal yard along the west side of the PTR yard. Lake Yard has a loop track at the south end, for turning equipment.

The switches at the north end of Lake Yard/south end of Willbridge Yard are in a two degree curve, limiting passenger train speed to fifty miles per hour. Oregon Department of Transportation is planning to replace these switches with Samson undercut switches to allow the Talgo speed limit to be increased to sixty-three miles per hour.

Willbridge (Distance 4 Rail Milepost 4)
St. Helens Road is parallel and adjacent to the west side of the line at the north end of Willbridge yard. Balboa Street intersects at a right angle, crossing the BNSF line. Oregon Department of Transportation plans to close or grade-separate this crossing.
Willbridge yard is on the east side of the line between rail milepost 3 and rail milepost 4. The Portland and Western line to Astoria joins the BNSF line on the west side, opposite the north end of Willbridge yard. A CTC control point handles access to Lake Yard, Willbridge Yard, and the Astoria line.

The line crosses the Willamette River just north of Willbridge, on a 1,767-foot bridge including a vertical lift span. Marine navigation includes ocean shipping. The bridge was generally constructed in 1908, but the lift span was constructed in the early 1980s, replacing the original swing span, to increase the width of the channel. The speed limit for all trains is thirty miles per hour on the bridge. The lift span can accept a higher speed limit, but the remaining portion of the original structure requires modification before the speed can be increased.

East St. Johns (Distance 7 Rail Milepost 7)

A small yard at East St. Johns is used for UP interchange traffic. A connection between BNSF and UP is located near the middle of the yard on the west side. BNSF crosses UP on a thirty-seven foot bridge. Yard tracks are located on both sides of the main track, an arrangement consistent with the current of traffic operation that existed on the line until 2002. The south end of the yard is located in a narrow cut about seventy feet deep. Four overhead highway bridges cross the cut, each with footings near the tracks. The north end of the yard is on fill. The line crosses Columbia Slough on a 306 foot bridge immediately north of the yard.

Just north of the Willamette River, the line passes through a residential and commercial area located at the top of the cut. North of the cut up to the Oregon Slough, the area around the rail line is generally industrial.

North Portland Junction (Distance 8 Rail Milepost 8)

The Union Pacific line to Albina and East Portland joins the BNSF line on the east side at North Portland Junction The BNSF line to Port of Portland Terminal 6 and the Rivergate industrial area joins on the west side.

All turnouts at North Portland Junction, a CTC control point, have a ten mile per hour speed limit. The UP line is single track between North Portland Junction and Albina Yard. The UP route from Barnes Yard to the east (Eastern Oregon and ultimately Chicago) crosses and connects at Peninsula Junction The junction routes have a twenty five miles per hour speed limit. The UP line is single track between Barnes Yard and the siding at Champ. A small yard at Kenton, between Peninsula Junction and Champ serves local industries. Switch engines at Kenton use the main track while switching. Single track running time between North Portland Junction and Champ is about twenty minutes. Single track running time between North Portland Junction and Albina Yard is similar. Columbia Blvd. is parallel to the UP east-west line at Peninsula Junction. Trains over 5000 feet long moving from Albina to the BNSF line cannot be held for traffic at North Portland Junction because of the Columbia Blvd. crossing.

The line crosses Oregon Slough on a 1,528-foot bridge, including a swing span, just north of North Portland Junction. The bridge was constructed in 1908. The bridge is open infrequently and is unattended. Navigation must request opening in advance. Oregon Slough is connected to the Columbia River at both ends, but the bridge cannot be made a fixed bridge because the adjacent Interstate 5 fixed bridge precludes access from the east. The speed limit on the bridge is thirty miles per hour for all traffic.

An engineering study is required to determine the requirements for increased speed.

Between Oregon Slough and the Columbia River, the line crosses Hayden Island through a generally wooded area. Port of Portland plans to develop Hayden Island immediately west of the railroad into a marine terminal. The port's preferred plan calls for the marine terminal rail facilities to be connected to the main tracks between the Oregon Slough and Columbia River bridges. The geometry of the proposed connection would limit the speed of movement between the marine terminal and the main tracks to ten miles per hour.

Vancouver, WA (Distance 10 Rail Milepost 9 = Rail Milepost 136)

The BNSF line crosses the Columbia River just south of Vancouver, on a bridge which includes a swing span. The speed limit on the bridge is thirty miles per hour for all traffic. An engineering study is required to determine the requirements for increased speed. Marine traffic is generally towboat/barge combinations. The Interstate 5 bridge, 4,700 feet east, has a movable span at the north end, and a high span near the middle to allow barge traffic to pass without opening the bridge. The channel under the high span is the route generally used by barge traffic. Passing from that channel to the movable span of the railroad bridge is a difficult maneuver, especially for a downstream (westward) tow. The railroad bridge must generally be opened well in advance of the arrival of a westward tow, to facilitate the difficult maneuver. The Columbia River Bridge has been considered for modification funding under the Truman-Hobbs Act, but does not meet the requirements for hazard to navigation.

The double track junction (two turnouts and a crossing) with the BNSF line to Pasco is located immediately north of the Columbia River Bridge and controlled by the bridge operator. The speed limit through the junction on the Pasco line and on the curve approaching the junction on the Pasco line is ten miles per hour. A spur between Vancouver yard and an industrial district crosses the Pasco line at grade in the curve approaching the junction, affecting the ability to increase the speed limit in the curve.

The Vancouver passenger station is located just north of the junction, between the Pasco and Seattle lines. A platform extends along the east side of Main Two on the Seattle Subdivision. A platform for Main One is located between the main tracks. Passengers must cross Main Two for access to the Main One platform, thus traffic on Main Two must stop if a passenger train is working passengers on Main One.

The Pasco line has two main tracks, CTC operation, between the junction at the Columbia River Bridge and McLoughlin. At 8th Street, east of the junction at the Columbia River Bridge, the south end of the Vancouver yard connects with the Pasco line. Through this junction, through traffic may use the yard lead to reach the Portland-Seattle line for through movement. Port of Vancouver, west of the Portland-Seattle line may also be reached via the connection at 8th Street. The speed limit for all movements on or off of the Pasco line main tracks at 8th Street is ten miles per hour.

There is a CTC control point just north of the Vancouver station at the south end of Vancouver yard., The line between 8th Street and the Port of Vancouver crosses the Portland-Seattle line at grade. The connections to the south end of the Vancouver yard and the Pasco line via 8th Street are just north of the Port of Vancouver connection crossing. Vancouver yard has three major component yards. NP Yard on the west side of the Portland – Seattle line is used for Port of Vancouver traffic. SP&S Yard, on the east side of the Portland – Seattle line, is the switching yard. B Yard, on the east side of the line north of SP&S Yard is used for receiving and departure. Hand throw crossovers at 39th Street connect B Yard and SP&S Yard with NP Yard. West 39th Street crosses the line, five tracks, at grade. The crossing has automatic signals and gates.

The north end of B Yard is connected to Main Two by a power switch in a CTC control point, and a lead north of the north switch of the yard.

Vancouver Junction / Vancouver Junction North (Distance14 Rail Milepost 133)

The Rye Branch connects to Main Two, facing south, at Vancouver Junction. It is an industrial spur that has only occasional traffic. The distant end of the line was sold to local interests to operate as a tourist railroad, the Chelatchie Prairie Railroad. This line has been considered for commuter service connecting the northern part of Vancouver to Portland but a practical arrangement has not been found and no formal proposals have been forwarded. The Vancouver Rail Project has been designed to allow the Rye Branch connection to be reversed to its original configuration facing north instead of south to facilitate commuter operation should such service be developed in the future.

Vancouver Junction North is a CTC control point north of Vancouver Junction with two crossovers. Between Vancouver Junction and Ridgefield, the line extends along the east shore of Vancouver Lake and the east bank of Lake River, generally at the base of steep bluffs. The line in this area is generally inaccessible by road except for a crossing at Felida (2.5 miles north of Vancouver Junction) and a crossing leading to the Ridgefield National Wildlife Refuge (one mile south of Ridgefield).

Southward trains that cannot be accommodated at Vancouver are generally held at the crossing at Felida to allow highway access to the train should hours of service relief of the crew be necessary. A CTC control point with two crossovers has been constructed at Felida as part of the PNWRC improvement program.

Ridgefield (Distance 22 Rail Milepost 122)

The line passes through the western part of Ridgefield, turning inland from the east bank of Lake River. The bluffs and steep slopes along the west side of the line flatten to a gentle slope through Ridgefield. Except for some houseboat residences west of the tracks in the south end of the city, the area west of the line is generally industrial. The area east of the line is generally residential and business. There are two road crossings at grade, both equipped with automatic signals and gates. A Washington Utilities and Transportation Commission (WUTC) order limiting train speed to thirty-five miles per hour was abrogated. The southern crossing is located in a two degree curve. The speed limit in the curve is Talgo-65 Passenger-50 Freight-35. Talgo and Passenger train speed cannot be increased above the current speed limit until the superelevation is changed, which will require changing the geometry of the roadway.

A CTC control point with two crossovers, Ridgefield South, is located 1.2 miles south of Ridgefield. A 5,000-foot storage track along Main Two at Ridgefield, the northward siding before CTC was installed, is typically used for grain cars that cannot be accommodated at the Kalama grain terminals. The former southward siding is used as an industrial lead.

Just north of Ridgefield, the line passes through the Ridgefield National Wildlife Refuge for about 0.4 miles (approximately rail milepost 121.5 – rail milepost 121.9) at the crossing of Gee Creek. An overhead pedestrian bridge for access to the Ridgefield National Wildlife Refuge is located just north of the Gee Creek crossing.

North of the wildlife refuge, the line follows the base of wooded bluffs and steep slopes up to 100 feet high along the east side of the tracks. In this area, the line follows the east shore of Lancaster Lake. Just north of Lancaster Lake, at rail milepost 119.2, the line crosses Lewis River on an 808 foot through truss bridge.

Woodland (Distance 30 Rail Milepost 116)

The line passes along the west edge of Woodland. The Port of Woodland advertises the Austin Point deep draft port and heavy industrial site, southwest of the city at the confluence of the Columbia River and Lewis River. It is not yet developed. The BNSF line is the only rail line in the area, and thus would serve this facility if it is constructed in the future. A

CTC control point with two crossovers was constructed two miles south of Woodland as part of the PNWRC improvement program.

North of Woodland, the line crosses under the southward lanes of Interstate 5 and runs between the northward and southward lane for 3.3 miles then crosses under the southward lanes to the west, immediately adjacent to the Columbia River.

Kalama (Distance 40 Rail Milepost 108)

The BNSF line is adjacent to the west side of Interstate 5 through Kalama. Generally, except for the Port of Kalama facilities, the entire city is located east of Interstate 5. Port of Kalama facilities located between the BNSF line and the Columbia River include two grain terminals and a heavy industrial district. The line crosses the Kalama River north of the city of Kalama, on a 344-foot bridge. Another port of Kalama facility, currently occupied only by a coil steel finishing plant, is located west of the line, north of the Kalama River.

A long industrial switching lead, constructed in 1984 extends along the west side of Main One, 3.7 miles between the two grain terminals at opposite ends of the southern Port of Kalama facility. All industrial tracks in the Port of Kalama facility are connected to this lead except the steel finishing plant and the south end of the south grain terminal.

There is a CTC control point with two crossovers at rail milepost 111, three miles south of Kalama.

Longview Junction (Distance 46 Rail Milepost 101)

Longview Junction yard consists of two groups of tracks, one group parallel to the main tracks and one group extending northwest from the main tracks, toward the Longview Switching Company bridge leading to Longview. A 9,382-foot siding is adjacent to the west side of Main One, between Main One and the yard tracks. The siding is of limited use for through train movement because only the south end has a power switch. There is a switching lead extending from the south end of the yard, joining the siding at the south end. Although the yard has two independent groups of tracks, the arrangement of switches at the south end of the yard prohibits access to both groups simultaneously from the siding and the switching lead. Two CTC control points at the south end of Longview Junction yard control access to the sidings and crossovers between the main tracks.

All industrial and port activity in Longview is located between the Columbia River and Cowlitz River, on the opposite side of the Cowlitz River from the BNSF line. The yard at Longview Junction is used for interchange of traffic between through trains and the Longview Switching

Company, which crosses the Cowlitz River on a bridge at the north end of the west group of yard tracks.

The main tracks cross the Coweeman River on a 160 foot bridge at the north end of Longview Junction yard.

Kelso (Distance 49 Rail Milepost 97)

The railroad is adjacent to the east bank of the Cowlitz River except for a short distance between the Coweeman River crossing and Kelso, where there is residential development and a golf course between the railroad and the river. Where they are adjacent, a flood protection dike extends between the BNSF track and the river.

A 5,100-foot storage track is located on the west side of the line between rail milepost 98.4 and rail milepost 97.3. Two pubic crossings, Mill Street and Yew Street, divide the storage track into three segments, making the usable capacity of the track 2,200 feet in separate sections of 1,080 feet and 1,140 feet. There is a CTC control point with two crossovers, Kelso South, 1.2 miles south of Kelso.

The passenger station is located on the east side of the line at rail milepost 97.3. A platform between Main One and Main Two provides access to trains on Main One. The use of the Main One platform is avoided because passengers must cross Main Two to reach the Main One platform and must stand between the tracks on less than fifteen foot centers.

Several short spur tracks, generally used for maintenance of way equipment, are located at rail milepost 97. One of these tracks is on the east side of the line. The nearest crossover is at Kelso South, so movement between the track on the east side of the line and the tracks on the west side is not convenient.

Rocky Point (Distance 50 Rail Milepost 96)

At Rocky Point, there is a small yard on the west side of the line, for interchange with the Columbia and Cowlitz Railroad (CLC). There is a 2,600-foot storage track on the east side. The nearest crossover is located at Ostrander, so movement between the east side storage track and the other freight tracks at Rocky Point is not convenient. Cowlitz Garden road crossing at the north end of the Rocky Point yard has automatic crossing signals with gates.

Ostrander (Distance 53 Rail Milepost 93)

Immediately north of Rocky Point, the line passes through an 1,165-foot long double track tunnel (Ostrander Tunnel). A small area immediately south of the south portal of the tunnel has poor drainage because of the obstruction formed by the BNSF and CLC tracks and Cowlitz Garden

Road. There is a permanent forty miles per hour speed restriction that can be eliminated after the drainage problem is corrected.

The CLC line and a parallel road cross above the BNSF line immediately north of the north portal of the Ostrander tunnel. Immediately north of the overhead bridge are located sections of a portable flood gate that can be erected across the track in an emergency. The floodgate was constructed after the 1980 Mt. St. Helens eruption. The city of Kelso is protected from flooding by a dike along the Cowlitz River. The area north of the Ostrander tunnel is not. The Mt. St. Helens eruption resulted in some significant flooding. The floodgate was constructed to be used should additional flooding of that magnitude occur.

Between the tunnel and the Ostrander CTC control point (two crossovers), the line is between and immediately adjacent to the Cowlitz River on the west and Interstate 5 on the east.

Castle Rock (Distance 58 Rail Milepost 88)

The line passes generally along the eastern edge of Castle Rock, however, there is some residential development along both sides of the tracks. The tracks pass through a cut, about thirty-five feet deep. A bank stabilization demonstration project addressed mudslide problems along the west side of the cut. Highway 504 crosses above the line on a bridge at the north end of the cut. Immediately south of the cut, a 4,000-foot storage track, formerly a siding, is located west of Main One.

North of Castle Rock, for about three miles, the line is between the Cowlitz River and Interstate 5. Large banks of volcanic ash, dredged from the river after the 1980 Mt. St. Helens eruption, extend between the track and the river for most of the three miles. The line crosses the Toutle River in this area, at rail milepost 85, on a 346-foot bridge. The rail milepost 85 CTC control point, right hand and left hand crossovers, is located at the north end of the bridge. North of rail milepost 83, Interstate 5 diverges to the east. The rail line remains close to the east bank of the Cowlitz River, through a generally agricultural and forested area until it crosses the Cowlitz River near rail milepost 81.5 on a 662-foot bridge. From there the line is adjacent to the west bank of the Cowlitz River for about three quarters of a mile then the west bank of Olequah Creek for two more miles. The rail line is on a high wooded bluff forty to sixty feet above the river and creek and eighty to one hundred feet below the top of the bluff. After the creek diverges to the east, the line continues along the base of a steep hillside, about 200 feet high, to Vader. Just south of Vader, at rail milepost 78.5, it crosses Olequah Creek on a 237-foot bridge.

Vader (Distance 69 Rail Milepost 77)
The line passes along the west edge of Vader. There is a 4,900-foot siding along the east side of Main Two. The siding is used for car storage rather than for the operating purpose of a siding. The Vader CTC control point, crossovers between the main tracks, is located between the switches of the storage track.

Between Vader and Winlock, the line extends through a valley, close but not adjacent to the east bank of Olequah Creek, following the base of steep, wooded hillsides to the east. The terrain between the rail line and Olequah Creek is gently sloping and generally agricultural.

Winlock (Distance 75 Rail Milepost 71)
The line passes through Winlock, located in the Olequah Creek valley followed by the BNSF line. A 2,900-foot storage and runaround track connects to local industry tracks. The line crosses Olequah Creek on a bridge north of Winlock, then follows the west bank of a tributary of Olequah Creek. The creek follows the base of the hills to the east. The terrain west of the railroad is gently rolling hills to generally flat. Near rail milepost 68, the creek turns east, away from the track, and the terrain along both sides of the track is gently rolling hills to flat, and generally agricultural, to Napavine. This area is the summit of the section of line known as "Napavine Hill".

Napavine (Distance 80 Rail Milepost 65)
The line passes through the middle of the business and residential areas of Napavine. A 5,000 foot storage track along Main One at Napavine is generally used only for maintenance of way equipment or for the first cut of southward trains that have insufficient power and must double to the top of Napavine Hill. A CTC control point with two crossovers is located just south of the south end of the storage track. As the line passes through Napavine, it traverses a three degree curve and begins descending along a generally wooded hillside. The line continues descending on the side of the slope until rail milepost 60, then continues to Chehalis across gently sloping to flat agricultural terrain.

Chehalis (Distance 89 Rail Milepost 58)
The line passes through the generally business and industrial area of Chehalis. There are runaround/storage tracks adjacent to both sides of the line and several industry spurs. A spur leading to an industrial park connects to Main Two at the south end of Chehalis. The Tacoma Rail Mountain Division (TR) line between Chehalis and Tacoma is parallel to the west side of the BNSF line. A CTC control point with two crossovers, Chehalis Junction, is located a mile south of Chehalis. There were once two connecting lines at Chehalis Junction but both have been abandoned.

The line crosses Dilingbaugh Creek on a 222-foot bridge between the crossovers in the CTC control point and the Newaukum River on a 206-foot bridge just south of the CTC control point.

Centralia (Distance 92 Rail Milepost 54)

Just south of Centralia, the line passes the west side of the county fairground, then through lightly developed business and residential areas. The line passes through along the east edge of the downtown business district. Most of the developed area is located west of the railroad and business district.

There is a 6,400-foot siding, with hand throw switches, along Main Two between rail milepost 53.7 and rail milepost 52.3. The siding is generally used only for the storage of coal trains for the power plant east of the line on a spur that connects to Main Two near rail milepost 51.8. A small yard is located west of Main One between rail milepost 53.8 and rail milepost 52.4. The yard generally handles local industry traffic for Centralia and Chehalis, and interchange traffic to and from Puget Sound and Pacific Railroad.

A four mile long spur to the "Centralia Steam Plant," a coal-fired power generating facility, connects to Main Two, facing north, at a hand throw switch at rail milepost 51.8.

The passenger station is located at rail milepost 54, near the center of the downtown business district.

There are three CTC control points at Centralia, one with crossovers between the main tracks and the other two handling access to the north and south end of the yard.

Between Centralia and Bucoda, the line extends through a generally flat valley, near or adjacent to the east bank of the Skookumchuck River, and generally along the base of the hills to the east.

Bucoda (Distance 100 Rail Milepost 46)

The line crosses the Skookumchuck River south of Bucoda on a 144-foot bridge then passes the west edge of Bucoda. The river turns to the east and the railroad crosses generally flat, wooded and agricultural terrain to Tenino. A 5,100-foot storage track, formerly a siding, is located east of Main Two between rail milepost 46.8 and rail milepost 45.7. The storage track is generally used for surplus empty freight equipment.

Tenino (Distance 102 Rail Milepost 44)

The line passes west of the developed area of Tenino. There is an infrequently used 3,100-foot storage track along the east side of Main Two between rail milepost 44.2 and rail milepost 43.5.

Just north of Tenino, the line passes through a narrow valley between steep, wooded hillsides, then crosses generally flat agricultural, wetland, and wooded terrain to East Olympia.

East Olympia (Distance 111 Rail Milepost 35)

East Olympia is a junction of the BNSF Seattle Subdivision with the Union Pacific Olympia branch. There is some residential and business development near the railroad, but the area is generally rural.

There is a 5,000-foot storage track, formerly a siding, along the west side of Main One between rail milepost 36 and rail milepost 35.1. The storage track is generally used for traffic moving to or from the Olympia branch. The Olympia branch junction is a wye, the south leg connecting to the storage track and the north leg connecting to Main One at rail milepost 34.6. There is a CTC control point with two crossovers, 2.5 miles south of East Olympia.

The line passes between two wooded hillsides just north of East Olympia then crosses flat, generally agricultural or wooded terrain to Centennial.

Centennial (Distance 114 Rail Milepost 32)

Centennial is the passenger station for Olympia and Lacey. The area around the station has been rural but is generally becoming suburban residential and business development. The station is located about three miles from the business center of Lacey, seven miles from the state government area of Olympia, and about eight miles from the central business district of Olympia.

The terrain between Centennial and rail milepost 30 is flat and generally suburban residential development or forested. Just north of East Olympia the line crosses Pattison Lake on a combination of fill and a 112-foot bridge, and along or through wetlands north of the lake. Between rail milepost 30 and St. Clair, the line descends through a wide cut continually increasing in depth to about sixty feet.

St. Clair (Distance 119 Rail Milepost 28)

St. Clair is the junction with the Lacey branch, formerly the Olympia branch. The line has few business customers and only occasional service. The junction is a hand throw switch on Main One facing south.

North of St. Clair, the line passes through hilly terrain; along hillsides and through wide cuts as much as sixty feet deep. The line leaves the hilly terrain, perpendicular to the hillside, near rail milepost 26.3, crossing the plain area adjacent to the Nisqually River on a fill about sixty feet high and about one mile long. The line crosses the Nisqually River on a 657-

foot bridge on a three degree curve about eighty feet above the water. Between the bridge and Nisqually, the line is located along a steep bluff, about sixty feet above the surrounding terrain and about one hundred sixty feet below the top of the bluff. A highway is adjacent, about twenty feet below the railroad.

Nisqually (Distance 121 Rail Milepost 25)
The junction of the Fort Lewis Line is on Main Two facing north at Nisqually. In the same CTC control point are left hand and right hand crossovers between Main One and Main Two. The highway that is adjacent to the west, south of Nisqually, crosses above the line on a bridge near the junction switch and continues to the top of the hill on the east side of the line. The railroad leaves the hillside, crossing part of the Nisqually River Delta on a fill about eighty feet high and about 3,000 feet long, crossing the northward and southward lanes of Interstate 5 on two separate bridges. Between the Nisqually River and Interstate 5 the line passes through the Fort Lewis Military Reservation. North of Interstate 5 the line passes along the east edge of part of the Nisqually National Wildlife Refuge. The line descends the face of a steep bluff, about three hundred feet high, to just above the water level of Puget Sound and follows the waterline along the face of the bluff to Nelson Bennett. Between about rail milepost 20 and rail milepost 17, the line passes along the west boundary of the Fort Lewis Military Reservation.

Steilacoom (Distance 130 Rail Milepost 15)
At Steilacoom, the steep bluff changes to gentle slopes. The rail line remains on the shoreline and passes along the west edge of Steilacoom. There is a 480-foot long storage track adjacent to Main Two facing southward that is generally used only by Maintenance of Way.

The bluffs east of the track increase in height up to the crossing of Chambers Creek at rail milepost 14.2. South of the bridge there is a small three track yard, opening only from the north with a hand throw switch to Main Two, for an industry that is no longer in service.

The line crosses Chambers Creek Waterway on a combination of fill and a 238-foot bridge including two lift spans. Navigation on the waterway is generally small pleasure craft. The bridge is unattended and requires advance notice for opening.

North of the Chambers Creek Waterway crossing, the bluffs have been excavated down to track level by a large quarry operation. There are two tracks adjacent to Main Two between rail milepost 13.4 and rail milepost 12.8 for the quarry. The tracks remain in service but are generally unused. The quarry is no longer active.

The Pioneer CTC control point, south of the quarry tracks, has right-hand and left-hand crossovers between Main One and Main Two. The bluffs continue north of the quarry to Titlow.

Titlow (Distance 137 Rail Milepost 10)

Titlow is a neighborhood in the city of Tacoma. Some residential development is located immediately adjacent to Main One. In some places, the residential access road is so close to Main One that the speed limit is restricted on Main One.

A 5,000-foot storage track, formerly a siding, is located along Main Two between rail milepost 9.5 and rail milepost 8.5. It is generally used for storing loaded grain cars that cannot be accommodated at the Tacoma grain terminal.

The bluffs become a gentle slope through Titlow then continue, about 100 feet high, north of Titlow to Nelson Bennett. North of the Tacoma Narrows Bridge crossing overhead at rail milepost 8.5, the bluffs increase in height to as much as 200 feet.

Nelson Bennett (Distance 139 Rail Milepost 7)

At Nelson Bennett, the line turns west into the bluff and through the 4,391-foot Nelson Bennett Tunnel. The tunnel was constructed as a two track tunnel, but reduced to single track in the early 1980s to accommodate high cars such as autoracks and Boeing airplane parts cars. The additional clearance is also now needed for doublestack container cars. There is a CTC control point for the switch at the beginning of single track.

North of the Nelson Bennett Tunnel, the line crosses a steep-sided valley for about 1,000 feet then into the 324-foot long Ruston Tunnel.

Ruston (Distance 141 Rail Milepost 5)

The second main track resumes at the Ruston CTC control point, just north of the Ruston tunnel.

The line continues along the bluffs and close to the shoreline of Commencement Bay from Ruston to 21st Street. A roadway is located parallel to and west of the tracks between Ruston and rail milepost 2.5. A grain terminal is located on the waterfront, immediately west of the main tracks, between rail milepost 2.5 and rail milepost 0.5 at 11th Street. On the east side of the line between rail milepost 1.2 and rail milepost 0.5, opposite the grain terminal, is a small yard called “Half Moon Yard,” or “Moon Yard” because of its general shape. The yard is generally used for storing loaded grain cars that cannot be accommodated immediately at the grain terminal. There are hand throw crossovers at the south end of Moon Yard for movement between the yard and the grain terminal.

Between rail milepost 1.5 and 21st Street, a limited access highway is located between the rail line and the bluff. On the shore side, development was once industrial but has generally been converted to residential and business.

21st Street (Distance 146 Rail Milepost 0 = 40x)

The 21st Street CTC control point has right hand and left hand crossovers between the main tracks and between Main One and Dock Street Lead. Dock Street Lead connects the grain terminal with Tacoma Yard.

Between 21st Street and Tacoma yard, the line passes through a ten degree curve with a central angle of about ninety degrees, known as “Head of Bay Curve” or “Thea Foss Curve” around the end of the Thea Foss Waterway. There are two street crossings in the curve and a parallel street immediately adjacent to the west side of the tracks. The speed limit in this curve is ten miles per hour, except for Talgo trains who’s limit is twenty miles per hour.

Tacoma (Distance 147 Rail Milepost 39x)

The Tacoma yard facility is generally located on a short tangent between rail milepost 39.6X and rail milepost 38.8X. Main Yard is located on the west side of the line, South Yard is located on the east side of the line. The easternmost track in South Yard is the Amtrak Lead. The Tacoma passenger station is located on this track. All passenger trains operate on the Amtrak Lead between D Street interlocking and River Street interlocking, approximately the south and north ends of Tacoma Yard. The Amtrak Lead is not signaled and all movements are made at restricted speed. The main track turnouts, with their sharp diverging angles, at either end are restricted to ten miles per hour.

As of this writing, Sound Transit commuter trains use the second from east track of South Yard and have a separate platform. Sound Transit passengers cross Amtrak Lead at grade at the north end of the station. Puyallup Avenue is parallel to the east side of the line at Tacoma. The Tacoma Transit Center is located on the opposite side of Puyallup Avenue from the Amtrak station and a short distance north. Several Pierce Transit and Sound Transit bus routes stop at the transit center. There is service between the transit center and the downtown Tacoma business district on about fifteen minute headway. A light rail line connecting the transit center with downtown Tacoma is under construction.

Reservation (Distance 148 Rail Milepost 38x)

The north leads of Main Yard, and connections to industrial development west of Main Yard extend through a six degree curve between the north end of the yard and the interlocking at Reservation, where they connect to Main One. The connection to the Port of Tacoma diverges to the west from the yard leads. Movements between the main tracks and the Port of Tacoma may be made by using a hand throw crossover between Main One and the yard at River Street, then through crossovers crossing the yard and industrial leads. These movements are restricted to ten miles per hour.

The Tacoma Rail Mountain Division line between Fife and Chehalis crosses above the BNSF line at Reservation. The Union Pacific line between Reservation and Seattle diverges to the west at Reservation, crossing the Puyallup River immediately after diverging from the BNSF line. All turnouts at Reservation have a ten mile per hour speed limit except the crossovers between the main tracks.

Nisqually (Distance 121 Rail Milepost 11.5x=Rail Milepost 25)

The Lakeview Subdivision diverges to the east from the Seattle Subdivision at Nisqually. It climbs a steep, wooded hillside on a grade of 1.5 percent to 1.6 percent for about one mile, then it diverges away from the hillside in a seven and eight degree reverse curve, crossing above Interstate 5 on two bridges each 120 feet long. The line is immediately adjacent to and west of Interstate 5 to Lakewood.

Between the Interstate 5 crossing and Ft. Lewis, the terrain is generally wooded, gently sloping hills. The railroad and adjacent Interstate 5 pass through the Fort Lewis Military Reservation.

Ft. Lewis (Distance 125 Rail Milepost 8x)

There are two double-ended yard tracks each about 2,000 feet long on the east side of the line, west of Interstate 5, at Ft. Lewis. One of two military railroad lines into Fort Lewis connects at the south end of the two yard tracks, facing north. It crosses under Interstate 5 and onto the base. The yard trackage at Ft. Lewis and the military railroad line are seldom used.

Camp Murray (Distance 128 Rail Milepost 4x)

There is a short spur and end loading dock, used infrequently, on the west side at Camp Murray, a National Guard facility. Sound Transit plans to construct a commuter train layover yard at Camp Murray.

Lakewood (Distance 132 Rail Milepost 0x)

Lakewood is not a BNSF station name. Lakewood is the city in which the BNSF station Lakeview (the name predates the existence of the city) is located. In the discussion, Lakewood refers to the Sound Transit commuter station location between Lakeview and Nisqually, about 0.5 miles from Lakeview. The BNSF line diverges away from Interstate 5 to the west. A Sound Transit commuter station will be located at Lakewood.

Lakeview (Distance 132 Rail Milepost 0x=Rail Milepost 9)

Lakeview (Located in the city of Lakewood) is the junction of the "American Lake Line" or "Ft. Lewis Line" between Lakeview and Nisqually and the "Prairie Line," which once extended between Tacoma and Tenino but now extends only as far south as Yelm.
Between Lakeview and South Tacoma, the terrain is generally flat.

There are industry tracks along the west side of the line north of Lakeview including a double ended industry lead, about 3,200 feet long, for an industrial park on the west side of the line immediately north of Lakeview. There is a 1,700-foot double ended storage track North of Lakeview on the east side of the line opposite the industrial lead.

South Tacoma (Distance 135 Rail Milepost 6)

Sound Transit will construct a commuter station at South Tacoma and a short siding, about one mile, immediately to the north. There are industry tracks on both sides of the line at South Tacoma, the most significant being a grain elevator with track capacity for about seven cars.

North of South Tacoma there is commercial and industrial development along the east side of the line and vacant land along the west side for about one mile. The vacant land was once the location of the Northern Pacific locomotive and car shop. From there north about 1.5 miles to rail milepost 3, there is industrial development along both sides of the line, with several spurs serving the industries.

Near rail milepost 3, the line begins to descend through a gulch. The railroad follows the bluff along the west side of the gulch, with a roadway adjacent to the east. The railroad grade is generally 2.2 percent descending from near rail milepost 3 to the connection with the Seattle Subdivision near rail milepost 1. Near rail milepost 2, the gulch opens to a steeply descending hillside. The railroad continues along the hillside, passing through the industrial area of the eastern part of Tacoma, to the connection with the Seattle Subdivision at 11th Street. BNSF has ceased operation on this line between a point near rail milepost 2 and 11th Street to accommodate Sound Transit light rail line construction.

Tacoma Rail Connection (Distance 139 Rail Milepost 2)

A new connection will be built, descending a moderately sloped hillside through an area of commercial development, from a point near rail milepost 2 on the BNSF Lakeview Subdivision to a connection with the Tacoma Rail Mountain Division near C Street.

Tacoma Rail (Distance 139 to 141 Rail Milepost 2 to 1 = Rail Milepost 38

Between D Street and Portland Avenue the grade is generally descending about one percent northward. Between Portland Avenue and Reservation, the grade is generally 0.5 percent ascending northward.

The line crosses flat terrain between hillsides on a timber trestle about 1,500 feet long, between G Street and L Street in Tacoma. After crossing the hillside between L Street and Portland Avenue, the line crosses Portland Avenue and Bay Street on a six hundred foot bridge consisting of plate girder spans and timber trestle, then continues on fill to Reservation, where it crosses the BNSF Seattle Subdivision and the Puyallup River on a series of through truss bridges and pile trestles.

In one mile between C Street and Portland Ave. there are 0.3 miles of curves of three degrees and four degrees. The longest tangent is 0.3 miles. The speed limit is ten miles per hour.

At C Street, the line approaches the new connection from the east, descending a grade of generally 3.5 percent through Tacoma Eastern Gulch. Near C Street on the connecting line, the Tacoma Rail line turns toward the north through a fourteen degree curve. There is a vertical curve throughout the fourteen degree curve, flattening from the 3.5 percent grade to the middle of the curve, then increasing to about 0.5 percent, climbing to D Street.

Freighthouse Square, at D Street, is a former Milwaukee Road freight house and office that is now a shopping mall. The track passes between the building and a bluff. The building will also become the Tacoma Dome Station; used initially by Sound Transit and later by Amtrak. Tacoma Dome Station is on the opposite side of the Tacoma Transit Center from the current Amtrak / Sound Transit station on the Seattle Subdivision. Between Portland Avenue and Reservation, a new connection will be constructed, with a grade of about 3.0 percent descending from the elevation of Tacoma Rail to the elevation of BNSF.

The distance at Reservation via Point Defiance is 148 miles; via Lakeview it is 141 miles. Distances shown for locations north of Reservation are distance from Portland via Point Defiance.

Puyallup (Distance 154 Rail Milepost 32x)

Between Reservation and about rail milepost 35.5X the line follows along the west base of hillsides adjoining a plain extending west to the Puyallup River. There is an adjacent highway on the east side of the line, generally on the hillside above the rail line. At rail milepost 35.5X the hillside turns to the east and the rail line extends across the flat terrain to Puyallup. There is a Sound Transit commuter rail station, associated parking lot, and transit bus stops at Puyallup.

North of the downtown area, there is a parallel street immediately adjacent to the east side of the line and industrial development along the west side. There is a lead for industry service, formerly a siding, located west of Main One between rail milepost 31.3 and rail milepost 30.7 and a storage track, formerly a siding, along Main Two between rail milepost 31.5 and rail milepost 30.8.

Meeker (Distance 156 Rail Milepost 30x)

There is a wye on the east side of Main 1 between rail milepost 30.2 and rail milepost 30.6 for the junction with the Meeker Southern Railroad (shortline between Meeker and McMillan), and a storage track along Main 2 between the legs of the wye. There is a right hand, hand throw crossover at the south end of the wye for movement between the wye and the Puyallup industry lead on the west side of the line.

Between Meeker and Sumner the line passes through generally agricultural land. At rail milepost 29.4, the line crosses the Puyallup River on a 307-foot bridge and passes through Sumner. There is a CTC control point with two crossovers immediately south of the bridge.

Sumner (Distance 158 Rail Milepost 29x)

The line passes through the central business district of Sumner. There is a Sound Transit commuter rail station, associated parking lot, and transit bus stops at Sumner.

Auburn (Distance 164 Rail Milepost 22x)

Auburn yard is located east of Main Two. The yard is generally used only for the storage of surplus empty freight cars and grain loads that cannot be accommodated at the Tacoma or Seattle grain terminals. There is a siding between Main Two and the yard. There is a CTC control point at both ends of the yard with power crossovers, siding switches, and yard access switches. At the north end of the yard, the junction of the Stampede Subdivision forms a wye. The south leg of the wye connects directly to the siding and yard. The north leg of the wye connects to Main Two at a CTC control point.

The line crosses the Stuck River on a 189 foot bridge immediately south of the yard and passes through the central business district of Auburn immediately north of the yard. There is a Sound Transit commuter rail station, associated parking lot, and transit bus stops at Auburn.

The line crosses the Green River on a 319-foot bridge south of Kent.

Kent (Distance 170 Rail Milepost 16x)
The line passes through the central business district of Kent. There is a Sound Transit commuter rail station, associated parking lot, and transit bus stops at Kent. A CTC control point with two crossovers is located immediately south of the central business district. An industrial lead, effectively a long siding, extends along the east side of Main Two between Kent and Orillia.

Orillia (Distance 174 Rail Milepost 12x)
There is a 5,200-foot siding between the main tracks at Orillia. Limited length and hand throw switches make this impractical as a siding for overtaking. The siding is used for car storage. There is a small yard for local industry traffic, on the east side of the industrial lead. Glacier Park industrial lead is adjacent to Main Two between Orillia and Tukwila.

Tukwila (Distance 176 Rail Milepost 10x)
Tukwila passenger station is a temporary structure. The only facilities are a parking lot and temporary platforms constructed of timber. Sound Transit commuter trains also use the Tukwila station. A permanent facility is planned.

The Union Pacific line between Reservation and Seattle crosses the BNSF line from the west side south of Tukwila to the east side north of Tukwila in the Tukwila CTC control point. The crossover and the connection turnouts have a twenty-five mile per hour speed limit. There is a hand throw switch for an industrial spur on Main Two in the interlocking.

Between Tukwila and Argo, the two BNSF main tracks and the single UP main track are operated as one three-track railroad, controlled by the BNSF train dispatcher.

South Seattle (Distance 178 Rail Milepost 8x)
Between Tukwila and South Seattle the UP line, east of and adjacent to the BNSF line is located along the base of a bluff.

South Seattle yard, the BNSF Seattle area domestic intermodal yard, is located along the west side of the line between rail milepost 9 and rail milepost 6. There are two double-ended storage tracks on the east side of Main Two, between Main Two and the UP track between rail milepost 9 and rail milepost 6.3 (PC Tracks named for the Pacific Coast Railroad once occupying that alignment), for the storage of surplus intermodal cars.

The terrain is generally flat on the west side of the line. The UP line follows the base of a bluff and hillsides to Argo. Interstate 5 extends along the top of the bluff and hillside east of the UP line between South Seattle and Argo.

There are two double ended yard tracks on the east side of the line, between the BNSF and UP main tracks ("Military Tracks" named for the now-closed Military Road crossing at rail milepost 5.3) between rail milepost 5.3 and Argo.

A UP yard for carload traffic is located east of the UP main track, between the main track and the base of the hillside, between BNSF rail milepost 5 and Argo.

Argo (Distance 183 Rail Milepost 3x)

The UP line crosses from the east side to the west side of the BNSF line at the Argo CTC control point. The UP Seattle intermodal yard is located west of the BNSF line and north of Argo. Argo is also a junction with the route to the BNSF Seattle International Gateway (SIG-international intermodal) and Stacy Street (carload, local industry) yards (Colorado Avenue Line). All turnouts in the Argo interlocking have a ten mile per hour speed limit. A second CTC control point north of Argo controls a second access to SIG and Stacy Street yards.

The UP yard is adjacent to the west side of the BNSF Colorado Avenue Line, which is adjacent to the west side of the BNSF Seattle Subdivision, for about 2,000 feet. The BNSF Seattle Subdivision line then diverges to the east away from the Colorado Avenue Line.

The Coach Wye connection at rail milepost 2.2X, the Spokane Street CTC control point, is the north leg of a wye connecting to the Colorado Avenue Line, Seattle International Gateway, and Stacy Street Yards. The wye has curvature of over fourteen degrees and a speed limit of ten miles per hour.

There is an industry lead and storage track, Mud Track, along the east side of the line between Spokane Street and Holgate Street. There are several industries on this lead, most notably a solid waste transfer site that generates traffic in the form of a full train per day. There is a second industry lead along the west side of the line, but only a small amount of remaining industry, most notably public team tracks.

Seattle (Distance 186 Rail Milepost 0 = Rail Milepost 0x)

Between Holgate Street and Royal Brougham Way, the Amtrak coach yard is adjacent to the main tracks on the east side. The Seattle Mariners baseball stadium is adjacent to the west side of the line. North of Royal

Brougham Way, the Seattle Seahawks football stadium and the King Street Station building are adjacent to the west side of the line; a city street and an interchange are adjacent to the east side of the line. The street is elevated on a bridge adjacent to the tracks.

King Street Station has two through tracks, a third track that will be through but the north switch has not been constructed yet, and four stub tracks that open facing south. The through tracks are west of the main tracks, numbered 1, 2, and 3 east to west. The four stub tracks are located west of the through tracks, numbered 4 through 7. Sound Transit commuter trains use tracks 1 and 2 exclusively. Amtrak trains use the other tracks of the station. All access to the track 1-2 platform is overhead from the adjacent streets and the Weller Street pedestrian bridge/overhead concourse. All passenger access between the building and the platforms used by Amtrak trains is at grade. All platforms, umbrella sheds, and overhead access has been recently constructed.

At the north end of the station, the tracks are in a cut with retaining walls on both sides.

South Portal (Distance 186 Rail Milepost 0)

South Portal is the north end of the King Street Station through tracks and the south end of the 1.4 mile King Street Tunnel under the downtown business district of Seattle. There is an interlocking with a right-hand crossover allowing movement between the station tracks and either main track. All switches have a ten mile per hour speed limit.

North Portal (Distance 188 Rail Milepost 1)

North Portal interlocking is north of the north portal of King Street Tunnel. The Alaska Way Viaduct crosses above the line immediately north of the north portal of the tunnel, with bridge structure located immediately adjacent to both sides of the line. North of the tunnel portal, the line extends through a narrow space between the base of a bluff and residential/commercial development.

There are four street crossings at-grade, two power crossovers between the crossings, and the hand throw switch for the south end of the Port of Seattle grain terminal on Main One and the hand throw switch for the “NP Main” yard track on Main Two.

The terrain between North portal and Galer Street is flat. The maintenance shop for the electric street railway line is located on the west side of the BNSF line, just north of North Portal. A city park is located along the west side of the line for about 1,800 feet. The Elliott Bay waterfront is immediately west of the park.

The Port of Seattle grain terminal is located on the west side of the line between the park and Galer Street. There are two yard tracks for arriving grain trains, several short tracks for unloading, and two tracks for empty cars. On the east side of the line, yard track "NP Main" (formerly the Northern Pacific line to Sumas) extends from North Portal to Galer Street. Double ended storage tracks and several industry tracks are adjacent to the east side of "NP Main" between North Portal and Galer Street. The terrain between North Portal and Galer Street is generally flat. There is industrial and commercial development along the east side of the line, across from the park and grain terminal.

Galer Street (Distance 190 Rail Milepost 3)

Galer Street is the interlocking north end of the Port of Seattle grain terminal and the south end of Interbay Yard. The line is single track between Galer Street and the interlocking at rail milepost 5.4. It was reduced from double track in 1947 to provide additional capacity for Interbay yard.

Interbay (Distance 190 Rail Milepost 4)

The yard extends along the west side of the line between the Galer Street interlocking and rail milepost 5.4 interlocking. Two additional control points between rail milepost 4 and 23rd Avenue also control access to the yard. It has a small hump (sixteen short tracks) and several short tracks for receiving, departure, storage, and flat switching. Only one track, the former Westward main track, will accommodate a 7,000-foot train. One track is less than 7,000 feet and the balance are less than 5,000 feet. There are no tracks dedicated to receiving and departure.

At the south end of the yard, west of the hump yard, there is a marine terminal for vessels of automobiles. A switch engine working the automobile facility blocks the route between the main tracks and the yard. Depending upon the length of the cuts handled, a switch engine trimming the hump yard will also block the route between the main tracks and the yard. A switch engine moving empty grain cars from the grain terminal into the yard for switching and departure will also block the route between the main tracks and the yard. Southward trains that must double before leaving the yard can do so without occupying a main track, however they may block the route between the main tracks and the yard, preventing other traffic from moving. Two movements between the yard and the main tracks cannot be made simultaneously.

There is a yard track east of the main track between Galer Street and rail milepost 4, and a second yard track to the east of it extending between Galer Street and the locomotive service facility north of rail milepost 4.

The car repair facility is located at the north end of the yard. The locomotive service and repair facility is located on the east side of the line between rail milepost 4 and 23rd Ave., across from the car repair facility. The facility consists of a recent-vintage open-air service track facility for fuel, sand, and other service, a roundhouse and turntable, and a locomotive servicing building. The new facility is oriented to entry/exit by way of the rail milepost 4 interlocking. There is enough room between the main track and the derails providing blue flag protection for the facility for about ten units. The train dispatcher may allow locomotives to enter and leave the main track at rail milepost 4 as needed, however if locomotives are attempting to leave the facility and enter the main track, arriving locomotives cannot be accommodated. If one of the yard tracks on the east side of the line between Galer Street and rail milepost 4 is clear, it may provide a second path to avoid impasse between locomotives arriving and leaving. Access to the older part of the facility is by way of the 23rd Avenue interlocking. The train dispatcher provides blue flag protection for the facility by blocking the controls of the power switch. The train dispatcher must have instructions from the service facility foreman for each movement entering or leaving the facility. Locomotive fuel arrives in tank cars, spotted to the service facility by switch engines. The main track must be used for access to the fuel storage track, a movement that also requires instructions from the service facility foreman before the switch from the main track can be lined.

There are two routes between the north end of the yard tracks and the main tracks; the interlocking at 23rd Avenue and the rail milepost 5.4 interlocking. Both routes have a common section of track just south of 23rd Avenue, so two trains cannot be accommodated simultaneously. The track adjacent to the main track between Galer Street and 23rd Avenue is an exception. A movement may be made to the main track at 23rd Avenue simultaneously with a movement between the yard and Main One at milepost 5.4. The main track is the only route between this track and the rest of the yard. All movements must pull out onto the main track then reverse direction. There is no lead between the main track switch and the switches for the north end of the yard at 23rd Avenue; the first switch is adjacent to the main track switch. There is about 1,400 feet of lead between the main track switch at milepost 5.4 and the yard tracks.

Between 23rd Avenue and the Ballard Bridge, the line passes through a cut about twenty feet deep.

Ballard 4 (Ballard Bridge) (Distance 192 Rail Milepost 6)

Bridge 4 over Salmon Bay is a 1,440-foot bridge including a bascule movable span. The speed limit on the bridge is twenty miles per hour. Marine traffic consists of pleasure craft and moderate-sized commercial vessels, generally commercial fishing boats. All vessels must pass through the Ballard Locks, located immediately east of the bridge, regulating marine traffic to some degree. There is generally no strong current that requires bridge opening significantly in advance of an approaching vessel, but the locks bunch traffic headed out to sea, sometimes causing openings of long duration.

During the 1995 preliminary work for establishing commuter service, the United States Coast Guard 13th District acknowledged the importance of reliable commuter train operation and the potential problems that would be caused by conflicts between commuter trains and navigation at the Ballard Bridge. The Commander of the 13th District authorized delays to navigation of up to ten minutes for the four scheduled commuter trains per day. The Chief, Plans/Programs Section agreed that when regular commuter service is instituted, some accommodation would be reasonable; probably either an arrangement allowing the bridge-tender to regulate traffic and/or a specific period during which the bridge would not be opened, similar to the situation on roadway bridges in Seattle.

Between the bridge and rail milepost 7, the line passes through a cut then follows a hillside.

Rail Milepost 7 (Distance 193 Rail Milepost 7)

The hillside along the east side of the track is wooded and has been susceptible to landslides in the past. The line was singled between the rail milepost 7 interlocking and the milepost 8 interlocking after a landslide destroyed both main tracks in 1957.

Rail Milepost 8 (Distance 194 Rail Milepost 8)

Between rail milepost 8 and Richmond Beach, the line follows the shoreline of Puget Sound. There is generally a stone seawall along the west side of the line. At low tide there is exposed beach at the base of the wall. At high tide, the water level is generally at or above the base of the wall. The line follows immediately to the west of high bluffs. Several areas of the bluffs are susceptible to landslides.

Richmond Beach (Distance 200 Rail Milepost 14)

At Richmond Beach, the shoreline diverges to the west of the tracks a short distance, and the bluffs flatten to steep-to-moderate hillside. There is residential development along the east side of the line at Richmond beach, and for a short distance along the west side on a narrow point of land between the railroad and the Puget Sound shoreline. Access to the residential area is a timber bridge over the track where it passes through a short cut. South of the residential area on the west side, there are two double ended storage tracks, each about 1,500 feet long. North of the residential area west of the line there is a petroleum storage tank farm, and an industry lead for the tank farm. On the east side of the line, the high bluff continues to Edmonds. The rock seawall resumes north of the tank farm, where the shoreline returns to the edge of the track. Several areas of the bluffs are susceptible to landslides.

There is no direct highway access to the tracks between Ballard and Edmonds.

Edmonds (Distance 203 Rail Milepost 17)

At Edmonds, the shoreline diverges to the west of the tracks for a short distance, and the bluffs flatten to gentle to moderately sloped hillside. The line is single track between the rail milepost 16 CTC control point and the rail milepost 18 CTC control point (1.9 miles), a result of a 1957 landslide that destroyed both tracks just north of rail milepost 16.

There are two street crossings at grade; one at each end of the Edmonds Station platform. There is a street immediately adjacent to the west side of the track between the two crossings. There is a recently installed fence along the edge of the street to prevent access to the track.

Sound Transit commuter trains will use the station when the service is started. A taxi service is available on call. There has been some planning for a new station, however the final location and design have not been chosen. The proposed station design will incorporate rail, buses, and the ferry terminal into a single intermodal terminal.

The Washington State Ferries Edmonds terminal is located west of the line, north of the station. The traffic queue for the ferry is adjacent to a street east of the tracks. Traffic to and from ferries crosses the track at grade at the north end of the station platform. The vessels have vehicle capacity of about 200 and passenger capacity of about 2,500. Sailing headway is not regular; ranging from forty minutes to an hour throughout the day.

The central business district of Edmonds is located on the east side of the line north of the station.

A BNSF track maintenance headquarters is located on the east side of the line south of the passenger station. On the west side of the line, opposite the track maintenance headquarters is a single end storage track, opening south, that is used by the track maintenance department. Generally, a self-propelled crane equipped with a clamshell bucket is kept on the storage track for use in clearing landslides along the coastline.

Between Edmonds and Mukilteo, the configuration of the line is generally the same as between Ballard and Edmonds. Several areas of the bluffs are susceptible to landslides. There is a stone seawall and the Puget Sound shoreline to the west, high bluffs and residential development to the east. At several locations, the shoreline diverges to the west. The only direct highway access to the tracks between Edmonds and Mukilteo is the Meadowdale crossing at rail milepost 21.3, which leads to a marina.

The line is single track between the rail milepost 27 CTC control point and the milepost 28 CTC control point (0.8 miles) because of destruction of the two main tracks by a landslide in 1957.

Mukilteo (Distance 214 Rail Milepost 29)

A station for Sound Transit commuter service will be constructed at Mukilteo.

There are two double ended storage tracks on the east side of the line and a single track storage track on the west side. These tracks are generally used for shipments to and from the Boeing Everett plant, where 747 and 777 aircraft are built. There is a spur to the Boeing facility, connected to the north end of the storage tracks on the east side of the line. The grade on the spur exceeds five percent. The locomotives used for this service are specially equipped, including extended range dynamic brakes. Operating rules require the locomotive to be on the downhill end of all movements on the grade. Operating rules prohibit train movement on the grade while a passenger train is approaching or passing.

Between Mukilteo and Everett Junction, there is generally residential development along the top of the bluff. The track is at the top of a stone seawall, with the Puget Sound shoreline at the base of the seawall. Several areas of the bluffs are susceptible to landslides, although not generally to the degree of the bluffs between Ballard and Mukilteo.

There is a CTC control point at Mukilteo with a left-hand crossover and a CTC control point at Howarth Park with a right-hand crossover. The two control points were constructed specifically for the movement of cars with containers containing parts for Boeing 777 aircraft. The parts are containerized, some of the containers over twenty feet wide, and brought to the Everett waterfront by barge for rail movement to the assembly plant. There is insufficient clearance to obstructions along the line and the cars must not only move as a single track movement between Everett Junction and Mukilteo, they must use Main Two between Everett Junction and Howarth Park and Main One between Howarth Park and Mukilteo to avoid fixed obstructions that will not clear the containers.

There are two double end storage tracks, about 2,500 feet and 1,500 feet long, on the east side of the line near rail milepost 31. There is a single storage track, about 3,000 feet long, on the west side of the line between

Howarth Park and Everett Junction. The north end of the track connects to the Bayside Yard line, not to the main track.

Everett Junction (Distance 218 Rail Milepost 32 = Rail Milepost 1785)

Everett Junction is the end of two main tracks. The Bayside Line (also known as Low Line) continues north on flat terrain to Bayside Yard and a surrounding industrial area. The main track (also known as High Line) climbs along the base of the bluff on a grade of generally 0.5 percent. The former passenger station is located on the east side of the line at Everett. The station was a two level station, with stairs and an elevator leading to the Low Line platform.

Just north of the former passenger station, the line passes under the Everett central business district in a 2,440-foot tunnel. The curvature at the ends of the tunnel changes the direction of the line about 120 degrees to the east. The summit of the 0.5 percent grade is just north of the north portal of the tunnel, about forty-six feet higher than Everett Junction. The line descends generally 0.22 percent toward PA Junction

At the north portal of the tunnel the line passes through a narrow cut that widens into generally flat terrain at PA Junction. There is commercial development on both sides of the line between the tunnel and PA Junction

PA Junction (Distance 220 Rail Milepost 1783 = Rail Milepost 0)

The recently completed Everett Multimodal Station is located just south of PA Junction, about one-half mile from the Everett central business district. The facility is used by Amtrak, three transit agencies and intercity bus lines, and will be used by Sound Transit commuter trains when the service is initiated.

The switches connecting the Vancouver, BC route and the Wenatchee/Spokane route are located at the north end of the platform. After leaving the station and diverging through the switches onto the Vancouver route, the line turns toward the west 160 degrees, descending along a hillside. Just north of the curve, the line generally follows the west bank of the Snohomish River to Delta Junction There are generally bluffs thirty to forty feet high along the west side of the line. Where the track is not immediately adjacent to the riverbank, there is industrial development on the east side of the line.

Sealine Junction (Distance 221 Rail Milepost 1=Rail Milepost 8)

At Sealine Junction, a line connecting with the Wenatchee/Spokane route at Lowell joins from the south on the east side of the line, at a hand throw switch.

GN Junction (Distance 222 Rail Milepost 9)

At GN Junction, the lead to Delta Yard diverges to the west at a hand throw switch. The lead is the former Great Northern main track between GN Junction and Delta Junction

Delta Yard (Distance 223 Rail Milepost 9)

Delta Yard is the southward/eastward yard, located between GN Junction and Delta Junction. Traffic arriving from north of Delta Junction is classified and made up into trains for Wenatchee, Seattle, Pasco, and Vancouver/ Portland.

The main yard consists of combination classification-receiving-departure tracks each about 4,000 feet long. The lead to the yard tracks connects to the GN Junction – Delta Junction track at a hand throw switch about 2,000 feet from GN Junction. The yard tracks are about 2,000 feet from that switch, thus a movement of about 4,000 feet may be made from the yard tracks before fouling the main track at GN Junction A train may be doubled together from two yard tracks without occupying the main track.

There are two tracks adjacent to the main track, one on each side between the middle and north end of Delta Yard, called Roger Old and Roger New. These former sidings are about 4,000 feet long each. They are generally used as receiving tracks for Delta Yard. There is a connection from the main track to the switching lead in the yard at the south end of these tracks. There is also a solid waste transfer industry track from the main track leading to the east, opening south, at the south end of these tracks. The industry generates a train of containers per day.

Bayside Yard (Distance 220 Rail Milepost 34)

The former Great Northern main track extends between Everett Junction and Delta Junction (the Bayside Line or Low Line). Bayside yard consists of this entire line and including associated yard and industry tracks. The longest yard track is about 4,000 feet. Yard operation does not affect main tracks. There is a direct connection between Bayside Yard and Delta Yard at Delta Junction that may be used without affecting main line traffic. Bayside Yard is the Northward/Westward yard. Traffic arriving from the south or east is switched and made up into trains for destinations north of Delta Junction.

Delta Junction (Distance 224 Rail Milepost 11 = Rail Milepost 37)

Delta Junction is the junction of the main line, the Bayside Yard Line, and the Delta Yard Line. An 859-foot bridge including a swing span (Bridge 37.0) is located immediately north of the junction. It is attended full time and opens regularly for marine traffic, generally small boats and tugs with log floats. The speed limit on Bridge 37.0 is ten miles per hour. A structural analysis must be performed before the requirements for a speed increase can be determined.

North of Bridge 37.0 there is a 534-foot long concrete trestle over Union Slough, a 1,072-foot bridge (including a swing span) over Steamboat Slough (Bridge 37.7), and a 698-foot bridge (including a swing span) over Ebey Slough (Bridge 38.3). The Steamboat Slough and Ebey Slough bridges open infrequently. They are not continuously attended; marine traffic must provide advance notice. The passenger train speed limit on the Steamboat Slough and Ebey Slough bridges was increased from twenty miles per hour to forty miles per hour after improvement funded by the state of Washington. The freight train speed limit remains at twenty miles per hour. A structural analysis must be performed before the requirements for a freight speed increase can be determined.

Marysville (Distance 226 Rail Milepost 39)

Marysville is immediately north of the Ebey Slough bridge. There are two industry tracks and a short double ended track used for running around cars, and occasionally for the local freight train to clear for other traffic.

The at-grade street crossings in Marysville are notable. There are seventeen public and private crossings within five miles, all at-grade. At the south end of Marysville, at the Ebey Slough Bridge there is a mile of thirty miles per hour speed limit and 1.3 miles of fifty miles per hour speed limit improved from twenty-five miles per hour by a Washington State Utilities and Transportation Commission order. Most such orders affecting the route have been abrogated. The process is continuing for the remaining orders.

Kruse Junction (Distance 229 Rail Milepost 42)

An industrial spur (former Northern Pacific main track) to Arlington (seven miles) diverges to the east at a hand throw switch at Kruse Junction Service on the line is occasional.

The terrain between Kruse Junction and English is flat. There is a parallel road on the east side until about a mile north of Kruse Junction, where the line diverges to the west away from the road and crosses under Interstate 5.

English (Distance 233 Rail Milepost 46)

There is a CTC siding on the west side of the main track at English. It has recently been extended from 6,800 feet to about 9,000 feet. At the north switch of the siding, the line descends along a wooded hillside to Silvana.

Silvana (Distance 236 Rail Milepost 50)
Silvana has no operating significance, however it is a changing point in the terrain. North of Silvana, the terrain is flat, and is floodplain of Portage Creek, Cook Slough, and the Stillaguamish River. The line is generally on embankment and not affected by flooding between Silvana and Stanwood, but there are twelve bridges in five miles, including bridges of 323 feet, 762 feet, and 1,472 feet that have one or more truss spans. The other bridges are timber trestle (or recently replaced with concrete trestle) with lengths between fifty feet and 500 feet.

Stanwood (Dist 243 Rail Milepost 56)
From Stanwood to the Snohomish/Skagit County line, the tracks curve around the base of a steep hillside on the east side. Between those two points, the line is as much as 1,000 feet west of the base of the hill, in flat terrain. There is a levee south of the central business district, extending from the hillside east of the railroad to higher ground west of the central business district. The railroad passes through an opening in the levee. During extreme flooding, it has been necessary to construct a dike across the railroad, closing the gap. This last occurred over ten years ago.

There is a 6,300-foot long CTC siding on the east side of the line at Stanwood, but the street crossing at the central business district, near the south end of the siding, limits the useful length to about 5,300 feet. There are two industry tracks at the south end of the siding on the east side of the line, one of them used regularly. There is an industry spur, about one mile long, connected to the main track on the west side near the middle of the siding.

There are eighteen public and private at-grade crossings in six miles between Stanwood and Conway, including one mile with seven crossings.

Conway (Distance 251 Rail Milepost 63)
There are two industry tracks in Conway; one not used and one used occasionally. Conway is a rural village, located on both sides of the line. There is one street through the town, crossing the railroad at grade. There is a second crossing at Conway, about 300 feet north of the main street crossing, for a bypass highway to carry through traffic around the center of town.

Mt. Vernon (Distance 254 Rail Milepost 67)
The railroad passes along the east edge of the central business district of Mt. Vernon. Just north of Mt. Vernon, the railroad curves to the west then the east around the base of the hill. Interstate 5 extends along the base of the hill, east of the railroad. It climbs the hillside as the railroad passes around it, crossing above the railroad. At that location, the Mt. Vernon

Terminal Railway track and a road are adjacent to the west side of the track, and the east bank of the Skagit River immediately adjacent to the road. The Interstate 5 highway bridge was designed to accommodate only the two single track rail lines and the existing road. Just north of the bridge, Mt. Vernon Terminal Railway connects with BNSF at a south-facing switch. South of the central business district, there is a 6,000-foot CTC siding on the east side of the main track, however a road crossing limits the useful length to about 4,500 feet.

A new multi-modal passenger station is being planned for a location adjacent to the central business district. The facility will replace the current station between Mt. Vernon and Burlington.

Mt. Vernon-Burlington (MVB) Station (Distance 256 Rail Milepost 69.4)

MVB Station is located between Mt. Vernon and Burlington. The former station building is used by BNSF. Passenger trains stop at the north end of the platform. A short spur track on the west side of the main track north of the platform, opening to the north at the north end of the platform, is used by BNSF for the locomotive of the Burlington-Anacortes local freight train between trips.

Burlington (Distance 259 Rail Milepost 72)

Just north of MVB Station, the line crosses the Skagit River on a 1,000-foot bridge. There is a small yard on the west side of the line between the Skagit River and the main crossing of the central business district. The yard is used for local industry traffic and traffic for or from the Anacortes branch. The Anacortes branch connects directly to the north end of the yard. The Sumas branch connects to the line on the east side just north of the Anacortes branch connection in a CTC control point.

Between Burlington and rail milepost 74.5, there is a highway parallel to and west of the railroad, and Interstate 5 west of the highway. At rail milepost 74.5, the line curves toward the west with a five degree curve, passing under the highway and Interstate 5.

Bow (Distance 268 Rail Milepost 80)

There is a 9,000-foot long CTC siding on the west side of the line at Bow. The siding was extended in the late 1990s. The work was funded by the state of Washington.

Samish (Distance 270 Rail Milepost 83)

Just north of Bow, the line passes along the west side of Blanchard, a small rural village. South of Blanchard, the terrain is flat agricultural land. There are steep hillsides east and north of the village. Just north of Blanchard, the rail line curves to the west, across Colony Creek and a tide flat, under a highway and onto the west shore of Samish Bay. At the south end of the Samish storage track, the hillside becomes a cliff. The railroad passes through a short rock cut with the highway passing over the outcropping about 100 feet above. A storage track, formerly a siding, extends along the east side of the line for about 3,500 feet in the small amount of flat terrain between the rock cut and Tunnel 18. The highway diverges to the east then returns and crosses about 120 feet above the railroad as it passes through Tunnel 18.

The railroad follows the base of the cliff along the east shore of Samish Bay. The highway is parallel and about 160 feet above the railroad. The top of the cliff is about one thousand feet above the water, where the slope reduces and continues to the top of Chuckanut Mountain at an elevation of about 1,800 feet.

After passing about a mile of beach at an elevation just above high tide level, the line begins to climb the face of the cliff, gaining about sixty feet in elevation, turning a short distance east of the shoreline, and passing through narrow rock cuts. The slope along the east side of the line diminishes to steep hillside and there are several points of land extending west of the line, separating Samish Bay from Chuckanut Bay. In this area, the line passes through two tunnels.

The line returns to the shoreline along Chuckanut Bay and the slope of the adjoining hillside increases to again become cliffs. The adjacent highway is about 200 feet above the track. Just south of South Bellingham, the line turns toward the west, crosses Chuckanut Bay on a 2,000-foot causeway and 200-foot bridge, passes through a 750-foot tunnel, crosses a short causeway and passes through a rock cut, and follows the east shoreline of Bellingham Bay to South Bellingham.

South Bellingham (Distance 280 Rail Milepost 93)

A 6,300-foot CTC siding extends along the west side of the line north of the tunnel and rock cut. The useful length is about 5,200 feet because of street crossings at the north end of the siding. The passenger station is located east of the main track at the north side of the siding. There is a short platform along the siding for occasional use if a train cannot stop at the main track platform. The Alaska Marine Highway ferry terminal is located adjacent to the track on the west side, across from the station.

Just north of the station and north end of the siding, the line crosses a timber trestle across a small bay at the outlet of Padden Creek and continues to follow the east coastline of Bellingham Bay. There is a commercial boat manufacturer on the east side of the line that moves boats across the line to and from the bay at a private crossing on the north shore of the creek. The slope of the hillside increases to a bluff along the east side of the line. The shoreline is historic commercial waterfront that is now parkland.

Bellingham (Distance 283 Rail Milepost 97 to Rail Milepost 95=Rail Milepost 96)

The bluff on the east side of the line diverges away from the track and reduces to a moderate slope near rail milepost 96.3. Between rail milepost 96.7 and rail milepost 97, Georgia Pacific Pulp and Paper Plant industrial facilities are located close to both sides of the main track, including tank car unloading facilities and a close-clearance driveway for heavy trucks. There is generally a guard rail between the driveway and the main track, but at one point it is possible for trucks to foul the main track while backing into or pulling away from a loading dock. Because of the hazards, the speed limit for all trains is twenty miles per hour. A plan for a line change to bypass the plant was developed, but the track geometry available between existing structures was poor. In 2002, Georgia Pacific closed most of the plant. The remaining functions of the plant are being evaluated. There is a possibility that the plant will close completely, or that parts of the facility that are a hazard to trains can be removed.

Just north of the Georgia Pacific plant, there is commercial and industrial development along both sides of the line. There is a road immediately adjacent to the west side of the line. The industrial development is between the shoreline and the road. The former Bellingham passenger station, now a BNSF office facility, is on the east side of the tracks and is on the historic register. There is another BNSF office immediately to the north.

The slope increases to a bluff along the east side of the line just north of the two BNSF buildings. There is a small yard along the west side of the main track for shipments originating and terminating in Bellingham. The road extends along the west side of the yard. At the north end of the yard, the line climbs the face of the bluff, crosses a deep ravine on a 540-foot bridge, and follows the top of the bluff on the opposite side of the ravine, about eighty feet above the shoreline. The elevation increases to about 100 feet above the shoreline near rail milepost 100. An industrial spur opening north at rail milepost 99.6 leads to a cement plant that has been closed for several years. The spur is used for car storage when needed.

Near rail milepost 100, the bluff has eroded to a point close to the west side of the track. A vertical motion detection system was installed to monitor earth movement and provide warning of failure of the bank. At this point the line passes just south of the south end of the runway at Bellingham International Airport. The airport boundary is 500 to 1,500 feet from the track.

North of the earth movement detection site, the top of the bluff diverges to the west, away from the track. There is an industry track opening north on the east side of the line near rail milepost 102. The industry, a lumber transloading facility, is located immediately adjacent to the main track. There is also an industrial track opening north on the east side of the line near rail milepost 104. Between rail milepost 104 and Ferndale, the terrain is generally wetland, Tenant State Wildlife Area, or parkland.

Ferndale (Distance 292 Rail Milepost 106)

The line crosses the Nooksack River on a 480-foot long bridge at the east edge of the Ferndale central business district. There is a CTC siding of about 8,600-foot length on the east side of the line, a double ended team track east of the siding, and a spur to the grain elevator opening north on the west side of the line.

A highway, Portal Way, extends adjacent to the east side of the line between the north end of the siding and Blaine.

Custer (Distance 297 Rail Milepost 111)

The line passes through the rural village of Custer. There is a storage track about 6,000 feet long along the west side of the line, used for storage of cars for Cherry Point Subdivision cars.

Intalco (Distance 298 Rail Milepost 112)

Intalco is a junction with the Cherry Point Subdivision, which diverges to the west through a wye. There is a yard track between the legs of the wye, a yard track north of the north leg of the wye, and two yard tracks on the Cherry Point Subdivision just west of the west wye switch. The yard tracks at Intalco are used for storing and switching cars to and from the Cherry Point industrial district, five to eight miles from Intalco.

Swift (Distance 302 Rail Milepost 116)

There is a 8,700-foot long CTC siding along the east side of the main track at Swift, and two short spur tracks, opening south, on the east and west side of the line that are used for cars being held by U.S. Customs.

Swift was constructed as an alternative to extending the siding at Blaine (Distance 305 rail milepost 119). The Blaine siding is 6,000 feet long, but the practical capacity is only about 4,100 feet because of a road crossing near the north end of the siding. It is not practical to extend the siding to the south because of the bluff adjacent to the track on the east and the shoreline of Drayton Harbor on the west. It is possible to extend the siding north, but it would extend into Canada. Extending the Blaine siding into Canada is not physically difficult but would involve administrative and regulatory considerations of US Customs, U.S. Immigration, and Canada Customs.

Between Swift and Blaine, the line crosses Dakota Creek on a 350-foot bridge.

White Rock (Distance 306 Rail Milepost 120)

Between the USA/Canada border the line is adjacent to the shore of Birch Bay and pass through the Semiahmoo First Nations reserve. The speed limit is fifty miles per hour. There are no specific reasons for the speed limit except general safety consideration from a Transport Canada ruling. A setout track at White Rock is used for cars that are detained by Canada Customs.

At the former White Rock location ("Old White Rock" Distance 308 rail milepost 122) the station building has been converted to a museum and a park has been constructed along both sides of the track, with pedestrian walkways parallel to the track beginning at the end of the ballast section and extending away from the track. The speed limit for all trains is twenty-one miles per hour, imposed by Transport Canada. There were talks in 1995 to secure a speed increase through the use of an unspecified system to warn pedestrians on the walkways. No system was agreed upon. The speed limit can be expected to remain twenty-one miles per hour.

North of White Rock, the line continues along the shoreline, at the foot of a high bluff in the city of Surrey, in an area known as 1000 Steps and 1001 Steps because of the two park areas established around stairways leading to the beach. The speed limit in this area was thirty-five miles per hour for a number of years before passenger service was re-instituted in 1995. The speed limit was once: passenger fifty-five miles per hour, freight fifty miles per hour. An attempt was made in 1995 to restore the speed limit to the original passenger fifty-five miles per hour freight fifty miles per hour, but Transport Canada would not support the increased speed limit unless some unspecified measures were taken to protect trespassers walking on the track, drawn there by the 1,000 Steps and 1001 Steps parks.

Bridge 69, over the Nickomeckl River (Distance 314 Rail Milepost 127) is a 1,505-foot bridge including a swing span. The bridge has a full time bridge-tender, who also operates the interlocking. Marine traffic is generally pleasure craft. The bridge is open for marine traffic infrequently. The speed limit on the bridge is fifteen miles per hour for all trains. Between Bridge 69 and Colebrook, the line crosses the Serpentine River on a 2,530-foot bridge.

Colebrook (Distance 317 Rail Milepost 131)

BC Railway crosses BNSF at Colebrook by way of two junctions, both CTC control points. The track between the junctions is owned by BNSF, but is controlled by BC Rail. BNSF is the diverging route at both junctions.

Between Colebrook and Townsend the line generally follows the base of a hillside to the east. Soil conditions are poor and track alignment is difficult to maintain, resulting in lower speed limits than might otherwise be expected for the track geometry.

Townsend (Distance 324 Rail Milepost 137)

The Tilbury Island industrial spur connects, facing south, in the Townsend CTC control point. Between Townsend and Brownsville, the line extends along the east bank of the Fraser River at the base of a bluff. Soil conditions are poor and track alignment is difficult to maintain, resulting in lower speed limits than might otherwise be expected for the track geometry.

Brownsville (Distance 327 Rail Milepost 140)

Brownsville is a junction and interchange point with Canadian National Railway (CN). There are two CTC sidings, 5,800 feet and 6,063 feet, and several tracks for car interchange. Several trains per day originate and terminate at Brownsville, generally occupying the main track for an extended time while doubling in or out of the interchange tracks. Soil conditions are poor and track alignment is difficult to maintain, resulting in lower speed limits than might otherwise be expected for the track geometry.

Fraser River Bridge (Distance 328 Rail Milepost 141)

The BNSF line runs parallel to the Fraser River north and south of the bridge. The approach turns ninety degrees at both the north and south end of the bridge.

Fraser River Bridge is owned by the government of Canada and operated by CN. Construction began in 1902 and was completed in 1904. The bridge consists of truss spans including a swing span, pile trestle, and plate girder approach spans. The bridge is used by Southern Railway of BC (SRY), CN, and BNSF. SRY and the CN New Westminster Subdivision join the BNSF route at an interlocking at the north end of the bridge and both leave the BNSF route at Fraser River Junction, an interlocking at the south end of the bridge. The bridge and interlockings are controlled by the drawbridge operator. The speed limit on the bridge is generally passenger fifteen miles per hour freight trains ten miles per hour, except that the speed limit over the swing span and north switch is eight miles per hour. The speed limit over the south switch is twelve miles per hour for passenger and freight trains.

The channel is relatively narrow and the current is swift, making necessary opening for navigation well in advance. The second truss span from the north was destroyed by a barge in the late 1970s.

Spruce (Distance 330 Rail Milepost 145)

Spruce CTC control point is the south end of two main tracks. The CP New Westminster Subdivision is parallel on the East from Spruce to the Fraser River Bridge approach. There are three street crossings between Spruce and Fraser River Bridge.

A new Skytrain route was recently constructed, crossing above the BNSF route between Spruce and Fraser River Bridge. Plans for the Skytrain line called for preservation of the ability to construct a second track between Spruce and the north end of Fraser River Bridge.

Braid/New Westminster (Distance 330 Rail Milepost 145)

The CP Subdivision connects (south leg of the wye) at the Braid CTC control point. Just south of Braid on the west side of the alignment is the former station building, housing local BNSF offices and the train dispatching office. A small BNSF yard, “Old Yard” is located east of the line between Spruce and Braid.

Brunette/CP Junction (Distance 331 Rail Milepost 146)

Brunette is the south end of the New Yard. CP Junction is a connection (north leg of the wye) to the CP subdivision, only on Main Two just south of Braid.

The speed limit on Main Two is less than the speed limit on Main One between Braid and Spruce because of the turnouts in the curve between Braid and Brunette.

The New Westminster New Yard is located on the east side of the alignment between Lake City and Braid. There is additional access to the yard at the North Road CTC control point (Distance 331 rail milepost 147). The New Yard is the main BNSF freight yard in British Columbia.

Lake City (Distance 331 Rail Milepost 146)

The north lead of New Yard extends through the CTC control point to become the Lake City industrial lead.

Between the North Road CTC control point and the Lake City CTC control point, the line crosses a high fill. North of Lake City, the line descends along a hillside to generally level terrain.

Between Lake City and Willingdon Junction there are two CTC control points, Piper (Distance 333 rail milepost 148) and Sperling (Distance 335 rail milepost 150), each with two crossovers. Soil conditions are poor and track alignment is difficult to maintain, resulting in lower speed limits than might otherwise be expected for the track geometry.

Willingdon Junction (Distance 337 Rail Milepost 152)

The CN North Shore line joins the BNSF route at Willingdon Junction. The North Shore line leaves a tunnel about 1000 feet north of Willingdon Junction. The line is single track with a grade of generally 1.1 percent ascending toward Willingdon Junction.

Immediately north of the tunnel, the line crosses the Second Narrows Bridge. The bridge is frequently open for ocean shipping. Openings are often of long duration because of the nature of the marine traffic and the navigation conditions. The main track ends at the north end of the bridge, the south end of yard. The CN Rail Traffic Controller (RTC) on the Second Narrows Bridge controls the North Shore line.

The CN North Shore line is important to operation on the BNSF line because the drawbridge and ascending grade may cause very long single track running time. A northward CN train meeting a southward CN train at Willingdon Junction occupies one of the BNSF main tracks, resulting in single track operation between the Willingdon Junction and Sperling control points. Also, if a northward CN train cannot be accommodated in the North Shore yard, it must generally wait on the BNSF line.
Soil conditions are poor and track alignment is difficult to maintain, resulting in lower speed limits than might otherwise be expected for the track geometry.

Still Creek (Distance 339 Rail Milepost 154)

Still Creek is the north end of two main tracks and the north end of CTC.

CN Junction (Distance 340 Rail Milepost 155)

CN Junction is the connection of the south wye connecting the BNSF and CN yards to the main track, and also the south end of Glen Yard. Between CN Junction and Still Creek the line is single track, ascending southward generally one percent through a narrow cut called Grandville Cut, or just "The Cut." A new Skytrain Automated Light Rail Transit system line was recently constructed in the cut, west of the BNSF alignment. Plans for the Skytrain line called for preservation of the ability to construct a second track between CN Junction and Still Creek.

The main track between CN Junction and Still Creek is ABS.

Vancouver Junction (Distance 341 Rail Milepost 156)

Vancouver Junction has two hand throw switches for the BI Line connection and the north wye leading to the BNSF and CN yards. BNSF has a locomotive storage track south of Vancouver Junction. Glen Yard is located on the east side of the alignment. The yard is owned jointly by BNSF and CN, however BNSF makes little use of the yard. CN typically uses Glen yard for storage of arriving grain trains until they can be accommodated in the grain terminal, excess intermodal equipment, and other traffic that cannot be accommodated immediately by industries or on trains.

Vancouver (Distance 342 Rail Milepost 157)

Pacific Central Station is the Vancouver BC passenger terminal. It has 12 tracks, a car washer, and a VIA rail maintenance shop. All switches are hand throw; there is no signal system. Amtrak *Cascades* trains can use only one track of the station, track 12. Track 12 is completely enclosed by a chain link and barbed wire fence to provide security for customs and immigration. The enclosure is long enough for only two locomotive units and twelve Talgo cars. When the enclosure gate is closed, the track is only accessible through the Customs and Immigration Office in the station. The concourse adjacent to the building is covered. The platform on this track is not. The passenger queue for customs and immigration generally extends beyond the covered concourse onto the platform after train arrival.

The platform tracks all connect to two leads; one connecting to the main track and one connecting to the VIA maintenance facility. The car washer lead connects to the main track connection. A train being pulled through the car washer can prevent movement to or from track 12.

This page intentionally left blank.

Appendix C
Assumptions for Operating Plan Development

Appendix C
Assumptions for Operating Plan Development

What were the general assumptions which were used as part of the original planning work?

Several initial assumptions were made before the Amtrak *Cascades* Operating and Capital Plan was developed. These assumptions were:

- A thorough understanding of rail operations is required. The required understanding includes the reasons for traffic patterns, the constraints of adjoining territory that supplies or takes traffic on the line under consideration, the requirements of industries along the line, the operation of yards along the line and the processes the yards perform.

- A thorough understanding of local geography is required. The Pacific Northwest includes a significant area in which construction, environmental permits or both can be very difficult. Construction can be expedited if environmentally sensitive and difficult to construct areas are avoided. When environmentally sensitive areas cannot be avoided, the permitting process can be expedited by having a complete explanation for the function and necessity of the construction and what measures were taken to avoid the sensitive location.

- Cooperation among several entities including the Burlington Northern and Santa Fe Railway Company, the Washington State Department of Transportation, Amtrak, rail freight customers, and regulatory agencies is required. Thus, the plan must satisfactorily address the needs and concerns of each of the parties.

- The benefit of capital projects funded by the public and jointly used by passenger and freight service will probably not be confined to the passenger service. The description of each project would require a detailed understanding of the expected use and benefit of the funding.

- Since freight service would have an accepted benefit from jointly used public agency capital projects, railroad-funded projects can be concentrated on yard and terminal improvements, where the freight railroad is the sole beneficiary. The public would share the benefit of the freight railroad capital projects since adequate terminals keep the main tracks free of standing trains.

- Funding agencies must be able to see a direct result for each phase of incremental improvement as a requirement for continued funding.

- No capital project should be made obsolete by a future capital project, or require subsequent modification for a later stage of the program.

What were the specific assumptions which were used as part of the original planning work?

Several specific assumptions supported the infrastructure and operating plan design. These specific assumptions were:

- Between Tacoma, WA and Portland, OR, passenger stations, except Centralia, WA are located on the east side of the line. Construction of all high speed track on the east side of the line would minimize traffic flow disruption and maximize the speed of movement to and from the high speed tracks.

- Operation of the passenger service as a single track line when on dedicated track, using the adjacent lower speed tracks for meeting high speed trains, would minimize the amount of new track required.

- Operation of the passenger trains on the east track of the two track joint operation sections between Nisqually, WA and Vancouver, WA would avoid crossing flows of traffic at the ends of the three track sections.

- The speed limits for shared track operation south of Nisqually, WA would be Talgo ninety miles per hour (mph), Freight sixty mph, and Passenger[1] whatever speed would be supported by the track geometry needed for Talgo ninety mph. North of Everett, WA the speed limits for shared track operation in the 110 mph areas would be Talgo 110 mph, Freight sixty mph, and Passenger whatever speed would be supported by the track geometry needed for Talgo 110 mph. Traffic and axle loading north of Everett, WA is relatively light, so freight trains would operate on high speed track, accepting the need for additional maintenance, instead of constructing two high

[1] *Amtrak currently operates two long distance trains along the PNWRC – the Coast Starlight and the Empire Builder. Throughout this operating and infrastructure plan, reference will be made to "Passenger" trains. This reference includes these two (and any future, non-Talgo) passenger trains.*

speed tracks where needed in addition to the existing conventional speed track. Other shared track north of Seattle would have conventional speed limits because of track geometry.

- The signal system required for speed of more than seventy-nine mph would be in place by the time speed of eighty mph or more would be necessary. National Transportation Safety Board has been requesting for many years that such a system be made mandatory.

- The speed limit between Everett and Lakewood should not exceed seventy-nine mph to limit the speed differential between Amtrak *Cascades* trains and other traffic and to eliminate the need for advanced signal system equipment on commuter trains. The need to equip commuter trains was considered for the eventuality that high speed operation might begin before advanced signal systems became mandatory.

- The speed limit between Vancouver, WA and Portland, OR should not exceed seventy-nine mph to limit the effect of speed differential between Amtrak *Cascades* trains and other traffic.

- The Federal Railroad Administration (FRA) would allow no road crossings at grade whenever the speed limit exceeded 110 mph.

- Segments of shared operation would be limited to areas where construction of new track would be difficult.

- When possible, all rail traffic should benefit from the changes required to support the passenger program.

- Infrastructure design should provide the flexibility needed to support the maximum amount of traffic with the least possible construction of additional track. Freight and passenger traffic would have a planned functional separation, but the infrastructure design would allow use of any track as needed if made necessary by maintenance or operating problems.

- No alignment change or additional track is reasonable between Samish and Bellingham.

- A new route would be necessary between about rail milepost 62 and rail milepost 75 between Chehalis and Vader to avoid sharp curves near Napavine and Winlock.

- On shared track, maximum super-elevation five inches, maximum unbalance six inches, and minimum curvature one degree fifty-seven minutes for ninety mph.

- On exclusive track, maximum super-elevation of six inches, maximum unbalance of eight inches, and minimum curvature of one degree thirty-nine minutes for 110 mph.

- Grade must not exceed the current grade for the existing tracks at any point.

- Trains always operate at the same headway: one hour between Seattle and Portland, OR and two hours between Seattle and Vancouver, BC -- to minimize the required amount of infrastructure.

- Opposing Amtrak *Cascades* trains should not meet between Vancouver, WA and Portland, OR because of capacity and infrastructure limitations.

- Schedule tolerance of five minutes (five minutes late is considered on time).

- Operation must be planned and executed with the precision found in Japan or Europe.

- New main tracks would be built at conventional fifteen-foot track centers from existing tracks.

- Earlier assumed mandatory installation of Advanced Signal and Control systems on all rail lines will not occur, at least not before such a system is required for Amtrak *Cascades* operation.

- Conventional passenger trains will not be specially accommodated by infrastructure, but will be operated as necessary to avoid conflict with Amtrak *Cascades* trains.

Have conditions changed that affect these original assumptions?

The PNWRC infrastructure and operating plan was developed between 1992 and 1995. There have been subsequent refinements because of study at an increasing level of detail. The design goal was to develop the most economical infrastructure arrangement that would support the desired service density and running time. As such, after 1995, a number of changes, which have occurred since the original analyses, have been incorporated into this operational analysis. These changes include:

- Burlington Northern Railroad became Burlington Northern and Santa Fe Railway Company (BNSF) after a merger.

- The planned speed limit for the new track between Ostrander and rail milepost 84 was reduced from 110 mph to ninety mph. This segment is not long enough for a significant amount of 110 mph operation. Opposing Amtrak *Cascades* trains would meet in this area, causing one of the trains to operate at ninety mph and lose the small benefit of 110 mph operation. Operation at 110 mph operation would involve more extensive curve realignment than ninety mph operation assuming the alignment was changed on all tracks.

    - BNSF found through simulation that if operation of the passenger trains on the east side for access to dedicated track is not necessary, that the segment between the end of the high speed track at Bucoda and the end of the high speed track at Kalama would be easier to operate and would better support traffic flow as a conventional two track line. This finding had the effect of limiting the usefulness of the proposed 110 mph track between Vader and Winlock.

    - The Tukwila station was added.

    - FRA allowed road crossings at grade for tracks with a speed limit of up to125 mph.

    - The new alignment between rail milepost 62 and milepost 75 was not discussed in the *1995 Options Report*.

    - A British Columbia Transportation Financing Authority report entitled *Route and Terminal Alternatives in British Columbia for Amtrak Passenger Train Service between Vancouver and Seattle*, June 1998, indicated possible advantages to a new Vancouver terminal location near the Scott Road Skytrain station in Surrey.

    -

- BNSF required new track constructed at twenty-five foot track centers. However, some situation-specific exceptions would be considered.
-
- Investigation of track maintenance cost indicated that the operation of freight trains on track with a ninety mph speed limit will result in very high maintenance cost. The result was significantly more than earlier anticipated, partially due to increasing axle loads of typical trains.

- Operation of passenger trains at ninety mph on shared track would require the PNWRC program to equip BNSF locomotives with the advanced signal system equipment required by the Federal Railroad Administration for speed over seventy-nine mph. These changes, and some changes in attainable speed at various locations along the route, caused the attainable Portland-Seattle schedule running time to be two hours 44 minutes instead of the two hour thirty minute goal.

How have these changes affect operating guidelines and assumptions?

The changes discussed above were sufficient to cause a reevaluation of the plan using new assumptions:

- Amtrak *Cascades* service will operate on a separate dedicated track except in terminal areas where separate operation is not practical.

- The alignment of the freight tracks need not be changed to support higher speed and greater capacity.

- Infrastructure changes to ensure maximum flexibility of the existing tracks are not necessary except at the ends of shared track operation.

- New or modified infrastructure for freight operation is not needed except in shared terminal areas,

- Where curve realignment is necessary, a 110 mph dedicated track may have less environmental effect than a ninety mph shared track alignment that allows a sixty mph freight speed limit.

- The Amtrak *Cascades* service will operate as a separate single track railroad except in the shared terminal areas and where scheduled meets occur. Scheduled meets on high speed track will be made without either train slowing.

- Grade on exclusive tracks may be as much as four percent for short distances as necessary to reduce construction cost or impact.

- The *Coast Starlight* and possibly some extra or late Amtrak *Cascades* trains, up to the number of trains currently operating, may need to use the freight tracks between some places to avoid conflict with Amtrak *Cascades* trains.

Appendix D
Specific Examples of Methodology

Appendix D: Specific Examples of Methodology

High Speed Track

The methodology for determining the generally required infrastructure was the same in the reevaluation as it was for the original plan. Example trains were operated using Train Performance Calculator (TPC) software. The speed limit zones were adjusted as practical to allow the goal schedule running time. The running time for a northward and southward train were plotted on separate overlay layers of a stringline diagram in CAD software and duplicated at one hour headway. Each train was also plotted seven minutes late (five minutes schedule tolerance and two minutes for switches, signals, and sight distance at meeting points). The set of southward trains was moved through time (vertically) on the diagram to examine the effect of different meeting points on infrastructure requirements.

Each meeting point was marked on the diagram by a vertical line showing the location of the scheduled meet and two vertical lines showing the location of the meet if one train or the other is five minutes late (the amount of the schedule tolerance) plus the two minute signal and response time. The distance between the two lines indicating one train five minutes late is the length of line that must be arranged for meeting without reduction in speed. This is called the *meeting zone* in the alternative arrangement descriptions. Each of the alternatives is based on the location of the south meeting zone, the meeting zone closest to Portland, OR. In the discussion, the succeeding meeting zones to the north are numbered in succession from the south zone.

The diagram for each train shows running time. Schedule running time would include eight percent recovery time; eleven minutes between Portland, OR and Seattle, WA and twelve minutes between Seattle, WA and Vancouver, BC. The diagrams show schedule running time except for the arrival at Portland, OR, Seattle, WA, and Vancouver, BC. Recovery time will make the schedule arrival at Portland and Seattle eleven minutes later for that segment and the schedule arrival at Seattle, WA and [Greater] Vancouver, BC twelve minutes later for that segment. Leaving time shown for all trains at Seattle, WA includes the recovery time as well as the schedule dwell.

The recovery time is added at the terminal stations and Seattle instead of incrementally along the route because of the numerous places such as drawbridges and slide-prone areas along the route that can generate unpredictable delays that approach the length of the recovery time.

Shared Track

The procedure for planning trackage to be used exclusively by passenger service was different from the procedure for planning trackage to be used by passenger and freight trains. Passenger train schedules are generally "operating schedules." Track resource allocation is an integral part of scheduling. When scheduled correctly, there is no conflict among the passenger train schedules. Freight train schedules are generally "transportation schedules." Interaction with the track resources and other trains is not considered. Transportation schedules may specify the time at each terminal or only the elapsed time expected between terminals. All interactions between trains are improvised. Adherence to transportation schedules is generally not as close as adherence to operating schedules. Trains may deviate from the schedule by a significant amount, or may not be operated. Decisions to modify schedules or cancel trains are made continually. A transportation schedule is easy to modify, so schedules may be appended, deleted, or modified on very short notice, adding another degree of uncertainty for infrastructure planning to accommodate.

Since infrastructure cannot be allocated directly to freight operation, the infrastructure design must rely upon replicating or exceeding the current level of utility. Current typical performance was examined. The capacity of the current infrastructure was measured by analytical methods. The analysis included separate consideration of each element of the system, including the connecting lines that supply or absorb traffic. Usage of the shared infrastructure by passenger trains was known from the result of the detailed planning. Shared infrastructure planning accommodates the current maximum capacity of the system for freight operation plus the requirements for the passenger service.

For example, the line between Seattle, WA and Everett, WA is generally double track with five single track segments. At Everett, there are two connecting lines; to Vancouver, BC and Spokane, WA and beyond. Each of the connecting lines is single track and has a capacity of approximately one train per hour. The yard at Everett, WA can generate or absorb traffic at the rate of about one train per hour. The line between Seattle, WA and Everett, WA in its current configuration has a capacity of about four trains per hour. The capacity of the three double track lines south of Seattle, WA is greater than the line between Seattle, WA and Everett, WA. The capacity of the Seattle, WA to Everett, WA segment needed to be increased to accommodate freight traffic, already near capacity, the *Sounder* commuter service, and the Amtrak *Cascades* service. However the freight traffic accommodation need not be greater than the connecting capacity at Everett, so increasing the single track-double track configuration of the line to double track throughout was sufficient.

This page intentionally left blank.

Appendix E
Alternative Track Arrangements

Appendix E
Alternative Track Arrangements

The following illustrations and discussion are an example of the planning steps and the observations made at each stage when considering alternative track arrangements. These examples are from recent reevaluation work. Although hourly service between Seattle, WA and Vancouver, BC is not planned, observations were made on the possible effect of increasing the frequency to one hour. All locations discussed in this narrative are located in Washington State, unless otherwise noted.

Arrangement A (Page E-7)

Arrangement A is the only alternative that uses a ten minute station dwell time at Seattle. All of the other alternatives use fifteen minutes at Seattle. Fifteen minutes is preferred, allowing time for restocking supplies and performing minor servicing or repair.

The north end of the south meeting zone is at the south end of the Felida to Kelso high speed track. The south end of the south meeting zone is between Vancouver, WA and North Portland Junction, OR. The south meeting point is at the same location in the original plan.

The second meeting zone is located between Rocky Point and Vader. Approximately twelve miles of second high speed track is required between these two points. The possibility of locating two additional tracks in the cut at Castle Rock is less likely than the possibility of locating only one. The need for a tunnel or an alternative route is more likely.

The third meeting zone is located between Wabash and East Olympia, requiring approximately fourteen miles of second high speed track.

The fourth meeting zone is located between Tacoma and Puyallup, requiring no more trackage than the original plan.

The fifth meeting zone is located between South Seattle and Seattle, requiring no more trackage than the original plan.

The sixth meeting zone is located between Seattle and Interbay, requiring no more trackage than the original plan.

The seventh meeting zone is located between Edmonds and Mukilteo. This meeting zone is not used for bi-hourly service.

The eighth meeting zone is located between English and Mt. Vernon. It requires about fourteen miles of second high speed track.

The ninth meeting zone is located between Samish and South Bellingham. This meeting zone precludes hourly service and limits the bi-hourly pattern to that shown. It would not be possible to substitute the set of unused train paths in either direction.

The tenth meeting zone is located between Intalco, BC and Colebrook, BC. It requires about thirteen miles of second high speed track.

Arrangement B (Page E-8)

Arrangement A and Arrangement B are identical between Portland, OR and Seattle.

The sixth meeting zone is located between Seattle and Interbay, requiring no more trackage than the original plan.

The seventh meeting zone is located between Edmonds and Mukilteo. This meeting zone is not used for bi-hourly service.

The eighth meeting zone is located between Marysville and Stanwood. It requires about nine miles of second track including about five miles of second high speed track.

The ninth meeting zone is located between Bow and South Bellingham. Hourly service would be possible, but the alternate hour schedules that are shown not used would need to be lengthened by approximately ten minutes to ensure reliability. The southward train [alternate hour] would leave [Greater] Vancouver, BC ten minutes earlier. The northward [alternate hour] train would be scheduled to arrive in [Greater] Vancouver, BC ten minutes later. This is shown in revised Arrangement B1 (Page E-9). Similar adjustment must be made if the paths shown as unused are used in either direction.

The tenth meeting zone is located between Ferndale and Blaine. It requires about twelve miles of second high speed track. If service is increased to hourly, the alternate hour meeting zone is located between Bellingham and Ferndale, requiring an additional nine miles of second track including four miles of high speed track.

Arrangement C (Page E-10)

The south end of the south meeting zone is at the south end of the Felida to Kelso high speed track. The north end of the south meeting zone is between Ridgefield South and Woodland. Approximately twelve miles of second high speed track is required in the meeting zone. Between Felida and Ridgefield, the line passes through a wildlife refuge and extensive wetlands. The first high speed track, necessary for the service, may prove difficult to permit and construct. A second high speed track may add considerably to the difficulty.

The second meeting zone is located between Castle Rock and Napavine. Approximately thirteen miles of second high speed track is required between these two points.

The third meeting zone is located between Plumb and Nisqually with the scheduled meet occurring at Centennial, requiring approximately nine miles of second high speed track including two tracks for Amtrak *Cascades* service at the Centennial Station.

The fourth meeting zone is located between Reservation and Auburn, requiring no more trackage than the original plan.

The fifth meeting zone is located between South Seattle and Seattle, requiring no more trackage than the original plan.

The sixth meeting zone is located between North Portal and Ballard, requiring no more trackage than the original plan.

The seventh meeting zone is located between Edmonds and Everett Junction. This meeting zone is not used for bi-hourly service.

The eighth meeting zone is located between English and Mt. Vernon. It requires about thirteen miles of second high speed track.

The ninth meeting zone is located between Samish and South Bellingham. This meeting zone precludes hourly service and limits the bi-hourly pattern to that shown. It would not be possible to substitute the set of unused train paths in either direction.

The tenth meeting zone is located between Swift and Colebrook, BC. It requires about twelve miles of second high speed track.

Arrangement D (Page E-11)

The south end of the south meeting zone is at Ridgefield, avoiding the problems of construction of a second high speed track between Felida and Ridgefield. Approximately thirteen miles of second high speed track is required. This arrangement requires two high speed tracks in the segment located between the northward and southward lanes of I-5 south of rail milepost 111. A second high speed track would probably require significant relocation of part of I-5 or a new alignment through the area for at least one of the high speed tracks.

The second meeting zone is located between Vader and Chehalis. Approximately thirteen miles of second high speed track is required between these two points.

The third meeting zone is located between Centennial and Fort Lewis. It requires approximately eleven miles of second high speed track including two tracks over the Nisqually River and on the Point Defiance Bypass between Nisqually and Fort Lewis.

The fourth meeting zone is located between Sumner and Kent, requiring no more trackage than the original plan.

The fifth meeting zone is at Seattle, requiring no more trackage than the original plan.

The sixth meeting zone is located between Galer Street and Richmond Beach, requiring no more trackage than the original plan.

The seventh meeting zone is located between Edmonds and Pacific Avenue. This meeting zone is not used for bi-hourly service. This meeting zone precludes hourly service unless a second main track is constructed between Everett Junction and Pacific Avenue, however, construction of the second track will still not allow hourly service because of the location of the ninth meeting zone.

The eighth meeting zone is located between Stanwood and Mt. Vernon. It requires about eleven miles of additional high speed track. It may require a second track at the new Mount Vernon Station.

The ninth meeting zone is located between Samish and South Bellingham. This meeting zone precludes hourly service. It limits the bi-hourly pattern to that shown. It would not be possible to substitute the set of unused train paths in either direction. Unlike Arrangement B1, the meeting zone cannot be corrected by schedule adjustment. In Arrangement B1, the second track on the north end of the meeting zone cannot be constructed. The north end of the schedule is adjusted to compensate. In this case, the second track on the south end of the meeting zone cannot be constructed. The required change affects the south end of the schedule with two possible results. The schedule dwell at Seattle is reduced, leaving only five minutes in Seattle, or the entire infrastructure design must be adjusted to accommodate the ninth meeting zone at a practical location. Neither is a practical alternative.

The tenth meeting zone is located between Blaine and Brownsville, BC. It requires about eight miles of second track including five miles of second high speed track.

Arrangement E (Page E-12)

The south meeting point is at Portland, OR. The north end of the south meeting zone is at Lake Yard, OR. Although one design assumption has been that Amtrak *Cascades* trains must not meet between Portland, OR and Vancouver, it appears that this arrangement may be consistent with the freight traffic pattern.

The second meeting zone is located between Woodland and Kelso. Approximately twelve miles of second high speed track is required between these two points. Meeting opposing Amtrak *Cascades* trains in this area has been avoided because of congestion and the geographical limitations on track construction. A second high speed track in this area could be very difficult and costly to construct, possibly requiring extensive relocation of part of Interstate 5 or alternatively, construction within the banks of the Columbia River.

The third meeting zone is located between Nisqually and South Tacoma. It requires approximately twelve miles of second high speed track on the Point Defiance Bypass and affects Sound Transit *Sounder* commuter train operation. A third main track may be required between Lakeview and South Tacoma to eliminate the effect.

The fourth meeting zone is located between Auburn and Orillia, requiring no more trackage than the original plan.

The fifth meeting zone is at Seattle, requiring no more trackage than the original plan.

The sixth meeting zone is located between Ballard and Edmonds, requiring no more trackage than the original plan.

The seventh meeting zone is located between Everett Junction and Pacific Avenue. This meeting zone is not used for bi-hourly service. Construction of a second track between Everett Junction and Pacific Avenue would allow hourly service.

The eighth meeting zone is located between Mt. Vernon and Bow. It requires about seven miles of additional track. High speed track is not necessary. The entire meeting zone is located in the conventional speed area of Mt. Vernon and Burlington. However, the second track may be difficult to construct between the new Mt. Vernon station and the original

Mount Vernon/Burlington Station because of the location of bridges and adjacent highways.

The ninth meeting zone is located between South Bellingham and Ferndale. It is not used for bi-hourly service. This meeting zone could accommodate hourly service with the extension of the South Bellingham-Bellingham double track north about two miles to approximately rail milepost 99.

The tenth meeting zone is located between Colebrook, BC and Brownsville, BC. It requires about six miles of second track. High speed track is not required because the entire meeting zone is located in a conventional speed area.

Conclusions

Eliminated Arrangements

Arrangement A may be unacceptable because of the short Seattle dwell. Assuming that some equipment will be operating through between Eugene, OR or Portland, OR and Vancouver, BC, ten minutes may not be sufficient for any restocking or service that may be necessary.

Arrangement C appears to be unacceptable because of the need for two high speed tracks between Felida and Ridgefield. Inability to expand Seattle to Vancouver, BC service to hourly is also a disadvantage.

Arrangement D appears to be unacceptable because of the need for two high speed tracks between the northward and southward lanes of I-5 between Woodland and Kalama. Inability to expand Seattle to Vancouver, BC service to hourly is also a disadvantage.

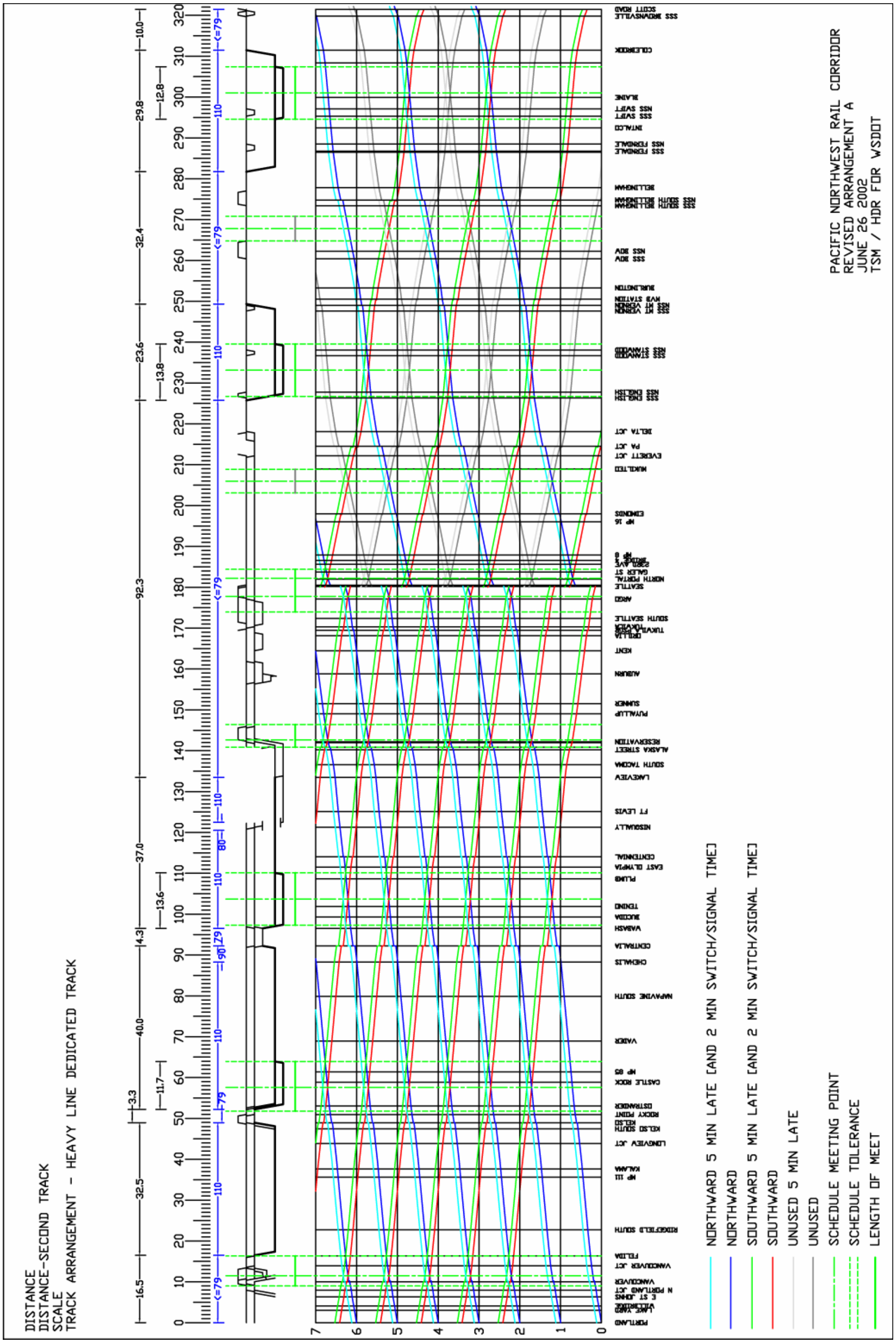
Arrangement E appears to be unacceptable because of the meeting zone in the Kalama to Kelso terminal area. Two high speed tracks on the Point Defiance Bypass in addition to the BNSF freight track may not be practical.

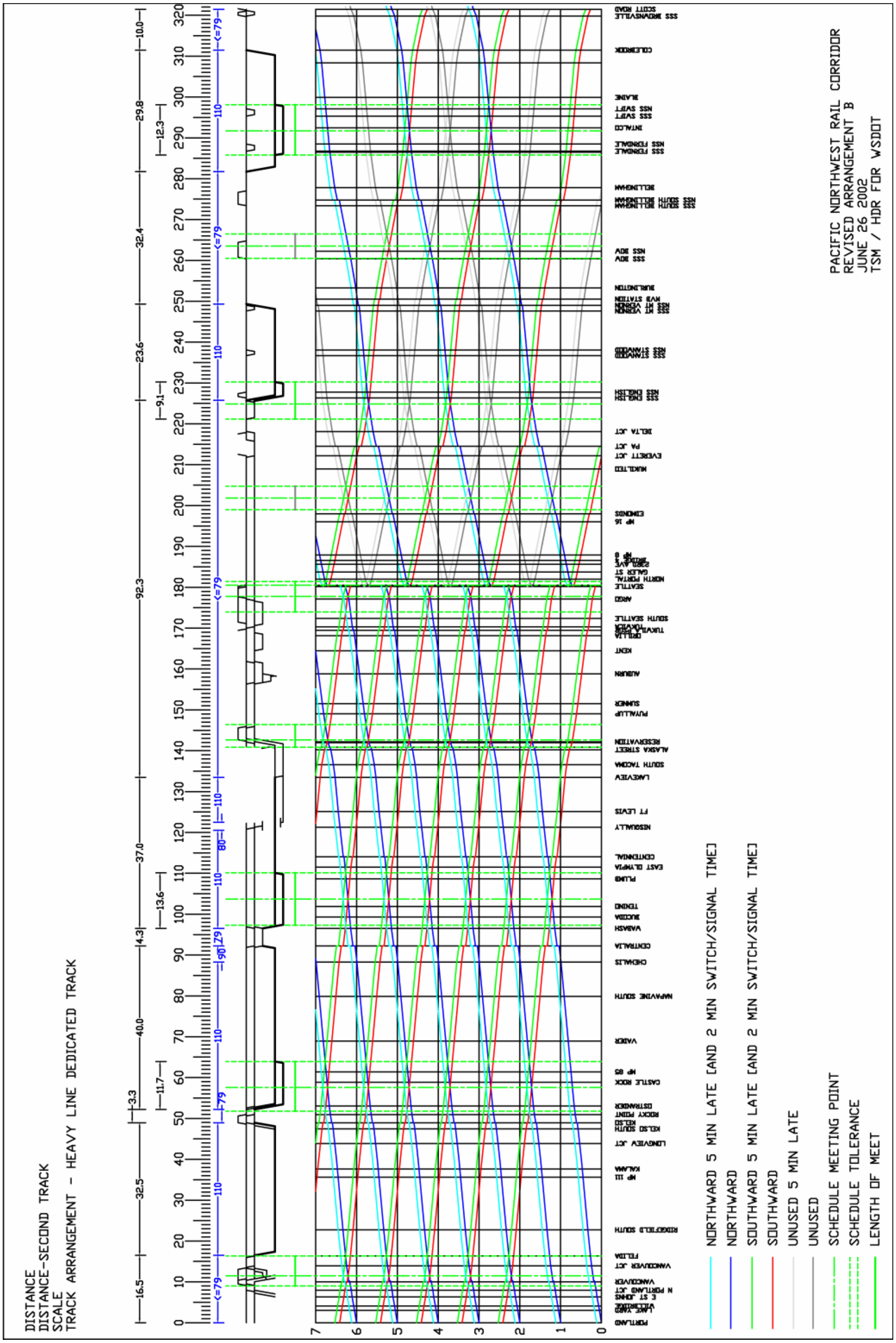
Supportable Arrangement

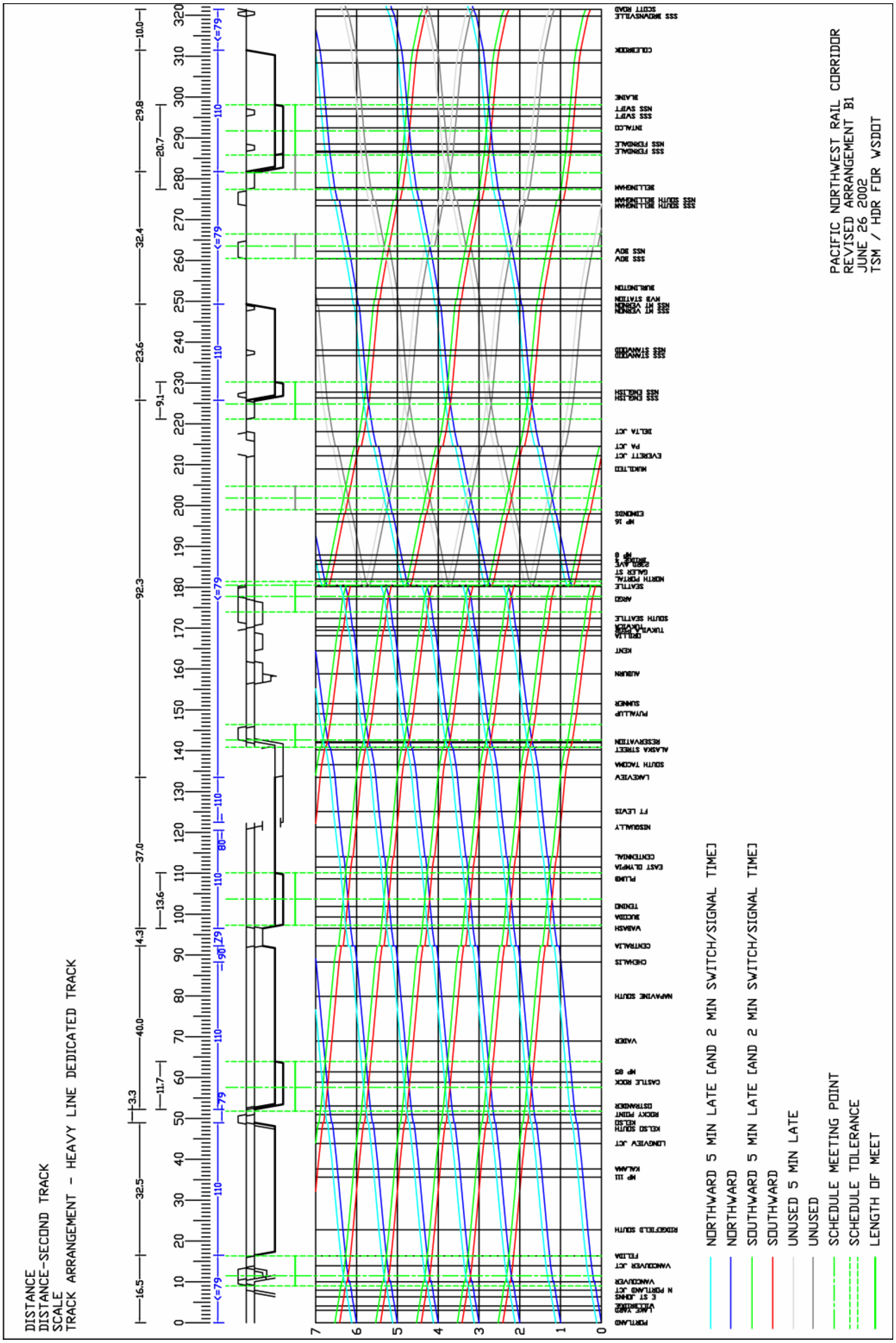
Arrangement B appears to contain the least significant difficulties of the five examined. Construction of a second high speed track between Ostrander and Vader presents problems, but none as significant as some of the problems found in the other alternatives. Seattle to Vancouver, BC service may be increased to hourly with a relatively minor infrastructure increase and schedule running time increase for trains in alternate hours. Additional work is required to develop the details leading to implementation, especially between Seattle and Vancouver, BC.

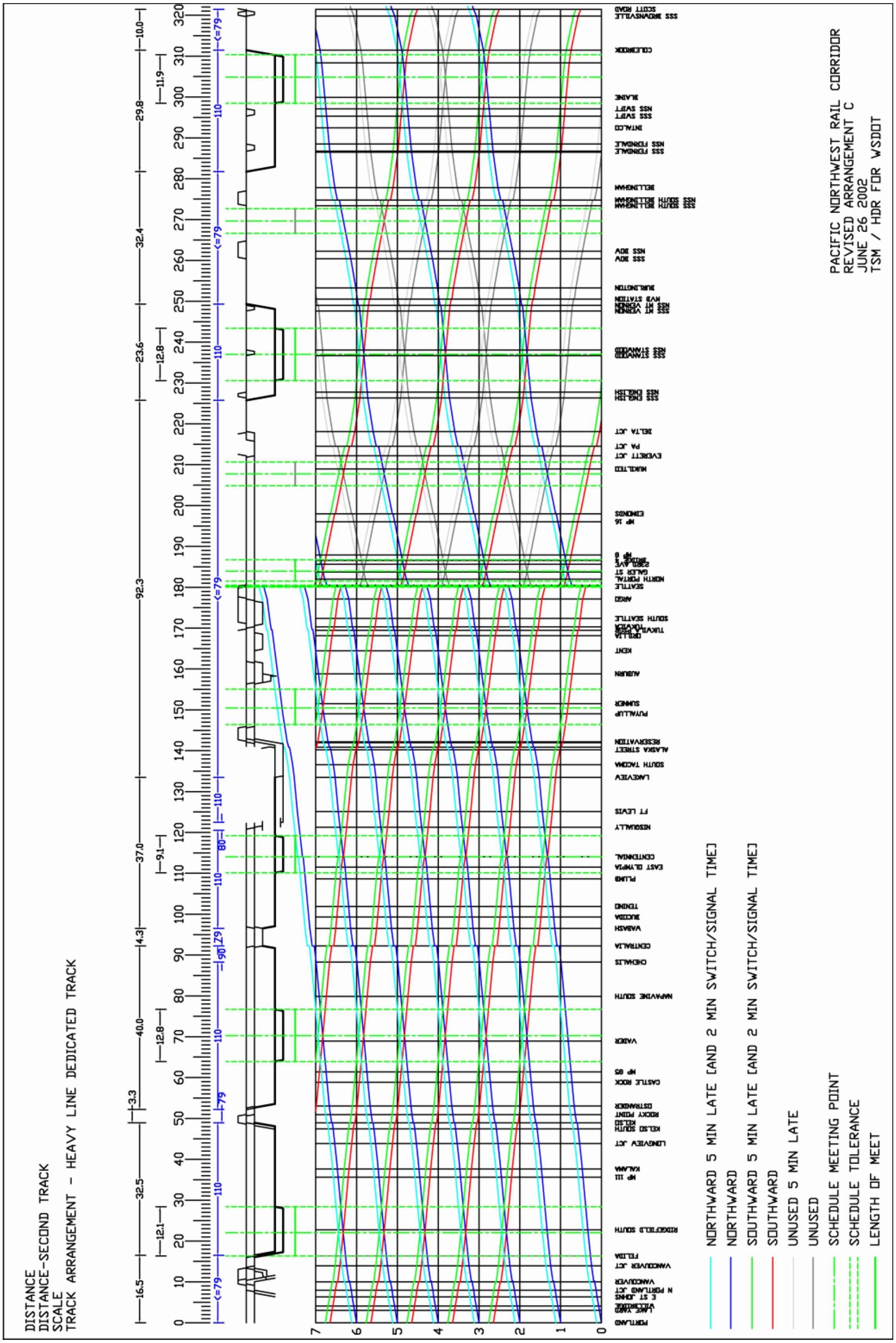
Subsequent Evaluation

Although Arrangement B provides the best track and schedule arrangement, none of the alternatives examined allow scheduled running time of less than three hours between Seattle and Vancouver, BC. Subsequent work developed additional high speed track between Burlington and Bellingham. Arrangement B2 (Page E-13) represents the track and schedule combination when this additional section of high speed track is added to the line. The difference in infrastructure between Arrangement B and Arrangement B2 lies entirely north of Burlington.

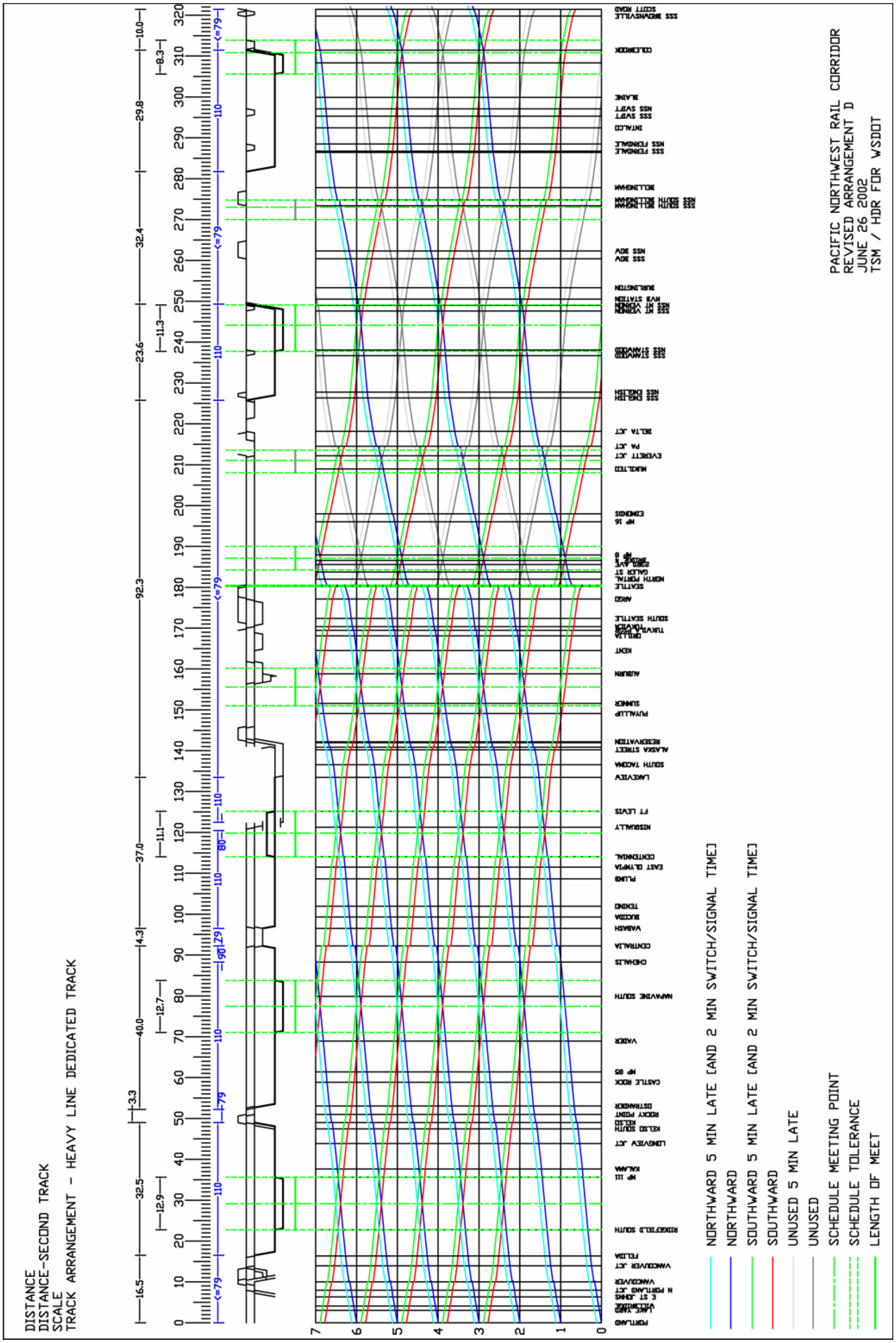

PACIFIC NORTHWEST RAIL CORRIDOR
REVISED ARRANGEMENT A
JUNE 26 2002
TSM / HDR FOR WSDOT
DISTANCE
DISTANCE-SECOND TRACK
SCALE
TRACK ARRANGEMENT - HEAVY LINE DEDICATED TRACK
NORTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
NORTHWARD
SOUTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
SOUTHWARD
UNUSED 5 MIN LATE
UNUSED
SCHEDULE MEETING POINT
SCHEDULE TOLERANCE
LENGTH OF MEET

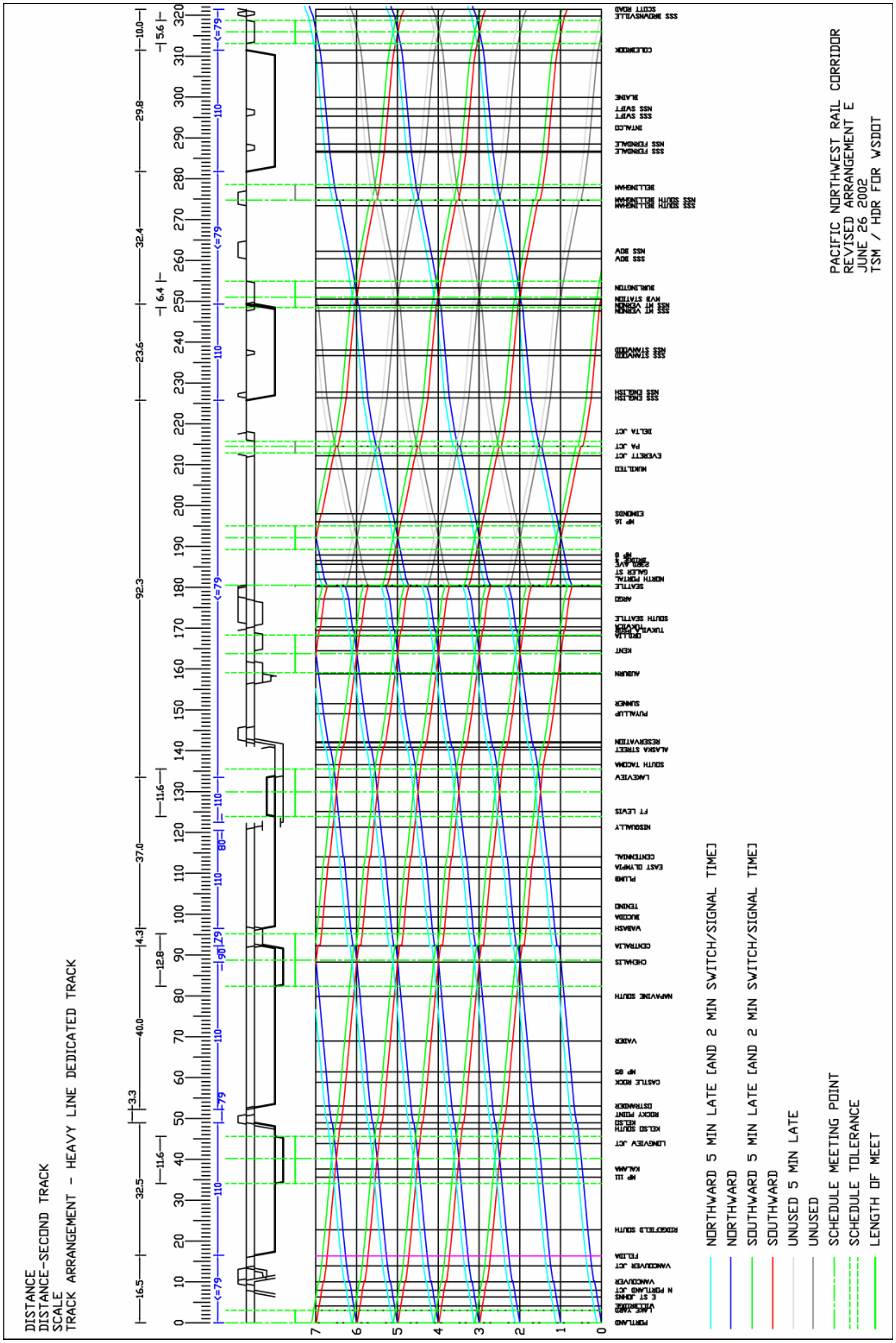

DISTANCE
DISTANCE-SECOND TRACK
SCALE
TRACK ARRANGEMENT - HEAVY LINE DEDICATED TRACK
PACIFIC NORTHWEST RAIL CORRIDOR
REVISED ARRANGEMENT B
JUNE 26 2002
TSM / HDR FOR WSDOT
NORTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
NORTHWARD
SOUTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
SOUTHWARD
UNUSED 5 MIN LATE
UNUSED
SCHEDULE MEETING POINT
SCHEDULE TOLERANCE
LENGTH OF MEET

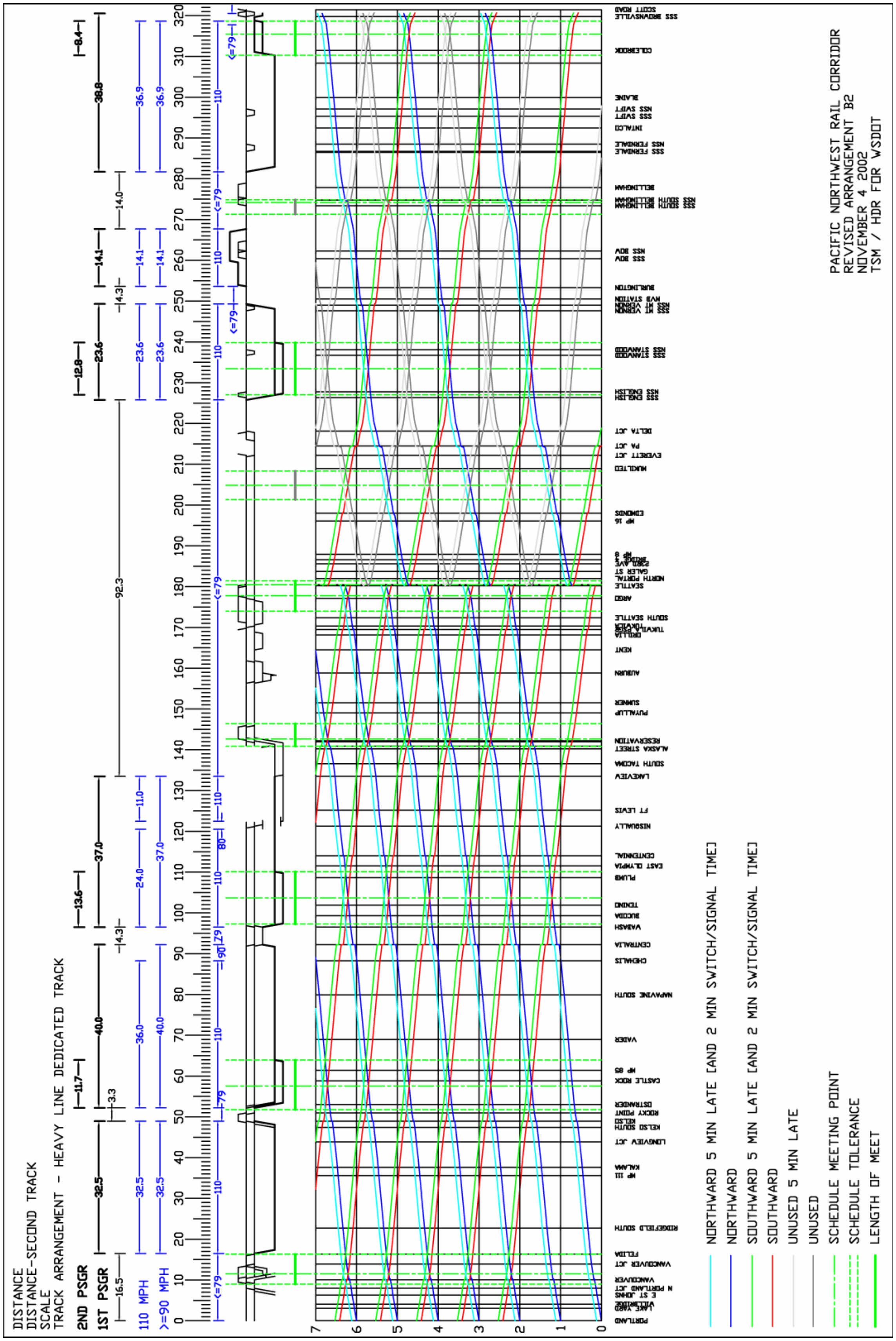

DISTANCE
DISTANCE-SECOND TRACK
SCALE
TRACK ARRANGEMENT - HEAVY LINE DEDICATED TRACK
NORTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
NORTHWARD
SOUTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
SOUTHWARD
UNUSED 5 MIN LATE
UNUSED
SCHEDULE MEETING POINT
SCHEDULE TOLERANCE
LENGTH OF MEET
PACIFIC NORTHWEST RAIL CORRIDOR
REVISED ARRANGEMENT B1
JUNE 26 2002
TSM / HDR FOR WSDOT



PACIFIC NORTHWEST RAIL CORRIDOR
REVISED ARRANGEMENT C
JUNE 26 2002
TSM / HDR FOR WSDOT
DISTANCE
DISTANCE-SECOND TRACK
SCALE
TRACK ARRANGEMENT - HEAVY LINE DEDICATED TRACK
NORTHWARD 5 MIN LATE (AND 2 MIN SWITCH/SIGNAL TIME)
NORTHWARD
SOUTHWARD 5 MIN LATE (AND 2 MIN SWITCH/SIGNAL TIME)
SOUTHWARD
UNUSED 5 MIN LATE
UNUSED
SCHEDULE MEETING POINT
SCHEDULE TOLERANCE
LENGTH OF MEET


DISTANCE
DISTANCE-SECOND TRACK
SCALE
TRACK ARRANGEMENT - HEAVY LINE DEDICATED TRACK
NORTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
NORTHWARD
SOUTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
SOUTHWARD
UNUSED 5 MIN LATE
UNUSED
SCHEDULE MEETING POINT
SCHEDULE TOLERANCE
LENGTH OF MEET
PACIFIC NORTHWEST RAIL CORRIDOR
REVISED ARRANGEMENT D
JUNE 26 2002
TSM / HDR FOR WSDOT


DISTANCE
DISTANCE-SECOND TRACK
SCALE
TRACK ARRANGEMENT - HEAVY LINE DEDICATED TRACK
NORTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
NORTHWARD
SOUTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
SOUTHWARD
UNUSED 5 MIN LATE
UNUSED
SCHEDULE MEETING POINT
SCHEDULE TOLERANCE
LENGTH OF MEET
PACIFIC NORTHWEST RAIL CORRIDOR
REVISED ARRANGEMENT E
JUNE 26 2002
TSM / HDR FOR WSDOT


DISTANCE
DISTANCE-SECOND TRACK
SCALE
TRACK ARRANGEMENT - HEAVY LINE DEDICATED TRACK
2ND PSGR
1ST PSGR
110 MPH
>=90 MPH
NORTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
NORTHWARD
SOUTHWARD 5 MIN LATE [AND 2 MIN SWITCH/SIGNAL TIME]
SOUTHWARD
UNUSED 5 MIN LATE
UNUSED
SCHEDULE MEETING POINT
SCHEDULE TOLERANCE
LENGTH OF MEET
PACIFIC NORTHWEST RAIL CORRIDOR
REVISED ARRANGEMENT B2
NOVEMBER 4 2002
TSM / HDR FOR WSDOT

Appendix F
Timetables A through F

Appendix G
Integraged Amtrak *Cascades* and *Sounder* Service

Appendix G
Integrated Amtrak *Cascades* and *Sounder* Service

It is not practical to integrate freight and Amtrak long distance passenger rail service into the Amtrak *Cascades* operating plan because of the degree of improvisation involved in the operation of each. The improvisation is accompanied, however, with a relative insensitivity to time. Integrated scheduling of Amtrak *Cascades* and *Sounder* service is essential, however. Passengers traveling the short distances of corridor and commuter service expect short schedules and a high degree of reliability. That cannot be achieved without detailed scheduling unless there is significant excess capacity. The Lakewood, WA to Everett, WA segment of the corridor, used jointly by Amtrak *Cascades* and *Sounder* service, has greater capacity than other parts of the corridor, but not sufficient capacity to forego detailed scheduling.

When there is not significant excess capacity, detailed scheduling is also essential to reliable operation among improvised traffic. If the schedules can be achieved with regularity, the operators of Amtrak *Cascades* and *Sounder* services can legitimately expect that the track will be available as defined in the schedule. If the schedules cannot be achieved as written, improvisation will eventually include Amtrak *Cascades* and *Sounder* service, with an associated decline in reliability as improvisation practices take increasing liberty with unachievable schedules.

Amtrak *Cascades* service is more capacity constrained than *Sounder* service, even at full development. Tailoring infrastructure to service minimizes the amount of construction required, but it also prevents changes in the service (other than within the designed pattern). Each service level of Amtrak *Cascades* program is designed to make the maximum use of the infrastructure that was constructed for that service level. Because there is generally little excess capacity, there is little ability to rearrange any of the schedules. The infrastructure being constructed for the implementation of *Sounder* service has comparatively greater capacity for the amount of traffic. It is generally more practical to make some arrangement in a *Sounder* schedule than in an Amtrak *Cascades* schedule, especially at the later stages of Amtrak *Cascades* development, when traffic approaches capacity. However, detailed scheduling must accommodate the commercial requirements of both services. If that is not possible, additional infrastructure must be constructed. If otherwise avoidable, infrastructure should not be constructed to accommodate only occasional conflict.

What methodology was used for this integration?

The methodology for integrating Amtrak *Cascades* and *Sounder* operating plans is more important than example schedules with all conflicts resolved. The Amtrak *Cascades* program has included extensive detailed planning. The *Sounder* program has used a more general planning process. For both programs, the plans for service involve the best current knowledge. However implementation occurs over a period of several years. Changes in train equipment, infrastructure, or commercial needs may cause modification to Amtrak *Cascades* or *Sounder* schedules. The commercial requirement for commuter service may be less predictable than the commercial requirement for long distance passenger rail service. As the commercial requirement becomes better understood through operations, *Sounder* schedules may change.

To accommodate both programs, detailed scheduling is required. Detailed scheduling determines: day of operation; the exact route through the network; and times at stations.

The schedule is a track allocation plan. Among scheduled trains, it is a guarantee that no train will need any segment of track simultaneously with another train during normal operation. When a scheduled train is operating among improvised trains, the schedule is essentially a reservation for specific trackage at specific times. The allocation extends to the signal headway ahead of each train that is required for normal speed operation.

The process must consider:

- details of the track arrangement;
- details of the signal system;
- speed limits;
- number and specific types of locomotives and cars assigned to each train;
- calculated or accurately timed running times between signals, interlockings, and stations;
- required amount of dwell for each station;
- train equipment assignments, crew assignments, and required turnaround times at terminals; and
- any other predictable event that requires time.

Recovery time amount and method (incremented or final station) should be determined carefully to avoid waiting for time at stations or causing traffic problems in terminals because of early arrival. Recovery time should be used only for events that cannot be predicted. Buffer time should be included to prevent the transmission of small delays from one train to another.

Schedules can be constructed manually or using scheduling software. Manual scheduling will become impractical as the passenger traffic increases. Scheduling software should be selected carefully to ensure that all of the required elements are considered.

For the Amtrak *Cascades* operating plan, there was one abridgement in the scheduling method. Blocking times were not calculated and signaling was not considered in detail. The details of the signal system are not as important in devising the Amtrak *Cascades* operating plan as they are to integrating Amtrak *Cascades* and *Sounder* service. The Amtrak *Cascades* operating plan does not involve closely following movements. The signal system is generally important to Amtrak *Cascades* schedules only at single track meeting points. Because the infrastructure is being designed to the service, signal system design will be dependent on the service plan instead of vice versa. The signal system between Lakewood and Everett is not being tailored to the service plan; however, the final signal system arrangement is not yet available. The discussion schedules assume that the signal headway for a Amtrak *Cascades* or *Sounder* train is five minutes, which simulates a four aspect signal system with approximately one mile blocks and one minute for engineer sight and reaction time. When schedules are designed for implementation, the process should include detailed consideration of the infrastructure.

How should the schedules be implemented?

The method of schedule integration of Amtrak *Cascades*, *Sounder*, and long distance passenger rail service has thus far been informal. As development of the Pacific Northwest Rail Corridor (PNWRC) and Sound Transit programs continues, integration of operation will become increasingly important.

A single office will be responsible for integration of Amtrak *Cascades* and *Sounder* schedules whenever changes to either is necessary, whether for additional service, temporary extra service, or adjustment to existing service. Detailed operating schedules will be submitted to Burlington Northern and Santa Fe Railway Company (BNSF) for implementation.

How do long distance passenger trains relate to this integration?

The Amtrak long distance service has not been included in the integration of *Sounder* and Amtrak *Cascades* service. Long distance service is not predictable partially because the schedules are constructed to accommodate the commercial requirements of a long route. They are subject to change because of requirements at distant places. Also, long distance passenger trains often do not adhere reliably to the schedule.

There is sufficient flexibility in long distance train scheduling and operation, and in the infrastructure constructed for Amtrak *Cascades* and *Sounder* service, that the long distance service may be readily adapted to the requirements of the Amtrak *Cascades* and *Sounder* services. Schedule revisions should, however, be integrated with Amtrak *Cascades* and *Sounder* schedules to ensure that it is possible to operate the long distance trains on time without conflicting with the schedules of Amtrak *Cascades* and *Sounder* trains.

How will train operations be handled at King Street Station?

The arrangement of tracks at the south end of King Street Station does not allow the simultaneous movement of two trains between the main tracks and the platform tracks. Five minutes must separate the arriving and leaving times of opposing trains.

The recovery time in northward Amtrak *Cascades* and *Sounder* schedules is applied to the arrival at Seattle. Thus, a northward train that is not delayed will arrive before the schedule arrival time. In some cases, a southward train leaves between the arrival and schedule arrival of a northward train. The practice of improvised operation will often allow the arriving train to delay the leaving train in this situation, because it arrived "first." For scheduled operation, the leaving train must not be prevented from leaving on time because of an arriving train arriving early. If it is available, the conflict may be avoided by operating the northward train on Main One, a track intended for freight operation, north of Spokane Street. Main One should not be used for this movement if it is needed for freight traffic.

The arrangement of King Street Station that is proposed for Amtrak *Cascades* Timetables D, E, and F eliminates this constraint.

Is Amtrak *Cascades* service related to Sound Transit construction projects?

The Amtrak *Cascades* program has seven service levels including the current timetable. The ensuing six are labeled A through F in the operating plan. Sound Transit has three service levels including the current timetable. The current level is Phase 1. The ensuing two are known as Phase 2 and Phase 3. The Amtrak *Cascades* service cannot move from the current schedule to the next level of service, Timetable A in the operating plan, until the construction required for Sound Transit Phase Two is complete. Timetable B in the Amtrak *Cascades* operating plan may also be implemented in conjunction with Sound Transit Phase 2 construction. All of the remaining levels of Amtrak *Cascades* service, Timetables C through F in the operating plan, require that the completion of construction for Sound Transit Phase Three. Implementation of Amtrak *Cascades* Timetable D, E, and F requires the King Street Station changes proposed in the operating plan. Thus, the plan for integration of the *Sounder* and Amtrak *Cascades* service considers Sound Transit Phase 2 with Amtrak *Cascades* Timetables A and B, Sound Transit Phase 3 with Amtrak *Cascades* Timetable C, and Sound Transit Phase 3 plus the King Street Station changes for Timetables D through F in the operating plan.

Where are the potential conflicts between the two services?

The discussion of each Amtrak *Cascades* timetable describes conflicts between Amtrak *Cascades* and *Sounder* trains, or between *Sounder* trains. The relationship among the Amtrak *Cascades* schedules is generally dictated by infrastructure limitations. In some cases, changes to the schedules of individual Amtrak *Cascades* trains to resolve the conflict are possible. In some cases, changes in Amtrak *Cascades* operation are not; especially in timetables C through F. The entire pattern of Amtrak *Cascades* trains may be moved ahead or back in time as allowed by commercial requirements of the service, however.

The final decision on resolution of most of the conflicts involves information that is not currently available. Changes in the Amtrak *Cascades* operating plan or *Sounder* schedules have not been made in the example timetables or the Amtrak *Cascades* crew and equipment plans. Instead, the available avenues of conflict resolution are discussed for each case to demonstrate the required process. Determination of the conflict resolution to be implemented will depend upon conditions in effect at the time of implementation.

Timetable A (Pages G-27 - G-28)

Train 101 conflicts with the arrival, but not the schedule arriving time, of Train 1506. Train 1506 arriving early must not prevent Train 101 from leaving on time. (Page G-29)

Train 107 overtakes Train 1519 at Sumner. No operating or commercial reason would prevent Train 107 from being set back five minutes to eliminate this conflict. (Page G-30)

Timetable B (Pages G-31 - G-32)

Train 101 overtakes Train 1505 at Puyallup. There are two alternatives for handling this conflict. There is sufficient time in the crew and equipment rotation to set back Train 101 by five minutes. Alternatively, Train 1505 may be set ahead by five minutes to eliminate the conflict. (Page G33)

Train 103 conflicts with the arrival, but not the schedule arriving time, of Train 1522. Train 1522 arriving early must not prevent Train 103 from leaving on time. (Page G-34)

Train 1513 conflicts with the arrival, but not the schedule arriving time, of Train 108. Train 108 arriving early must not prevent Train 1522 from leaving on time. (Page G-35)

Train 1521 conflicts with the arrival, but not the schedule arriving time, of Train 1520. Train 1520 arriving early must not prevent Train 1521 from leaving on time. (Page G-36)

Train 107 overtakes Train 1519 at Sumner. There is no operating or commercial requirement that would present prevent Train 107 from being set back five minutes to eliminate this conflict. The crew of train 107 has a twelve hour and fifty-five minute workday including a five hour fifteen minute release in Seattle, however. The release can be extended to accommodate setting Train 107 back, but any extension of the workday for this crew is not desirable. The crew for Train 107 arrives on Train 106, which leaves Portland at 08:45 after arrival from Eugene (assuming service from Eugene continues). Train 106 may be set back five minutes from Eugene or Portland to offset the later leaving time of train 107. (Page G-37)

Train 1523 conflicts with the arrival, but not the schedule arriving time, of Train 110. Train 110 arriving early must not prevent Train 1523 from leaving on time. (Page G-38)

Timetable C (Pages G-39 – G-41)

Train 101 overtakes Train 1501 at Lakeview. Were Train 1501 not meeting Train 1508 at Lakeview, there would be no conflict, however, neither Train 1508 nor Train 1501 has time to clear Train 101. Adjusting Train 101 is not practical because of several secondary conflicts that would be created. The conflict may be eliminated by setting train 1508 ahead five minutes, setting Train 1501 ahead ten minutes (to allow making the station stop then moving to clear in the layover yard), or turning train 1501 back as train 1508. (Page G-42)

Train 1505 conflicts with the arrival, but not the schedule arriving time, of Train 1506. Train 1506 arriving early must not prevent Train 1505 from leaving on time. (Page G-43)

Train 103 conflicts with the arrival, but not the schedule arriving time, of Train 1508. Train 1508 arriving early must not prevent Train 103 from leaving on time. (Page G-44)

Train 1507 conflicts with the arrival, but not the schedule arriving time, of Train 104. Train 104 arriving early must not prevent Train 1507 from leaving on time. (Page G-44)

Train 113 conflicts with the arrival, but not the schedule arriving time, of Train 1518, however, Train 1515 conflicts with the schedule arriving time of train 1518. The conflicts may be eliminated by setting Train 1518 ahead eight minutes or setting train 1515 back two minutes. If the conflict is resolved by setting train 1515 back, then Train 1518 arriving early must not prevent train 113 from leaving on time. (Page G-45)

Train 1519 conflicts with the arrival, but not the schedule arriving time, of Train 112. Train 112 arriving early must not prevent Train 1519 from leaving on time. (Page G-46)

Train 1521 conflicts with the arrival, but not the schedule arriving time, of Train 1522. Train 1522 arriving early must not prevent Train 1521 from leaving on time. (Page G-46)

Train 1529 conflicts with the arrival, but not the schedule arriving time, of Train 118. Train 118 arriving early must not prevent Train 1529 from leaving on time. (Page G-47)

Timetable D (Pages G-48 – G-50)

The large number of secondary conflicts that would be generated by changing *Cascades* schedules makes adjusting Amtrak *Cascades* schedules to eliminate Amtrak *Cascades-Sounder* conflicts impractical.

Train 101 overtakes Train 1503 at Auburn. Train 1503 can use Main One and Train 101 Main Two at Thomas, with Train 1503 following Train 101 from Ellingson. Train 1503 will wait for Train 101 at Ellingson about two minutes and will have additional Seattle-Lakeview running time of four minutes. (Page G-51)

Train 102 overtakes Train 2504 immediately on leaving Seattle. Train 2504 must be set ahead eight minutes or back five minutes to eliminate the conflict. (Page G-52)

Train 104 overtakes Train 1508 at Sumner. If Train 1508 is set ahead two minutes, train 104 will overtake it at Ellingson. Train 1508 can use Main Three and Train 104 Main Two to pass between Ellingson and Thomas. Train 1508 will wait for Train 104 at Thomas about four minutes and will have additional Seattle-Lakeview running time of six minutes. (Page G-53)

Train 112 overtakes train 1516 between Sumner and Ellingson. If 1516 is set ahead one minute, it can use Main three between Ellingson and Thomas and 112 Main Two to pass between Ellingson and Thomas. Train 1516 will wait for Train 112 at Thomas about four minutes and will have additional Seattle-Lakeview running time of six minutes. (Page G-54)

Train 119 overtakes train 1525 between South Sumner and Puyallup. Train 1525 must be set ahead four minutes to eliminate the conflict. Train 1525 meets Train 120 and Train 1526 between Reservation and Alaska Street, then runs on Main Two between Alaska Street and Lakeview. (Page G-556)

Timetable E (Pages G-56 – G-58)

The large number of secondary conflicts that would be generated by changing *Cascades* schedules makes adjusting Amtrak *Cascades* schedules to eliminate Amtrak *Cascades* and *Sounder* conflicts impractical.

Train 113 overtakes Train 1511 immediately upon leaving Seattle. Train 1511 may be set back eight minutes to eliminate the conflict, or may be set ahead five minutes to be overtaken by Train 113 between Thomas and Ellingson. Train 1511 would use Main One and Train 113 would use Main Two at Thomas. Train 1511 will wait for Train 113 at Ellingson about four minutes and will have additional Seattle to Lakeview running time of six minutes. (Page G-59)

Train 117 and Train 1515 leave Seattle at the same time. Train 1515 must be set back three minutes to avoid conflict. (Page G-60)

Train 119 overtakes Train 1517 at Lakeview. Were Train 1517 not meeting Train 1522 at Lakeview, there would be no conflict, however, neither Train 1522 nor Train 1517 has time to clear Train 119. The conflict may be eliminated by setting train 1522 ahead five minutes, setting Train 1517 ahead ten minutes (to allow making the station stop then moving to clear in the layover yard), or turning Train 1517 back as Train 1522. (Page G-60)

Train 121 overtakes Train 1521 at Lakeview. Were Train 1521 not meeting Train 1524 at Lakeview, there would be no conflict, however, neither Train 1524 nor Train 1521 has time to clear Train 121. The conflict may be eliminated by setting Train 1524 ahead five minutes, setting Train 1521 ahead ten minutes (to allow making the station stop then moving to clear in the layover yard), or turning Train 1521 back as Train 1524. (Page G-61)

Train 123 overtakes Train 1525 at Argo. Train 1525 may be set back eight minutes to eliminate the conflict, or be set ahead five minutes to be overtaken by Train 123 between Thomas and Ellingson. Train 1525 would use Main One and Train 123 would use Main Two at Thomas. Train 1525 will wait for Train 123 at Thomas about four minutes and will have additional Seattle-Lakeview running time of six minutes. (Page G-62)

Timetable F (Pages G-63 – G-65)

The large number of secondary conflicts that would be generated by changing *Cascades* schedules makes adjusting Amtrak *Cascades* schedules to eliminate Amtrak *Cascades* and *Sounder* conflicts impractical.

Train 113 overtakes Train 1511 at South Tacoma. Train 1511 can use Main Two between Alaska Street and Lakewood to eliminate this conflict. (Page G-66)

Train 119 overtakes Train 1517 at Kent. The conflict can be eliminated by setting Train 1517 ahead two minutes, allowing Train 113 to pass on Main Two between Thomas and Auburn while Train 1517 uses Main one. Train 1517 will wait for Train 119 at Ellingson about two minutes and will have additional Seattle-Lakeview running time of four minutes. (Page G-67)

Train 121 overtakes Train 1521 at Kent. The conflict can be eliminated by setting Train 1521 ahead two minutes, allowing Train 121 to pass on Main Two between Thomas and Auburn while Train 1521 uses Main One. Train 1521 will wait for Train 121 at Ellingson about two minutes and will have additional Seattle to Lakeview running time of four minutes. (Page G-68)

Train 118 overtakes Train 2518 between Mukilteo and Howarth Park. Train 2518 must be set ahead two minutes to eliminate the conflict. (Page G-69)

This page intentionally left blank

Integrated Amtrak *Cascades* and Other Transit Service

The Amtrak *Cascades* program is not intended to be a stand-alone transportation mode. It is a component of a balanced and integrated transportation system. At least one end of any trip is probably not within walking distance of the train station. Therefore, mode change is a significant consideration. Mode change, and as well connections between vehicles in the same mode, must be convenient and easy to understand for a public transportation mode to have significant value.

Connections between Amtrak *Cascades* service and automobile transportation, whether privately owned or rental, are relatively easy to arrange provided that sufficient land is available for automobile storage. Any passenger that uses an automobile at one end of the trip will probably still require a connection at the other, whether the connection is another automobile or public transportation. Also, automobile use at either end of the trip may include a remote parking area such as a Park & Ride facility and public transit. Thus, convenient and easy to understand connections are important even to passengers using an automobile. The availability of Park & Ride lots and convenient public transit from the Park & Ride lots or typical passenger origin or destination points also helps to limit the amount of land that must be dedicated to automobile storage at the railroad stations.

Public transportation connections are not as easy to arrange as automobile connections. The availability of public transportation connections, whether fixed-route like buses or on-call like taxicabs, is dependent upon many more factors than train arrival and departure time. Vehicle and driver availability and utilization and connections among the transit company routes may make establishing connections difficult if the station is not on a main transit route or, in the case of on-call services, does not consistently generate connecting passengers.

In Seattle, frequent bus service adjacent to King Street Station predates Amtrak *Cascades* service. Since the beginning of the Amtrak *Cascades* service, other cities along the line have begun to coordinate local transit service with Amtrak *Cascades* service by constructing transit centers at or adjacent to stations or routing major transit bus routes on streets adjacent to stations.

It is not practical to adjust train schedules for local transit services because of the many infrastructure constraints that limit train schedules and the diverse requirements of the transit systems; however it is possible to provide the consistent headway and reliability that is needed for coordination with local transit services. The early stages of the Amtrak *Cascades* program do not have the service frequency that facilitates local transit connections. The transit agencies are providing service to all stations on the line, generally with headway of one hour or less, making connections at any station possible if not always convenient. Sounder commuter trains do not operate as frequently as the other transit services, but there are already some connections between Sounder and Amtrak Cascades service that virtually extend Amtrak Cascades service to Sounder stations. One of the long-term goals of the program is integration with local transit services by providing the needed frequency and reliability for coordinated service.

The schedules of Timetable F (full development of the Amtrak *Cascades* program) make a “clockface” or “memory” timetable, also known as a fixed-interval timetable. Each train operates at the same minute of the hour from any station. For example, each *Cascades* train leaving Seattle for Portland leaves at six minutes after the hour. Clockface timetables have been used in Europe for over thirty years. Switzerland has just completed a twenty year program that established clockface timetables for all passenger services in the country and integrated them, constructing infrastructure as necessary to support the concept. The integration provides planned and easy to use connections among all of the routes and services. The Amtrak *Cascades* program is similar in principle to the Swiss program.

Clockface timetables have several advantages.

- Passengers don’t need to consult a timetable for every trip. This is not entirely true for the Amtrak *Cascades* service represented in Timetable F because, as a matter of potential economy, there are two of the one hour intervals in each direction that do not have service.
- “Practice makes perfect” applies to railroad employees as well as to musicians and athletes. When the required resources must be available at the same time every hour and the required actions must be performed at the same time every hour, correct handling of a train becomes habit and is not subject to being overlooked. This is especially important when operating on the lines of a freight railroad. Freight trains do not operate on detailed schedules that remain in effect for extended periods of time. To a great extent, freight operation is improvised as conditions, including the transportation requirements of customers, change. A consistent clockface timetable of passenger service provides a framework around which freight service can be improvised and helps to ensure that a passenger train will not be overlooked.
- A clockface timetable reduces the infrastructure requirements. When passenger trains operate at fixed intervals, infrastructure required for their operation can be limited to the areas of need. For example, the Amtrak *Cascades* program requires an extensive amount of third main track. Some of this track is intended specifically for high speed operation, other sections of third track are located in congested areas through which the Amtrak *Cascades* trains operate at conventional train speed. In all cases, the third track maintains BNSF’s level of utility by maintaining two main tracks free at almost any location along the line regardless of the increased

number of passenger trains. Where the third track is a high speed track, the higher speed is needed in order to achieve the desired schedule running time. Where Amtrak *Cascades* trains moving in opposite directions meet, a second high speed track is needed so that both trains can achieve the goal schedule running time. Infrastructure constructed to the requirements of a clockface timetable has twenty-five miles of second high speed track between Portland and Seattle. Infrastructure constructed to allow the goal schedule running time at any desired time would have 109 miles of second high speed track. The additional cost between Seattle and Portland would be more than $240 million. It is also likely that an additional 65 miles of conventional-speed track would be required between Portland and Seattle because the clockface schedules are designed to avoid having two Amtrak *Cascades* in one of these congested areas at the same time. The additional conventional-speed track would increase the cost by more than $183 million above the cost of the additional high speed track, for an increase of about $423 million.

- Infrequent train service at inconsistent intervals is not conducive to connections with other public transit modes. Clockface schedules simplify integration with other transportation modes. Most of the transit agencies connecting with Amtrak *Cascades* service already use clockface schedules. An important characteristic of a network of clockface schedules is that an entire local network of schedules can be shifted in time as needed without need to rework all of the schedules to retain or establish connections. Thus, if connections with Amtrak *Cascades* service are better suited to a departure at quarter past the hour instead of on the hour, the adjustment can be made easily.

This page intentionally left blank

Integrated Amtrak *Cascades* and Freight Movement

This appendix addresses the effect of the Amtrak Cascades Program on the mobility of freight rail. This paper was written as a supplement to the information provided in Appendix G: Amtrak Cascades/Sounder Integration.[1] In essence, it is not anticipated that the Amtrak Cascades Program will negatively impact freight mobility. Assessing the potential impact of implementing passenger rail on freight lines is important, given the current state of at-capacity freight corridors in the U.S. today. This motivation is backed by the policies of the FRA, the BNSF, and the WSDOT, and all three agencies have mechanisms to ensure that potential impacts are minimal or none. There are both a technical analysis that is used to evaluate the potential impact, as well as the environmental process required by SEPA and NEPA. In addition, the Amtrak Cascades Program includes numerous improvements to the corridor that will enhance rail operations, for both freight and passenger rail. Given these "safety valve" measures of oversight of potential impacts and the proposed infrastructure improvements, it is not anticipated that any negative impact would occur to freight mobility. In fact, there is the potential for freight mobility to be improved. The potential for reduction to truck traffic on the highways is also discussed. All of these issues are presented in more detail in this White Paper.

Why Assess the Potential Impact on Freight Mobility?

Freight traffic has increased dramatically over the last decade and a half and is projected to continue to increase well into the future (Pages G-70 – G-78); therefore, it is important to assess the potential impact of any project that could affect capacity and operations. The Burlington Northern Santa Fe (BNSF) corridor that would be used by the Amtrak Cascades service was similar to that of railroads throughout the US. In the early 1990s, the effect of long heavy freight trains operating on the infrastructure of the 1960s was beginning to become apparent. Freight train delays were increasing as the freight traffic consumed the available capacity. The effects of constrained capacity were offset by rail industry concentration on high-weight, high-volume, non-time-sensitive freight traffic for which the increasing delays were of little consequence. During the 1990s, rail freight traffic grew to almost fill all available capacity. Therefore, any addition of rail traffic to at-capacity corridors potentially affects the ability of the freight operators to move goods.

Given the capacity issues facing the freight rail industry, the Federal Railroad Administration (FRA) and the Burlington Northern Santa Fe (BNSF), as well as the Washington State Department of Transportation (WSDOT), have measures in place to ensure that impacts to the freight mobility are not adverse. The FRA will not allow federal railroad funds to be spent on rail projects that are

[1] *The Sounder program is subject to the same policies as the Amtrak Cascades program.*

detrimental to rail freight service or that will diminish rail safety. For projects that will not involve the use of federal railroad funds, FRA will most often be involved during the environmental review comment period, particularly if the proposed project could potentially negatively affect railroad freight operation.

The BNSF, too, has strong interest in ensuring that there are no negative impacts to freight mobility. The BNSF Chairman and CEO Rob Krebs outlined the company's policy on passenger service being added to freight through the following ten principles he called the "ten commandments"[2]:

1) No Amtrak service change should degrade BNSF's service to freight customers.
2) BNSF must be compensated for costs associated with service changes and increased track speeds. ("The relationship must be based on a commercial footing.")
3) Capital investments necessary for Amtrak service additions or changes are Amtrak's responsibility. ("Although our freight service is becoming more like passenger service, the discipline is tighter for passenger service and the redundancy in the physical plant must be greater.")
4) Actual operating conditions and costs must be considered in Amtrak service studies. ("Construction costs must reflect our actual labor contract costs.")
5) Projected freight growth must also be considered in Amtrak service studies.
6) BNSF must not incur a higher tax burden for Amtrak investments.
7) BNSF must retain operating control of its rail facilities, dispatching, maintenance, and construction.
8) Grade crossing warning devices and fencing must be included in financed improvements.
9) Service changes involving additional mail and express cars will be negotiated separately.
10) Additional BNSF property needed for Amtrak intercity services may be handled under separate lease (rather than handled as an amendment to an existing contract).

Therefore, the BNSF will scrutinize any project that is proposed to add traffic on their rail lines.

Finally, the WSDOT rail office has staff dedicated to passenger/public transport and to freight transportation. Improving railroad passenger service at the expense

[2] Speech at the Passenger Trains of Freight Railroads conference, Washington DC October 2000

of railroad freight service is contrary to the best interest of the state and the policy of the department and the legislature. The potential effects of any program on rail mobility are evaluated by WSDOT through the NEPA environmental process (see Amtrak Cascades Environmental Overview, Volume 6).

BNSF has a staff of experts on railroad engineering and on railroad capacity, traffic management, and train scheduling. WSDOT maintains an available staff of railroad engineering and operations consultants with similar expertise. Although BNSF operates several passenger services on its system, the design of new passenger service, especially an incrementally developed high speed service, is a specialty that is not within its customary realm of activity. The design of the operation and a significant part of the design of the infrastructure is handled by WSDOT. The BNSF staff ensures that nothing in this part of the program will have a negative effect on freight service. The remaining design, generally involving the operation and infrastructure needed for a high volume of freight and passenger traffic, is a collaborative effort of BNSF and WSDOT. Each party contributes ideas and testing and ensures that the result meets its requirements.

The completed work undergoes a double-check and a triple-check. NEPA requires public comment to environmental documents and appropriate response by the project proposer. Any affected party, including railroad customers and the host railroad, may comment on or object to all or part of a project or program. Thus if the railroad or its customers felt that the proposed project had an adverse effect, the objection would be recorded and an appropriate response required. Ultimately, failure to address the comment or objection could result in the denial of a permit to continue with the project.

The triple-check is the authority of the Federal Railroad Administration to comment or object in response to the environmental document. FRA maintains a staff of expert railroad engineers and experts on railroad capacity, traffic management, and operations and also maintains an available staff of consultants with similar expertise.

Can Passenger Trains Operate on Freight Railroads Without Adverse Impact?

“Freight railroad” is a relatively recent term generally applicable only in North America. It describes business goals more than railroad technology. Before 1971, there were “railroads” in the US, not “freight railroads”. There was no Amtrak and there were no government agencies operating commuter train service. The railroads operated freight and passenger service. The federal government required the railroads to provide passenger service as a condition of common carrier status. In 1971, political and economic conditions led to the establishment of Amtrak, relieving the railroads of the responsibility of maintaining passenger service.

A similar combination of politics, national policy, and economics is responsible for high-value freight and many just in time shipments moving by truck rather than rail. This type of freight requires an arrangement of infrastructure and method of operation similar to that required for passenger trains. The existing combination of politics, policy, and economics favors rail transportation of freight as wholesale rather than retail service. This type of service typically involves operating the smallest possible number of trains, each with the greatest possible number of cars, each car carrying the greatest possible weight. It also involves operating trains as determined by the economics of the individual train rather than on a fixed schedule. The railroad corporations own the property, so lines that were not required to remain suitable for passenger service at the formation of Amtrak were gradually changed in configuration to that most suited to wholesale freight service, were sold as shortlines, or were abandoned. On the lines that retained passenger service, the contracts between Amtrak and the railroads effectively required maintenance of conditions as they were in 1971, maintaining the designated level of utility for the passenger service. The result is a railroad network that is configured for infrequent slow heavy trains or configured for a mixture of freight and passenger services of the 1950s or 1960s.

Rail technology doesn't preclude the shared use of a railroad by passenger trains and freight trains. The North American implementations of rail technology in the last 50 years makes shared use appear impossible, however. Information developed in the analysis of current infrastructure and operation leads to the appropriate infrastructure arrangement.

What is the Process for Assessment of the Potential Impact?

In addition to the environmental assessment, the effect of the passenger service on the freight service is determined by comparing the performance characteristics of the current operation with the performance characteristics of the proposed operation. There are four important steps:

- First, determine the performance of the freight service under the current infrastructure and Operation;
- Second, project the traffic volume at the completion of the program.
- Third, determine the infrastructure needed to produce the desired passenger performance and the desired freight performance at the projected traffic volume; and
- Fourth, conduct a program of testing and analysis to make sure that the infrastructure program will produce the expected results. If it does not, the third step must be repeated.

Determine Performance of Freight Service under Current Infrastructure and Operation

Before the effect of the passenger program on freight operation can be determined and appropriate infrastructure can be designed, the current infrastructure and operation must be understood in detail. The detailed information needed includes when trains are operated, why they are operated at the specified times, how they are processed in terminals, how and when freight customers are handled at intermediate points, the reason for speed restrictions, the reason capacity limiting infrastructure was constructed in that manner, why capacity limiting infrastructure has not been changed, and known geological or weather related conditions that affect train operation.

Projection of Future Traffic

The same methods were applied to projected traffic as a test of the proposed infrastructure. The quality of the operation should not deteriorate over the life of the program. Freight traffic was projected and validated in several ways including

- traffic projections produced by the railroads,
- traffic projections produced by the port authorities along the corridor,
- general economic forecasts for the region.

Attention was given to pending land use changes, such as proposed areas of industrial development, as well.

A projection of a percentage increase in traffic volume does not necessarily mean a similar growth in the number of trains. The number of trains can be affected by whether the current trains are generally loaded to the length or tonnage limit, new types of cars that allow heavier loads per car, infrastructure that allows longer trains, locomotives that allow heavier trains, and shipping containers that have greater volume than the heretofore standard sizes. Traffic for each commodity type was considered individually. The size of existing trains was increased with a portion of the projected growth traffic where appropriate.

Traffic was projected for program completion. The same methodology was used to project traffic for a time thirty years hence. The infrastructure and operating plan was tested thoroughly for the traffic volume at program completion. It was informally tested for the traffic volume of a time thirty years hence to observe the robustness of the arrangement.

Analysis of Infrastructure and Operation

Analytical Methods

Railroad capacity can be determined by the use of analytical methods on individual elements of the network. In a simplified example, a rail line with a signal system that allows trains to operate on a four mile headway at sixty mph can accommodate one train of one mile length every five minutes. A junction with a thirty mph speed limit can accommodate one train every six minutes. A bridge with a ten mph speed limit can accommodate one train every nine minutes. All of the trackage over which the proposed passenger service will operate and the trackage connecting to that route is evaluated in this manner.

Hose Analysis

A rail line is a complex arrangement of many segments that have a range of capacities.

It is similar to a length of hose made up of sections of different diameters. No more water will pass through the hose than can pass through the smallest diameter part of the hose. The analysis of the infrastructure generates a list of segments of the line with varying capacity. If the example hose has sections of one inch, two inch, and three inch diameter, replacing part of the one inch sections with two inch or three inch sections will not increase the capacity of the hose. If the capacity of the hose is to be increased, all of the one inch segments must be identified and replaced with larger diameter sections of hose.

When the small diameter hose is replaced, the goal capacity of the hose will determine the size of the replacement sections. If the volume than can be produced by a two inch diameter hose is the goal, the one inch diameter sections are replaced by two inch diameter sections. If a larger amount is the goal volume, the one inch sections are replaced by segments of the diameter required to support the desired volume so that the new sections will not become obsolete before the hose improvement is complete. These larger diameter sections will have no effect on the capacity of the hose until there are no remaining sections that are of a smaller diameter.

The same method applies to the rail line. The list of segments of the line and their capacities is examined to determine the changes required to produce the desired capacity.

Simulation

Simulation (also known as modeling) is a commonly used tool for infrastructure and operations analysis. Simulation generally refers to the use of computer software, but the processes conducted by the software may be conducted partially or entirely manually in simple cases.

The simulation input data consists generally of:

- A description of the trackage on the line being evaluated (e.g., an origin point from which all distances are measured, the location of switch points, signals, speed limit changes, and the location and elevation of points at which the gradient changes),
- A description of the rules governing train movement (e.g., special speed limits, prohibition of certain types of trains from individual tracks, direction of traffic, and control of switches),
- A description of the trains to be operated (e.g., locomotive weight and tractive effort, weight and length of the cars in the train, braking characteristics, and aerodynamic characteristics of the locomotive and train),
- A schedule of trains to be operated (e.g., origin track, destination track, tracks to be used at intermediate stations, leaving times, and dwell times).

The simulation software has two major components: the train simulation and the dispatching simulation. The train simulation calculates the location of each train frequently (generally once per simulated second) using an equation that compares propulsive forces (e.g., locomotive power, momentum, gravity) to resistive forces (e.g., friction, braking, gravity, aerodynamic resistance, inertia). The result of the calculation is the speed and distance traveled during the time since the last calculation. The speed and location is recorded for display on a time/distance diagram or a diagram of the track arrangement. They are also recorded in a data file for subsequent analysis.

Replicating the movement of the trains is only one important function of the simulation. Since trains must remain on a track and only change routes at switches, the simulation must determine in advance that no train is using any segment of the track at the same time as another. If that situation occurs, it must provide a realistic alternative. The dispatching simulation of the software attempts to duplicate decisions that would be made by train dispatchers and traffic planners. It detects route conflicts among the trains, and reroutes and/or stops trains as needed to avoid the conflicts. The route taken by the train and its movement along the route are displayed on a time/distance graph and sometimes on a schematic diagram of the study area. The intended route, the route that was used after resolving route conflicts, the times that the trains passed specified points, the amount of delay, and the occupancy of track segments are recorded in a data file for subsequent analysis.

The simulation provides a time-distance diagram of the traffic and a variety of arrival/leaving times, measurements, and statistics. The output does not include any infrastructure suggestions or answers about the suitability of the infrastructure for the proposed traffic. Examination and analysis of the output must determine that. There are three methods that can be applied to the simulation output data, Statistical Analysis, Root Cause Analysis, and Analytical Methods.

Statistical Analysis

Statistical analysis of the simulation output data is the simplest and most commonly used form of analysis. The ratio of delay to running time (time during which trains are moving) or elapsed time (the total amount of time that trains spent between the initial and final terminal whether moving or stopped) is compared to the same ratio for the current situation and the proposed situation. The comparison indicates whether the traffic condition has improved, degraded, or remains the same.

Root Cause Analysis

The train dispatching simulation may not handle complex traffic situations correctly. This situation is not unexpected because the software to flawlessly handle the movement of actual railroad traffic has not been devised. The inability to correctly resolve traffic situations may result in extreme delays and deadlock (unable to find a solution) situations that can have a significant effect on the output statistics and therefore on the comparison between the current and proposed situation.

Root cause analysis of the delays in the simulation output serves two purposes. First it gives a basis for adjusting simulation output statistics to more accurately represent the traffic situation. Second, it assists in the location of inadequate infrastructure. The second may be necessary because the delays may occur at a great distance from the cause.

Analytical Methods

The same methods that are used to examine the current infrastructure can be used to locate and correct sources of unacceptable delay found in the simulation of the proposed infrastructure and operation.

Iteration

The complex interaction between rail infrastructure and traffic may lead to the need for additional changes to the proposed infrastructure, demonstrated by the three methods of analysis of the simulation. The proposed infrastructure is modified as determined by the analysis of the simulation output and a new simulation is conducted. Iteration continues until the proposed infrastructure produces the desired result.

Information developed in the analysis of current infrastructure and operation leads to the appropriate infrastructure arrangement between the various agencies involved in the program development.

Will the Amtrak Cascades Program be Subsidizing Freight Railroads?

The program constructs the facilities it needs for the planned passenger train operation. That requires a rail line that can be predictably clear when needed. This effect can be achieved in two ways; build a separate rail line for passenger trains or improve the traffic flow of the existing line. The infrastructure improvements are limited to those needed to ensure that the required main line routes are clear of other traffic when needed by Amtrak Cascades trains. It will not construct facilities used only for freight service, such as freight yards, industrial tracks, or freight equipment repair facilities. In some cases, the program will construct facilities that will be used only by freight trains as a component of providing a clear route for Amtrak Cascades trains as needed.

In some cases, however, construction of facilities needed for the support of the Amtrak Cascades service will displace existing freight facilities such as storage or yard tracks. The program must replace them with equivalent facilities. Many of these facilities are approaching 100 years old and were converted to their current use when they were no longer needed for their original use. Replacing these facilities may cause improvement to freight operation and service as a secondary effect. For example, sidings at Ridgefield, Kalama, Kelso, Castle Rock, and Vader were originally used by slow freight trains clearing the way for passenger trains. In past decades, they became obsolete for the original purpose and acquired the new function of grain car storage. They are not conveniently located, but the railroad made use of the existing facilities. Each of these tracks will ultimately be lost to the construction of new track for high speed operation. They will be replaced by tracks in a new yard at Kalama. The yard at Kalama is more suited to the purpose of storing grain cars than are several storage tracks distributed along sixty miles of line. The freight and passenger services will share the common benefit of location. Freight service will not have the added expense of moving cars long distances between storage and the customer and the passenger service will encounter less traffic on the line, decreasing the chance of delay.

What Improvements are Proposed in the Corridor to Reduce the Potential Effect?

The improvements proposed as part of the Amtrak Cascade Program are detailed below.

Main Tracks

Main tracks are generally the only railroad facility that passenger trains and freight trains must share. The two types of traffic use different terminal facilities: storage, equipment service and maintenance, and loading/unloading. At conventional speed of 79 mph or less, main tracks maintained for freight and for passenger service have similar characteristics. There are two significant differences: superelevation of curves and the size and strength of the track components.

The amount of superelevation that allows a desirable passenger train speed is undesirable for slow heavy freight trains. The consequence of superelevation desirable for passenger train service is generally increased track maintenance cost because the weight of the freight cars is unevenly distributed between the two rails. In some cases, the superelevation desirable for passenger train operation is not feasible because of the possibility of derailing long heavy freight trains. Tilting passenger trains form a compromise by requiring less superelevation for greater speed. The superelevation can be more suitable for both passenger and freight trains without being optimized for either.

Typical loaded freight cars weigh about 36 tons per axle. Typical conventional passenger cars such as the Amtrak Superliner cars or the multi-level commuter cars typical in the US weigh about 18 tons per axle. Lightweight high speed passenger trains weigh about 15 tons per axle. The track must be much more substantial to accommodate typical US freight trains than to accommodate passenger trains.

At speeds between 80 mph and 90 mph, compatibility of the track for mixed use is still practical, but is expensive. High speeds require a much smaller tolerance in track dimensions such as the distance between the rails and the difference in the elevation of one rail over the other (which should be zero, or level, on straight track and specific prescribed amounts on curves). The movement of very heavy freight trains makes the small track measurement tolerances required for higher passenger train speed difficult to maintain. At passenger train speeds above 90 mph, the amount of expense and effort required to maintain the tolerance required for passenger trains makes shared use impractical. Therefore, where the speed of the Amtrak Cascades trains will exceed 79 mph, they will operate on a dedicated passenger train track generally located adjacent to the current shared use tracks.

The second significant difference that must be accommodated is the difference in speed between freight and passenger trains. When freight trains are operating at 35 mph to 50 mph and passenger trains are operating at 60 mph to 79 mph, there must be facilities that allow passenger trains to overtake freight trains. The same facilities are also used when fast freight trains must overtake slower ones. Because the speed differential is greater between passenger trains and freight trains than among freight trains, the need to overtake slower traffic is more frequent for passenger trains than for freight trains. Therefore, third (and perhaps fourth) main tracks may be needed in some places before frequent passenger train service can be accommodated.

The Amtrak Cascades program plan includes the construction of third and fourth main tracks throughout the corridor as needed for both the accommodation of speed differential among the trains and exclusive use of passenger trains operating at over 79 mph.

Sidings

On a single track railroad, sidings serve the dual purpose of allowing a train to clear the way for a train moving in the opposite direction and to allow a train to clear the way to be passed by another moving in the same direction. On a two track (or more) railroad, sidings generally allow trains that must stop to be passed by other trains and to allow trains to clear the way for faster trains to pass. Generally, passenger trains stopped for loading and unloading remain standing for only a minute or two. Freight trains that are stopped to deliver and pick up cars are often stopped for an extended time. Therefore, sidings intended to accommodate stopped trains are generally intended for freight train use. Whether a siding or a third main track is appropriate for allowing slow trains to be overtaken on a two track railroad is determined by the specific situation.

The Amtrak Cascades plan includes the construction of sidings on single track that will increase the capacity by reducing the length of single track sections and sidings on two track segments that will allow slow or stopped trains to be passed and allow slow trains to be overtaken.

Secondary Tracks

Trains entering and leaving yards move very slowly, generally about ten mph. When moving directly between yards and main tracks, a freight train uses track capacity that could otherwise be used by several trains. When necessary and possible, infrastructure improvements for the Amtrak Cascades program include extended yard leads that function like the entrance and exit ramps of an interstate highway, allowing speed to be increased or decreased clear of the normal traffic flow.

Signal System

Railroad signal systems perform two functions. They are traffic control devices, just as the stoplights at street and highway intersections. They also extend the range of vision of the locomotive engineer controlling the train. Unlike most land transportation vehicles, the normal operating speed of a train generally exceeds the range of vision. The engineer must be warned in advance of a condition that will require the train to slow or stop. On a highway, if there is a sign warning of a change in speed limit, it is a few hundred feet from the beginning of the new speed limit. On a railroad, such signs are generally one or two miles from the speed limit change. The same principle applies to non-permanent conditions that require a train to slow or stop. For example, if a slow moving or standing train is being overtaken by a moving train, the signal system must detect the presence of the slow or standing train and provide a warning to the following train sufficiently in advance to allow it to slow or stop as necessary.

The significant difference between signal systems designed for typical North American freight trains and for passenger trains is the distance between the signals. A lightweight high speed train can stop from 79 mph in less than a mile. A bulk commodity (e.g., coal or grain) needs two or more miles to stop from 45 mph. The wayside signals for a line configured only for freight are spaced two or more miles apart. This distance is too great for passenger trains. The warning to slow and prepare to stop occurs a mile or more earlier than it must, delaying the passenger train unnecessarily. The wayside signals for a line configured only for passenger trains are too close together to provide sufficient warning for a freight train.

The Amtrak Cascades program plan makes changes to both aspects of the current signal system. The traffic control element is improved to allow operation on any track in either direction instead of the “adjacent one way streets” configuration used on much of the corridor. The advance warning element combines the configuration needed for both passenger and freight trains. The signals are located at an interval short enough to be suitable for passenger operation, and display information about the line in a way that provides sufficient warning for freight trains. This is accomplished by changing from the conventional system of three consecutive signals indicating proceed at normal speed, slow now and stop at the next signal, and stop, to a system of proceed at normal speed, stop at the second signal (in some cases perhaps the third signal) from here, stop at the next signal, and stop.

Yard and Storage Tracks

In general, yard and storage facilities are business requirements of a freight railroad. They are not shared by passenger trains. In general, the Amtrak

Cascades program makes no changes and provides no new facilities. In some locations, however, new facilities constructed as part of the Amtrak Cascades program displace existing facilities used exclusively by rail freight. These facilities must be replaced with equivalent facilities.

Will the Amtrak Cascades Program Improve Freight Mobility?

In general, the Amtrak Cascades program will improve freight mobility along the length of its route (Page G-79). Facilities constructed to allow stopped freight trains to be passed will allow other freight trains, as well as passenger trains, to pass unobstructed. Traffic control systems that allow trains to move either direction on any track will facilitate freight trains overtaking other freight trains, as it will also allow passenger trains to overtake freight trains. They also allow freight trains and passenger trains to detour around track defects or maintenance.

Will the Railroad Provide the Desired Level of Service to the Passenger Trains After the Work is Complete?

The relationship between Washington State Department of Transportation and Burlington Northern Santa Fe is subject to a contract between the parties. The contract makes requirements of both parties and provides ways of ensuring compliance.

If It Improves Freight Mobility, Will It Take Trucks Off Of The Highways?

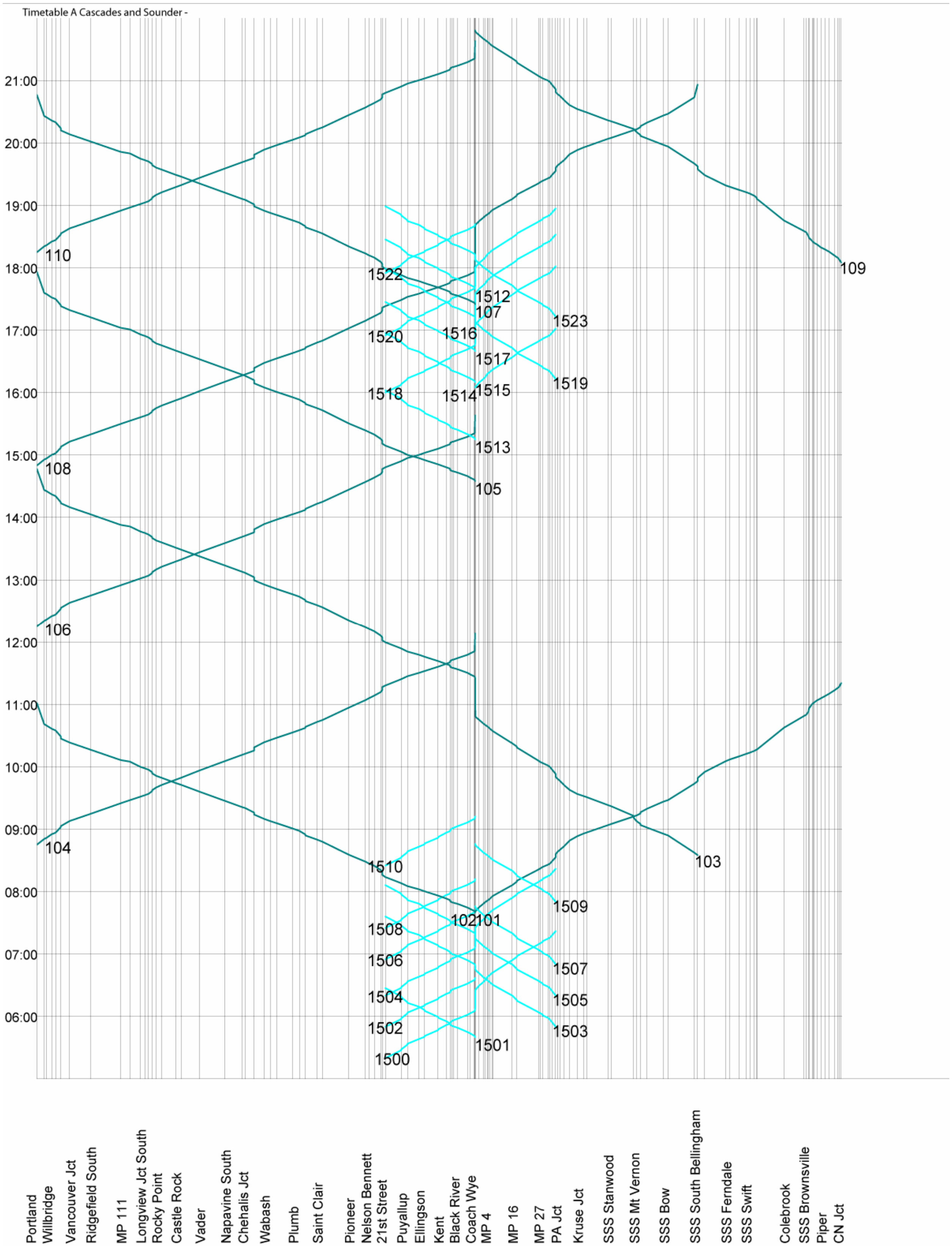
Regardless of the improvements in mobility resulting from the Amtrak Cascades program, increasing freight rail traffic and reducing highway truck traffic will probably not be among the effects. There are several factors involved in the modal split of freight between rail and truck. The capacity of the main lines between terminals, which is generally the factor affected by the Amtrak Cascades program, is not among the most significant factors.

TIMETABLE A — **SOUTHWARD TRAINS**

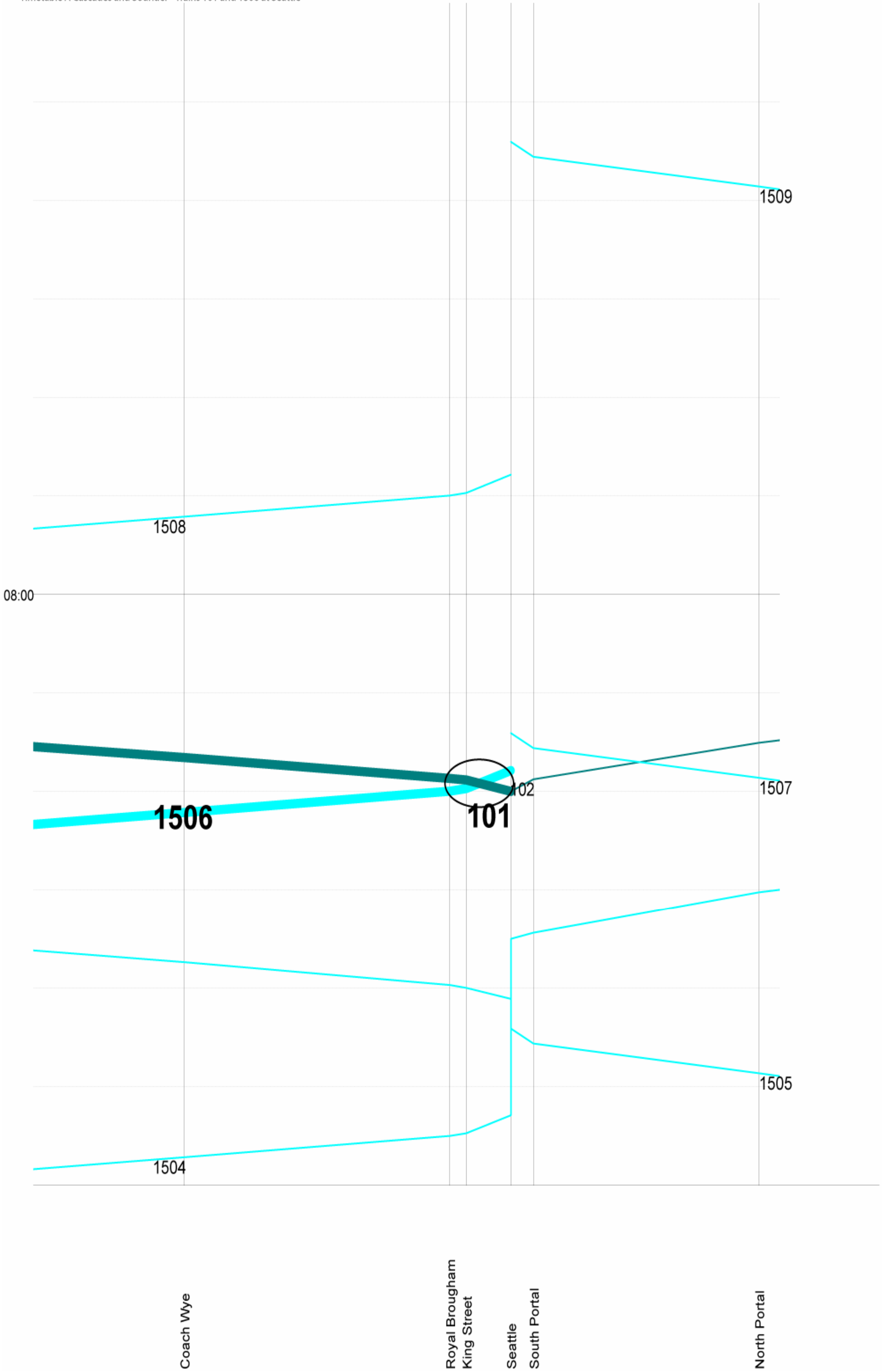
Example Train Numbers	109	1512	107	1523	1517	1519	1515	1513	105	103	1509	101	1507	1505	1503	1501
Vancouver BC	**6:05 P**															
Bellingham	**7:37 P**									8:35 A						
Mt Vernon	**8:07 P**									9:05 A						
Everett	**8:51 P**			**5:13 P**		**4:13 P**				9:53 A	7:50 A		6:50 A	6:20 A	5:50 A	
Edmonds	**9:18 P**			**5:38 P**		**4:38 P**				10:19 A	8:15 A		7:15 A	6:45 A	6:15 A	
Seattle	**10:00 P**	**5:40 P**	**5:25 P**	**6:08 P**	**4:40 P**	**5:08 P**	**4:10 P**	**3:15 P**	**2:35 P**	11:00 A 11:25 A	8:45 A	7:40 A	7:45 A	07:15	6:45 A	5:40 A
Tukwila		**5:53 P**	**5:36 P**	**6:25 P**	**4:53 P**	**5:25 P**	**4:23 P**	**3:28 P**	**2:46 P**	11:37 A		7:51 A		7:32 A	7:02 A	5:53 A
Kent		**5:59 P**		**6:31 P**	**4:59 P**	**5:31 P**	**4:29 P**	**3:34 P**						7:38 A	7:08 A	5:59 A
Auburn		**6:06 P**		**6:38 P**	**5:06 P**	**5:38 P**	**4:36 P**	**3:41 P**						7:45 A	7:15 A	6:06 A
Sumner		**6:13 P**		**6:45 P**	**5:13 P**	**5:45 P**	**4:43 P**	**3:48 P**						7:52 A	7:22 A	6:13 A
Puyallup		**6:19 P**		**6:51 P**	**5:19 P**	**5:51 P**	**4:49 P**	**3:54 P**						7:58 A	7:28 A	6:19 A
Reservation		*6:27 P*		*6:59 P*	*5:27 P*	*5:59 P*	*4:57 P*	*4:02 P*						*8:06 A*	*7:36 A*	*6:27 A*
Tacoma			**6:03 P**						**3:13 P**	**12:04 P**		8:18 A				
Centennial			**6:40 P**						**3:50 P**	**12:40 P**		8:55 A				
Centralia			**7:01 P**						**4:12 P**	**1:02 P**		9:16 A				
Kelso			**7:39 P**						**4:50 P**	**1:41 P**		9:54 A				
Vancouver			**8:14 P**						**5:24 P**	**2:14 P**		10:29 A				
Portland			**8:50 P**						**6:00 P**	**2:50 P**		11:05 A				

TIMETABLE A — **NORTHWARD TRAINS**

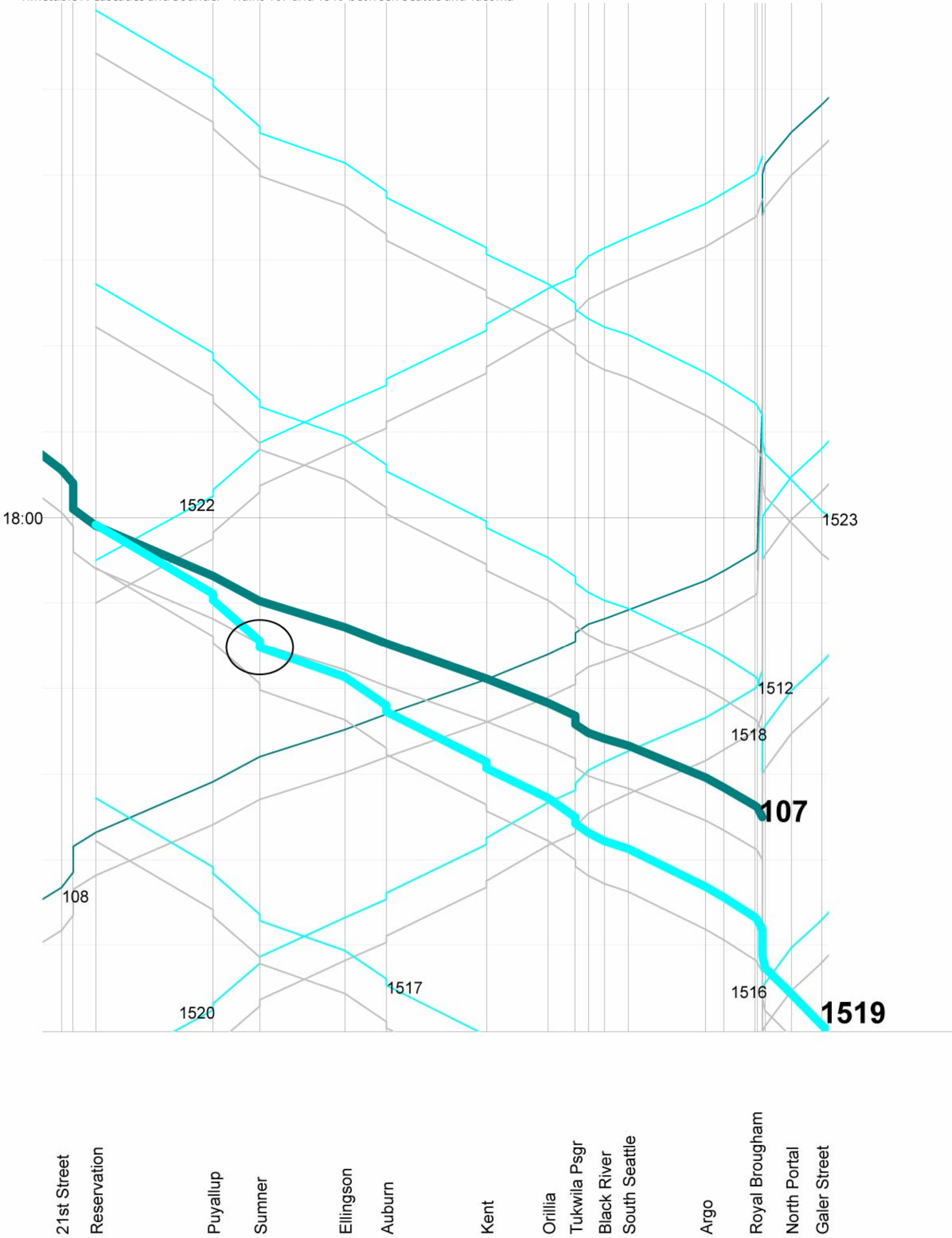
Example Train Numbers	1500	1502	1504	1506	1508	102	1510	104	106	108	1518	1514	1520	1516	1522	110
Vancouver BC						11:35 A										
Bellingham						9:49 A				**9:05 P**						
Mt Vernon						9:16 A				**8:16 P**						
Everett	7:21 A		8:21 A			8:36 A				**7:36 P**	**6:01 P**	**5:01 P**	**6:56 P**	**6:01 P**		
Edmonds	6:57 A		7:57 A			8:10 A				**7:10 P**	**5:37 P**	**4:37 P**	**6:32 P**	**5:37 P**		
Seattle	6:25 A	6:37 A	7:25 A	7:42 A	8:12 A	7:40 A	9:12 A	**12:10 P**	**3:40 P**	**6:40 P** **6:15 P**	**5:05 P**	**4:05 P**	**6:00 P**	**5:05 P**	**6:42 P**	**9:40 P**
Tukwila	5:53 A	6:23 A	6:53 A	7:28 A	7:58 A		8:58 A	11:41 A	**3:11 P**	**5:46 P**	**4:33 P**		**5:28 P**		**6:28 P**	**9:11 P**
Kent	5:47 A	6:17 A	6:47 A	7:22 A	7:52 A		8:52 A				**4:27 P**		**5:22 P**		**6:22 P**	
Auburn	5:41 A	6:11 A	6:41 A	7:16 A	7:46 A		8:46 A				**4:21 P**		**5:16 P**		**6:16 P**	
Sumner	5:33 A	6:03 A	6:33 A	7:08 A	7:38 A		8:38 A				**4:13 P**		**5:08 P**		**6:08 P**	
Puyallup	5:28 A	5:58 A	6:28 A	7:03 A	7:33 A		8:33 A				**4:08 P**		**5:03 P**		**6:03 P**	
Reservation	*5:20 A*	*5:50 A*	*6:20 A*	*6:55 A*	*7:25 A*		*8:25 A*				***4:00 P***		***4:55 P***		***5:55 P***	
Tacoma								11:16 A	**2:46 P**	**5:21 P**						**8:46 P**
Centennial								10:38 A	**2:08 P**	**4:43 P**						**8:08 P**
Centralia								10:18 A	**1:48 P**	**4:23 P**						**7:48 P**
Kelso								9:37 A	**1:07 P**	**3:42 P**						**7:07 P**
Vancouver								9:03 A	**12:33 P**	**3:08 P**						**6:33 P**
Portland								8:45 A	**12:15 P**	**2:50 P**						**6:15 P**


Timetable A Cascades and Sounder -
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
110
109
1522
1512
107
1523
1520
1516
1517
1519
1518
1514
1515
1513
108
105
106
104
103
1510
1509
1508
102
101
1506
1507
1504
1505
1502
1503
1501
1500
Portland
Willbridge
Vancouver Jct
Ridgefield South
MP 111
Longview Jct South
Rocky Point
Castle Rock
Vader
Napavine South
Chehalis Jct
Wabash
Plumb
Saint Clair
Pioneer
Nelson Bennett
21st Street
Puyallup
Ellingson
Kent
Black River
Coach Wye
MP 4
MP 16
MP 27
PA Jct
Kruse Jct
SSS Stanwood
SSS Mt Vernon
SSS Bow
SSS South Bellingham
SSS Ferndale
SSS Swift
Colebrook
SSS Brownsville
Piper
CN Jct

Timetable A Cascades and Sounder - Trains 101 and 1506 at Seattle



Timetable A Cascades and Sounder - Trains 107 and 1519 between Seattle and Tacoma

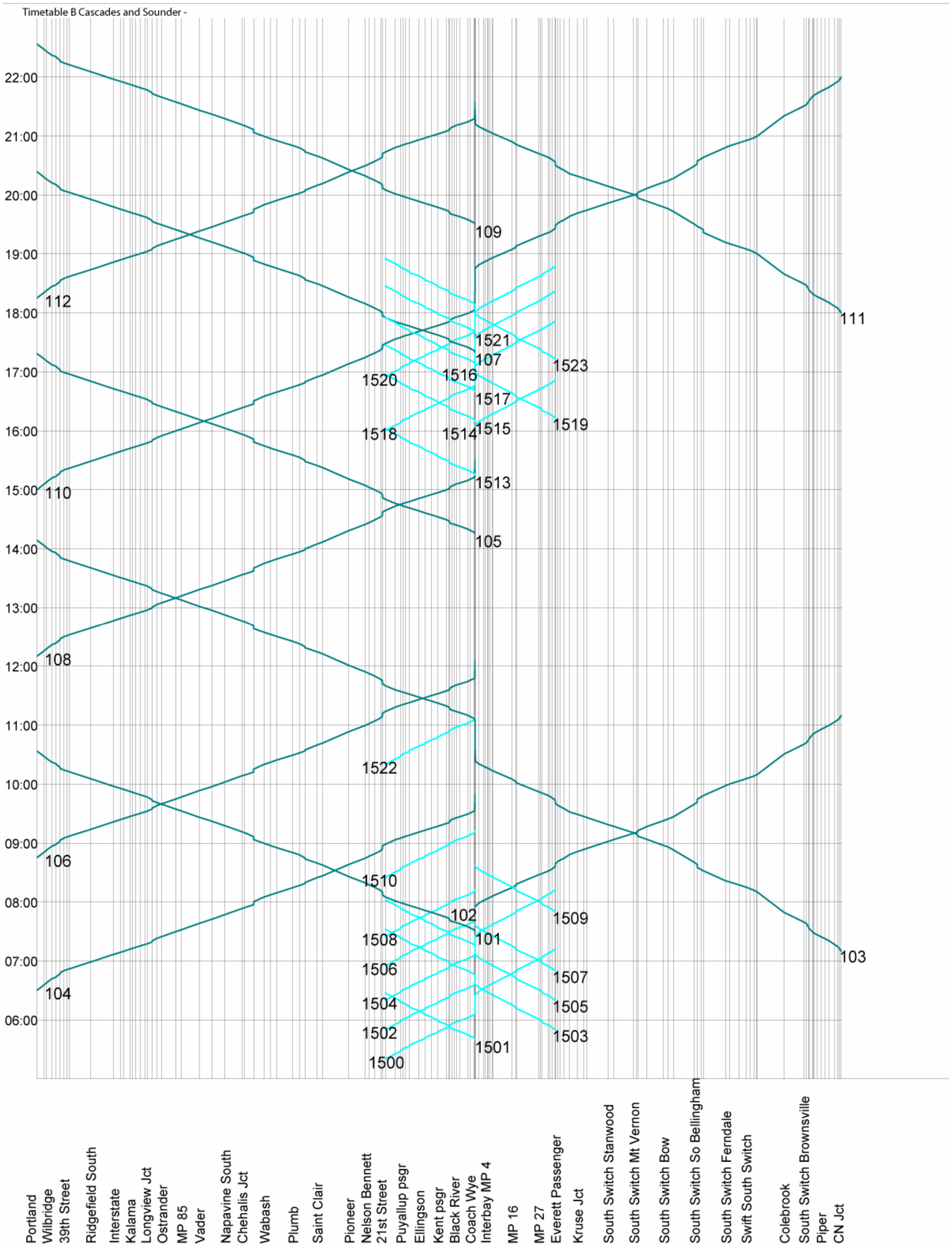


TIMETABLE B — **SOUTHWARD TRAINS**

Example Train Numbers	109	111	1521	107	1523	1517	1519	1515	1513	105	1509	101	103	1507	1505	1503	1501
Vancouver BC		**6:00 P**											7:10 A				
Bellingham		**7:28 P**											8:38 A				
Mt Vernon		**7:57 P**											9:07 A				
Everett		**8:33 P**			**5:13 P**		**4:13 P**				7:50 A		9:43 A	6:50 A	6:20 A	5:50 A	
Edmonds		**8:52 P**			**5:35 P**		**4:35 P**				8:12 A		10:02 A	7:12 A	6:42 A	6:12 A	
Seattle	**7:30 P**	**9:30 P**	**5:40 P**	**5:20 P**	**6:08 P**	**4:40 P**	**5:08 P**	**4:10 P**	**3:15 P**	**2:15 P**	8:37 A	7:30 A	10:40 A 11:05 A	7:37 A	7:15 A	6:45 A	5:40 A
Tukwila	**7:42 P**		**5:52 P**	**5:32 P**	**6:20 P**	**4:52 P**	**5:20 P**	**4:22 P**	**3:27 P**	**2:27 P**		7:42 A	11:17 A		7:27 A	6:57 A	5:52 A
Kent psgr			**5:59 P**		**6:27 P**	**4:59 P**	**5:27 P**	**4:29 P**	**3:34 P**						7:34 A	7:04 A	5:59 A
Auburn			**6:06 P**		**6:34 P**	**5:06 P**	**5:34 P**	**4:36 P**	**3:41 P**						7:41 A	7:11 A	6:06 A
Sumner			**6:13 P**		**6:41 P**	**5:13 P**	**5:41 P**	**4:43 P**	**3:48 P**						7:48 A	7:18 A	6:13 A
Puyallup			**6:19 P**		**6:47 P**	**5:19 P**	**5:47 P**	**4:49 P**	**3:54 P**						7:54 A	7:24 A	6:19 A
Reservation			***6:27 P***		***6:55 P***	***5:27 P***	***5:55 P***	***4:57 P***	***4:02 P***						*8:02 A*	*7:32 A*	*6:27 A*
Tacoma	**8:10 P**			**6:00 P**						**2:55 P**		8:10 A	11:45 A				
Centennial	**8:44 P**			**6:34 P**						**3:29 P**		8:44 A	**12:19 P**				
Centralia	**9:06 P**			**6:56 P**						**3:51 P**		9:06 A	**12:41 P**				
Kelso	**9:44 P**			**7:34 P**						**4:29 P**		9:44 A	**1:19 P**				
Vancouver	**10:16 P**			**8:06 P**						**5:01 P**		10:16 A	**1:51 P**				
Portland	**10:50 P**			**8:40 P**						**5:35 P**		10:50 A	**2:25 P**				

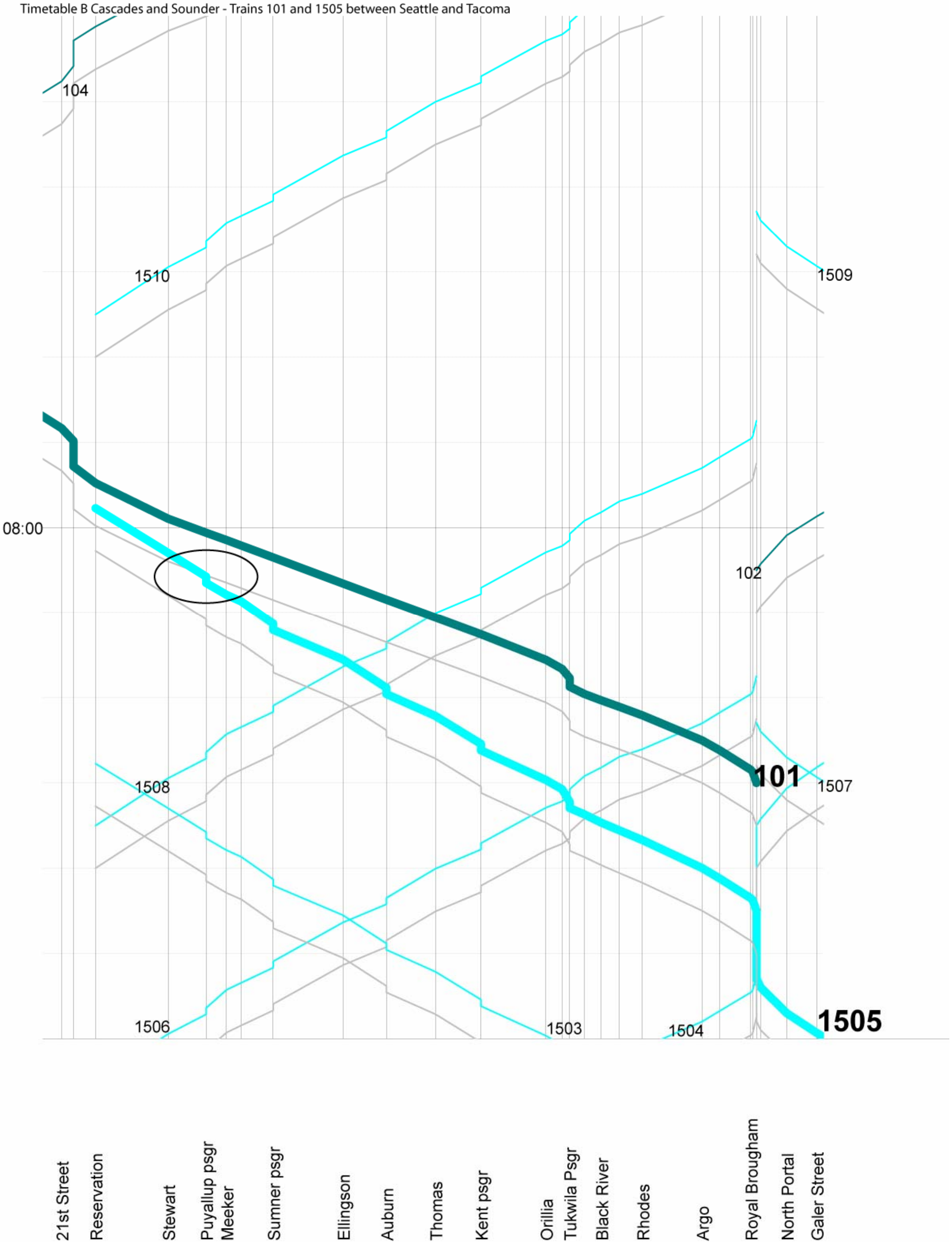
TIMETABLE B — **NORTHWARD TRAINS**

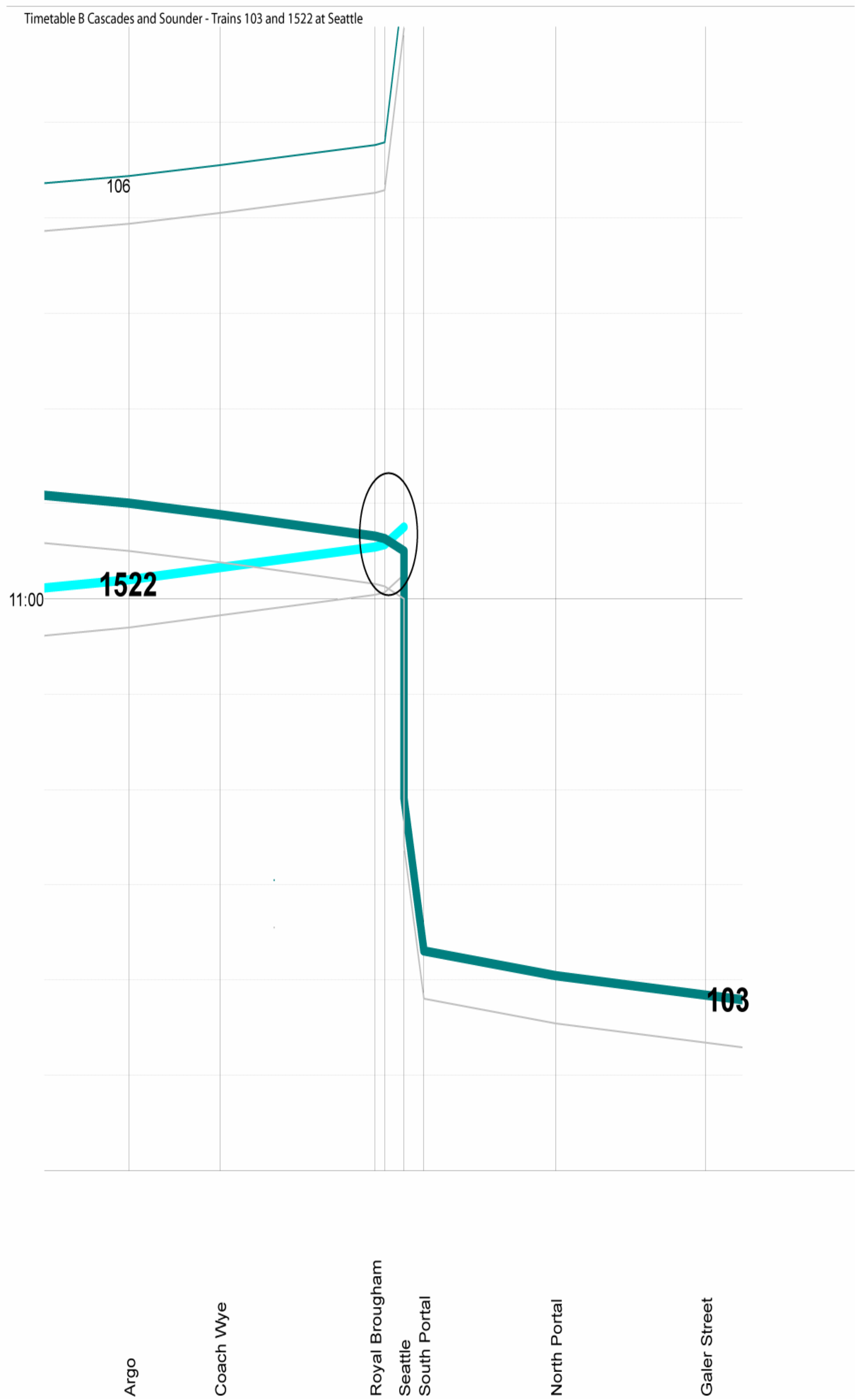
Example Train Numbers	1500	1502	1504	104	1506	1508	102	1510	106	1522	108	110	1518	1514	1520	1516	112
Vancouver BC							11:25 A					**10:15 P**					
Bellingham							9:44 A					**8:34 P**					
Mt Vernon							9:12 A					**8:02 P**					
Everett	7:12 A		8:12 A				8:39 A					**7:29 P**	**6:22 P**	**4:51 P**	**6:47 P**	**5:51 P**	
Edmonds	6:50 A		7:50 A				8:17 A					**7:07 P**	**6:00 P**	**4:30 P**	**6:25 P**	**5:30 P**	
Seattle	6:25 A	6:37 A	7:25 A	9:50 A	7:42 A	8:12 A	7:55 A	9:12 A	**12:05 P**	11:07 A	**3:30 P**	**6:45 P** **6:20 P**	**5:35 P**	**4:05 P**	**6:00 P**	**5:05 P**	**9:35 P**
Tukwila	5:54 A	6:24 A	6:54 A	9:22 A	7:29 A	7:59 A		8:59 A	11:37 A	10:54 A	**3:02 P**	**5:52 P**	**4:34 P**		**5:29 P**		**9:07 P**
Kent psgr	5:47 A	6:17 A	6:47 A		7:22 A	7:52 A		8:52 A		10:47 A			**4:27 P**		**5:22 P**		
Auburn	5:41 A	6:11 A	6:41 A		7:16 A	7:46 A		8:46 A		10:41 A			**4:21 P**		**5:16 P**		
Sumner	5:34 A	6:04 A	6:34 A		7:09 A	7:39 A		8:39 A		10:34 A			**4:14 P**		**5:09 P**		
Puyallup	5:28 A	5:58 A	6:28 A		7:03 A	7:33 A		8:33 A		10:28 A			**4:08 P**		**5:03 P**		
Reservation	*5:20 A*	*5:50 A*	*6:20 A*		*6:55 A*	*7:25 A*		*8:25 A*		*10:20 A*			***4:00 P***		***4:55 P***		
Tacoma				8:57 A					11:12 A		**2:37 P**	**5:27 P**					**8:42 P**
Centennial				8:19 A					10:34 A		**1:59 P**	**4:49 P**					**8:04 P**
Centralia				8:00 A					10:15 A		**1:40 P**	**4:30 P**					**7:45 P**
Kelso				7:20 A					9:35 A		**1:00 P**	**3:50 P**					**7:05 P**
Vancouver				6:47 A					9:02 A		**12:27 P**	**3:17 P**					**6:32 P**
Portland				6:30 A					8:45 A		**12:10 P**	**3:00 P**					**6:15 P**



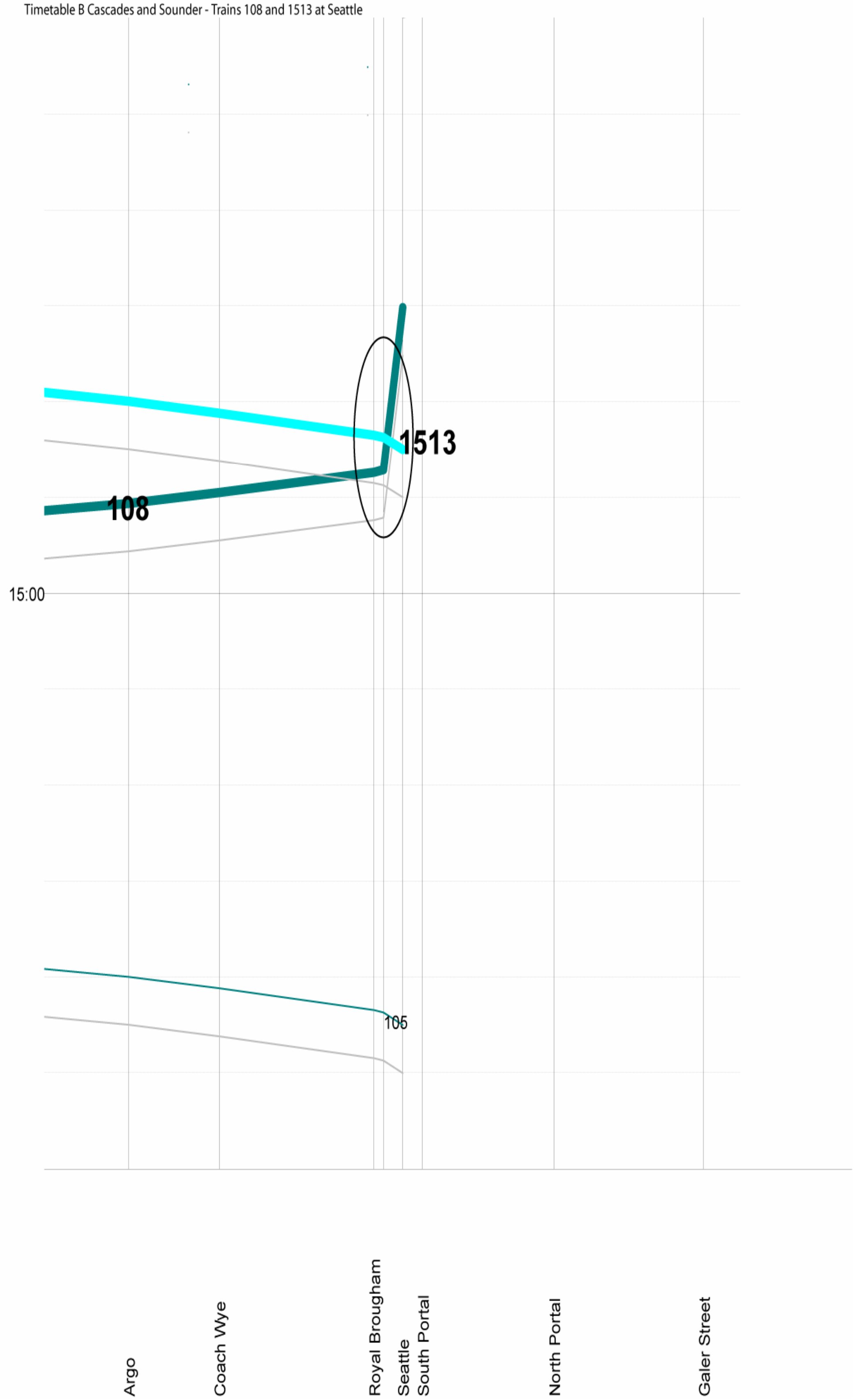
Timetable B Cascades and Sounder -
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
109
112
111
1521
107
1523
1520
1516
1517
1518
1514
1515
1519
110
1513
105
108
1522
106
1510
1509
102
1508
101
103
1506
1507
104
1504
1505
1502
1503
1501
1500
Portland
Wilbridge
39th Street
Ridgefield South
Interstate
Kalama
Longview Jct
Ostrander
MP 85
Vader
Napavine South
Chehalis Jct
Wabash
Plumb
Saint Clair
Pioneer
Nelson Bennett
21st Street
Puyallup psgr
Ellingson
Kent psgr
Black River
Coach Wye
Interbay MP 4
MP 16
MP 27
Everett Passenger
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
South Switch So Bellingham
South Switch Ferndale
Swift South Switch
Colebrook
South Switch Brownsville
Piper
CN Jct

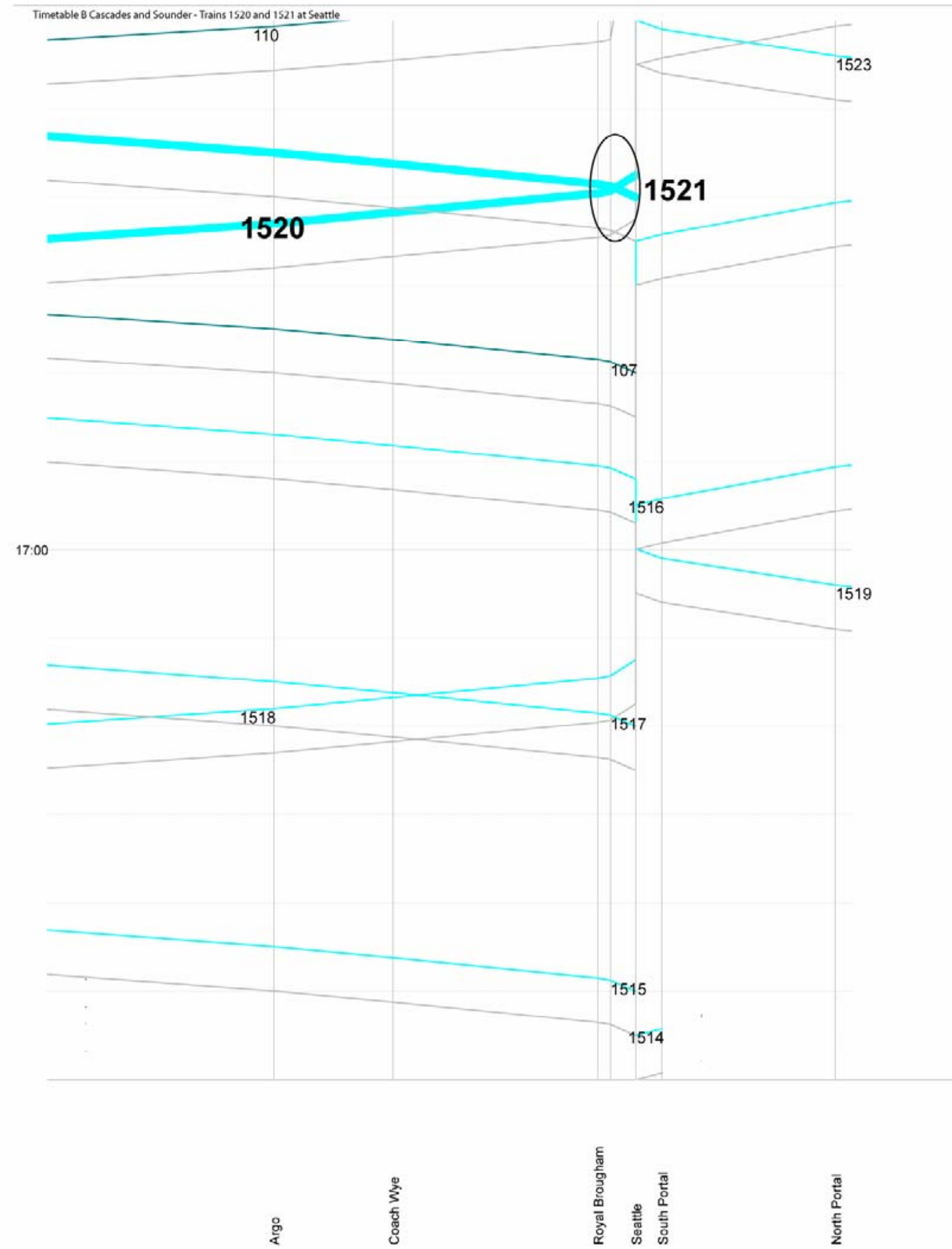
Timetable B Cascades and Sounder - Trains 101 and 1505 between Seattle and Tacoma

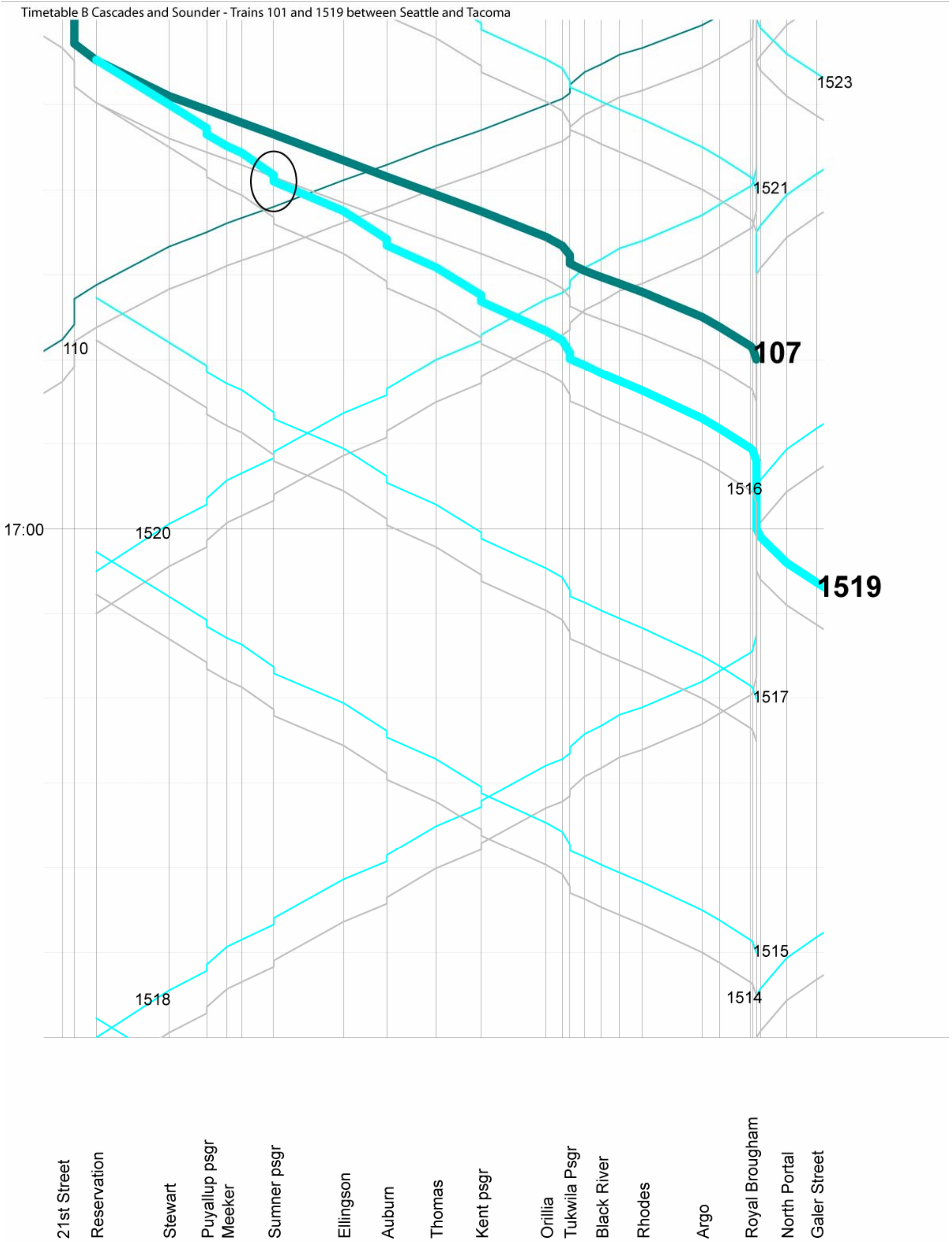


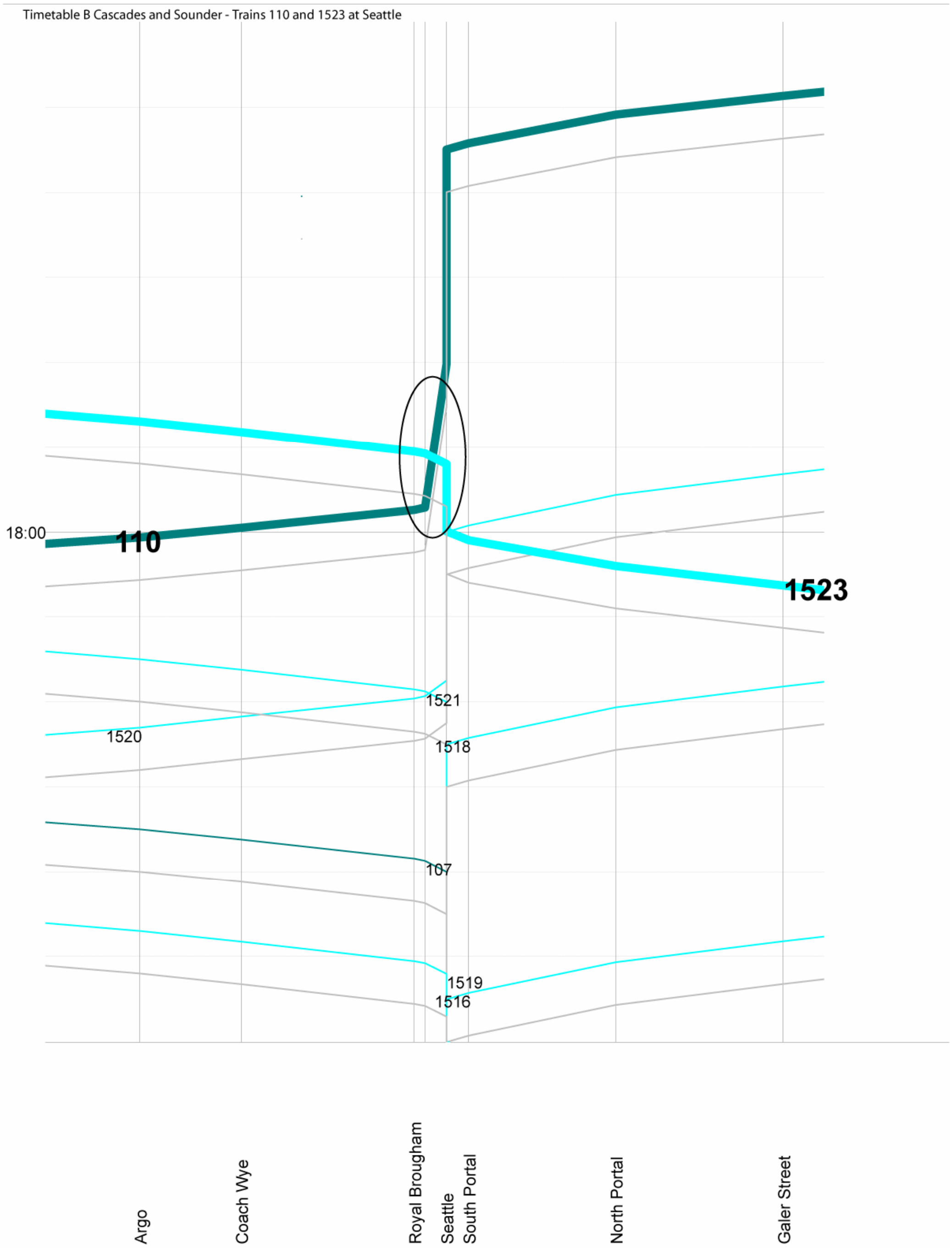

Timetable B Cascades and Sounder - Trains 103 and 1522 at Seattle
106
1522
11:00
103
Argo
Coach Wye
Royal Brougham
Seattle
South Portal
North Portal
Galer Street

Timetable B Cascades and Sounder - Trains 108 and 1513 at Seattle




Timetable B Cascades and Sounder - Trains 1520 and 1521 at Seattle
110
1523
1521
1520
107
1516
17:00
1519
1518
1517
1515
1514
Argo
Coach Wye
Royal Brougham
Seattle
South Portal
North Portal


Timetable B Cascades and Sounder - Trains 101 and 1519 between Seattle and Tacoma
1523
1521
107
110
1516
17:00
1520
1519
1517
1515
1518
1514
21st Street
Reservation
Stewart
Puyallup psgr
Meeker
Sumner psgr
Ellingson
Auburn
Thomas
Kent psgr
Orillia
Tukwila Psgr
Black River
Rhodes
Argo
Royal Brougham
North Portal
Galer Street


Timetable B Cascades and Sounder - Trains 110 and 1523 at Seattle
18:00
110
1523
1521
1520
1518
107
1519
1516
Argo
Coach Wye
Royal Brougham
Seattle
South Portal
North Portal
Galer Street

TIMETABLE C — **SOUTHWARD TRAINS**

Example Train Numbers	1529	1527	115	1525	1523	111	117	1521	1519	1517	2519	1515	2523	1513	109
Vancouver BC							6:10 P								
Bellingham							7:36 P								
Mt Vernon							8:04 P								
Everett							8:39 P				4:13 P		3:23 P		
Mukilteo											4:21 P		3:31 P		
Edmonds							8:58 P				4:35 P		3:45 P		
Seattle	10:30 P	8:10 P	7:40 P	7:15 P	6:25 P	6:20 P	9:35 P	5:56 P	5:25 P	4:56 P	5:00 P	4:10 P	4:10 P	3:10 P	2:10 P
Tukwila	10:43 P	8:23 P	7:51 P	7:28 P	6:38 P	6:31 P		6:09 P	5:38 P	5:09 P		4:23 P		3:23 P	2:21 P
Kent psgr	10:49 P	8:29 P		7:34 P	6:44 P			6:15 P	5:44 P	5:15 P		4:29 P		3:29 P	
Auburn	10:56 P	8:36 P		7:41 P	6:51 P			6:22 P	5:51 P	5:22 P		4:36 P		3:36 P	
Sumner	11:03 P	8:43 P		7:48 P	6:58 P			6:29 P	5:58 P	5:29 P		4:43 P		3:43 P	
Puyallup	11:09 P	8:49 P		7:54 P	7:04 P			6:35 P	6:04 P	5:35 P		4:49 P		3:49 P	
Tacoma	11:20 P	9:00 P	8:19 P	8:05 P	7:15 P	6:59 P		6:46 P	6:15 P	5:46 P		5:00 P		4:00 P	2:49 P
South Tacoma	11:27 P	9:08 P		8:13 P	7:23 P			6:54 P	6:23 P	5:54 P		5:08 P		4:08 P	
Lakewood	11:32 P	9:12 P		8:17 P	7:27 P			6:58 P	6:27 P	5:58 P		5:12 P		4:12 P	
Centennial			8:42 P			7:22 P									3:12 P
Centralia			9:03 P			7:43 P									3:33 P
Kelso			9:40 P			8:20 P									4:10 P
Vancouver			10:12 P			8:52 P									4:42 P
Portland			10:40 P			9:20 P									5:10 P

TIMETABLE C — **SOUTHWARD TRAINS**

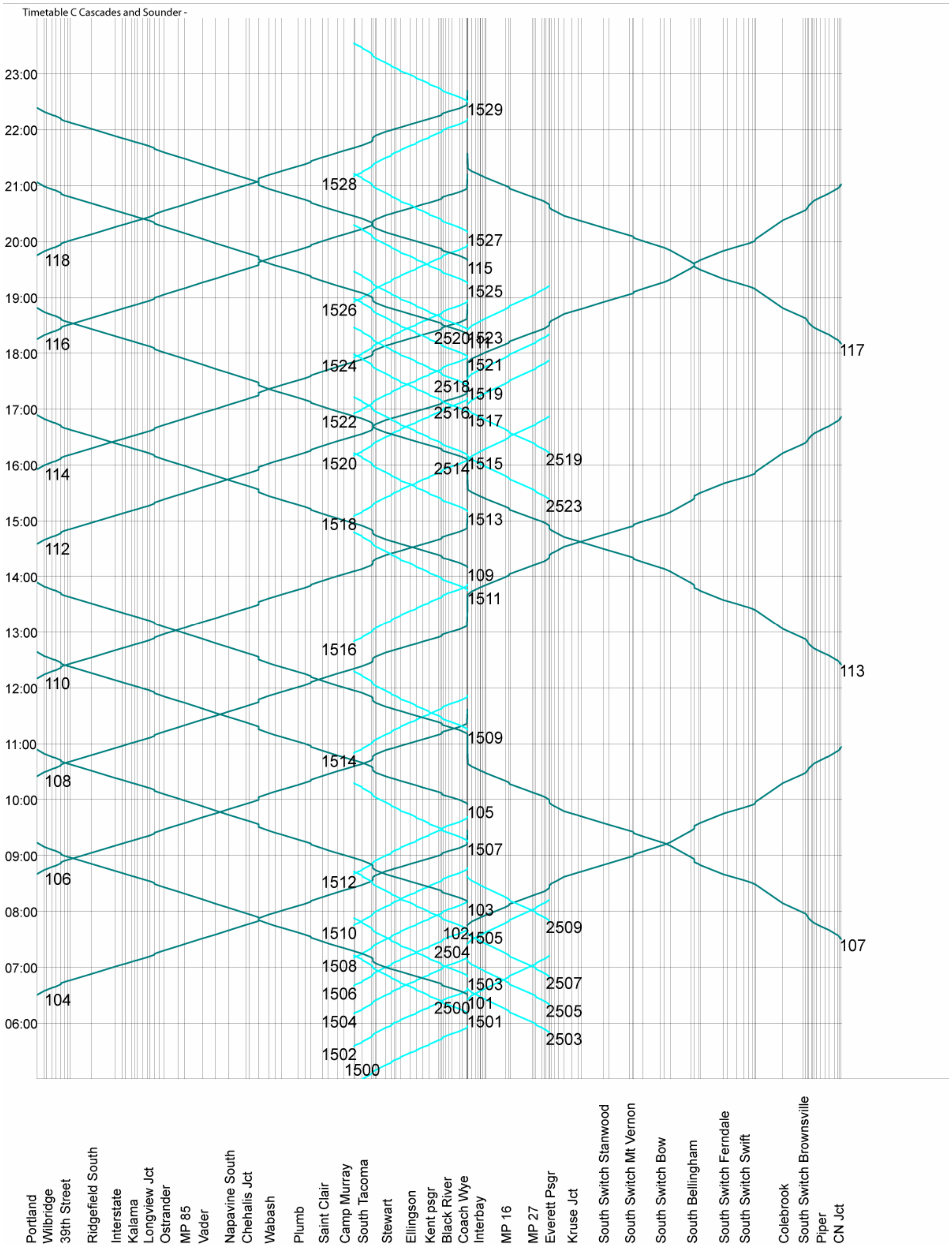
Example Train Numbers	1511	113	105	1507	103	2509	1505	107	2507	1503	101	2505	1509	1501	2503
Vancouver BC		12:25 P						7:30 A							
Bellingham		1:51 P						8:56 A							
Mt Vernon		2:19 P						9:24 A							
Everett		2:54 P				7:50 A		9:59 A	6:50 A			6:20 A			5:50 A
Mukilteo						7:58 A			6:58 A			6:28 A			5:58 A
Edmonds		3:13 P				8:12 A		10:18 A	7:12 A			6:42 A			6:12 A
		3:50 P				8:37 A		10:55 A	7:37 A			7:07 A			6:37 A
Seattle	1:45 P	4:05 P	9:55 A	9:15 A	8:10 A		7:40 A	11:10 A		6:50 A	6:30 A		6:10 A	6:10 A	
Tukwila	1:58 P	4:16 P	10:06 A	9:28 A	8:21 A		7:53 A	11:21 A		7:03 A	6:41 A		6:23 A	6:23 A	
Kent psgr	2:04 P			9:34 A			7:59 A			7:09 A			6:29 A	6:29 A	
Auburn	2:11 P			9:41 A			8:06 A			7:16 A			6:36 A	6:36 A	
Sumner	2:18 P			9:48 A			8:13 A			7:23 A			6:43 A	6:43 A	
Puyallup	2:24 P			9:54 A			8:19 A			7:29 A			6:49 A	6:49 A	
Tacoma	2:35 P	4:44 P	10:34 A	10:05 A	8:49 A		8:30 A	11:49 A		7:40 A	7:09 A		7:00 A	7:00 A	
South Tacoma	2:43 P			10:13 A			8:38 A			7:48 A			7:08 A	7:08 A	
Lakewood	2:47 P			10:17 A			8:42 A			7:52 A			7:12 A	7:12 A	
Centennial		5:07 P	10:57 A		9:12 A			12:12 P			7:32 A				
Centralia		5:28 P	11:18 A		9:33 A			12:33 P			7:53 A				
Kelso		6:05 P	11:55 A		10:10 A			1:10 P			8:30 A				
Vancouver		6:37 P	12:27 P		10:42 A			1:42 P			9:02 A				
Portland		7:05 P	12:55 P		11:10 A			2:10 P			9:30 A				

TIMETABLE C — **NORTHWARD TRAINS**

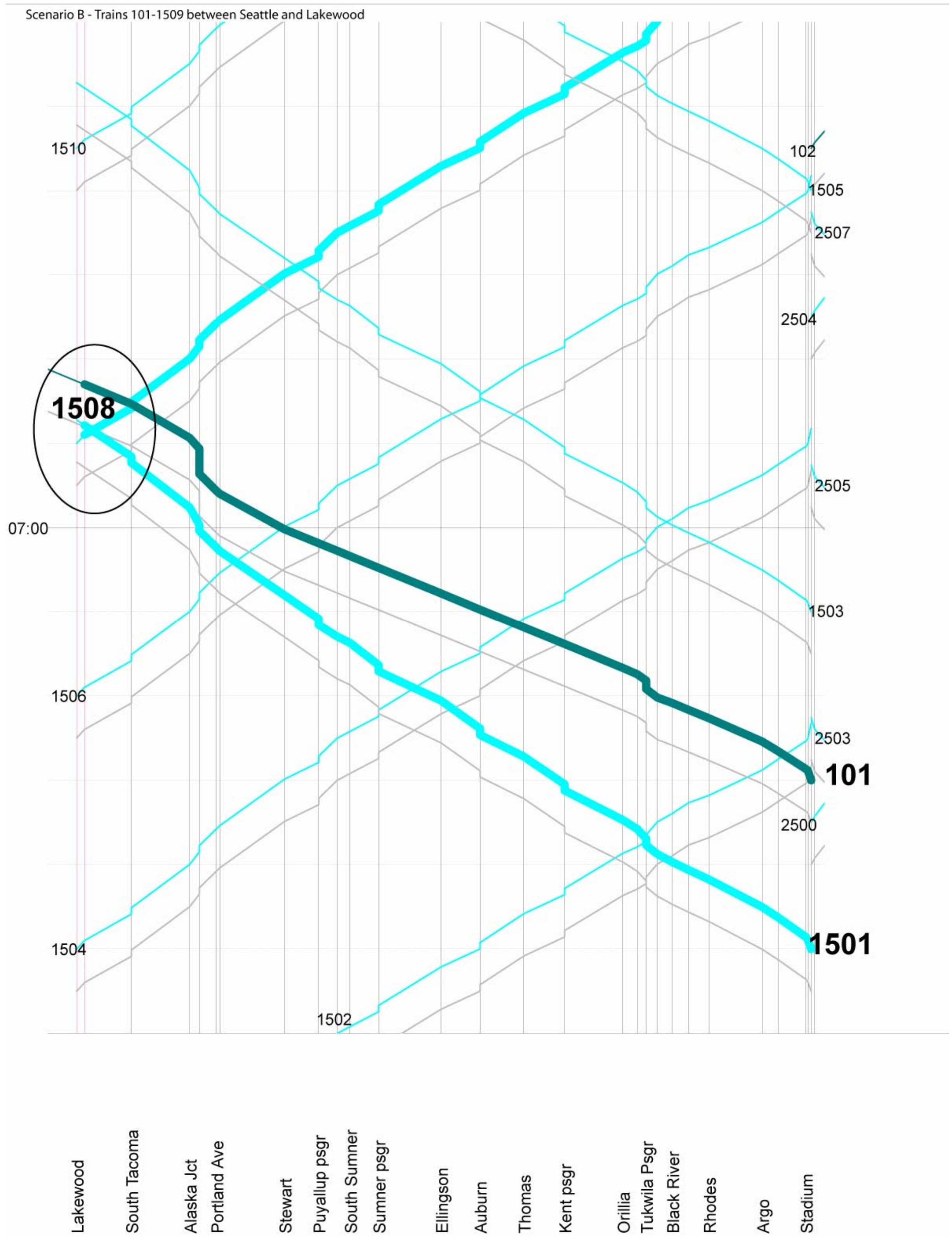
Example Train Numbers	1500	1502	1504	2500	104	1506	1508	2504	1510	102	1512	106	108	1514	110
Vancouver BC										11:10 A			**5:05 P**		
Bellingham										9:31 A			**3:26 P**		
Mt Vernon										9:00 A			**2:55 P**		
Everett				7:12 A				8:12 A		8:28 A			**2:23 P**		
Mukilteo				7:04 A				8:04 A							
Edmonds				6:50 A				7:50 A		8:07 A			**2:02 P**		
				6:25 A				7:25 A		7:45 A			**1:40 P**		
Seattle	5:56 A	6:36 A	7:11 A		9:13 A	7:41 A	8:11 A		8:46 A		9:41 A	11:40 A	**1:25 P**	11:51 A	**3:10 P**
Tukwila	5:43 A	6:23 A	6:58 A		9:03 A	7:28 A	7:58 A		8:33 A		9:28 A	11:13 A	**12:58 P**	11:38 A	**2:43 P**
Kent	5:37 A	6:17 A	6:52 A			7:22 A	7:52 A		8:27 A		9:22 A			11:32 A	
Auburn	5:30 A	6:10 A	6:45 A			7:15 A	7:45 A		8:20 A		9:15 A			11:25 A	
Sumner	5:23 A	6:03 A	6:38 A			7:08 A	7:38 A		8:13 A		9:08 A			11:18 A	
Puyallup	5:17 A	5:57 A	6:32 A			7:02 A	7:32 A		8:07 A		9:02 A			11:12 A	
Tacoma	5:07 A	5:47 A	6:22 A		8:36 A	6:52 A	7:22 A		7:57 A		8:52 A	10:46 A	**12:31 P**	11:02 A	**2:16 P**
South Tacoma	4:59 A	5:39 A	6:14 A			6:44 A	7:14 A		7:49 A		8:44 A			10:54 A	
Lakewood	4:55 A	5:35 A	6:10 A			6:40 A	7:10 A		7:45 A		8:40 A			10:50 A	
Centennial					8:11 A							10:21 A	**12:06 P**		**1:51 P**
Centralia					7:52 A							10:02 A	11:47 A		**1:32 P**
Kelso					7:14 A							9:24 A	11:09 A		**12:54 P**
Vancouver					6:42 A							8:52 A	10:37 A		**12:22 P**
Portland					6:30 A							8:40 A	10:25 A		**12:10 P**

TIMETABLE C — **NORTHWARD TRAINS**

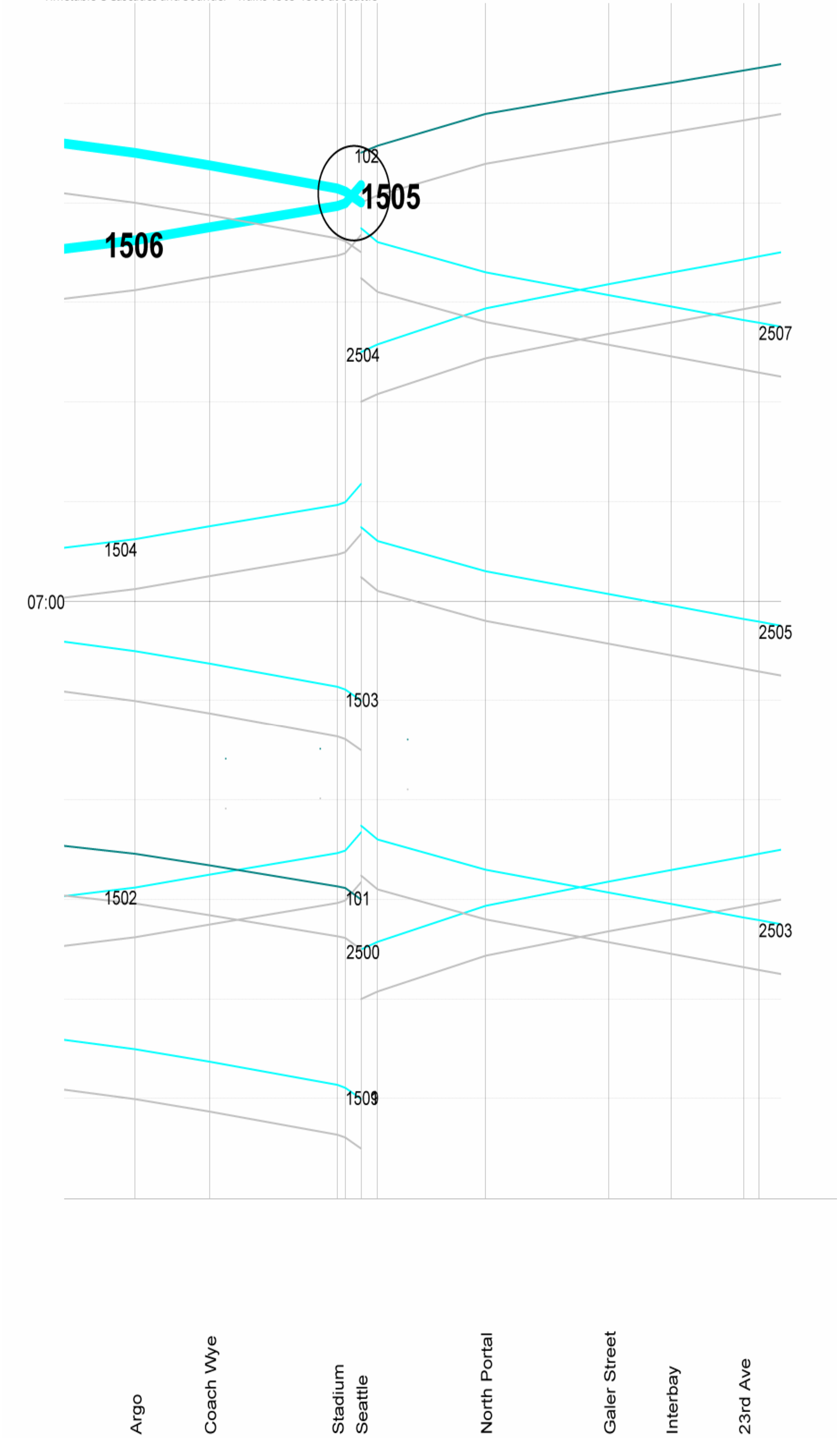
Example Train Numbers	1516	112	1518	114	2514	1520	1522	2516	2518	1524	116	2520	1526	118	1528
Vancouver BC		9:15 P													
Bellingham		7:36 P													
Mt Vernon		7:05 P													
Everett		6:33 P			4:52 P			5:52 P	6:20 P			7:12 P			
Mukilteo					4:44 P			5:44 P	6:12 P			7:04 P			
Edmonds		6:12 P			4:30 P			5:30 P	5:58 P			6:50 P			
		5:50 P			4:05 P			5:05 P	5:33 P			6:25 P			
Seattle	1:51 P	5:35 P	4:06 P	6:55 P		5:11 P	5:56 P			6:56 P	9:15 P		7:56 P	10:45 P	10:11 P
Tukwila	1:38 P	5:08 P	3:53 P	6:28 P		4:58 P	5:43 P			6:43 P	8:48 P		7:43 P	10:18 P	9:58 P
Kent	1:32 P		3:47 P			4:52 P	5:37 P			6:37 P			7:37 P		9:52 P
Auburn	1:25 P		3:40 P			4:45 P	5:30 P			6:30 P			7:30 P		9:45 P
Sumner	1:18 P		3:33 P			4:38 P	5:23 P			6:23 P			7:23 P		9:38 P
Puyallup	1:12 P		3:27 P			4:32 P	5:17 P			6:17 P			7:17 P		9:32 P
Tacoma	1:02 P	4:41 P	3:17 P	6:01 P		4:22 P	5:07 P			6:07 P	8:21 P		7:07 P	9:51 P	9:22 P
South Tacoma	12:54 P		3:09 P			4:14 P	4:59 P			5:59 P			6:59 P		9:14 P
Lakewood	12:50 P		3:05 P			4:10 P	4:55 P			5:55 P			6:55 P		9:10 P
Centennial		4:16 P		5:36 P							7:56 P			9:26 P	
Centralia		3:57 P		5:17 P							7:37 P			9:07 P	
Kelso		3:19 P		4:39 P							6:59 P			8:29 P	
Vancouver		2:47 P		4:07 P							6:27 P			7:57 P	
Portland		2:35 P		3:55 P							6:15 P			7:45 P	



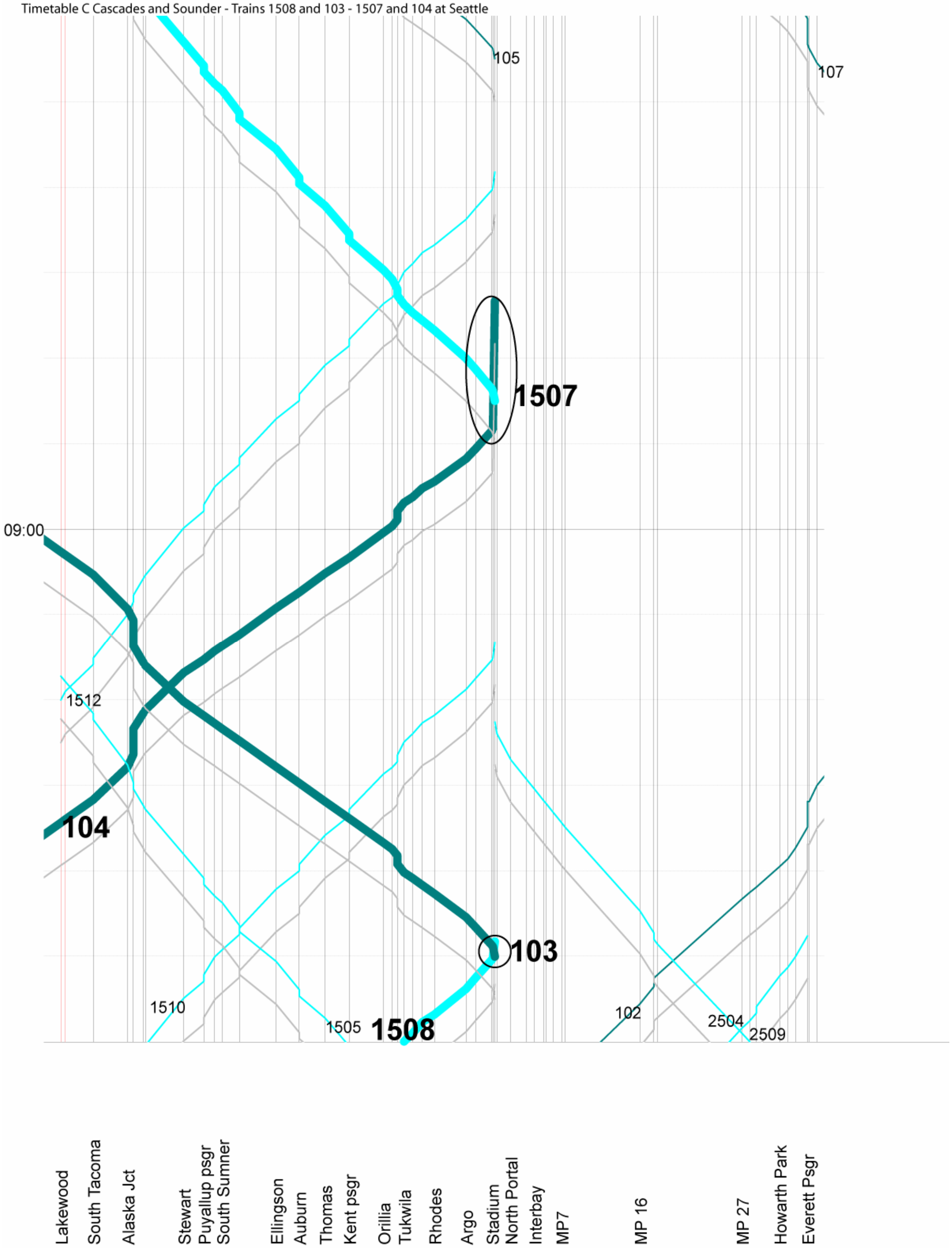
Timetable C Cascades and Sounder -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
1529
1528
1527
115
1525
1526
2520
111
1523
1521
1524
2518
1519
2516
1517
1522
1520
2514
1515
2519
2523
1518
1513
109
1511
1516
113
117
1509
1514
105
1507
1512
103
102
1505
1510
2504
2509
107
1508
1503
2507
1506
2500
101
1504
1501
2505
2503
1502
1500
118
116
114
112
110
108
106
104
Portland
Wilbridge
39th Street
Ridgefield South
Interstate
Kalama
Longview Jct
Ostrander
MP 85
Vader
Napavine South
Chehalis Jct
Wabash
Plumb
Saint Clair
Camp Murray
South Tacoma
Stewart
Ellingson
Kent psgr
Black River
Coach Wye
Interbay
MP 16
MP 27
Everett Psgr
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
South Bellingham
South Switch Ferndale
South Switch Swift
Colebrook
South Switch Brownsville
Piper
CN Jct

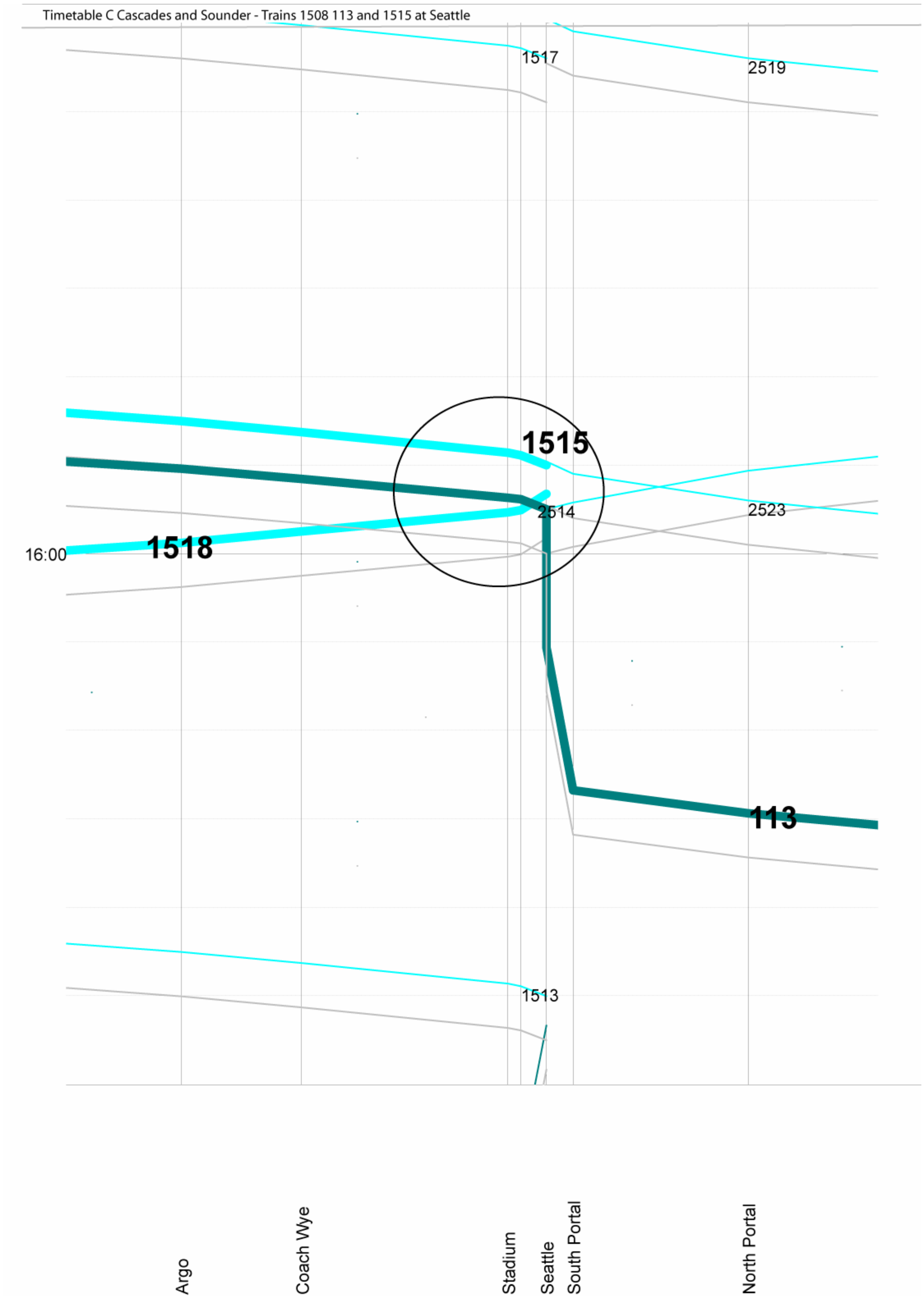

Scenario B - Trains 101-1509 between Seattle and Lakewood
1510
102
1505
2507
2504
1508
2505
07:00
1503
1506
2503
101
2500
1504
1501
1502
Lakewood
South Tacoma
Alaska Jct
Portland Ave
Stewart
Puyallup psgr
South Sumner
Sumner psgr
Ellingson
Auburn
Thomas
Kent psgr
Orillia
Tukwila Psgr
Black River
Rhodes
Argo
Stadium

Timetable C Cascades and Sounder - Trains 1505-1506 at Seattle

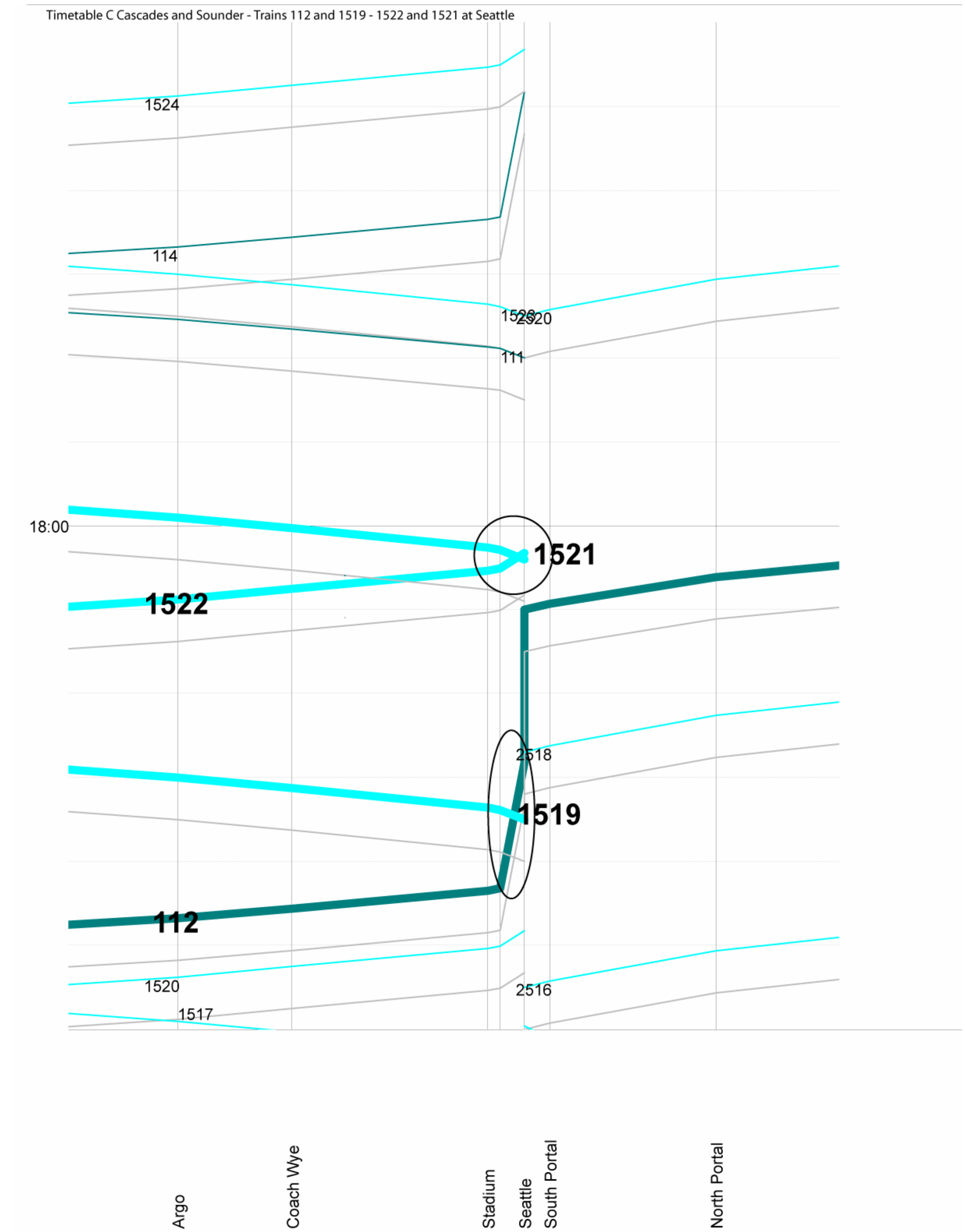


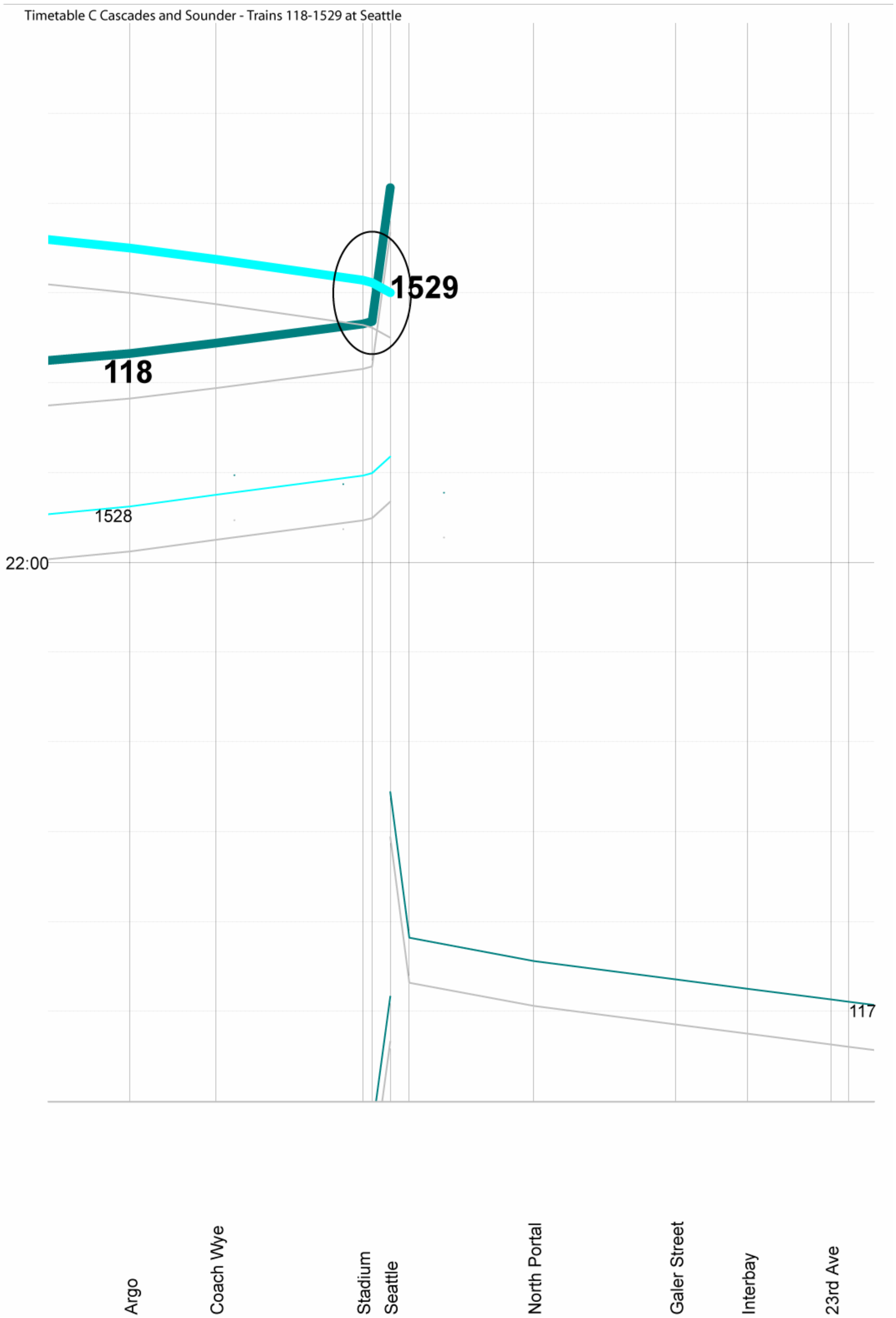
Timetable C Cascades and Sounder - Trains 1508 and 103 - 1507 and 104 at Seattle





Timetable C Cascades and Sounder - Trains 1508 113 and 1515 at Seattle
1517
2519
1515
2514
2523
1518
16:00
113
1513
Argo
Coach Wye
Stadium
Seattle
South Portal
North Portal


Timetable C Cascades and Sounder - Trains 112 and 1519 - 1522 and 1521 at Seattle
1524
114
1520
2520
111
18:00
1521
1522
2518
1519
112
1520
2516
1517
Argo
Coach Wye
Stadium
Seattle
South Portal
North Portal



Timetable C Cascades and Sounder - Trains 118-1529 at Seattle
1529
118
1528
22:00
117
Argo
Coach Wye
Stadium
Seattle
North Portal
Galer Street
Interbay
23rd Ave

TIMETABLE D — **SOUTHWARD TRAINS**

Example Train Numbers	1529	1527	119	1525	1523	121	1521	1519	117	2523	1517	2519	1515	1513	113	1511
Vancouver BC						6:15 P										
Bellingnham						7:40 P										
Mt Vernon						8:09 P										
Everett						8:44 P				5:13 P		4:13 P				
Mukilteo										5:21 P		4:21 P				
Edmonds						9:03 P				5:35 P		4:35 P				
Seattle	10:30 P	8:10 P	7:30 P	7:15 P	6:25 P	9:40 P	5:55 P	5:25 P	5:20 P	6:00 P	4:50 P	5:00 P	4:05 P	3:10 P	2:35 P	1:50 P
Tukwila	10:43 P	8:23 P	7:42 P	7:28 P	6:38 P		6:08 P	5:38 P	5:32 P		5:03 P		4:18 P	3:23 P	2:47 P	2:03 P
Kent	10:49 P	8:29 P		7:34 P	6:44 P		6:14 P	5:44 P			5:09 P		4:24 P	3:29 P		2:09 P
Auburn	10:56 P	8:36 P		7:41 P	6:51 P		6:21 P	5:51 P			5:16 P		4:31 P	3:36 P		2:16 P
Sumner	11:04 P	8:44 P		7:49 P	6:59 P		6:29 P	5:59 P			5:24 P		4:39 P	3:44 P		2:24 P
Puyallup	11:09 P	8:49 P		7:54 P	7:04 P		6:34 P	6:04 P			5:29 P		4:44 P	3:49 P		2:29 P
Tacoma	11:20 P	9:00 P	8:09 P	8:05 P	7:15 P		6:45 P	6:15 P	5:59 P		5:40 P		4:55 P	4:00 P	3:14 P	2:40 P
South Tacoma	11:28 P	9:08 P		8:13 P	7:23 P		6:53 P	6:23 P			5:48 P		5:03 P	4:08 P		2:48 P
Lakewood	11:33 P	9:13 P		8:18 P	7:28 P		6:58 P	6:28 P			5:53 P		5:08 P	4:13 P		2:53 P
Centennial			8:31 P						6:21 P						3:36 P	
Centralia			8:52 P						6:42 P						3:57 P	
Kelso			9:27 P						7:17 P						4:32 P	
Vancouver			9:59 P						7:49 P						5:04 P	
Portland			10:25 P						8:15 P						5:30 P	

TIMETABLE D — **SOUTHWARD TRAINS**

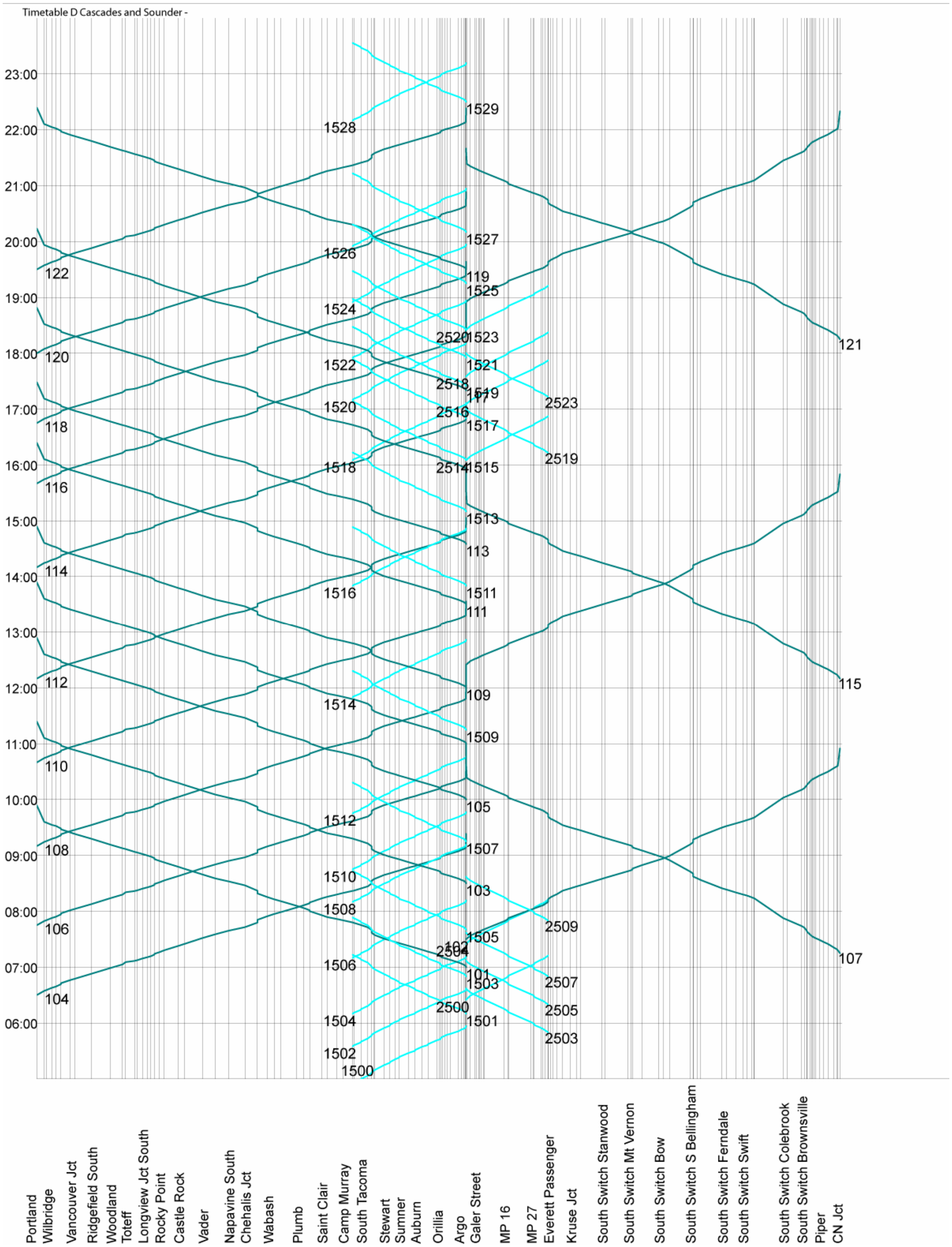
Example Train Numbers	111	115	109	1509	105	1507	103	2509	1505	107	101	2507	1503	2505	1501	2503
Vancouver BC		12:10 P								7:15 A						
Bellingnham		1:35 P								8:40 A						
Mt Vernon		2:04 P								9:09 A						
Everett		2:39 P						7:50 A		9:44 A		6:50 A		6:20 A		5:50 A
Mukilteo								7:58 A				6:58 A		6:28 A		5:58 A
Edmonds		2:58 P						8:12 A		10:03 A		7:12 A		6:42 A		6:12 A
Seattle	1:30 P	3:35 P 3:55 P	12:00 P	11:15 A	10:00 A	9:15 A	8:30 A	8:37 A	7:40 A	10:40 A 11:00A	7:00 A	7:37 A	6:50 A	7:07 A	6:10 A	6:37 A
Tukwila	1:42 P	4:07 P	12:12 P	11:28 A	10:12 A	9:28 A	8:42 A		7:53 A	11:12 A	7:12 A		7:03 A		6:23 A	
Kent				11:34 A		9:34 A			7:59 A				7:09 A		6:29 A	
Auburn				11:41 A		9:41 A			8:06 A				7:16 A		6:36 A	
Sumner				11:49 A		9:49 A			8:14 A				7:24 A		6:44 A	
Puyallup				11:54 A		9:54 A			8:19 A				7:29 A		6:49 A	
Tacoma	2:09 P	4:34 P	12:39 P	12:05 P	10:36 A	10:05 A	9:09 A		8:30 A	11:39 A	7:39 A		7:40 A		7:00 A	
South Tacoma				12:13 P		10:13 A			8:38 A				7:48 A		7:08 A	
Lakewood				12:18 P		10:18 A			8:43 A				7:53 A		7:13 A	
Centennial	2:31 P	4:56 P	1:01 P		11:01 A		9:31 A			12:01 P	8:01 A					
Centralia	2:52 P	5:17 P	1:22 P		11:22 A		9:52 A			12:22 P	8:22 A					
Kelso	3:27 P	5:52 P	1:57 P		11:57 A		10:27 A			12:57 P	8:57 A					
Vancouver	3:59 P	6:24 P	2:29 P		12:29 P		10:59 A			1:29 P	9:29 A					
Portland	4:25 P	6:50 P	2:55 P		12:55 P		11:25 A			1:55 P	9:55 A					

TIMETABLE D — **NORTHWARD TRAINS**

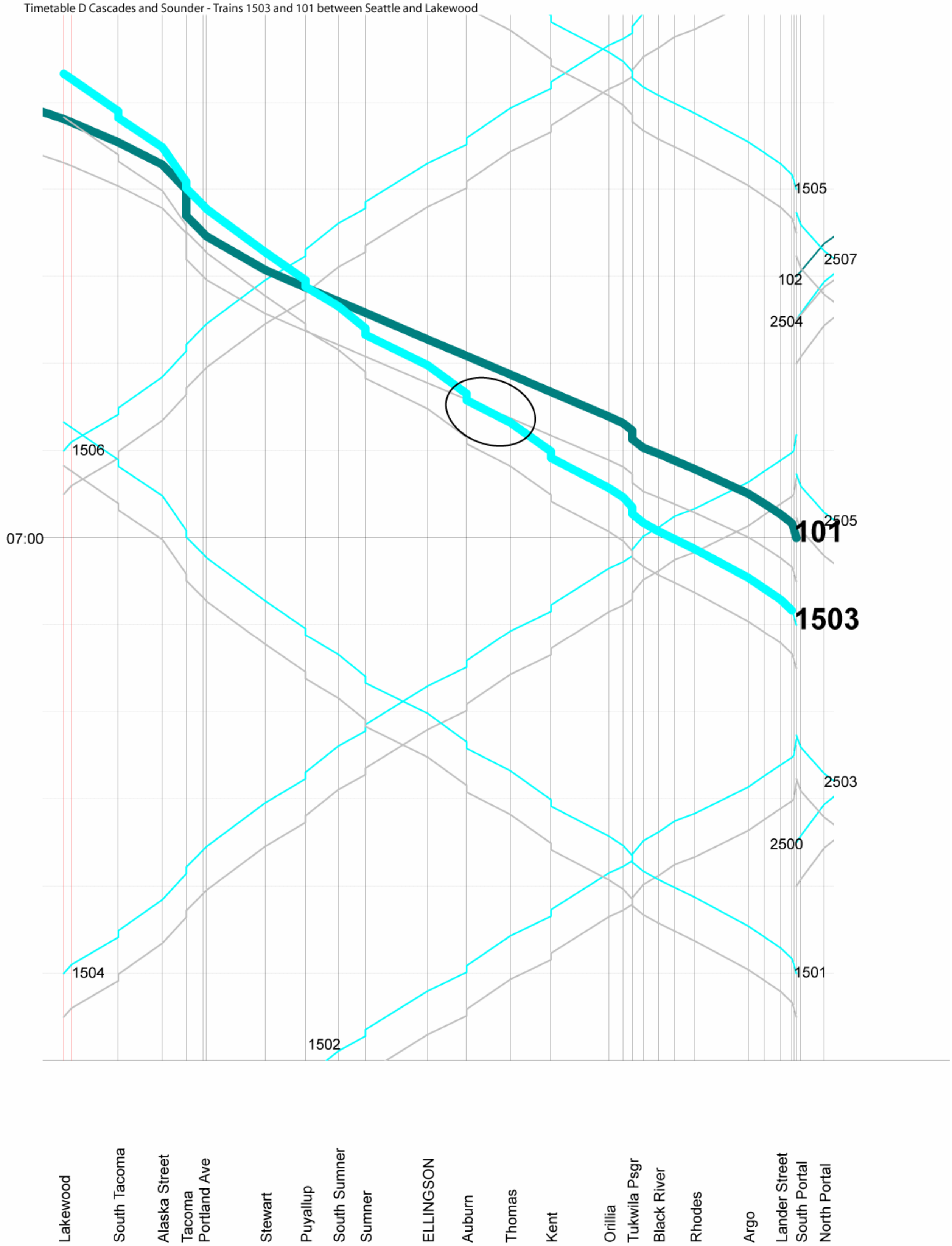
Example Train Numbers	1500	1502	1504	2500	104	1506	2504	102	106	1508	1510	108	1512	110	1514	112
Vancouver BC								10:55 A				3:50 P				
Bellingnham								9:17 A				2:12 P				
Mt Vernon								8:46 A				1:41 P				
Everett				7:12 A			8:12 A	8:13 A				1:08 P				
Mukilteo				7:04 A			8:04 A									
Edmonds				6:50 A			7:50 A	7:52 A				12:47 P				
Seattle	5:56 A	6:36 A	7:11 A	6:25 A	9:25 A	8:11 A	7:25 A	7:30 A	10:40 A	9:11 A	9:46 A	12:25 P 12:05 P	10:46 A	1:35 P	12:51 P	3:05 P
Tukwila	5:43 A	6:23 A	6:58 A		8:58 A	7:58 A			10:13 A	8:58 A	9:33 A	11:38 A	10:33 A	1:08 P	12:38 P	2:38 P
Kent	5:37 A	6:17 A	6:52 A			7:52 A				8:52 A	9:27 A		10:27 A		12:32 P	
Auburn	5:30 A	6:10 A	6:45 A			7:45 A				8:45 A	9:20 A		10:20 A		12:25 P	
Sumner	5:23 A	6:03 A	6:38 A			7:38 A				8:38 A	9:13 A		10:13 A		12:18 P	
Puyallup	5:18 A	5:58 A	6:33 A			7:33 A				8:33 A	9:08 A		10:08 A		12:13 P	
Tacoma	5:07 A	5:47 A	6:22 A		8:32 A	7:22 A			9:47 A	8:22 A	8:57 A	11:12 A	9:57 A	12:42 P	12:02 P	2:12 P
South Tacoma	4:59 A	5:39 A	6:14 A			7:14 A				8:14 A	8:49 A		9:49 A		11:54 A	
Lakewood	4:55 A	5:35 A	6:10 A			7:10 A				8:10 A	8:45 A		9:45 A		11:50 A	
Centennial					8:09 A				9:24 A			10:49 A		12:19 P		1:49 P
Centralia					7:50 A				9:05 A			10:30 A		12:00 P		1:30 P
Kelso					7:14 A				8:29 A			9:54 A		11:24 A		12:54 P
Vancouver					6:42 A				7:57 A			9:22 A		10:52 A		12:22 P
Portland					6:30 A				7:45 A			9:10 A		10:40 A		12:10 P

TIMETABLE D — **NORTHWARD TRAINS**

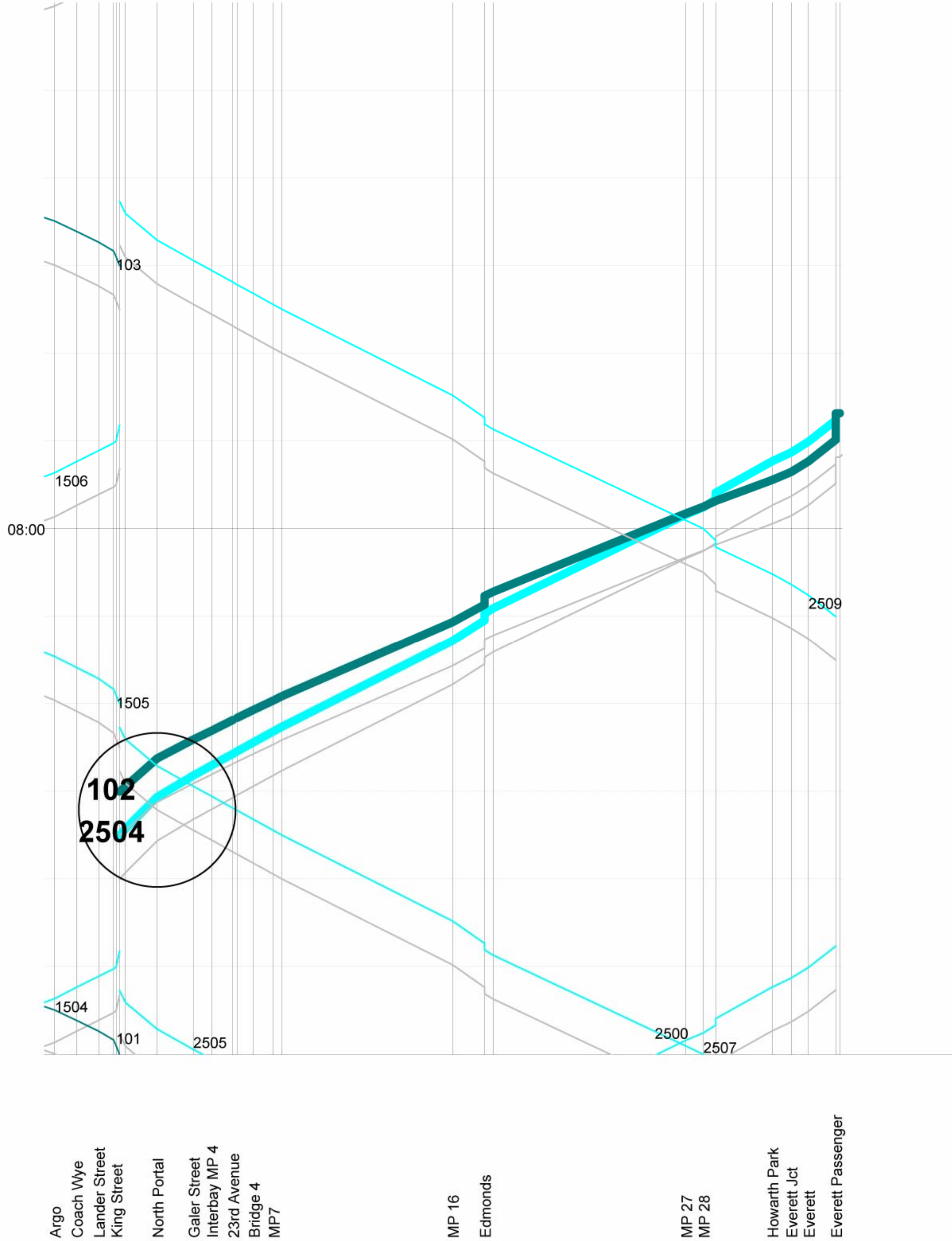
Example Train Numbers	1516	114	116	2514	1518	118	2516	1520	2518	1522	120	2520	1524	122	1526	1528
Vancouver BC			10:20 P													
Bellingnham			8:42 P													
Mt Vernon			8:11 P													
Everett			7:38 P	4:52 P			5:52 P		6:22 P			7:12 P				
Mukilteo				4:44 P			5:44 P		6:14 P			7:04 P				
Edmonds			7:17 P	4:30 P			5:30 P		6:00 P			6:50 P				
Seattle	2:51 P	5:05 P	6:55 P 6:35P	4:05 P	5:06 P	7:40 P	5:05 P	6:11 P	5:35 P	6:56 P	8:55 P	6:25 P	7:56 P	10:25 P	8:56 P	11:11 P
Tukwila	2:38 P	4:38 P	6:08 P		4:53 P	7:13 P		5:58 P		6:43 P	8:28 P		7:43 P	9:58 P	8:43 P	10:58 P
Kent	2:32 P				4:47 P			5:52 P		6:37 P			7:37 P		8:37 P	10:52 P
Auburn	2:25 P				4:40 P			5:45 P		6:30 P			7:30 P		8:30 P	10:45 P
Sumner	2:18 P				4:33 P			5:38 P		6:23 P			7:23 P		8:23 P	10:38 P
Puyallup	2:13 P				4:28 P			5:33 P		6:18 P			7:18 P		8:18 P	10:33 P
Tacoma	2:02 P	4:12 P	5:42 P		4:17 P	6:47 P		5:22 P		6:07 P	8:02 P		7:07 P	9:32 P	8:07 P	10:22 P
South Tacoma	1:54 P				4:09 P			5:14 P		5:59 P			6:59 P		7:59 P	10:14 P
Lakewood	1:50 P				4:05 P			5:10 P		5:55 P			6:55 P		7:55 P	10:10 P
Centennial		3:49 P	5:19 P			6:24 P					7:39 P			9:09 P		
Centralia		3:30 P	5:00 P			6:05 P					7:20 P			8:50 P		
Kelso		2:54 P	4:24 P			5:29 P					6:44 P			8:14 P		
Vancouver		2:22 P	3:52 P			4:57 P					6:12 P			7:42 P		
Portland		2:10 P	3:40 P			4:45 P					6:00 P			7:30 P		

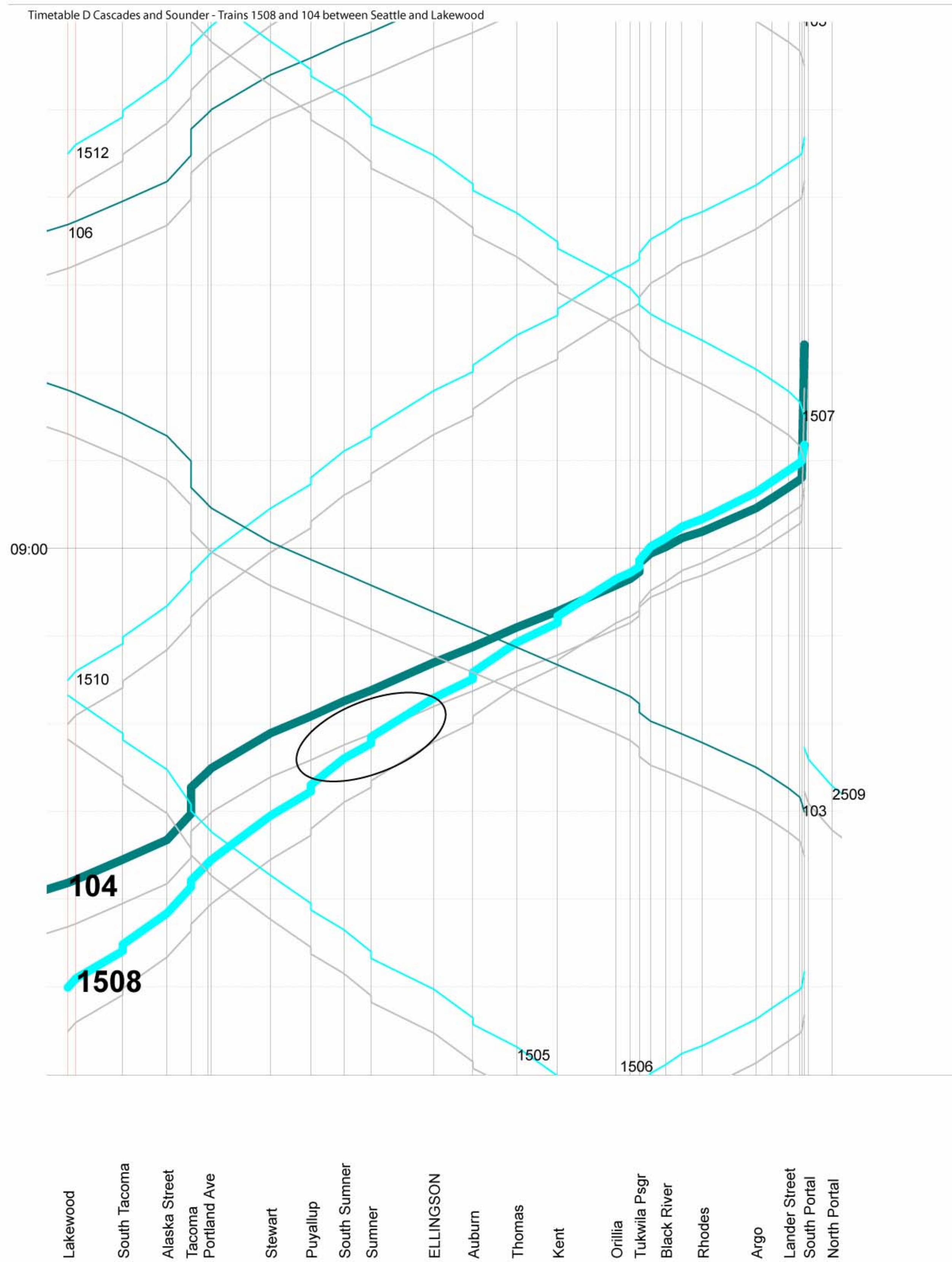

Timetable D Cascades and Sounder -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
1529
1528
1527
1526
122
119
1525
1524
121
2520
1523
120
1522
1521
2518
1519
117
2523
1520
2516
118
1517
2519
1518
2514
1515
116
1513
113
114
1516
1511
111
115
112
109
1514
1509
110
105
1512
1507
108
1510
103
1508
2509
106
1505
102
2504
107
1506
101
1503
2507
104
2500
2505
1504
1501
2503
1502
1500
Portland
Wilbridge
Vancouver Jct
Ridgefield South
Woodland
Toteff
Longview Jct South
Rocky Point
Castle Rock
Vader
Napavine South
Chehalis Jct
Wabash
Plumb
Saint Clair
Camp Murray
South Tacoma
Stewart
Sumner
Auburn
Orillia
Argo
Galer Street
MP 16
MP 27
Everett Passenger
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
South Switch S Bellingham
South Switch Ferndale
South Switch Swift
South Switch Colebrook
South Switch Brownsville
Piper
CN Jct

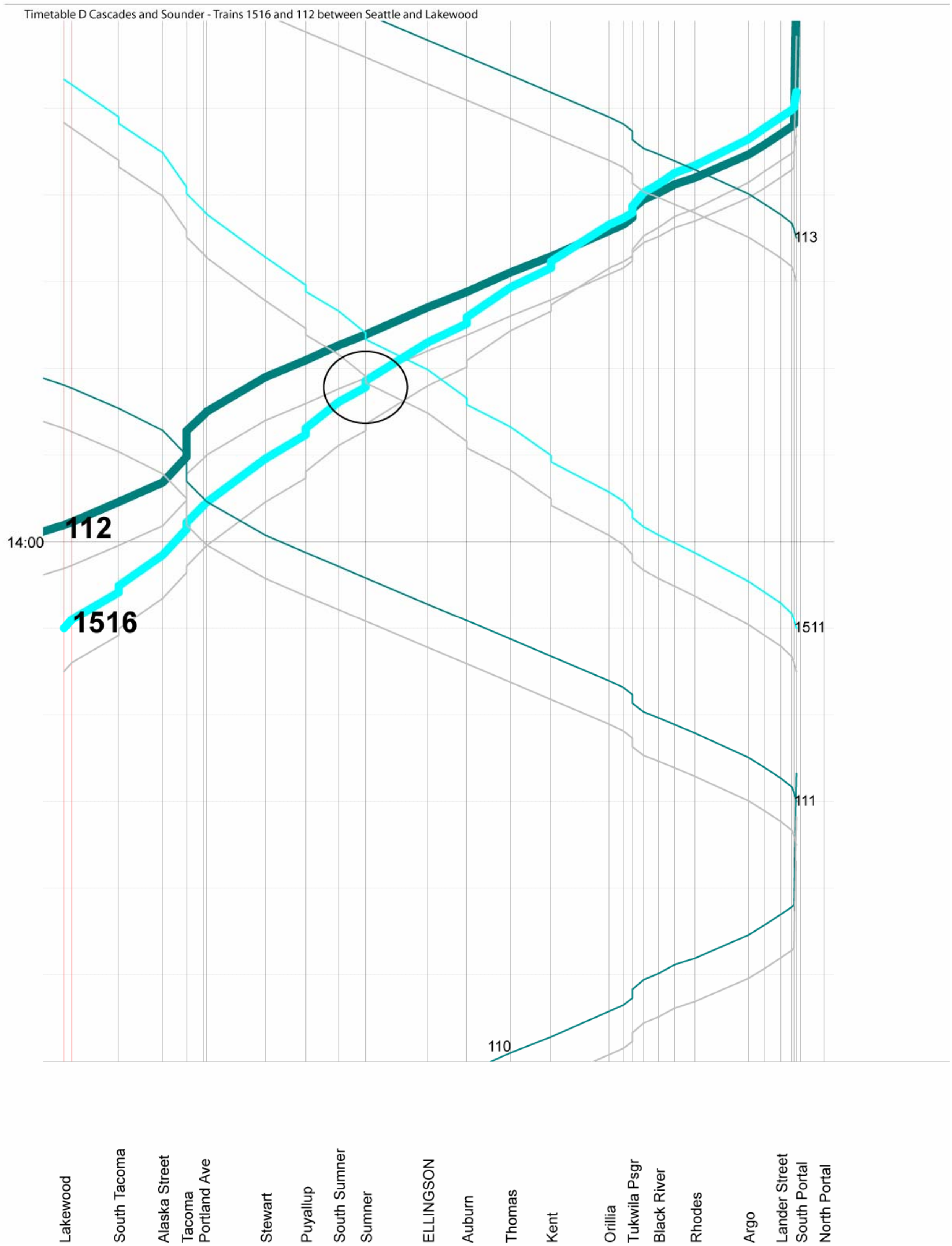
Timetable D Cascades and Sounder - Trains 1503 and 101 between Seattle and Lakewood



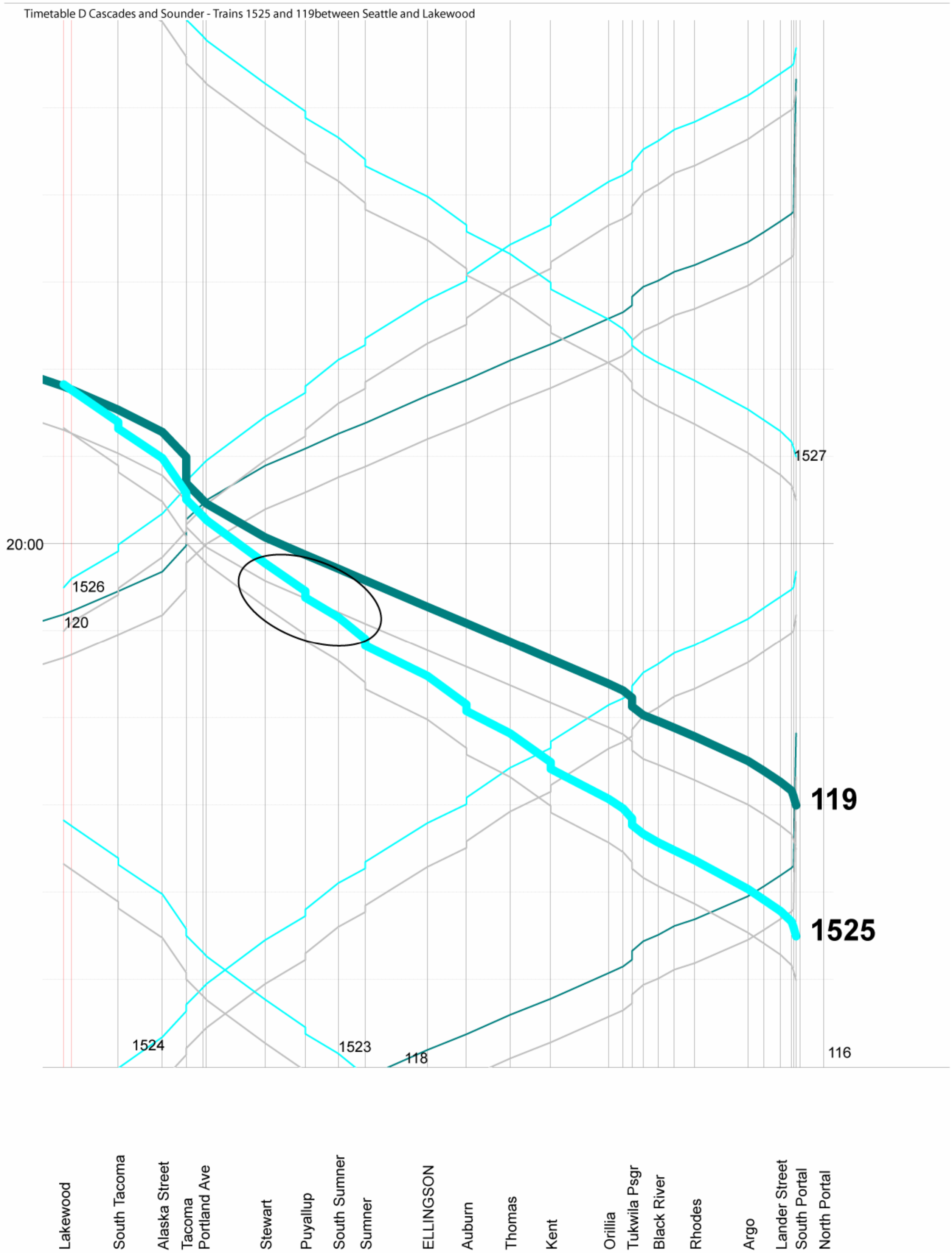
Timetable D Cascades and Sounder - Trains 2504 and 102 between Seattle and Everett




Timetable D Cascades and Sounder - Trains 1508 and 104 between Seattle and Lakewood
1512
106
1507
09:00
1510
2509
103
104
1508
1505
1506
Lakewood
South Tacoma
Alaska Street
Tacoma
Portland Ave
Stewart
Puyallup
South Sumner
Sumner
ELLINGSON
Auburn
Thomas
Kent
Orillia
Tukwila Psgr
Black River
Rhodes
Argo
Lander Street
South Portal
North Portal



Timetable D Cascades and Sounder - Trains 1516 and 112 between Seattle and Lakewood
14:00
112
1516
113
1511
111
110
Lakewood
South Tacoma
Alaska Street
Tacoma
Portland Ave
Stewart
Puyallup
South Sumner
Sumner
ELLINGSON
Auburn
Thomas
Kent
Orillia
Tukwila Psgr
Black River
Rhodes
Argo
Lander Street
South Portal
North Portal


Timetable D Cascades and Sounder - Trains 1525 and 119between Seattle and Lakewood
20:00
1527
1526
120
119
1525
1524
1523
118
116
Lakewood
South Tacoma
Alaska Street
Tacoma
Portland Ave
Stewart
Puyallup
South Sumner
Sumner
ELLINGSON
Auburn
Thomas
Kent
Orillia
Tukwila Psgr
Black River
Rhodes
Argo
Lander Street
South Portal
North Portal

TIMETABLE E — **SOUTHWARD TRAINS**

Example Train Numbers	1529	1527	123	1525	1523	121	1521	125	1519	2523	119	1517	2519	1515	1513	115	113
Vancouver BC								5:40 P									
Bellingham								7:05 P									
Mt Vernon								7:33 P									
Everett								8:08 P		5:13 P			4:13 P				
Mukilteo										5:21 P			4:21 P				
Edmonds								8:26 P		5:35 P			4:35 P				
Seattle	10:30 P	8:10 P	7:20 P	7:15 P	6:25 P	6:10 P	5:55 P	9:05 P	5:25 P	6:00 P	5:10 P	4:50 P	5:00 P	4:05 P	3:10 P	3:00 P	1:55 P
Tukwila	10:43 P	8:23 P	7:32 P	7:28 P	6:38 P	6:22 P	6:08 P		5:38 P		5:22 P	5:03 P		4:18 P	3:23 P	3:12 P	2:07 P
Kent	10:49 P	8:29 P		7:34 P	6:44 P		6:14 P		5:44 P			5:09 P		4:24 P	3:29 P		
Auburn	10:56 P	8:36 P		7:41 P	6:51 P		6:21 P		5:51 P			5:16 P		4:31 P	3:36 P		
Sumner	11:04 P	8:44 P		7:49 P	6:59 P		6:29 P		5:59 P			5:24 P		4:39 P	3:44 P		
Puyallup	11:09 P	8:49 P		7:54 P	7:04 P		6:34 P		6:04 P			5:29 P		4:44 P	3:48 P		
Tacoma	11:20 P	9:00 P	7:59 P	8:05 P	7:15 P	6:49 P	6:45 P		6:15 P		5:49 P	5:40 P		4:55 P	4:00 P	3:39 P	2:34 P
South Tacoma	11:28 P	9:08 P		8:13 P	7:23 P		6:53 P		6:23 P			5:48 P		5:03 P	4:08 P		
Lakewood	11:33 P	9:13 P		8:18 P	7:28 P		6:58 P		6:28 P			5:53 P		5:08 P	4:12 P		
Centralia			8:39 P			7:29 P					6:29 P					4:19 P	3:14 P
Kelso			9:06 P			7:56 P					6:56 P					4:46 P	3:41 P
Vancouver			9:37 P			8:27 P					7:27 P					5:17 P	4:12 P
Portland			10:05 P			8:55 P					7:55 P					5:45 P	4:40 P

TIMETABLE E — **SOUTHWARD TRAINS**

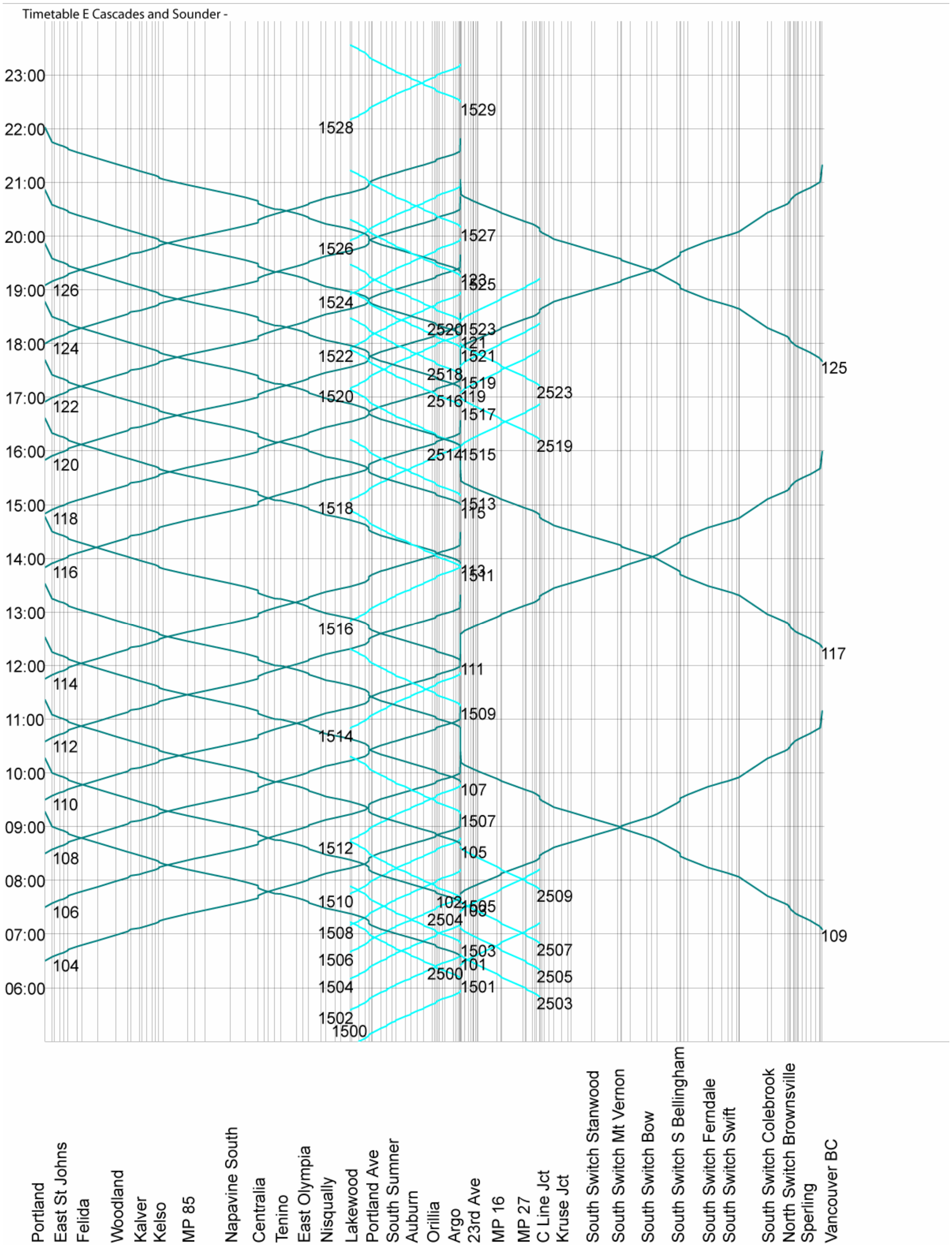
Example Train Numbers	1511	117	111	1509	107	1507	105	2509	1505	103	109	2507	1503	101	2505	1501	2503
Vancouver BC		12:20 P									7:05 A						
Bellingham		1:45 P									8:30 A						
Mt Vernon		2:13 P									8:58 A						
Everett		2:48 P						7:50 A			9:33 A	6:50 A			6:20 A		5:50 A
Mukilteo								7:58 A				6:58 A			6:28 A		5:58 A
Edmonds		3:06 P						8:12 A			9:51 A	7:12 A			6:42 A		6:12 A
		3:45 P						8:37 A			10:30 A	7:37 A			7:07 A		6:37 A
Seattle	1:50 P	4:05 P	12:05 P	11:15 A	9:50 A	9:15 A	8:40 A		7:40 A	7:35 A	10:50 P		6:50 A	6:35 A		6:10 A	
Tukwila	2:03 P	4:17 P	12:17 P	11:28 A	10:02 A	9:28 A	8:52 A		7:53 A	7:47 A	11:02 A		7:03 A	6:47 A		6:23 A	
Kent	2:09 P			11:34 A		9:34 A			7:59 A				7:09 A			6:29 A	
Auburn	2:16 P			11:41 A		9:41 A			8:06 A				7:16 A			6:36 A	
Sumner	2:24 P			11:49 A		9:49 A			8:14 A				7:24 A			6:44 A	
Puyallup	2:29 P			11:54 A		9:54 A			8:19 A				7:29 A			6:49 A	
Tacoma	2:40 P	4:44 P	12:44 P	12:05 P	10:29 A	10:05 A	9:19 A		8:30 A	8:14 A	11:29 A		7:40 A	7:14 A		7:00 A	
South Tacoma	2:48 P			12:13 P		10:13 A			8:38 A				7:48 A			7:08 A	
Lakewood	2:53 P			12:18 P		10:18 A			8:43 A				7:53 A			7:13 A	
Centralia		5:24 P	1:24 P		11:09 A		9:59 A			8:54 A	12:09 P			7:54 A			
Kelso		5:51 P	1:51 P		11:36 A		10:26 A			9:21 A	12:36 P			8:21 A			
Vancouver		6:22 P	2:22 P		12:07 P		10:57 A			9:52 A	1:07 P			8:52 A			
Portland		6:50 P	2:50 P		12:35 P		11:25 A			10:20 A	1:35 P			9:20 A			

TIMETABLE E — **NORTHWARD TRAINS**

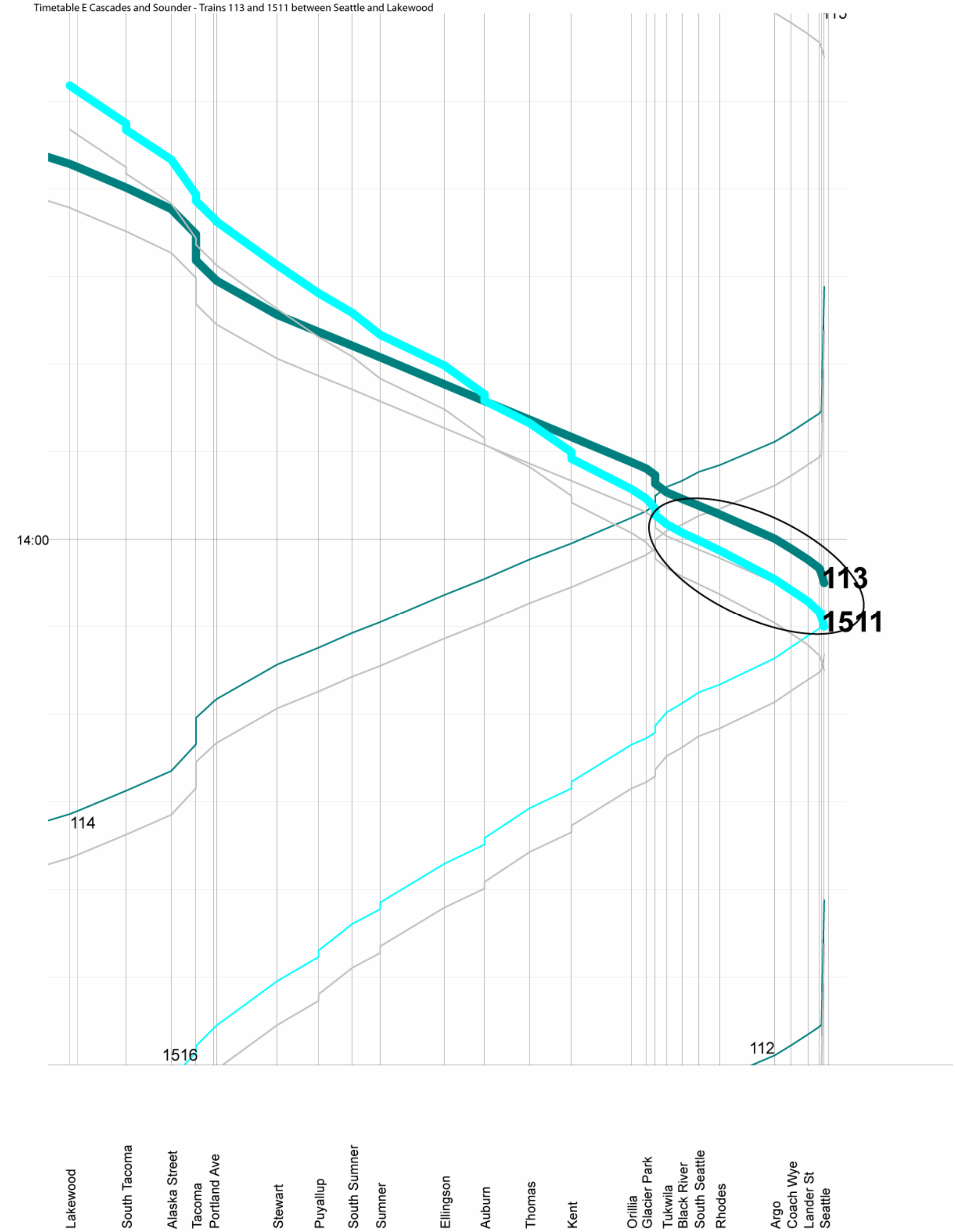
Example Train Numbers	1500	1502	1504	2500	104	1506	1508	2504	106	102	1510	108	1512	110	112	1514	114
Vancouver BC										11:10 A				4:00 P			
Bellingnham										9:31 A				2:21 P			
Mt Vernon										9:00 A				1:50 P			
Everett				7:12 A				8:12 A		8:27 A				1:17 P			
Mukilteo				7:04 A				8:04 A									
Edmonds				6:50 A				7:50 A		8:07 A				12:57 P			
Seattle	5:56 A	6:36 A	7:11 A	6:25 A	9:15 A	7:41 A	8:11 A	7:25 A	10:15 A	7:45 A	8:46 A	11:15 A	9:46 A	12:35 P 12:15 P	1:20 P	11:51 A	2:30 P
Tukwila	5:43 A	6:23 A	6:58 A		8:49 A	7:28 A	7:58 A		9:49 A		8:33 A	10:49 A	9:33 A	11:48 A	12:54 P	11:38 A	2:04 P
Kent	5:37 A	6:17 A	6:52 A			7:22 A	7:52 A				8:27 A		9:27 A			11:32 A	
Auburn	5:30 A	6:10 A	6:45 A			7:15 A	7:45 A				8:20 A		9:20 A			11:25 A	
Sumner	5:23 A	6:03 A	6:38 A			7:08 A	7:38 A				8:13 A		9:13 A			11:18 A	
Puyallup	5:18 A	5:58 A	6:33 A			7:03 A	7:33 A				8:08 A		9:08 A			11:13 A	
Tacoma	5:07 A	5:47 A	6:22 A		8:24 A	6:52 A	7:22 A		9:24 A		7:57 A	10:24 A	8:57 A	11:23 A	12:29 P	11:02 A	1:39 P
South Tacoma	4:59 A	5:39 A	6:14 A			6:44 A	7:14 A				7:49 A		8:49 A			10:54 A	
Lakewood	4:55 A	5:35 A	6:10 A			6:40 A	7:10 A				7:45 A		8:45 A			10:50 A	
Centralia					7:42 A				8:42 A			9:42 A		10:41 A	11:47 A		12:57 P
Kelso					7:14 A				8:14 A			9:14 A		10:13 A	11:19 A		12:29 P
Vancouver					6:42 A				7:42 A			8:42 A		9:42 A	10:47 A		11:57 A
Portland					6:30 A				7:30 A			8:30 A		9:30 A	10:35 A		11:45 A

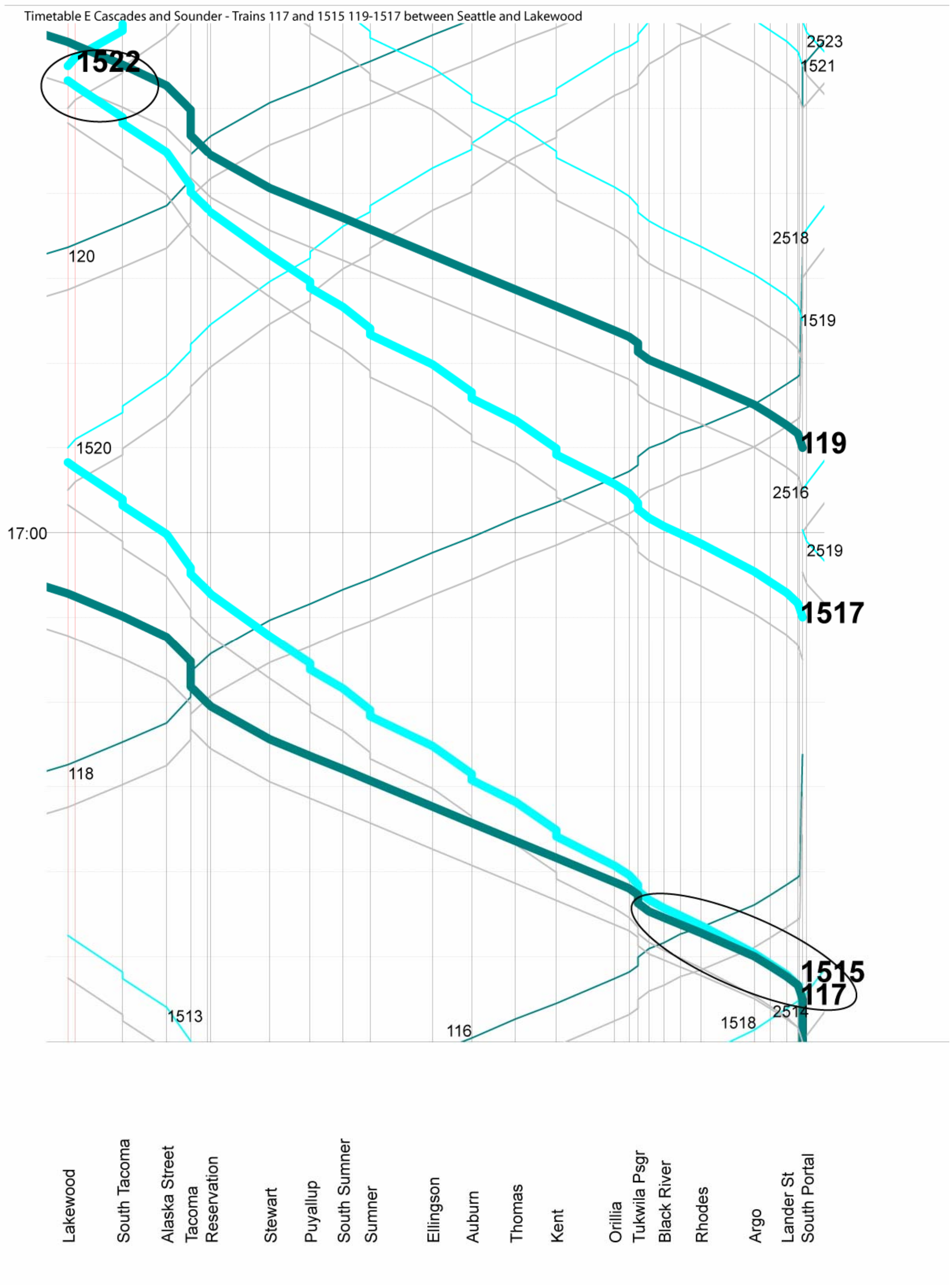
TIMETABLE E — **NORTHWARD TRAINS**

Example Train Numbers	1516	116	118	1518	120	2514	122	2516	1520	2518	1522	124	2520	1524	126	1526	1528
Vancouver BC			9:20 P														
Bellingnham			7:41 P														
Mt Vernon			7:10 P														
Everett			6:37 P			4:52 P		5:52 P		6:22 P			7:12 P				
Mukilteo						4:44 P		5:44 P		6:14 P			7:04 P				
Edmonds			6:17 P			4:30 P		5:30 P		6:00 P			6:50 P				
Seattle	1:51 P	4:35 P	5:55 P 5:35 P	4:06 P	6:35 P	4:05 P	7:40 P	5:05 P	6:11 P	5:35 P	6:56 P	8:45 P	6:25 P	7:56 P	9:50 P	8:56 P	11:11 P
Tukwila	1:38 P	4:09 P	5:08 P	3:53 P	6:09 P		7:14 P		5:58 P		6:43 P	8:19 P		7:43 P	9:24 P	8:43 P	10:58 P
Kent	1:32 P			3:47 P					5:52 P		6:37 P			7:37 P		8:37 P	10:52 P
Auburn	1:25 P			3:40 P					5:45 P		6:30 P			7:30 P		8:30 P	10:45 P
Sumner	1:18 P			3:33 P					5:38 P		6:23 P			7:23 P		8:23 P	10:38 P
Puyallup	1:13 P			3:28 P					5:33 P		6:18 P			7:18 P		8:18 P	10:33 P
Tacoma	1:02 P	3:44 P	4:43 P	3:17 P	5:44 P		6:49 P		5:22 P		6:07 P	7:54 P		7:07 P	8:59 P	8:07 P	10:22 P
South Tacoma	12:54 P			3:09 P					5:14 P		5:59 P			6:59 P		7:59 P	10:14 P
Lakewood	12:50 P			3:05 P					5:10 P		5:55 P			6:55 P		7:55 P	10:10 P
Centralia		3:02 P	4:01 P		5:02 P		6:07 P					7:12 P			8:17 P		
Kelso		2:34 P	3:33 P		4:34 P		5:39 P					6:44 P			7:49 P		
Vancouver		2:02 P	3:02 P		4:02 P		5:07 P					6:12 P			7:17 P		
Portland		1:50 P	2:50 P		3:50 P		4:55 P					6:00 P			7:05 P		


Timetable E Cascades and Sounder -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
Portland
East St Johns
Felida
Woodland
Kalver
Kelso
MP 85
Napavine South
Centralia
Tenino
East Olympia
Nisqually
Lakewood
Portland Ave
South Sumner
Auburn
Orillia
Argo
23rd Ave
MP 16
MP 27
C Line Jct
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
South Switch S Bellingham
South Switch Ferndale
South Switch Swift
South Switch Colebrook
North Switch Brownsville
Sperling
Vancouver BC

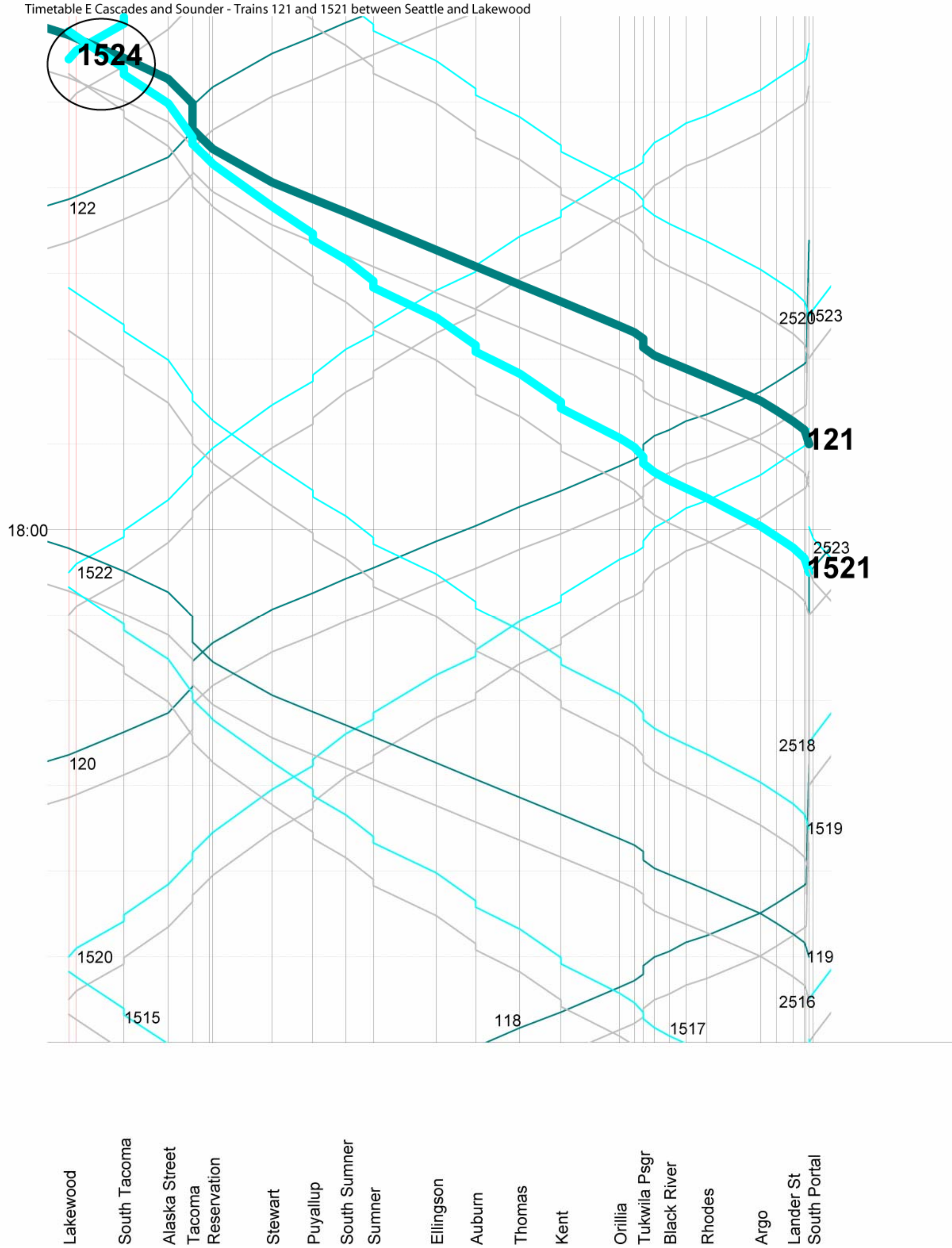
Timetable E Cascades and Sounder - Trains 113 and 1511 between Seattle and Lakewood

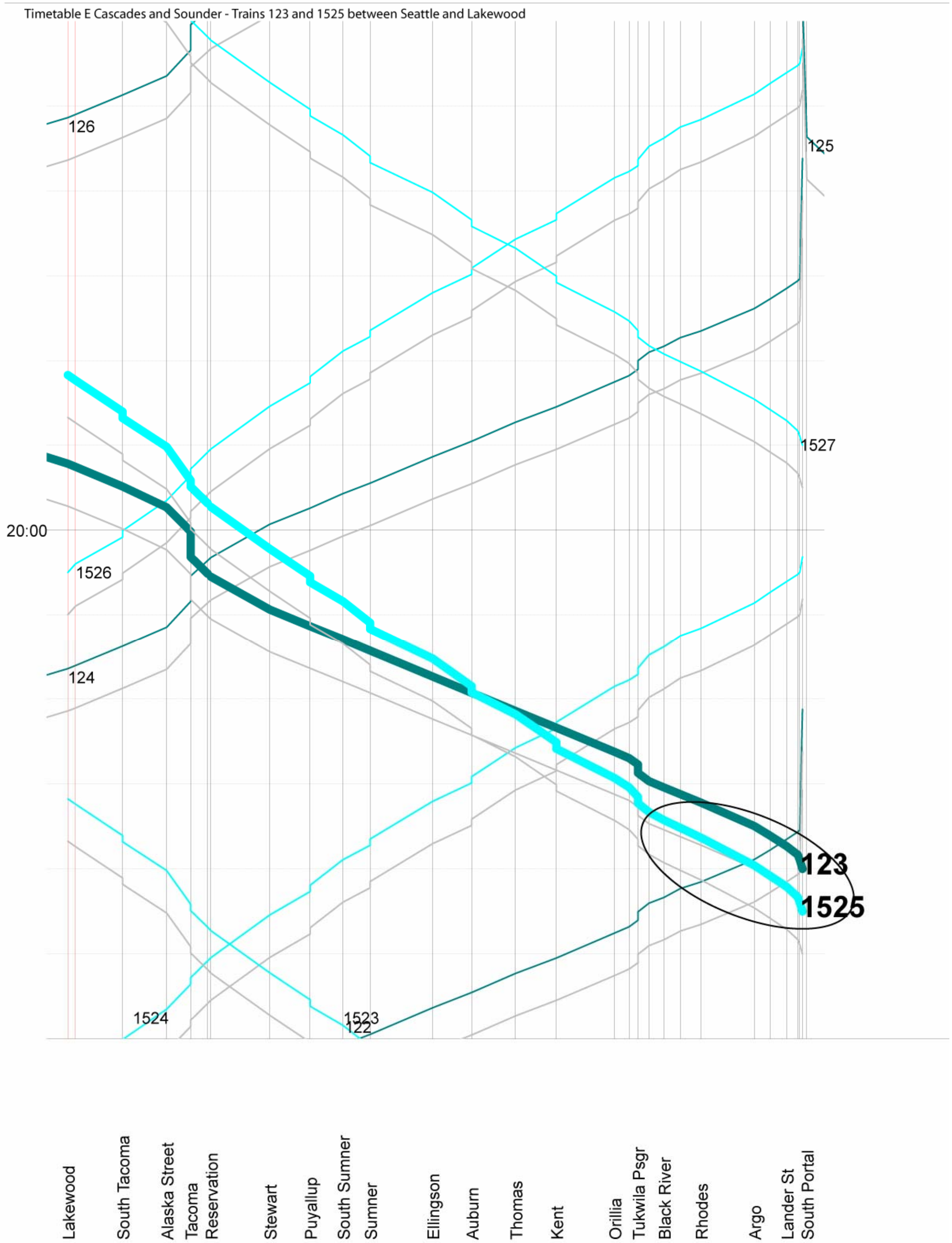




Timetable E Cascades and Sounder - Trains 117 and 1515 119-1517 between Seattle and Lakewood
1522
2523
1521
120
2518
1519
1520
119
2516
17:00
2519
1517
118
1515
117
1513
116
1518
2514
Lakewood
South Tacoma
Alaska Street
Tacoma
Reservation
Stewart
Puyallup
South Sumner
Sumner
Ellingson
Auburn
Thomas
Kent
Orillia
Tukwila Psgr
Black River
Rhodes
Argo
Lander St
South Portal

Timetable E Cascades and Sounder - Trains 121 and 1521 between Seattle and Lakewood





Timetable E Cascades and Sounder - Trains 123 and 1525 between Seattle and Lakewood
20:00
126
125
1527
1526
124
123
1525
1524
1523
122
Lakewood
South Tacoma
Alaska Street
Tacoma
Reservation
Stewart
Puyallup
South Sumner
Sumner
Ellingson
Auburn
Thomas
Kent
Orillia
Tukwila Psgr
Black River
Rhodes
Argo
Lander St
South Portal

TIMETABLE E — **NORTHWARD TRAINS**

Example Train Numbers	1500	1502	1504	2500	104	1506	1508	2504	106	102	1510	108	1512	110	112	1514	114
Vancouver BC										11:10 A				4:00 P			
Bellingnham										9:31 A				2:21 P			
Mt Vernon										9:00 A				1:50 P			
Everett				7:12 A				8:12 A		8:27 A				1:17 P			
Mukilteo				7:04 A				8:04 A									
Edmonds				6:50 A				7:50 A		8:07 A				12:57 P			
Seattle	5:56 A	6:36 A	7:11 A	6:25 A	9:15 A	7:41 A	8:11 A	7:25 A	10:15 A	7:45 A	8:46 A	11:15 A	9:46 A	12:35 P 12:15 P	1:20 P	11:51 A	2:30 P
Tukwila	5:43 A	6:23 A	6:58 A		8:49 A	7:28 A	7:58 A		9:49 A		8:33 A	10:49 A	9:33 A	11:48 A	12:54 P	11:38 A	2:04 P
Kent	5:37 A	6:17 A	6:52 A			7:22 A	7:52 A				8:27 A		9:27 A			11:32 A	
Auburn	5:30 A	6:10 A	6:45 A			7:15 A	7:45 A				8:20 A		9:20 A			11:25 A	
Sumner	5:23 A	6:03 A	6:38 A			7:08 A	7:38 A				8:13 A		9:13 A			11:18 A	
Puyallup	5:18 A	5:58 A	6:33 A			7:03 A	7:33 A				8:08 A		9:08 A			11:13 A	
Tacoma	5:07 A	5:47 A	6:22 A		8:24 A	6:52 A	7:22 A		9:24 A		7:57 A	10:24 A	8:57 A	11:23 A	12:29 P	11:02 A	1:39 P
South Tacoma	4:59 A	5:39 A	6:14 A			6:44 A	7:14 A				7:49 A		8:49 A			10:54 A	
Lakewood	4:55 A	5:35 A	6:10 A			6:40 A	7:10 A				7:45 A		8:45 A			10:50 A	
Centralia					7:42 A				8:42 A			9:42 A		10:41 A	11:47 A		12:57 P
Kelso					7:14 A				8:14 A			9:14 A		10:13 A	11:19 A		12:29 P
Vancouver					6:42 A				7:42 A			8:42 A		9:42 A	10:47 A		11:57 A
Portland					6:30 A				7:30 A			8:30 A		9:30 A	10:35 A		11:45 A

TIMETABLE E — **NORTHWARD TRAINS**

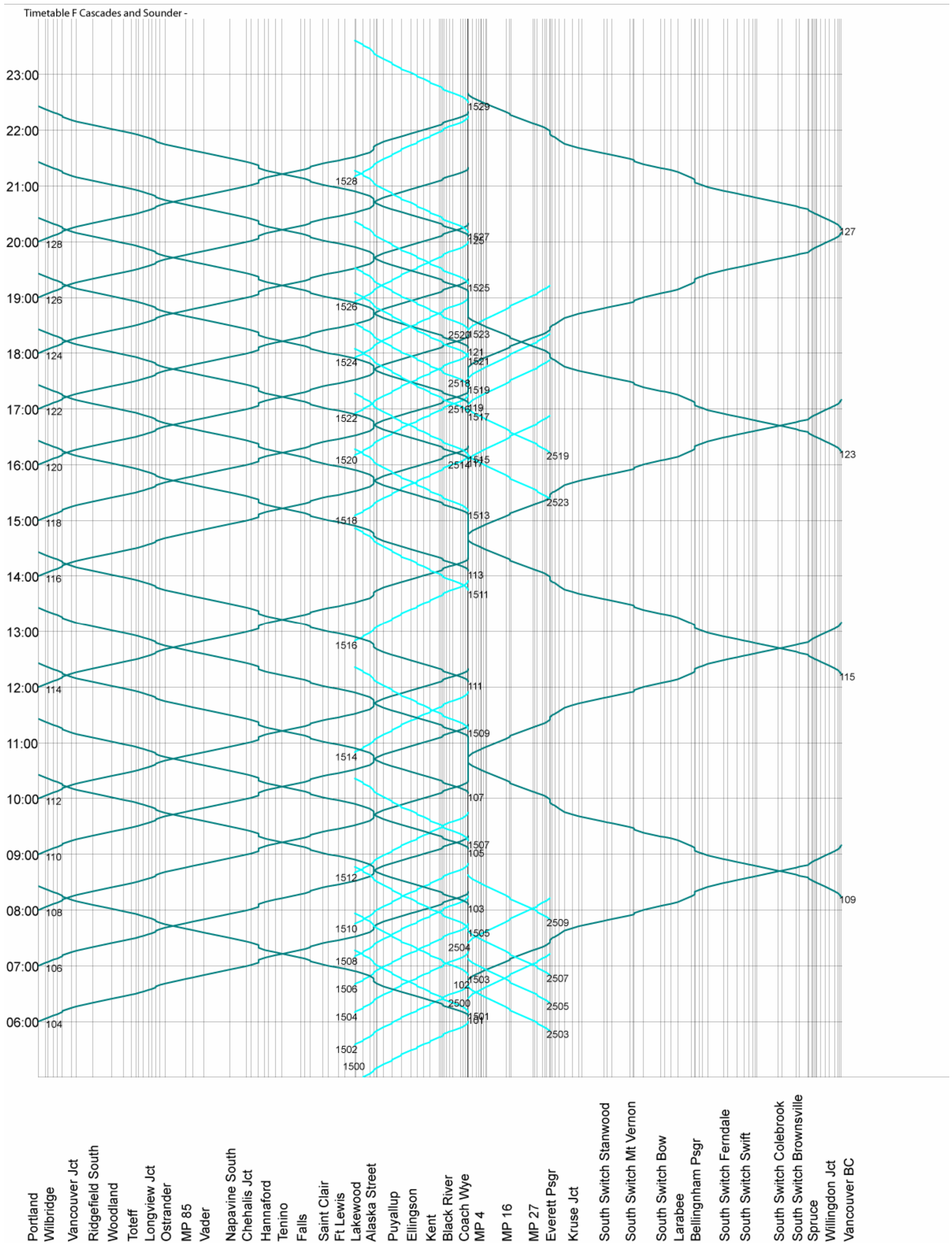
Example Train Numbers	1516	116	118	1518	120	2514	122	2516	1520	2518	1522	124	2520	1524	126	1526	1528
Vancouver BC			9:20 P														
Bellingnham			7:41 P														
Mt Vernon			7:10 P														
Everett			6:37 P			4:52 P		5:52 P		6:22 P			7:12 P				
Mukilteo						4:44 P		5:44 P		6:14 P			7:04 P				
Edmonds			6:17 P			4:30 P		5:30 P		6:00 P			6:50 P				
Seattle	1:51 P	4:35 P	5:55 P 5:35 P	4:06 P	6:35 P	4:05 P	7:40 P	5:05 P	6:11 P	5:35 P	6:56 P	8:45 P	6:25 P	7:56 P	9:50 P	8:56 P	11:11 P
Tukwila	1:38 P	4:09 P	5:08 P	3:53 P	6:09 P		7:14 P		5:58 P		6:43 P	8:19 P		7:43 P	9:24 P	8:43 P	10:58 P
Kent	1:32 P			3:47 P					5:52 P		6:37 P			7:37 P		8:37 P	10:52 P
Auburn	1:25 P			3:40 P					5:45 P		6:30 P			7:30 P		8:30 P	10:45 P
Sumner	1:18 P			3:33 P					5:38 P		6:23 P			7:23 P		8:23 P	10:38 P
Puyallup	1:13 P			3:28 P					5:33 P		6:18 P			7:18 P		8:18 P	10:33 P
Tacoma	1:02 P	3:44 P	4:43 P	3:17 P	5:44 P		6:49 P		5:22 P		6:07 P	7:54 P		7:07 P	8:59 P	8:07 P	10:22 P
South Tacoma	12:54 P			3:09 P					5:14 P		5:59 P			6:59 P		7:59 P	10:14 P
Lakewood	12:50 P			3:05 P					5:10 P		5:55 P			6:55 P		7:55 P	10:10 P
Centralia		3:02 P	4:01 P		5:02 P		6:07 P					7:12 P			8:17 P		
Kelso		2:34 P	3:33 P		4:34 P		5:39 P					6:44 P			7:49 P		
Vancouver		2:02 P	3:02 P		4:02 P		5:07 P					6:12 P			7:17 P		
Portland		1:50 P	2:50 P		3:50 P		4:55 P					6:00 P			7:05 P		

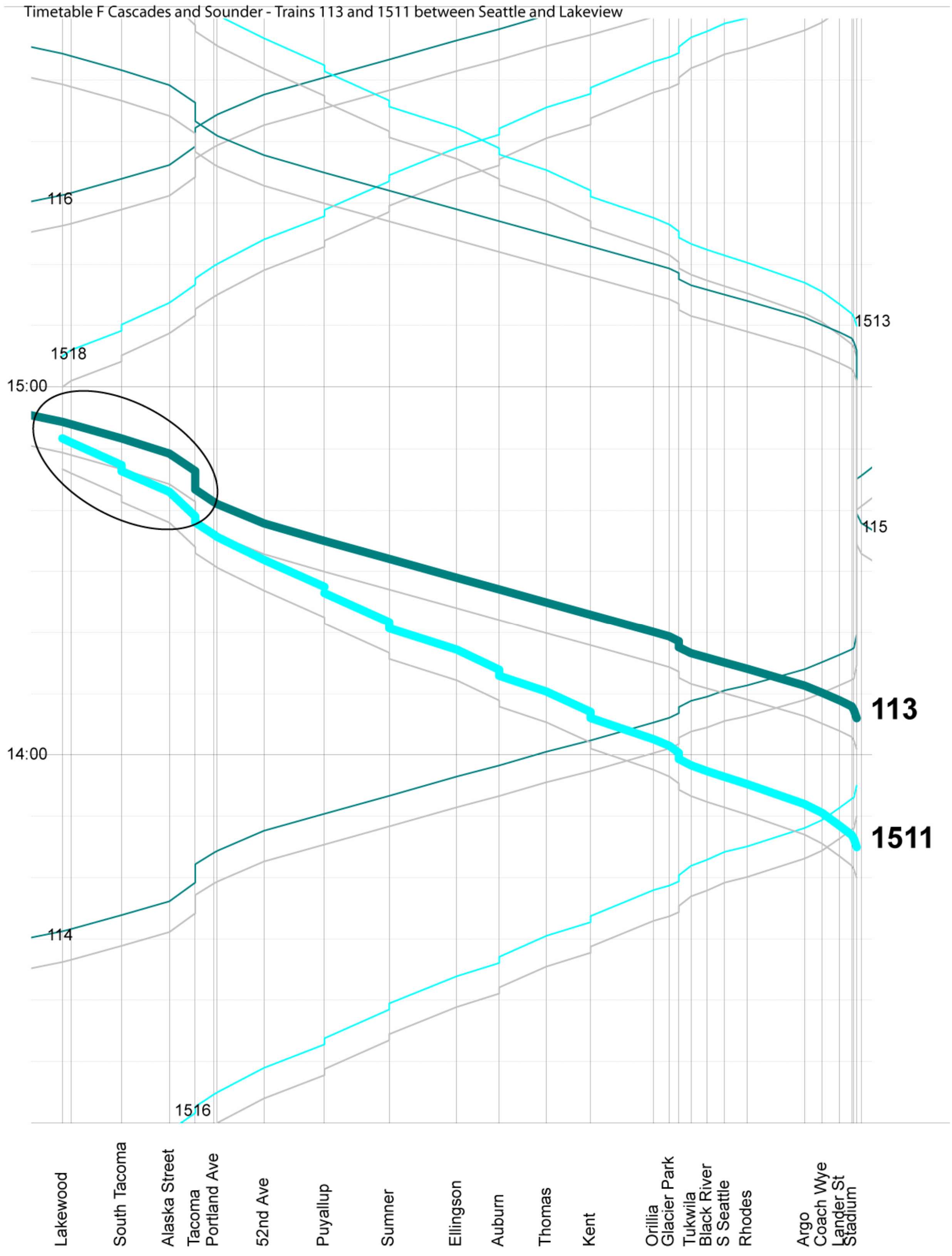
TIMETABLE F — **SOUTHWARD TRAINS**

Example Train Numbers	1529	127	1527	125	1525	1523	121	1521	1519	119	1517	123	2519	1515	117	2523	1513	113
Vancouver BC		8:14 P										4:14 P						
Bellingnham		9:07 P										5:07 P						
Mt Vernon		9:27 P										5:27 P						
Everett		9:59 P										5:59 P	4:13 P			3:23 P		
Mukilteo													4:21 P			3:31 P		
Edmonds		10:17 P										6:17 P	4:36 P			3:46 P		
		10:51 P										6:51 P	5:05 P			5:15 P		
Seattle	10:30 P		8:10 P	8:06 P	7:15 P	6:25 P	6:06 P	5:56 P	5:25 P	5:06 P	4:56 P	7:06 P		4:10 P	4:06 P		3:10 P	2:06 P
Tukwila	10:45 P		8:25 P	8:18 P	7:30 P	6:40 P	6:18 P	6:11 P	5:40 P	5:18 P	5:11 P	7:18 P		4:25 P	4:18 P		3:25 P	2:18 P
Kent	10:52 P		8:32 P		7:37 P	6:47 P		6:18 P	5:47 P		5:18 P			4:32 P			3:32 P	
Auburn	10:58 P		8:38 P		7:43 P	6:53 P		6:24 P	5:53 P		5:24 P			4:38 P			3:38 P	
Sumner	11:06 P		8:46 P		7:51 P	7:01 P		6:34 P	6:01 P		5:34 P			4:46 P			3:46 P	
Puyallup	11:12 P		8:52 P		7:57 P	7:07 P		6:40 P	6:07 P		5:40 P			4:52 P			3:52 P	
Tacoma	11:23 P		9:03 P	8:46 P	8:08 P	7:18 P	6:46 P	6:52 P	6:18 P	5:46 P	5:52 P	7:46 P		5:03 P	4:46 P		4:03 P	2:46 P
South Tacoma	11:32 P		9:12 P		8:17 P	7:27 P		7:00 P	6:27 P		6:00 P			5:12 P			4:12 P	
Lakewood	11:52 P		9:32 P		8:37 P	7:47 P		7:17 P	6:47 P		6:12 P			5:27 P			4:32 P	
Centennial				9:05 P			7:05 P			6:05 P		8:05 P			5:05 P			3:05 P
Centralia				9:22 P			7:22 P			6:22 P		8:22 P			5:22 P			3:22 P
Kelso				9:49 P			7:49 P			6:49 P		8:49 P			5:49 P			3:49 P
Vancouver				10:15 P			8:15 P			7:15 P		9:15 P			6:15 P			4:15 P
Portland				10:36 P			8:36 P			7:36 P		9:36 P			6:36 P			4:36 P

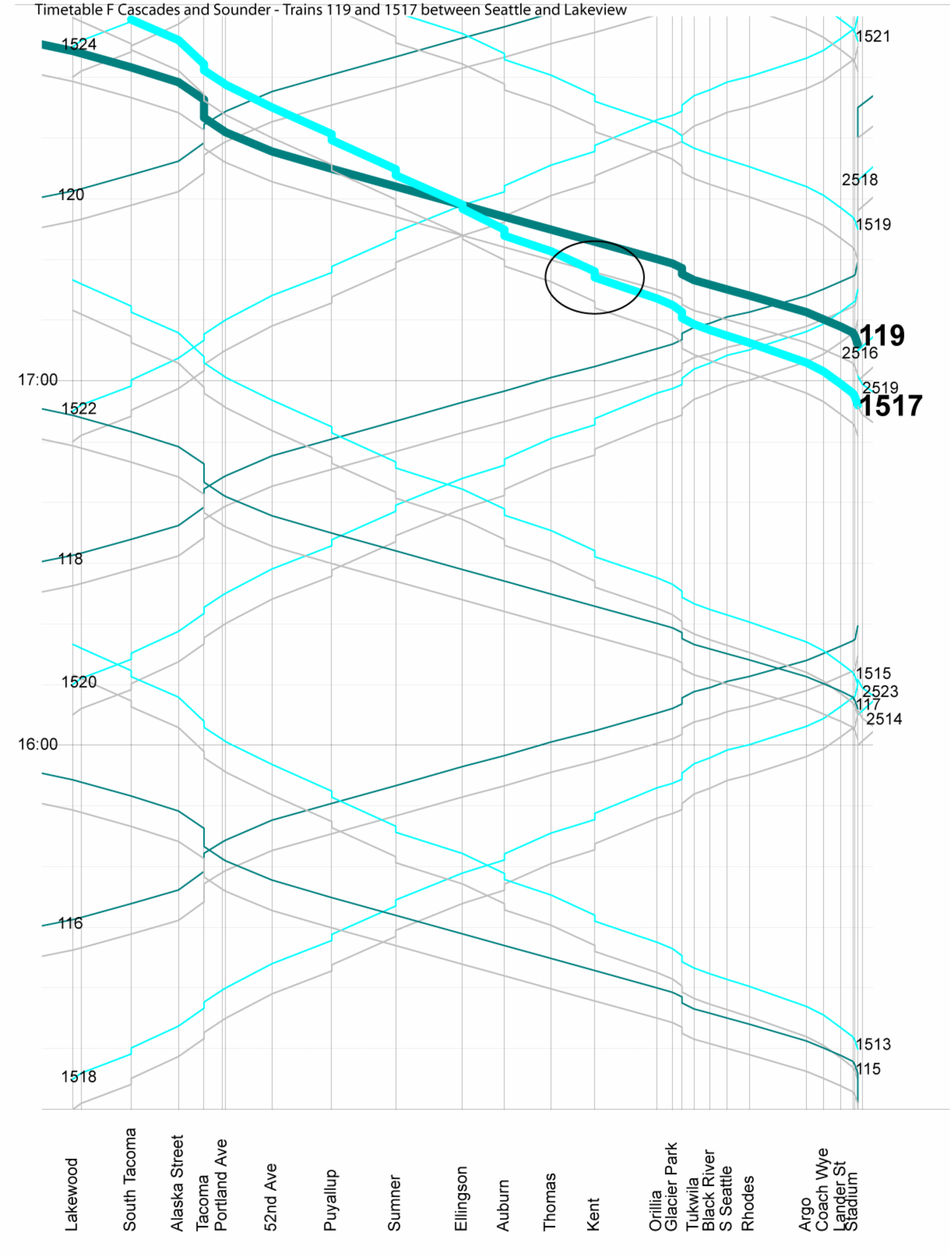
TIMETABLE F — **SOUTHWARD TRAINS**

Example Train Numbers	1511	115	111	1509	107	1507	105	109	103	2509	1505	2507	1503	2505	1501	101	2503
Vancouver BC		12:14 P						8:14 A									
Bellingnham		1:07 P						9:07 A									
Mt Vernon		1:27 P						9:27 A									
Everett		1:59 P						9:59 A		7:50 A		6:50 A		6:20 A			5:50 A
Mukilteo										7:58 A		6:58 A		6:28 A			5:58 A
Edmonds		2:17 P						10:17 A		8:13 A		7:13 A		6:43 A			6:13 A
		2:51 P						10:51 A		8:42 A		7:42 A		7:12 A			
Seattle	1:45 P	3:06 P	12:06 P	11:15 A	10:06 A	9:15 A	9:06 A	11:06 A	8:06 A		7:40 A		6:50 A		6:10 A	6:06 A	6:42 A
Tukwila	2:00 P	3:18 P	12:18 P	11:30 A	10:18 A	9:30 A	9:18 A	11:18 A	8:18 A		7:55 A		7:05 A		6:25 A	6:18 A	
Kent	2:07 P			11:37 A		9:37 A					8:02 A		7:12 A		6:32 A		
Auburn	2:13 P			11:43 A		9:43 A					8:08 A		7:18 A		6:38 A		
Sumner	2:21 P			11:51 A		9:51 A					8:16 A		7:26 A		6:46 A		
Puyallup	2:27 P			11:57 A		9:57 A					8:22 A		7:32 A		6:52 A		
Tacoma	2:38 P	3:46 P	12:46 P	12:08 P	10:46 A	10:08 A	9:46 A	11:46 A	8:46 A		8:33 A		7:43 A		7:03 A	6:46 A	
South Tacoma	2:47 P			12:17 P		10:17 A					8:42 A		7:52 A		7:12 A		
Lakewood	3:12 P			12:37 P		10:37 A					9:02 A		8:12 A		7:32 A		
Centennial		4:05 P	1:05 P		11:05 A		10:05 A	12:05 P	9:05 A							7:05 A	
Centralia		4:22 P	1:22 P		11:22 A		10:22 A	12:22 P	9:22 A							7:22 A	
Kelso		4:49 P	1:49 P		11:49 A		10:49 A	12:49 P	9:49 A							7:49 A	
Vancouver		5:15 P	2:15 P		12:15 P		11:15 A	1:15 P	10:15 A							8:15 A	
Portland		5:36 P	2:36 P		12:36 P		11:36 A	1:36 P	10:36 A							8:36 A	

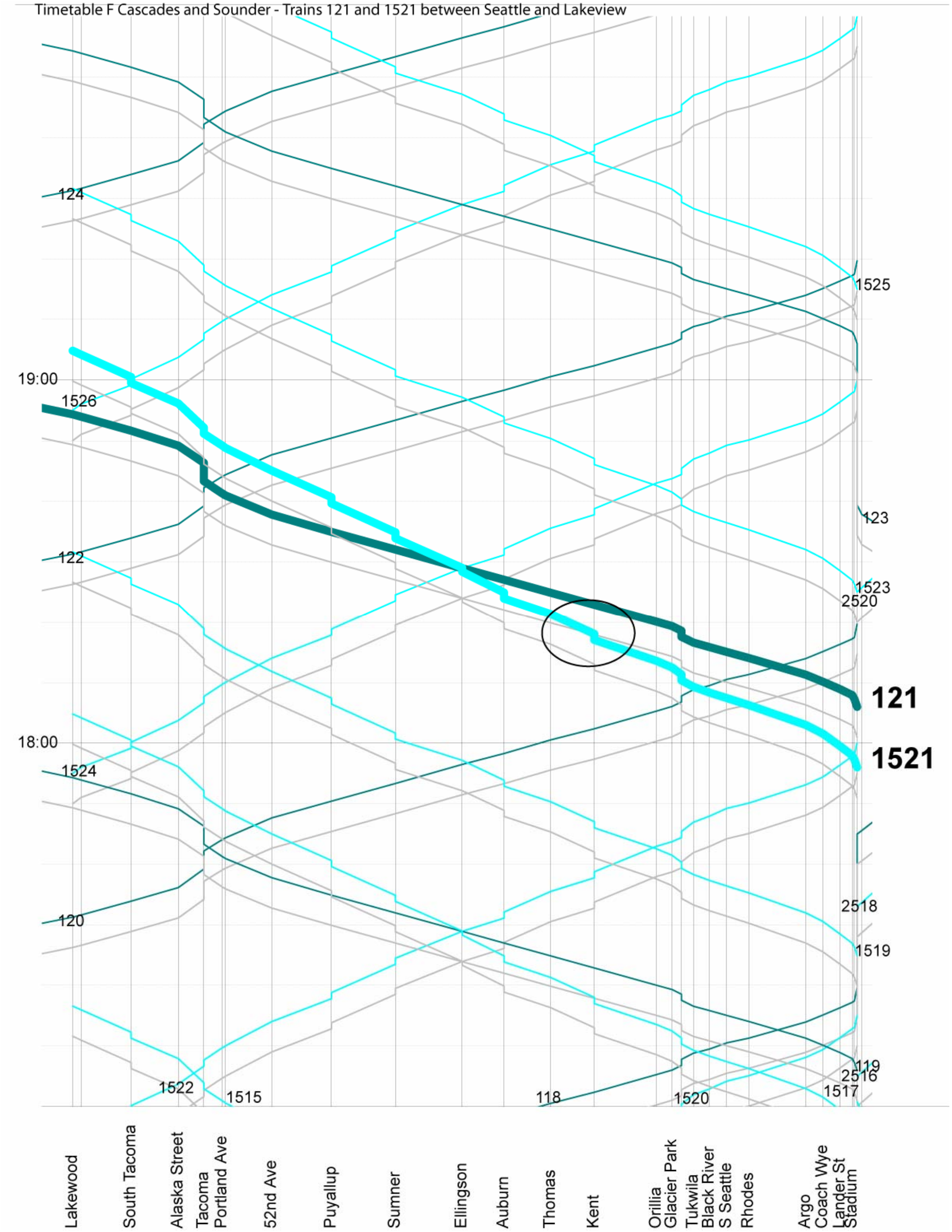

Timetable F Cascades and Sounder -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
Portland
Wilbridge
Vancouver Jct
Ridgefield South
Woodland
Toteff
Longview Jct
Ostrander
MP 85
Vader
Napavine South
Chehalis Jct
Hannaford
Tenino
Falls
Saint Clair
Ft Lewis
Lakewood
Alaska Street
Puyallup
Ellingson
Kent
Black River
Coach Wye
MP 4
MP 16
MP 27
Everett Psgr
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
Larabee
Bellingham Psgr
South Switch Ferndale
South Switch Swift
South Switch Colebrook
South Switch Brownsville
Spruce
Willingdon Jct
Vancouver BC


Timetable F Cascades and Sounder - Trains 113 and 1511 between Seattle and Lakeview
116
1518
1513
15:00
115
113
14:00
1511
114
1516
Lakewood
South Tacoma
Alaska Street
Tacoma
Portland Ave
52nd Ave
Puyallup
Sumner
Ellingson
Auburn
Thomas
Kent
Orillia
Glacier Park
Tukwila
Black River
S Seattle
Rhodes
Argo
Coach Wye
Lander St
Stadium

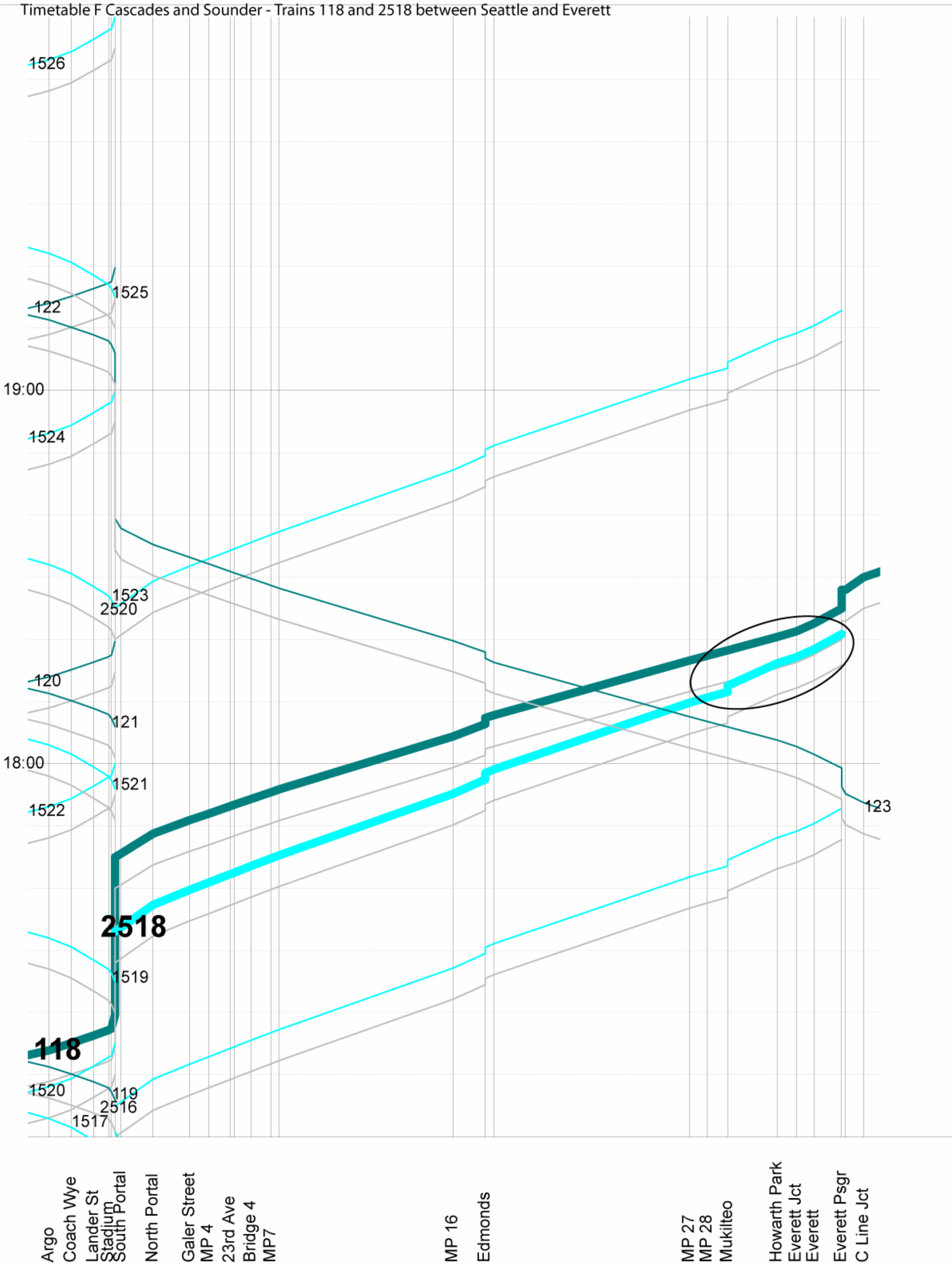
Timetable F Cascades and Sounder - Trains 119 and 1517 between Seattle and Lakeview



Timetable F Cascades and Sounder - Trains 121 and 1521 between Seattle and Lakeview



Timetable F Cascades and Sounder - Trains 118 and 2518 between Seattle and Everett



TIMETABLE F WITH SAMPLE OF PROJECTED FREIGHT TRAFFIC

Portland - Tacoma: BNSF projections made in 2000 by BNSF

Tacoma - Everett: projections made in 2000 by BNSF

Everett - Fraser River Jct.: Current traffic exceeds the 1993 Burlington Northern projections, the most recent available. Current traffic is shown.

Fraser River Jct. - Vancouver: projections made in 1995 by Canadian National.

Freight traffic shown represents schedules projected by the railroads and not actual day to day traffic.

Freight traffic is not shown on the Point Defiance Line between Nisqually and Reservation and on the current alignment between Winlock and Chehalis Jct. because of the length in distance between the bypass routes and the current routes. Freight traffic is shown on the current line between Swift and Colebrook because of the similar length of the current line and the White Rock Bypass.

The diagrams represent 20:00 Wednesday until 20:00 Friday, typically the busiest period.

LEGEND

BNSF

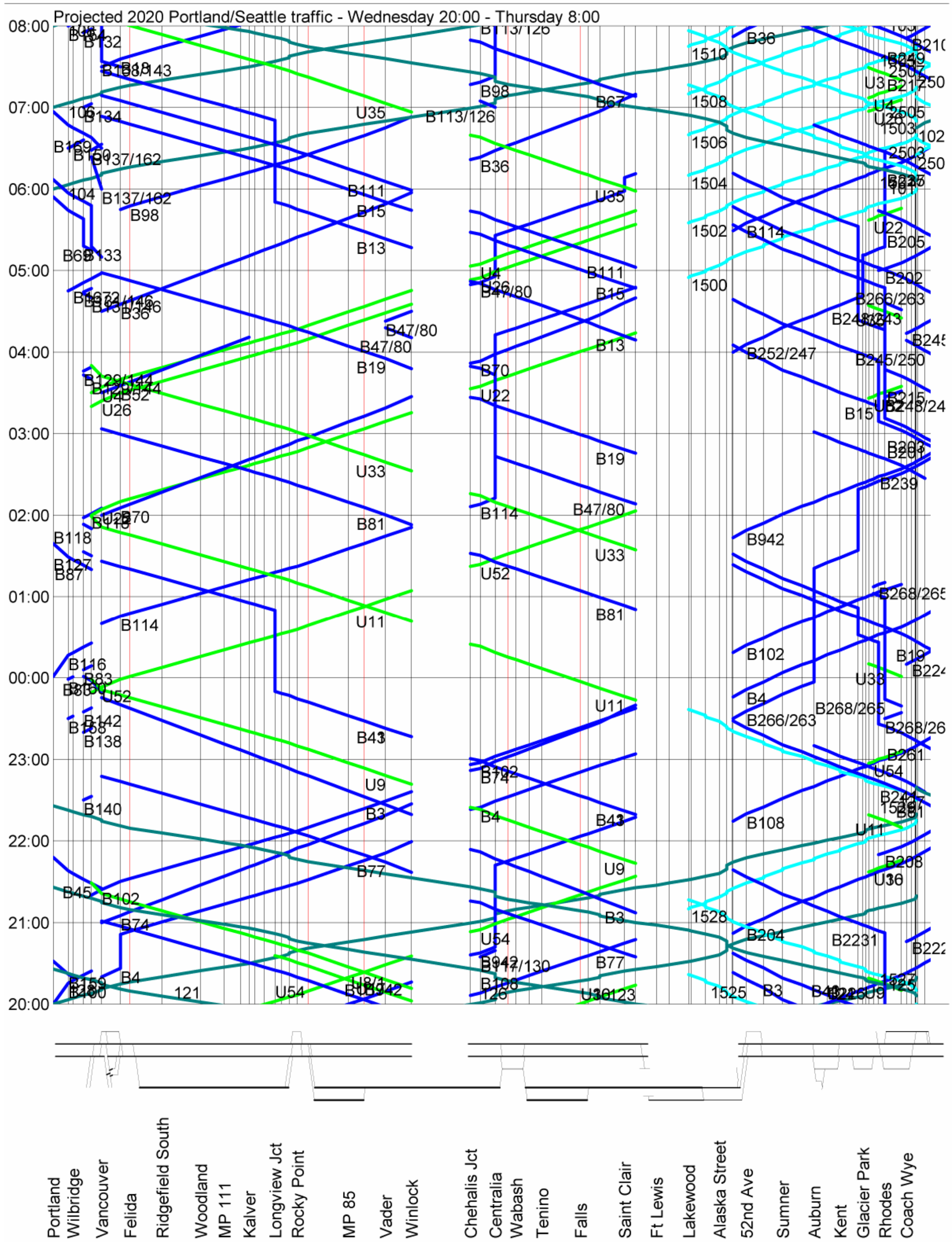
UP

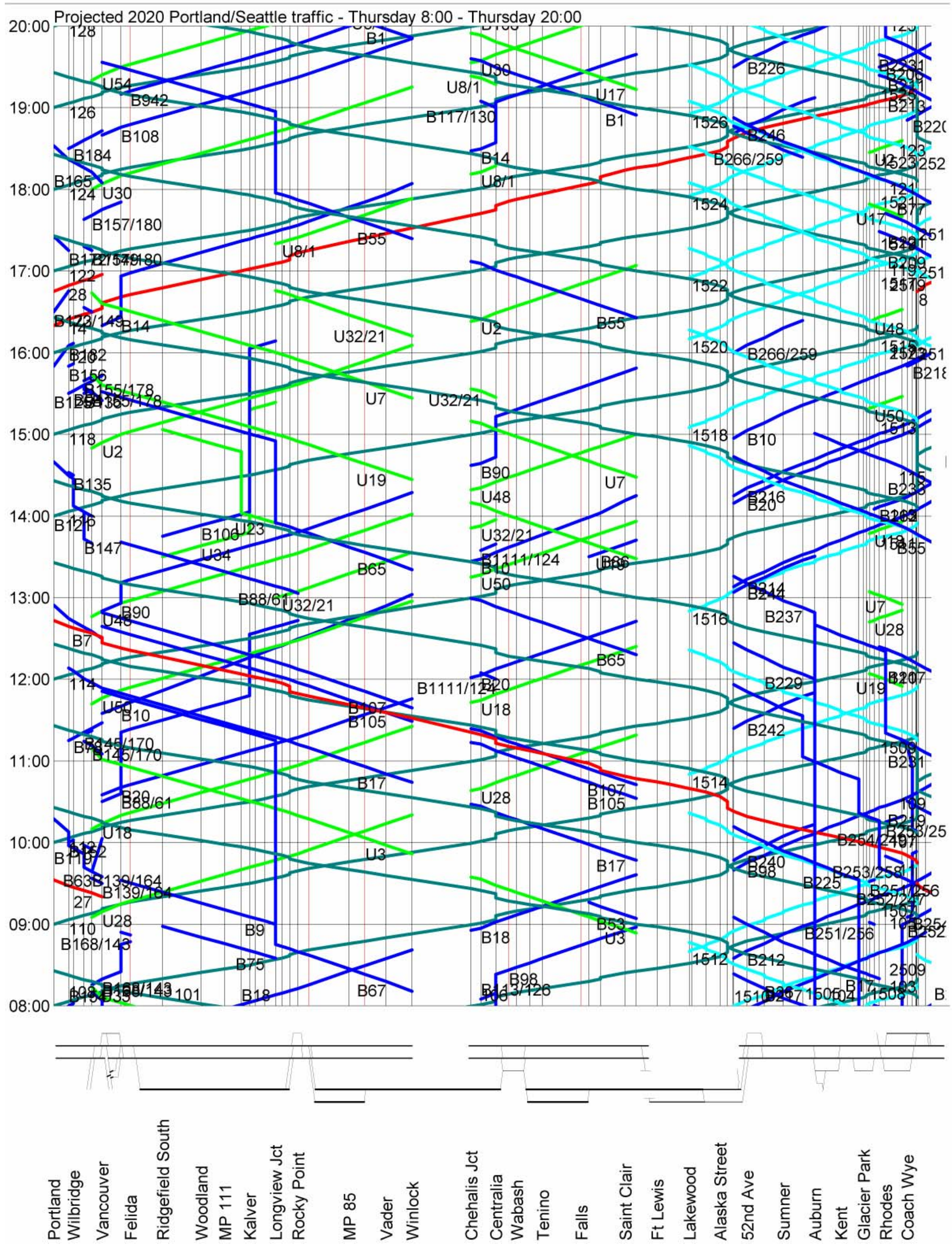
Canadian National

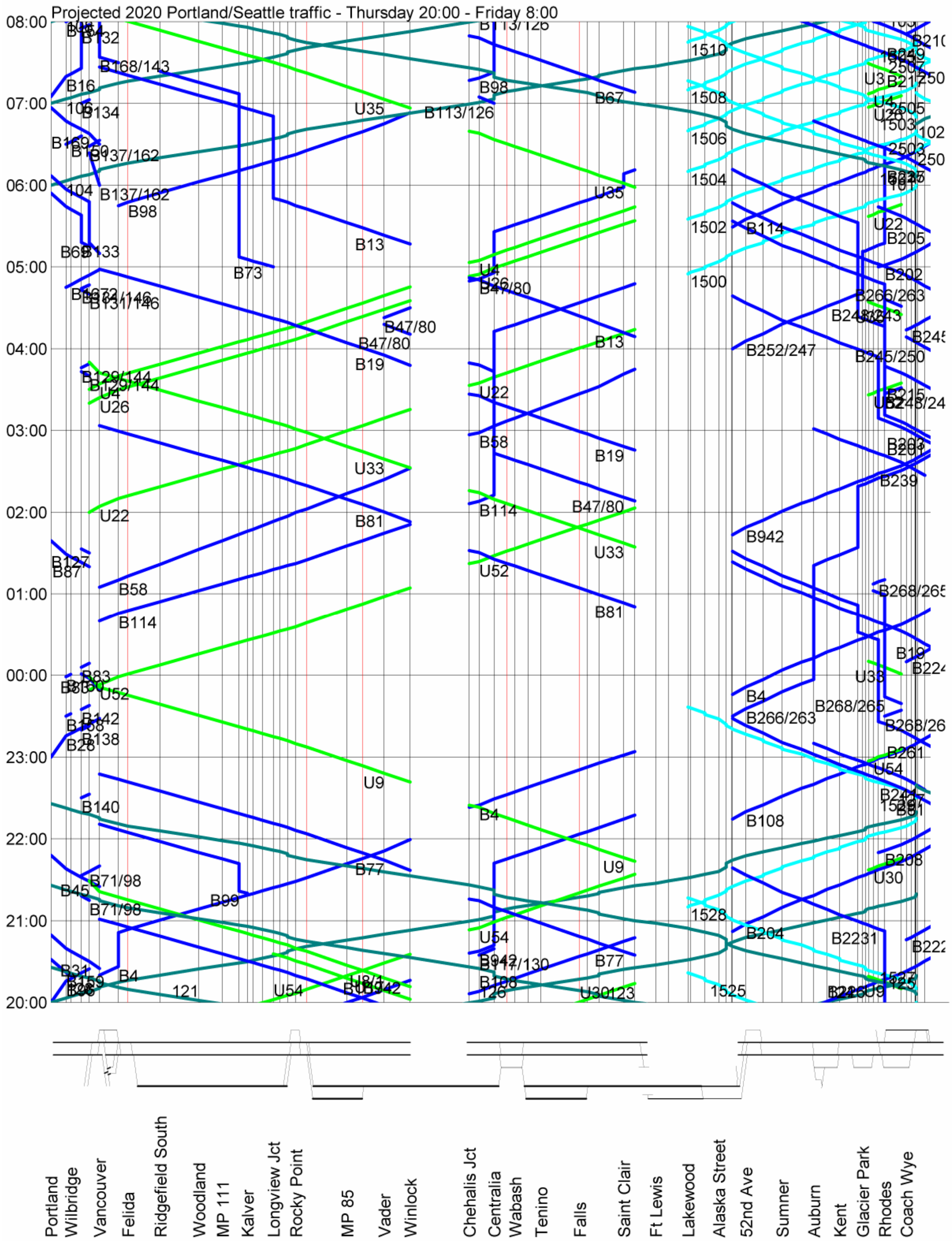
Amtrak intercity

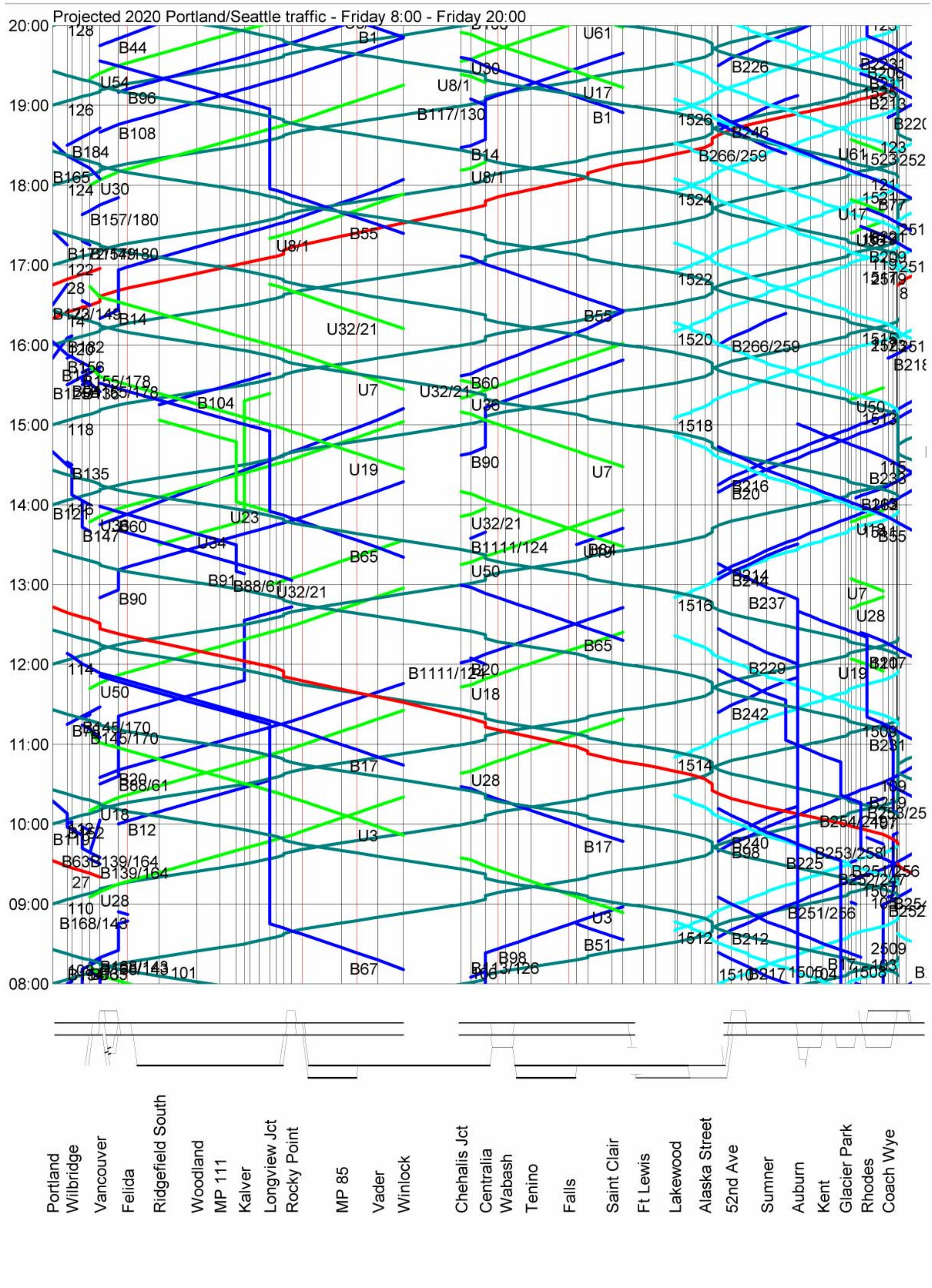
Amtrak Cascades

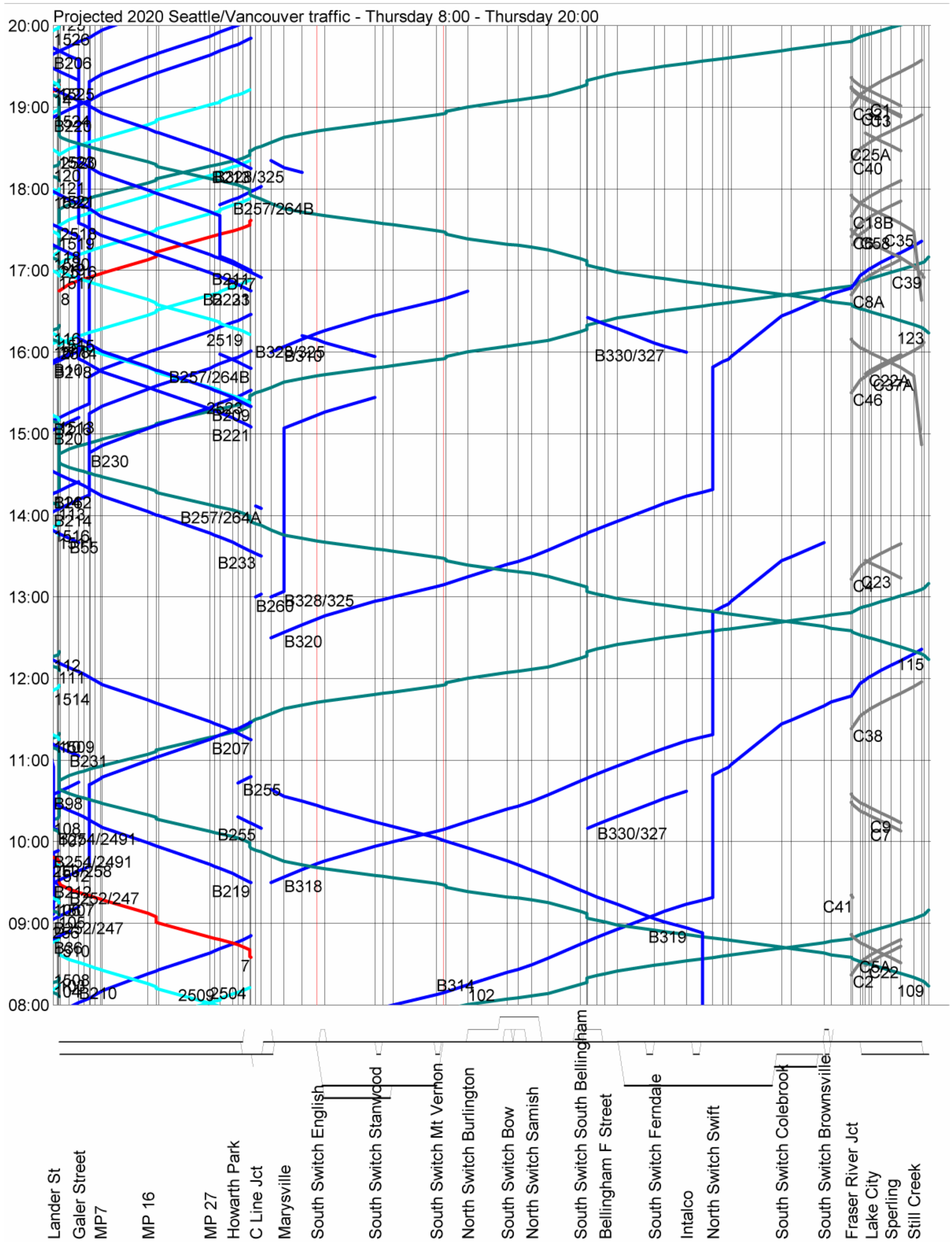
Sounder

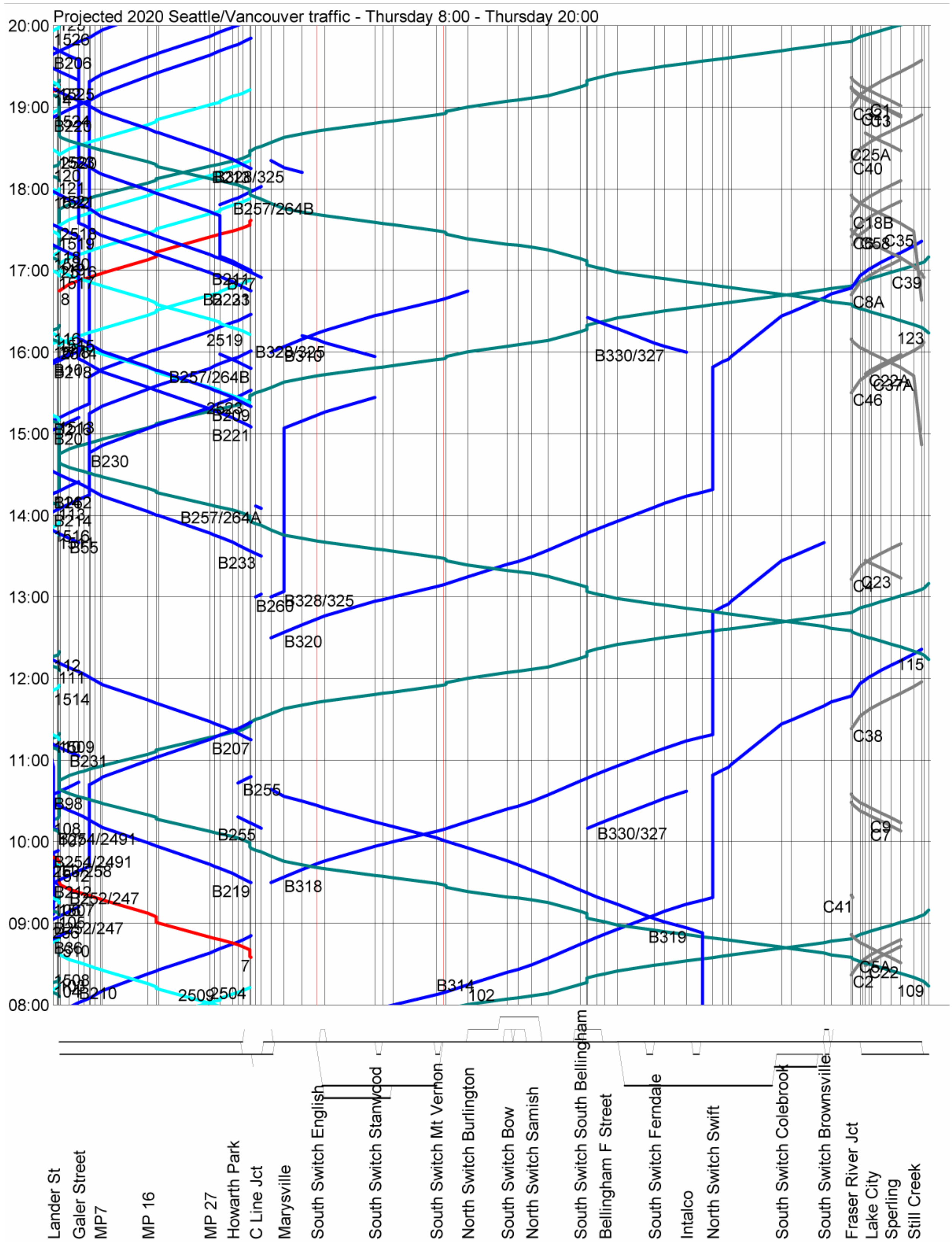

Projected 2020 Portland/Seattle traffic - Wednesday 20:00 - Thursday 8:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
23:00
22:00
21:00
20:00
Portland
Wilbridge
Vancouver
Felida
Ridgefield South
Woodland
MP 111
Kalver
Longview Jct
Rocky Point
MP 85
Vader
Winlock
Chehalis Jct
Centralia
Wabash
Tenino
Falls
Saint Clair
Ft Lewis
Lakewood
Alaska Street
52nd Ave
Sumner
Auburn
Kent
Glacier Park
Rhodes
Coach Wye

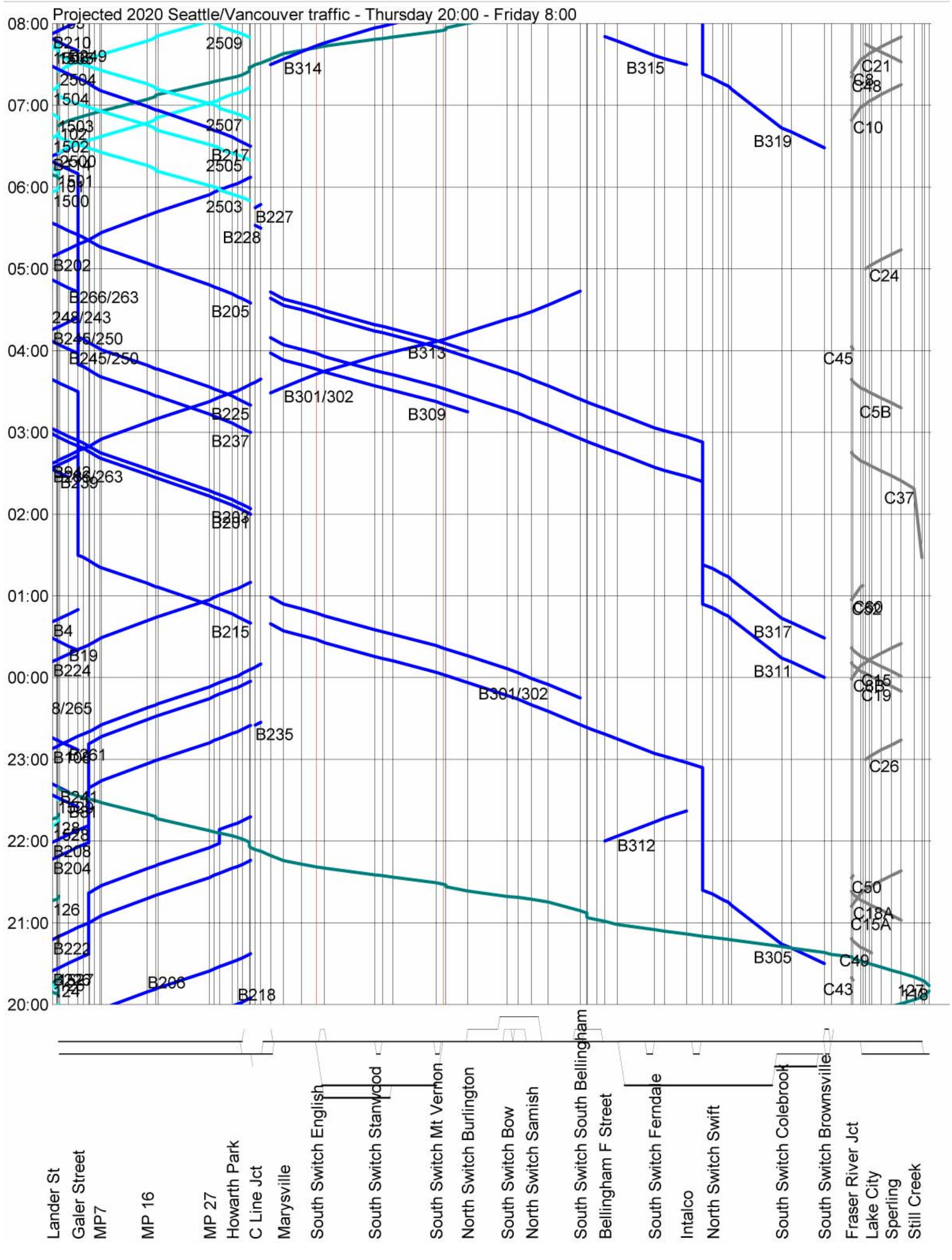

Projected 2020 Portland/Seattle traffic - Thursday 8:00 - Thursday 20:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
Portland
Wilbridge
Vancouver
Felida
Ridgefield South
Woodland
MP 111
Kalver
Longview Jct
Rocky Point
MP 85
Vader
Winlock
Chehalis Jct
Centralia
Wabash
Tenino
Falls
Saint Clair
Ft Lewis
Lakewood
Alaska Street
52nd Ave
Sumner
Auburn
Kent
Glacier Park
Rhodes
Coach Wye

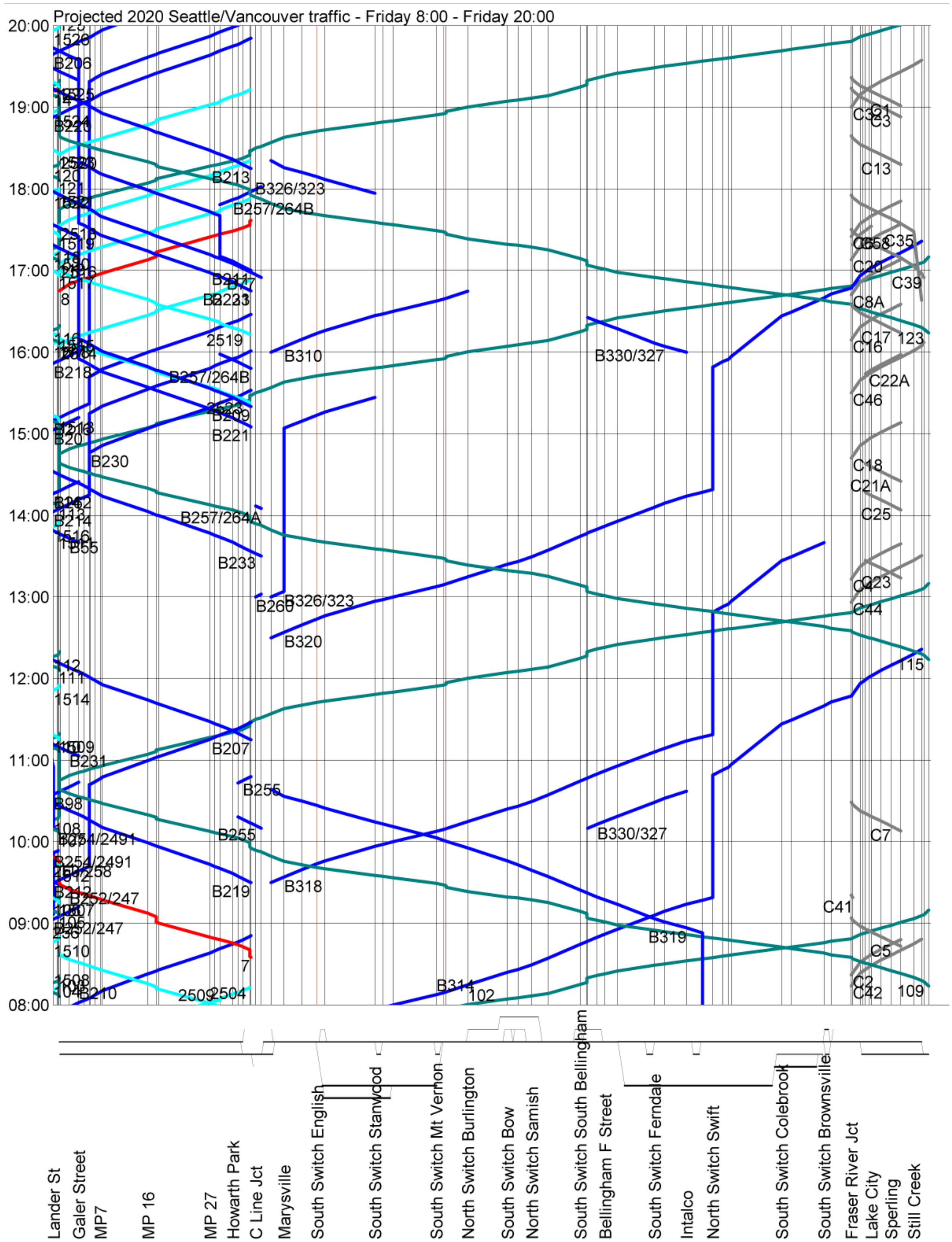

Projected 2020 Portland/Seattle traffic - Thursday 20:00 - Friday 8:00
Portland
Wilbridge
Vancouver
Felida
Ridgefield South
Woodland
MP 111
Kalver
Longview Jct
Rocky Point
MP 85
Vader
Winlock
Chehalis Jct
Centralia
Wabash
Tenino
Falls
Saint Clair
Ft Lewis
Lakewood
Alaska Street
52nd Ave
Sumner
Auburn
Kent
Glacier Park
Rhodes
Coach Wye

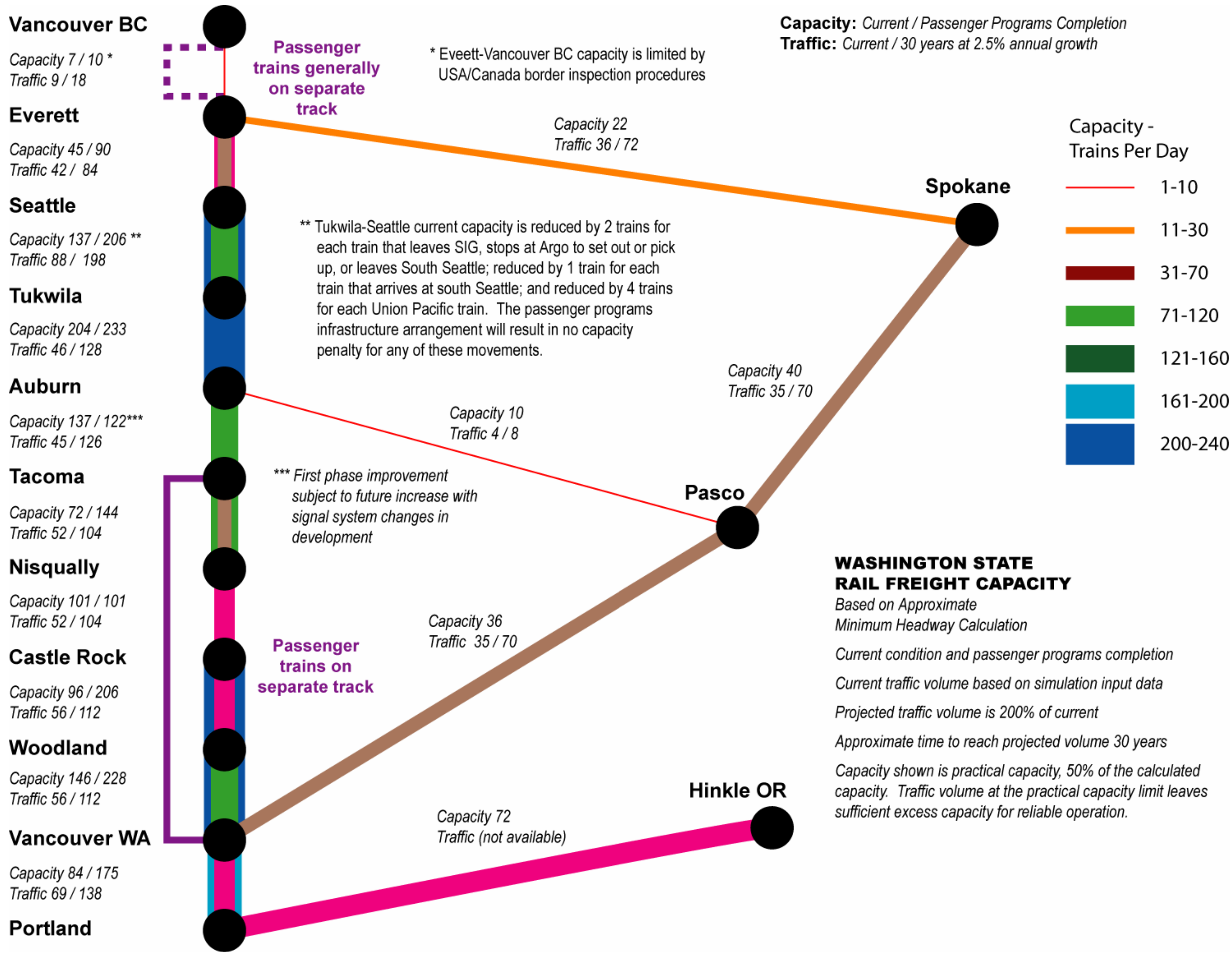

Projected 2020 Portland/Seattle traffic - Friday 8:00 - Friday 20:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
Portland
Wilbridge
Vancouver
Felida
Ridgefield South
Woodland
MP 111
Kalver
Longview Jct
Rocky Point
MP 85
Vader
Winlock
Chehalis Jct
Centralia
Wabash
Tenino
Falls
Saint Clair
Ft Lewis
Lakewood
Alaska Street
52nd Ave
Sumner
Auburn
Kent
Glacier Park
Rhodes
Coach Wye


Projected 2020 Seattle/Vancouver traffic - Thursday 8:00 - Thursday 20:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
B206
B230
B257/264B
B257/264A
B233
B221
B207
B219
B255
B318
B320
B328/325
B330/327
B319
B314
102
2519
2509
2504
C39
C8A
123
C46
C38
C41
C2
109
115
Lander St
Galer Street
MP7
MP 16
MP 27
Howarth Park
C Line Jct
Marysville
South Switch English
South Switch Stanwood
South Switch Mt Vernon
North Switch Burlington
South Switch Bow
North Switch Samish
South Switch South Bellingham
Bellingham F Street
South Switch Ferndale
Intalco
North Switch Swift
South Switch Colebrook
South Switch Brownsville
Fraser River Jct
Lake City
Sperling
Still Creek


Projected 2020 Seattle/Vancouver traffic - Thursday 8:00 - Thursday 20:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
Lander St
Galer Street
MP7
MP 16
MP 27
Howarth Park
C Line Jct
Marysville
South Switch English
South Switch Stanwood
South Switch Mt Vernon
North Switch Burlington
South Switch Bow
North Switch Samish
South Switch South Bellingham
Bellingham F Street
South Switch Ferndale
Intalco
North Switch Swift
South Switch Colebrook
South Switch Brownsville
Fraser River Jct
Lake City
Sperling
Still Creek


Projected 2020 Seattle/Vancouver traffic - Thursday 20:00 - Friday 8:00
08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
23:00
22:00
21:00
20:00
B314
B315
B319
B227
B228
B202
B266/263
B205
B313
B301/302
B309
B225
B237
B215
B317
B311
B4
B19
B224
B235
C26
B312
B204
126
B222
B206
B218
B305
C49
C43
C21
C10
C24
C45
C5B
C37
C50
C18A
C15A
Lander St
Galer Street
MP7
MP 16
MP 27
Howarth Park
C Line Jct
Marysville
South Switch English
South Switch Stanwood
South Switch Mt Vernon
North Switch Burlington
South Switch Bow
North Switch Samish
South Switch South Bellingham
Bellingham F Street
South Switch Ferndale
Intalco
North Switch Swift
South Switch Colebrook
South Switch Brownsville
Fraser River Jct
Lake City
Sperling
Still Creek

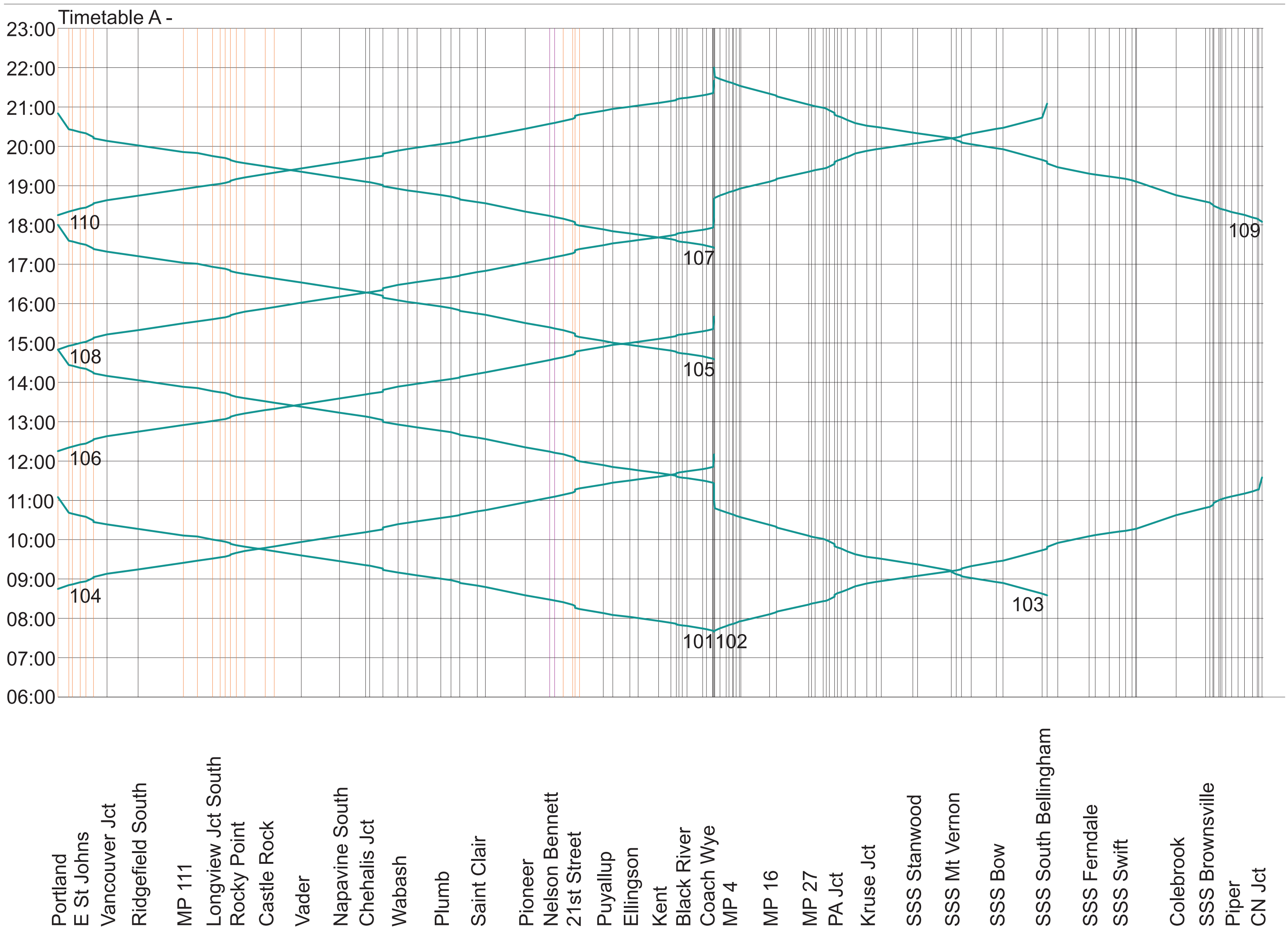

Projected 2020 Seattle/Vancouver traffic - Friday 8:00 - Friday 20:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
B206
B213
B326/323
B257/264B
B310
B330/327
B218
B221
B230
B257/264A
B233
B320
B207
B231
B255
B219
B318
B319
B314
102
B210
C13
C35
C39
C8A
C16
123
C22A
C46
C18
C21A
C25
C44
115
C7
C41
C5
C42
109
Lander St
Galer Street
MP7
MP 16
MP 27
Howarth Park
C Line Jct
Marysville
South Switch English
South Switch Stanwood
South Switch Mt Vernon
North Switch Burlington
South Switch Bow
North Switch Samish
South Switch South Bellingham
Bellingham F Street
South Switch Ferndale
Intalco
North Switch Swift
South Switch Colebrook
South Switch Brownsville
Fraser River Jct
Lake City
Sperling
Still Creek


Capacity: Current / Passenger Programs Completion
Traffic: Current / 30 years at 2.5% annual growth
Vancouver BC
Capacity 7 / 10 *
Traffic 9 / 18
Everett
Capacity 45 / 90
Traffic 42 / 84
Seattle
Capacity 137 / 206 **
Traffic 88 / 198
Tukwila
Capacity 204 / 233
Traffic 46 / 128
Auburn
Capacity 137 / 122***
Traffic 45 / 126
Tacoma
Capacity 72 / 144
Traffic 52 / 104
Nisqually
Capacity 101 / 101
Traffic 52 / 104
Castle Rock
Capacity 96 / 206
Traffic 56 / 112
Woodland
Capacity 146 / 228
Traffic 56 / 112
Vancouver WA
Capacity 84 / 175
Traffic 69 / 138
Portland
Passenger trains generally on separate track
* Eveett-Vancouver BC capacity is limited by USA/Canada border inspection procedures
Capacity 22
Traffic 36 / 72
Spokane
** Tukwila-Seattle current capacity is reduced by 2 trains for each train that leaves SIG, stops at Argo to set out or pick up, or leaves South Seattle; reduced by 1 train for each train that arrives at south Seattle; and reduced by 4 trains for each Union Pacific train. The passenger programs infrastructure arrangement will result in no capacity penalty for any of these movements.
Capacity 40
Traffic 35 / 70
Capacity 10
Traffic 4 / 8
Pasco
*** First phase improvement subject to future increase with signal system changes in development
Capacity 36
Traffic 35 / 70
Passenger trains on separate track
Hinkle OR
Capacity 72
Traffic (not available)
Capacity - Trains Per Day
1-10
11-30
31-70
71-120
121-160
161-200
200-240
WASHINGTON STATE
RAIL FREIGHT CAPACITY
Based on Approximate
Minimum Headway Calculation
Current condition and passenger programs completion
Current traffic volume based on simulation input data
Projected traffic volume is 200% of current
Approximate time to reach projected volume 30 years
Capacity shown is practical capacity, 50% of the calculated capacity. Traffic volume at the practical capacity limit leaves sufficient excess capacity for reliable operation.

This page intentionally left blank.

Appendix H
Timetables, Crew and Equipment Plans

SOUTHWARD TRAINS					TIMETABLE A	NORTHWARD TRAINS				
109	**107**	**105**	**103**	**101**	Example Train Numbers	**102**	**104**	**106**	**108**	**110**
6:05 P					Vancouver BC	11:35 A				
7:37 P			8:35 A		Bellingham	9:49 A			**9:05 P**	
8:07 P			9:05 A		Mt Vernon	9:16 A			**8:16 P**	
8:51 P			9:53 A		Everett	8:36 A			**7:36 P**	
9:18 P			10:19 A		Edmonds	8:10 A			**7:10 P**	
10:00 P			11:00 A		Seattle	7:40 A			**6:40 P**	
	5:25 P	**2:35 P**	11:25 A	7:40 A			**12:10 P**	**3:40 P**	**6:15 P**	**9:40 P**
	5:36 P	**2:46 P**	11:37 A	7:51 A	Tukwila		11:41 A	**3:11 P**	**5:46 P**	**9:11 P**
	6:03 P	**3:13 P**	**12:04 P**	8:18 A	Tacoma		11:16 A	**2:46 P**	**5:21 P**	**8:46 P**
	6:40 P	**3:50 P**	**12:40 P**	8:55 A	Centennial		10:38 A	**2:08 P**	**4:43 P**	**8:08 P**
	7:01 P	**4:12 P**	**1:02 P**	9:16 A	Centralia		10:18 A	**1:48 P**	**4:23 P**	**7:48 P**
	7:39 P	**4:50 P**	**1:41 P**	9:54 A	Kelso		9:37 A	**1:07 P**	**3:42 P**	**7:07 P**
	8:14 P	**5:24 P**	**2:14 P**	10:29 A	Vancouver		9:03 A	**12:33 P**	**3:08 P**	**6:33 P**
	8:50 P	**6:00 P**	**2:50 P**	11:05 A	Portland		8:45 A	**12:15 P**	**2:50 P**	**6:15 P**



Timetable A -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
110
108
106
104
107
105
101
102
103
109
Portland
E St Johns
Vancouver Jct
Ridgefield South
MP 111
Longview Jct South
Rocky Point
Castle Rock
Vader
Napavine South
Chehalis Jct
Wabash
Plumb
Saint Clair
Pioneer
Nelson Bennett
21st Street
Puyallup
Ellingson
Kent
Black River
Coach Wye
MP 4
MP 16
MP 27
PA Jct
Kruse Jct
SSS Stanwood
SSS Mt Vernon
SSS Bow
SSS South Bellingham
SSS Ferndale
SSS Swift
Colebrook
SSS Brownsville
Piper
CN Jct

Crew Plan
Timetable A

Assignment	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - PORTLAND						
SP1	7:10	22:10	**15:00**	101	*5:30*	110
SP2	16:55	21:20	**4:25**	107		
SP3 = SP2 return	11:45	16:10	**4:25**	106		
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - VANCOUVER						
SV1	7:10	22:30	**15:20**	102	*7:30*	109
PORTLAND - SEATTLE	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PS1	8:15	18:30	**10:15**	104	*2:15*	105
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PORTLAND - BELLINGHAM						
PV1	14:20	21:35	**7:15**	108		
PV2 = PV1 return	8:05	15:20	**7:15**	103		

First named station is crew headquarters

Equipment Plan
Timetable A

Equipment Asgnmt													
1	Train	**101**		**106**		**107**							
	Miles	187		187		187					561	Miles	
	Time in Service	3:25		3:25		3:25					10:15	Time in Service	78% Schedule Day
	Layover Time		1:10		1:45						2:55	Layover Time	22% Schedule Day
		Seattle	7:40						Portland	20:50	13:10	Total Time	55% Calendar Day
2	Train	**103**		**110**									
	Miles	283		187							470	Miles	
	Time in Service	6:15		3:25							9:40	Time in Service	74% Schedule Day
	Layover Time		3:25								3:25	Layover Time	26% Schedule Day
		Bellingham	8:35						Seattle	21:40	13:05	Total Time	55% Calendar Day
3	Train	**104**		**105**									
	Miles	187		187							374	Miles	
	Time in Service	3:25		3:25							6:50	Time in Service	74% Schedule Day
	Layover Time		2:25								2:25	Layover Time	26% Schedule Day
		Portland	8:45						Portland	18:00	9:15	Total Time	39% Calendar Day
4	Train	**108**											
	Miles	283									283	Miles	
	Time in Service	6:15									6:15	Time in Service	100% Schedule Day
	Layover Time										0:00	Layover Time	0% Schedule Day
		Portland	14:50						Bellingham	21:05	6:15	Total Time	26% Calendar Day
5	Train	**102**		**109**									
	Miles	156		156							312	Miles	
	Time in Service	3:55		3:55							7:50	Time in Service	55% Schedule Day
	Layover Time		6:30								6:30	Layover Time	45% Schedule Day
		Seattle	7:40						Seattle	22:00	14:20	Total Time	60% Calendar Day

One equipment set required for each assignment

Terminating Equipment

Seattle		Portland	
Asgnmt	Arrive	Asgnmt	Arrive
2	21:40	3	17:25
		1	20:50
5	21:55		

Originating Equipment

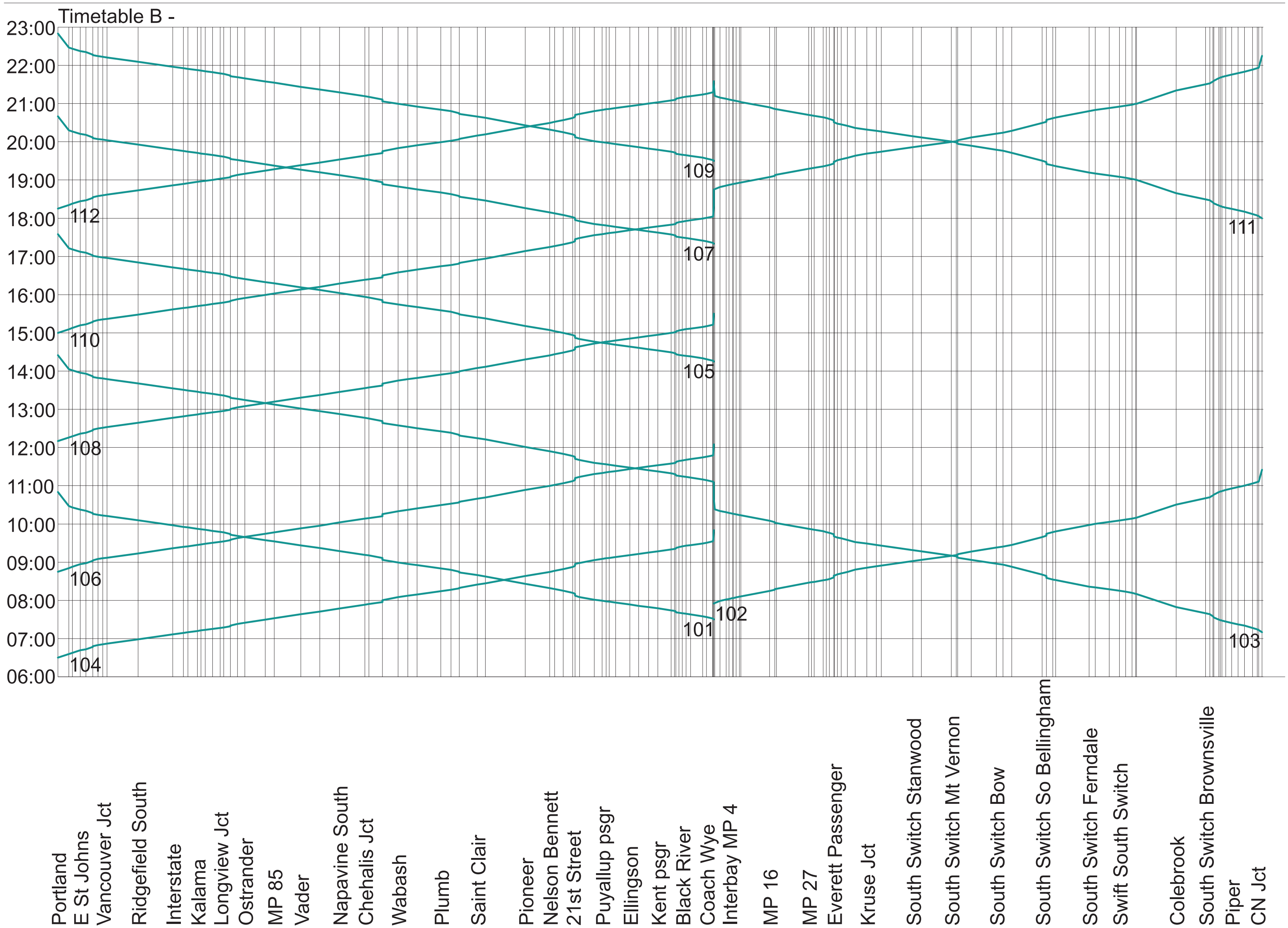
Seattle		Portland	
Asgnmt	Leave	Asgnmt	Leave
1	7:40	3	8:45
		4	14:45
5	7:45		

Equipment Rotation

Originate	Asgnmt	Miles	Seattle-Seattle Miles	Seatle time
Seattle	1	561		
Portland	3	374		
Portland	4	283		
Bellingham	2	470	1688	10:00
Seattle	5	312	312	9:50

Each set works assignments in top to bottom order then repeats the cycle.

SOUTHWARD TRAINS						TIMETABLE B	NORTHWARD TRAINS					
109	**111**	**107**	**105**	**101**	**103**	Example Train Numbers	**104**	**102**	**106**	**108**	**110**	**112**
	6:00 P				7:10 A	Vancouver BC		11:25 A			10:15 P	
	7:28 P				8:38 A	Bellingham		9:44 A			8:34 P	
	7:57 P				9:07 A	Mt Vernon		9:12 A			8:02 P	
	8:33 P				9:43 A	Everett		8:39 A			7:29 P	
	8:52 P				10:02 A	Edmonds		8:17 A			7:07 P	
7:30 P	9:30 P	5:20 P	2:15 P	7:30 A	10:40 A 11:05 A	Seattle	9:50 A	7:55 A	12:05 P	3:30 P	6:45 P 6:20 P	9:35 P
7:42 P		5:32 P	2:27 P	7:42 A	11:17 A	Tukwila	9:22 A		11:37 A	3:02 P	5:52 P	9:07 P
8:10 P		6:00 P	2:55 P	8:10 A	11:45 A	Tacoma	8:57 A		11:12 A	2:37 P	5:27 P	8:42 P
8:44 P		6:34 P	3:29 P	8:44 A	12:19 P	Centennial	8:19 A		10:34 A	1:59 P	4:49 P	8:04 P
9:06 P		6:56 P	3:51 P	9:06 A	12:41 P	Centralia	8:00 A		10:15 A	1:40 P	4:30 P	7:45 P
9:44 P		7:34 P	4:29 P	9:44 A	1:19 P	Kelso	7:20 A		9:35 A	1:00 P	3:50 P	7:05 P
10:16 P		8:06 P	5:01 P	10:16 A	1:51 P	Vancouver	6:47 A		9:02 A	12:27 P	3:17 P	6:32 P
10:50 P		8:40 P	5:35 P	10:50 A	2:25 P	Portland	6:30 A		8:45 A	12:10 P	3:00 P	6:15 P



Timetable B -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
112
110
108
106
104
109
107
105
101
102
111
103
Portland
E St Johns
Vancouver Jct
Ridgefield South
Interstate
Kalama
Longview Jct
Ostrander
MP 85
Vader
Napavine South
Chehalis Jct
Wabash
Plumb
Saint Clair
Pioneer
Nelson Bennett
21st Street
Puyallup psgr
Ellingson
Kent psgr
Black River
Coach Wye
Interbay MP 4
MP 16
MP 27
Everett Passenger
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
South Switch So Bellingham
South Switch Ferndale
Swift South Switch
Colebrook
South Switch Brownsville
Piper
CN Jct

Crew Plan
Timetable B

Assignment	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - PORTLAND						
SP1	7:00	16:00	**9:00**	101	*1:20*	108
SP2	13:45	22:05	**8:20**	105	*0:40*	112
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - VANCOUVER						
SV1	7:25	22:00	**14:35**	102	*6:35*	111
SV2	18:15	22:45	**4:30**	110		
SV3	6:40	11:10	**4:30**	103		
PORTLAND - SEATTLE	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PS1	6:00	14:55	**8:55**	104	*0:40*	103
PS2	8:15	21:10	**12:55**	106	*5:15*	107
PS3	14:30	23:20	**8:50**	110	*1:10*	109

First named station is crew headquarters

Equipment Plan
Timetable B

Equipment Asgnmt													
1	Train	**104**		**109**									
	Miles	187		187							374	Miles	
	Time in Service	3:20		3:20							6:40	Time in Service	41% Schedule Day
	Layover Time		9:30								9:30	Layover Time	59% Schedule Day
		Portland	6:30						Portland	22:50	16:10	Total Time	67% Calendar Day
2	Train	**106**		**105**		**112**							
	Miles	187		187		187					561	Miles	
	Time in Service	3:20		3:20		3:20					10:00	Time in Service	78% Schedule Day
	Layover Time		2:10		0:40						2:50	Layover Time	22% Schedule Day
		Portland	8:45						Seattle	21:35	12:50	Total Time	53% Calendar Day
3	Train	**101**		**108**		**107**							
	Miles	187		187		187					561	Miles	
	Time in Service	3:20		3:20		3:20					10:00	Time in Service	76% Schedule Day
	Layover Time		1:20		1:50						3:10	Layover Time	24% Schedule Day
		Seattle	7:30						Portland	20:40	13:10	Total Time	55% Calendar Day
4	Train	**103**											
	Miles	343									343	Miles	
	Time in Service	7:15									7:15	Time in Service	100% Schedule Day
	Layover Time										0:00	Layover Time	0% Schedule Day
		Vancouver	7:10						Portland	14:25	7:15	Total Time	30% Calendar Day
5	Train	**110**											
	Miles	343									343	Miles	
	Time in Service	7:15									7:15	Time in Service	100% Schedule Day
	Layover Time										0:00	Layover Time	0% Schedule Day
		Portland	15:00						Vancouver	22:15	7:15	Total Time	30% Calendar Day
6	Train	**102**		**111**									
	Miles	156		156							312	Miles	
	Time in Service	3:20		3:20							6:40	Time in Service	50% Schedule Day
	Layover Time		6:35								6:35	Layover Time	50% Schedule Day
		Seattle	7:55						Seattle	21:30	13:15	Total Time	55% Calendar Day

One equipment set required for each assignment

Terminating Equipment

Seattle		Portland	
Asgnmt	Arrive	Asgnmt	Arrive
6	21:30	4	14:25
2	21:35	3	20:40
		1	22:50
1	9:50		

Originating Equipment

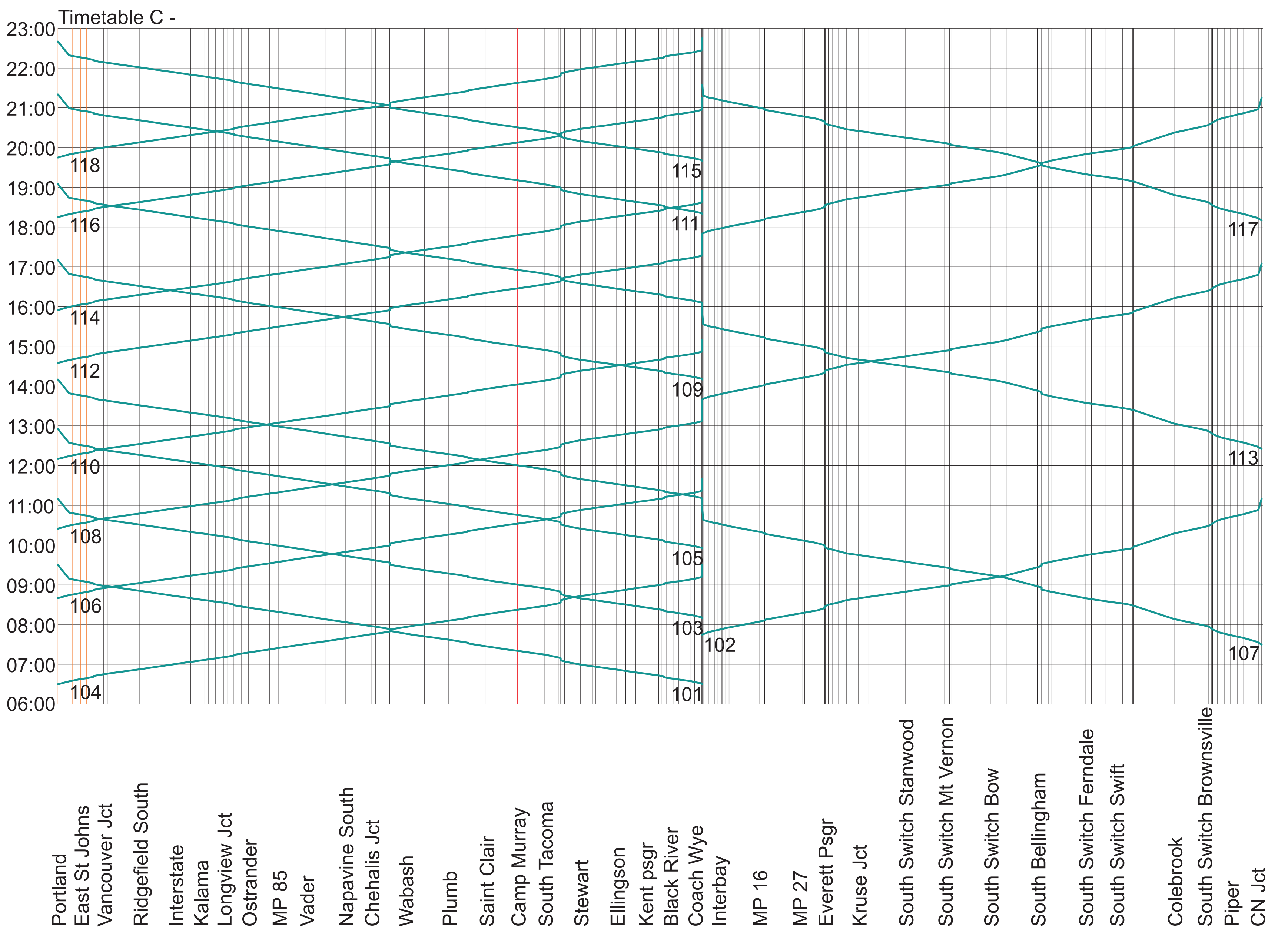
Seattle		Portland	
Asgnmt	Leave	Asgnmt	Leave
3	7:30	1	6:30
6	7:55	2	8:45
		5	15:00
1	19:30		

Equipment Rotation

Originate	Asgnmt	Miles	Seattle-Seattle Miles	Seatle time
Seattle	3	561		
Portland	2	561	1122	9:55
Seattle	3	561		
Portland	5	343		
Vancouver	4	343		
Portland	2 #1	187	1434	7:25
Seattle	1 #2	187		
Portland	1 #1	187	374	9:30
Seattle	1 #2	187		
Portland	1 #1	187	374	4:25
Seattle	2 #2&3	374	374	9:55
Complete cycle 8 days.				
Seattle	6	312	312	10:25

Each set works assignments in top to bottom order then repeats the cycle.

SOUTHWARD TRAINS									TIMETABLE C	NORTHWARD TRAINS								
115	111	117	109	113	105	103	107	101	Example Train Numbers	104	102	106	108	110	112	114	116	118
		6:10 P		12:25 P			7:30 A		Vancouver BC		11:10 A		5:05 P		9:15 P			
		7:36 P		1:51 P			8:56 A		Bellingham		9:31 A		3:26 P		7:36 P			
		8:04 P		2:19 P			9:24 A		Mt Vernon		9:00 A		2:55 P		7:05 P			
		8:39 P		2:54 P			9:59 A		Everett		8:28 A		2:23 P		6:33 P			
		8:58 P		3:13 P			10:18 A		Edmonds		8:07 A		2:02 P		6:12 P			
		9:35 P		3:50 P			10:55 A		Seattle		7:45 A		1:40 P		5:50 P			
7:40 P	6:20 P		2:10 P	4:05 P	9:55 A	8:10 A	11:10 A	6:30 A		9:30 A		11:40 A	1:25 P	3:10 P	5:35 P	6:55 P	9:15 P	10:45 P
7:51 P	6:31 P		2:21 P	4:16 P	10:06 A	8:21 A	11:21 A	6:41 A	Tukwila	9:01 A		11:11 A	12:56 P	2:41 P	5:06 P	6:26 P	8:46 P	10:16 P
8:19 P	6:59 P		2:49 P	4:44 P	10:34 A	8:49 A	11:49 A	7:09 A	Tacoma	8:36 A		10:46 A	12:31 P	2:16 P	4:41 P	6:01 P	8:21 P	9:51 P
8:42 P	7:22 P		3:12 P	5:07 P	10:57 A	9:12 A	12:12 P	7:32 A	Centennial	8:11 A		10:21 A	12:06 P	1:51 P	4:16 P	5:36 P	7:56 P	9:26 P
9:03 P	7:43 P		3:33 P	5:28 P	11:18 A	9:33 A	12:33 P	7:53 A	Centralia	7:52 A		10:02 A	11:47 A	1:32 P	3:57 P	5:17 P	7:37 P	9:07 P
9:40 P	8:20 P		4:10 P	6:05 P	11:55 A	10:10 A	1:10 P	8:30 A	Kelso	7:14 A		9:24 A	11:09 A	12:54 P	3:19 P	4:39 P	6:59 P	8:29 P
10:12 P	8:52 P		4:42 P	6:37 P	12:27 P	10:42 A	1:42 P	9:02 A	Vancouver	6:42 A		8:52 A	10:37 A	12:22 P	2:47 P	4:07 P	6:27 P	7:57 P
10:40 P	9:20 P		5:10 P	7:05 P	12:55 P	11:10 A	2:10 P	9:30 A	Portland	6:30 A		8:40 A	10:25 A	12:10 P	2:35 P	3:55 P	6:15 P	7:45 P


Timetable C -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
118
116
114
112
110
108
106
104
115
111
109
105
103
101
102
117
113
107
Portland
East St Johns
Vancouver Jct
Ridgefield South
Interstate
Kalama
Longview Jct
Ostrander
MP 85
Vader
Napavine South
Chehalis Jct
Wabash
Plumb
Saint Clair
Camp Murray
South Tacoma
Stewart
Ellingson
Kent psgr
Black River
Coach Wye
Interbay
MP 16
MP 27
Everett Psgr
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
South Bellingham
South Switch Ferndale
South Switch Swift
Colebrook
South Switch Brownsville
Piper
CN Jct

Crew Plan
Timetable C

Assignment	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - PORTLAND						
SP1	6:00	13:55	**7:55**	101	*0:55*	108
SP2	7:40	15:40	**8:00**	103	*1:00*	110
SP3	9:25	21:45	**12:20**	105	*5:20*	116
SP4	15:40	23:15	**7:35**	113	*0:35*	118
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - VANCOUVER						
SV1	7:15	16:25	**9:10**	102	*1:15*	113
SV2	13:10	22:05	**8:55**	108	*1:05*	117
SV3	17:20	21:45	**4:25**	112		
SV4	7:00	11:25	**4:25**	107		
PORTLAND - SEATTLE	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PS1	6:00	14:45	**8:45**	104	*1:45*	107
PS2	8:10	17:40	**9:30**	106	*2:30*	109
PS3	14:05	21:50	**7:45**	112	*0:45*	111
PS4	15:25	23:10	**7:45**	114	*0:45*	113

First named station is crew headquarters

Equipment Plan
Timetable C

Equipment Asgnmt													
1	Train	**104**		**105**		**112**							
	Miles	179		179		335					693	Miles	
	Time in Service	3:00		3:00		6:40					12:40	Time in Service	87% Schedule Day
	Layover Time		0:25		1:30						1:55	Layover Time	13% Schedule Day
		Portland	6:30						Vancouver	21:15	14:35	Total Time	61% Calendar Day
2	Train	**106**		**109**		**116**							
	Miles	179		179		179					537	Miles	
	Time in Service	3:00		3:00		3:00					9:00	Time in Service	72% Schedule Day
	Layover Time		2:30		1:05						3:35	Layover Time	28% Schedule Day
		Portland	8:40						Seattle	21:15	12:35	Total Time	52% Calendar Day
3	Train	**101**		**108**		**117**							
	Miles	179		335		156					670	Miles	
	Time in Service	3:00		6:40		3:25					13:05	Time in Service	87% Schedule Day
	Layover Time		0:55		1:05						2:00	Layover Time	13% Schedule Day
		Seattle	6:30						Seattle	21:35	15:05	Total Time	63% Calendar Day
4	Train	**103**		**110**		**111**							
	Miles	179		179		179					537	Miles	
	Time in Service	3:00		3:00		3:00					9:00	Time in Service	68% Schedule Day
	Layover Time		1:00		3:10						4:10	Layover Time	32% Schedule Day
		Seattle	8:10						Portland	21:20	13:10	Total Time	55% Calendar Day
5	Train	**107**		**114**		**115**							
	Miles	335		179		179					693	Miles	
	Time in Service	6:40		3:00		3:00					12:40	Time in Service	84% Schedule Day
	Layover Time		1:40		0:45						2:25	Layover Time	16% Schedule Day
		Vancouver	7:30						Portland	22:40	15:05	Total Time	63% Calendar Day
6	Train	**102**		**113**		**118**							
	Miles	156		335		179					670	Miles	
	Time in Service	3:25		6:40		3:00					13:05	Time in Service	88% Schedule Day
	Layover Time		1:15		0:35						1:50	Layover Time	12% Schedule Day
		Seattle	7:45						Seattle	22:45	14:55	Total Time	62% Calendar Day

One equipment set required for each assignment

Terminating Equipment

Seattle		Portland	
Asgnmt	Arrive	Asgnmt	Arrive
2	21:15	4	21:20
3	21:35	5	22:40
6	22:45		

Originating Equipment

Seattle		Portland	
Asgnmt	Leave	Asgnmt	Leave
3	6:30	1	6:30
6	7:45	2	8:40
4	8:10		

Equipment Rotation

Originate	Asgnmt	Miles	Seattle-Seattle Miles	Seatle time
Seattle	4	539		
Portland	1	693		
Vancouver	5	693		
Portland	2	539	2464	9:15
Seattle	3	670	670	10:10
Seattle	6	670	670	9:20

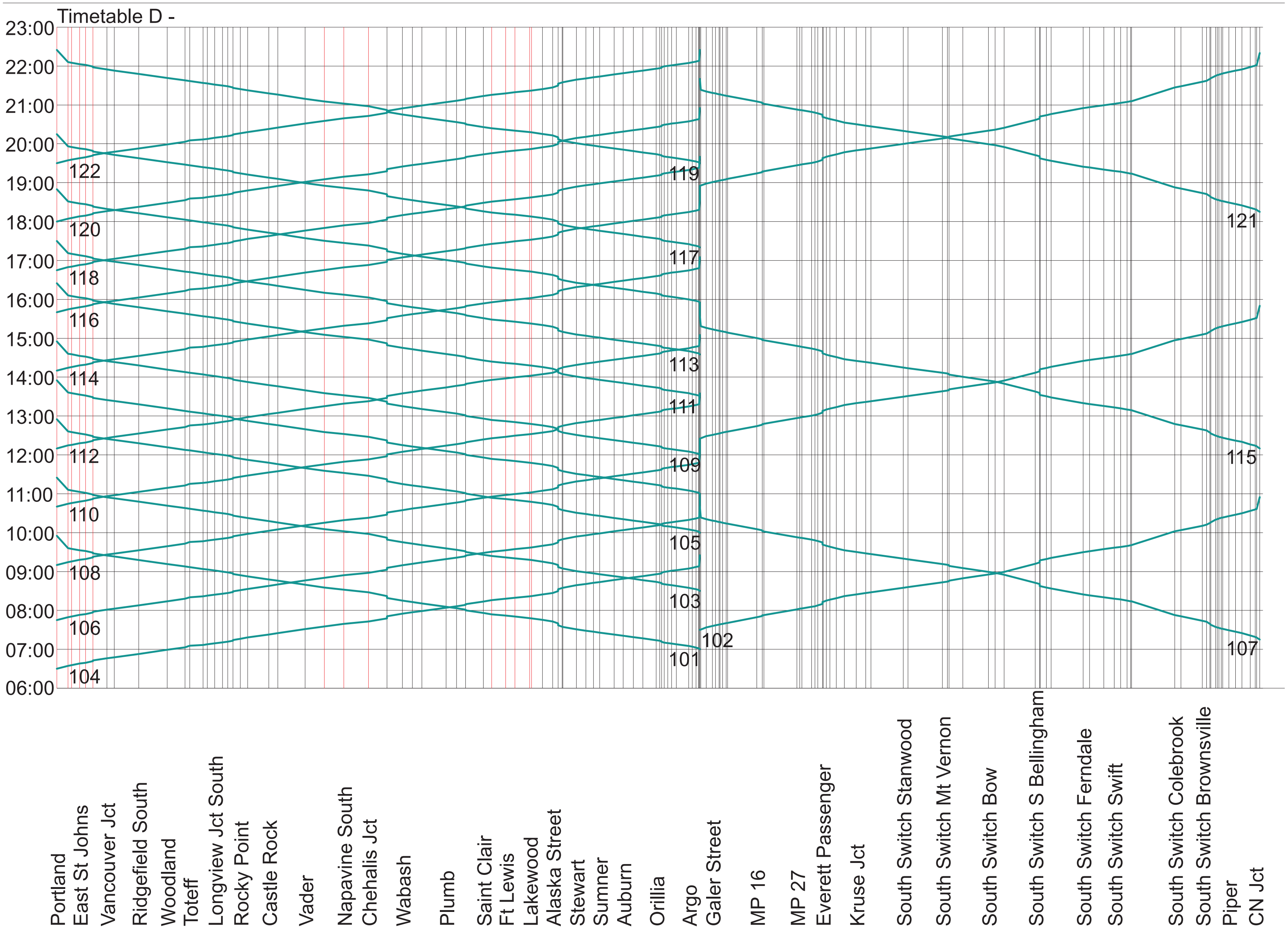
Each set works assignments in top to bottom order then repeats the cycle.

TIMETABLE D — **SOUTHWARD TRAINS**

Example Train Numbers	119	121	117	113	111	115	109	105	103	107	101
Vancouver BC		6:15 P				12:10 P				7:15 A	
Bellingnham		7:40 P				1:35 P				8:40 A	
Mt Vernon		8:09 P				2:04 P				9:09 A	
Everett		8:44 P				2:39 P				9:44 A	
Edmonds		9:03 P				2:58 P				10:03 A	
Seattle	7:30 P	9:40 P	5:20 P	2:35 P	1:30 P	3:35 P 3:55 P	12:00 P	10:00 A	8:30 A	10:40 A 11:00 A	7:00 A
Tukwila	7:42 P		5:32 P	2:47 P	1:42 P	4:07 P	12:12 P	10:12 A	8:42 A	11:12 A	7:12 A
Tacoma	8:09 P		5:59 P	3:14 P	2:09 P	4:34 P	12:39 P	10:39 A	9:09 A	11:39 A	7:39 A
Centennial	8:31 P		6:21 P	3:36 P	2:31 P	4:56 P	1:01 P	11:01 A	9:31 A	12:01 P	8:01 A
Centralia	8:52 P		6:42 P	3:57 P	2:52 P	5:17 P	1:22 P	11:22 A	9:52 A	12:22 P	8:22 A
Kelso	9:27 P		7:17 P	4:32 P	3:27 P	5:52 P	1:57 P	11:57 A	10:27 A	12:57 P	8:57 A
Vancouver	9:59 P		7:49 P	5:04 P	3:59 P	6:24 P	2:29 P	12:29 P	10:59 A	1:29 P	9:29 A
Portland	10:25 P		8:15 P	5:30 P	4:25 P	6:50 P	2:55 P	12:55 P	11:25 A	1:55 P	9:55 A

TIMETABLE D — **NORTHWARD TRAINS**

Example Train Numbers	104	106	102	108	110	112	114	116	118	120	122
Vancouver BC			10:55 A	3:50 P				10:20 P			
Bellingnham			9:17 A	2:12 P				8:42 P			
Mt Vernon			8:46 A	1:41 P				8:11 P			
Everett			8:13 A	1:08 P				7:38 P			
Edmonds			7:52 A	12:47 P				7:17 P			
Seattle	9:25 A	10:40 A	7:30 A	12:25 P 12:05 P	1:35 P	3:05 P	5:05 P	6:55 P 6:35 P	7:40 P	8:55 P	10:25 P
Tukwila	8:58 A	10:13 A		11:38 A	1:08 P	2:38 P	4:38 P	6:08 P	7:13 P	8:28 P	9:58 P
Tacoma	8:32 A	9:47 A		11:12 A	12:42 P	2:12 P	4:12 P	5:42 P	6:47 P	8:02 P	9:32 P
Centennial	8:09 A	9:24 A		10:49 A	12:19 P	1:49 P	3:49 P	5:19 P	6:24 P	7:39 P	9:09 P
Centralia	7:50 A	9:05 A		10:30 A	12:00 P	1:30 P	3:30 P	5:00 P	6:05 P	7:20 P	8:50 P
Kelso	7:14 A	8:29 A		9:54 A	11:24 A	12:54 P	2:54 P	4:24 P	5:29 P	6:44 P	8:14 P
Vancouver	6:42 A	7:57 A		9:22 A	10:52 A	12:22 P	2:22 P	3:52 P	4:57 P	6:12 P	7:42 P
Portland	6:30 A	7:45 A		9:10 A	10:40 A	12:10 P	2:10 P	3:40 P	4:45 P	6:00 P	7:30 P


Timetable D -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
122
120
118
116
114
112
110
108
106
104
119
117
113
111
109
105
103
101
102
121
115
107
Portland
East St Johns
Vancouver Jct
Ridgefield South
Woodland
Toteff
Longview Jct South
Rocky Point
Castle Rock
Vader
Napavine South
Chehalis Jct
Wabash
Plumb
Saint Clair
Ft Lewis
Lakewood
Alaska Street
Stewart
Sumner
Auburn
Orillia
Argo
Galer Street
MP 16
MP 27
Everett Passenger
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
South Switch S Bellingham
South Switch Ferndale
South Switch Swift
South Switch Colebrook
South Switch Brownsville
Piper
CN Jct

Crew Plan
Timetable D

Assignment	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - PORTLAND						
SP1	6:30	14:05	**7:35**	101	*0:45*	110
SP2	8:00	17:35	**9:35**	103	*2:45*	114
SP3	10:30	20:10	**9:40**	107	*2:50*	118
SP4	14:05	21:25	**7:20**	113	*0:30*	120
SP5	15:25	22:55	**7:30**	115	*0:40*	122
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - VANCOUVER						
SV1	7:00	16:05	**9:05**	102	*1:15*	115
SV2	11:55	22:10	**10:15**	108	*2:25*	121
SV3	18:25	22:50	**4:25**	116		
SV4	6:45	11:10	**4:25**	107		
PORTLAND - SEATTLE	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PS1	6:00	13:25	**7:25**	104	*0:35*	105
PS2	7:15	15:25	**8:10**	106	*1:20*	109
PS3	8:40	16:55	**8:15**	108	*1:25*	111
PS4	11:40	20:45	**9:05**	112	*2:15*	117
PS5	15:10	22:55	**7:45**	116	*0:55*	119

First named station is crew headquarters

Equipment Plan
Timetable D

Equipment Asgnmt													
1	Train	**104**		**109**		**116**							
	Miles	179		179		335					693	Miles	
	Time in Service	2:55		2:55		6:40					12:30	Time in Service	79% Schedule Day
	Layover Time		2:35		0:45						3:20	Layover Time	21% Schedule Day
		Portland	6:30						Vancouver	22:20	15:50	Total Time	66% Calendar Day
2	Train	**106**		**111**		**120**							
	Miles	179		179		179					537	Miles	
	Time in Service	2:55		2:55		2:55					8:45	Time in Service	66% Schedule Day
	Layover Time		2:50		1:35						4:25	Layover Time	34% Schedule Day
		Portland	7:45						Seattle	20:55	13:10	Total Time	55% Calendar Day
3	Train	**108**		**121**									
	Miles	335		156							491	Miles	
	Time in Service	6:40		3:25							10:05	Time in Service	81% Schedule Day
	Layover Time		2:25								2:25	Layover Time	19% Schedule Day
		Portland	9:10						Seattle	21:40	12:30	Total Time	52% Calendar Day
4	Train	**101**		**110**		**113**		**122**					
	Miles	179		179		179		179			716	Miles	
	Time in Service	2:55		2:55		2:55		2:55			11:40	Time in Service	76% Schedule Day
	Layover Time		0:45		1:00		2:00				3:45	Layover Time	24% Schedule Day
		Seattle	7:00						Seattle	22:25	15:25	Total Time	64% Calendar Day
5	Train	**103**		**112**		**117**							
	Miles	179		179		179					537	Miles	
	Time in Service	2:55		2:55		2:55					8:45	Time in Service	74% Schedule Day
	Layover Time		0:45		2:15						3:00	Layover Time	26% Schedule Day
		Seattle	8:30						Portland	20:15	11:45	Total Time	49% Calendar Day
6	Train	**105**		**114**		**119**							
	Miles	179		179		179					537	Miles	
	Time in Service	2:55		2:55		2:55					8:45	Time in Service	70% Schedule Day
	Layover Time		1:15		2:25						3:40	Layover Time	30% Schedule Day
		Seattle	10:00						Portland	22:25	12:25	Total Time	52% Calendar Day
7	Train	**107**		**118**									
	Miles	335		179							514	Miles	
	Time in Service	6:40		2:55							9:35	Time in Service	77% Schedule Day
	Layover Time		2:50								2:50	Layover Time	23% Schedule Day
		Vancouver	7:15						Seattle	19:40	12:25	Total Time	52% Calendar Day
8	Train	**102**		**115**									
	Miles	156		335							491	Miles	
	Time in Service	3:25		6:40							10:05	Time in Service	89% Schedule Day
	Layover Time		1:15								1:15	Layover Time	11% Schedule Day
		Seattle	7:30						Portland	18:50	11:20	Total Time	47% Calendar Day

One equipment set required for each assignment

Terminating Equipment

Seattle		Portland	
Asgnmt	Arrive	Asgnmt	Arrive
7	19:40	8	18:50
2	20:55	5	20:15
3	21:40	6	22:25
4	22:25		

Originating Equipment

Seattle		Portland	
Asgnmt	Leave	Asgnmt	Leave
4	7:00	1	6:30
8	7:30	2	7:45
5	8:30	3	9:10
6	10:00		

Equipment Rotation

Originate	Asgnmt	Miles	Seattle-Seattle Miles	Seatle time
Seattle	4	716	716	10:05
Seattle	5	537		
Portland	1	693		
Vancouver	7	514	1744	11:50
Seattle	8	491		
Portland	2	537	1028	13:05
Seattle	6	537		
Portland	3	491	1028	9:20

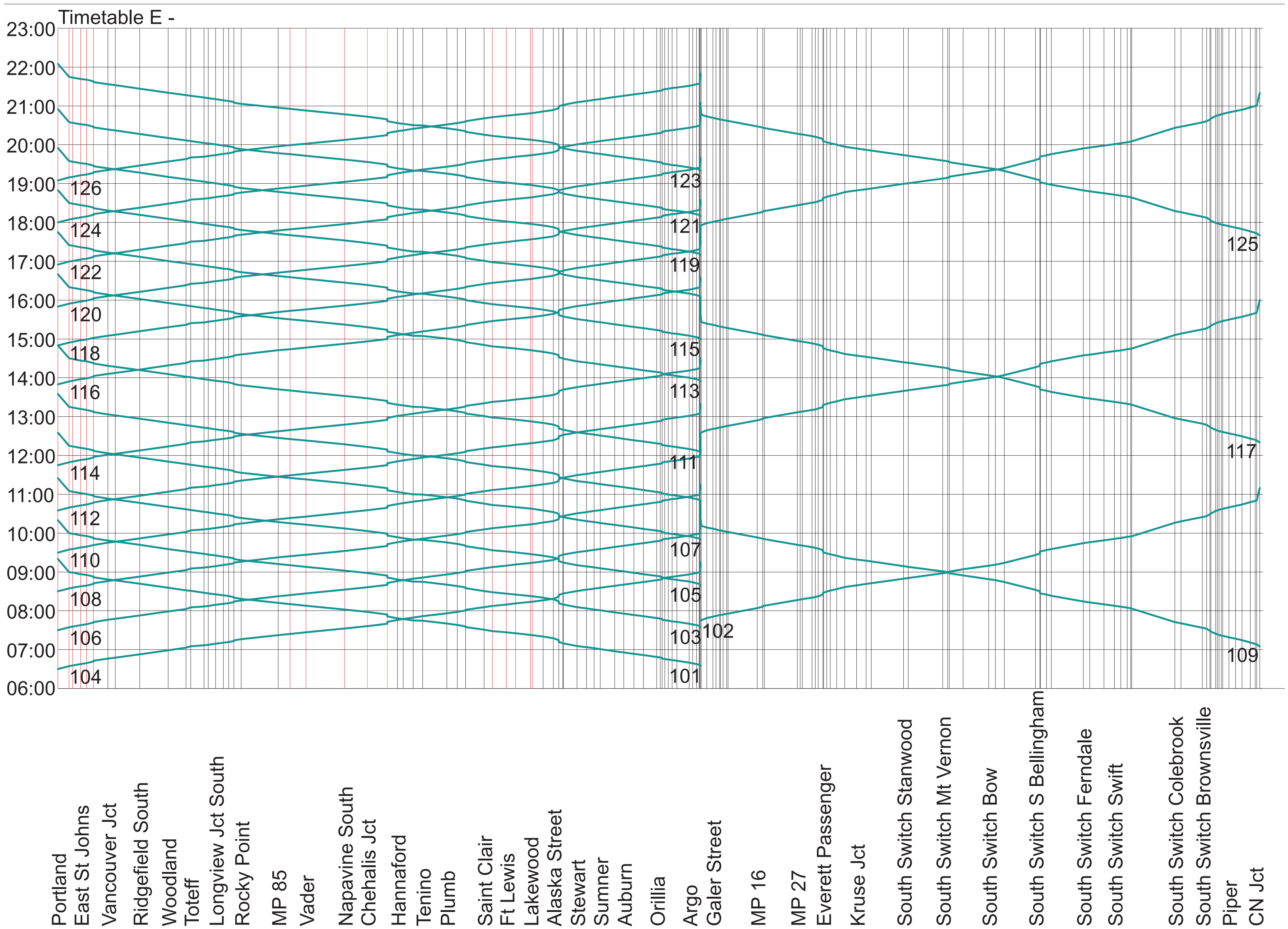
Each set works assignments in top to bottom order then repeats the cycle.

Timetable E — **SOUTHWARD TRAINS**

Example Train Numbers	123	121	125	119	115	113	117	111	107	105	103	109	101
Vancouver BC			5:40 P				12:20 P					7:05 A	
Bellingnham			7:05 P				1:45 P					8:30 A	
Mt Vernon			7:33 P				2:13 P					8:58 A	
Everett			8:08 P				2:48 P					9:33 A	
Edmonds			8:26 P				3:06 P					9:51 A	
Seattle	7:20 P	6:10 P	9:05 P	5:10 P	3:00 P	1:55 P	3:45 P 4:05 P	12:05 P	9:50 A	8:40 A	7:35 A	10:30 A 10:50 A	6:35 A
Tukwila	7:31 P	6:21 P		5:21 P	3:11 P	2:06 P	4:16 P	12:16 P	10:01 A	8:51 A	7:46 A	11:01 A	6:46 A
Tacoma	7:59 P	6:49 P		5:49 P	3:39 P	2:34 P	4:44 P	12:44 P	10:29 A	9:19 A	8:14 A	11:29 A	7:14 A
Centennial	8:20 P	7:10 P		6:10 P	4:00 P	2:55 P	5:05 P	1:05 P	10:50 A	9:40 A	8:35 A	11:50 A	7:35 A
Centralia	8:39 P	7:29 P		6:29 P	4:19 P	3:14 P	5:24 P	1:24 P	11:09 A	9:59 A	8:54 A	12:09 P	7:54 A
Kelso	9:06 P	7:56 P		6:56 P	4:46 P	3:41 P	5:51 P	1:51 P	11:36 A	10:26 A	9:21 A	12:36 P	8:21 A
Vancouver	9:37 P	8:27 P		7:27 P	5:17 P	4:12 P	6:22 P	2:22 P	12:07 P	10:57 A	9:52 A	1:07 P	8:52 A
Portland	10:05 P	8:55 P		7:55 P	5:45 P	4:40 P	6:50 P	2:50 P	12:35 P	11:25 A	10:20 A	1:35 P	9:20 A

Timetable E — **NORTHWARD TRAINS**

Example Train Numbers	104	106	102	108	110	112	114	116	118	120	122	124	126
Vancouver BC			11:10 A		4:00 P				9:20 P				
Bellingnham			9:31 A		2:21 P				7:41 P				
Mt Vernon			9:00 A		1:50 P				7:10 P				
Everett			8:27 A		1:17 P				6:37 P				
Edmonds			8:07 A		12:57 P				6:17 P				
Seattle	9:15 A	10:15 A	7:45 A	11:15 A	12:35 P 12:15 P	1:20 P	2:30 P	4:35 P	5:55 P 5:35 P	6:35 P	7:40 P	8:45 P	9:50 P
Tukwila	8:49 A	9:49 A		10:49 A	11:48 A	12:54 P	2:04 P	4:09 P	5:08 P	6:09 P	7:14 P	8:19 P	9:24 P
Tacoma	8:24 A	9:24 A		10:24 A	11:23 A	12:29 P	1:39 P	3:44 P	4:43 P	5:44 P	6:49 P	7:54 P	8:59 P
Centennial	8:01 A	9:01 A		10:01 A	11:00 A	12:06 P	1:16 P	3:21 P	4:20 P	5:21 P	6:26 P	7:31 P	8:36 P
Centralia	7:42 A	8:42 A		9:42 A	10:41 A	11:47 A	12:57 P	3:02 P	4:01 P	5:02 P	6:07 P	7:12 P	8:17 P
Kelso	7:14 A	8:14 A		9:14 A	10:13 A	11:19 A	12:29 P	2:34 P	3:33 P	4:34 P	5:39 P	6:44 P	7:49 P
Vancouver	6:42 A	7:42 A		8:42 A	9:42 A	10:47 A	11:57 A	2:02 P	3:02 P	4:02 P	5:07 P	6:12 P	7:17 P
Portland	6:30 A	7:30 A		8:30 A	9:30 A	10:35 A	11:45 A	1:50 P	2:50 P	3:50 P	4:55 P	6:00 P	7:05 P


Timetable E -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
126
124
122
120
118
116
114
112
110
108
106
104
123
121
119
115
113
111
107
105
103
101
102
125
117
109
Portland
East St Johns
Vancouver Jct
Ridgefield South
Woodland
Toteff
Longview Jct South
Rocky Point
MP 85
Vader
Napavine South
Chehalis Jct
Hannaford
Tenino
Plumb
Saint Clair
Ft Lewis
Lakewood
Alaska Street
Stewart
Sumner
Auburn
Orillia
Argo
Galer Street
MP 16
MP 27
Everett Passenger
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
South Switch S Bellingham
South Switch Ferndale
South Switch Swift
South Switch Colebrook
South Switch Brownsville
Piper
CN Jct

Crew Plan
Timetable E

Assignment	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - PORTLAND						
SP1	6:05	13:50	**7:45**	101	*1:15*	112
SP2	7:05	15:00	**7:55**	103	*1:25*	114
SP3	8:10	20:10	**12:00**	105	*5:30*	122
SP4	13:25	21:15	**7:50**	113	*1:20*	124
SP5	14:30	22:20	**7:50**	115	*1:20*	126
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - VANCOUVER						
SV1	7:15	16:15	**9:00**	102	*1:10*	117
SV2	12:05	21:35	**9:30**	110	*1:40*	125
SV3	17:25	21:50	**4:25**	118		
SV4	6:35	11:00	**4:25**	109		
PORTLAND - SEATTLE	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PS1	6:00	13:05	**7:05**	104	*0:35*	107
PS2	7:00	14:05	**7:05**	106	*0:35*	109
PS3	8:00	15:20	**7:20**	108	*0:50*	111
PS4	9:00	19:10	**10:10**	110	*3:50*	117
PS5	13:20	20:25	**7:05**	116	*0:35*	119
PS6	14:20	21:25	**7:05**	118	*0:35*	121
PS7	15:20	22:35	**7:15**	120	*0:45*	123

First named station is crew headquarters

Equipment Plan
Timetable E

Equipment Asgnmt														
1	Train	**104**		**107**		**118**								
	Miles	179		179		335					693	Miles	
	Time in Service	2:45		2:45		6:30					12:00	Time in Service	81% Schedule Day
	Layover Time		0:35		2:15						2:50	Layover Time	19% Schedule Day
		Portland	6:00						Vancouver	21:20	14:50	Total Time	62% Calendar Day
2	Train	**106**		**111**		**122**							
	Miles	179		179		179					537	Miles	
	Time in Service	2:45		2:45		2:45					8:15	Time in Service	68% Schedule Day
	Layover Time		1:50		2:05						3:55	Layover Time	32% Schedule Day
		Portland	7:30						Seattle	19:40	12:10	Total Time	51% Calendar Day
3	Train	**108**		**113**		**124**							
	Miles	179		179		179					537	Miles	
	Time in Service	2:45		2:45		2:45					8:15	Time in Service	67% Schedule Day
	Layover Time		2:40		1:20						4:00	Layover Time	33% Schedule Day
		Portland	8:30						Seattle	20:45	12:15	Total Time	51% Calendar Day
4	Train	**110**		**125**									
	Miles	335		156							491	Miles	
	Time in Service	6:30		3:25							9:55	Time in Service	86% Schedule Day
	Layover Time		1:40								1:40	Layover Time	14% Schedule Day
		Portland	9:30						Seattle	21:05	11:35	Total Time	48% Calendar Day
5	Train	**101**		**112**		**115**		**126**					
	Miles	179		179		179		179			716	Miles	
	Time in Service	2:45		2:45		2:45		2:45			11:00	Time in Service	72% Schedule Day
	Layover Time		1:15		1:40		1:20				4:15	Layover Time	28% Schedule Day
		Seattle	6:35						Seattle	21:50	15:15	Total Time	64% Calendar Day
6	Train	**103**		**114**		**119**							
	Miles	179		179		179					537	Miles	
	Time in Service	2:45		2:45		2:45					8:15	Time in Service	67% Schedule Day
	Layover Time		1:25		2:40						4:05	Layover Time	33% Schedule Day
		Seattle	7:35						Portland	19:55	12:20	Total Time	51% Calendar Day
7	Train	**105**		**116**		**121**							
	Miles	179		179		179					537	Miles	
	Time in Service	2:45		2:45		2:45					8:15	Time in Service	67% Schedule Day
	Layover Time		2:25		1:35						4:00	Layover Time	33% Schedule Day
		Seattle	8:40						Portland	20:55	12:15	Total Time	51% Calendar Day
8	Train	**102**		**117**									
	Miles	156		335							491	Miles	
	Time in Service	3:25		6:30							9:55	Time in Service	89% Schedule Day
	Layover Time		1:10								1:10	Layover Time	11% Schedule Day
		Seattle	7:45						Portland	18:50	11:05	Total Time	46% Calendar Day
9	Train	**109**		**120**		**123**							
	Miles	335		179		179					693	Miles	
	Time in Service	6:30		2:45		2:45					12:00	Time in Service	80% Schedule Day
	Layover Time		2:15		0:45						3:00	Layover Time	20% Schedule Day
		Vancouver	7:05						Portland	22:05	15:00	Total Time	63% Calendar Day

One equipment set required for each assignment

Terminating Equipment

Seattle		Portland	
Asgnmt	Arrive	Asgnmt	Arrive
2	19:40	8	18:50
3	20:45	6	19:55
4	21:05	7	20:55
5	21:50	9	22:05

Originating Equipment

Seattle		Portland	
Asgnmt	Leave	Asgnmt	Leave
5	6:35	1	6:00
6	7:35	2	7:30
8	7:45	3	8:30
7	8:40	4	9:30

Equipment Rotation

Originate	Asgnmt	Miles	Seattle-Seattle Miles	Seatle time
Seattle	5	716	716	9:45
Seattle	6	537		
Portland	1	693		
Vancouver	9	693		
Portland	2	537	2460	13:00
Seattle	7	537		
Portland	3	537	1074	11:00
Seattle	8	491		
Portland	4	491	982	9:30

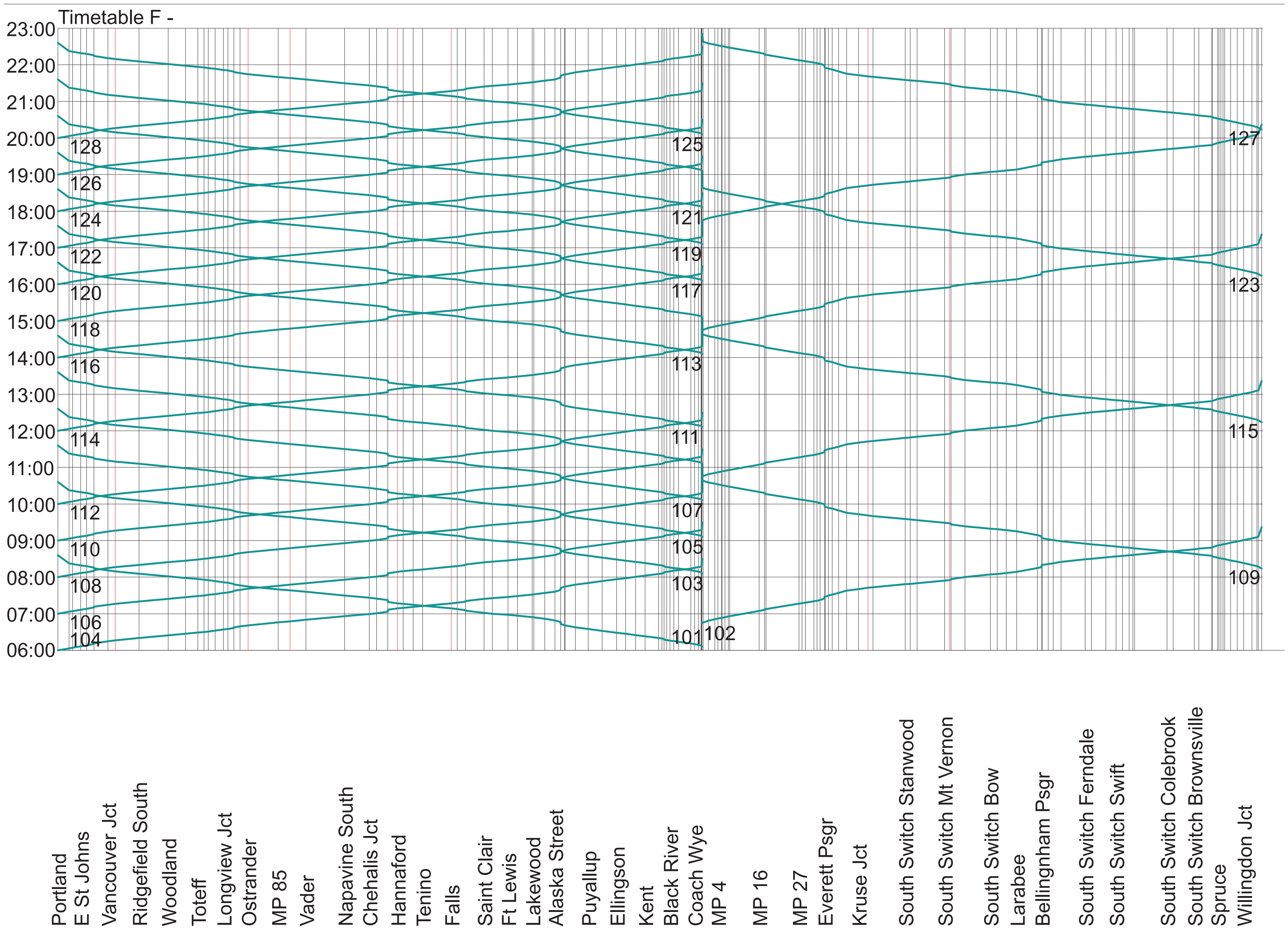
Each set works assignments in top to bottom order then repeats the cycle.

Timetable F **SOUTHWARD TRAINS**

Example Train Numbers	127	125	121	119	123	117	113	115	111	107	105	109	103	101
Vancouver BC	8:14 P				4:14 P			12:14 P				8:14 A		
Bellingnham	9:07 P				5:07 P			1:07 P				9:07 A		
Mt Vernon	9:27 P				5:27 P			1:27 P				9:27 A		
Everett	9:59 P				5:59 P			1:59 P				9:59 A		
Edmonds	10:17 P				6:17 P			2:17 P				10:17 A		
	10:51 P				6:51 P			2:51 P				10:51 A		
Seattle		8:06 P	6:06 P	5:06 P	7:06 P	4:06 P	2:06 P	3:06 P	12:06 P	10:06 A	9:06 A	11:06 A	8:06 A	6:06 A
Tukwila		8:18 P	6:18 P	5:18 P	7:18 P	4:18 P	2:18 P	3:18 P	12:18 P	10:18 A	9:18 A	11:18 A	8:18 A	6:18 A
Tacoma		8:46 P	6:46 P	5:46 P	7:46 P	4:46 P	2:46 P	3:46 P	12:46 P	10:46 A	9:46 A	11:46 A	8:46 A	6:46 A
Centennial		9:05 P	7:05 P	6:05 P	8:05 P	5:05 P	3:05 P	4:05 P	1:05 P	11:05 A	10:05 A	12:05 P	9:05 A	7:05 A
Centralia		9:22 P	7:22 P	6:22 P	8:22 P	5:22 P	3:22 P	4:22 P	1:22 P	11:22 A	10:22 A	12:22 P	9:22 A	7:22 A
Kelso		9:49 P	7:49 P	6:49 P	8:49 P	5:49 P	3:49 P	4:49 P	1:49 P	11:49 A	10:49 A	12:49 P	9:49 A	7:49 A
Vancouver		10:15 P	8:15 P	7:15 P	9:15 P	6:15 P	4:15 P	5:15 P	2:15 P	12:15 P	11:15 A	1:15 P	10:15 A	8:15 A
Portland		10:36 P	8:36 P	7:36 P	9:36 P	6:36 P	4:36 P	5:36 P	2:36 P	12:36 P	11:36 A	1:36 P	10:36 A	8:36 A

Timetable F **NORTHWARD TRAINS**

Example Train Numbers	104	102	106	108	110	112	114	116	118	120	122	124	126	128
Vancouver BC		9:22 A		1:22 P			5:22 P		8:22 P					
Bellingnham		8:19 A		12:19 P			4:19 P		7:19 P					
Mt Vernon		7:56 A		11:56 A			3:56 P		6:56 P					
Everett		7:27 A		11:27 A			3:27 P		6:27 P					
Edmonds		7:07 A		11:07 A			3:07 P		6:07 P					
		6:45 A		10:45 A			2:45 P		5:45 P					
Seattle	8:30 A		9:30 A	10:30 A	11:30 A	12:30 P	2:30 P	4:30 P	5:30 P	6:30 P	7:30 P	8:30 P	9:30 P	10:30 P
Tukwila	8:07 A		9:07 A	10:07 A	11:07 A	12:07 P	2:07 P	4:07 P	5:07 P	6:07 P	7:07 P	8:07 P	9:07 P	10:07 P
Tacoma	7:42 A		8:42 A	9:42 A	10:42 A	11:42 A	1:42 P	3:42 P	4:42 P	5:42 P	6:42 P	7:42 P	8:42 P	9:42 P
Centennial	7:20 A		8:20 A	9:20 A	10:20 A	11:20 A	1:20 P	3:20 P	4:20 P	5:20 P	6:20 P	7:20 P	8:20 P	9:20 P
Centralia	7:06 A		8:06 A	9:06 A	10:06 A	11:06 A	1:06 P	3:06 P	4:06 P	5:06 P	6:06 P	7:06 P	8:06 P	9:06 P
Kelso	6:37 A		7:37 A	8:37 A	9:37 A	10:37 A	12:37 P	2:37 P	3:37 P	4:37 P	5:37 P	6:37 P	7:37 P	8:37 P
Vancouver	6:11 A		7:11 A	8:11 A	9:11 A	10:11 A	12:11 P	2:11 P	3:11 P	4:11 P	5:11 P	6:11 P	7:11 P	8:11 P
Portland	6:00 A		7:00 A	8:00 A	9:00 A	10:00 A	12:00 P	2:00 P	3:00 P	4:00 P	5:00 P	6:00 P	7:00 P	8:00 P


Timetable F -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
128
126
124
122
120
118
116
114
112
110
108
106
104
125
121
119
117
113
111
107
105
103
101
102
127
123
115
109
Portland
E St Johns
Vancouver Jct
Ridgefield South
Woodland
Toteff
Longview Jct
Ostrander
MP 85
Vader
Napavine South
Chehalis Jct
Hannaford
Tenino
Falls
Saint Clair
Ft Lewis
Lakewood
Alaska Street
Puyallup
Ellingson
Kent
Black River
Coach Wye
MP 4
MP 16
MP 27
Everett Psgr
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
Larabee
Bellingham Psgr
South Switch Ferndale
South Switch Swift
South Switch Colebrook
South Switch Brownsville
Spruce
Willingdon Jct

Crew Plan
Timetable F

Assignment	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - PORTLAND						
SP1	5:36	12:00	**6:24**	101	*0:24*	110
SP2	7:36	15:00	**7:24**	103	*1:24*	114
SP3	13:36	21:00	**7:24**	113	*1:24*	124
SP4	15:36	22:00	**6:24**	117	*0:24*	126
SP5	16:36	23:00	**6:24**	119	*0:24*	128
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - VANCOUVER						
SV1	6:15	16:20	**10:05**	102	*2:47*	115
SV2	10:15	18:50	**8:35**	108	*2:47*	123
SV3	14:15	23:20	**9:05**	114	*2:47*	127
PORTLAND - SEATTLE	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PS1	5:30	12:06	**6:36**	104	*0:36*	105
PS2	6:30	13:06	**6:36**	106	*0:36*	107
PS3	7:30	15:06	**7:36**	108	*1:36*	111
PS4	9:30	18:06	**8:36**	112	*2:36*	115
PS5	13:30	21:06	**7:36**	116	*1:36*	121
PS6	15:30	22:06	**6:36**	120	*0:36*	123
PS7	16:30	23:06	**6:36**	122	*0:36*	125
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PORTLAND - VANCOUVER						
PV1	14:30	20:57	**6:27**	118	*10:47*	T/U
PV2 = PV1 return	7:44	14:06	**6:22**	109		

First named station is crew headquarters

Equipment Plan
Timetable F

Equipment Asgnmt													
1	Train	**101**		**110**		**111**		**120**					
	Miles	187		187		187		187			748	Miles	
	Time in Service	2:30		2:30		2:30		2:30			10:00	Time in Service	81% Schedule Day
	Layover Time		0:24		0:36		1:24				2:24	Layover Time	19% Schedule Day
		Seattle	6:06						Seattle	18:30	12:24	Total Time	52% Calendar Day
2	Train	**102**		**115**		**124**							
	Miles	150		337		187					674	Miles	
	Time in Service	2:37		5:22		2:30					10:29	Time in Service	76% Schedule Day
	Layover Time		2:52		0:24						3:16	Layover Time	24% Schedule Day
		Seattle	6:45						Seattle	20:30	13:45	Total Time	57% Calendar Day
3	Train	**103**		**114**		**127**							
	Miles	187		337		150					674	Miles	
	Time in Service	2:30		5:22		2:36					10:28	Time in Service	71% Schedule Day
	Layover Time		1:24		2:52						4:16	Layover Time	29% Schedule Day
		Seattle	8:06						Seattle	22:50	14:44	Total Time	61% Calendar Day
4	Train	**104**		**105**		**116**		**119**		**128**			
	Miles	187		187		187		187		187	935	Miles	
	Time in Service	2:30		2:30		2:30		2:30		2:30	12:30	Time in Service	76% Schedule Day
	Layover Time		0:36		2:24		0:36		0:24		4:00	Layover Time	24% Schedule Day
		Portland	6:00						Seattle	22:30	16:30	Total Time	69% Calendar Day
5	Train	**107**		**118**									
	Miles	187		337							524	Miles	
	Time in Service	2:30		5:22							7:52	Time in Service	77% Schedule Day
	Layover Time		2:24								2:24	Layover Time	23% Schedule Day
		Seattle	10:06						Vancouver	20:22	10:16	Total Time	43% Calendar Day
6	Train	**109**		**122**		**125**							
	Miles	337		187		187					711	Miles	
	Time in Service	5:22		2:30		2:30					10:22	Time in Service	72% Schedule Day
	Layover Time		3:24		0:36						4:00	Layover Time	28% Schedule Day
		Vancouver	8:14						Portland	22:36	14:22	Total Time	60% Calendar Day
7	Train	**108**		**123**									
	Miles	337		337							674	Miles	
	Time in Service	5:22		5:22							10:44	Time in Service	79% Schedule Day
	Layover Time		2:52								2:52	Layover Time	21% Schedule Day
		Portland	8:00						Portland	21:36	13:36	Total Time	57% Calendar Day
8	Train	**112**		**113**		**126**							
	Miles	187		187		187					561	Miles	
	Time in Service	2:30		2:30		2:30					7:30	Time in Service	65% Schedule Day
	Layover Time		1:36		2:24						4:00	Layover Time	35% Schedule Day
		Portland	10:00						Seattle	21:30	11:30	Total Time	48% Calendar Day
9	Train	**106**		**121**									
	Miles	187		187							374	Miles	
	Time in Service	2:30		2:30							5:00	Time in Service	37% Schedule Day
	Layover Time		8:36								8:36	Layover Time	63% Schedule Day
		Portland	7:00						Portland	20:36	13:36	Total Time	57% Calendar Day
10	Train	**117**											
	Miles	187									187	Miles	
	Time in Service	2:30									2:30	Time in Service	100% Schedule Day
	Layover Time										0:00	Layover Time	0% Schedule Day
		Seattle	16:06						Portland	18:36	2:30	Total Time	10% Calendar Day

One equipment set required for each assignment

Terminating Equipment

Seattle		Portland	
Asgnmt	Arrive	Asgnmt	Arrive
1	18:30	10	18:36
2	20:30	9	20:36
8	21:30	7	21:36
4	22:30	6	22:36
3	22:50		

Originating Equipment

Seattle		Portland	
Asgnmt	Leave	Asgnmt	Leave
1	6:06	4	6:00
2	6:45	9	7:00
3	8:06	7	8:00
5	10:06	8	10:00
10	16:06		

Equipment Rotation

Originate	Asgnmt	Miles	Seattle-Seattle Miles	Seatle time
Seattle	1	748	748	15:36
Seattle	5	524		
Vancouver	6	711		
Portland	8	561	1796	18:36
Seattle	10	187		
Portland	7	674		
Portland	9	374		
Portland	4	935	2170	9:36
Seattle	3	674	674	7:55
Seattle	2	674	674	9:36

Each set works assignments in top to bottom order then repeats the cycle.

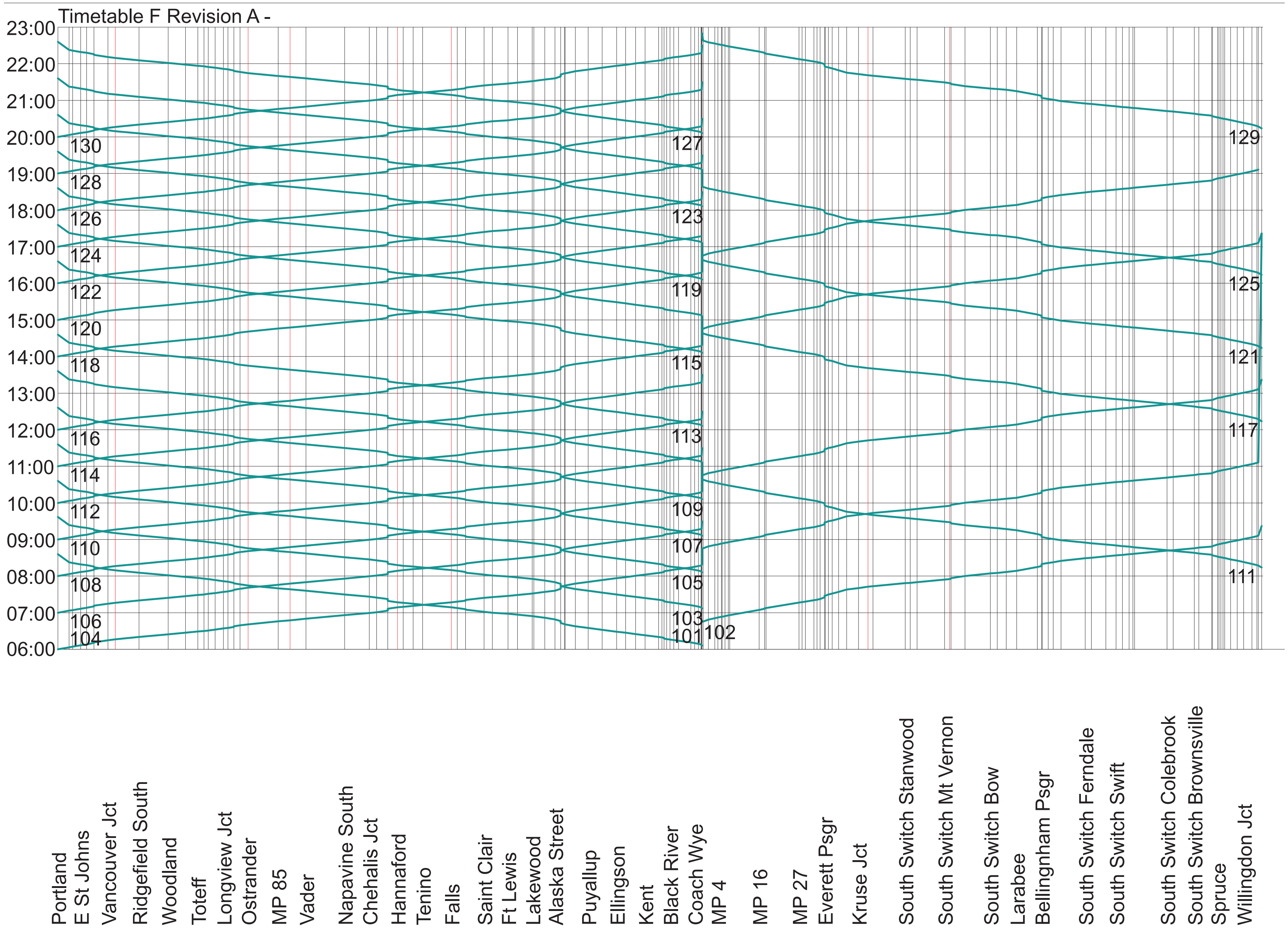
Appendix I
Timetable F, Revision A

Timetable F Revision A — **SOUTHWARD TRAINS**

Example Train Numbers	129	127	125	123	121	119	117	115	113	111	109	107	105	103	101
Vancouver BC	8:14 P		4:14 P		2:14 P		12:14 P			8:14 A					
Bellingnham	9:07 P		5:07 P		3:07 P		1:07 P			9:07 A					
Mt Vernon	9:27 P		5:27 P		3:27 P		1:27 P			9:27 A					
Everett	9:59 P		5:59 P		3:59 P		1:59 P			9:59 A					
Edmonds	10:17 P		6:17 P		4:17 P		2:17 P			10:17 A					
	10:51 P		6:51 P		4:51 P		2:51 P			10:51 A					
Seattle		8:06 P	7:06 P	6:06 P	5:06 P	4:06 P	3:06 P	2:06 P	12:06 P	11:06 A	10:06 A	9:06 A	8:06 A	7:07 A	6:06 A
Tukwila		8:18 P	7:18 P	6:18 P	5:18 P	4:18 P	3:18 P	2:18 P	12:18 P	11:18 A	10:18 A	9:18 A	8:18 A	7:19 A	6:18 A
Tacoma		8:46 P	7:46 P	6:46 P	5:46 P	4:46 P	3:46 P	2:46 P	12:46 P	11:46 A	10:46 A	9:46 A	8:46 A	7:47 A	6:46 A
Centennial		9:05 P	8:05 P	7:05 P	6:05 P	5:05 P	4:05 P	3:05 P	1:05 P	12:05 P	11:05 A	10:05 A	9:05 A	8:06 A	7:05 A
Centralia		9:22 P	8:22 P	7:22 P	6:22 P	5:22 P	4:22 P	3:22 P	1:22 P	12:22 P	11:22 A	10:22 A	9:22 A	8:23 A	7:22 A
Kelso		9:49 P	8:49 P	7:49 P	6:49 P	5:49 P	4:49 P	3:49 P	1:49 P	12:49 P	11:49 A	10:49 A	9:49 A	8:50 A	7:49 A
Vancouver		10:15 P	9:15 P	8:15 P	7:15 P	6:15 P	5:15 P	4:15 P	2:15 P	1:15 P	12:15 P	11:15 A	10:15 A	9:16 A	8:15 A
Portland		10:36 P	9:36 P	8:36 P	7:36 P	6:36 P	5:36 P	4:36 P	2:36 P	1:36 P	12:36 P	11:36 A	10:36 A	9:37 A	8:36 A

Timetable F Revision A — **NORTHWARD TRAINS**

Example Train Numbers	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
Vancouver BC	9:22 A	11:22 A		1:22 P				5:22 P	8:22 P						
Bellingnham	8:16 A	10:16 A		12:16 P				4:16 P	6:16 P						
Mt Vernon	7:56 A	9:56 A		11:56 A				3:56 P	5:56 P						
Everett	7:27 A	9:27 A		11:27 A				3:27 P	5:27 P						
Edmonds	7:07 A	9:07 A		11:07 A				3:07 P	5:07 P						
	6:45 A	08:45 A		10:45 A				2:45 P	4:45 P						
Seattle		08:30 A	9:30 A	10:30 A	11:30 A	12:30 P	1:30 P	2:30 P	4:30 P	5:30 P	6:30 P	7:30 P	8:30 P	9:30 P	10:30 P
Tukwila		8:07 A	9:07 A	10:07 A	11:07 A	12:07 P	1:07 P	2:07 P	4:07 P	5:07 P	6:07 P	7:07 P	8:07 P	9:07 P	10:07 P
Tacoma		7:42 A	8:42 A	9:42 A	10:42 A	11:42 A	12:42 P	1:42 P	3:42 P	4:42 P	5:42 P	6:42 P	7:42 P	8:42 P	9:42 P
Centennial		7:20 A	8:20 A	9:20 A	10:20 A	11:20 A	12:20 P	1:20 P	3:20 P	4:20 P	5:20 P	6:20 P	7:20 P	8:20 P	9:20 P
Centralia		7:06 A	8:06 A	9:06 A	10:06 A	11:06 A	12:06 P	1:06 P	3:06 P	4:06 P	5:06 P	6:06 P	7:06 P	8:06 P	9:06 P
Kelso		6:37 A	7:37 A	8:37 A	9:37 A	10:37 A	11:37 A	12:37 P	2:37 P	3:37 P	4:37 P	5:37 P	6:37 P	7:37 P	8:37 P
Vancouver		6:11 A	7:11 A	8:11 A	9:11 A	10:11 A	11:11 A	12:11 P	2:11 P	3:11 P	4:11 P	5:11 P	6:11 P	7:11 P	8:11 P
Portland		6:00 A	7:00 A	8:00 A	9:00 A	10:00 A	11:00 A	12:00 P	2:00 P	3:00 P	4:00 P	5:00 P	6:00 P	7:00 P	8:00 P



Timetable F Revision A -
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
09:00
08:00
07:00
06:00
130
128
126
124
122
120
118
116
114
112
110
108
106
104
127
123
119
115
113
109
107
105
103
101
102
129
125
121
117
111
Portland
E St Johns
Vancouver Jct
Ridgefield South
Woodland
Toteff
Longview Jct
Ostrander
MP 85
Vader
Napavine South
Chehalis Jct
Hannaford
Tenino
Falls
Saint Clair
Ft Lewis
Lakewood
Alaska Street
Puyallup
Ellingson
Kent
Black River
Coach Wye
MP 4
MP 16
MP 27
Everett Psgr
Kruse Jct
South Switch Stanwood
South Switch Mt Vernon
South Switch Bow
Larabee
Bellingham Psgr
South Switch Ferndale
South Switch Swift
South Switch Colebrook
South Switch Brownsville
Spruce
Willingdon Jct

Crew Plan
Timetable F Revision A

Assignment	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - PORTLAND						
SP1	5:36	12:00	**6:24**	101	*0:24*	110
SP2	6:36	13:00	**6:24**	103	*0:24*	112
SP3	7:36	14:00	**6:24**	105	*0:24*	114
SP4	13:36	20:00	**6:24**	115	*0:24*	124
SP5	14:36	21:00	**6:24**	117	*0:24*	126
SP6	15:36	22:00	**6:24**	119	*0:24*	128
SP7	16:36	23:00	**6:24**	121	*0:24*	130
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
SEATTLE - VANCOUVER						
SV1	6:15	19:20	**13:05**	102	*6:52*	125
SV2	8:15	15:20	**7:05**	108	*0:52*	123
SV3	10:15	17:20	**7:05**	108	*0:52*	121
SV4	16:15	23:20	**7:05**	118	*0:52*	129
PORTLAND - SEATTLE	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PS1	5:30	12:06	**6:36**	104	*0:36*	107
PS2	6:30	13:06	**6:36**	106	*0:36*	109
PS3	7:30	15:06	**7:36**	108	*1:36*	113
PS4	13:30	21:06	**7:36**	118	*1:36*	123
PS5	14:30	22:06	**7:36**	120	*1:36*	125
PS6	15:30	23:06	**7:36**	122	*1:36*	127
	On Duty	Off Duty	**Time On Duty**	Train	*Layover Time*	Train
PORTLAND - VANCOUVER						
PV1	11:30	17:52	**6:22**	116	*14:52*	T/U
PV2 = PV1 return	7:44	14:06	**6:22**	111		

First named station is crew headquarters

Equipment Plan
Timetable F Revision A

Equipment Set													
1	Train	**104**		**121**		**130**							
	Miles	337		337		187					861	Miles	
	Time in Service	5:22		5:22		2:30					13:14	Time in Service	80% Schedule Day
	Layover Time		2:52		0:24						3:16	Layover Time	20% Schedule Day
		Portland	6:00						Seattle	22:30	16:30	Total Time	69% Calendar Day
2	Train	**106**		**109**		**118**							
	Miles	187		187		337					711	Miles	
	Time in Service	2:30		2:30		5:22					10:22	Time in Service	78% Schedule Day
	Layover Time		0:36		2:24						3:00	Layover Time	22% Schedule Day
		Portland	7:00						Vancouver	19:22	13:22	Total Time	56% Calendar Day
3	Train	**108**		**125**									
	Miles	337		337							674	Miles	
	Time in Service	5:22		5:22							10:44	Time in Service	88% Schedule Day
	Layover Time		1:24								1:24	Layover Time	12% Schedule Day
		Portland	8:00						Portland	21:36	12:08	Total Time	51% Calendar Day
4	Train	**101**		**110**		**113**		**130**		**123**			
	Miles	187		187		187		187		187	935	Miles	
	Time in Service	2:30		2:30		2:30		2:30		2:30	12:30	Time in Service	86% Schedule Day
	Layover Time		0:24		0:36		0:24		0:36		2:00	Layover Time	14% Schedule Day
		Seattle	6:06						Portland	20:36	14:30	Total Time	60% Calendar Day
5	Train	**102**		**117**		**126**							
	Miles	150		337		187					674	Miles	
	Time in Service	2:37		5:22		2:30					10:29	Time in Service	76% Schedule Day
	Layover Time		2:52		0:24						3:16	Layover Time	24% Schedule Day
		Seattle	6:45						Seattle	20:30	13:45	Total Time	57% Calendar Day
6	Train	**103**		**112**		**115**		**124**		**127**			
	Miles	187		187		187		187		187	935	Miles	
	Time in Service	2:30		2:30		2:30		2:30		2:30	12:30	Time in Service	81% Schedule Day
	Layover Time		0:24		1:36		0:24		0:36		3:00	Layover Time	19% Schedule Day
		Seattle	7:06						Portland	22:36	15:30	Total Time	65% Calendar Day
7	Train	**105**		**114**		**119**		**128**					
	Miles	187		187		187		187			748	Miles	
	Time in Service	2:30		2:30		2:30		2:30			10:00	Time in Service	75% Schedule Day
	Layover Time		0:24		2:36		0:24				3:24	Layover Time	25% Schedule Day
		Seattle	8:06						Seattle	21:30	13:24	Total Time	56% Calendar Day
8	Train	**107**		**116**		**129**							
	Miles	187		337		150					674	Miles	
	Time in Service	2:30		5:22		2:37					10:29	Time in Service	76% Schedule Day
	Layover Time		0:24		2:52						3:16	Layover Time	24% Schedule Day
		Seattle	9:06						Seattle	22:50	13:45	Total Time	57% Calendar Day
9	Train	**111**		**120**									
	Miles	337		187							524	Miles	
	Time in Service	5:22		2:30							7:52	Time in Service	77% Schedule Day
	Layover Time		2:24								2:24	Layover Time	23% Schedule Day
		Vancouver	8:14						Seattle	18:30	10:16	Total Time	43% Calendar Day

Seattle		Portland	
Set	Arrive	Set	Arrive
9	18:30	4	20:36
5	20:30	3	21:36
7	21:30	6	22:36
1	22:30		
8	22:50		

Seattle		Portland	
Set	Leave	Set	Leave
4	6:06	1	6:00
5	6:45	2	7:00
6	7:06	3	8:00
7	8:06		
8	9:06		

Originate	Asgnmt	Miles	Seattle-Seattle Miles	Seatle time
Seattle	4	935		
Portland	3	674		
Portland	1	861	2470	10:36
Seattle	8	674	674	9:16
Seattle	7	748	748	9:15
Seattle	5	674	674	10:36
Seattle	6	935	935	
Portland	2	711		
Vancouver	9	524	1235	11:36

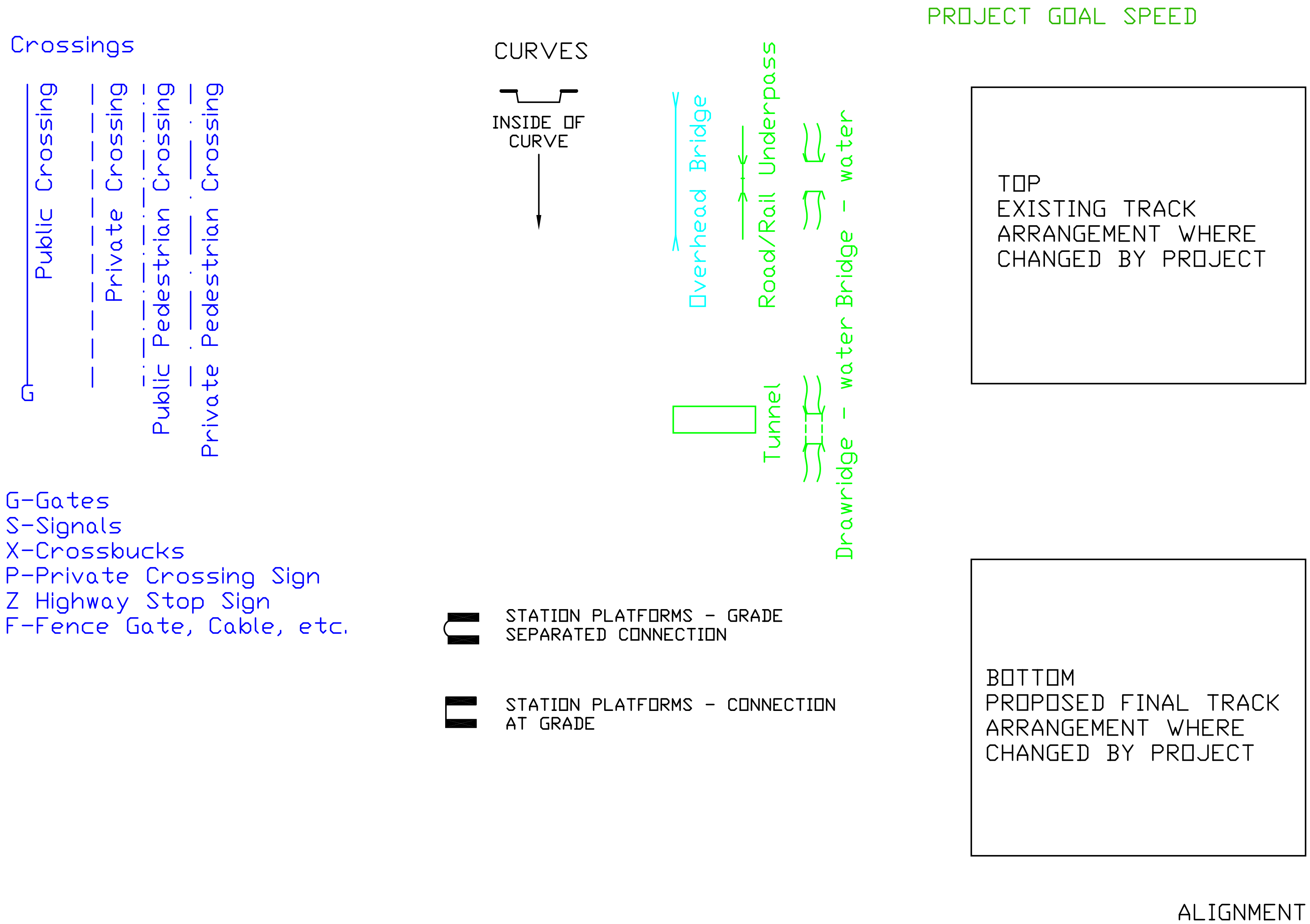
Appendix J
Track Charts

CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC
PORTLAND - NISQUALLY

TRANSIT SAFETY MANAGEMENT / HDR FOR
WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION

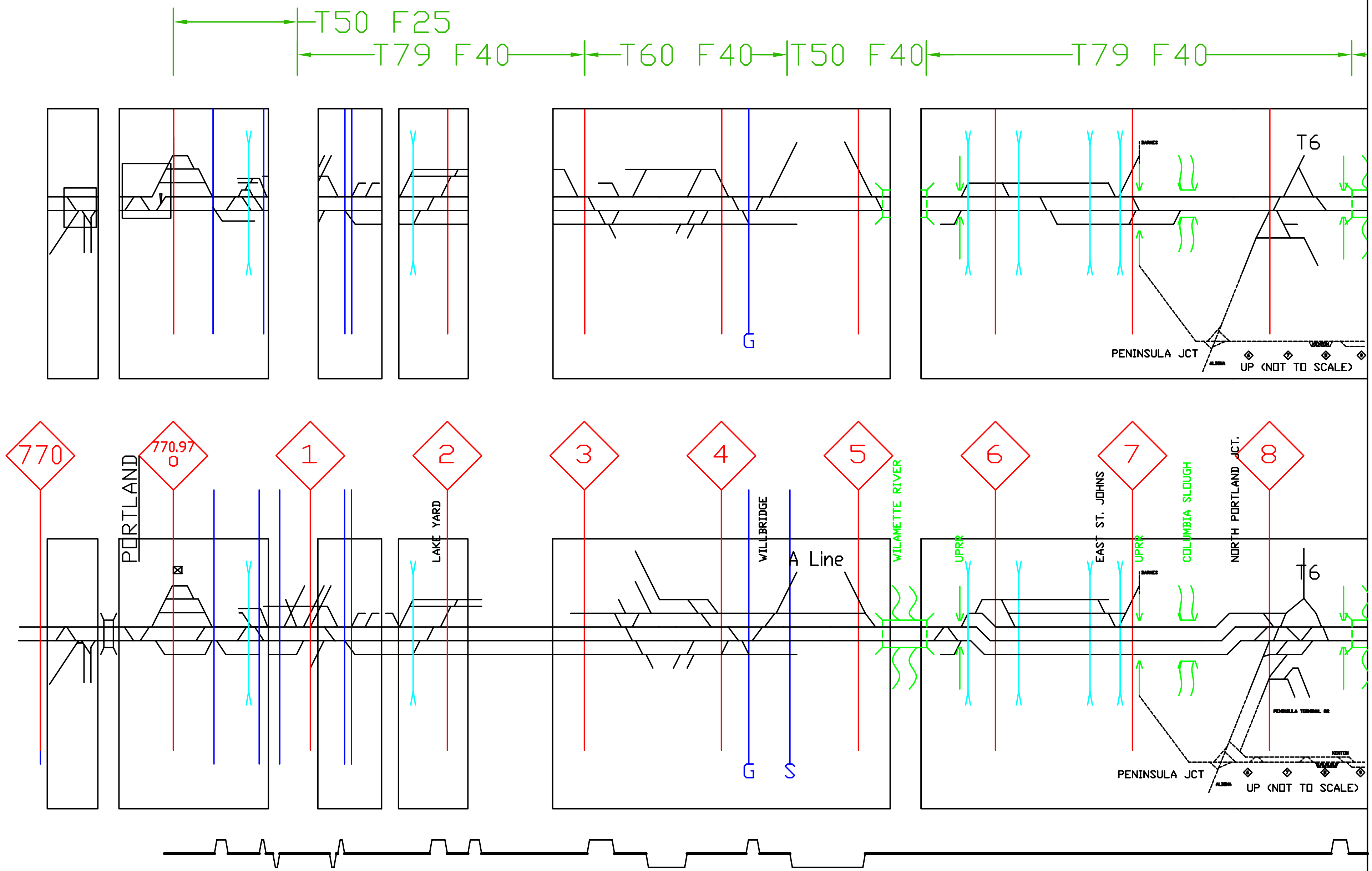
JUNE 30 2003 FEB 5 2006

SEE SEPARATE PAGES INDEXED BY MP FOR ADDITIONAL INFORMATION



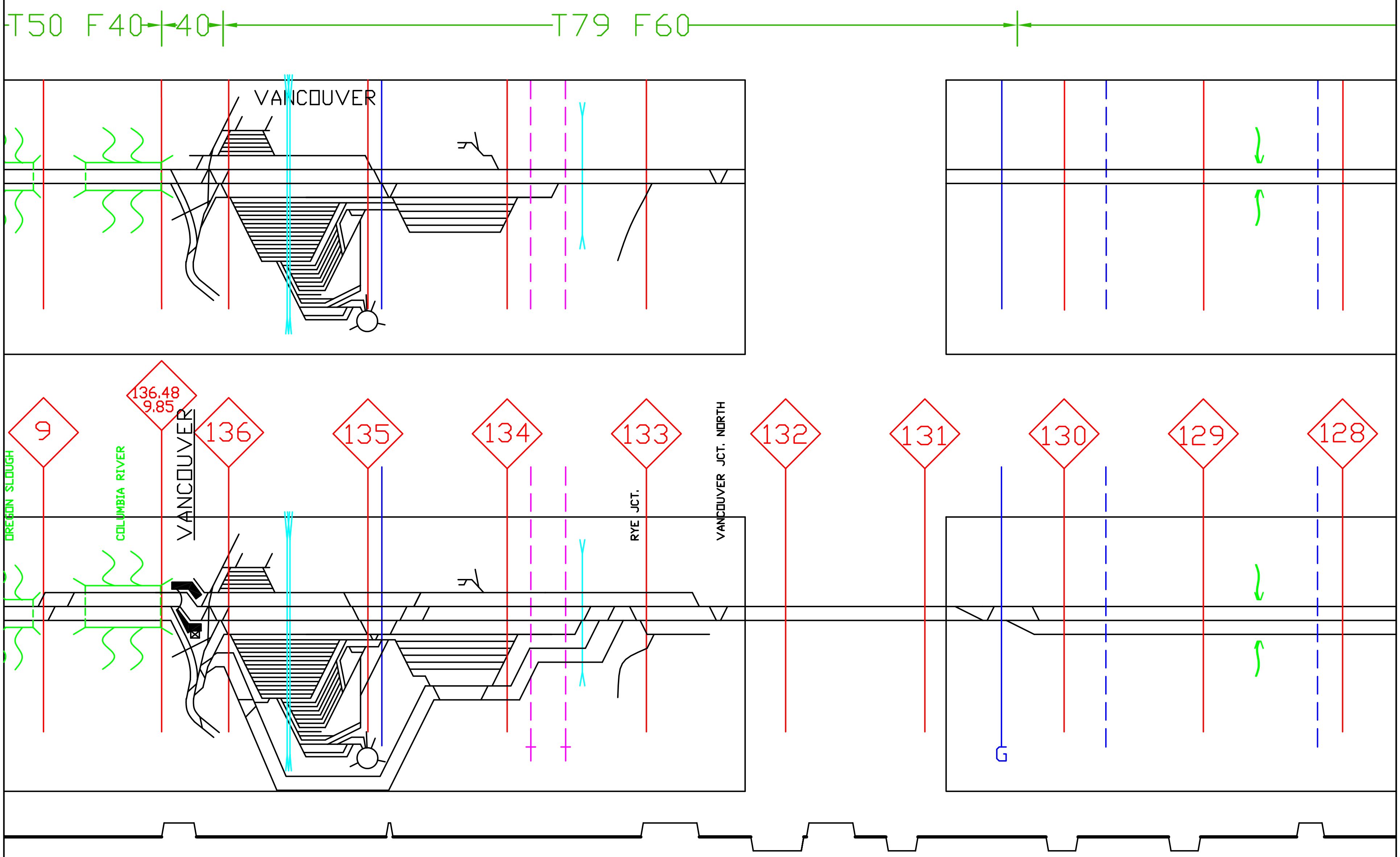
PORTLAND - NISQUALLY
2 OF 15

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT

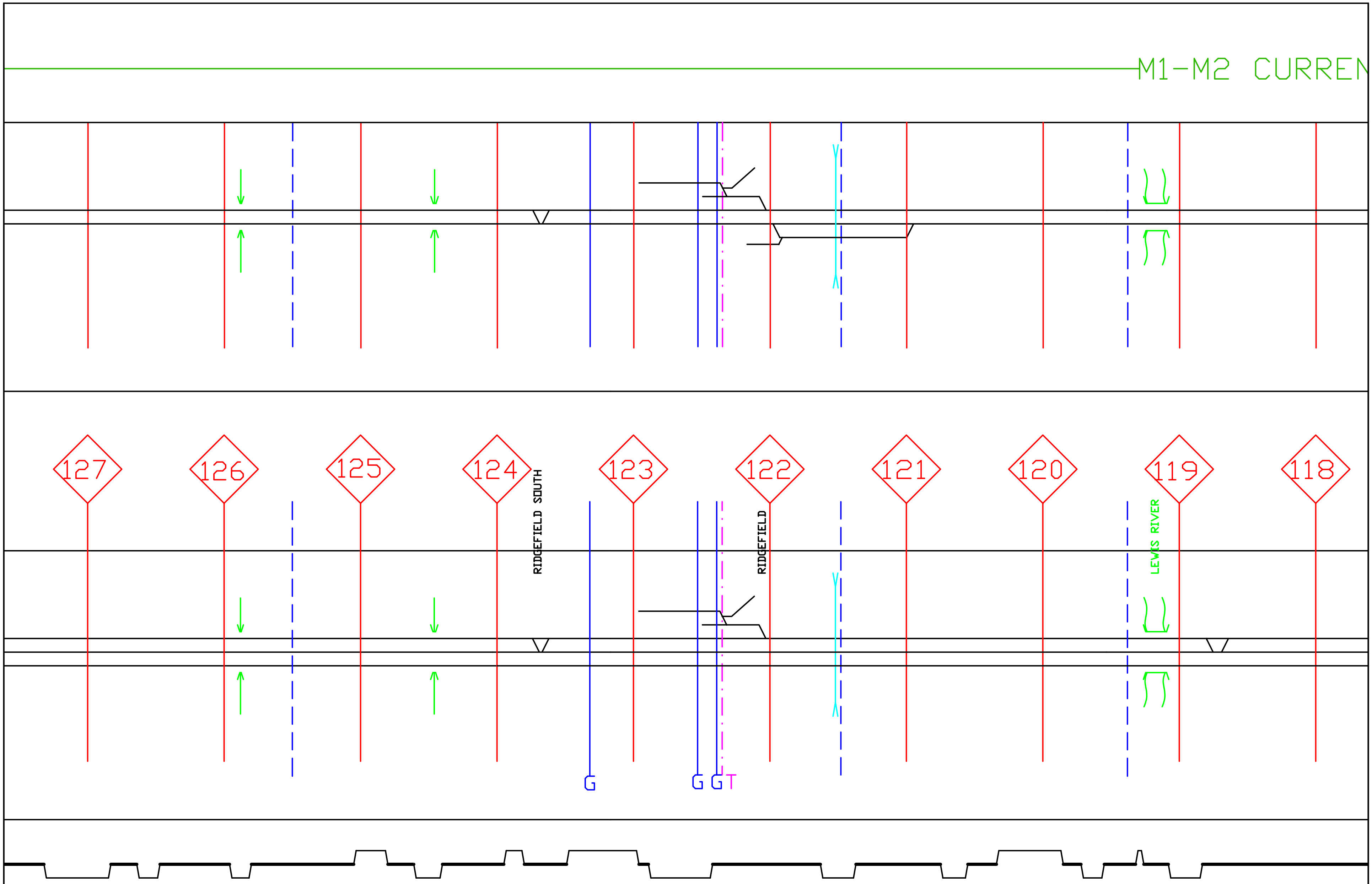


PORTLAND - NISQUALLY
3 OF 15

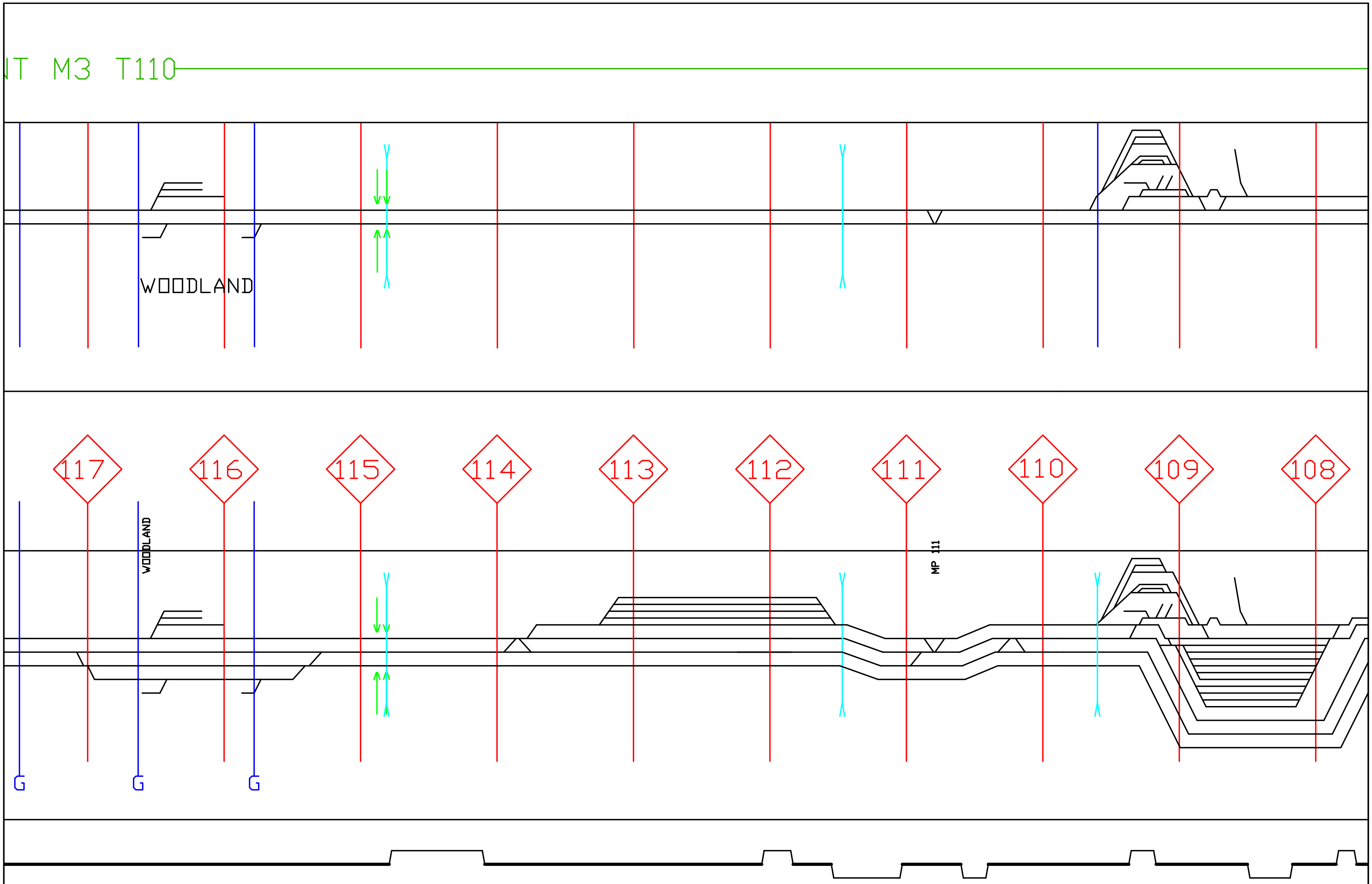
CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



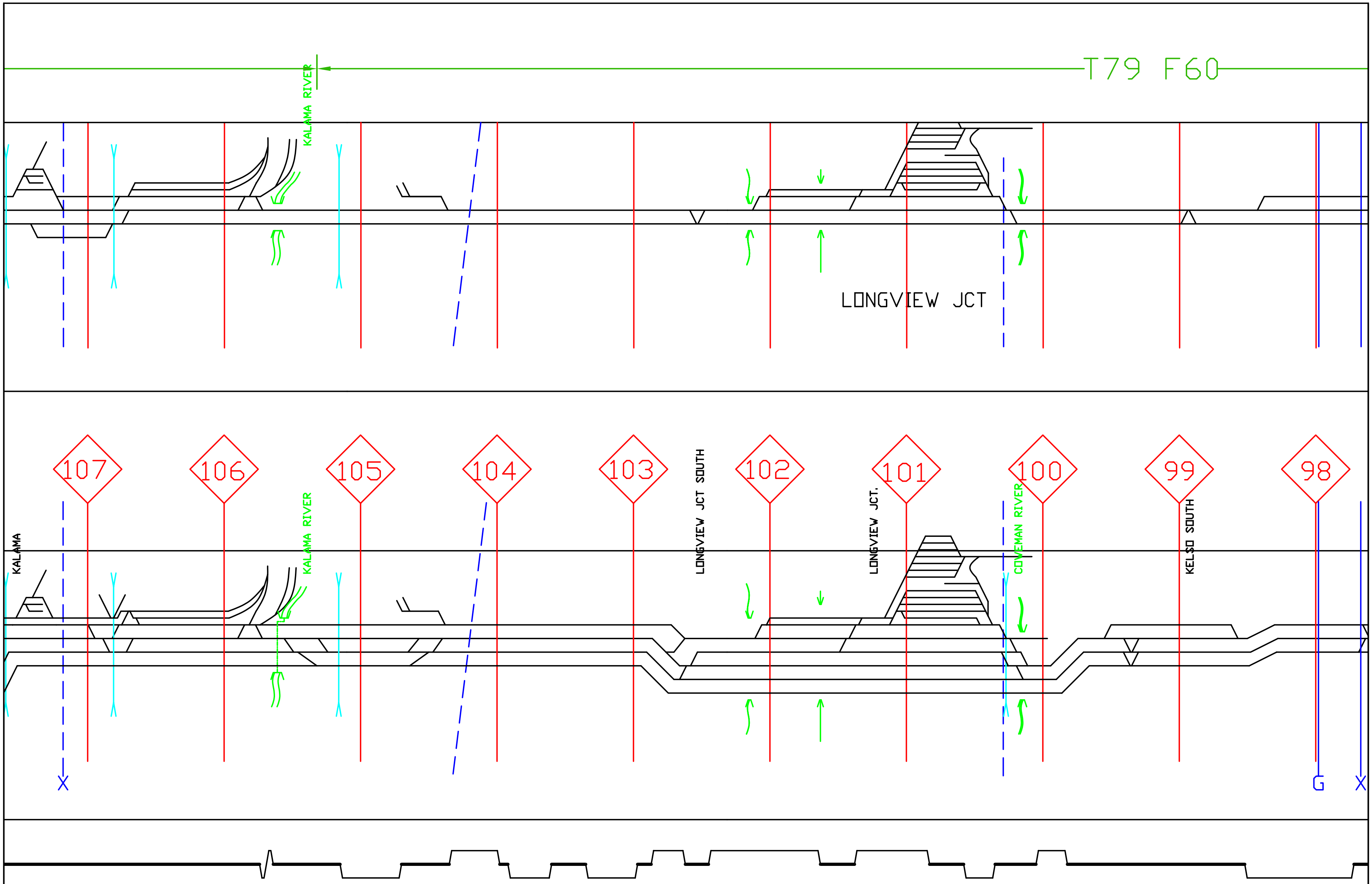
CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



PORTLAND - NISQUALLY

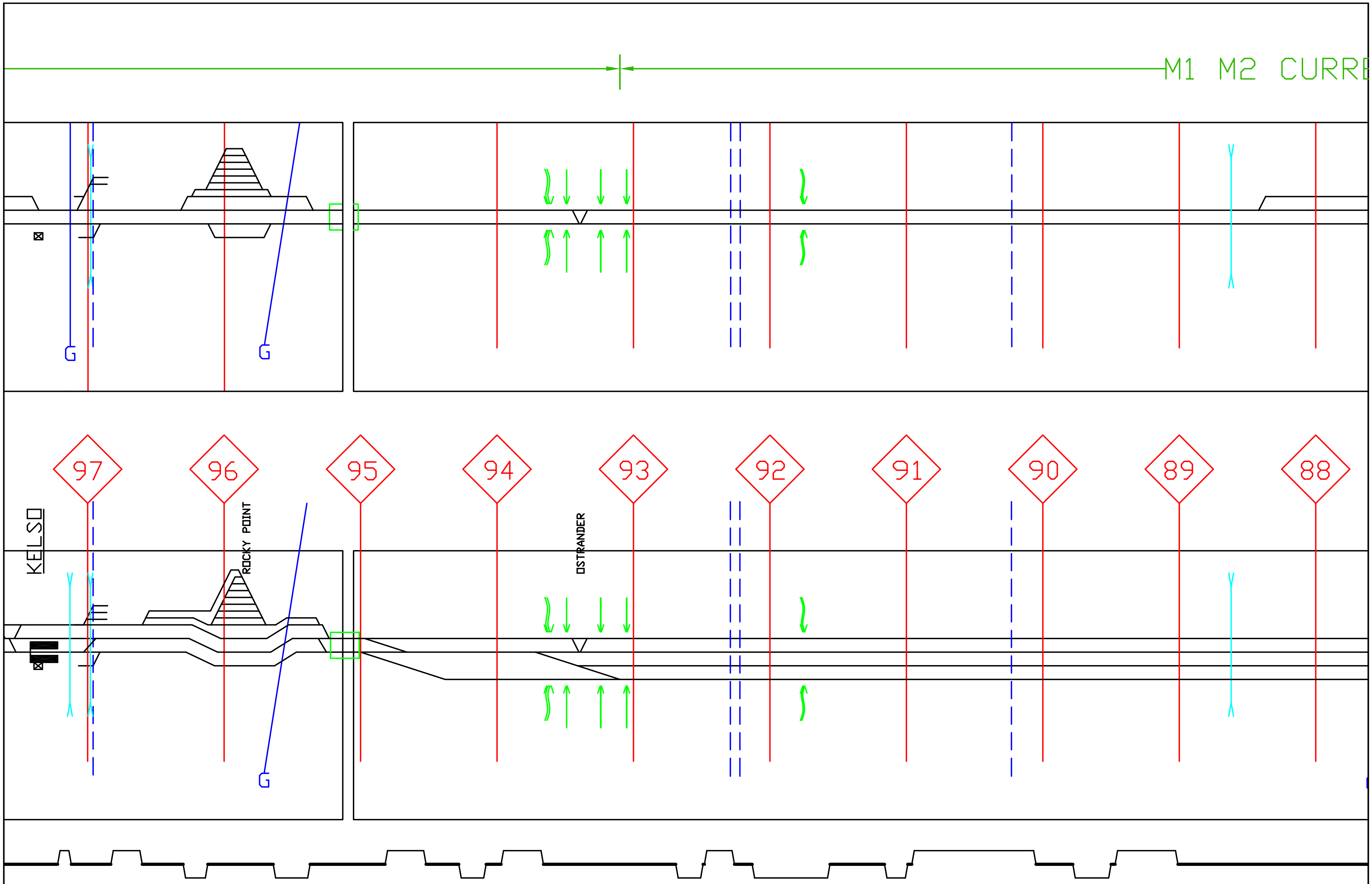


NT M3 T110
WOODLAND
117
116
115
114
113
112
111
110
109
108
WOODLAND
MP 111
G
G
G



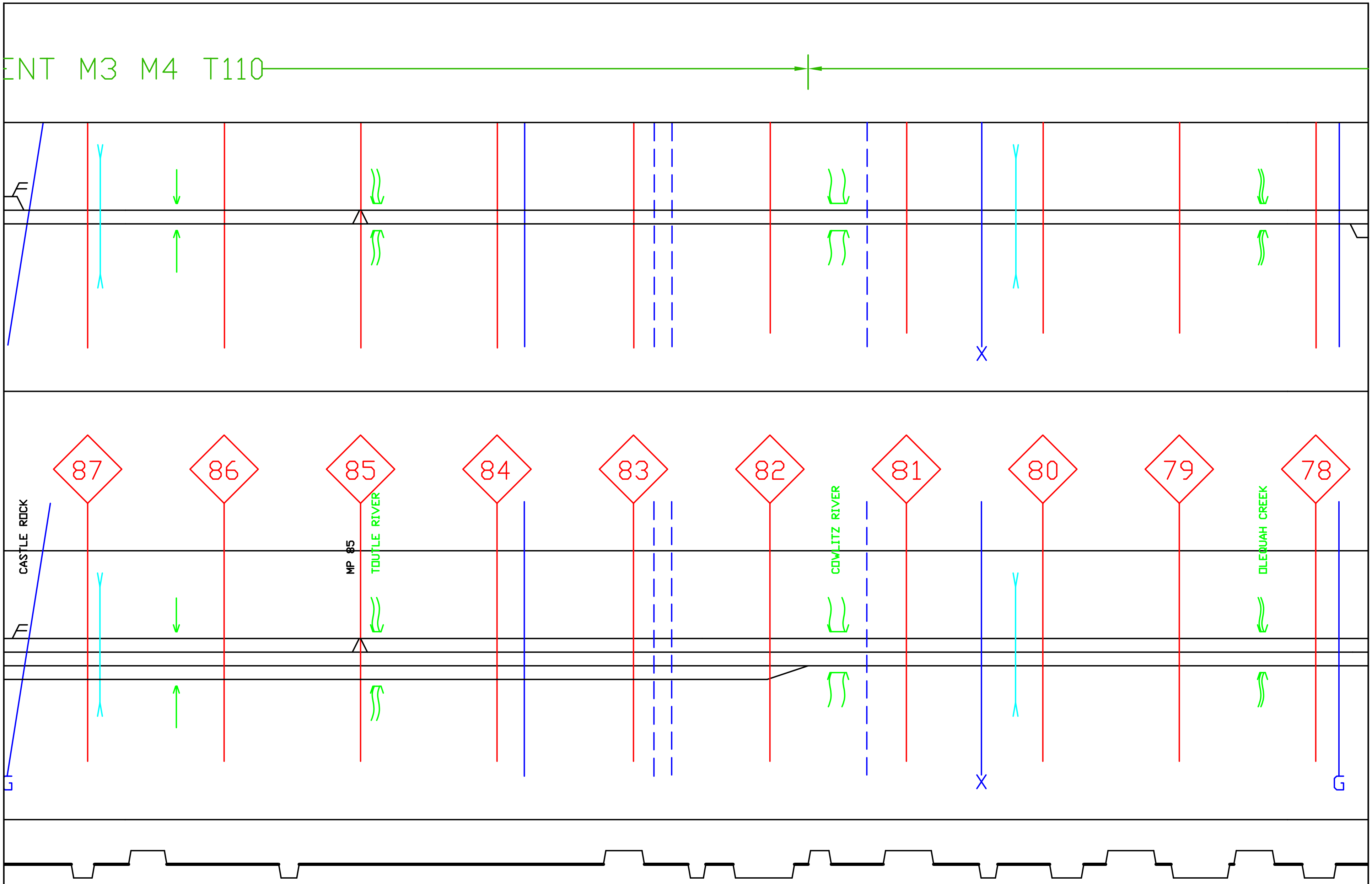
PORTLAND - NISQUALLY
7 OF 15

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



PORTLAND - NISQUALLY
8 OF 15

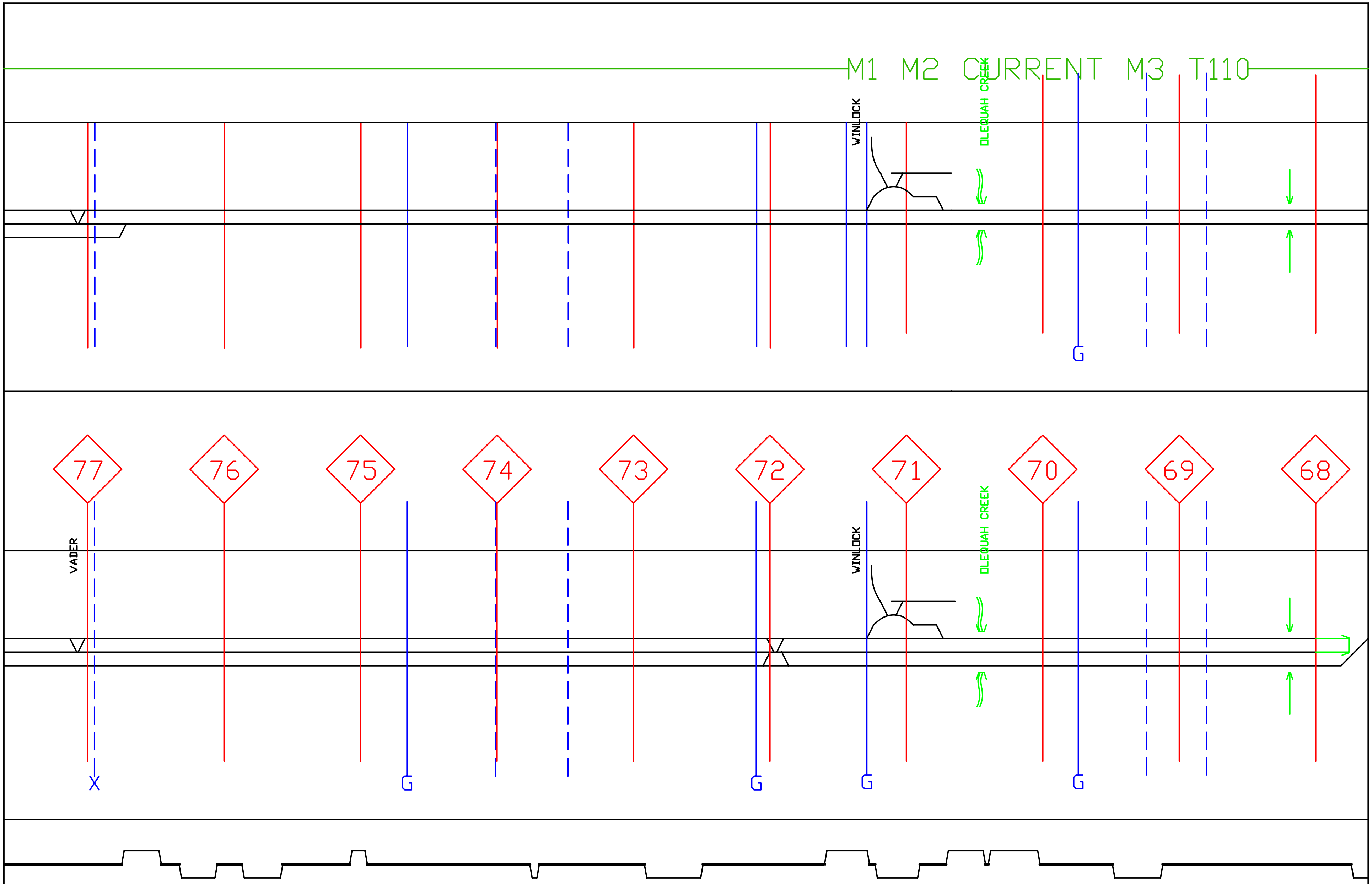
CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



PORTLAND - NISQUALLY

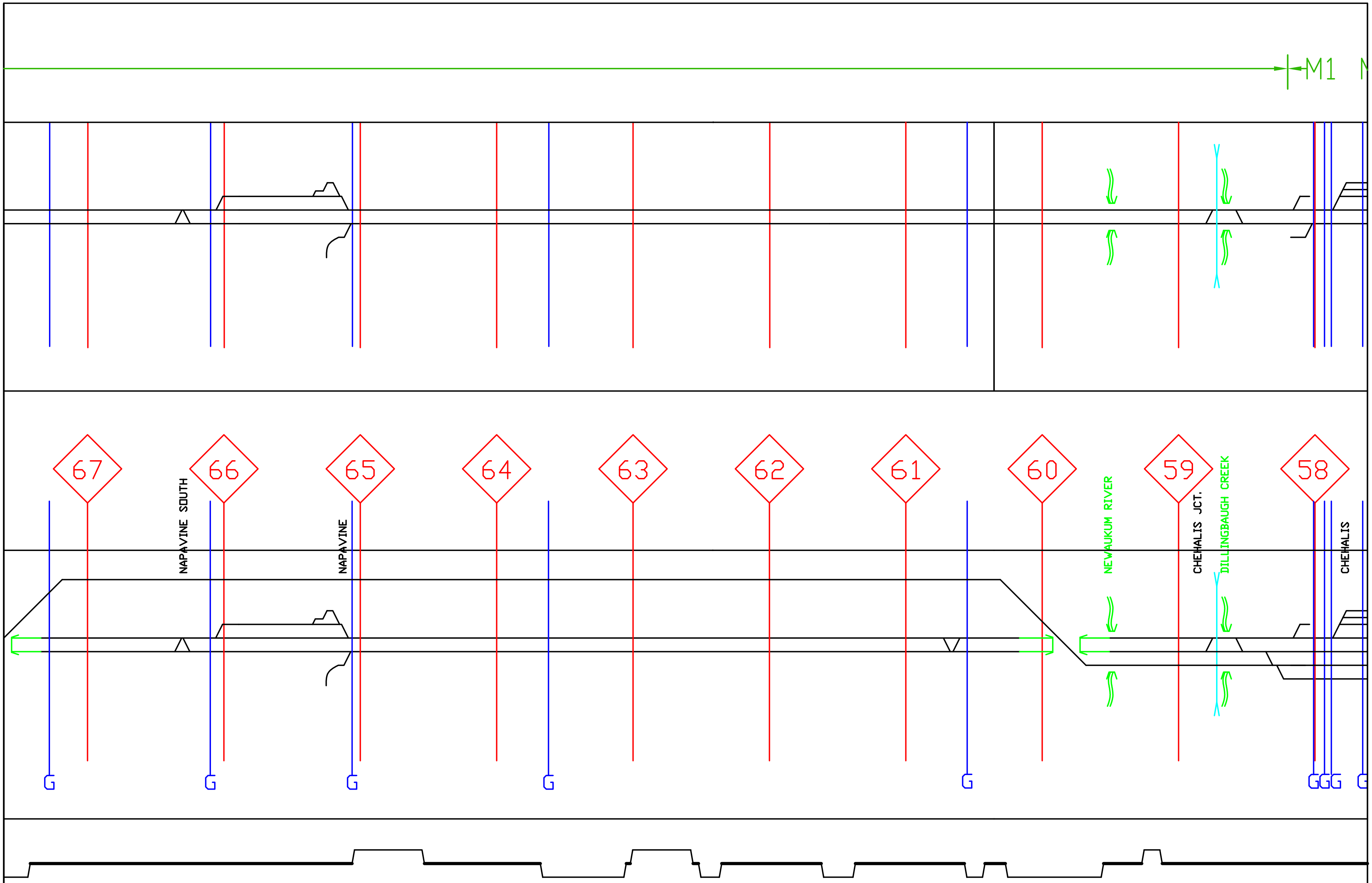
9 OF 15

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



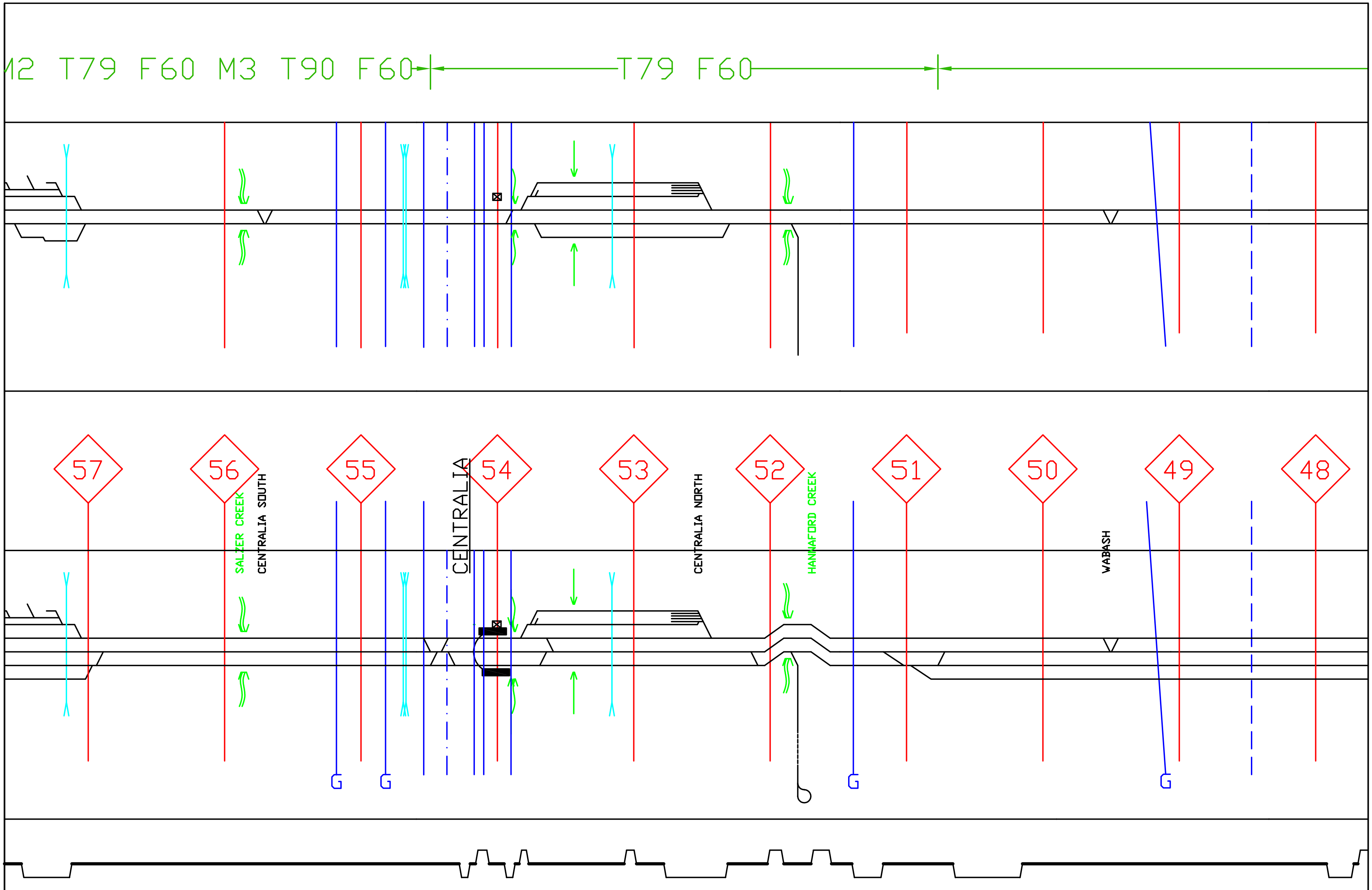
PORTLAND - NISQUALLY
10 OF 15

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



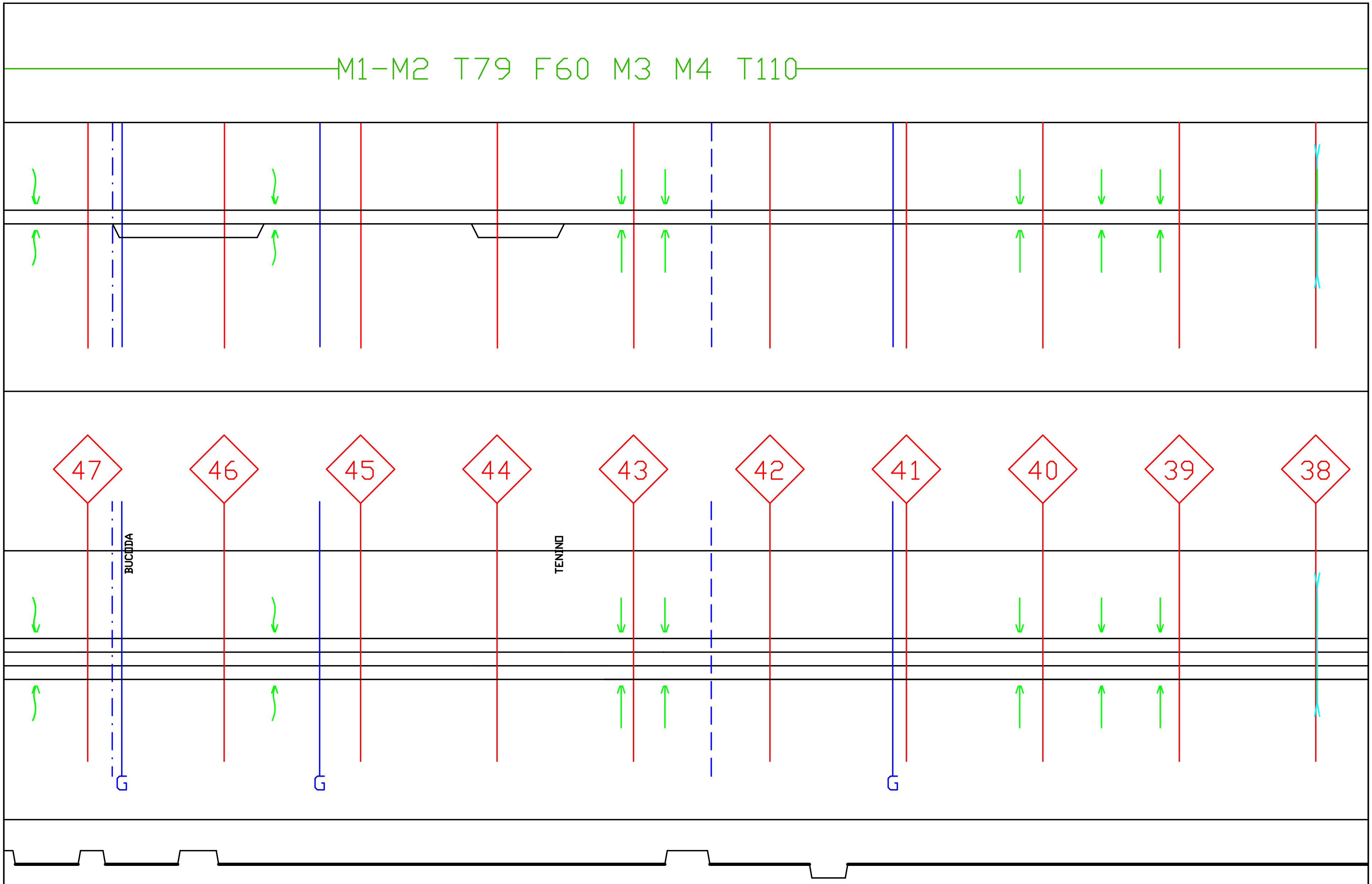
PORTLAND - NISQUALLY

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



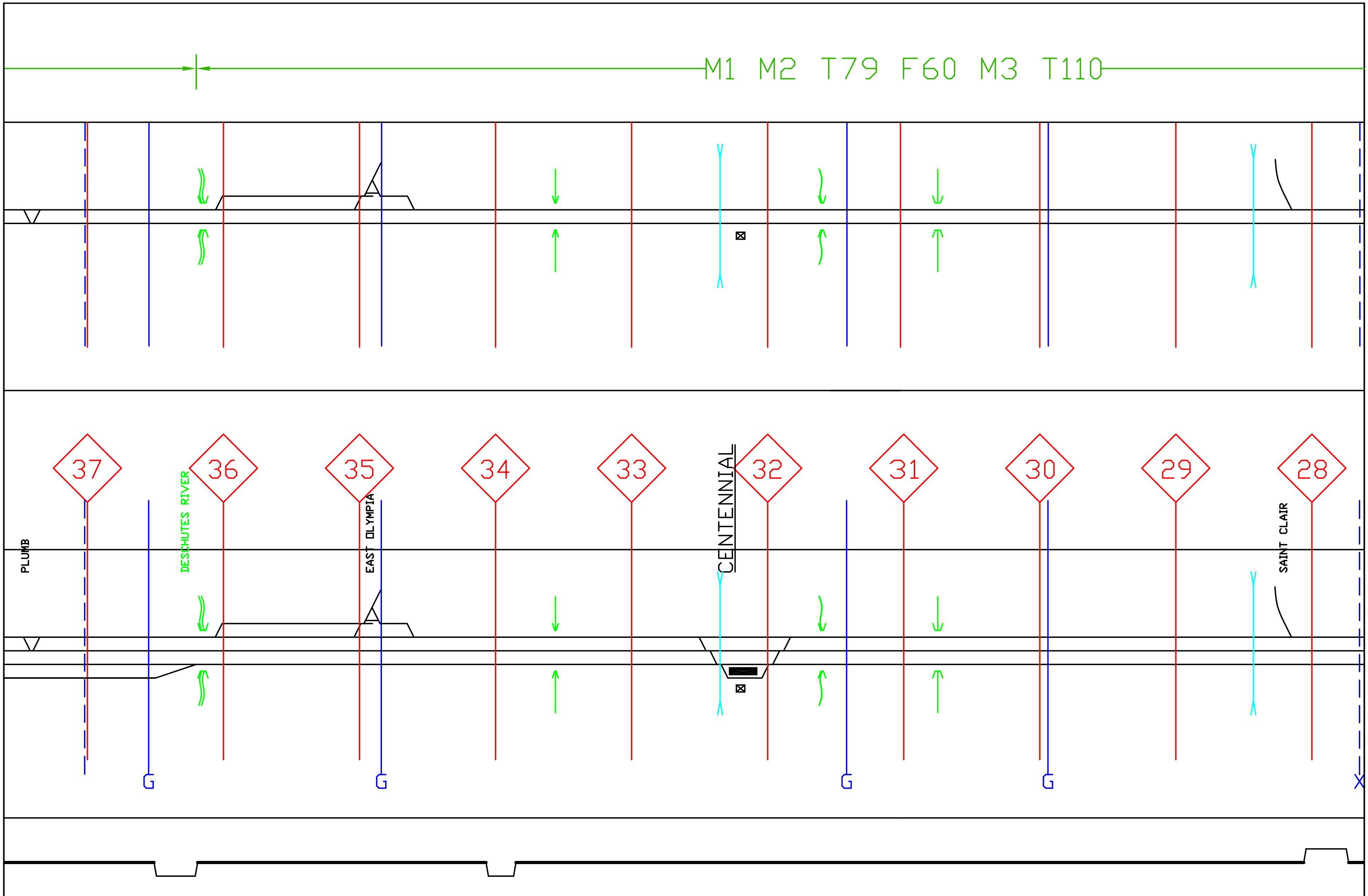
PORTLAND - NISQUALLY
12 OF 15

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



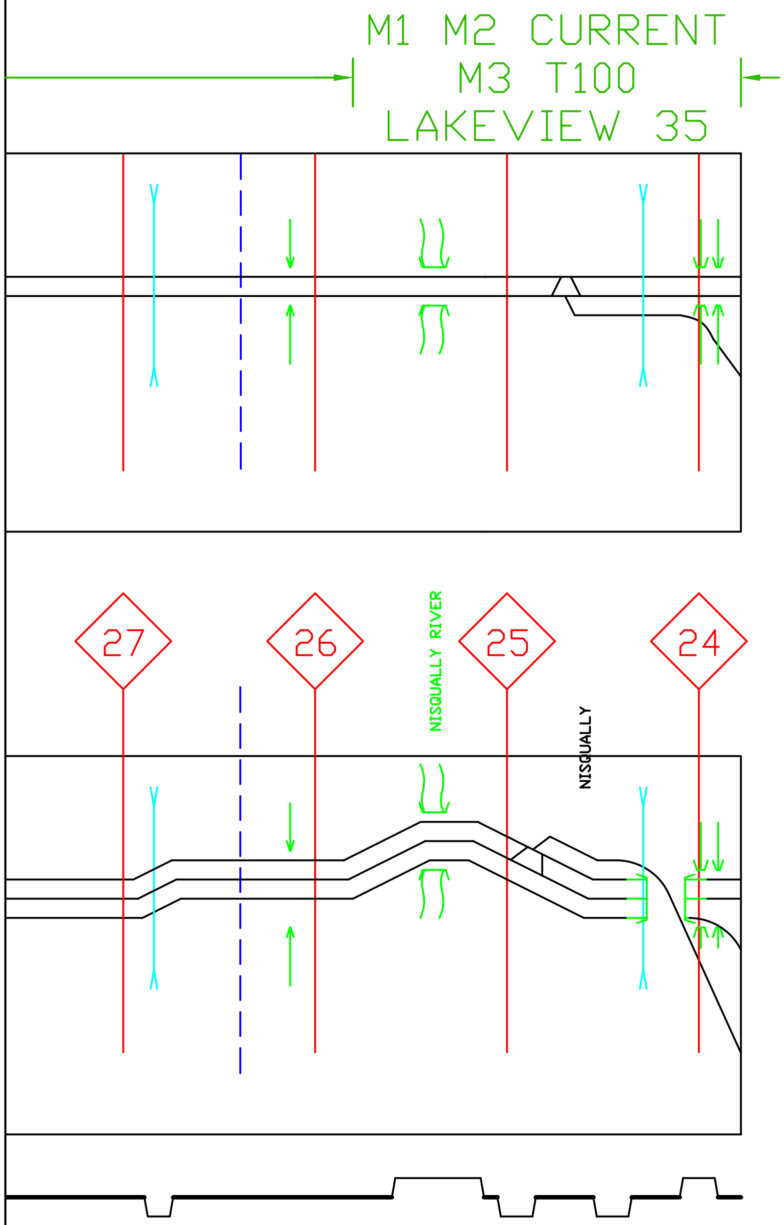
PORTLAND - NISQUALLY

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



PORTLAND - NISQUALLY
14 OF 15

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



PORTLAND - NISQUALLY
15 OF 15

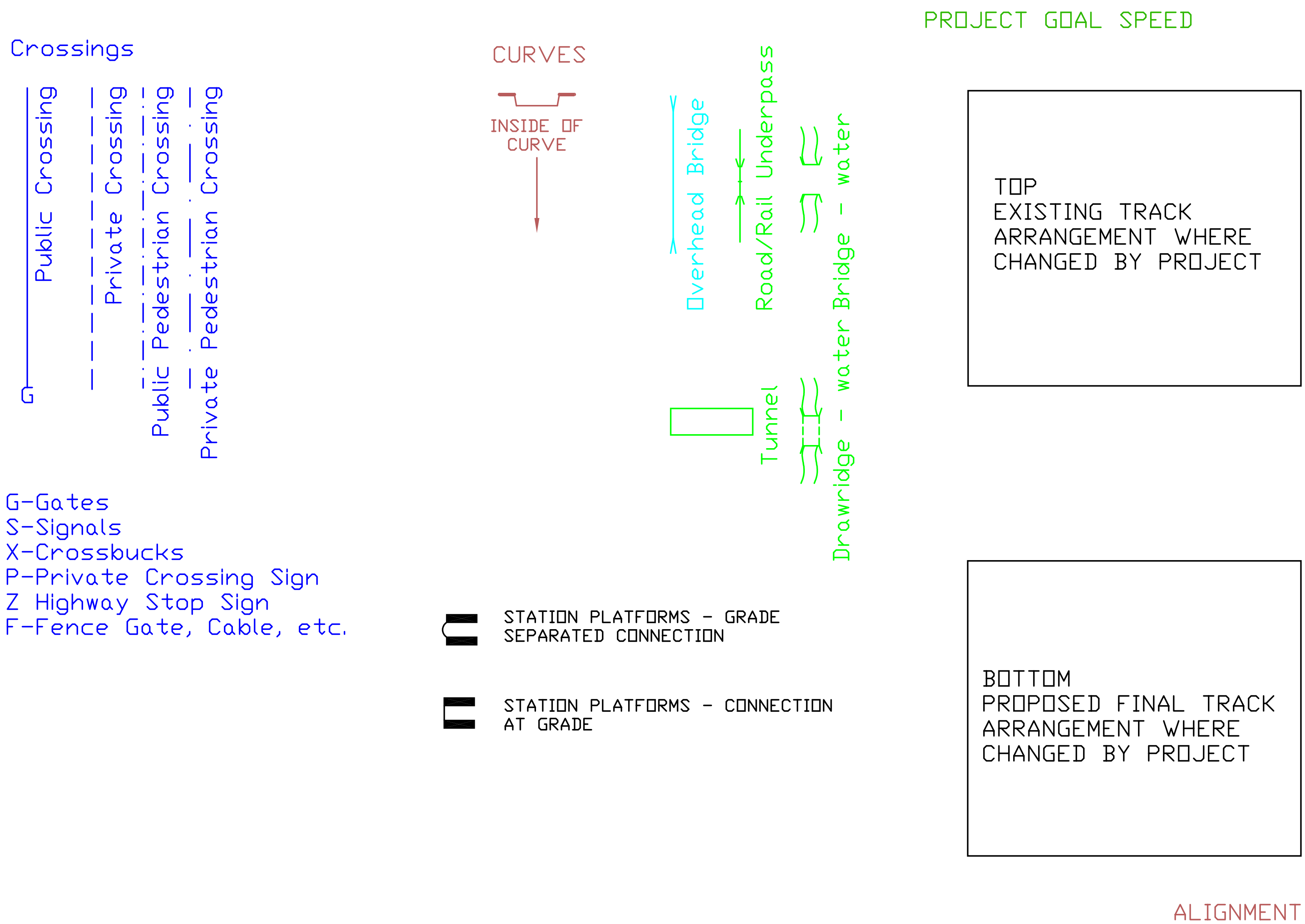
CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT

CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC NISQUALLY - RESERVATION

TRANSIT SAFETY MANAGEMENT / HDR FOR WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

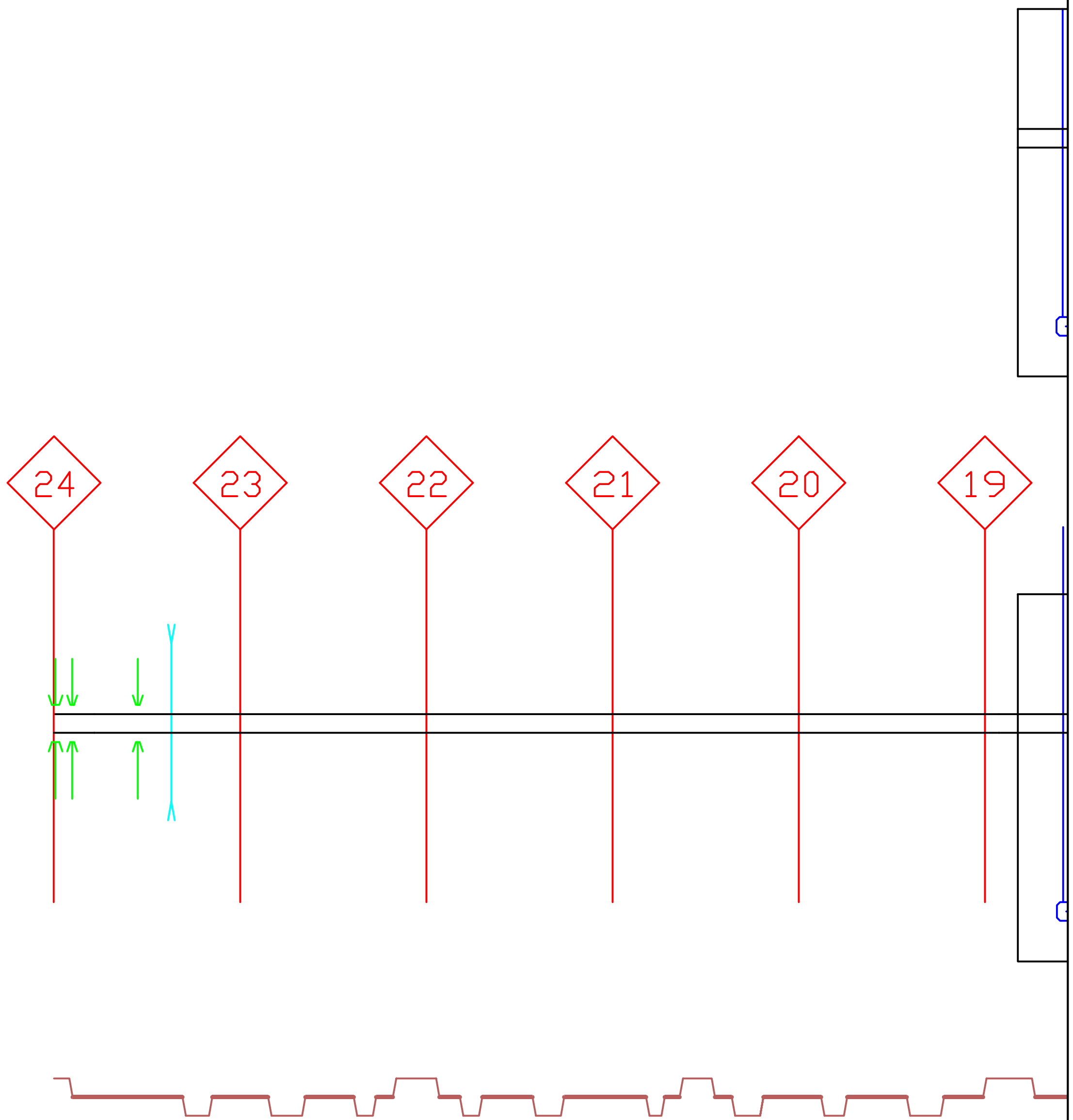
MARCH 1 2004

SEE SEPARATE PAGES INDEXED BY MP FOR ADDITIONAL INFORMATION



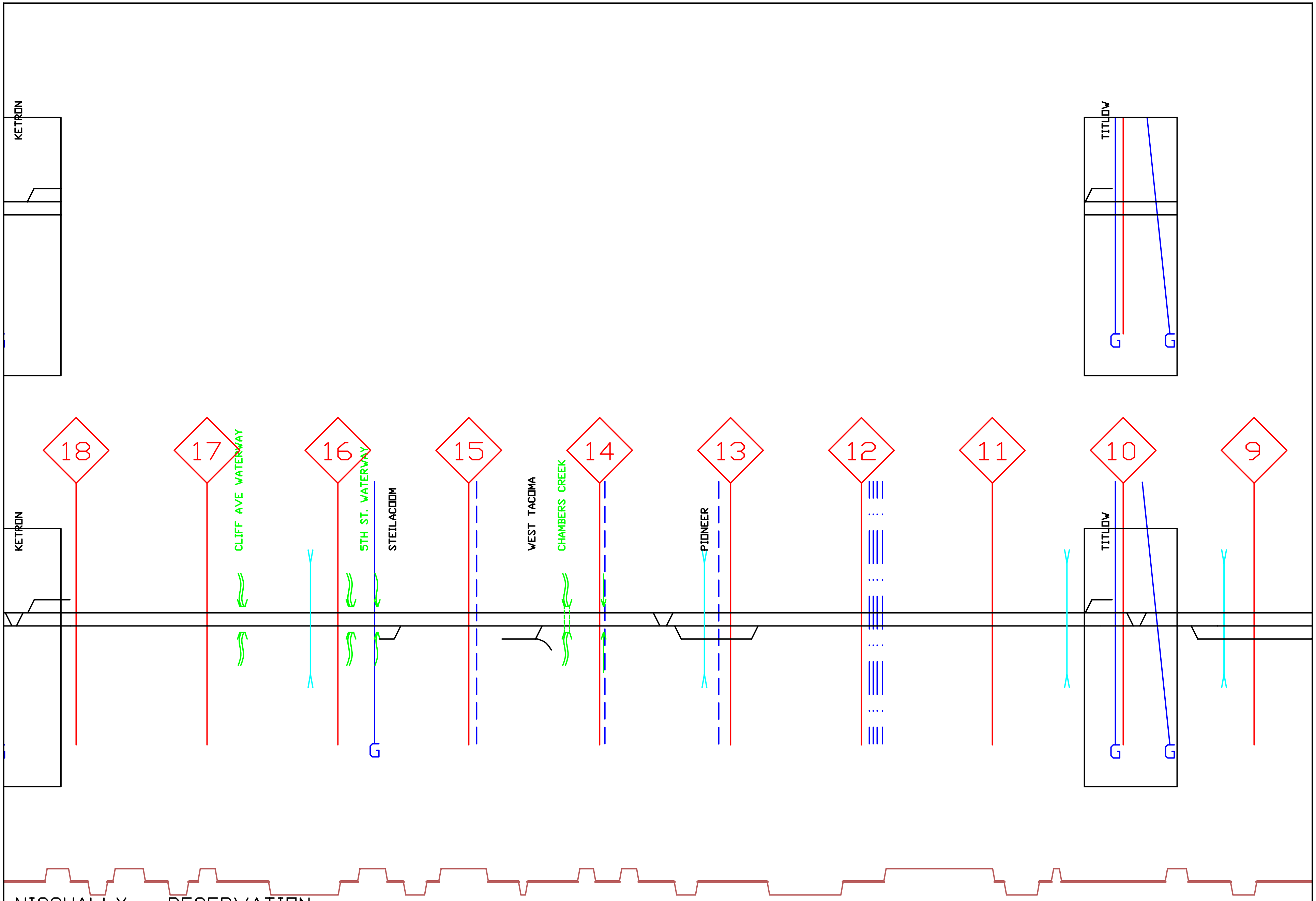
NISQUALLY - RESERVATION
2 OF 5

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



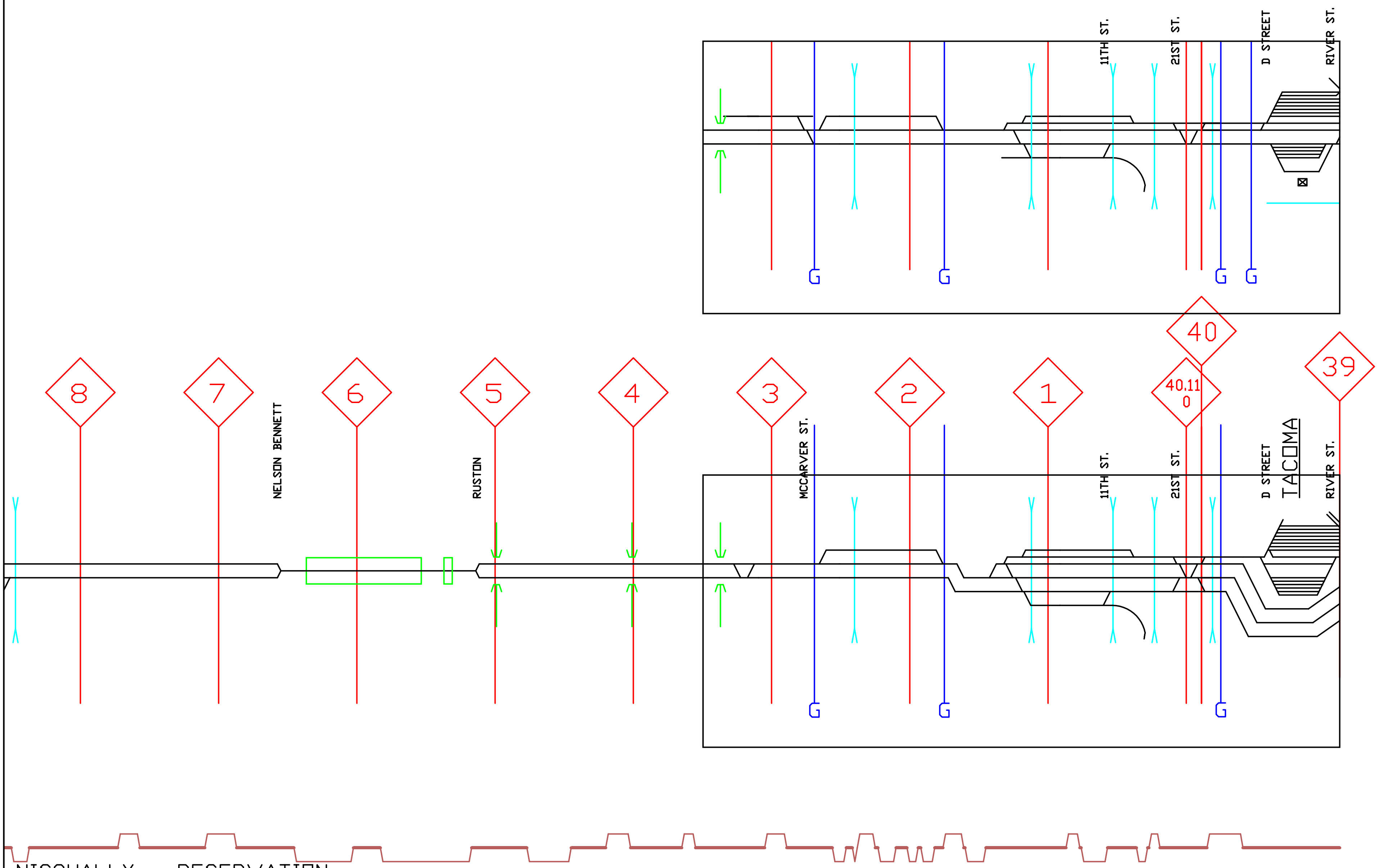
NISQUALLY - RESERVATION
3 OF 5

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



NISQUALLY - RESERVATION
4 OF 5

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



NISQUALLY - RESERVATION
5 OF 5

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT

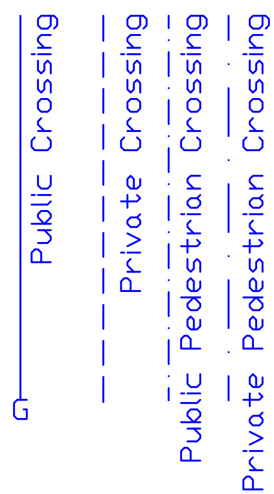
CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC
NISQUALLY - RESERVATION

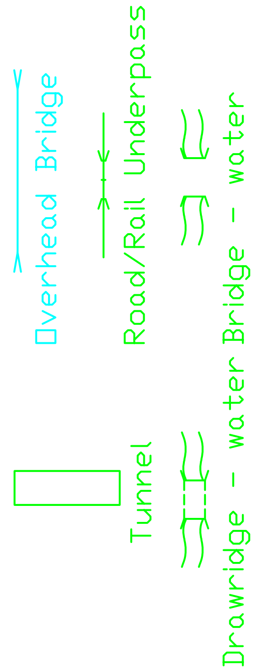
TRANSIT SAFETY MANAGEMENT / HDR FOR
WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION

JUNE 30 2003 REV FEB 2 2006

PROJECT GOAL SPEED

Crossings





G-Gates
S-Signals
X-Crossbucks
P-Private Crossing Sign
Z Highway Stop Sign
F-Fence Gate, Cable, etc.

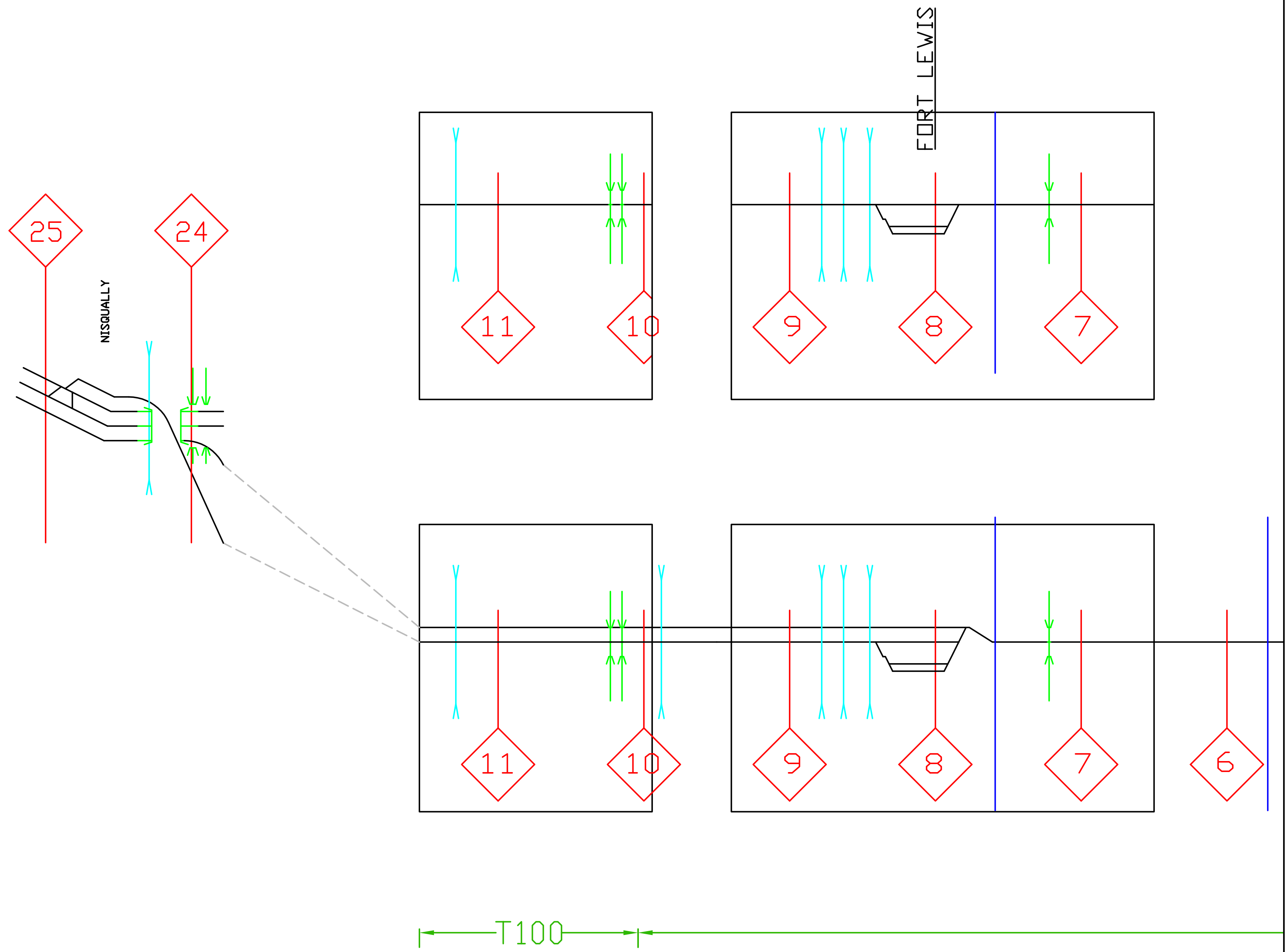
STATION PLATFORMS - GRADE SEPARATED CONNECTION

STATION PLATFORMS - CONNECTION AT GRADE

TOP
EXISTING TRACK ARRANGEMENT WHERE CHANGED BY PROJECT

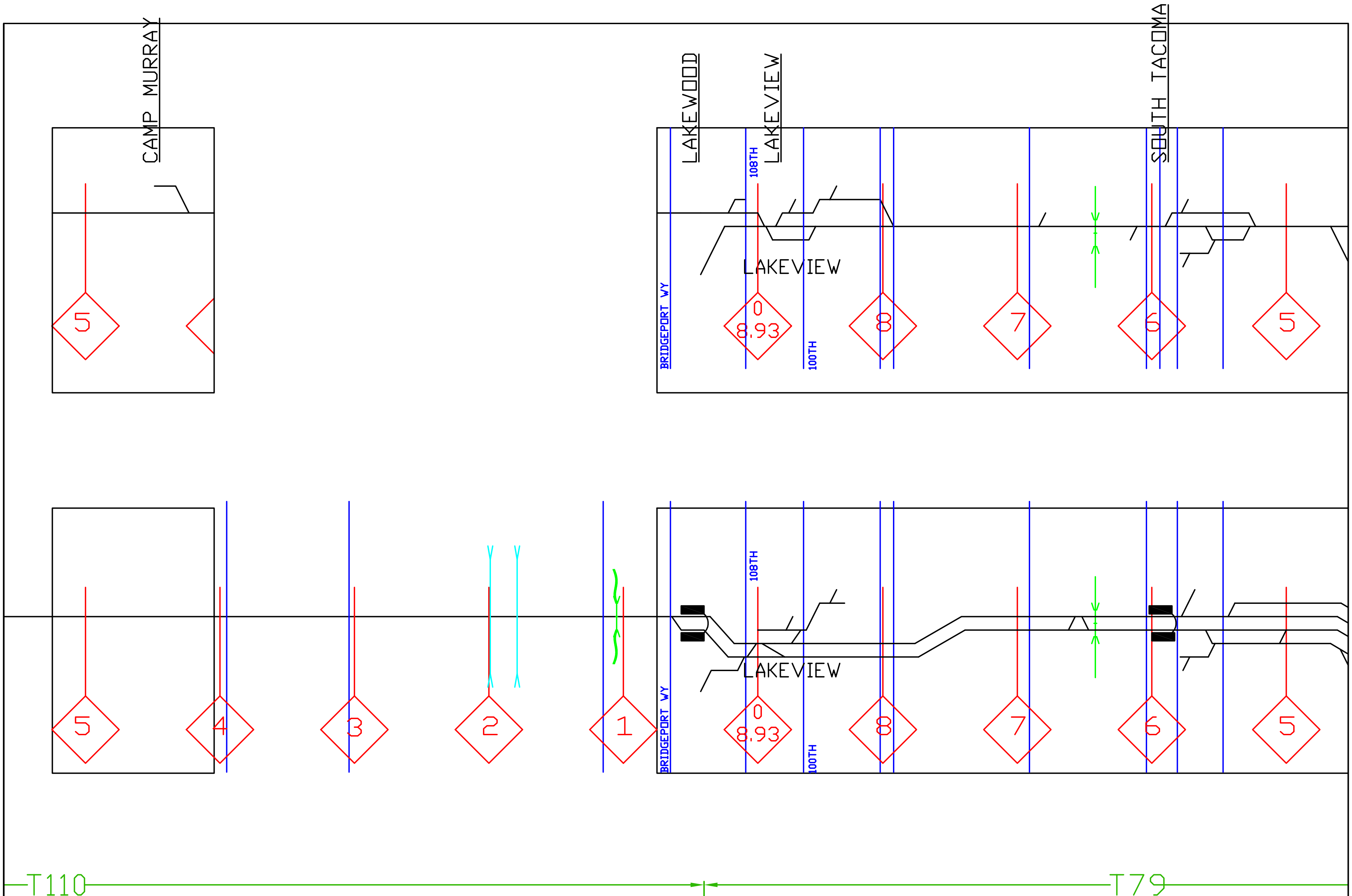
BOTTOM
PROPOSED FINAL TRACK ARRANGEMENT WHERE CHANGED BY PROJECT

RESERVATION - NISQUALLY
2 OF 5



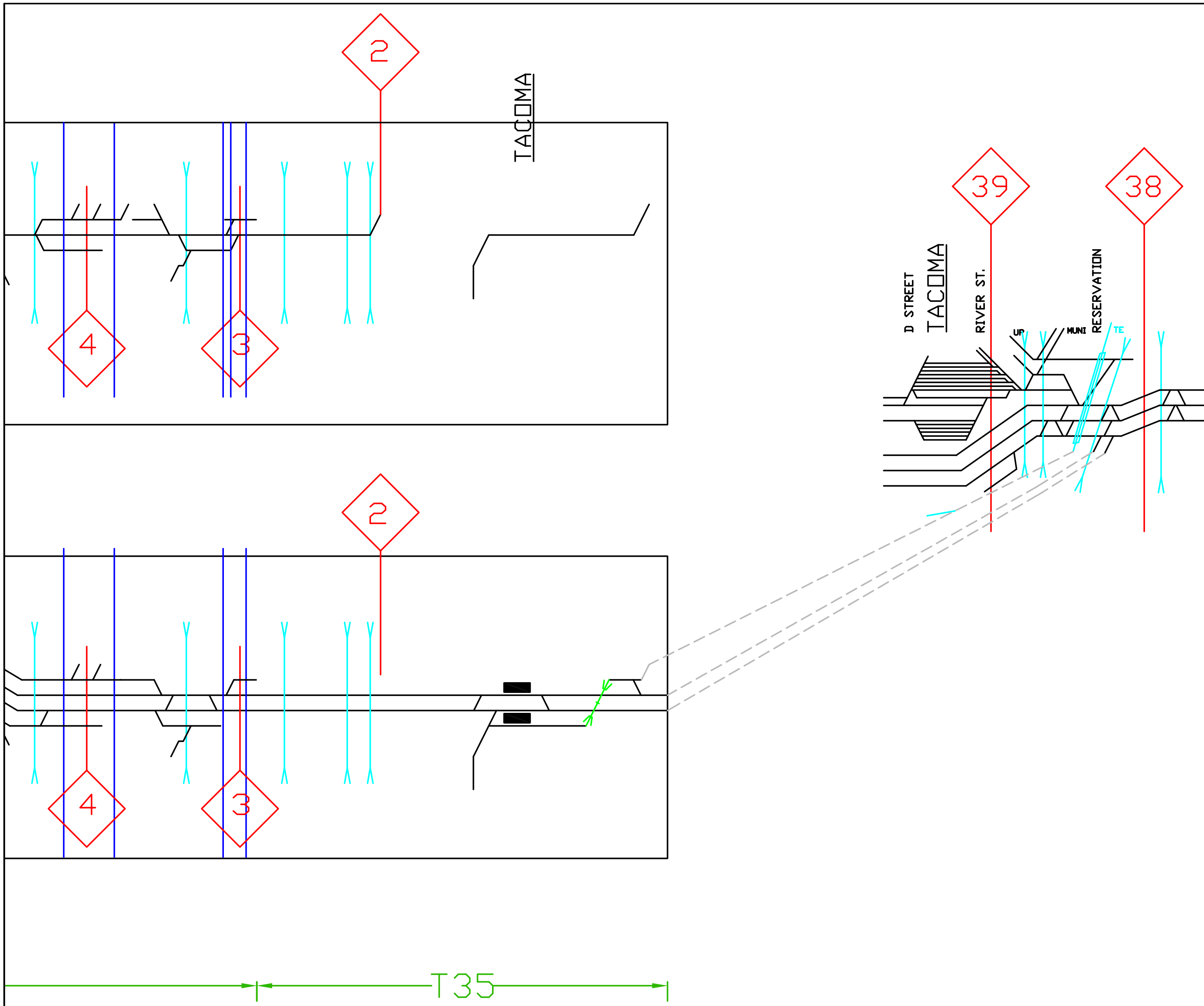
RESERVATION - NISQUALLY
3 OF 5

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



RESERVATION - NISQUALLY
4 OF 5

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



RESERVATION - NISQUALLY
5 OF 5

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT

CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC RESERVATION - EVERETT

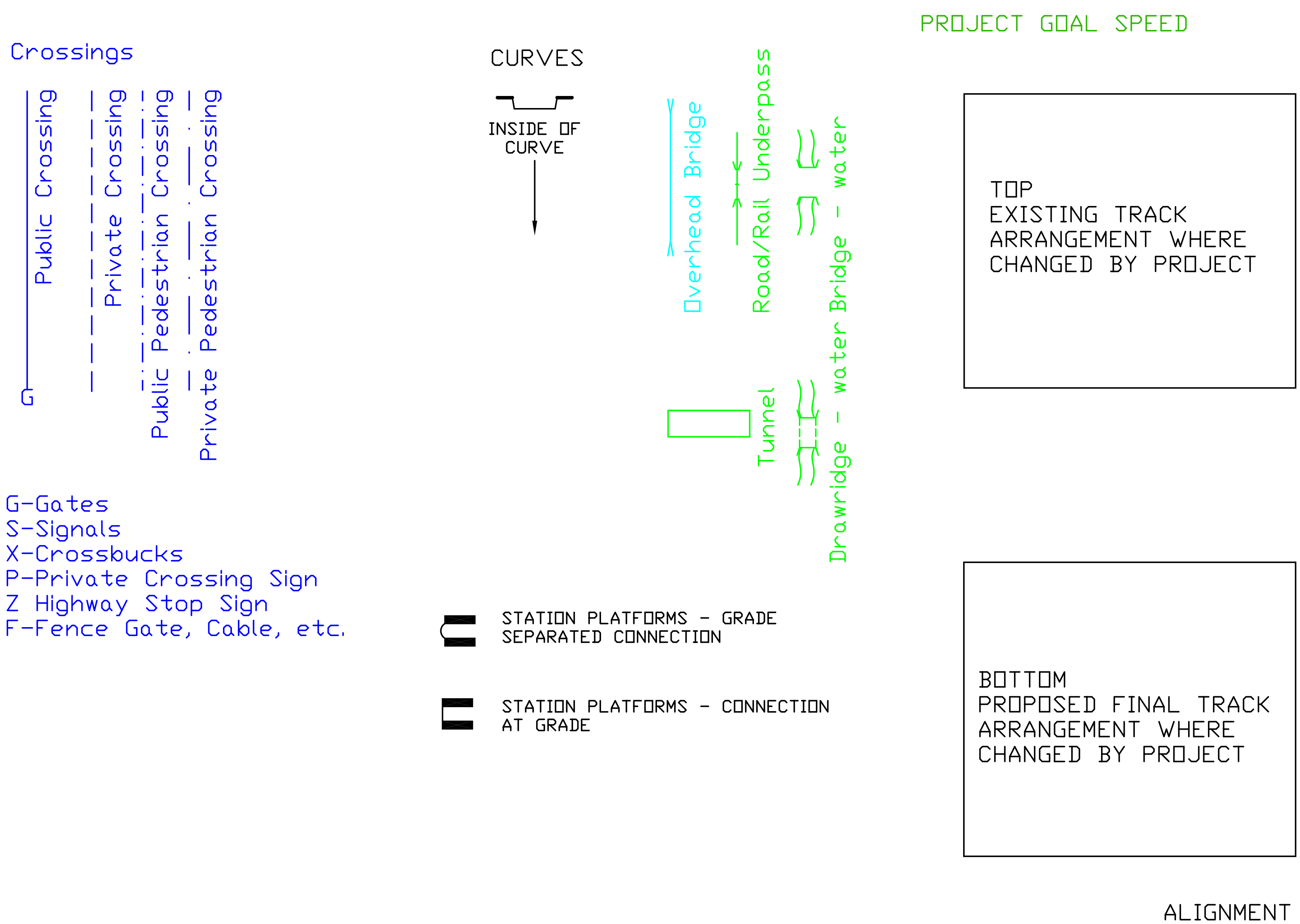
TRANSIT SAFETY MANAGEMENT / HDR FOR WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

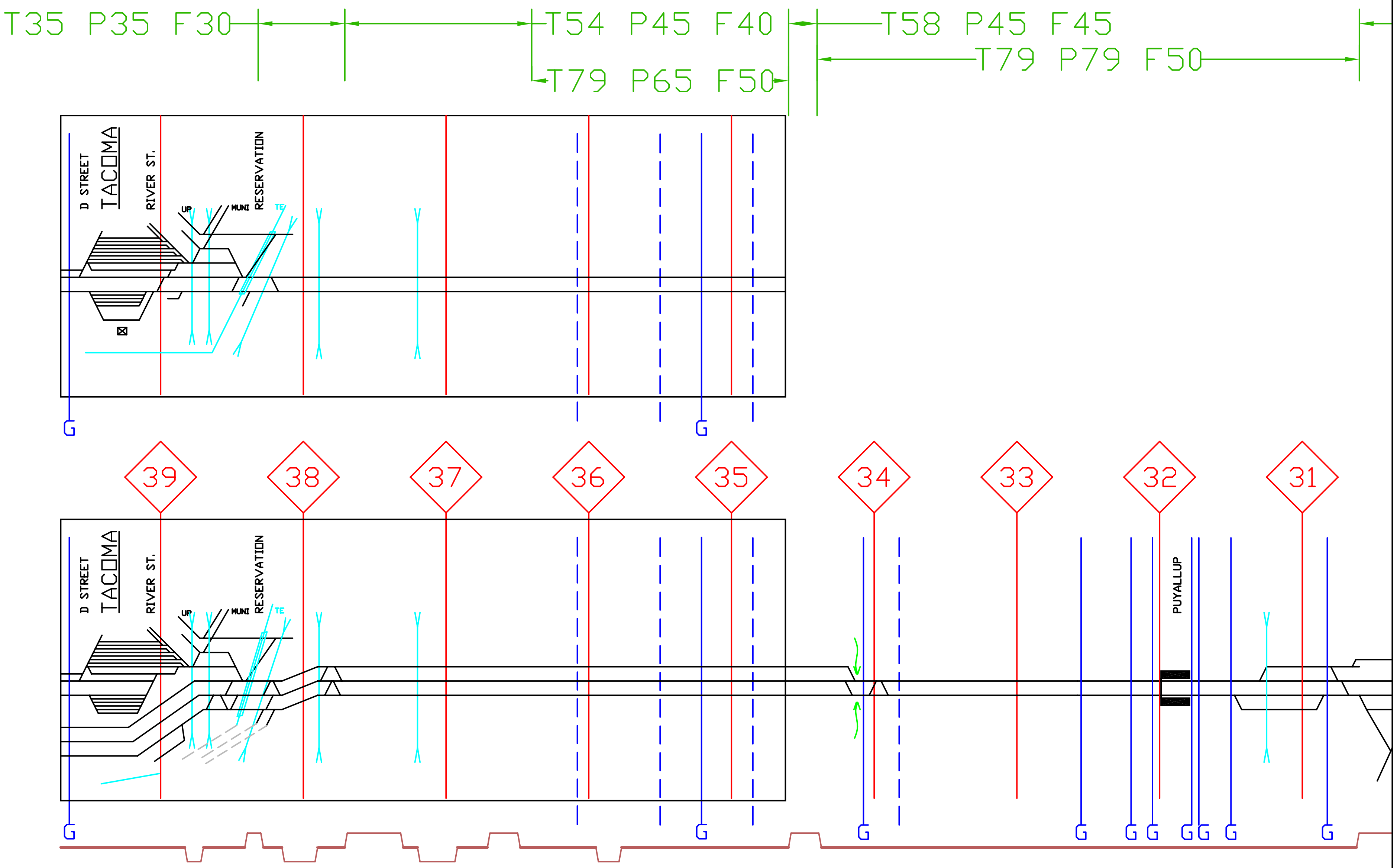
JUNE 30 2003

BETWEEN EVERETT AND RESERVATION SEVERAL PROJECTS ARE BEING DESIGNED INDEPENDENTLY OF PNWRC TO SUPPORT SOUND TRANSIT COMMUTER SERVICE
THE PROJECTS ARE REQUIRED FOR SPECIFIED PNWRC SERVICE LEVELS

ARRANGEMENTS SHOWN HERE MAY NOT REFLECT CURRENT DEVELOPMENT OF PROJECTS

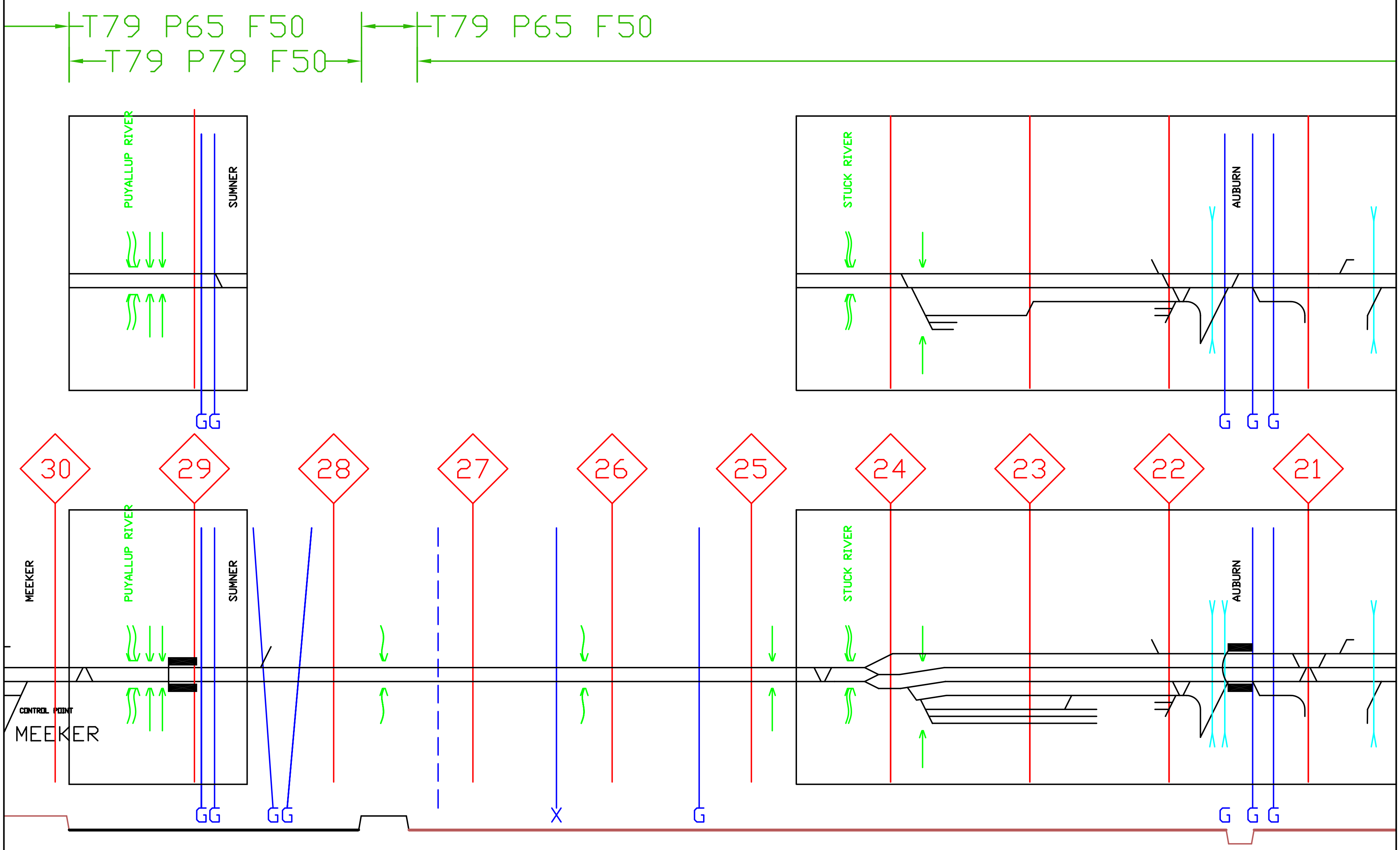
SEE SEPARATE PAGES INDEXED BY MP FOR ADDITIONAL INFORMATION


Crossings
G
Public Crossing
Private Crossing
Public Pedestrian Crossing
Private Pedestrian Crossing
G-Gates
S-Signals
X-Crossbucks
P-Private Crossing Sign
Z Highway Stop Sign
F-Fence Gate, Cable, etc.
CURVES
INSIDE OF CURVE
Overhead Bridge
Road/Rail Underpass
Drawridge - water Bridge - water
Tunnel
STATION PLATFORMS - GRADE SEPARATED CONNECTION
STATION PLATFORMS - CONNECTION AT GRADE
PROJECT GOAL SPEED
TOP
EXISTING TRACK
ARRANGEMENT WHERE
CHANGED BY PROJECT
BOTTOM
PROPOSED FINAL TRACK
ARRANGEMENT WHERE
CHANGED BY PROJECT
ALIGNMENT



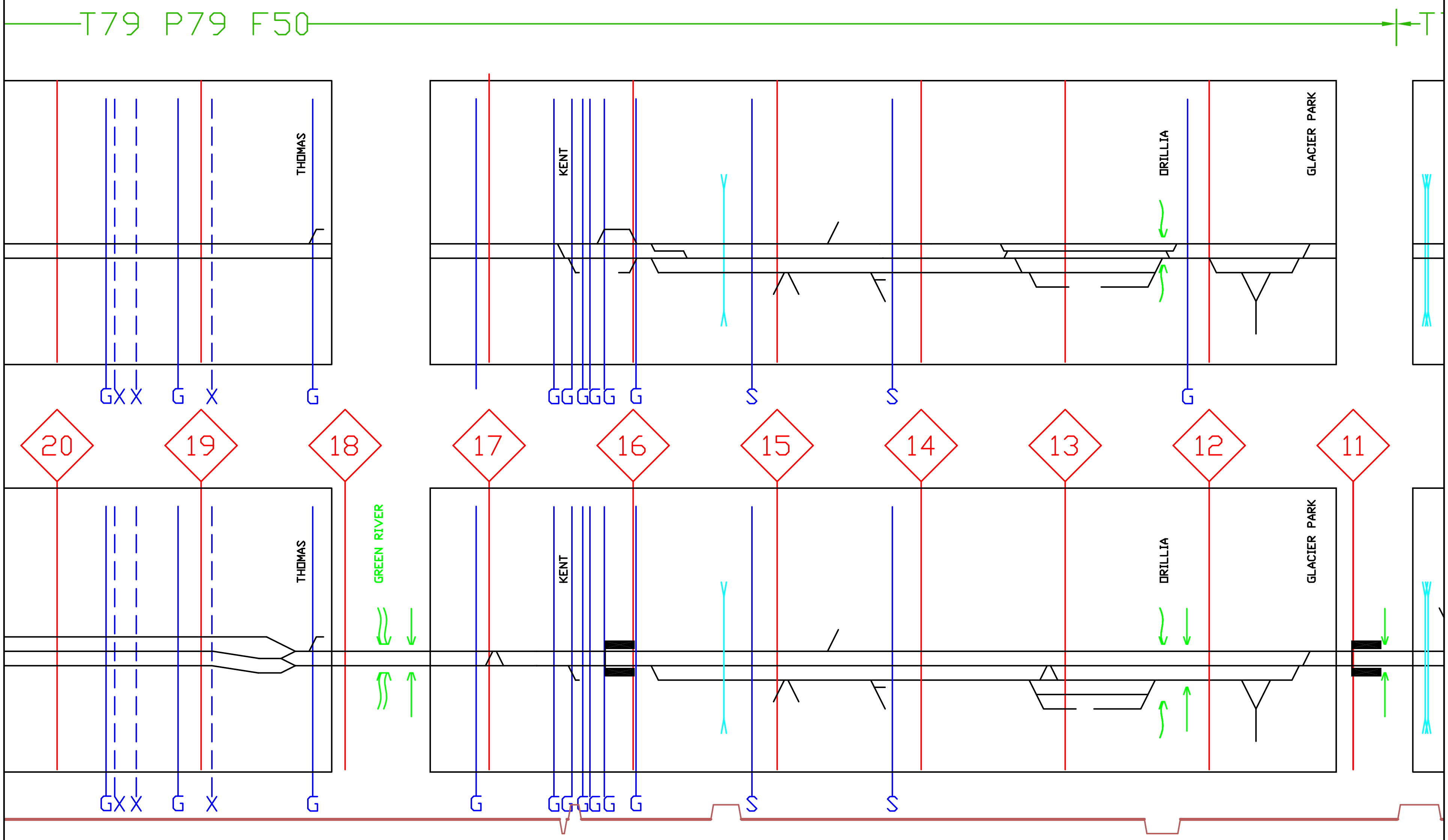
EVERETT - RESERVATION
3 OF 10

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



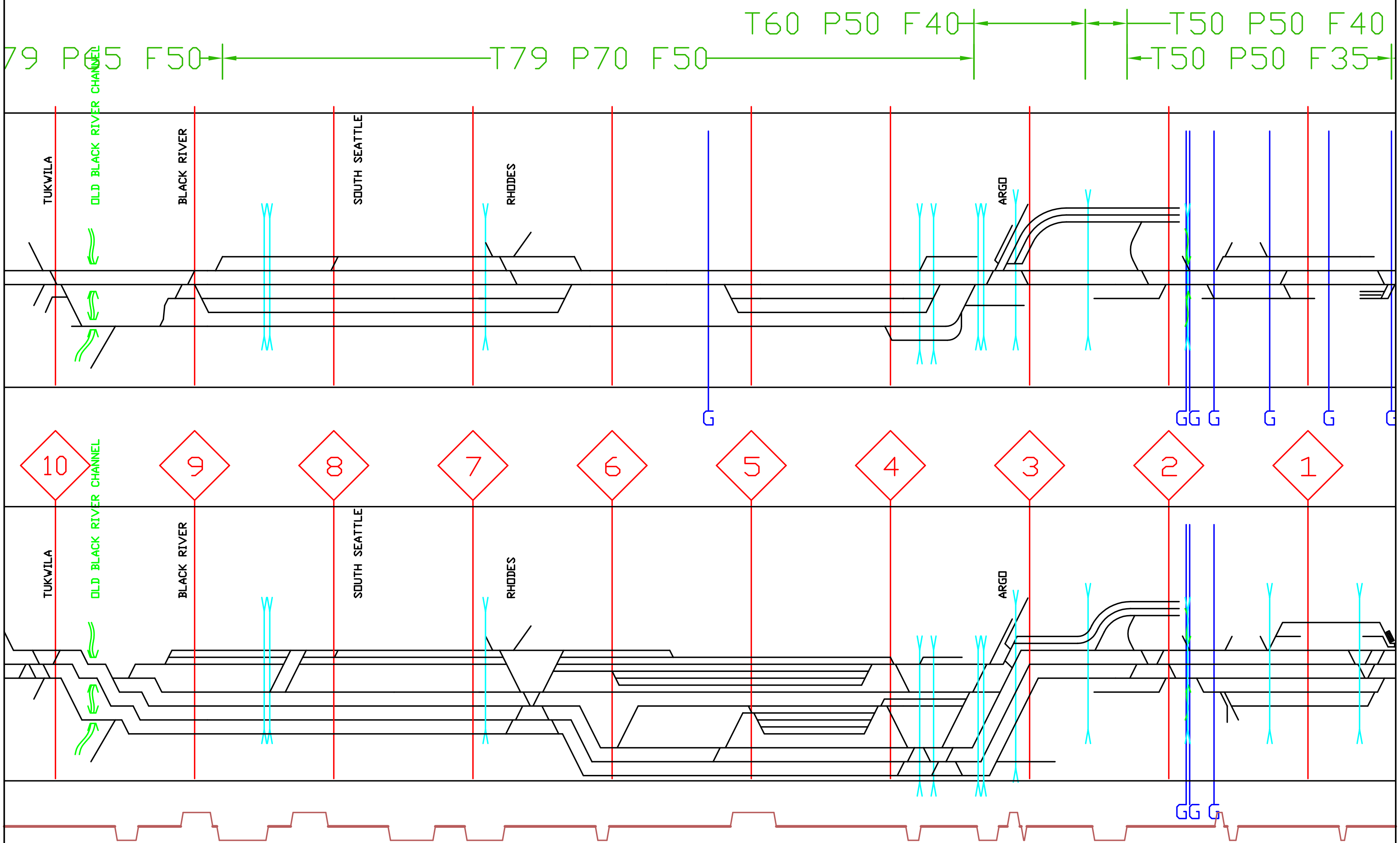
EVERETT - RESERVATION
4 OF 10

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



EVERETT - RESERVATION
5 OF 10

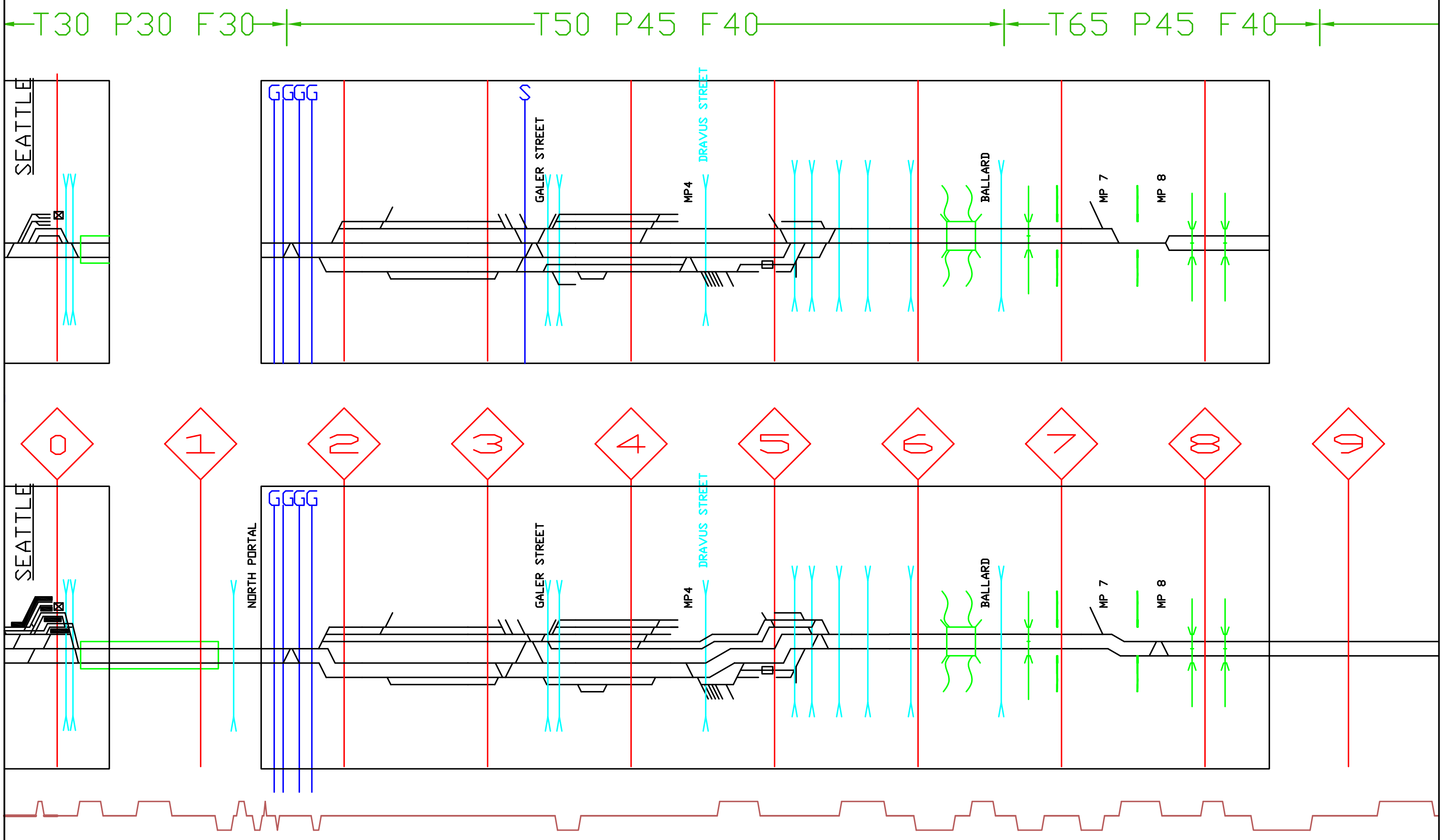
CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



ARGO-TUKWILA CURRENT ARRANGEMENT INFORMATION NOT AVAILABLE

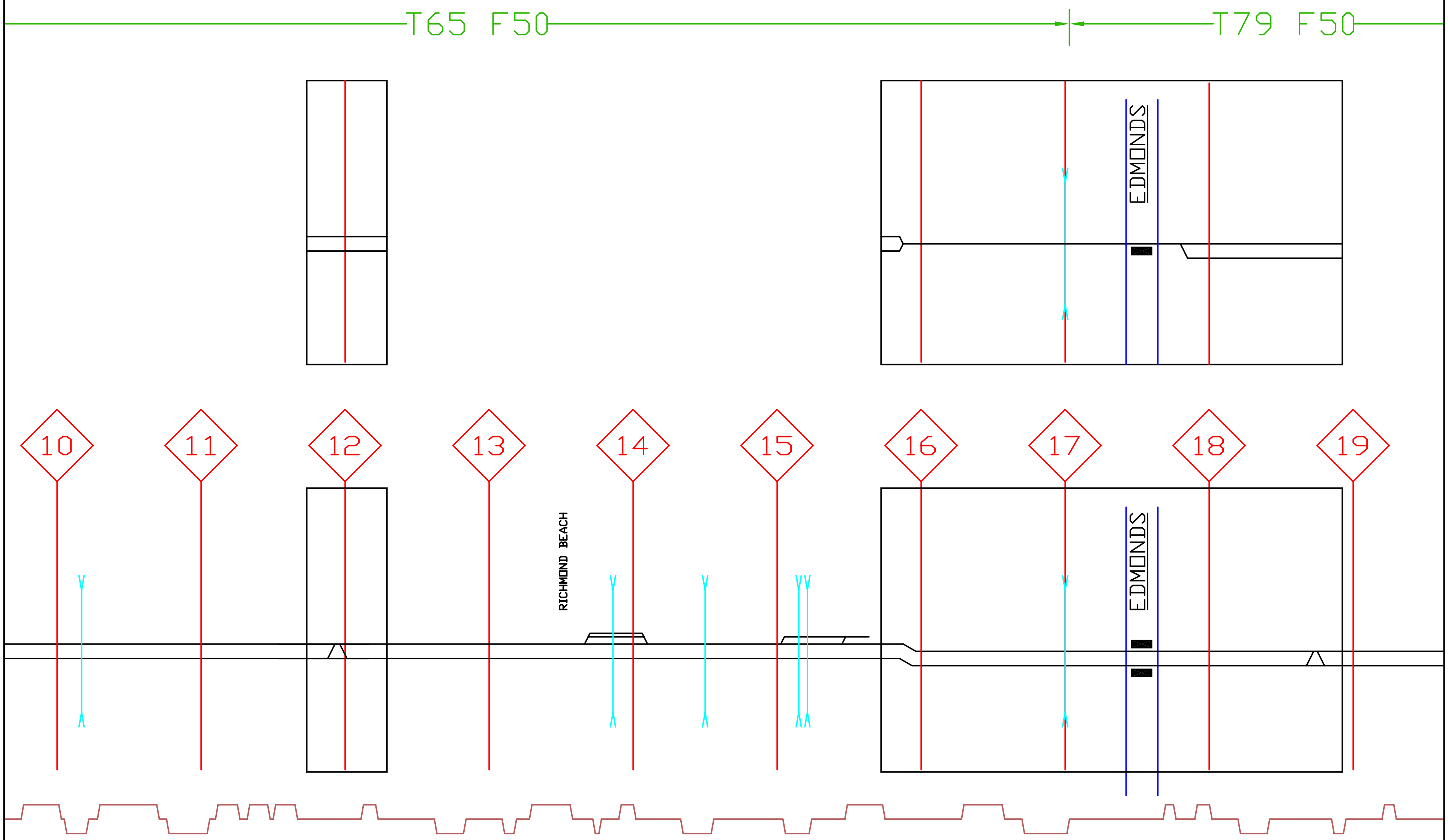
EVERETT - RESERVATION
6 OF 10

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



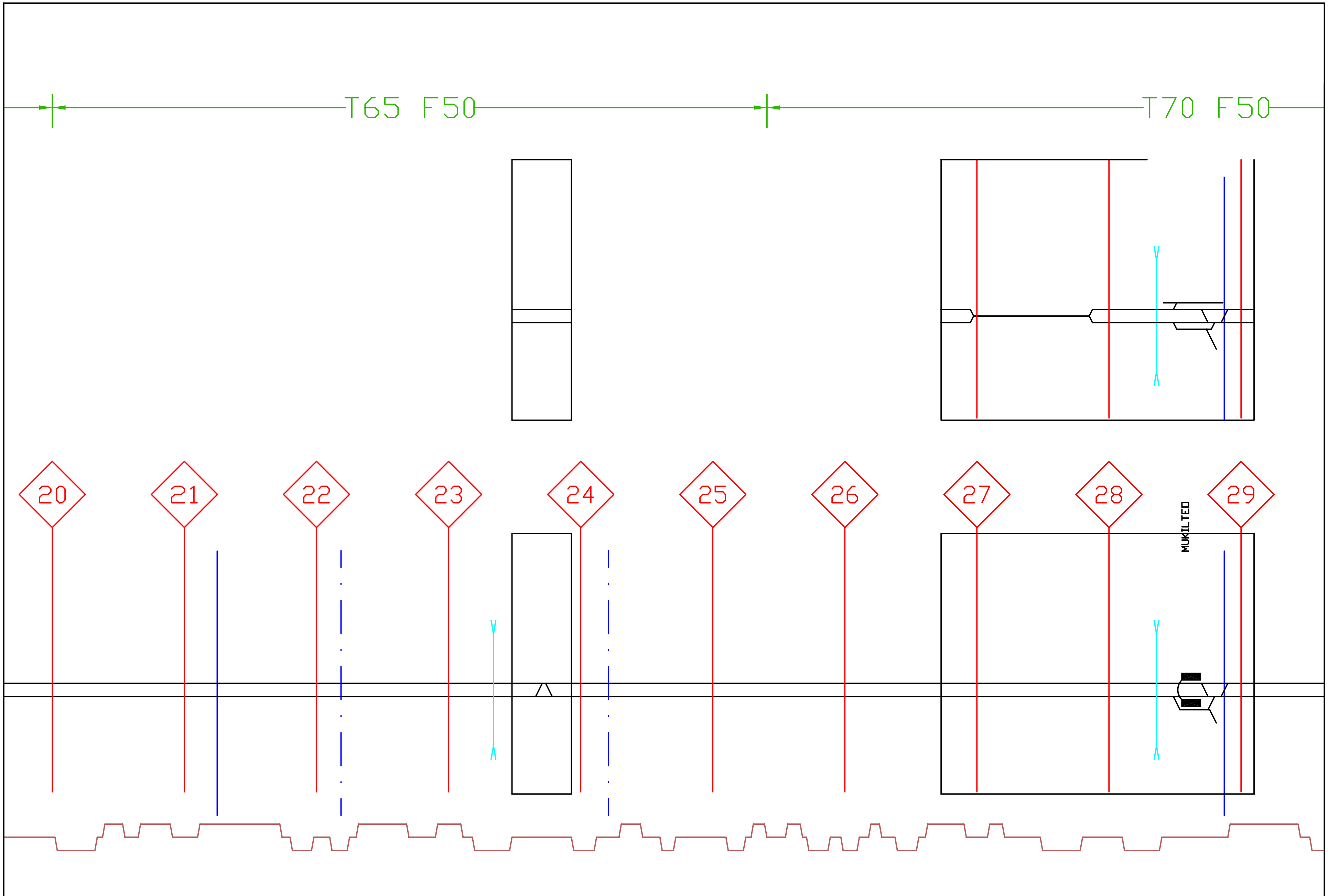
EVERETT - RESERVATION
7 OF 10

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



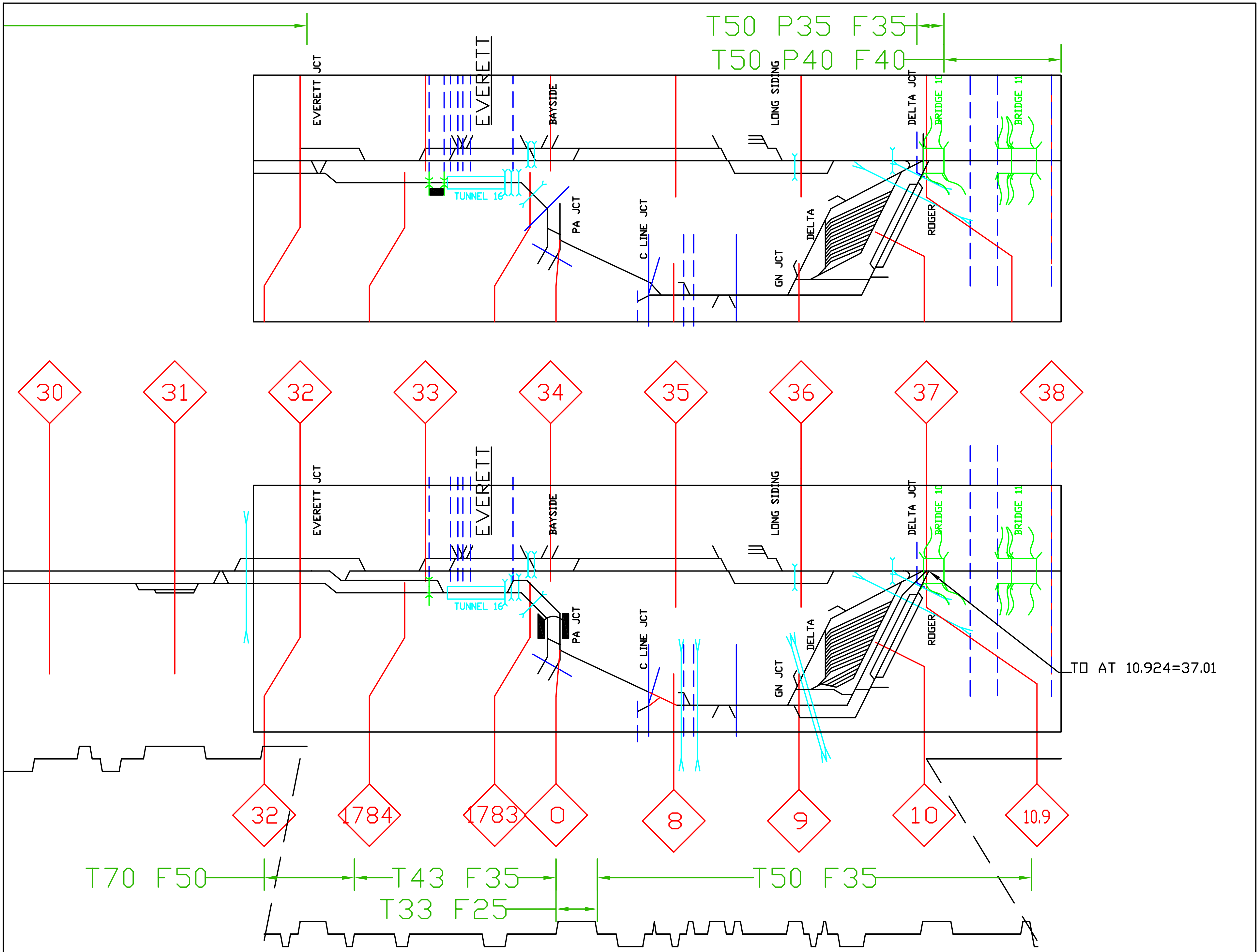
EVERETT - RESERVATION
8 OF 10

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



EVERETT - RESERVATION
9 OF 10

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



EVERETT - RESERVATION
10 OF 10

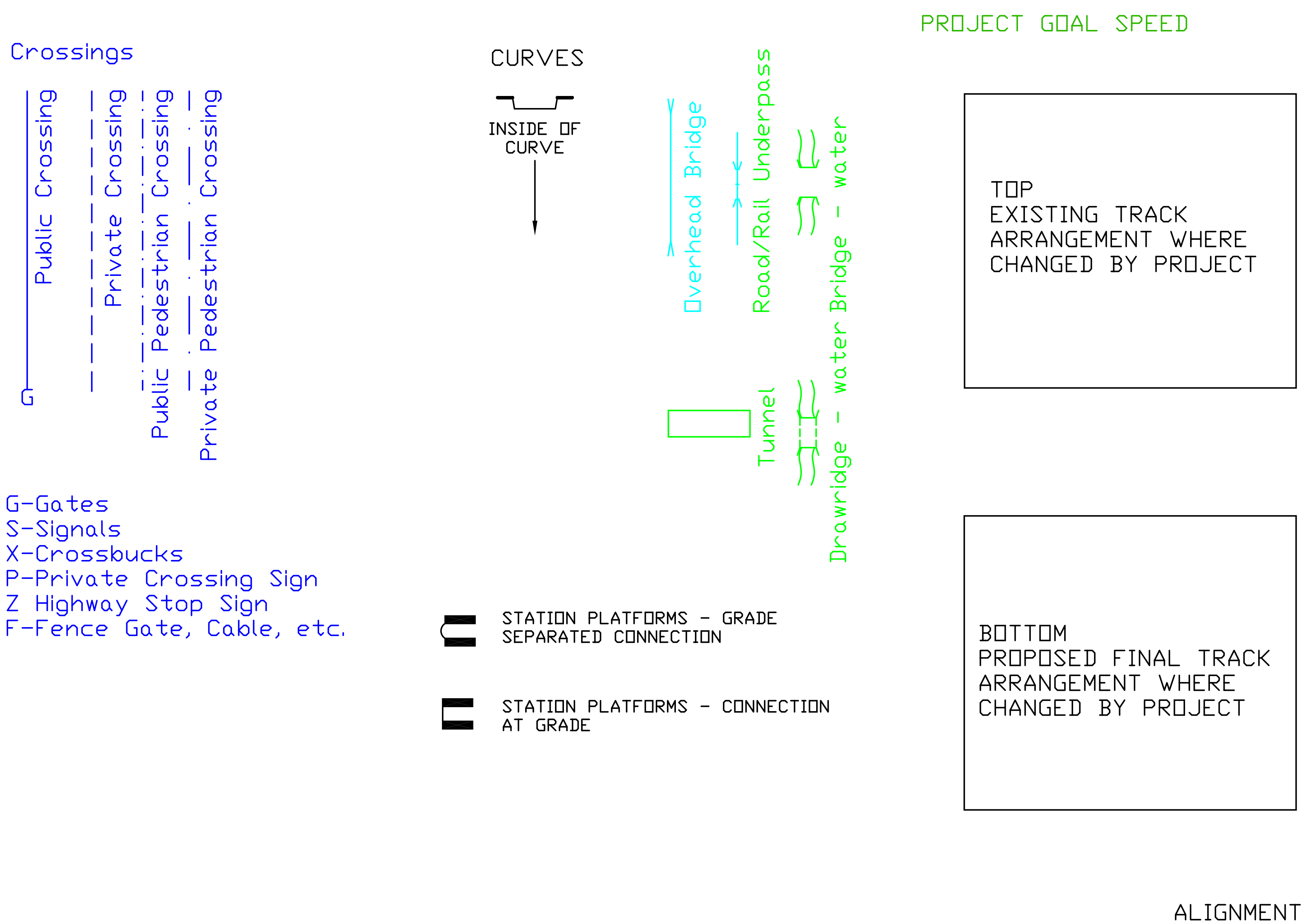
CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT

CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC
EVERETT - VANCOUVER

TRANSIT SAFETY MANAGEMENT / HDR FOR
WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION

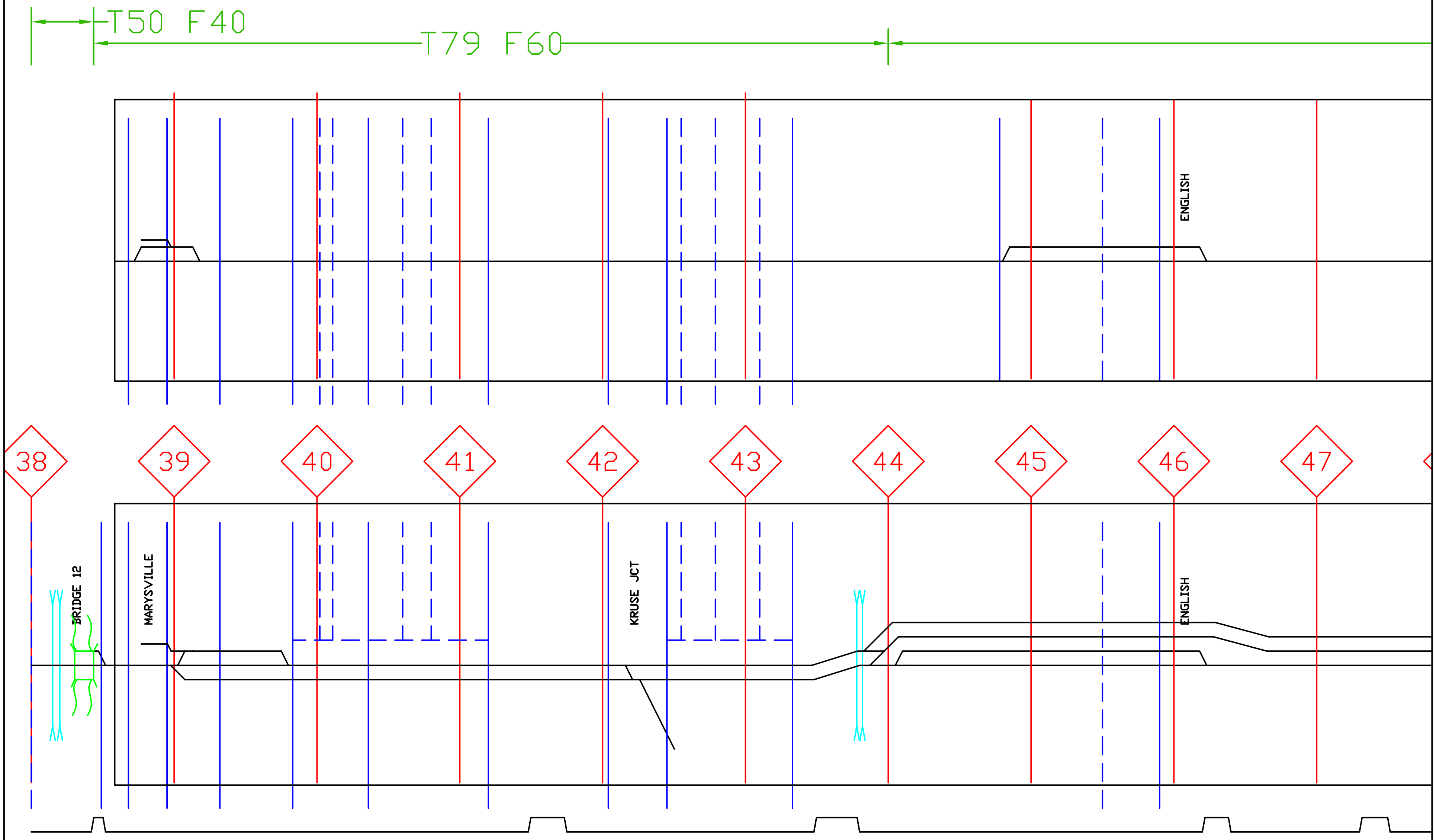
JUNE 30 2003

SEE SEPARATE PAGES INDEXED BY MP FOR ADDITIONAL INFORMATION



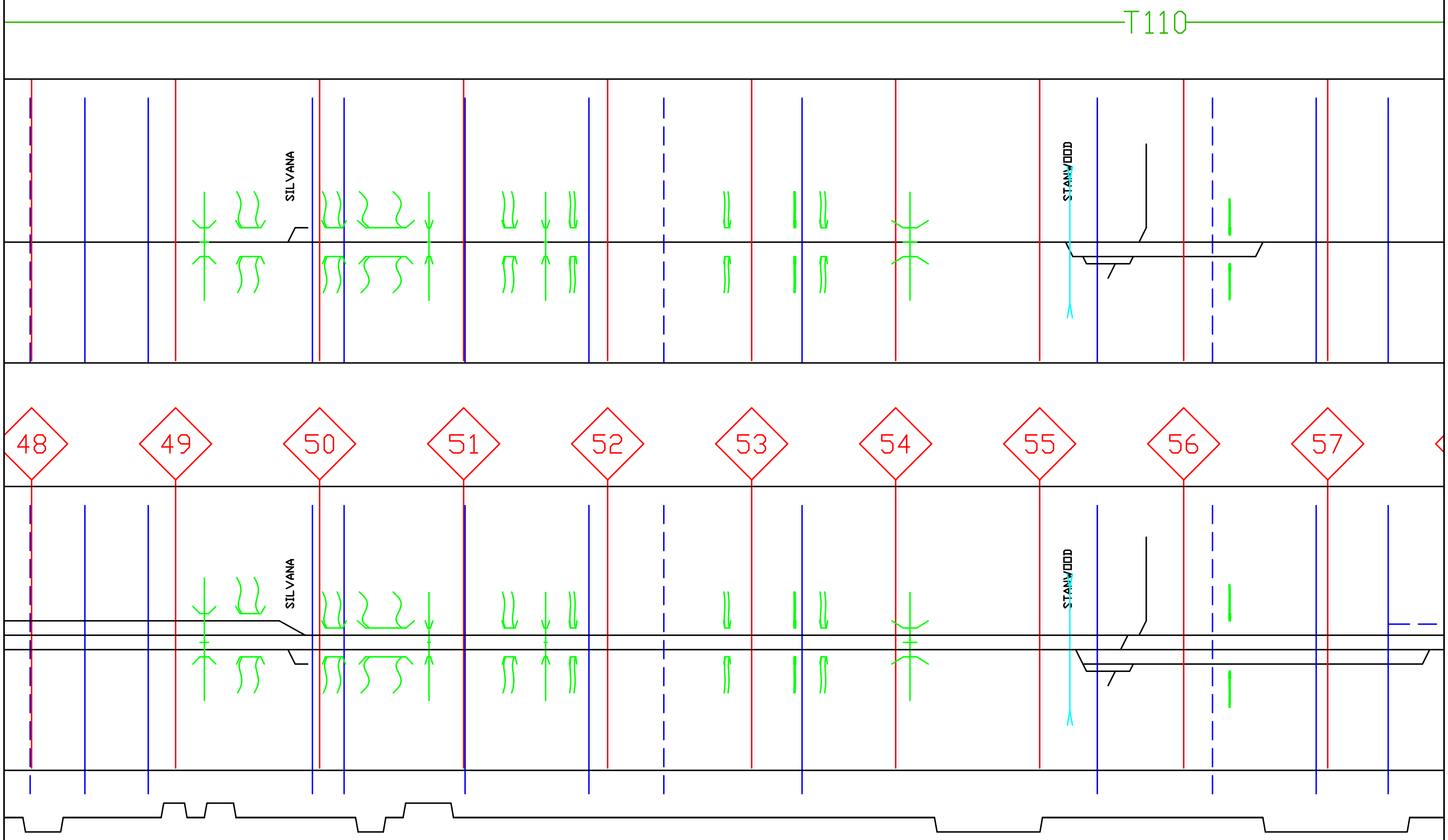
VANCOUVER - EVERETT

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



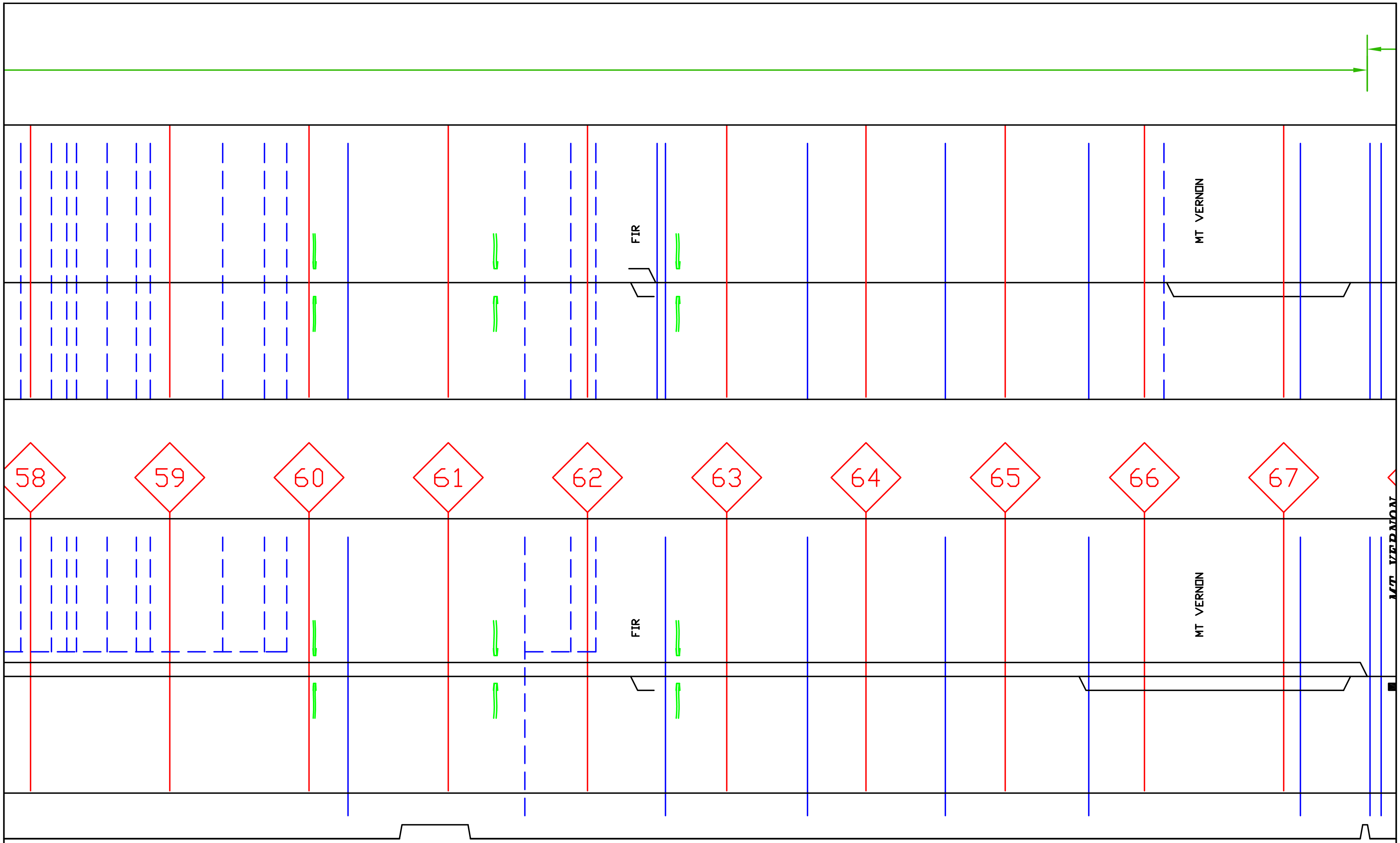
VANCOUVER - EVERETT

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



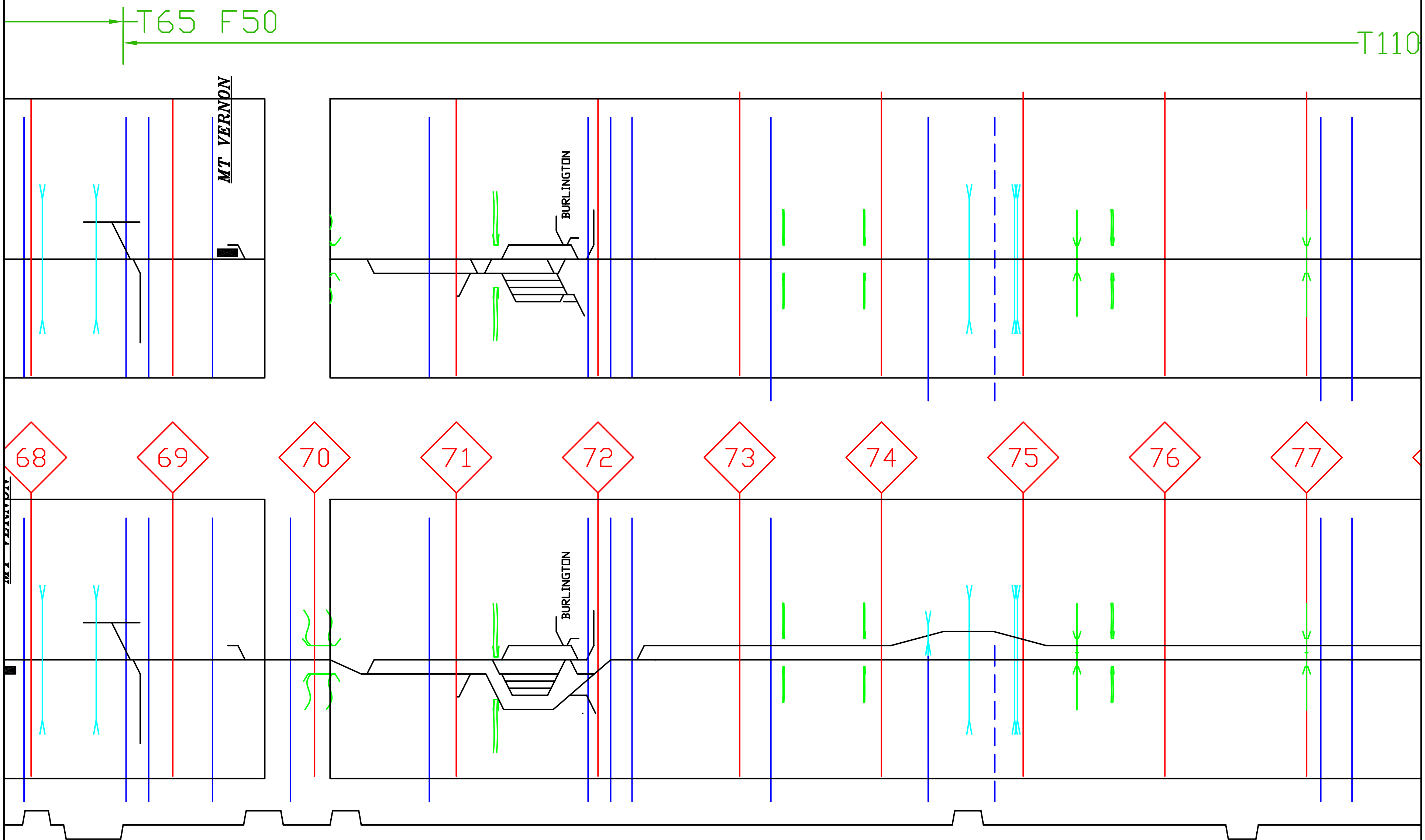
VANCOUVER - EVERETT
4 OF 16

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



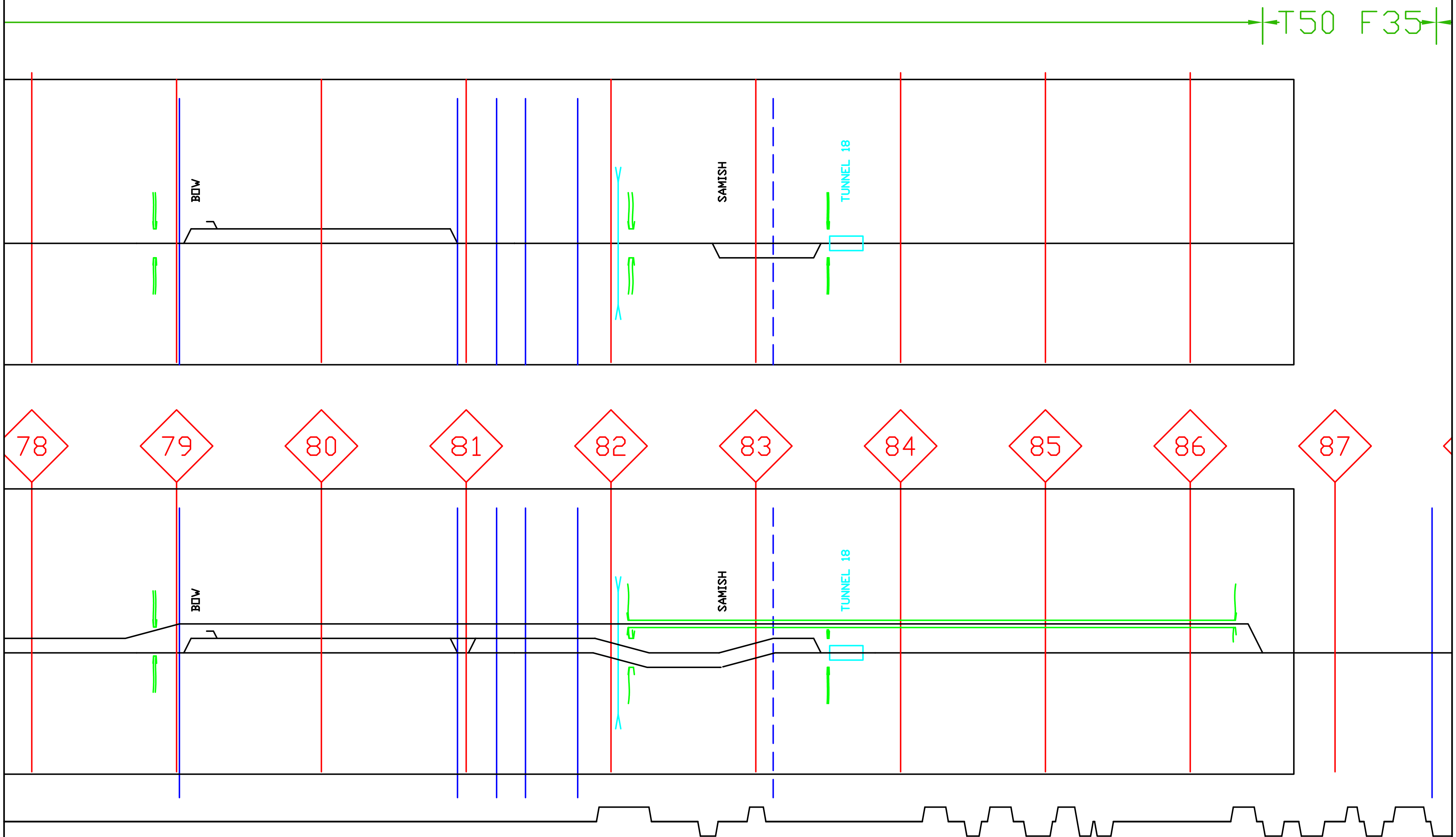
VANCOUVER - EVERETT

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT

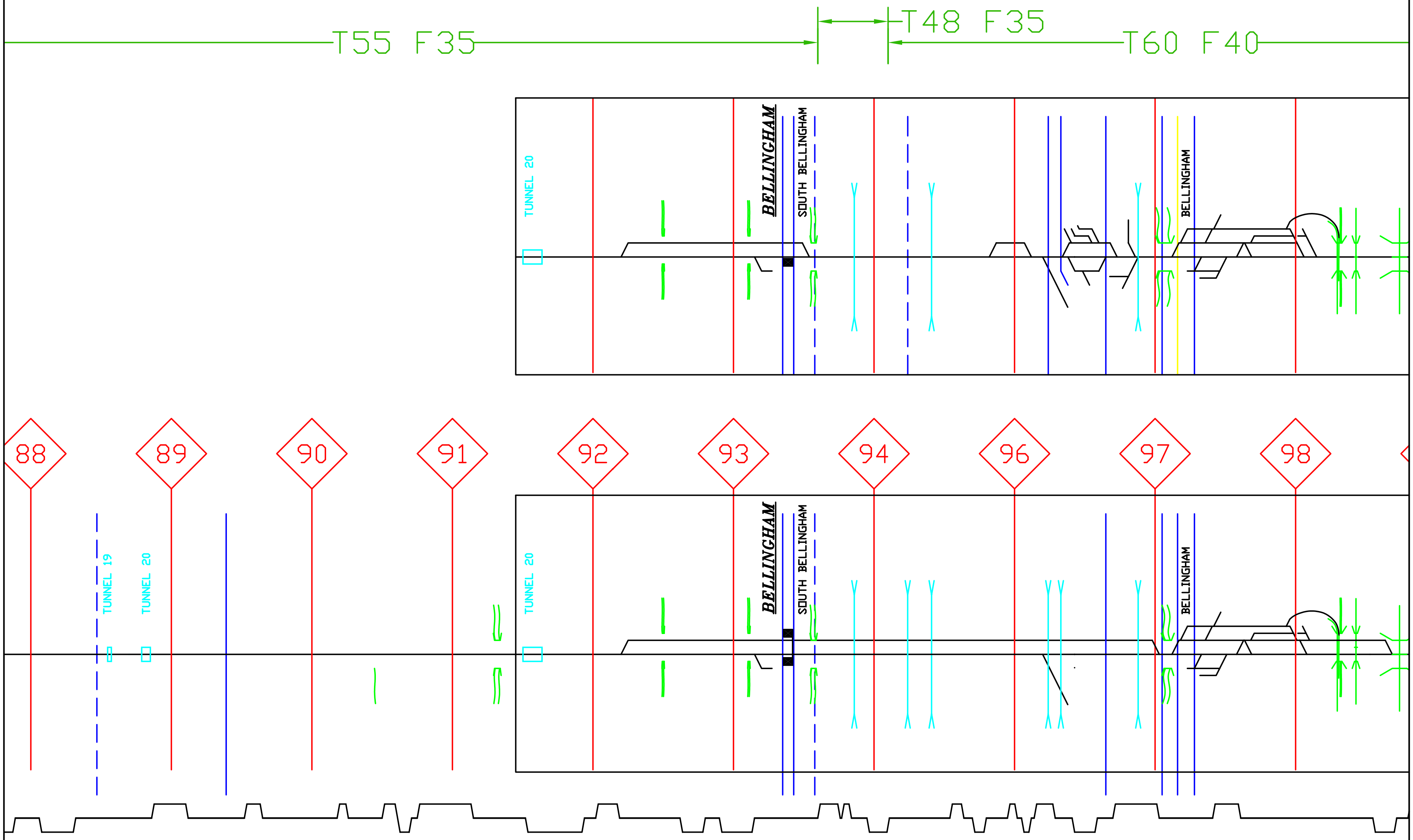


VANCOUVER - EVERETT
6 OF 16

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT

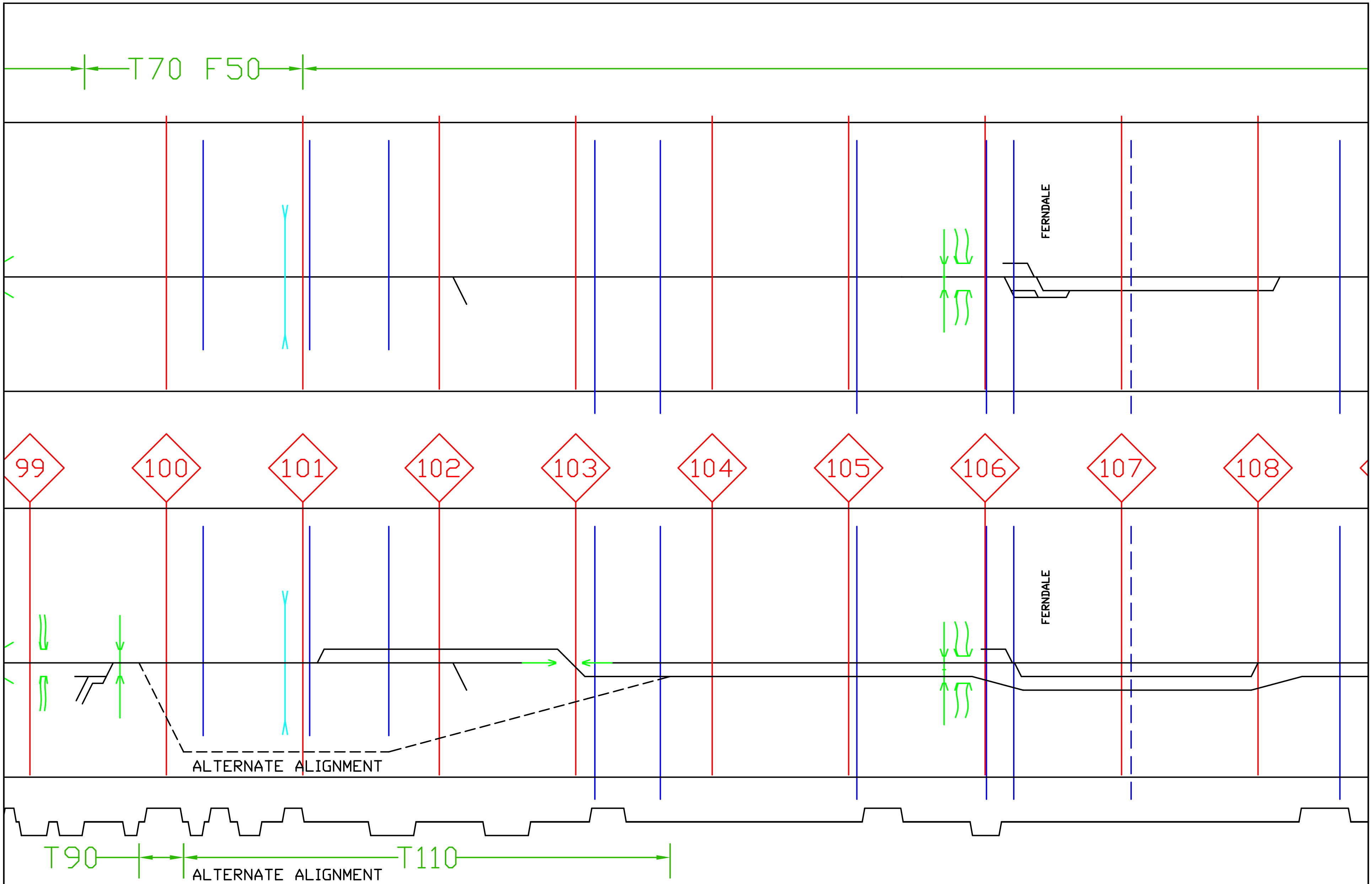


CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



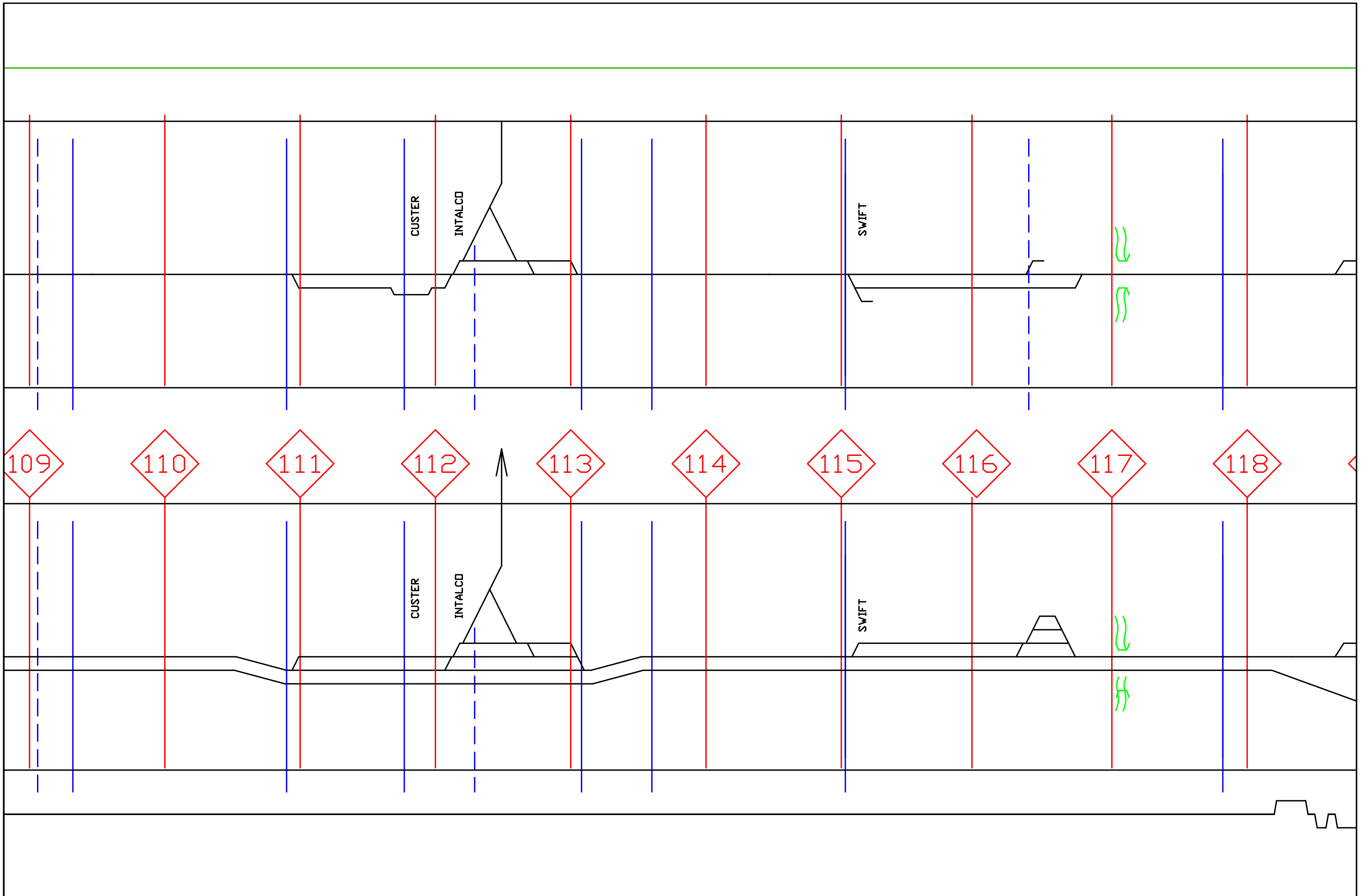
VANCOUVER - EVERETT
8 OF 16

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



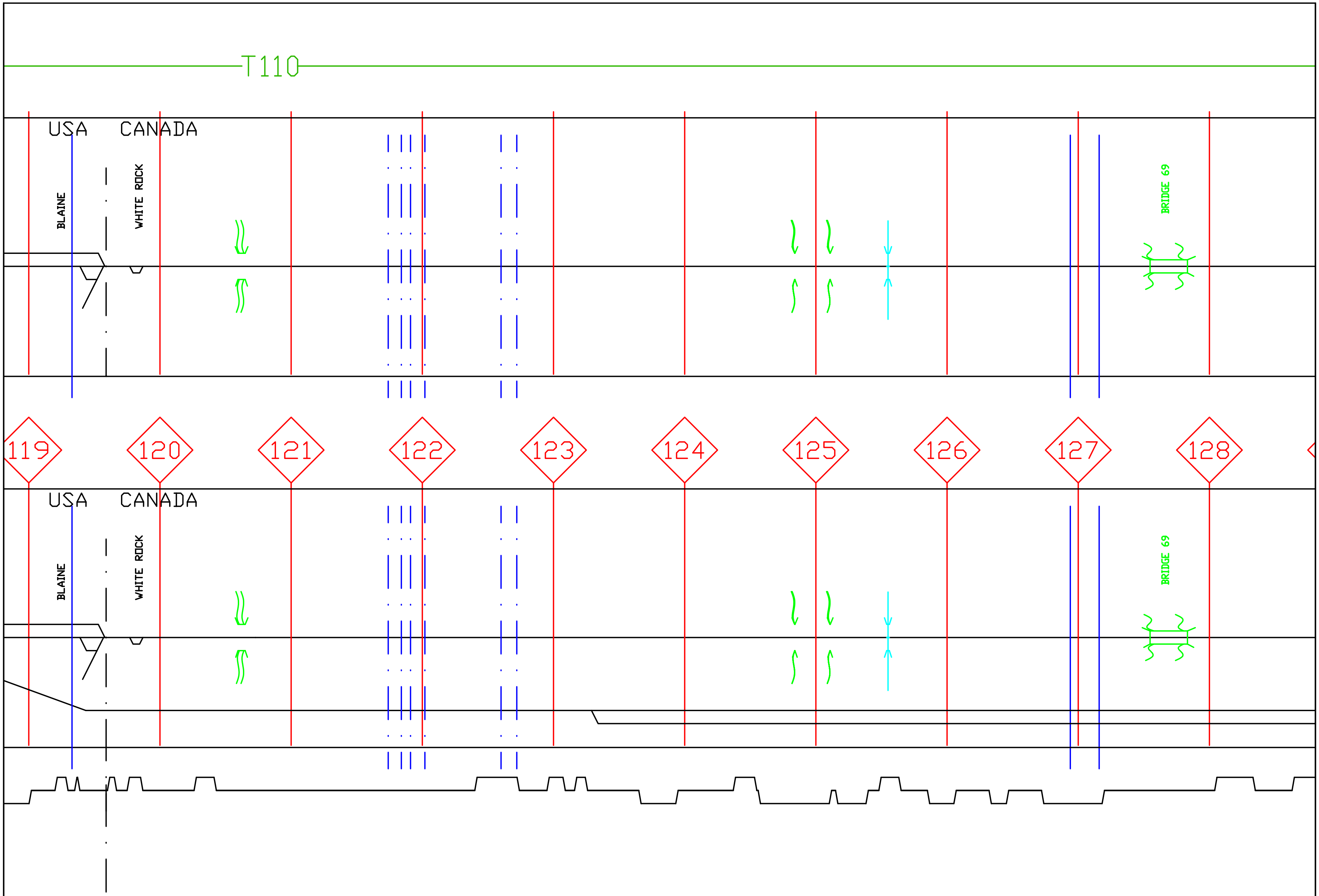
VANCOUVER - EVERETT

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



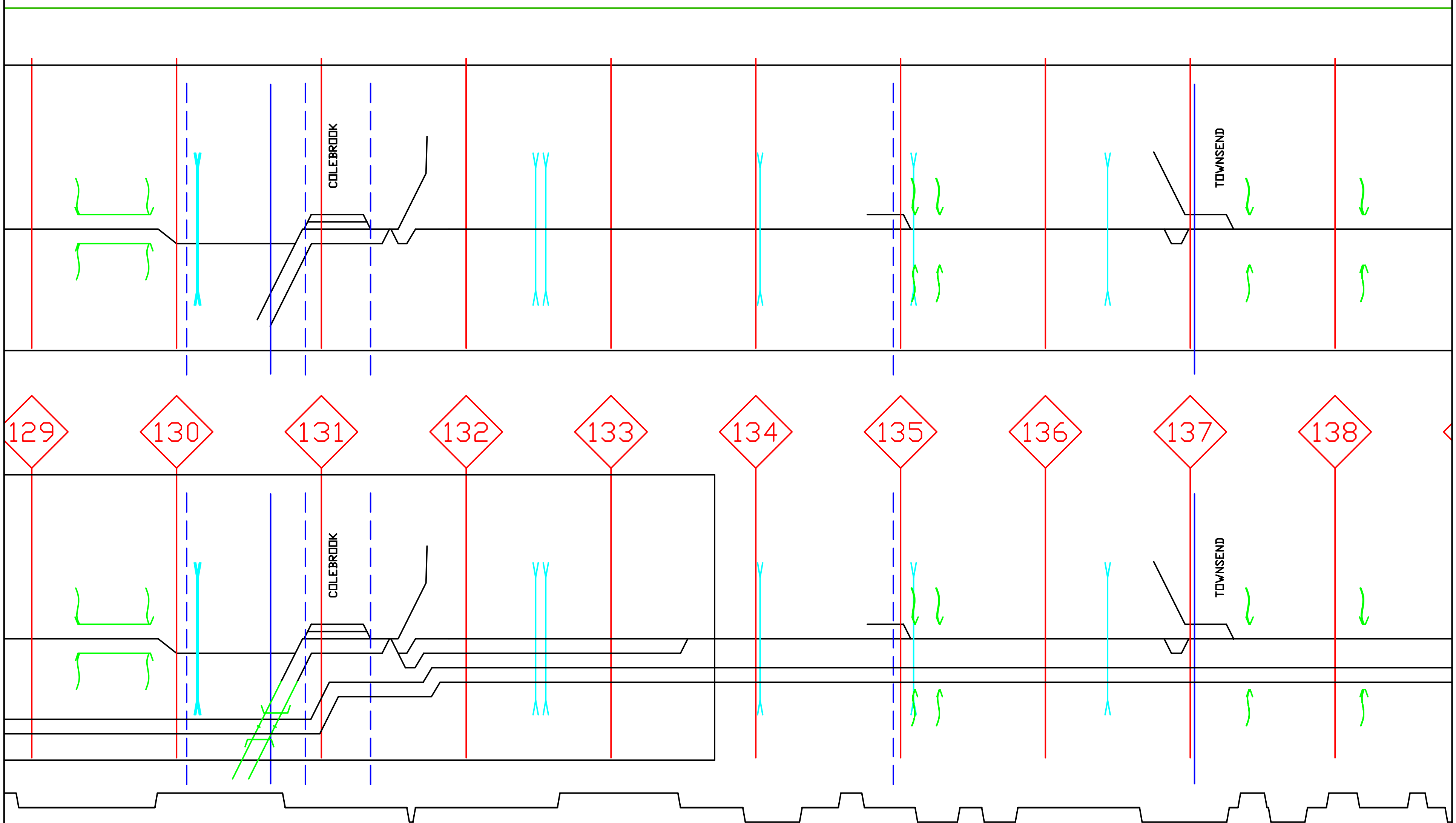
VANCOUVER - EVERETT
10 OF 16

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



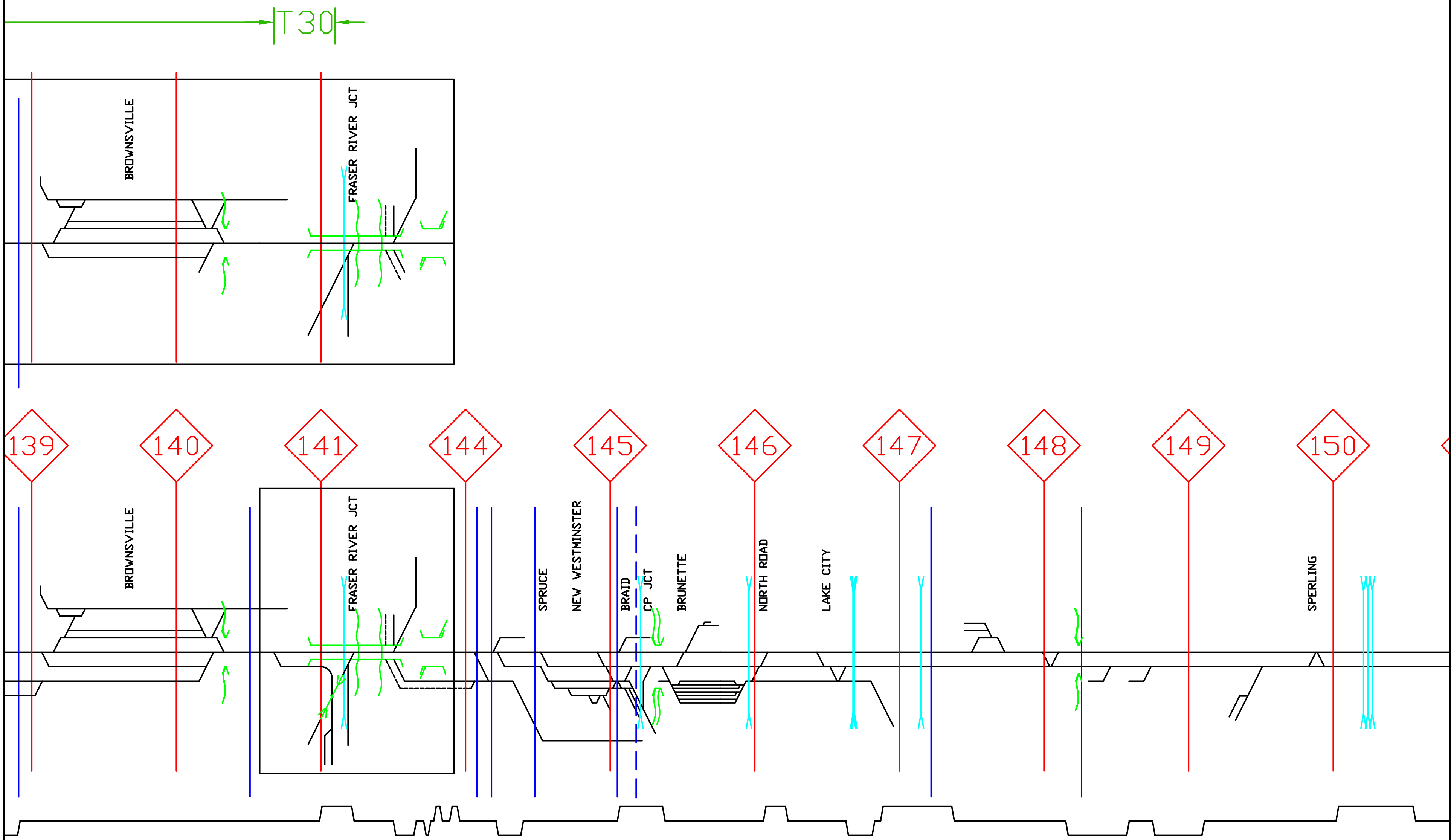
VANCOUVER - EVERETT

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



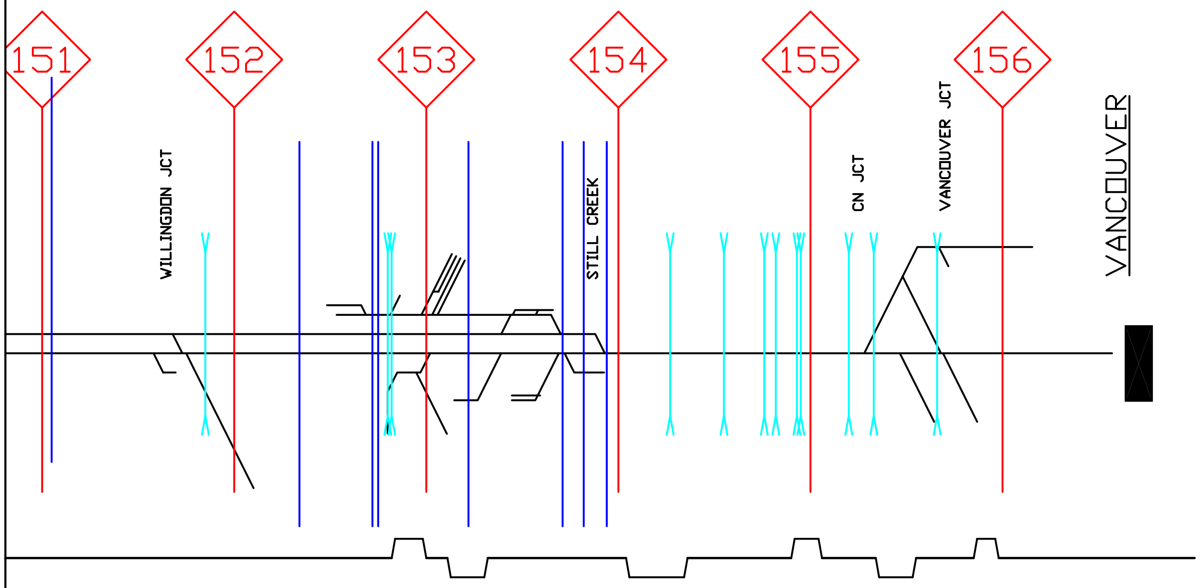
VANCOUVER - EVERETT
12 OF 16

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



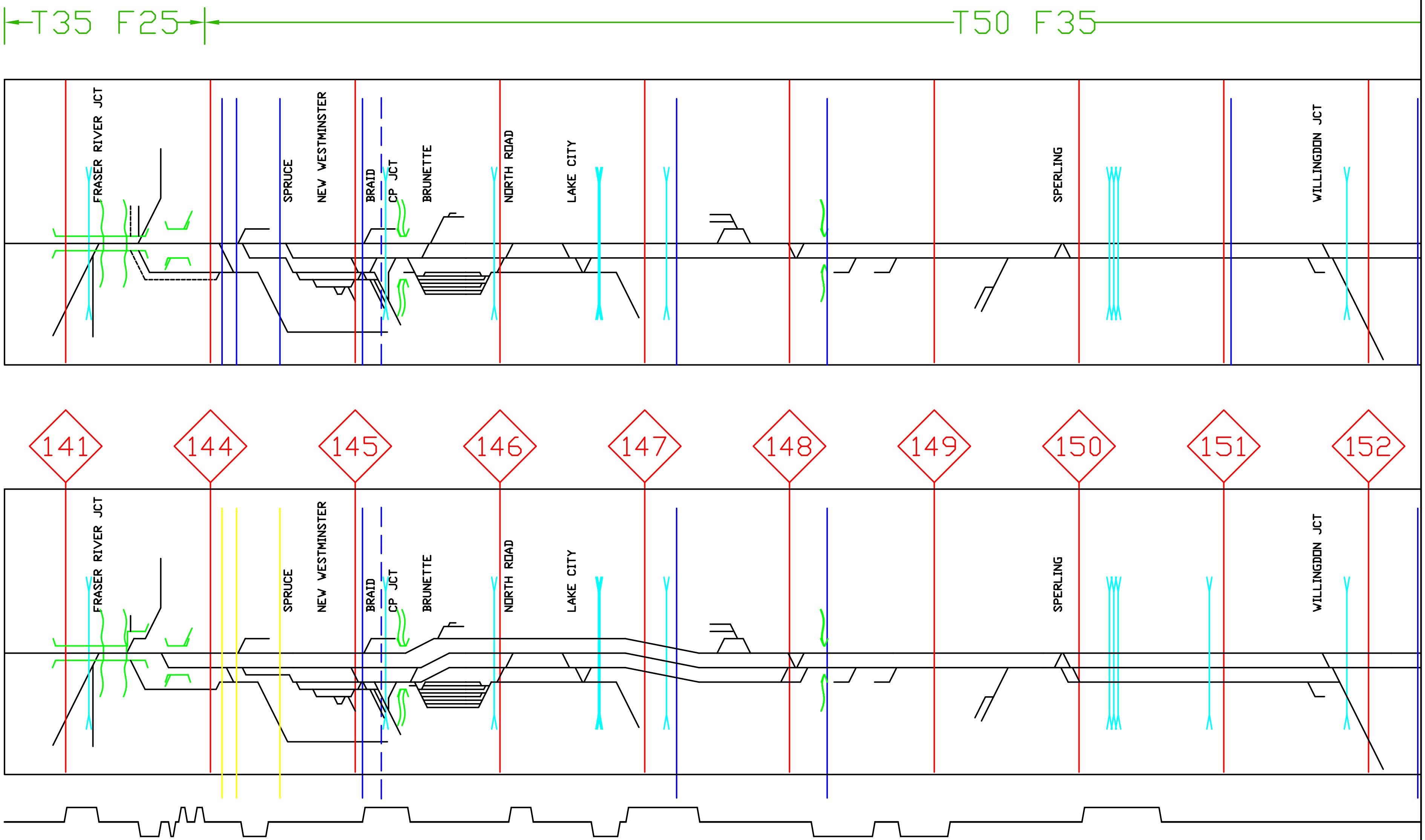
VANCOUVER - EVERETT

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



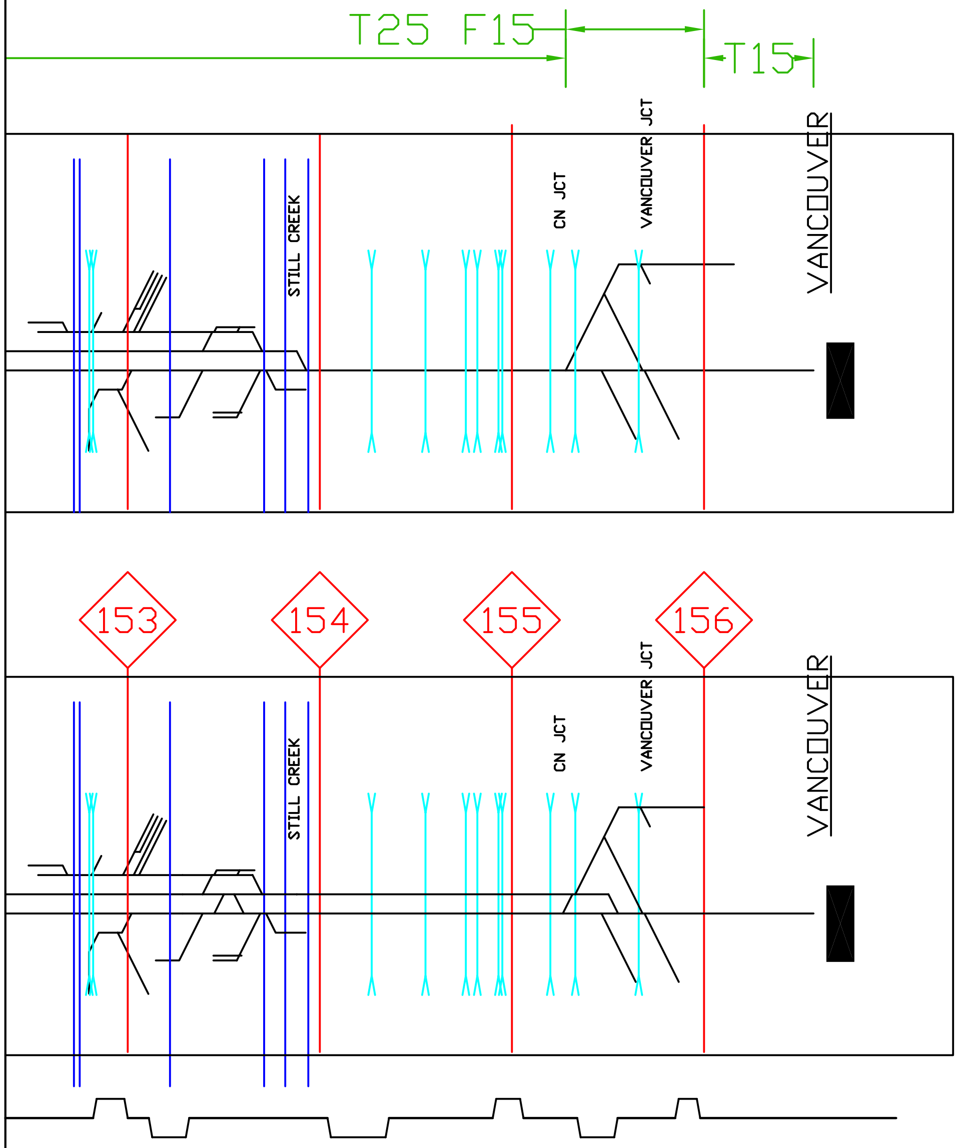
VANCOUVER - EVERETT
14 OF 16

CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



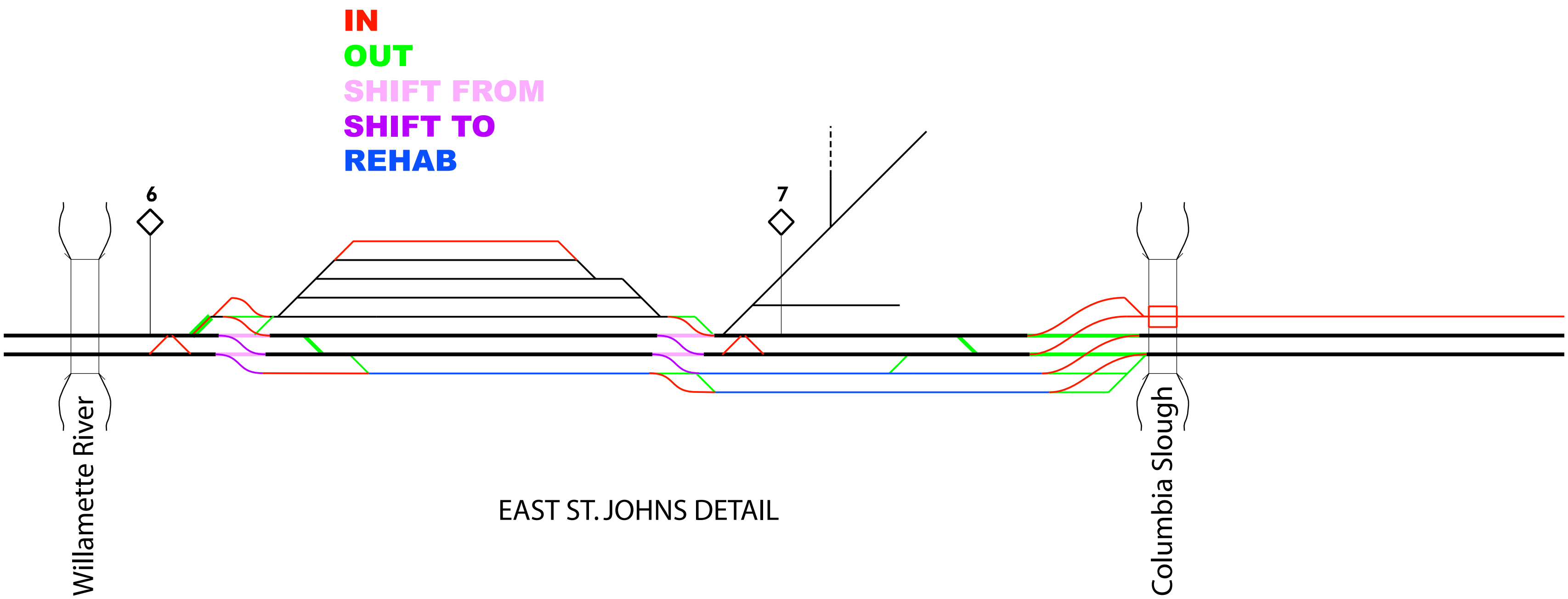
ALTERNATE ARRANGEMENT
VANCOUVER - EVERETT
15 OF 16

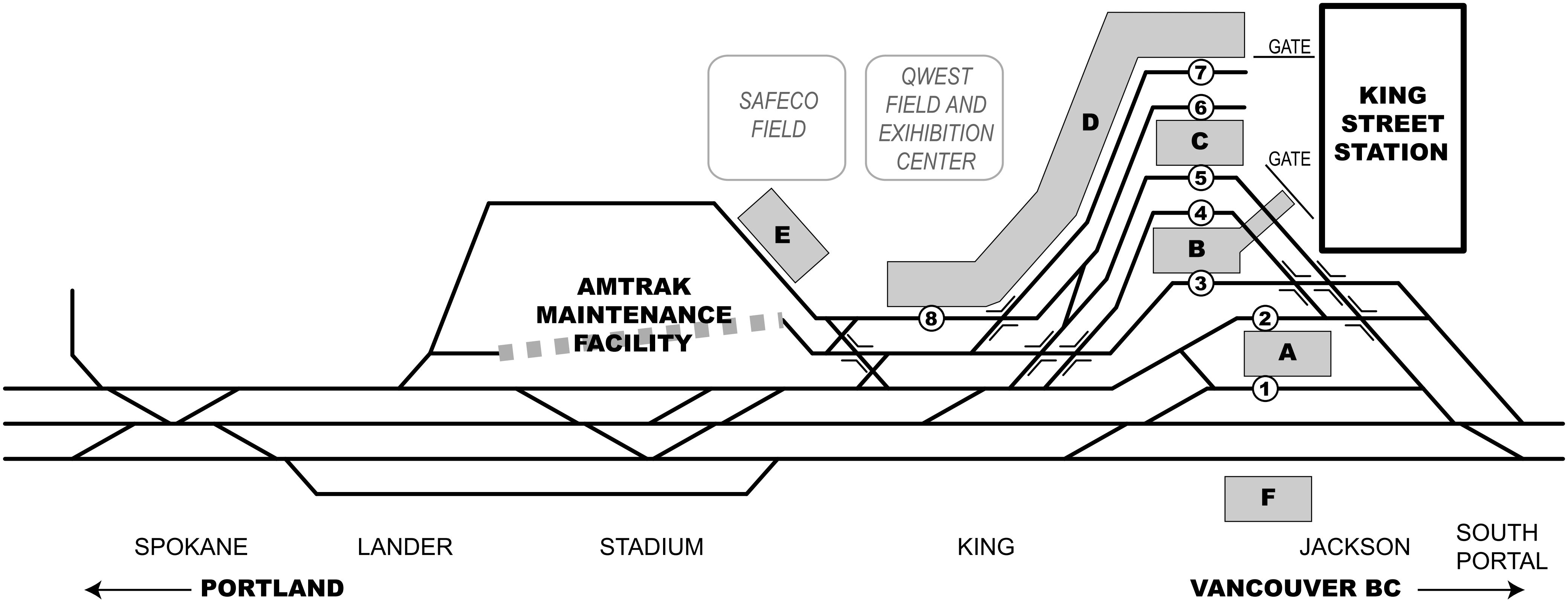
CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT



ALTERNATE ARRANGEMENT
VANCOUVER - EVERETT
16 OF 16

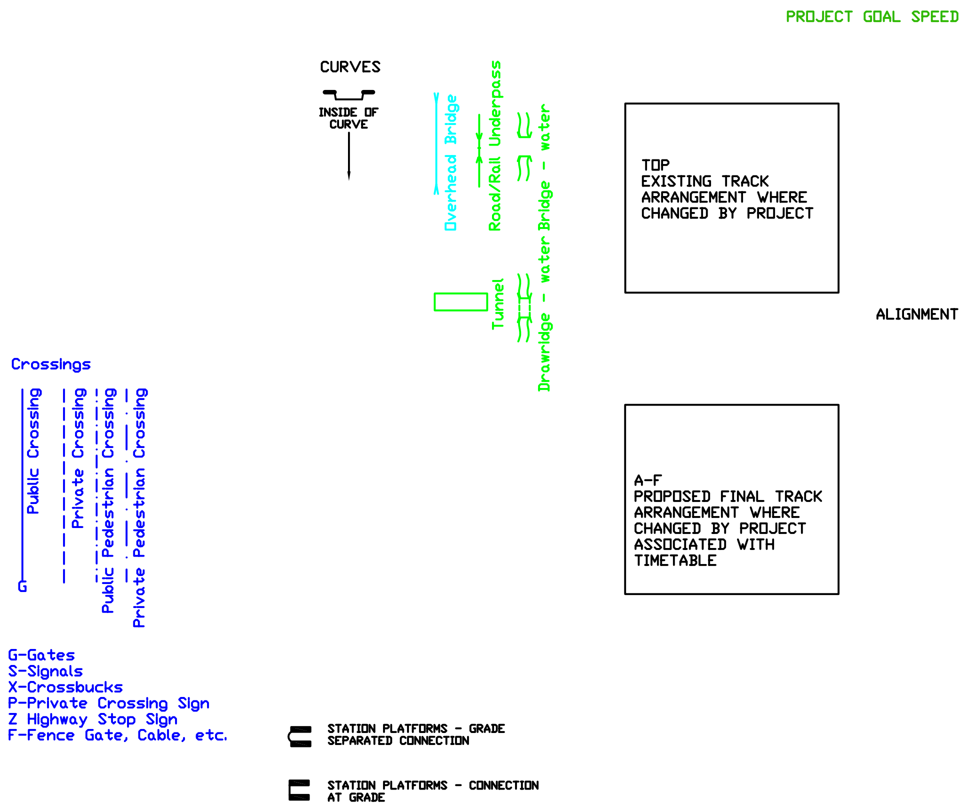
CONCEPTUAL IMPROVEMENT PLAN FOR THE PNWRC 06/30/03 TSM/HDR FOR WSDOT


IN
OUT
SHIFT FROM
SHIFT TO
REHAB
6
7
Willamette River
Columbia Slough
EAST ST. JOHNS DETAIL



NORMAL PLATFORM ASSIGNMENTS
A - TRACK 1 AND 2: SOUNDER
B - TRACK 3: CASCADES NORTH
TRACK 4: EMPIRE BUILDER AND CASCADES SPARE
C - TRACK 5: CASCADES SOUTH
TRACK 6: AMTRAK SPARE
D - TRACK 7: COAST STARLIGHT, EVENT AND CHARTER TRAINS, SOUNDER OVERFLOW
TRACK 8: EXTRA LENGTH FOR TRACK 7, EVENT TRAINS
E - EVENT TRAINS
F - FUTURE PLATFORM FOR LAKEWOOD-EVERETT SOUNDER TRAINS

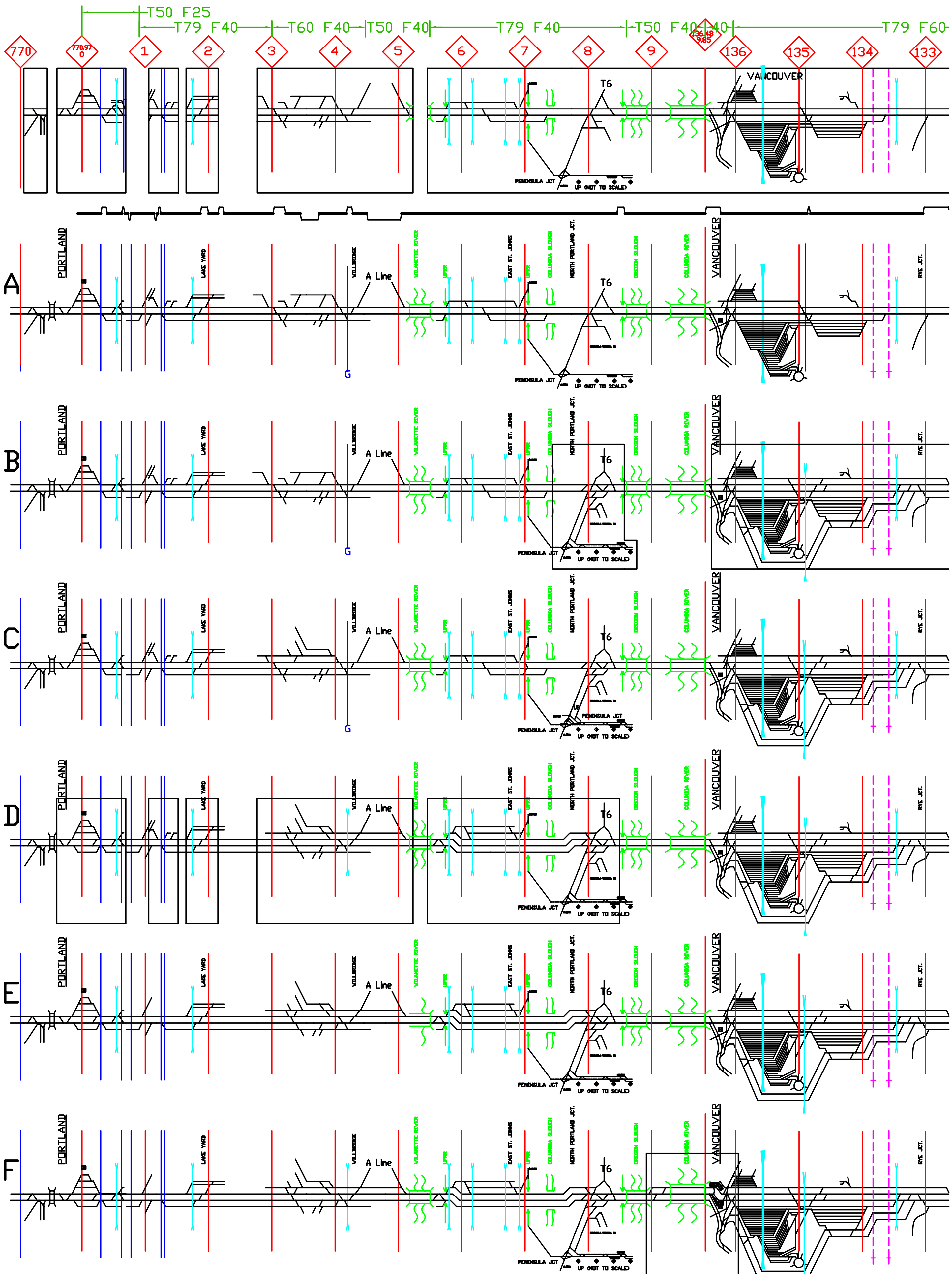
KING STREET STATION DETAIL



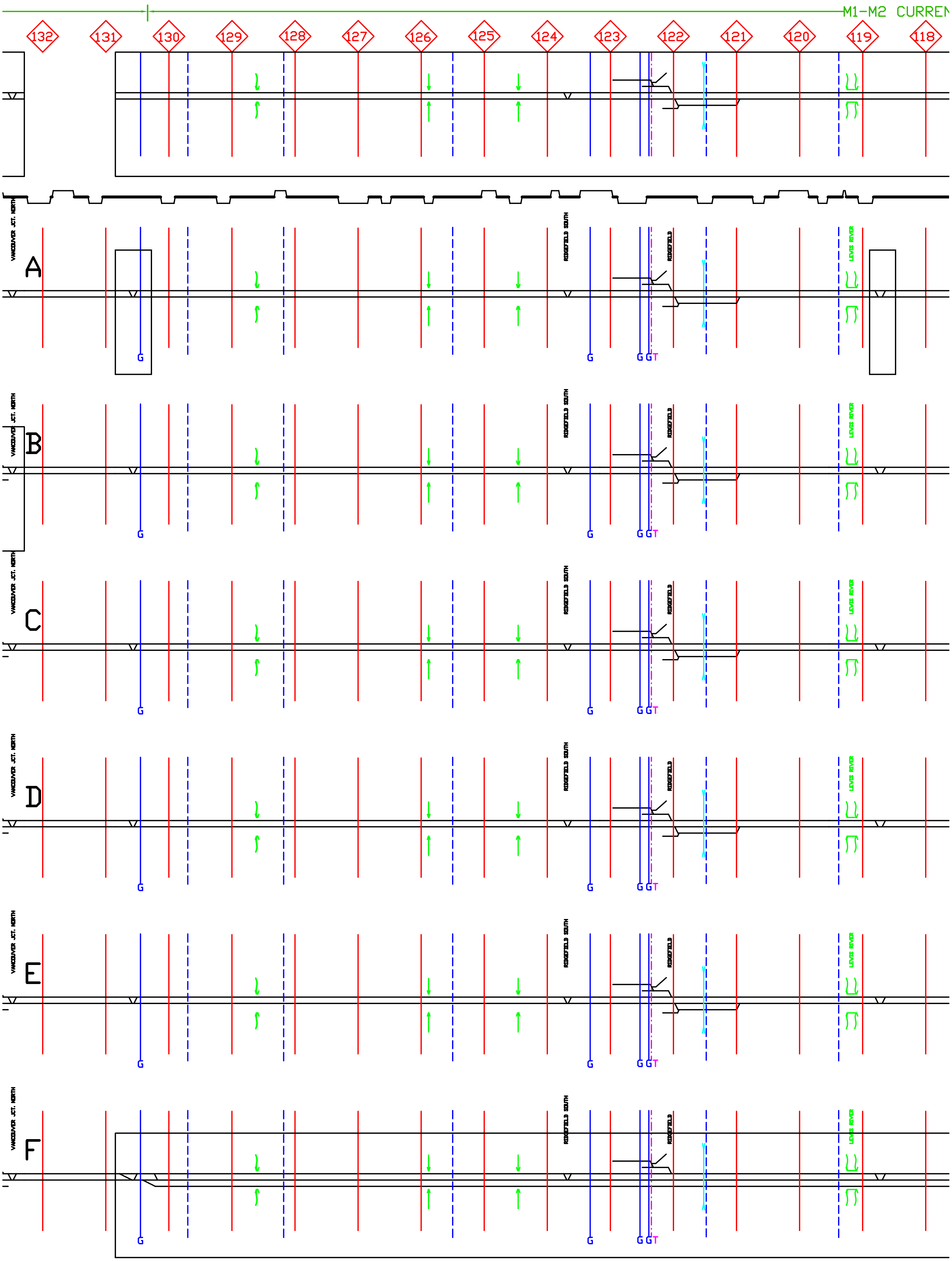
CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC
PORTLAND - NISQUALLY

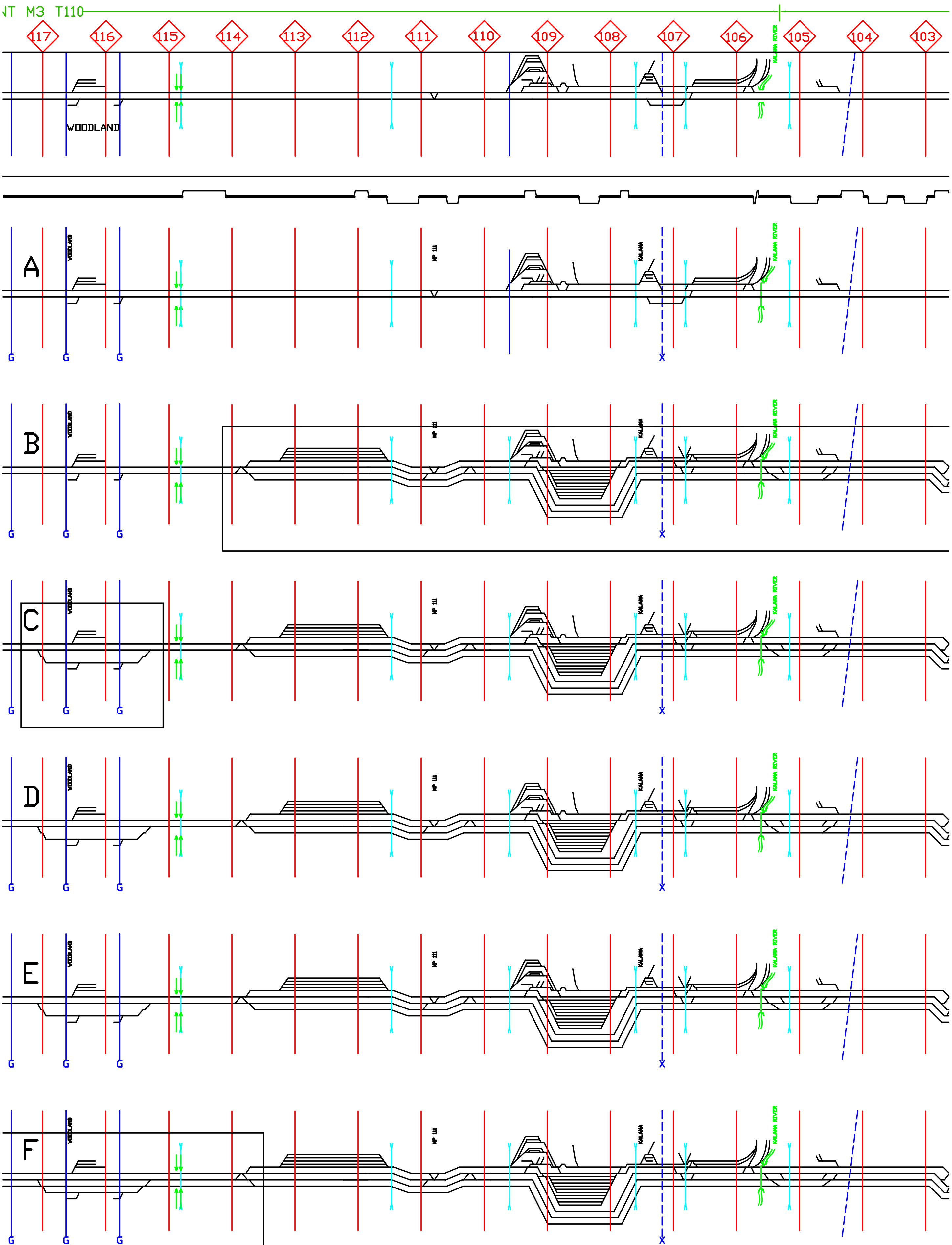
TRANSIT SAFETY MANAGEMENT / HDR FOR
WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION

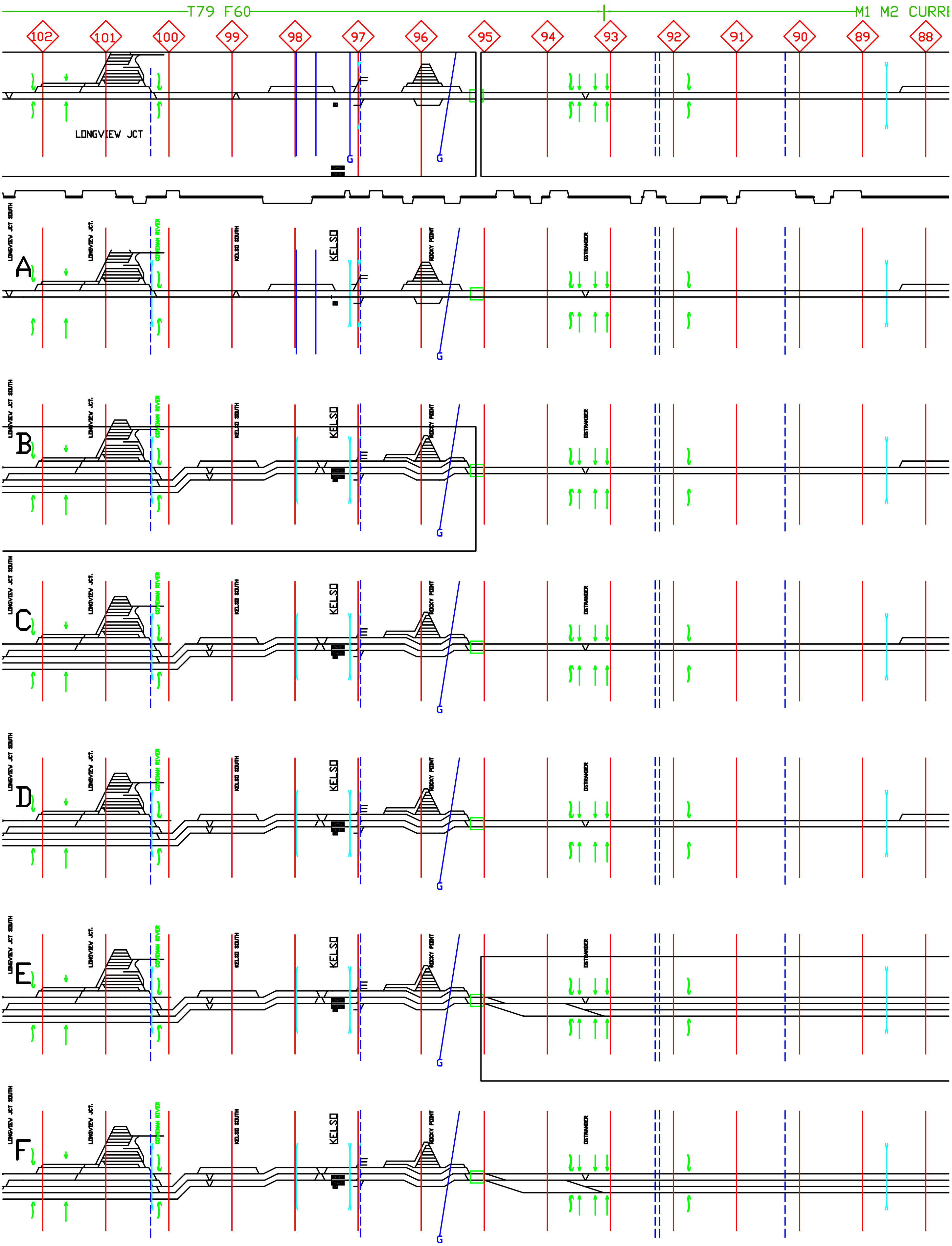
JUNE 30 2003 REV NOV 28 2003 FEB 5 2006

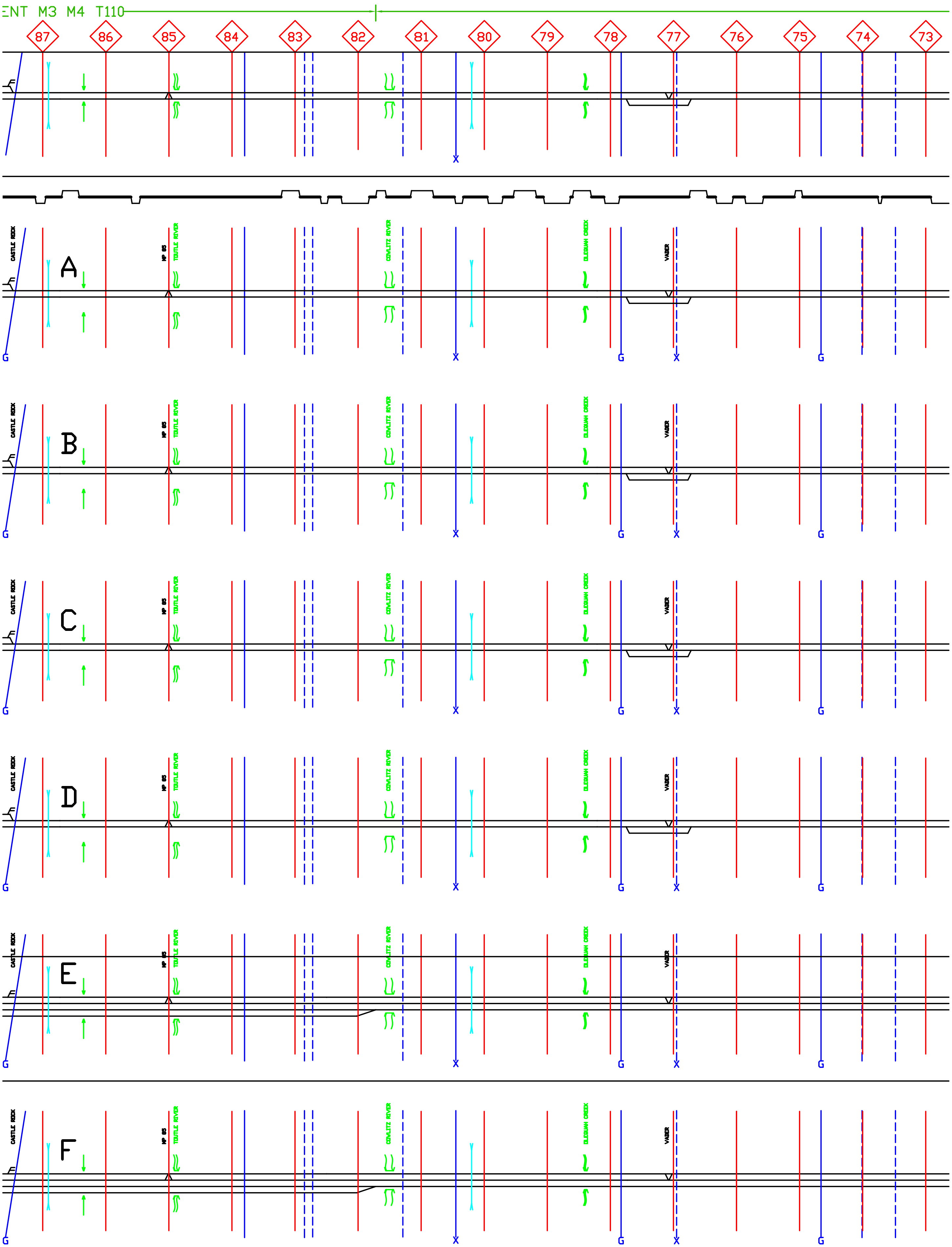


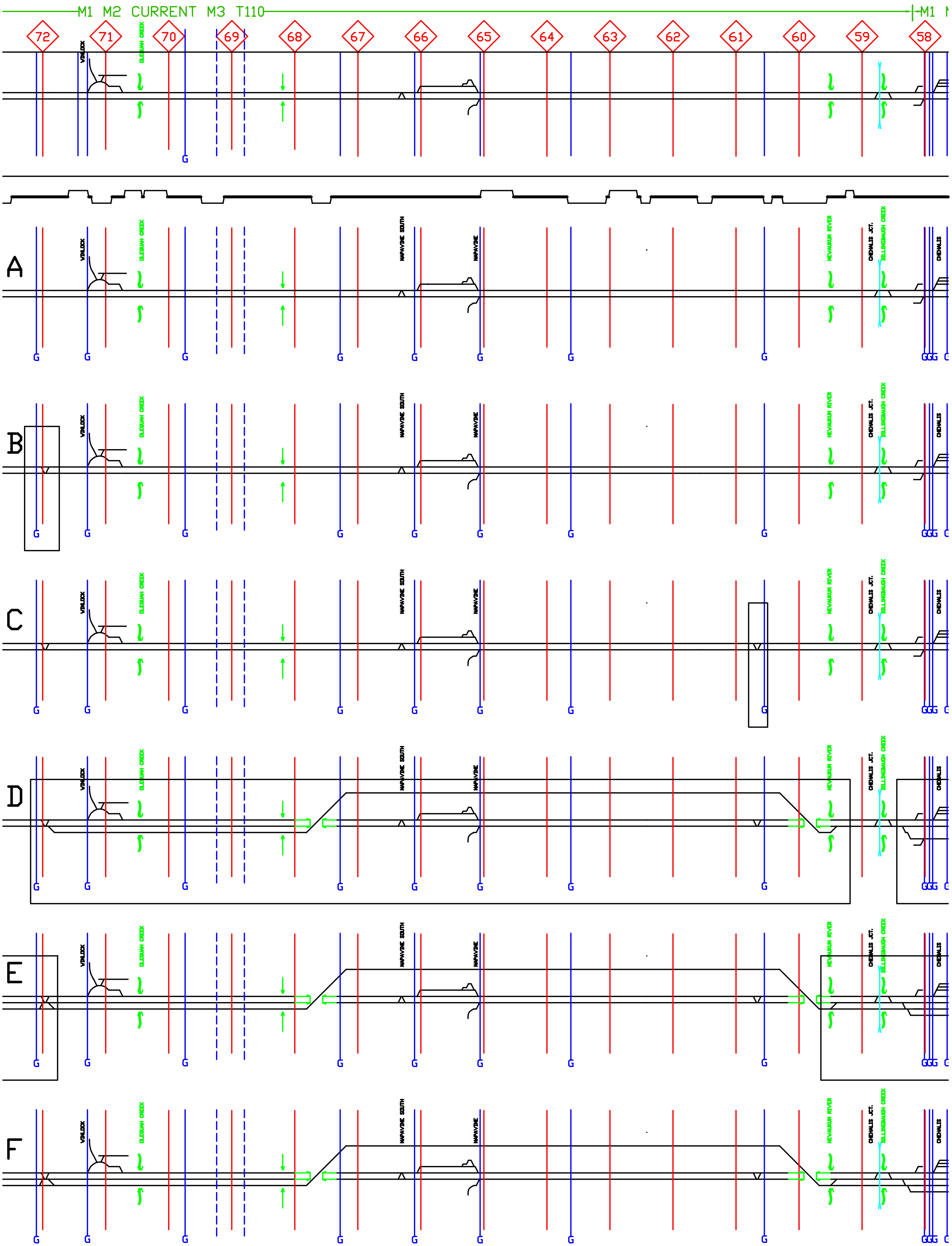
T50 F25
T79 F40
T60 F40
T50 F40
T79 F40
T50 F40
40
T79 F60
770
770.97
0
1
2
3
4
5
6
7
8
9
136.48
9.85
136
135
134
133
VANCOUVER
T6
PENINSULA JCT
UP (NOT TO SCALE)
A
B
C
D
E
F
PORTLAND
LAKE YARD
WILLBRIDGE
A Line
WILLAMETTE RIVER
UPRR
EAST ST. JOHNS
COLUMBIA SLOUGH
NORTH PORTLAND JCT.
OREGON SLOUGH
COLUMBIA RIVER
RYE JCT.
G


M1-M2 CURREN
132
131
130
129
128
127
126
125
124
123
122
121
120
119
118
VANCOUVER JCT. NORTH
RIDGEFIELD SOUTH
RIDGEFIELD
LEWIS RIVER
A
B
C
D
E
F
G
T

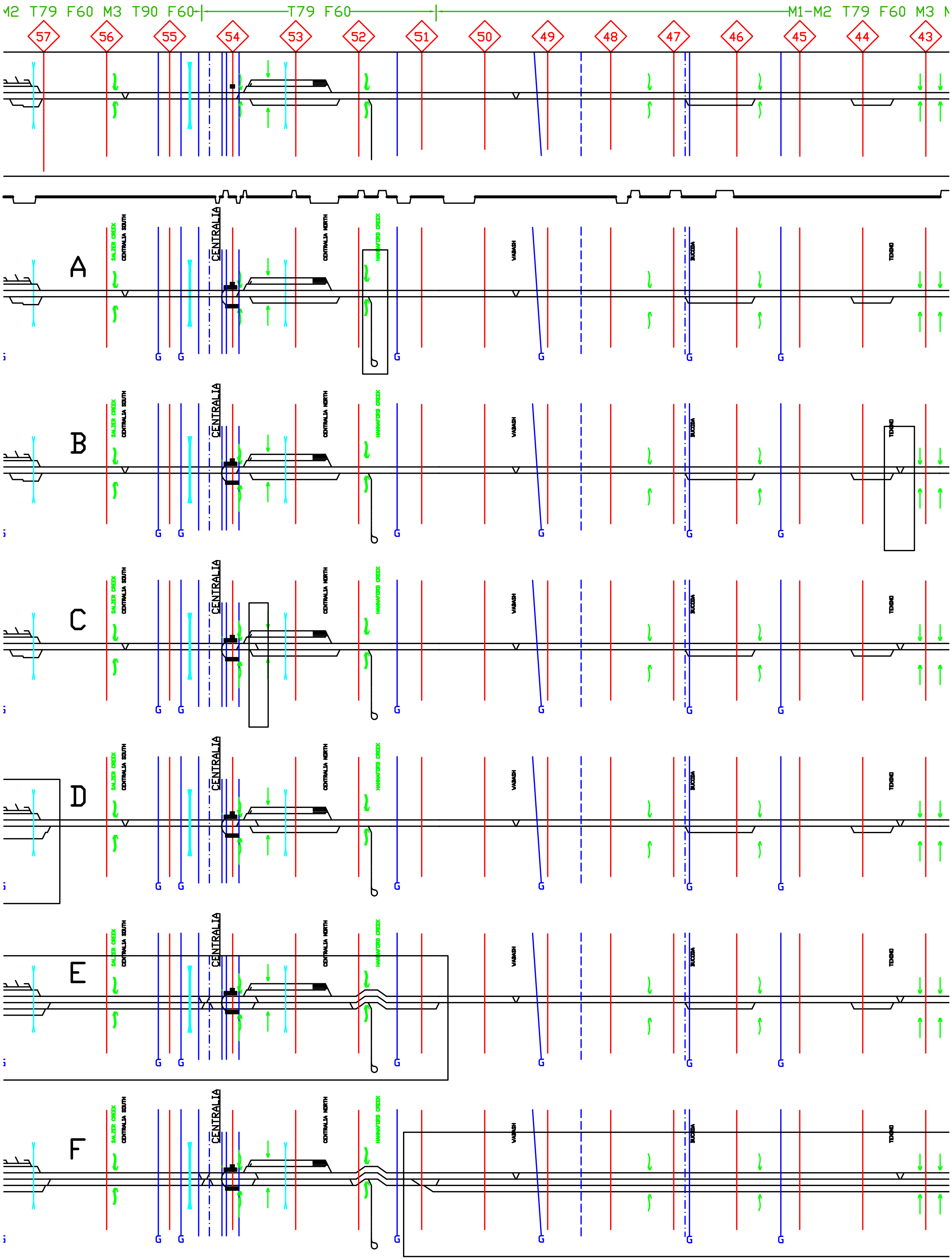

NT M3 T110
117
116
115
114
113
112
111
110
109
108
107
106
105
104
103
WOODLAND
A
B
C
D
E
F
G
X
MP 111
KALAMA
KALAMA RIVER

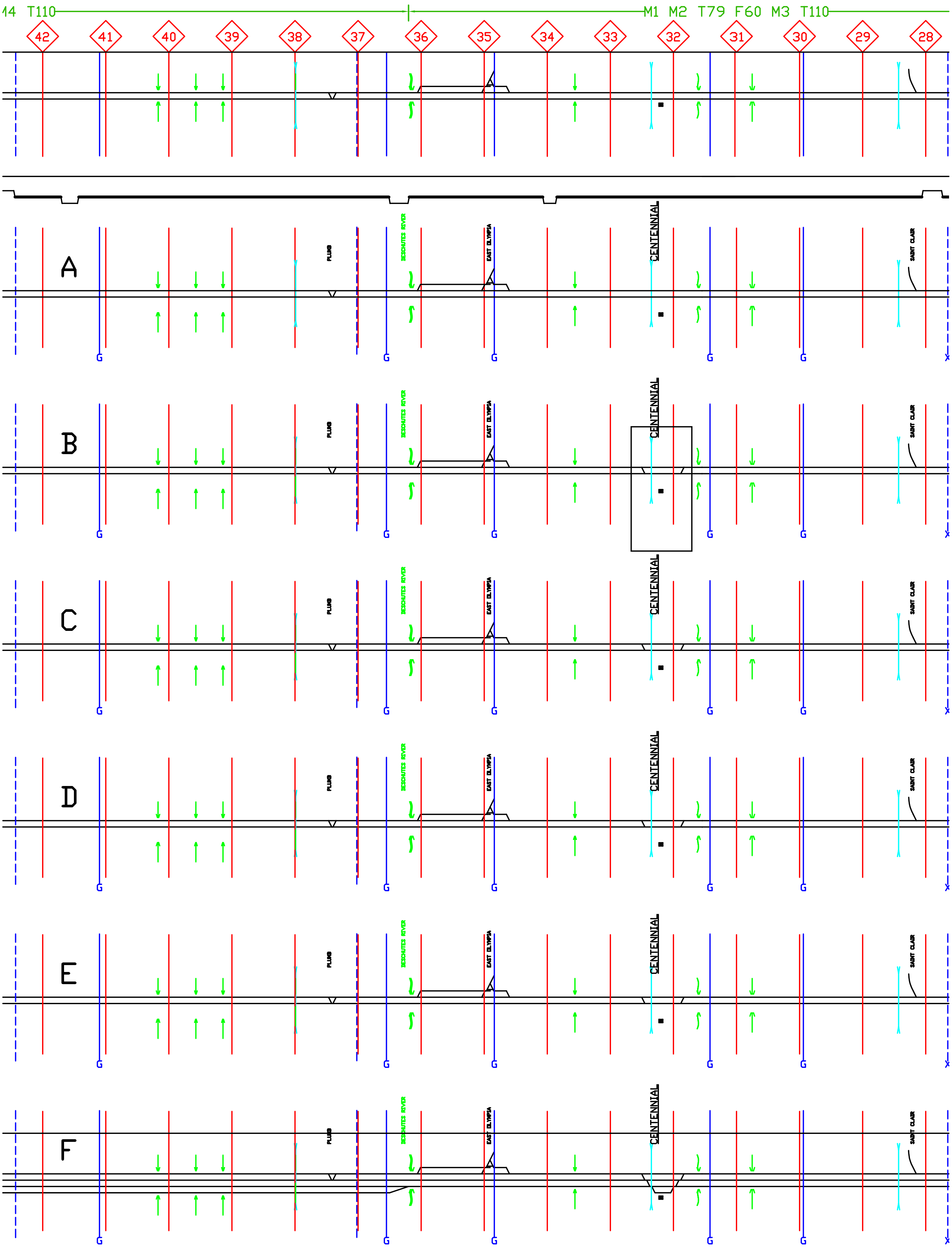

T79 F60
M1 M2
102
101
100
99
98
97
96
95
94
93
92
91
90
89
88
LONGVIEW JCT
G
A
B
C
D
E
F
LONGVIEW JCT SOUTH
LONGVIEW JCT.
KELSO SOUTH
KELSO
ROCKY POINT
OSTRANDER


ENT M3 M4 T110
87
86
85
84
83
82
81
80
79
78
77
76
75
74
73
CASTLE ROCK
MP 85
TOUTLE RIVER
COWLITZ RIVER
OLEQUAH CREEK
VADER
A
B
C
D
E
F
G
X

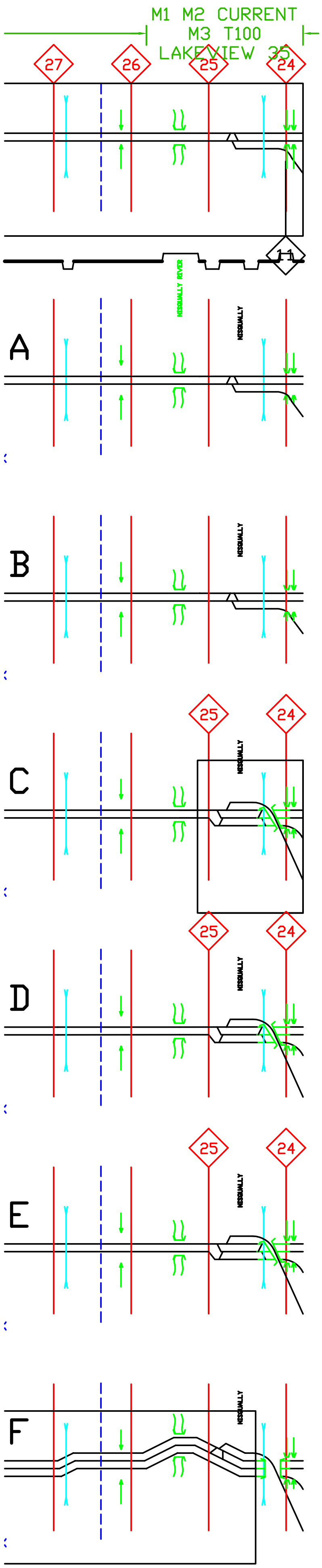


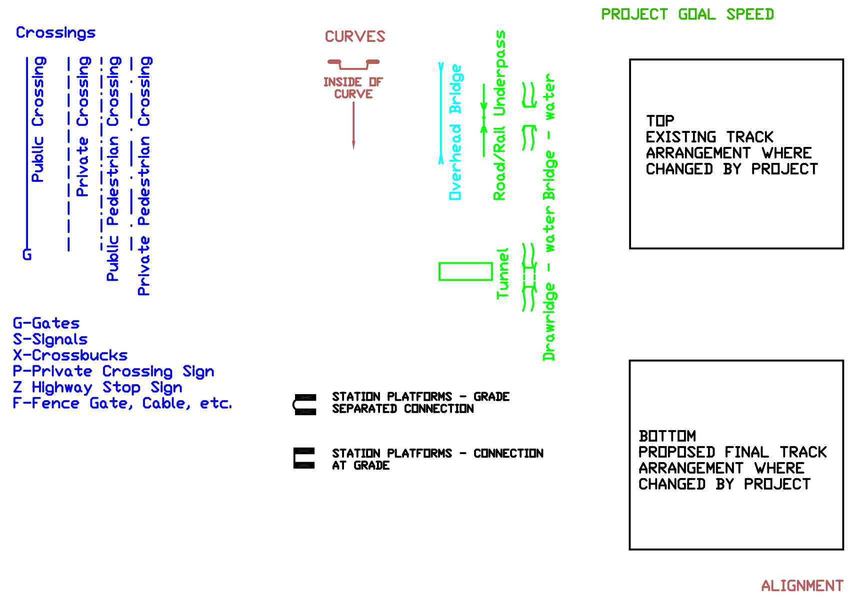
PACIFIC NORTHWEST RAIL CORRIDOR PORTLAND - NISQUALLY 7 OF 10


M2 T79 F60 M3 T90 F60
T79 F60
M1-M2 T79 F60 M3
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
A
B
C
D
E
F
SALZER CREEK
CENTRALIA SOUTH
CENTRALIA
CENTRALIA NORTH
HANAFORD CREEK
WABASH
BUCODA
TENINO
G



44 T110
M1 M2 T79 F60 M3 T110
42 41 40 39 38 37 36 35 34 33 32 31 30 29 28
A
B
C
D
E
F
PLUMB
DESCHUTES RIVER
EAST OLYMPIA
CENTENNIAL
SAINT CLAIR
G

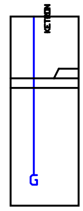

M1 M2 CURRENT
M3 T100
LAKEVIEW 35
27
26
25
24
11
NISQUALLY RIVER
NISQUALLY
A
B
C
D
E
F



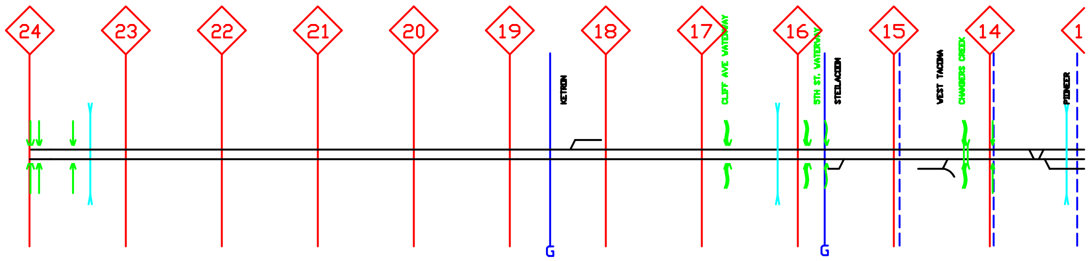
CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC
NISQUALLY - RESERVATION

TRANSIT SAFETY MANAGEMENT / HDR FOR
WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION

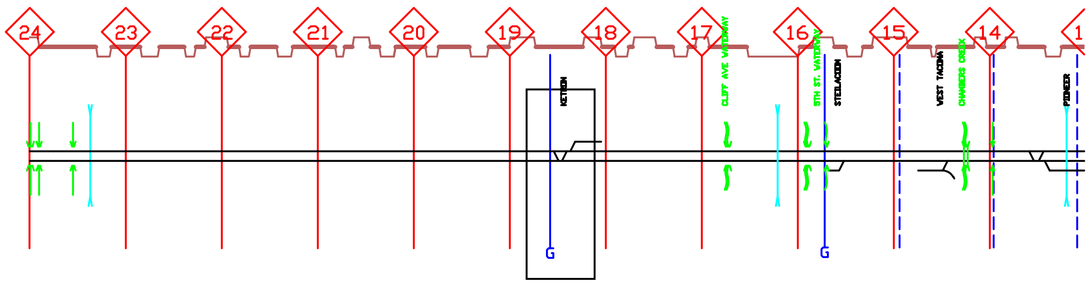
MARCH 1 2004



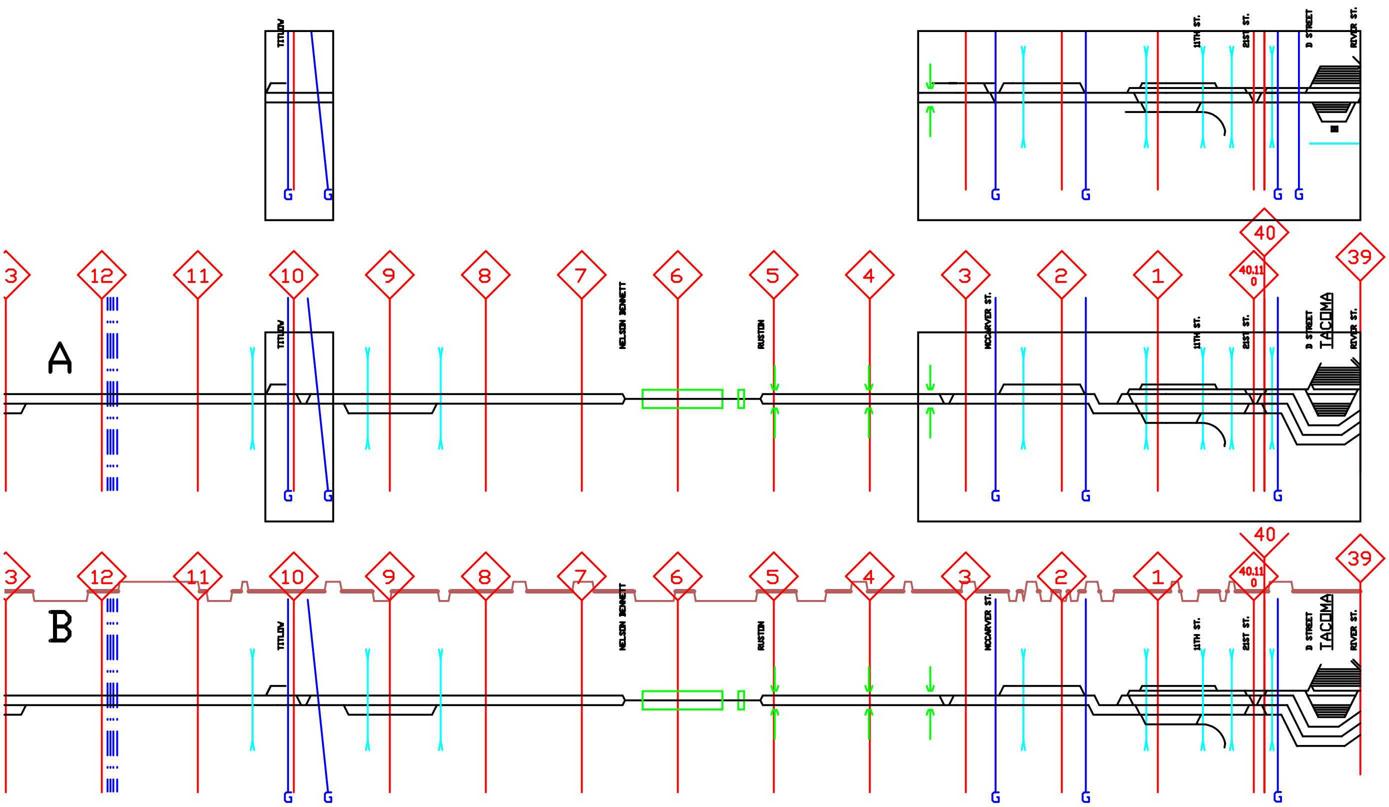
A



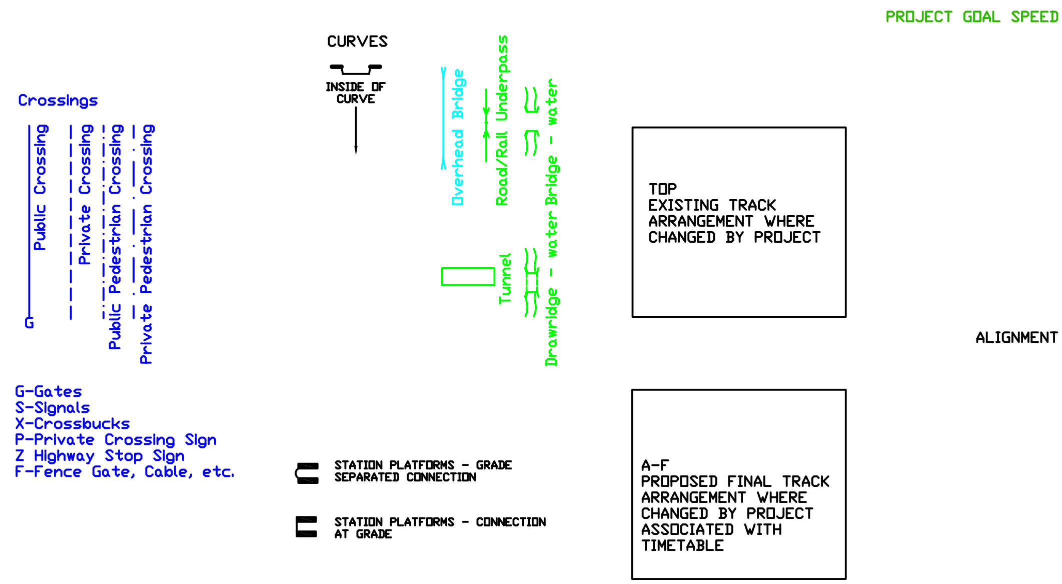
B



C, D, E, F
NO CHANGES
PASSENGER SERVICE VIA
PT DEFIANCE BYPASS



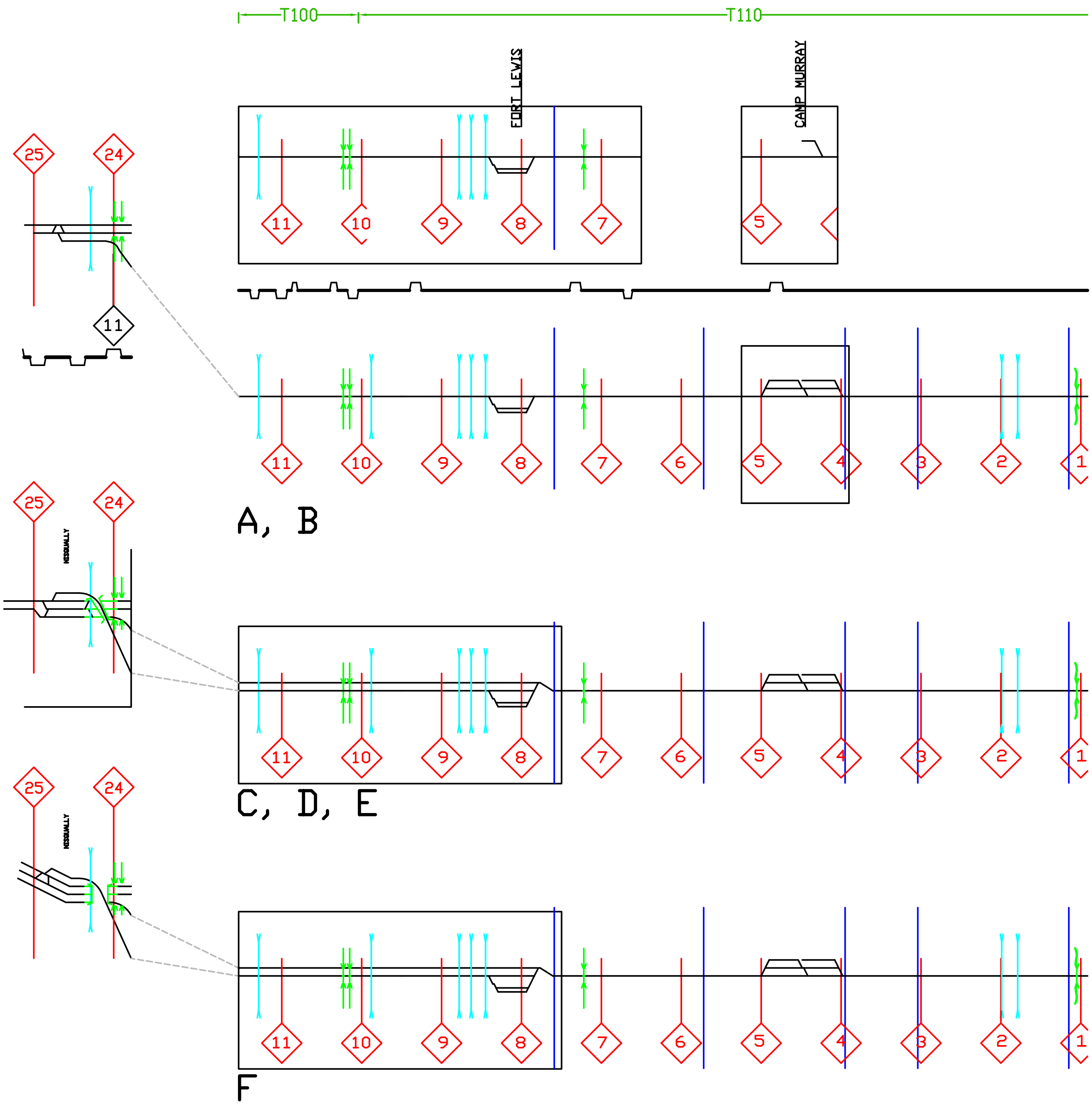
C, D, E, F
NO CHANGES
PASSENGER SERVICE VIA
PT DEFIANCE BYPASS

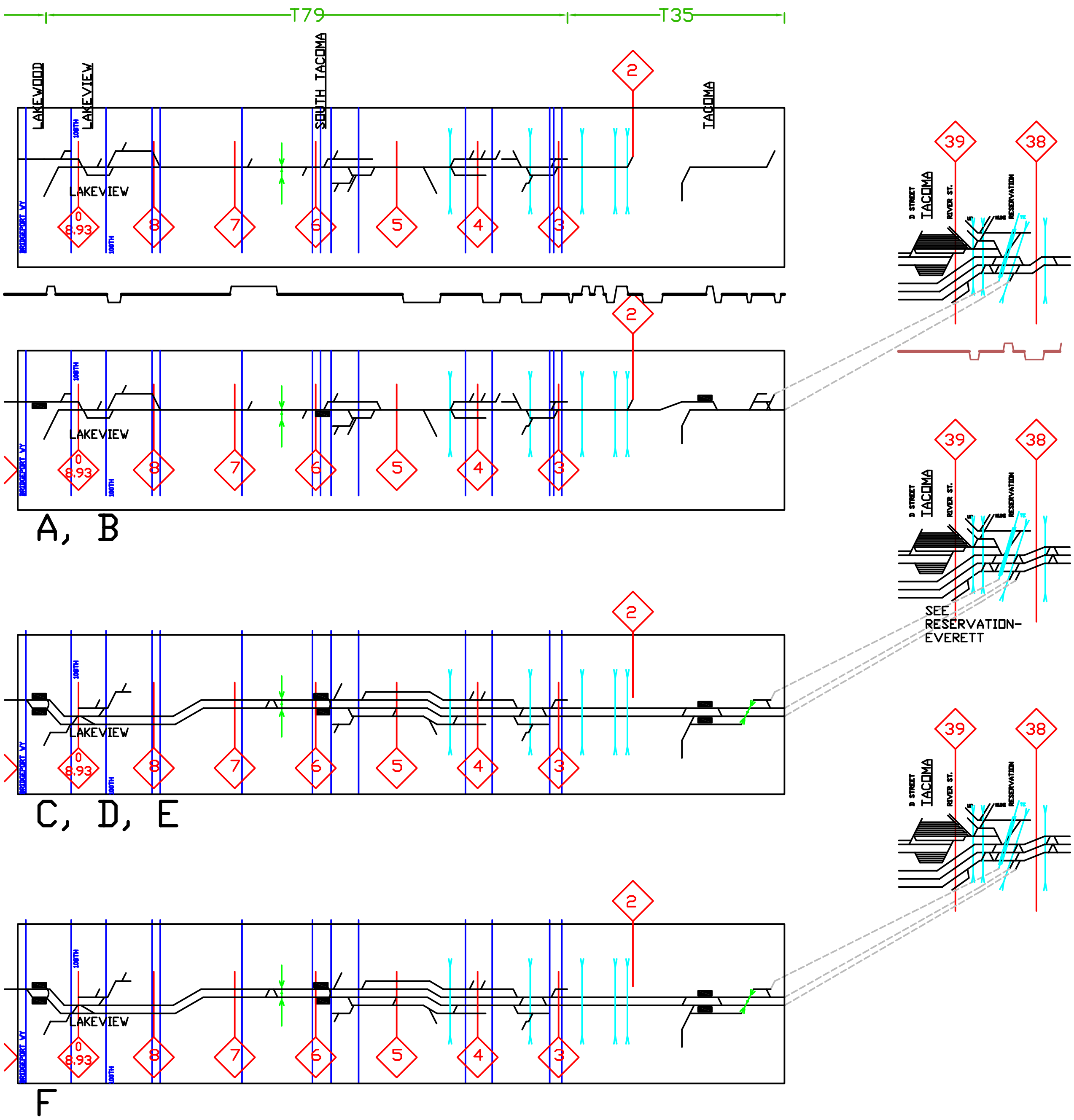


CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC
NISQUALLY - RESERVATION

TRANSIT SAFETY MANAGEMENT / HDR FOR
WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION

JUNE 30 2003 REV NOV 28 2003 FEB 5 2006

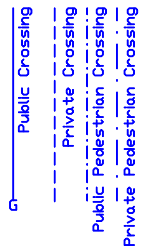

T100
T110
FORT LEWIS
CAMP MURRAY
25
24
11
10
9
8
7
6
5
4
3
2
1
A, B
NISQUALLY
C, D, E
F



PACIFIC NORTHWEST RAIL CORRIDOR NISQUALLY - RESERVATION 3 OF 3

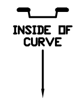
PROJECT GOAL SPEED

Crossings



G-Gates
S-Signals
X-Crossbucks
P-Private Crossing Sign
Z Highway Stop Sign
F-Fence Gate, Cable, etc.

CURVES



STATION PLATFORMS - GRADE SEPARATED CONNECTION

STATION PLATFORMS - CONNECTION AT GRADE

TOP
EXISTING TRACK ARRANGEMENT WHERE CHANGED BY PROJECT

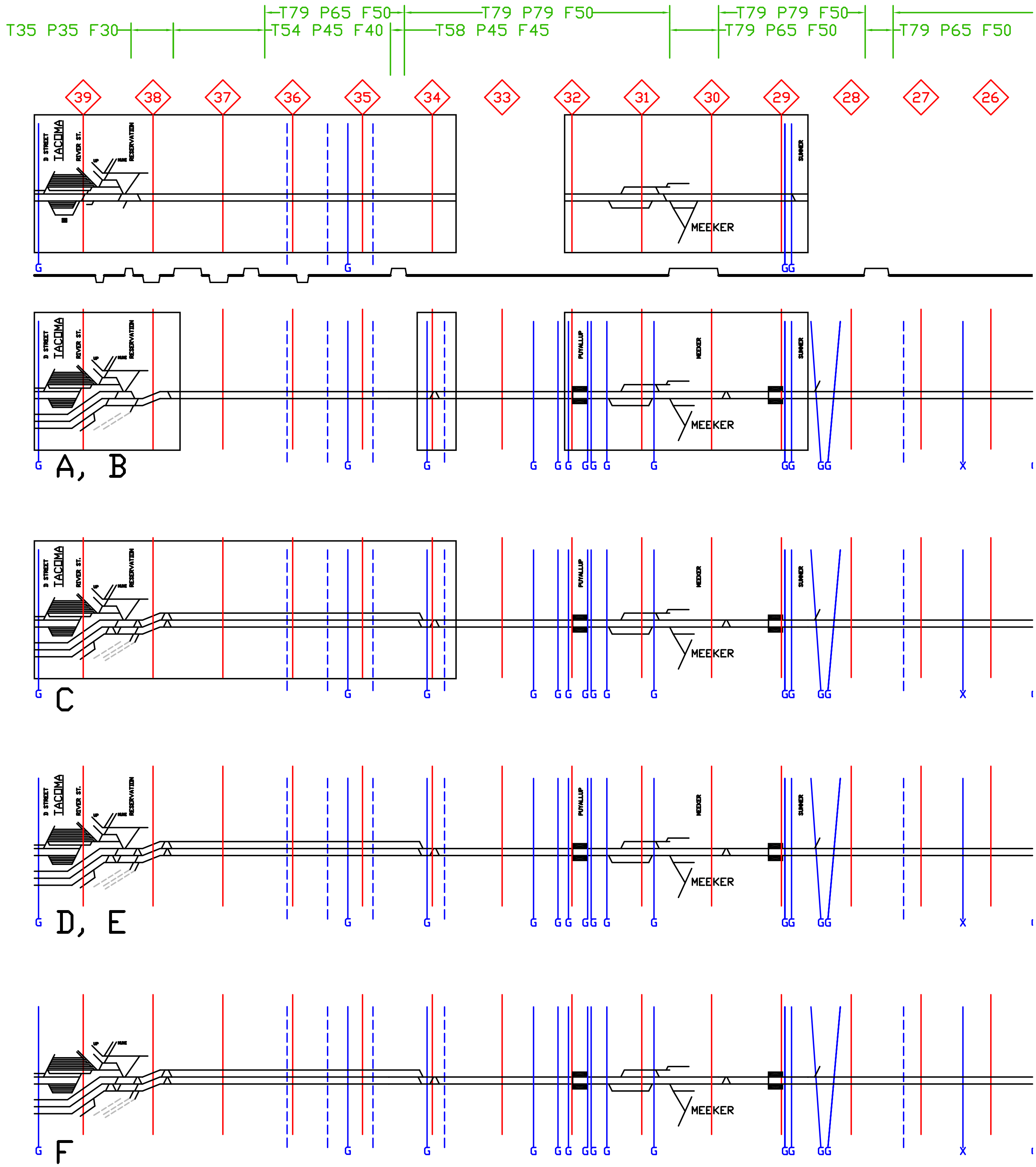
ALIGNMENT

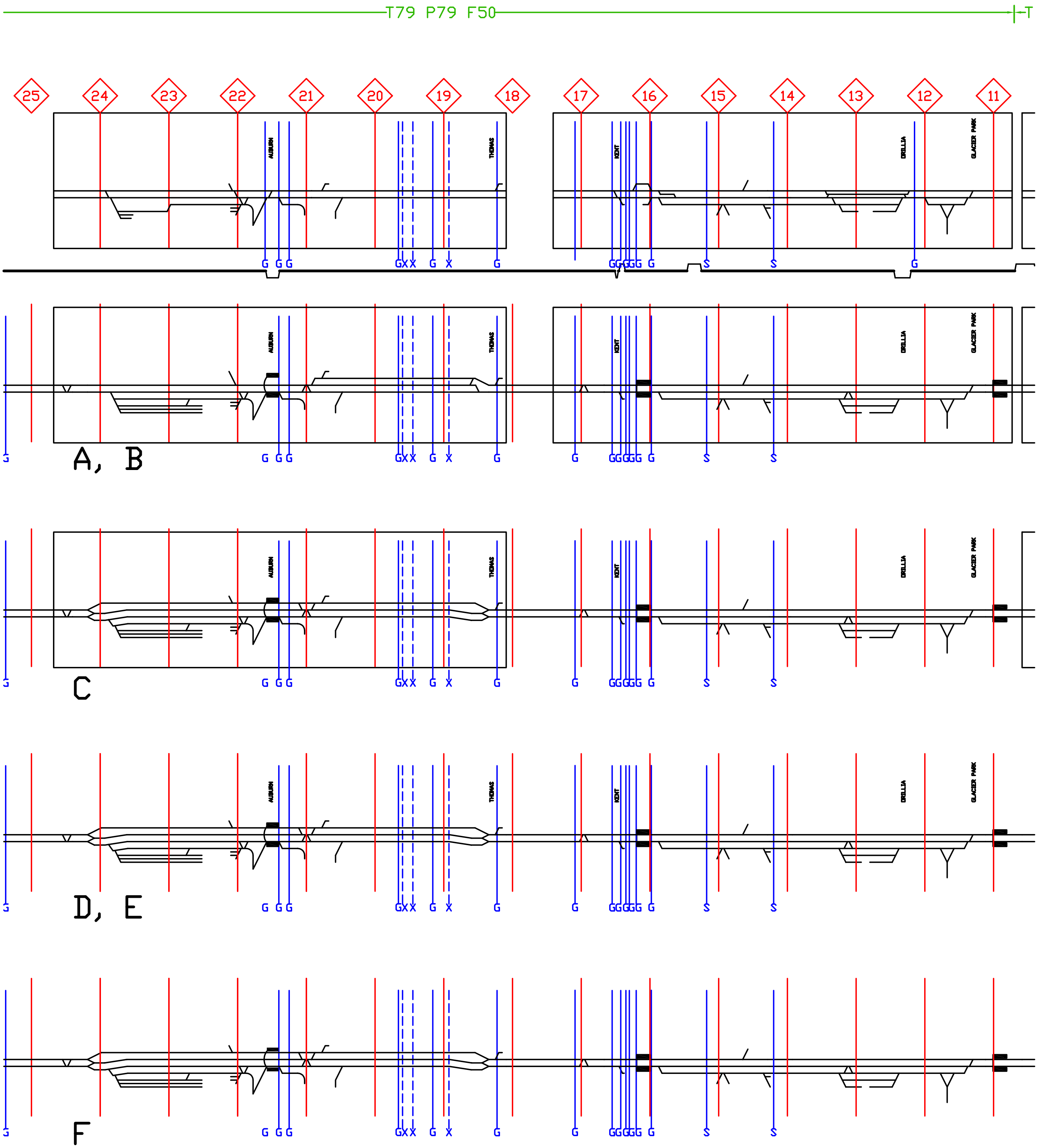
A-F
PROPOSED FINAL TRACK ARRANGEMENT WHERE CHANGED BY PROJECT ASSOCIATED WITH TIMETABLE

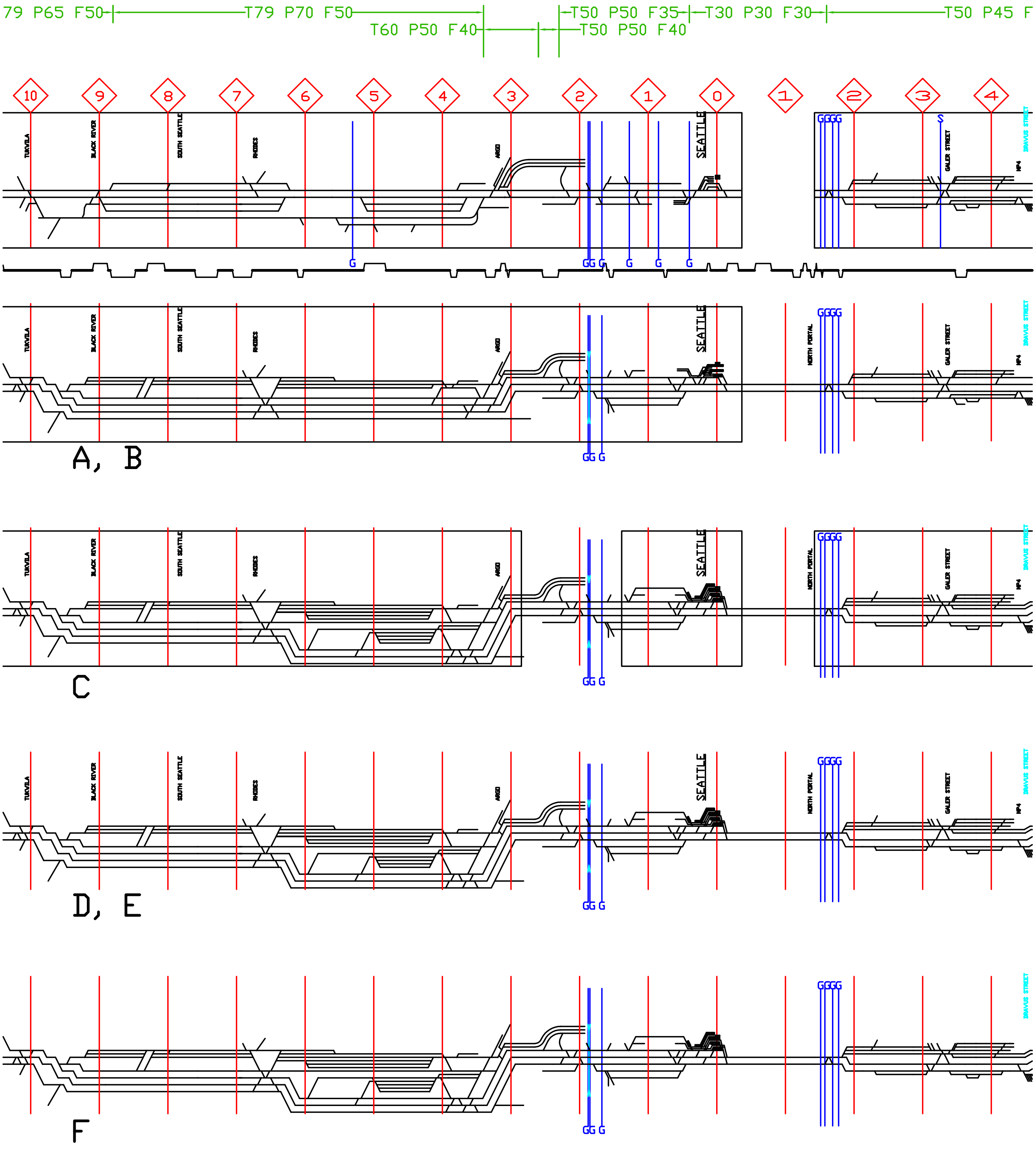
CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC RESERVATION - EVERETT

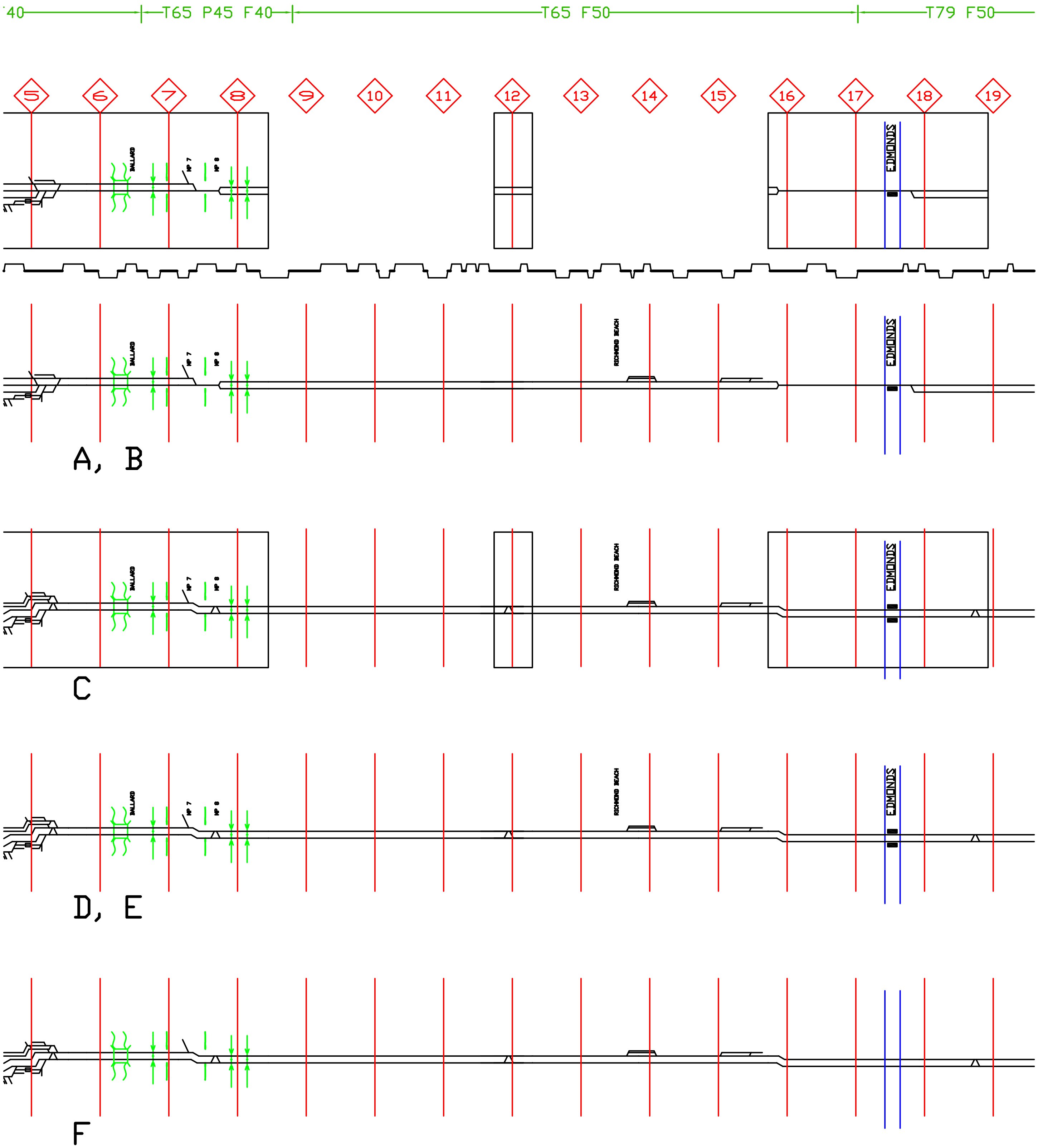
TRANSIT SAFETY MANAGEMENT / HDR FOR WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

JUNE 30 2003 REV NOV 28 2003

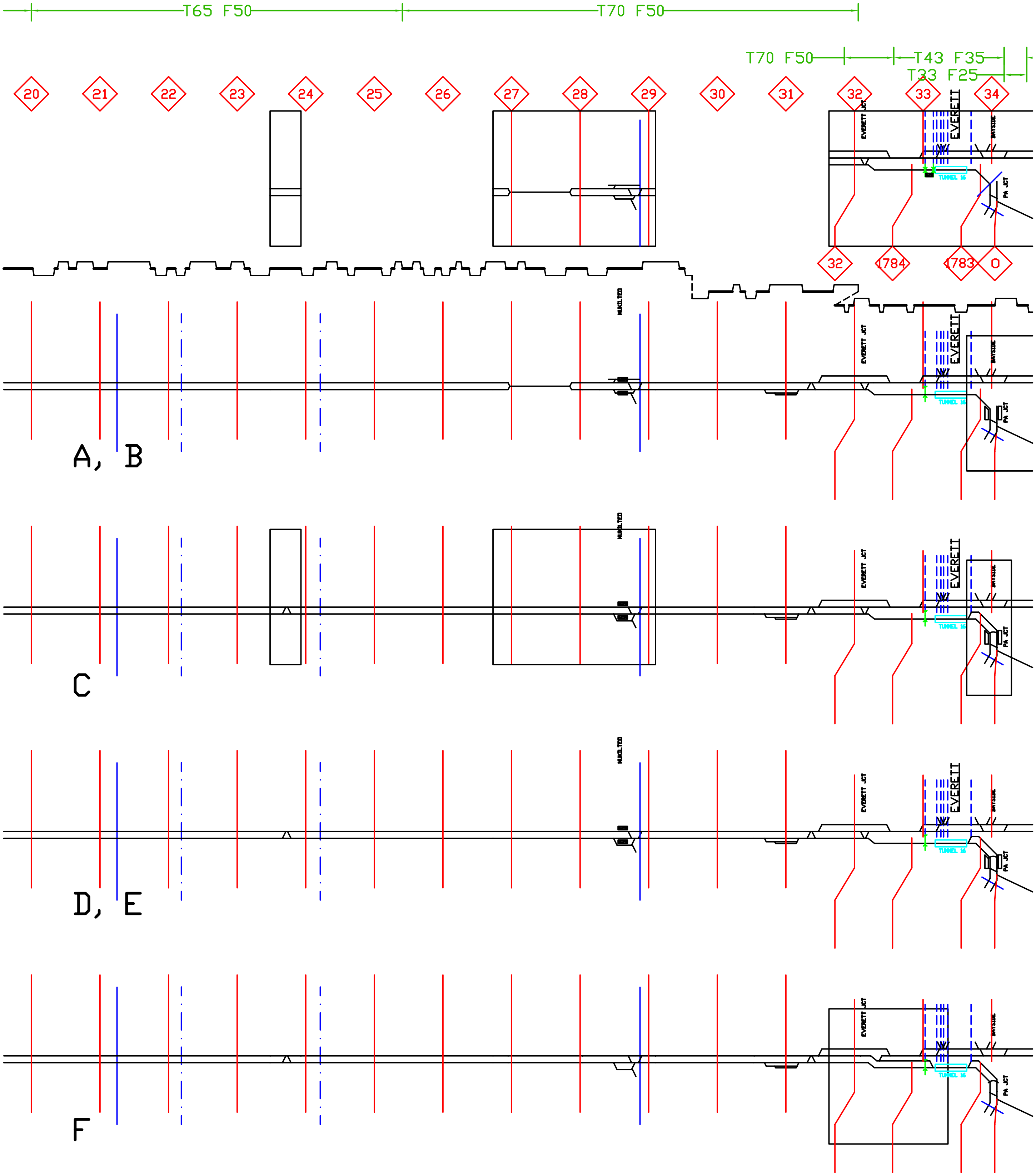

T35 P35 F30
T79 P65 F50
T54 P45 F40
T79 P79 F50
T58 P45 F45
T79 P79 F50
T79 P65 F50
T79 P65 F50
39
38
37
36
35
34
33
32
31
30
29
28
27
26
D STREET
TACOMA
RIVER ST.
RESERVATION
PUYALLUP
MEEKER
SUMNER
A, B
C
D, E
F


T79 P79 F50
T
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
AUBURN
THOMAS
KENT
ORILLIA
GLACIER PARK
A, B
C
D, E
F

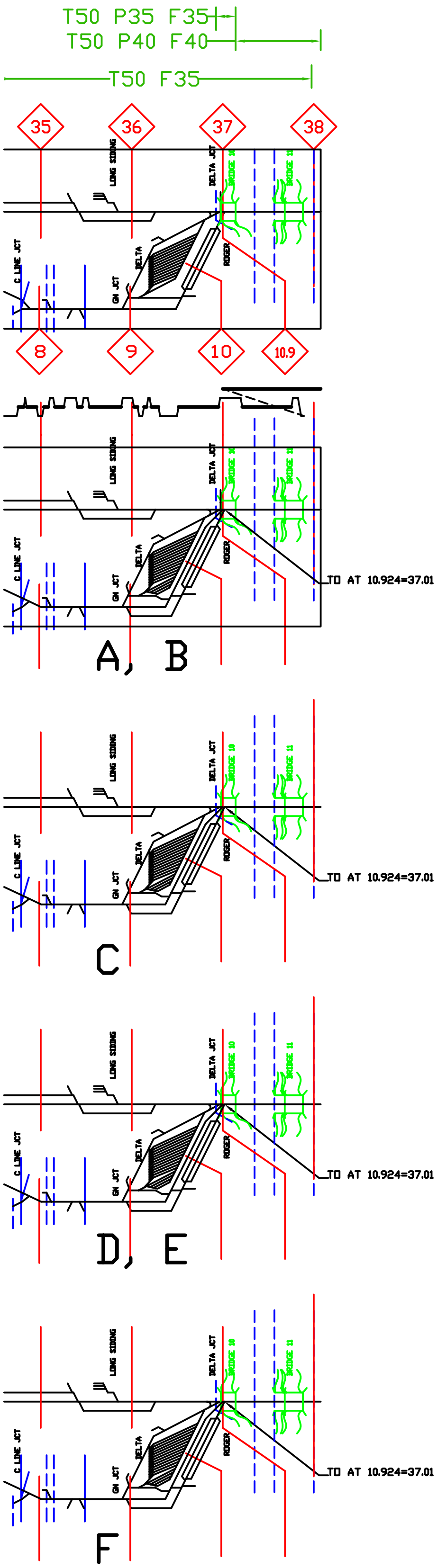

79 P65 F50
T79 P70 F50
T60 P50 F40
T50 P50 F35
T30 P30 F30
T50 P45 F
T50 P50 F40
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
TUKWILA
BLACK RIVER
SOUTH SEATTLE
RHODES
ARGO
SEATTLE
NORTH PORTAL
GALER STREET
MP4
DRAVUS STREET
A, B
C
D, E
F

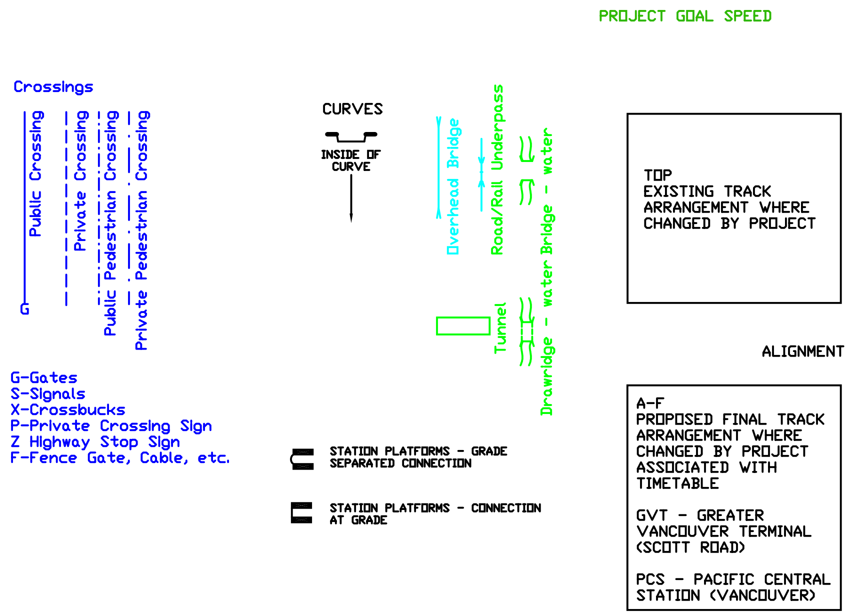


40
T65 P45 F40
T65 F50
T79 F50
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
BALLARD
MP 7
MP 8
RICHMOND BEACH
EDMONDS
A, B
C
D, E
F



T65 F50
T70 F50
T70 F50
T43 F35
T33 F25
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
32
1784
1783
0
EVERETT JCT
EVERETT
BAYSIDE
PA JCT
MUKILTEO
A, B
C
D, E
F

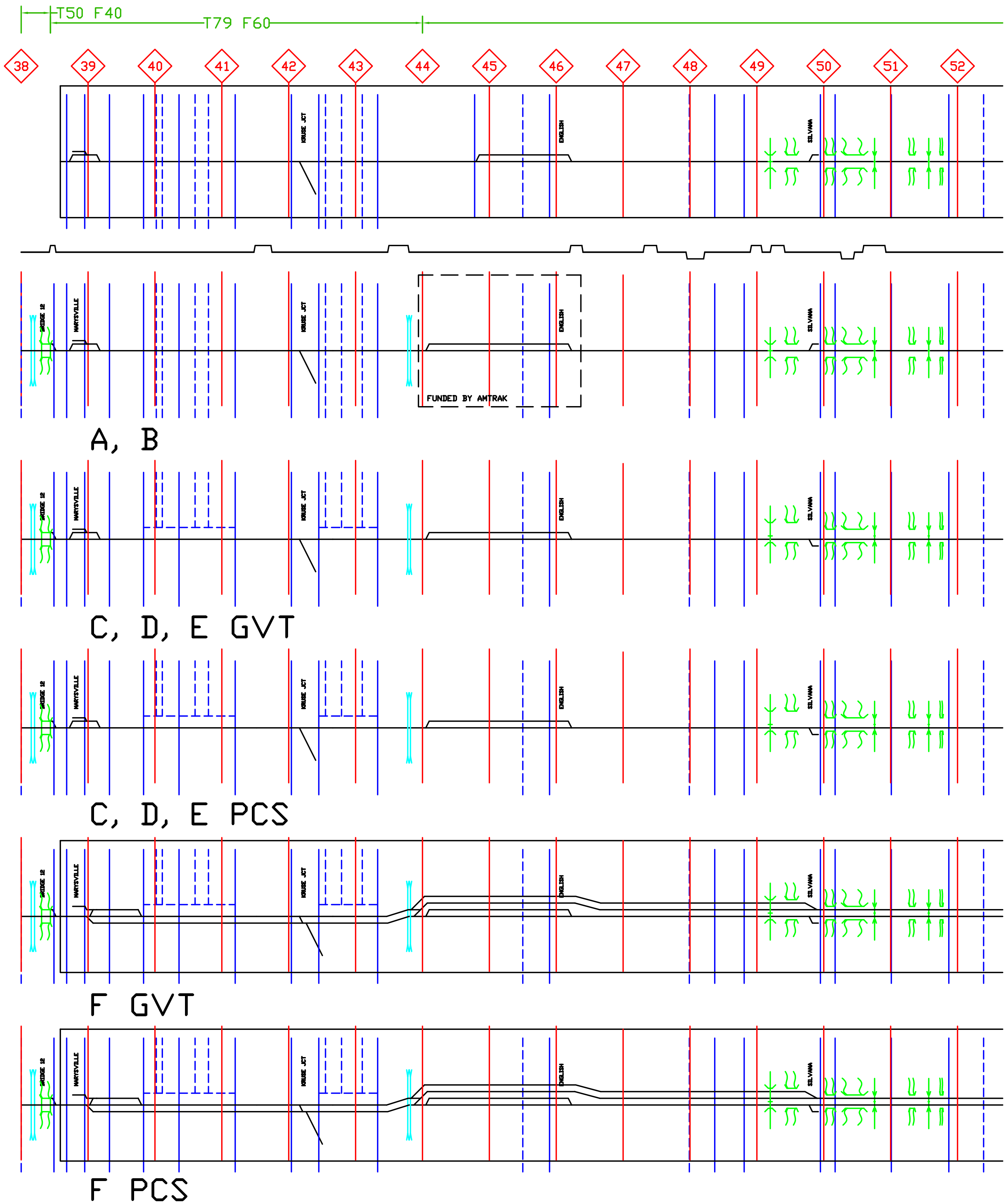

T50 P35 F35
T50 P40 F40
T50 F35
35
36
37
38
LONG SIDING
DELTA JCT
ROGER
DELTA
GN JCT
C LINE JCT
8
9
10
10.9
TO AT 10.924=37.01
A, B
C
D, E
F



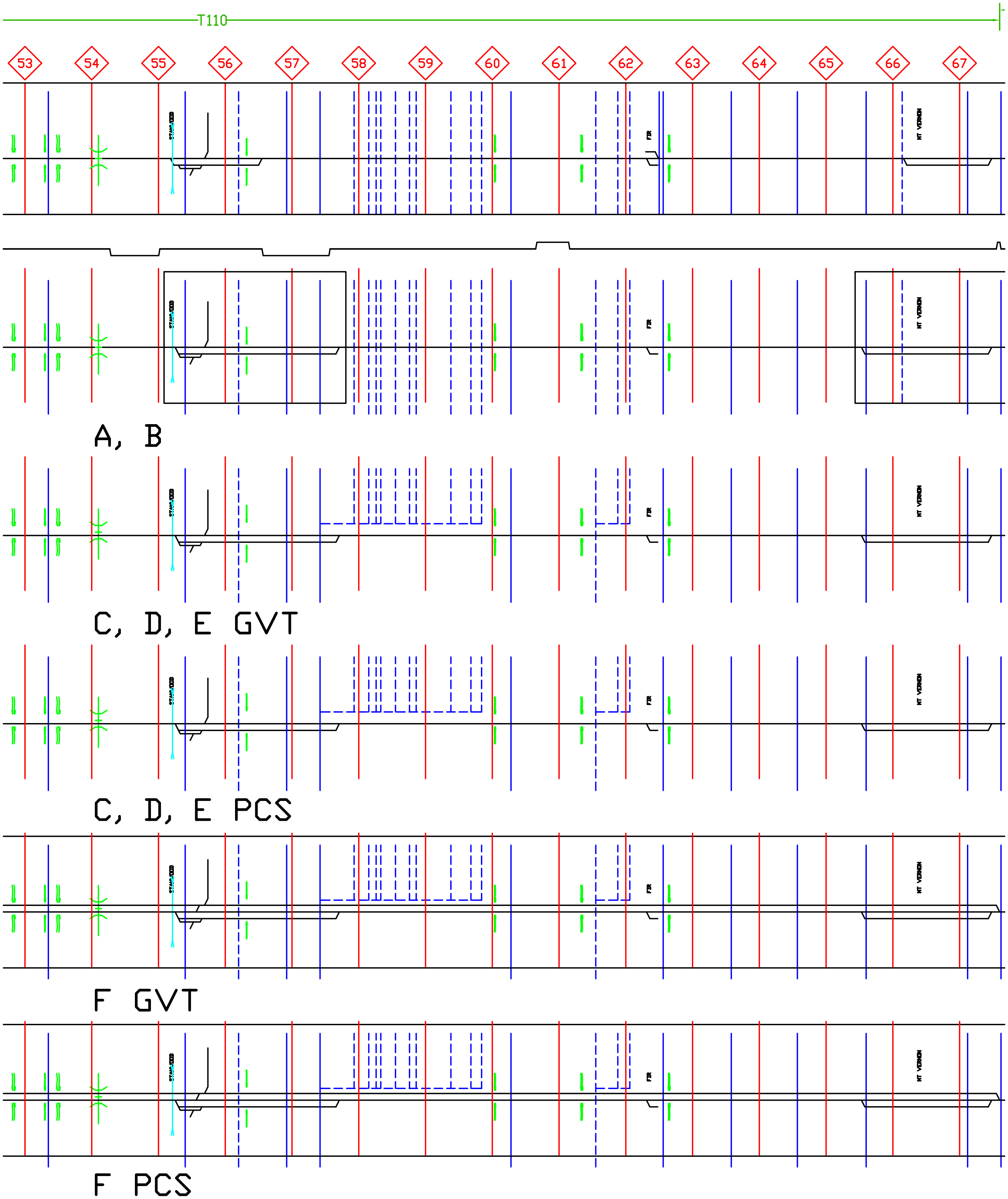
CONCEPTUAL IMPROVEMENT PLAN FOR PNWRC
EVERETT - VANCOUVER

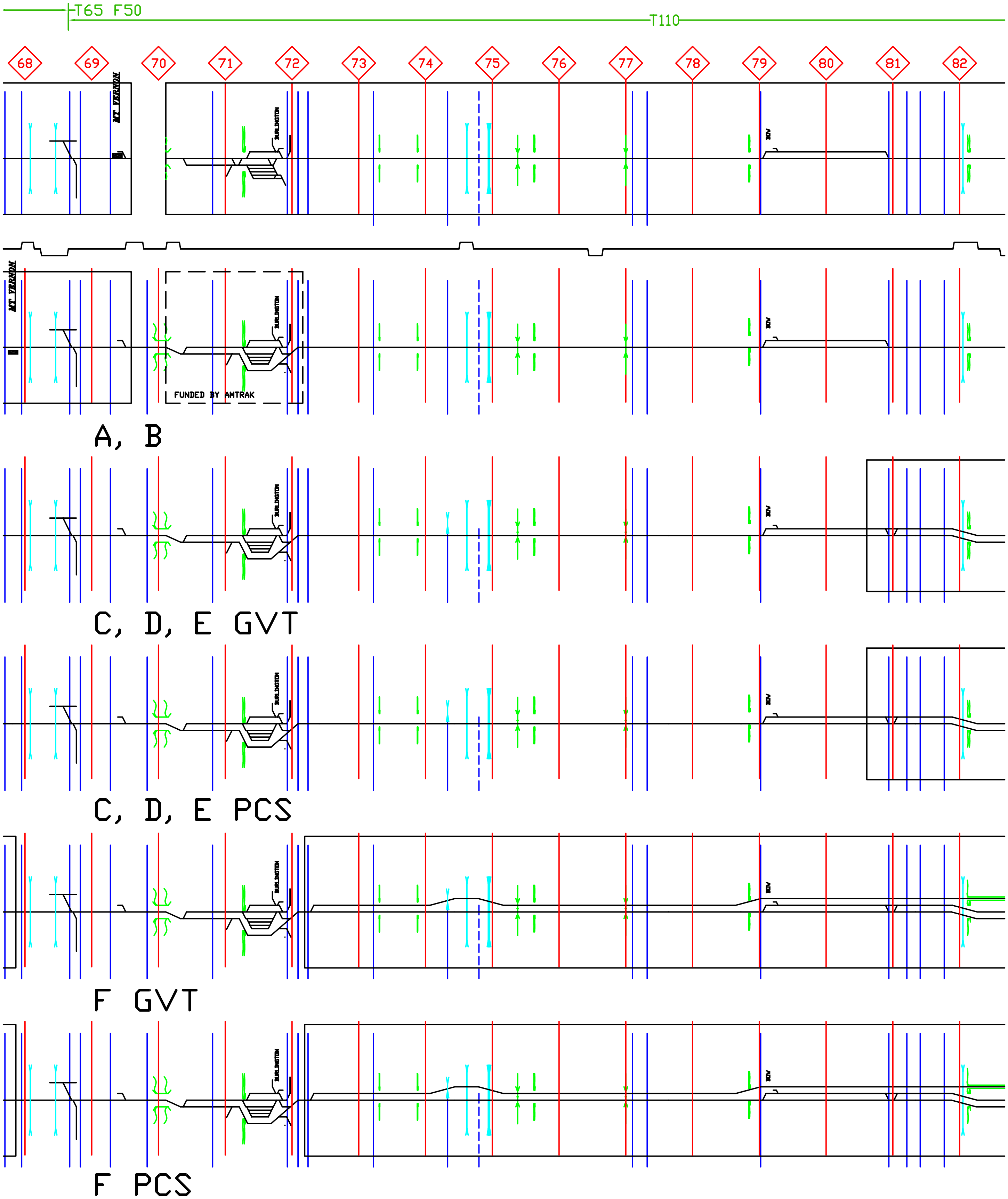
TRANSIT SAFETY MANAGEMENT / HDR FOR
WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION

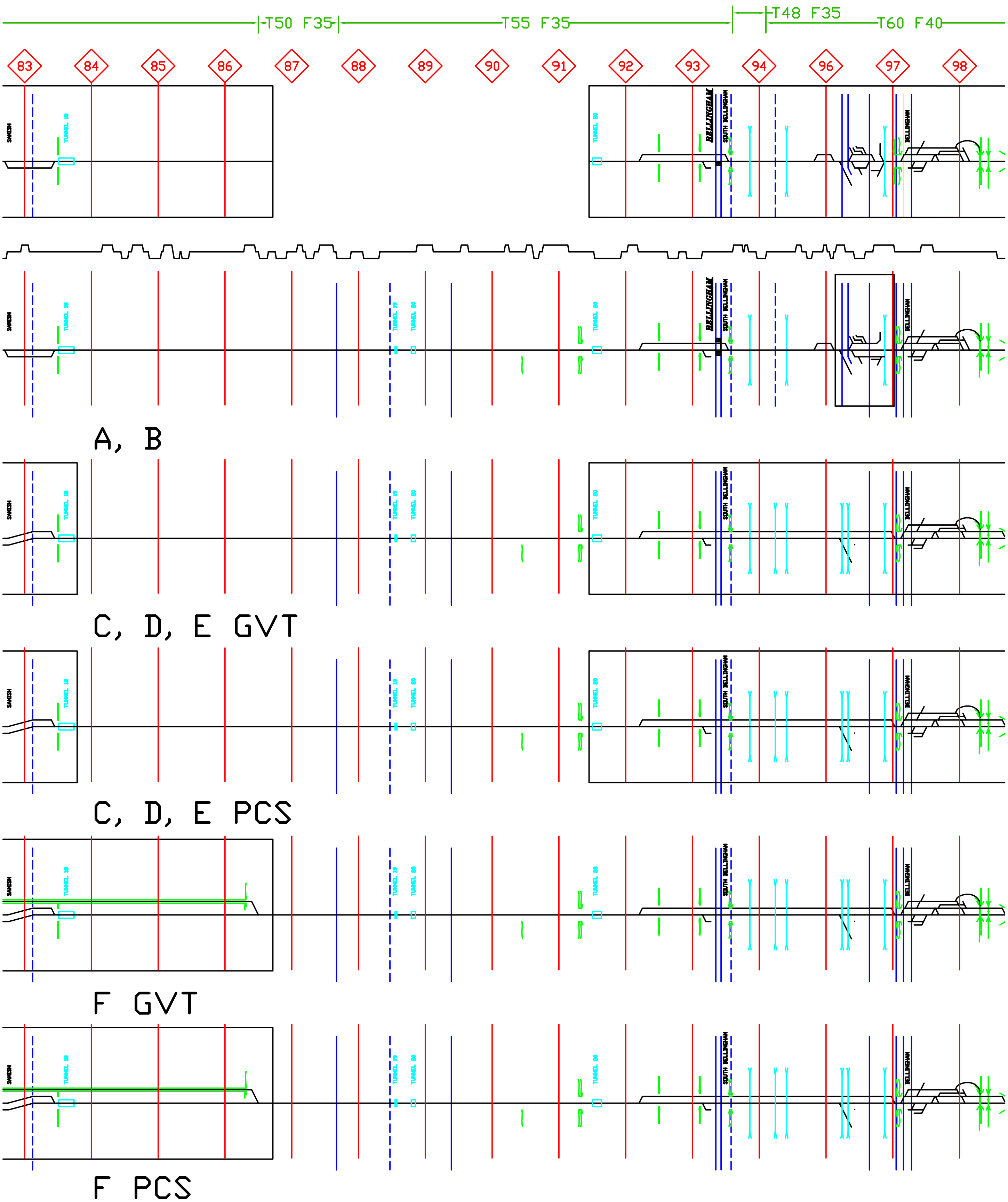
JUNE 30 2003 REV NOV 28 2003

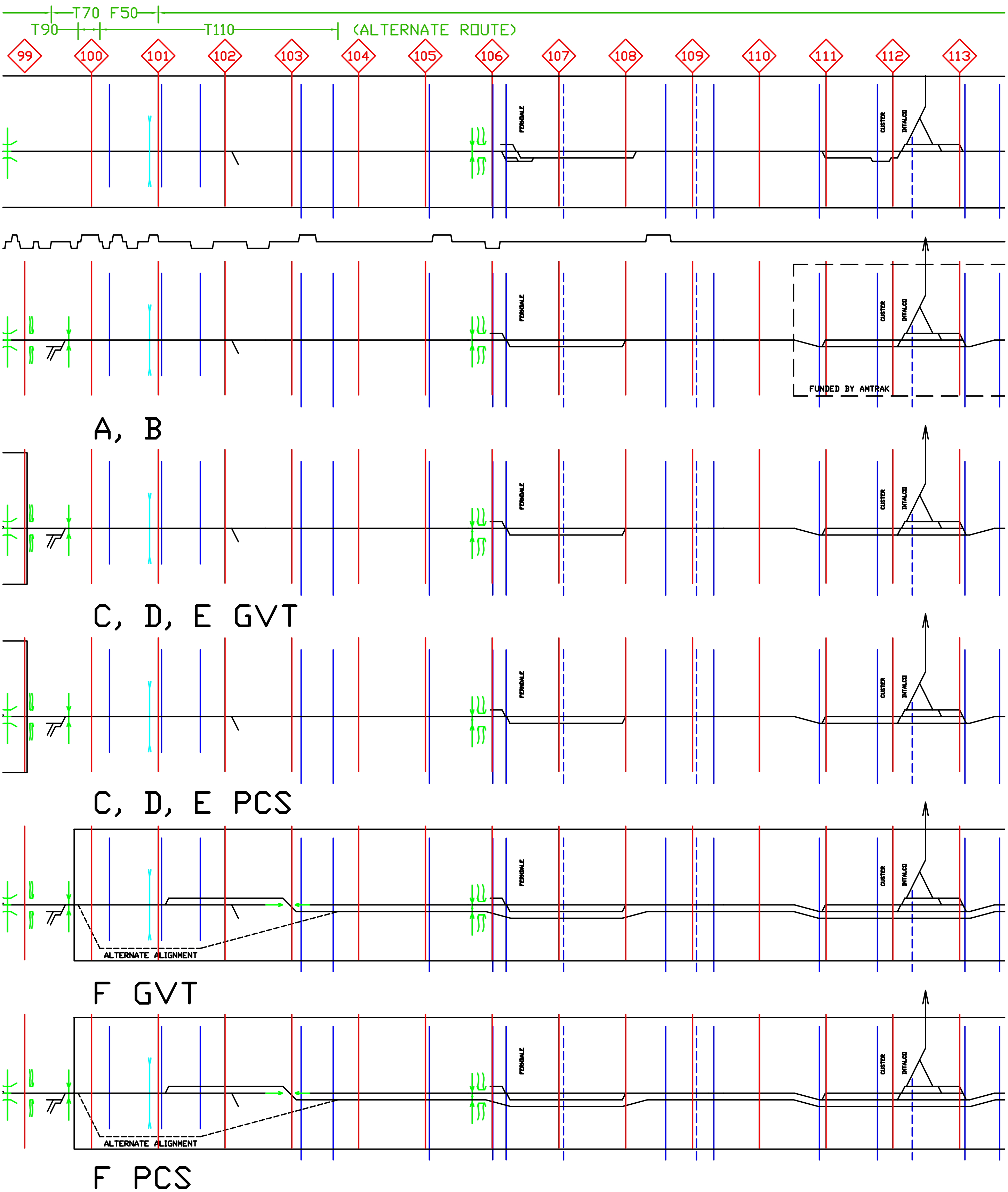


PACIFIC NORTHWEST RAIL CORRIDOR VANCOUVER - EVERETT 2 OF 9

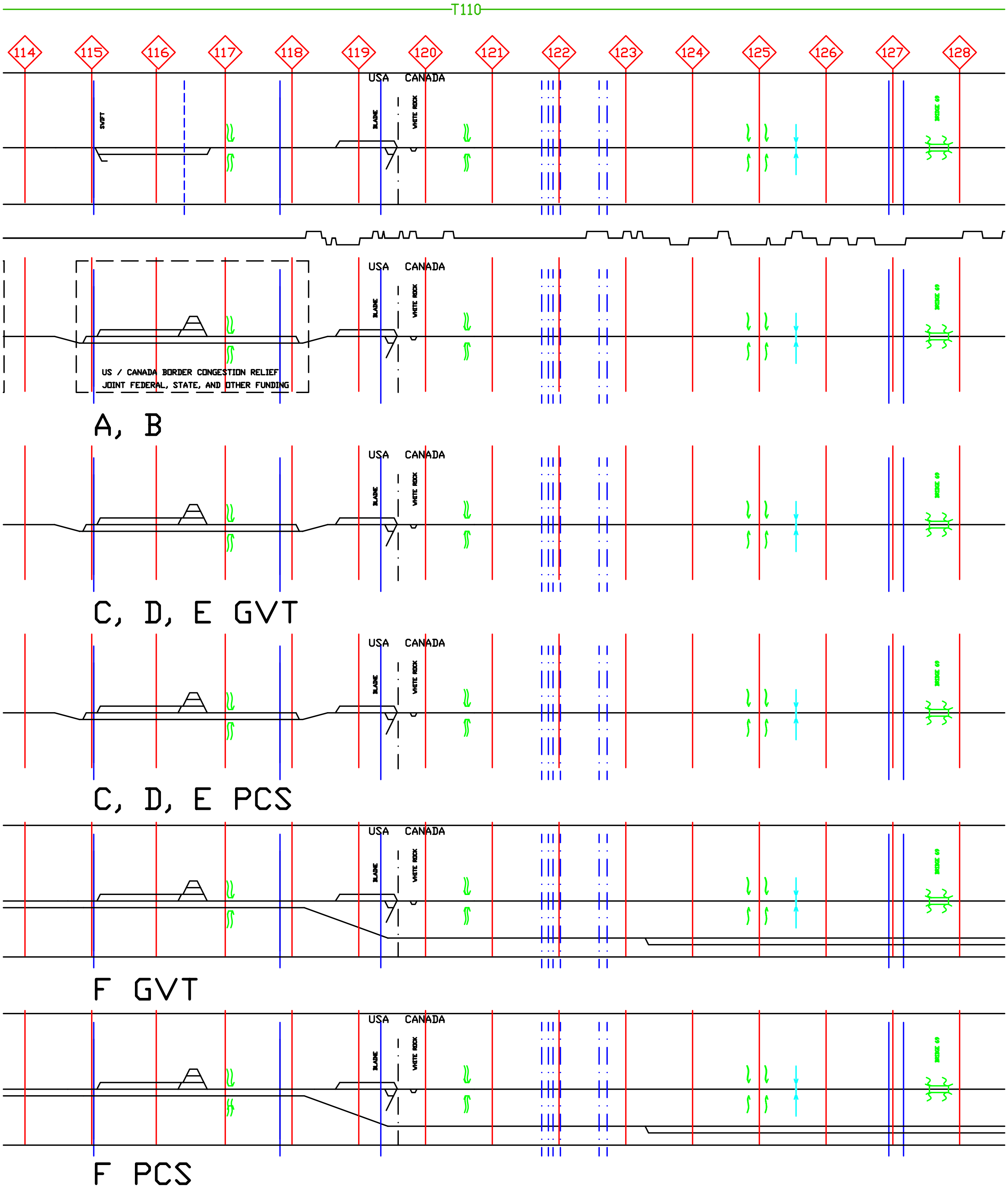

T110
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
STANWOOD
FIR
MT VERNON
A, B
C, D, E GVT
C, D, E PCS
F GVT
F PCS

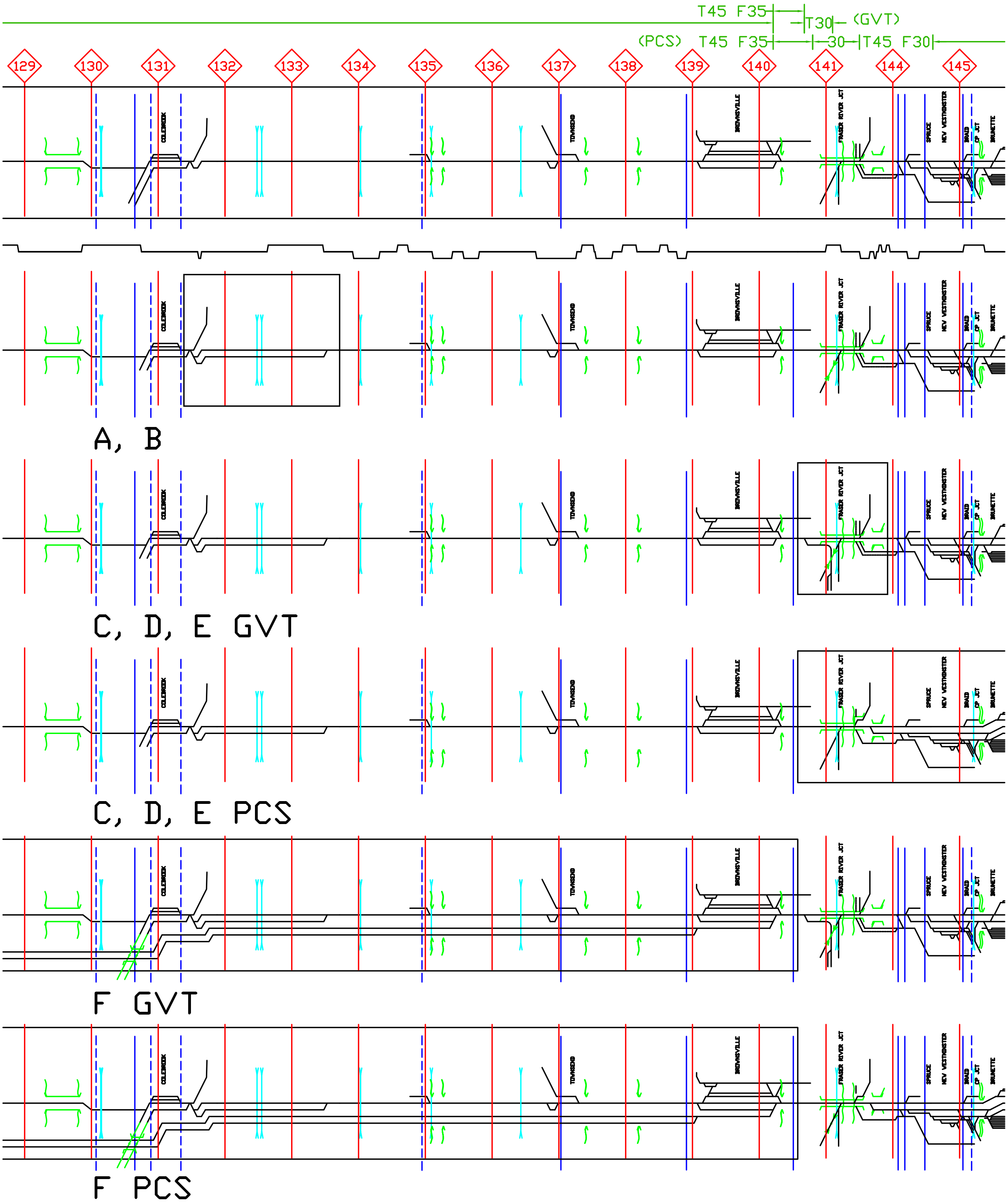

T65 F50
T110
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
MT. VERNON
BURLINGTON
FUNDED BY AMTRAK
A, B
C, D, E GVT
C, D, E PCS
F GVT
F PCS


T50 F35
T55 F35
T48 F35
T60 F40
83
84
85
86
87
88
89
90
91
92
93
94
96
97
98
BELLINGHAM
SOUTH BELLINGHAM
A, B
C, D, E GVT
C, D, E PCS
F GVT
F PCS

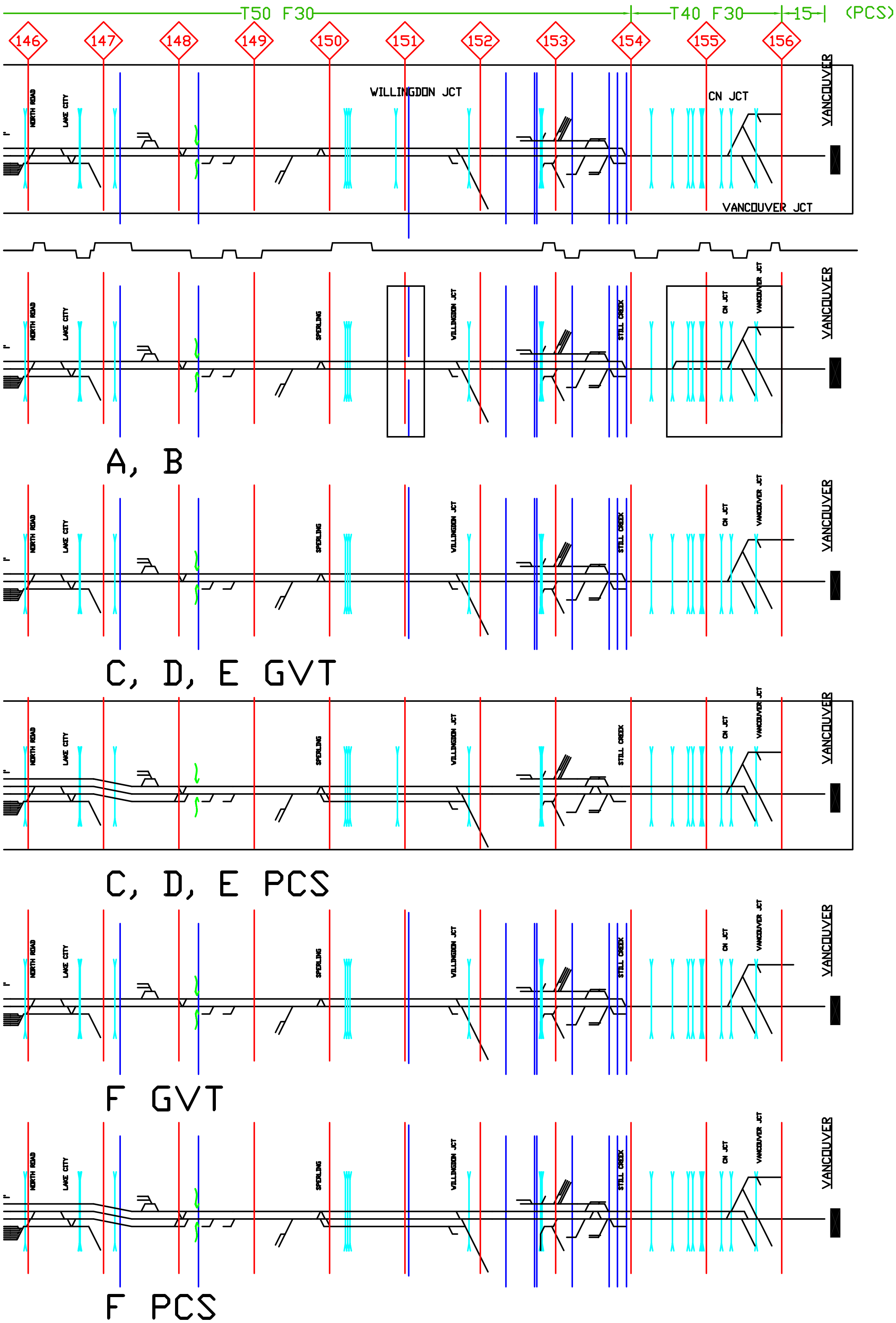


T70 F50
T90
T110
(ALTERNATE ROUTE)
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
FUNDED BY AMTRAK
A, B
C, D, E GVT
C, D, E PCS
ALTERNATE ALIGNMENT
F GVT
F PCS


T110
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
USA
CANADA
US / CANADA BORDER CONGESTION RELIEF
JOINT FEDERAL, STATE, AND OTHER FUNDING
A, B
C, D, E GVT
C, D, E PCS
F GVT
F PCS



T45 F35
T30
(GVT)
(PCS)
T45 F35
30
T45 F30
129
130
131
132
133
134
135
136
137
138
139
140
141
144
145
A, B
C, D, E GVT
C, D, E PCS
F GVT
F PCS



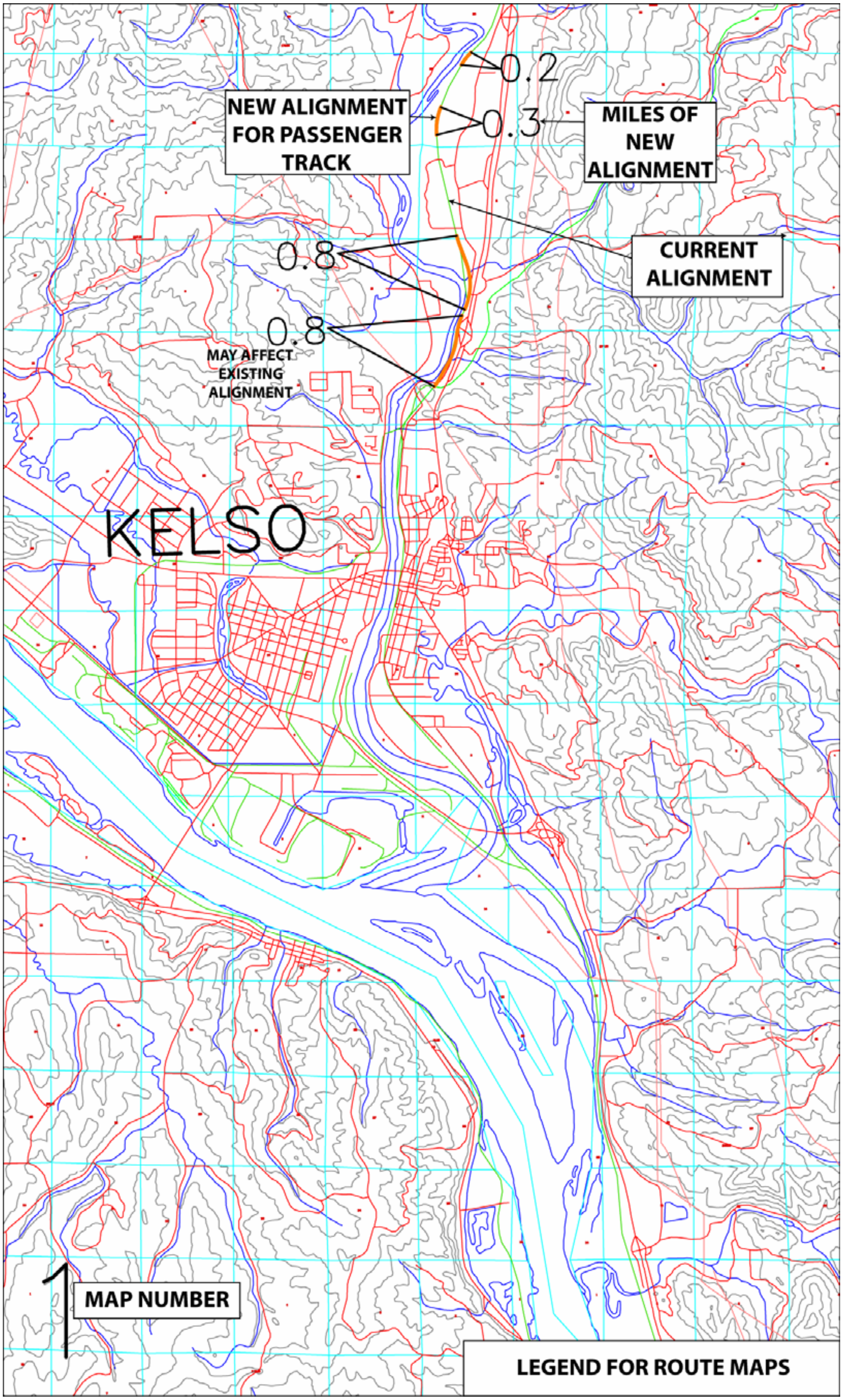
T50 F30
T40 F30
15
(PCS)
146
147
148
149
150
151
152
153
154
155
156
WILLINGDON JCT
CN JCT
VANCOUVER JCT
VANCOUVER
NORTH ROAD
LAKE CITY
SPERLING
WILLINGDON JCT
STILL CREEK
CN JCT
VANCOUVER JCT
A, B
C, D, E GVT
C, D, E PCS
F GVT
F PCS

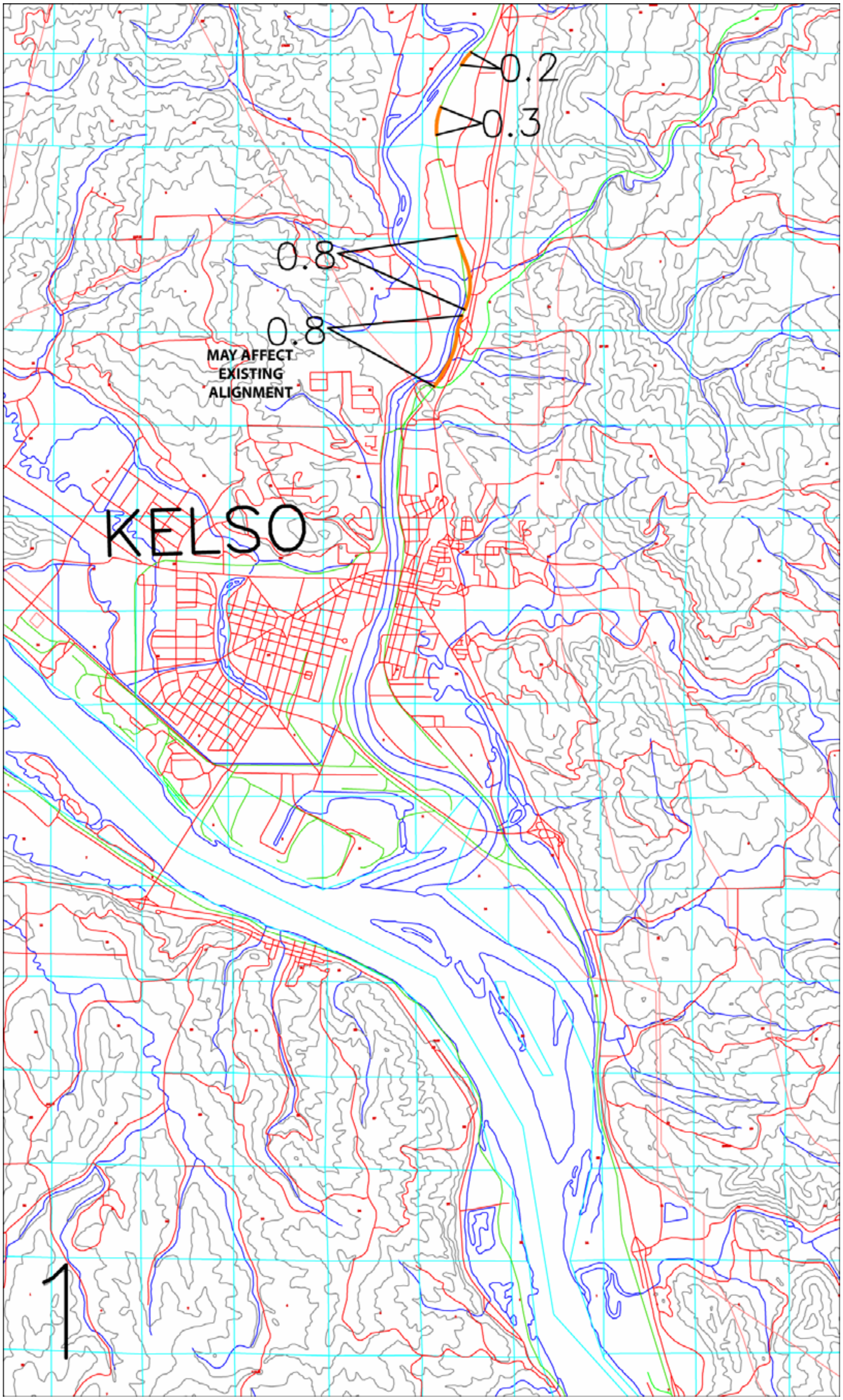
Appendix K
Alignment Changes, Movable Bridges, and Passenger-Only Tracks

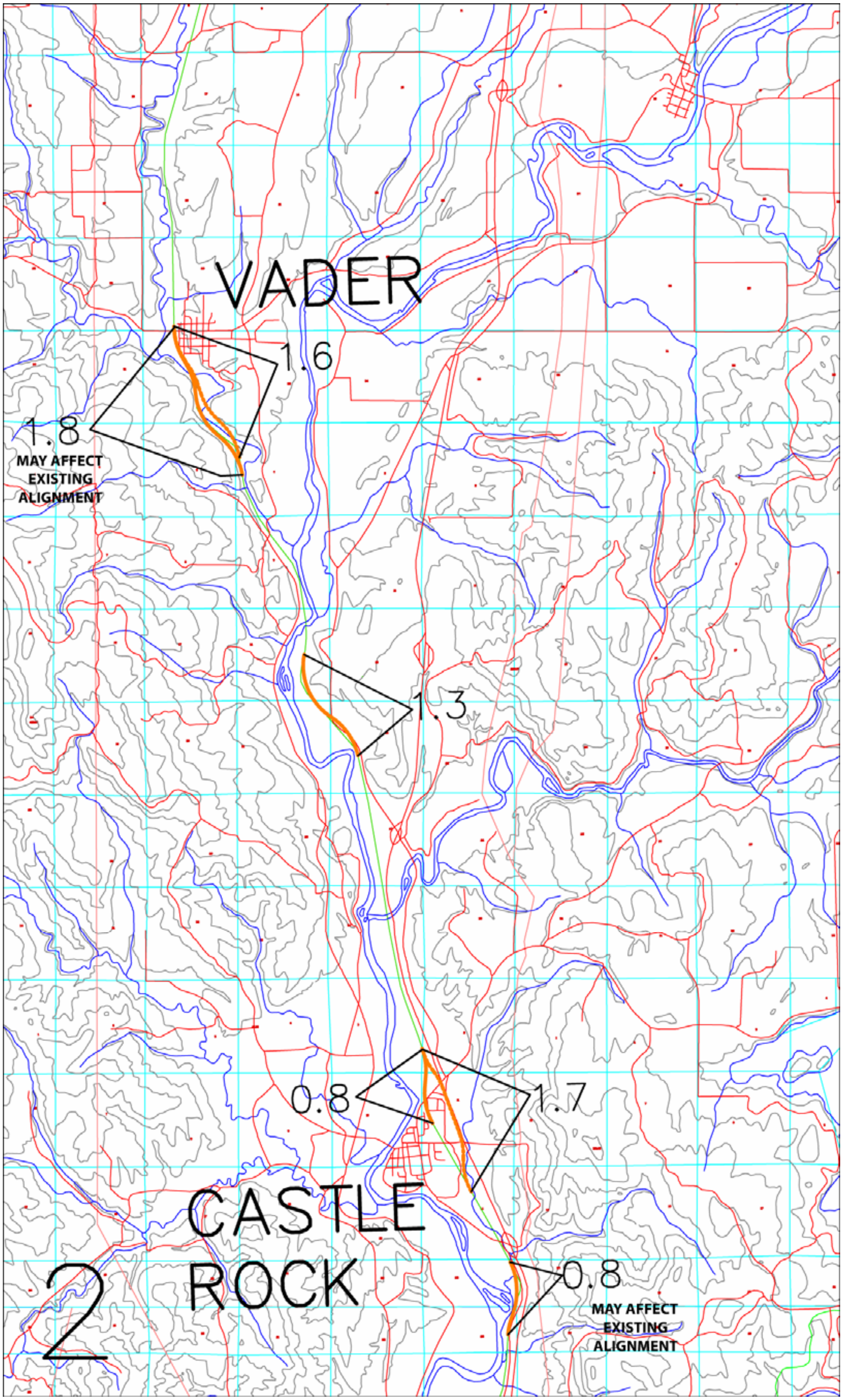
Appendix K
Alignment Changes, Movable Bridges, and Passenger-Only Tracks

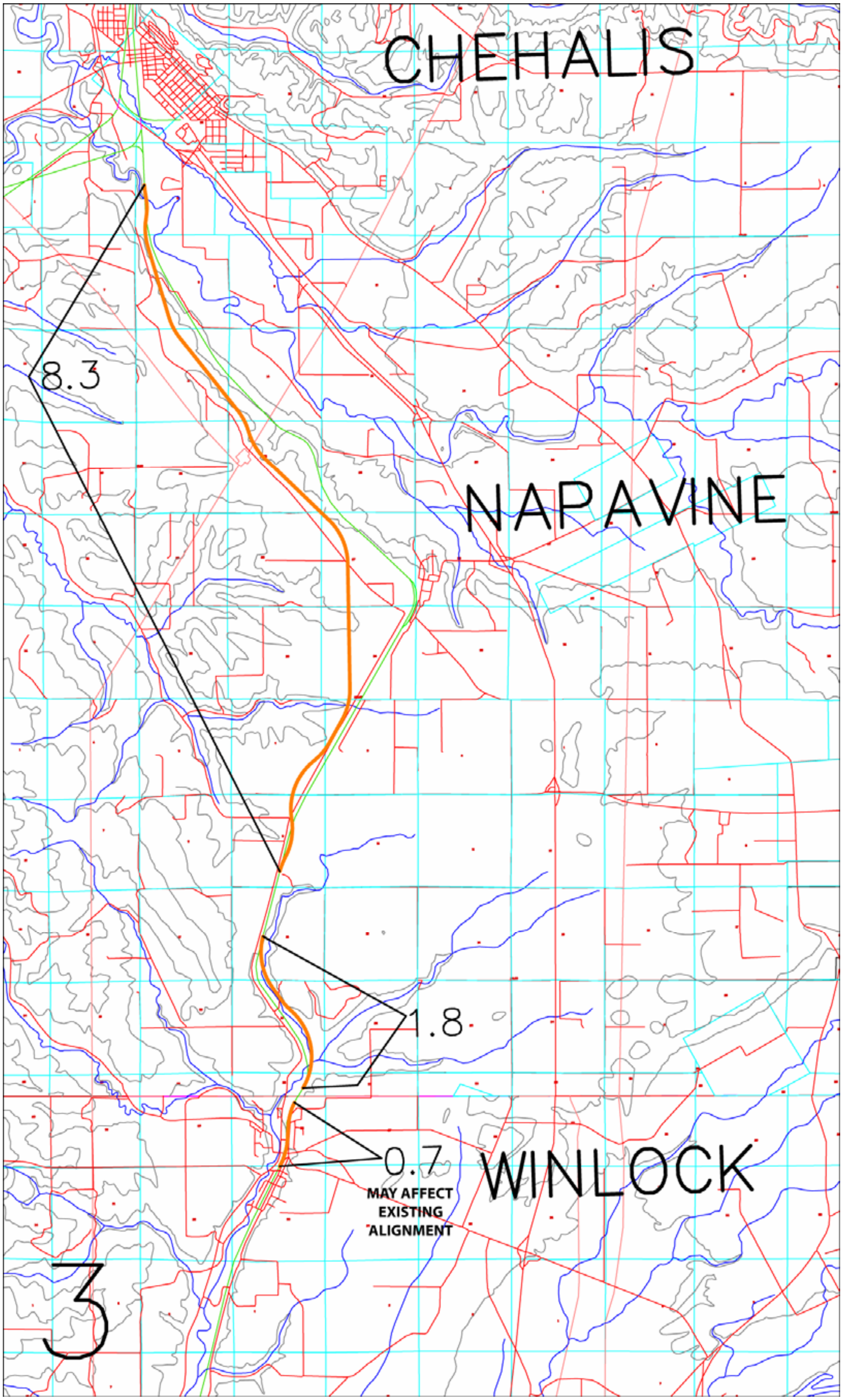
Alignment Changes

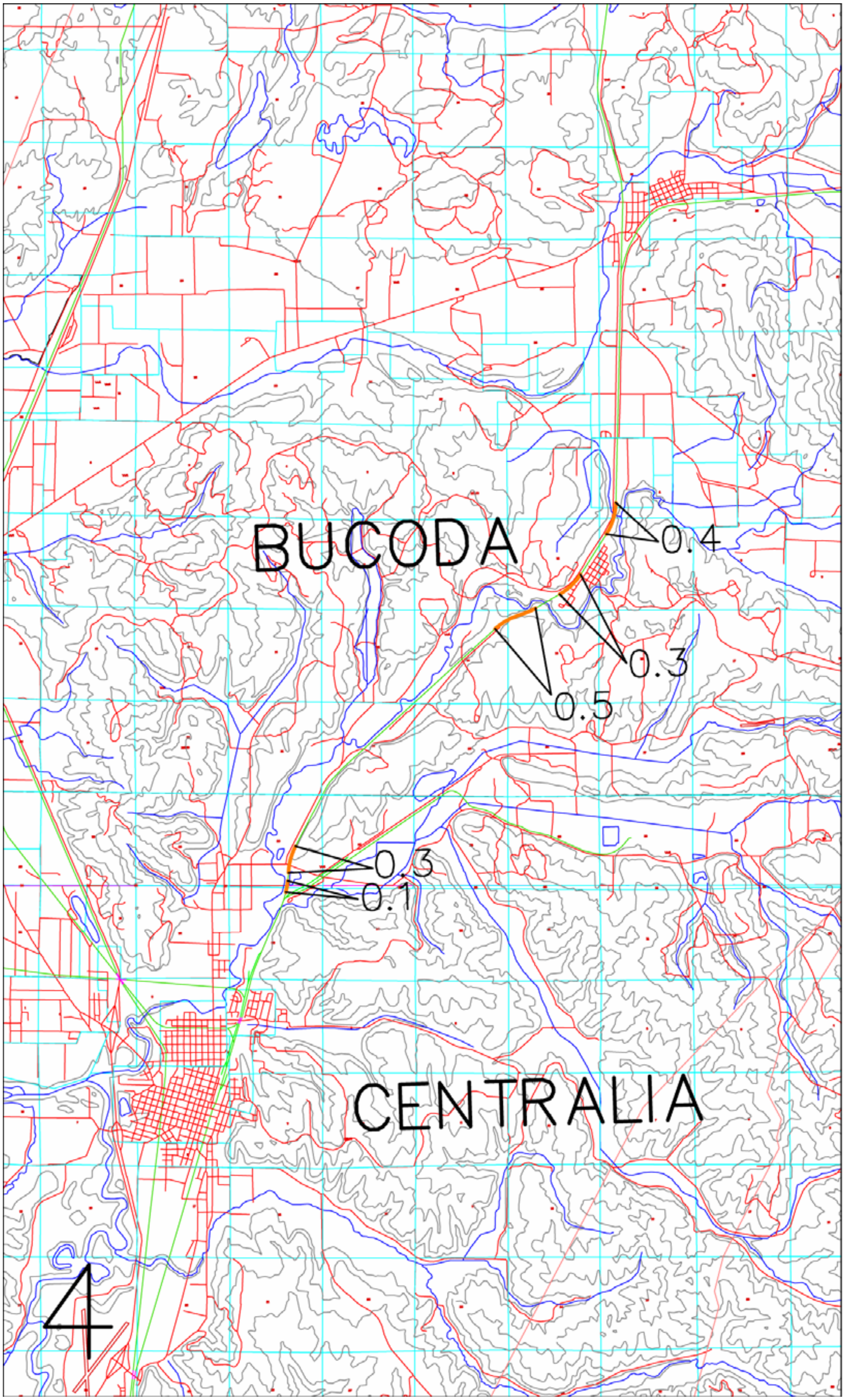
The maps on Pages K-2 through K-10 show the areas in which the high speed passenger tracks, and in some cases possibly the freight tracks as well, will deviate from the current Burlington Northern Santa Fe alignment.

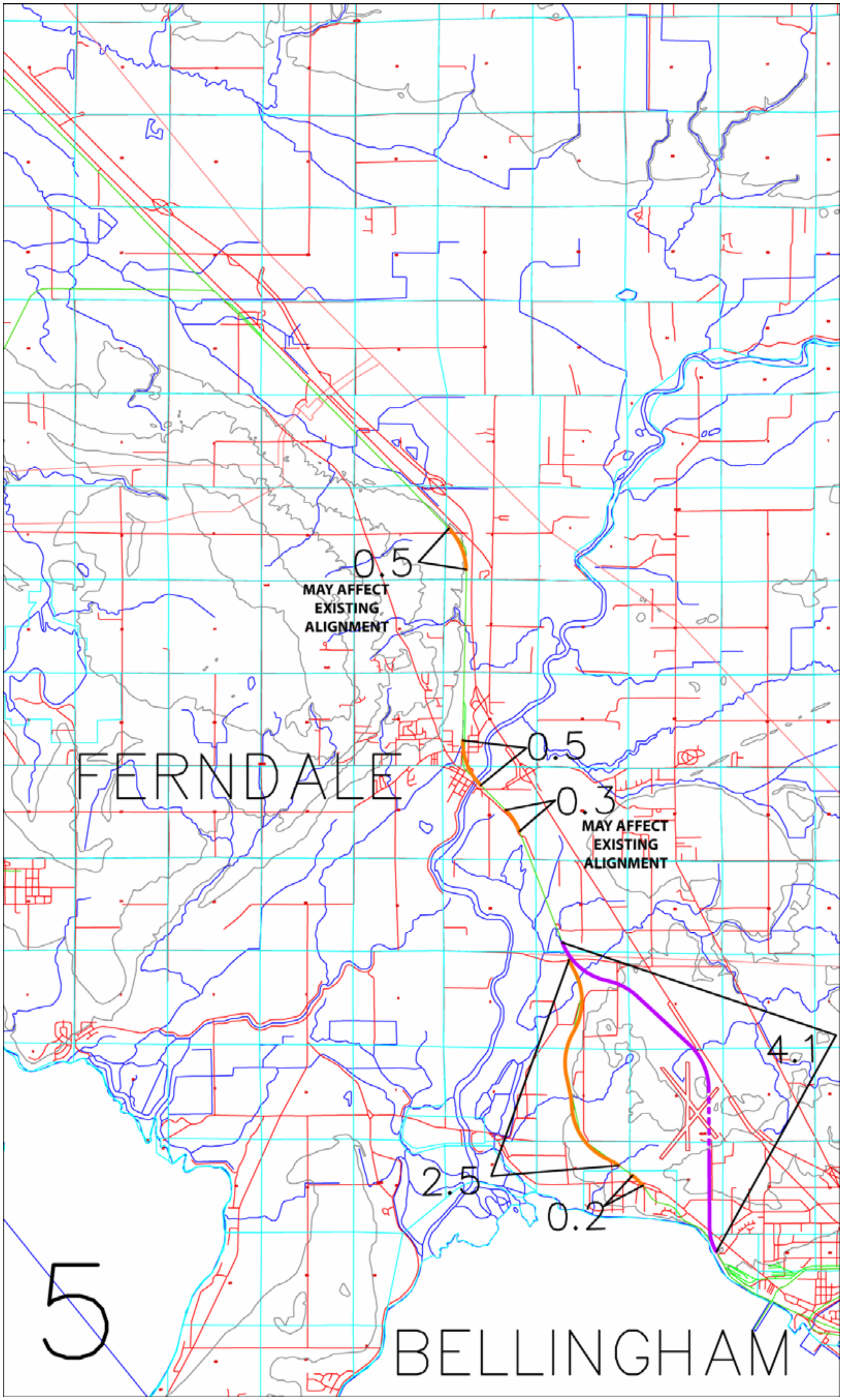

0.2
NEW ALIGNMENT FOR PASSENGER TRACK
0.3
MILES OF NEW ALIGNMENT
CURRENT ALIGNMENT
0.8
0.8
MAY AFFECT EXISTING ALIGNMENT
KELSO
1
MAP NUMBER
LEGEND FOR ROUTE MAPS

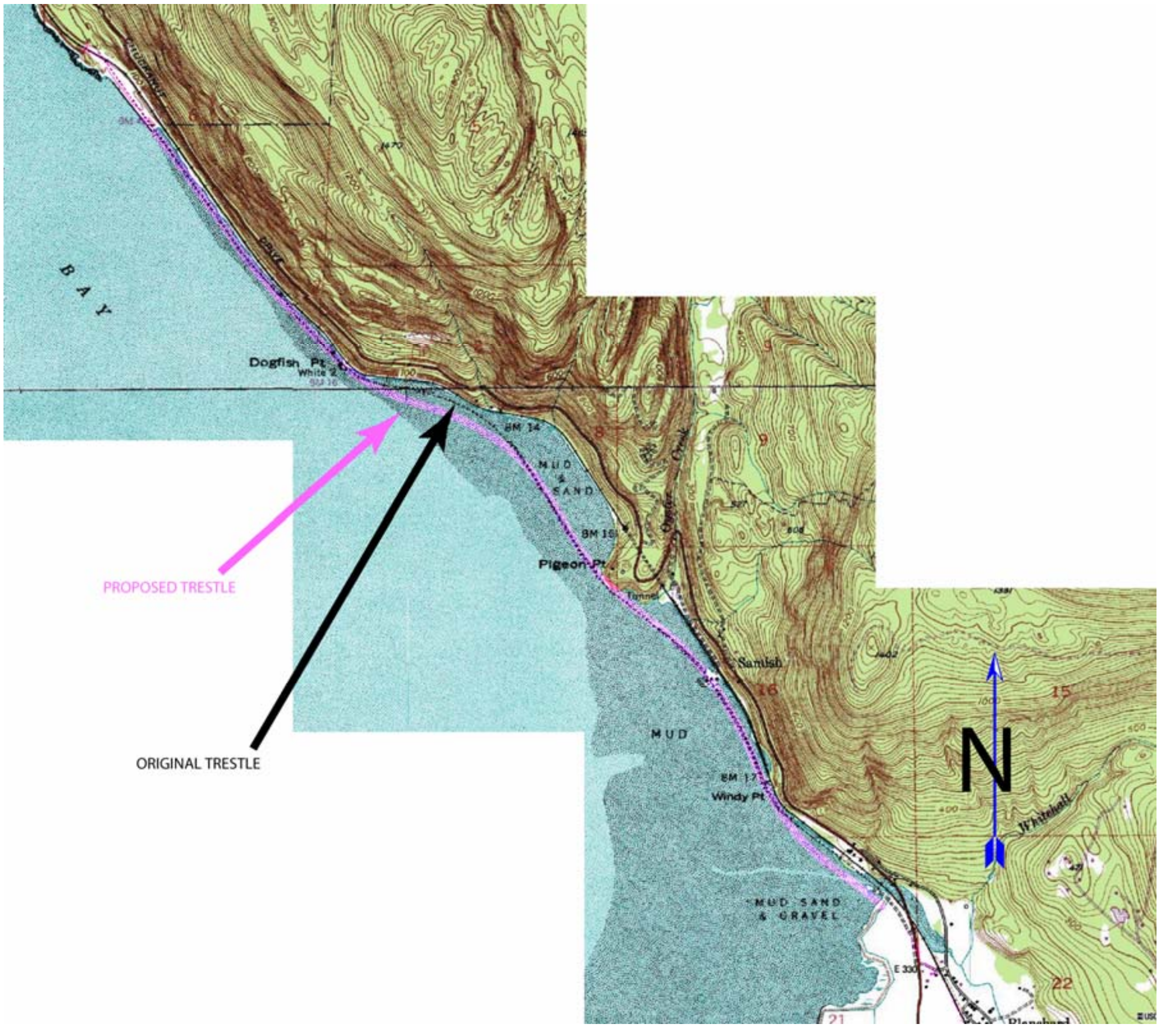

0.2
0.3
0.8
0.8
MAY AFFECT
EXISTING
ALIGNMENT
KELSO
1

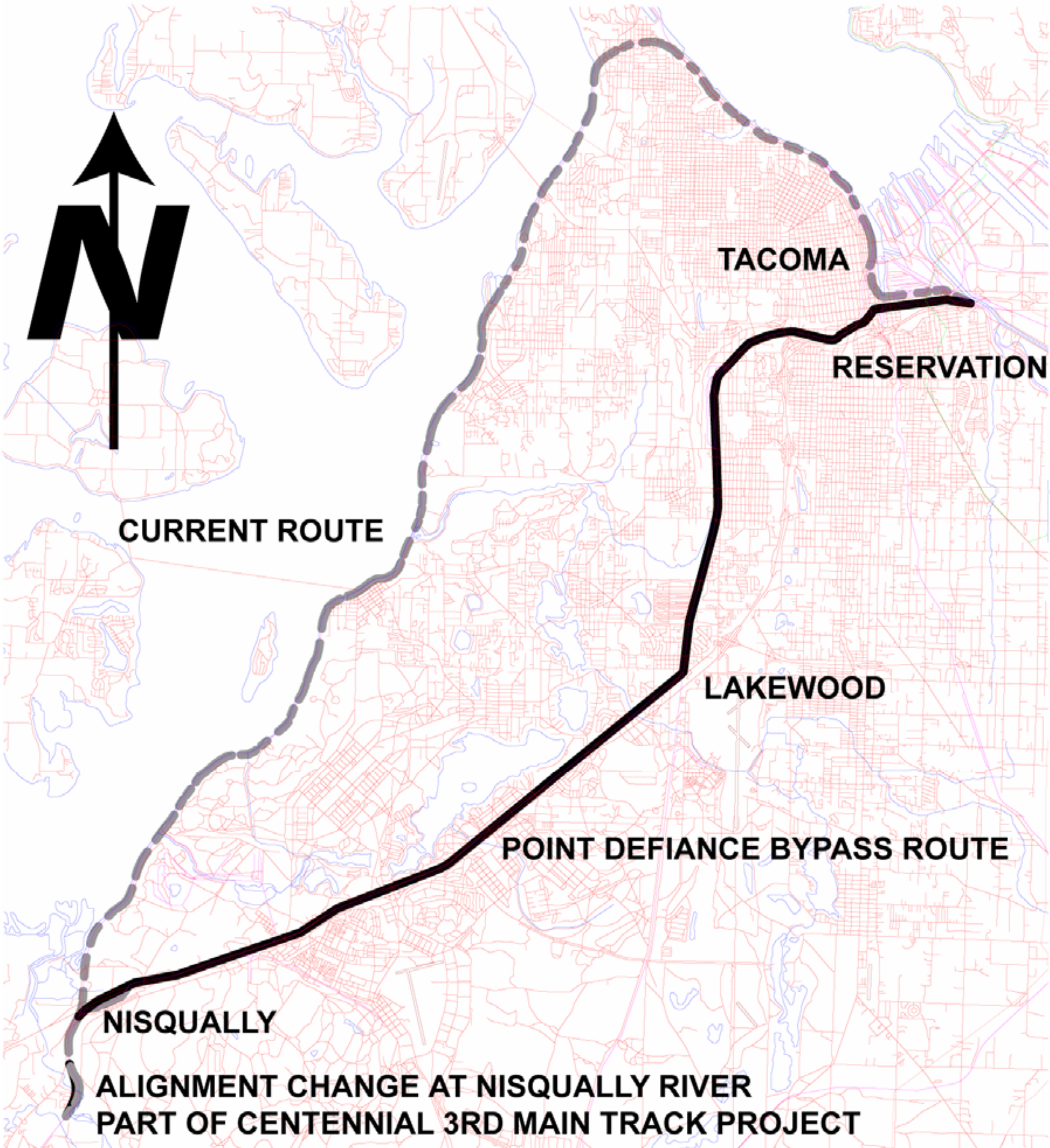

VADER
1.6
1.8
MAY AFFECT
EXISTING
ALIGNMENT
1.3
0.8
1.7
CASTLE
ROCK
0.8
MAY AFFECT
EXISTING
ALIGNMENT
2

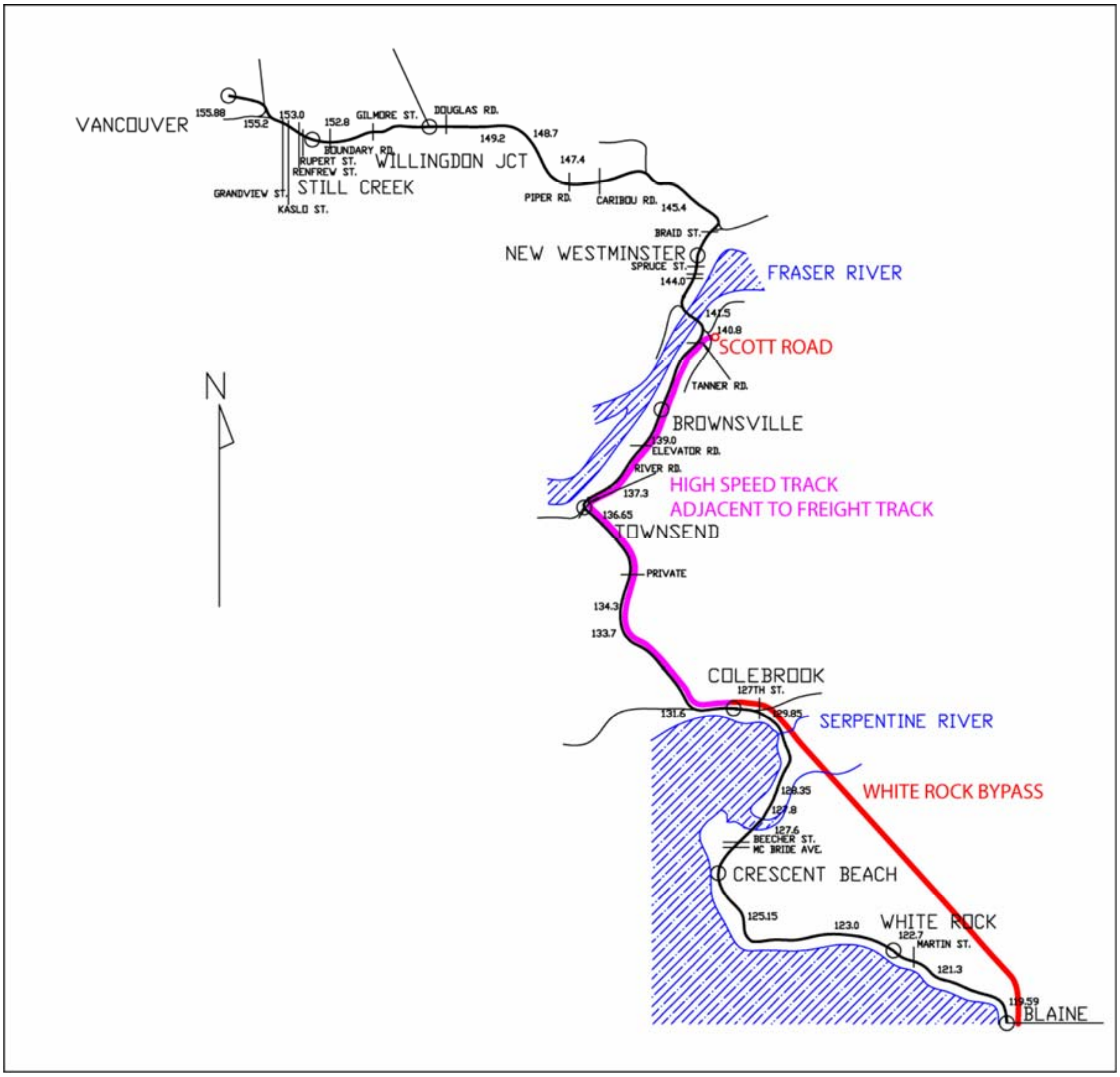

CHEHALIS
NAPAVINE
8.3
1.8
0.7
MAY AFFECT
EXISTING
ALIGNMENT
WINLOCK
3


BUCODA
0.4
0.3
0.5
0.3
0.1
CENTRALIA
4


0.5
MAY AFFECT EXISTING ALIGNMENT
FERNDALE
0.5
0.3
MAY AFFECT EXISTING ALIGNMENT
4.1
2.5
0.2
5
BELLINGHAM


PROPOSED TRESTLE
ORIGINAL TRESTLE
N
BAY
Dogfish Pt
Pigeon Pt
Samish
Windy Pt
MUD & SAND
MUD
MUD SAND & GRAVEL
BM 14
BM 15
BM 17
Tunnel
Whitehall


N
TACOMA
RESERVATION
CURRENT ROUTE
LAKEWOOD
POINT DEFIANCE BYPASS ROUTE
NISQUALLY
ALIGNMENT CHANGE AT NISQUALLY RIVER
PART OF CENTENNIAL 3RD MAIN TRACK PROJECT


VANCOUVER
WILLINGDON JCT
STILL CREEK
NEW WESTMINSTER
FRASER RIVER
SCOTT ROAD
BROWNSVILLE
HIGH SPEED TRACK
ADJACENT TO FREIGHT TRACK
TOWNSEND
COLEBROOK
SERPENTINE RIVER
WHITE ROCK BYPASS
CRESCENT BEACH
WHITE ROCK
BLAINE
N
GILMORE ST.
DOUGLAS RD.
BOUNDARY RD.
RUPERT ST.
RENFREW ST.
GRANDVIEW ST.
KASLO ST.
PIPER RD.
CARIBOU RD.
BRAID ST.
SPRUCE ST.
TANNER RD.
ELEVATOR RD.
RIVER RD.
PRIVATE
127TH ST.
BEECHER ST.
MC BRIDE AVE.
MARTIN ST.

Movable Bridges

There are ten movable bridges, commonly known as drawbridges, on the Pacific Northwest Rail Corridor between Portland OR and Vancouver BC. Exhibit 1 presents a list of these bridges. None of these bridges is suffering from any structural condition that affects the safety of the bridge and no rehabilitation or replacements because of failure are planned. The age of these structures must be considered, however. Bridges of similar age on the Northeast Corridor are failing and must be replaced. These bridges have had much higher rail traffic density throughout their existence and thus, probably a much larger number of operating cycles (opening and closing). Traffic on the PNWRC is now increasing significantly, which may increase the operating cycles of these bridges significantly. These bridges may experience an accelerated rate of deterioration in the coming years.

The oldest movable bridge on the PNWRC is 102 years old. The newest is 56 years old. The others range between 85 and 98 years old. Each restricts the speed of trains. An eleventh movable bridge, the Steel Bridge (93 year old vertical lift bridge) at the south end of Union Station in Portland affects the movement of traffic with its six mph speed limit, but is not currently considered for any study or work that will result in a speed increase.

These bridges, and the restrictions and regulations attached to their operation (as discussed below), present challenges for implementing passenger rail service. There are two ways in which movable bridges affect rail traffic: opening of the bridge for marine traffic and speed restrictions over the bridge, both of which can affect schedule, and the latter of which may require changes to rail equipment.

When a railroad crosses navigable water, federal law requires that the waterway not be obstructed. The vessels using the navigable water may fit through a channel below a fixed bridge span, but railroads are generally unable to cross the water at a height that would provide sufficient clearance, so a movable bridge is usually required. Federal law also requires that, with occasional special exceptions, navigation has right of way over trains at movable bridges. Therefore, trains will either be stopped when the bridge is opened for vessels (sometimes for unanticipated conditions such as weather) or will be restricted in speed as they cross the bridge. Some of these scenarios can be built into passenger train schedule; others, such as longer delays due to weather, could cause schedule delays.

Opening for Marine Traffic

The amount of time that a bridge is open for navigation is affected by the amount of marine traffic and the size of the vessels, the current and the width of the channel, and the design of the bridge. In general, vertical lift and bascule bridges open by lifting. Vertical lift bridges are suspended between two towers and are raised vertically while remaining level (Exhibit 1A Page K-16). Bascule bridges are hinged on one end, pivoting on the hinge to a near-vertical position when open (Exhibit 1B Page K-16). Swing bridges open horizontally by pivoting, usually in the center (Exhibit 1C Page K-16). Swing bridges usually require a longer time to close and lock for rail traffic than vertical lift or bascule bridges. When a vertical lift or bascule bridge has reached the ground, the bridge is closed and ready to lock. Swing bridges must be aligned perfectly with the fixed spans on either end, which is sometimes a slow process. Once the bridge is aligned perfectly, it is locked in place and thereafter the rails can be aligned and locked for train movement.

The current and the width of the channel can be important components of the length of time a bridge is open for navigation. Vessels moving with a strong current have less ability to stop short of a bridge that is closed or not fully open than vessels in calm water or moving against a current. A narrow channel under the bridge or an approach that is not straight, especially moving with a strong current, can make navigation difficult. Fog can add even more difficulty in navigating a vessel through a bridge. Under any or all of these conditions, bridges are often opened well in advance of an approaching vessel to ensure that there is no failure to have the bridge fully open when the vessel reaches the bridge. This situation has the potential to lead to delay for rail traffic

Speed Restrictions over the Bridge

Speed restrictions on movable bridges are generally related to one of two sources: rail locks, and bridge design and condition. Depending upon the specific reason for the speed restriction, modifications to allow a speed increase may be desirable.

Rail Locks

The only place on a rail line at which the rails are entirely discontinuous is at each end of a movable bridge. There are gaps in the rail head in crossing and turnout frogs, but the rails are fixed in alignment in the assembly. The rails at each end of a movable bridge must be entirely separate yet match correctly for train movement. As speed increases, the tolerance for mismatch, either horizontal or vertical, diminishes. The rail ends are matched in an assembly called a mitre rail (Exhibit 2 Page K-17). These are commonly called by the name of one of their components, rail locks.

The mitre rails must have a sophisticated design that keeps the rails in correct alignment regardless of expansion and contraction of the bridge as the temperature changes. If greater speed is desired over a movable bridge, the increase in speed can generally be achieved through the replacement of the mitre rails with those of a different design that allow higher speed. The replaced mitre rails will reduce the alignment tolerance between the fixed (land) rails and the moving (bridge) rails and in turn allow for greater speeds.

Bridge Design and Condition

Bridge design and condition can limit train speed. This limitation does not mean that the bridge is not safe for normal operation at the current speed limit. Bridges are frequently inspected in detail for signs of failure. The restriction does mean that increasing the speed over the existing speed may require engineering research, however.

Bridges must do more than hold up the train. They must withstand the pushing that the moving train exerts on the bridge structure; the weight concentrated in many places (each wheel) with no weight on the bridge between the loading points; the movement of the loading points; potential lateral (sideways) movement from rocking cars and/or the force of wind on the car sides; the force of wind on the bridge structure itself; and/or the weight of rain, snow, or ice on the bridge. Of course, they must also support their own weight. The design of some types of movable bridge spans is complicated by the need to support their entire weight (and associated forces of wind and precipitation) on a single area of the bridge rather than at the two areas of support (the ends) of a fixed span. Movable bridges must also be able to withstand the forces associated with initiating movement and stopping.

Bridge designers must make specific assumptions about train weight and speed when designing bridges. The designers of the PNWRC bridges were generally quite conservative in their figuring, demonstrated by the current speed limits over fixed bridges. None of the fixed bridges on the PNWRC, which are generally over ninety years old, limit train speed. Freight trains often travel as fast now as passenger trains did when many of the bridges on the PNWRC were designed, and each axle now supports a weight similar to an entire freight car of the era. It is feasible to increase speed over most of the movable bridges through the implementation of upgraded equipment and to assume a relatively modest cost for the upgrade. If an increase in train speed is desired, it is often necessary to study the original design criteria in addition to inspecting the bridge condition and the bridge inspection records. Movable bridges are of particular concern when increasing train speed because they are subject to more and different stresses than fixed bridges.

Exhibit 1
Movable Bridges in the Pacific Northwest Rail Corridor in 2005

Channel	Type of Bridge/ Frequency of Lift	Location	Speed	Approximate age and Remarks
Willamette River	Vertifcal Lift/ Frequent/ocean shipping	Portland	30	97 years - Original swing span replaced with vertical lift span mid-1980s. Approach spans are original 1908 and require minor work before speed can be increased to goal 50 mph. This bridge is on the list of ongoing PNWRC speed improvement projects.
Oregon Slough	(Swing) Occasional/barges	Portland	30	97 years - Requires engineering assessment to determine work necessary to increase speed to P/T50 F35. This bridge is on the list of ongoing PNWRC speed improvement projects.
Columbia River	(Swing) Frequent/barge tows	Vancouver WA	30	97 years - Requires engineering assessment to determine work necessary to increase speed to P/T50 F35. BNSF has completed an $8 million improvement project on this bridge, which may be found to be sufficient. This bridge is on the list of ongoing PNWRC speed improvement projects.
Chambers Creek Waterway	(Bascule) Seasonal/pleasure	West Tacoma	30	91 years - No speed increase anticipated. The Point Defiance Bypass project will bypass this bridge.
Salmon Bay	(Bascule) Frequent/commercial fishing and pleasure	Ballard	20	92 years - An engineering assessment of this bridge is in progress. Rehabilitation for speed increase to T45 P39 F35 is a capital project item in the PNWRC plan. The estimate shown is based on similar projects and not the condition of this specific bridge. Improvement is complicated by curved track on the south end of the bridge.
Snohomish River	(Swing) Frequent/log rafts	Delta Jct.	10	85 years – An engineering assessment indicates that improvements to this bridge that will be required to increase speed to T/P50 F35 will cost approximately $3.4 million. This is part of the Delta line relocation project.
Steamboat Slough	(Swing) Occasional/log rafts	Marysville	T/P40 F20	97 years – A WSDOT speed increase project has replaced mitre rails to allow T/P40 speed. Freight speed remains 20 mph. Requires engineering assessment to determine work necessary to increase speed to P/T50 F45. An estimate for improvement to this bridge, based on similar projects, is included in the Marysville-Mt. Vernon 2nd/3rd track project.
Ebey Slough	(Swing) Occasional/log rafts	Marysville	T/P40 F20	98 years - A WSDOT speed increase project has replaced mitre rails to allow T/P40 speed. Freight speed remains 20 mph. Requires engineering assessment to determine work necessary to increase speed to P/T50 F40. An estimate for improvement to this bridge, based on similar projects, is included in the Marysville-Mt. Vernon 2nd/3rd track project.
Nickomeckl River	(Swing) Seasonal/pleasure	Colebrook	15	56 years – No action anticipated because of pending alternate route.
Fraser River	(Swing) Frequent/barge tows	New Westminster	8-15	102 years – Province of British Columbia is studying replacement alternatives for this bridge.

Exhibit 1
Bridge Types on the PNWRC

Key to Bridge Types:

A: Vertical Lift Bridge
B: Bascule Bridge
C: Swing Bridge

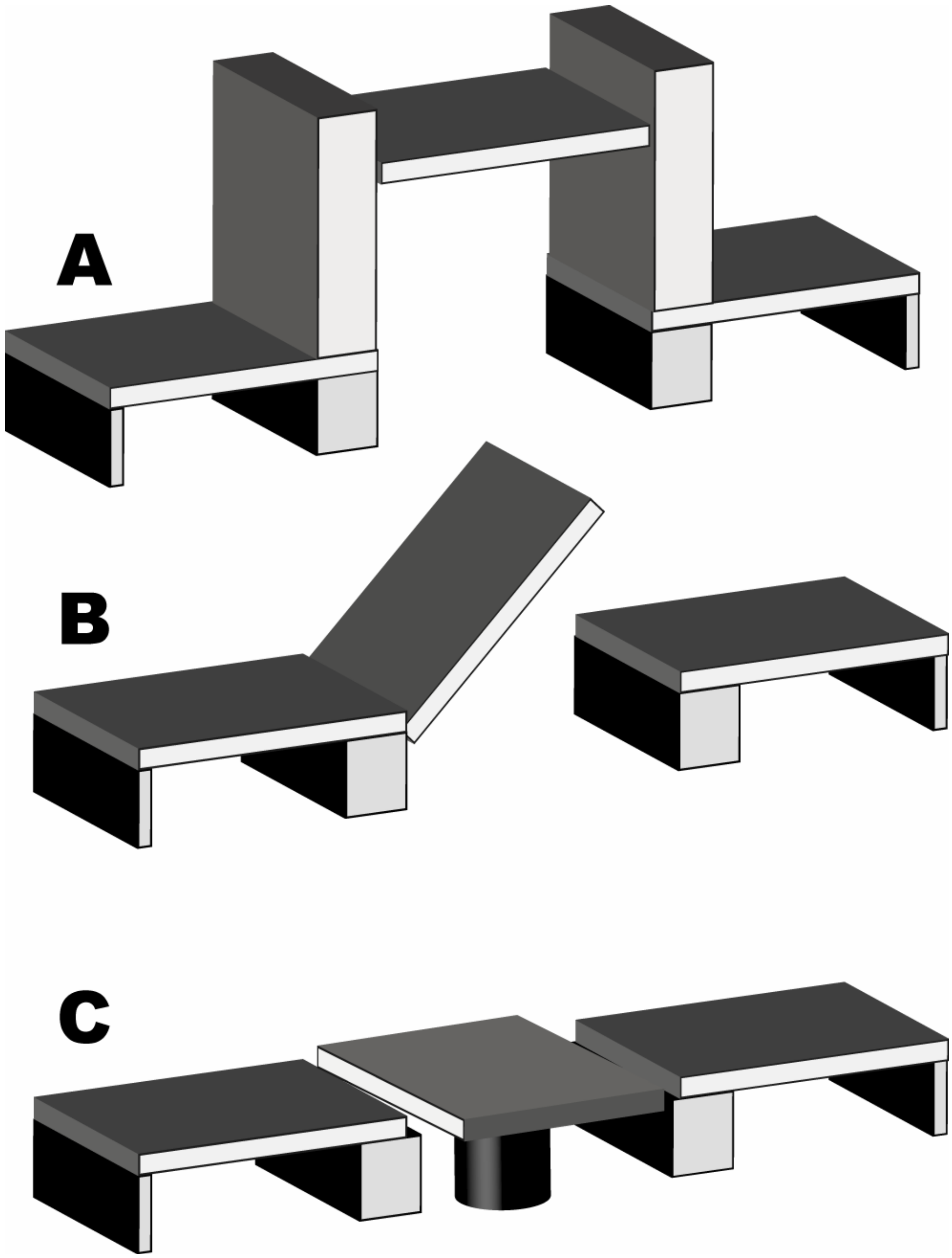
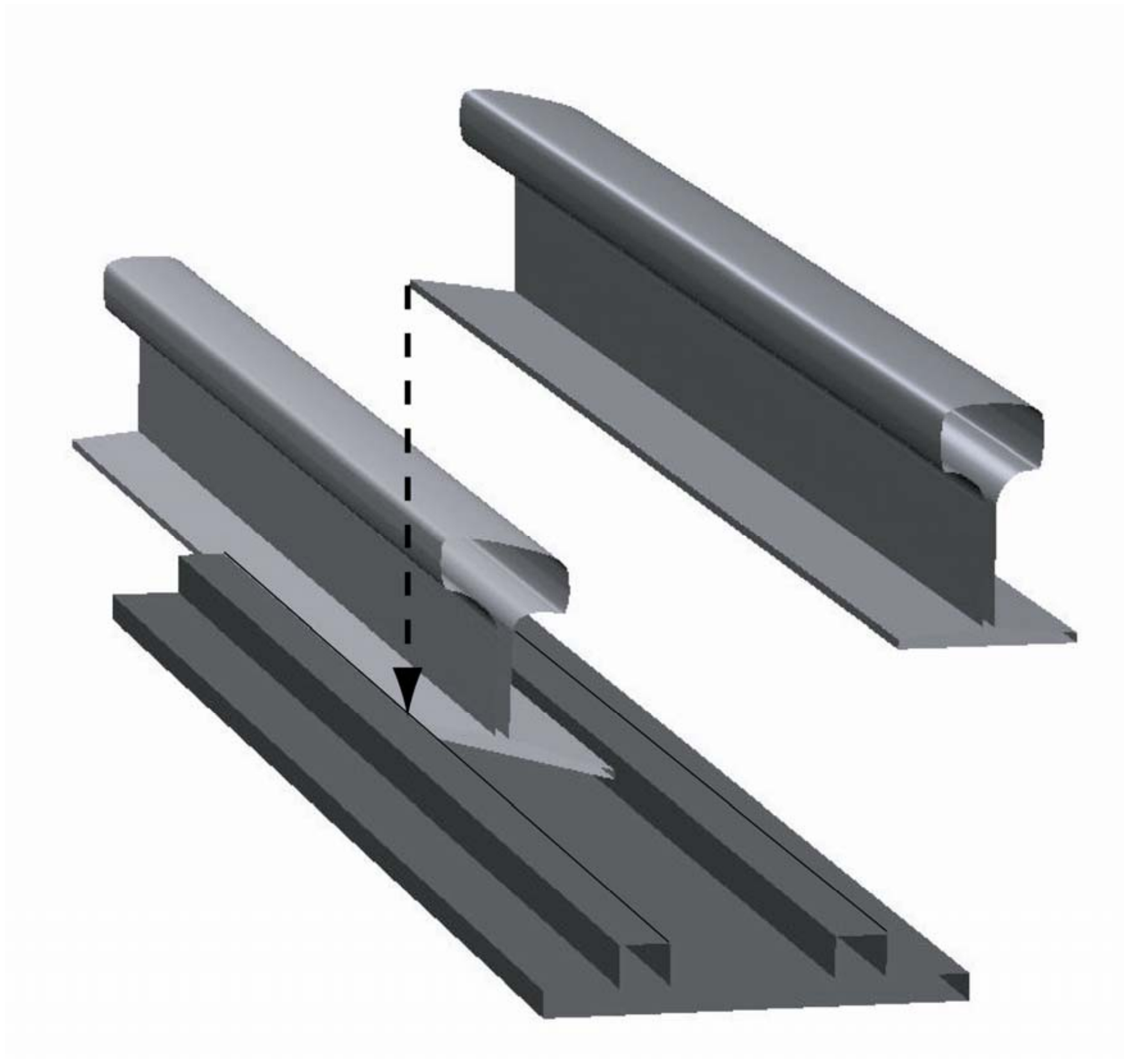


Exhibit 2
Rail Locks (Mitre Rail) on Bridge Ends



Exclusive Versus Shared Passenger Track

This appendix addresses the issues related to developing exclusive track for passenger traffic or uses shared track with freight traffic. This paper was written as a supplement to the information provided in Appendix K: Alignment Changes. The paper addresses those characteristics (volume of traffic, track capacity, train speed, weight, curves, and signaling) that present challenges to shared track between high speed passenger and freight rail traffic, demonstrating the need for the exclusive track that is proposed for the Amtrak *Cascades* Program.

Introduction

The fully developed Pacific Northwest Rail Corridor plan will include about 185 miles of third main track and about 46 miles of fourth main track that will be used virtually exclusively by Amtrak *Cascades* trains. The only other traffic expected on this trackage is the Amtrak *Coast Starlight* and occasional special passenger service. There will also be about twenty-four miles of third main track, and two miles of fourth and fifth main tracks that will be used by any traffic as necessary. The track that will be used exclusively by passenger trains has rather modest utilization at about two trains per hour on the three track sections and one train per hour on the sections of four tracks, but hourly traffic is the capacity of the high speed line as it is currently designed. The characteristics of the traffic on the line make it necessary.

Train Traffic and Track Capacity

Each track of a two track railroad can accommodate six trains per hour (144 trains per day) moving at a uniform speed with relative ease. The capacity diminishes with the introduction of speed differential, but is mitigated when faster trains can overtake slower trains. Where traffic is moderate, Centralized Traffic Control (CTC) allows the overtaking of trains to be made using the two tracks in the same way that one vehicle overtakes another on a two lane road. As with a two lane road, this does not work well when there is heavy traffic.

The capacity is also reduced when a section of track is removed from service for maintenance. Given crossover spacing that allows ten minutes running time between crossovers, the capacity of the remaining track is reduced from six trains per hour to about three trains per hour. The reduction in capacity is greater if the running time between crossovers is greater.

When traffic is heavy and overtaking is required, the capacity of a two track railroad can be retained by the use of sidings. The slower train clears the main track in the siding for the overtaking train and the flow of traffic on the other main track remains uninterrupted. There are two arrangements of sidings. The most common arrangement is adjacent to each main track on the outside (the side away from the adjacent main track). In this arrangement, each main track has its own passing facilities. The sidings can also be located between the main tracks (known as center sidings); used by trains on either main track that must take siding to be passed. Center sidings are effective if few overtakes are required or if traffic density is moderate.

Between Vancouver and Nisqually, the section of the line having high speed third and fourth main tracks, a typical non-stop freight train will be overtaken by an Amtrak *Cascades* train one or two times, depending upon the time (relative to the last and next Amtrak *Cascades* train) it enters the line at Vancouver or Nisqually. Assuming a planned freight train headway of twenty minutes and a practical capacity of fifty percent of theoretical capacity, a siding of about three miles in length would be required for each track at about fifteen mile (center of siding to center of siding) intervals. The three mile length allows the freight train to leave the main track at nearly the maximum speed for the track, thereby not reducing capacity. The freight train delay per overtake would be approximately the same as it is currently, but the number of freight trains delayed by overtakes would increase because of passenger train frequency, thus diminishing the railroad's level of utility. This effect is mitigated by not using both main tracks when overtaking.

Speed and Weight

The Federal Railroad Administration (FRA) divides track into ten maintenance categories, each with a maximum speed and specification of the tolerance to certain important track dimensions and conditions. As the allowed speed increases, the tolerances become smaller. The two classes of track of particular importance to the Amtrak *Cascades* program are Class 4 and Class 6.

The maximum train speeds allowed on Class 4 track (generally the class of track on the PNWRC) are sixty mph freight and eighty mph passenger. The maximum allowed passenger train speed on Class 6 track is 110 mph. Freight trains of specially constructed cars that have dynamic performance equal to that of passenger cars may also operate at 110 mph. The regulation is not explicit, but it appears that the maximum speed for conventional freight trains on Class 6 track is the same as it is for Class 5 track, eighty mph.

Examples of the Difference in Tolerances

Maximum Track Gauge

- Class 4: 4’ 9 ½”
- Class 6: 4’ 9 ¼”

Maximum change in track gauge per 31 feet of track

- Class 4: No Restriction
- Class 6: ½”

Deviation of Tangent Track Alignment

- Class 4: 1 ½” per 62 feet of track
- Class 6 : ½” per 31 feet of track

Deviation from Uniform Profile of either rail at the mid-ordinate of a 62 foot chord

- Class 4: 2”
- Class 6: 1”

The speed and weight of a train have an effect on the track, causing it to move longitudinally, laterally, and/or vertically as the train passes. The amount of movement is related to train weight and speed. This effect is generally not visible to the eye on a railroad track but can be seen most readily on the asphalt pavement of a city street. A street that has transit bus and/or heavy truck traffic will have ruts and ridges that are not present on a street that has only automobile traffic, especially at the base of steep hills where trucks and buses must stop or start from a stop.

The effect of the moving train on the track is related to the kinetic energy of the train (calculated by the formula half of the mass [weight] times the square of the speed [velocity]). For the purpose of discussion, assume that the effect on the track (and thus the maintenance required to maintain track condition) and the kinetic energy are directly related. A 14,000 ton grain train moving at 45 mph (the speed limit for such trains on BNSF tracks) has 4.7 times the effect on the track of a 500 ton passenger train moving at 110 mph. A 7,000 ton intermodal train has 2.9 times the effect of a 500 ton passenger train on the track.

Accurate calculation of the effect would be complex because of the range of train speeds and weights, but some germane comparisons can be made. Given a 26 trains-per-day schedule of Amtrak *Cascades* trains and two *Coast Starlight* trains, the annual weight of passenger train traffic is 5.4 million tons. Given 44 freight trains-per-day of 7,000 tons each, the annual weight of the freight train traffic on the line is 112.4 million tons. If the passenger trains operate at 110 mph and the freight trains operate at 45 mph, the freight trains have 3.5 times the effect on the track as the passenger trains.

The relationship is not simple, however. The effect on the track is dependent on weight and speed, but also on the concentration of the load, known as axle loading, which is the amount of weight that each axle supports. The required strength of track components can be directly affected by axle loading. In Europe, the maximum axle loading is 25 tons. In the US, freight car axle loading is generally 33-36 tons. There are specific track structure problems associated with high axle loading, but because speed is also an important component of the effect on the track, the comparison is not that simple. US freight trains travel at 40-50 mph. European trains travel at 90-100 mph. The effect of one axle of a European freight train on the track is about 3.5 times the effect of one axle of a US freight train. Amtrak *Cascades* trains have an average axle loading of about 25 tons and will operate at 110 mph. Each axle of an Amtrak *Cascades* train has 4.3 times the effect of one axle of a freight train moving at 45 mph. The significant difference is that the freight trains have over twenty times the number of axles as Amtrak *Cascades* trains.

The FRA is conducting research to determine the requirements for track that would be compatible with both heavy freight trains and high speed passenger trains. The results have not yet been published. It appears from the energy calculations that unless the strength of the track structure is increased significantly that the number of freight trains that can be operated with effect on the track equal to passenger trains is about half of the number of passenger trains. The cost for maintaining Class 6 tolerance is significantly higher than maintaining Class 4 tolerance, however. The number of freight trains on the sections of the Pacific Northwest Rail Corridor that will have third or fourth tracks for passenger trains will number about twice the number of passenger trains. It appears that maintenance cost or track construction to maintain the required tolerance under the expected volume of freight traffic will be significantly higher. The additional cost of maintenance for the shared track would be the responsibility of the passenger services.

Curves and Train Speed

The maximum speed of trains through curves is governed by the radius of the curve and the superelevation. Superelevation is “banking” to offset the effect of centrifugal force. An extreme example may be seen in the curves of an automobile race track. Greater superelevation allows greater speed for a curve of the same radius. Railroad superelevation is measured in inches, meaning the number of inches that the outer rail of the curve is raised over the inner rail. Part of the superelevation for trains is called unbalanced superelevation, unbalance, or cant deficiency.

If superelevation offsets centrifugal forces exactly, the forces applied to the track are balanced; the same as if the track were tangent and level. When calculating the maximum permissible speed for a curve, a certain amount of unbalance is allowed. The federal track safety standards allow three inches of unbalance in the curve speed calculation. Thus, if the outer rail of the curve is two inches higher than the inner rail, the speed limit for the curve may be calculated as if the outer rail were five inches higher than the inner rail. The speed limit for freight trains is generally calculated with two inches of unbalance. Tilting passenger trains such as the Amtrak *Cascades* trains can operate with as much as nine inches of unbalance, so the speed for a curve with two inches of superelevation would be calculated as if the outer rail were eleven inches higher than the inner rail. Thus, the maximum allowed speed for a tilting passenger train can be significantly greater than the speed of a freight train in the same curve.

The amount of superelevation is also important to track maintenance. If the maximum speed for a train in a curve is calculated using zero superelevation, the condition is called equilibrium. That means that the effect of centrifugal force and gravity balance each other and the weight of the train is distributed equally on the two rails. If the unbalance is greater than 0, more of the weight of the train is borne by the outside rail. If the unbalance is less than 0, more of the train is borne on the low rail. If the amount of unbalance is significant, either positive or negative, there can be a significant effect on the track. That is why tilting trains that operate at a high amount of unbalance must be very light. That is also a significant reason for calculating freight trains speeds using two inches of unbalance instead of three and why railroads prefer to use the minimum amount of superelevation practical for their freight operation. Another consideration is the possibility that a heavy train being moved by a great amount of power applied to the front of the train may be pulled off of the track toward the center of the curve (stringline) or that cars may overturn toward the center of the curve if there is a great amount of superelevation.

For example, a curve of 1,910 foot radius can be negotiated by a freight train at 62 mph with six inches of superelevation and two inches unbalance. The speed limit for a conventional passenger train on this curve would be 66 mph. For a tilting train using nine inches of unbalance the speed limit would be 85 mph. Equilibrium speed for this curve is 54 mph, so slow moving trains would be applying an excessive amount of force to the inner rail of the curve. Were this curve to have only two inches of superelevation, the two inch unbalance speed limit would be 44 mph and the equilibrium speed would be 31 mph. These speeds would be consistent with the operation of heavy trains with a moderate amount of locomotive power. This track geometry is not consistent with passenger service using conventional passenger train equipment. The speed limit for a conventional passenger train on this curve would be 49 mph. A tilting train with nine inches of unbalance would be 72 mph, a speed more consistent with passenger service. Tilting trains can operate at speeds consistent with passenger service on track geometry suitable for freight service.

Caution must be used when operating a tilting train at high cant deficiency on track shared with freight trains. In the 1,910 foot radius curve example above, the track is Class 4 for conventional passenger trains (assuming the 62 mph speed limit is reduced to 60 mph, the convention for establishing freight train speed limits) and Class 5 for the tilting train. A significant amount of additional maintenance would likely be required to keep the track, being used by freight trains operating at 60 mph, in compliance with Class 5 standards.

The situation is reversed if there is a goal speed limit, such as the 110 mph needed by the Amtrak *Cascades* trains to achieve the goal running time. A curve with ¾ inch of superelevation (the standard minimum superelevation for BNSF) and a 50 mph freight (two inch unbalance) speed would have a radius of 3,646 feet and an equilibrium speed of 26 mph. This is consistent with freight service requirements but would have a nine inch unbalance tilt train speed of 94 mph. 110 mph would require 4.3 inches of superelevation, which would make equilibrium speed 63 mph. It is apparent that even tilting trains will not necessarily allow the same track geometry to be suitable for freight and passenger service.

In Europe, the situation is addressed by operating very light freight trains with enough power to operate at 100 mph. Consideration of underbalance (trains operating below equilibrium speed) is unnecessary. In the US, that is not practical. Freight railroads generally supply wholesale transportation for bulk commodities. A train that is economical for a railroad to operate weighs 10,000 to 15,000 tons. It is not practical to operate such a train at high speed. Movement at 100 mph would require 27 3,000 horsepower locomotives on a railroad with typical moderate grades. The stopping distance is also impractical. For such a train, stopping from 100 mph would take approximately eleven miles.

A track for use by high speed passenger trains and freight trains would have increased maintenance cost because of the weight of the freight traffic and the underbalance of freight trains in curves. Since an extensive amount of third or fourth track would be required in the form of sidings on a mixed use line (a length of track roughly sixty percent of the length of the line), a separate track designed for the requirements of passenger service is reasonable.

Once construction of a special track for passenger trains has been decided, tilting trains can reduce the amount of additional property required if the new track is associated with the existing right of way. For example, between Kelso and Centralia, there are several curves of about 1,910 foot radius. A curve with 7 inch superelevation that will allow a conventional passenger train to operate at 110 mph has a radius of 4,853 feet. A curve with 7 inch superelevation that will allow a tilting passenger train to operate at 9 inch unbalance at 110 mph is 3,033 feet. The curve for the tilting train would deviate from the existing line less than the curve for the conventional passenger train. (See Exhibit 3 on page K-27).

Speed and Signaling

A federal regulation (49 CFR 236.0) limits train speed to 79 mph unless an automatic cab signal, automatic train stop, or automatic train control system is installed. When one of these systems is installed, all trains must be equipped with the system. Such systems are costly and are unusual in the US, with a relatively small amount of equipped trackage in the national system. An Interstate Commerce Commission (ICC) order of 1922 required every railroad to install such a system on one subdivision (one continuous section of line between two points, generally one hundred to three hundred miles) on which passenger trains operated. A 1947 ICC order (the predecessor of the current regulation) required one of these systems anywhere the speed limit was eighty mph or more. Before that time, there were passenger train operations of ninety to one hundred miles per hour throughout the country. Most railroads chose to limit trains to 79 mph rather than go to the expense of installing the system on the track and in the freight locomotives, which would never need to exceed seventy-nine mph.

Generally, the systems called Automatic Train Control and Automatic Train Stop are very old technology that is not generally allowed by the FRA for new installations. There are new systems called Positive Train Control (PTC) that will ultimately be the replacements for the obsolete systems. These systems are not specified in the regulations because no standard for all such systems has been developed and accepted; however, FRA has issued a notice of proposed rulemaking for such standards. Elsewhere in this document, any system that would meet the requirement for operation at 80 mph or more, whether obsolete, current, or future is called "Advanced Signal System". There are six PTC systems, one of which is in use and the other five of which are in various stages of development and testing. BNSF has one installation of continuous automatic cab signals, a system that FRA will approve for new installations. BNSF has no locomotives equipped for operation with this system, however. This installation, 39 miles between Chicago and Aurora, predates the requirement that all trains be equipped for the system. It is used only by Metra commuter trains. Of the six PTC systems, one of them is a BNSF design that is being tested by BNSF.

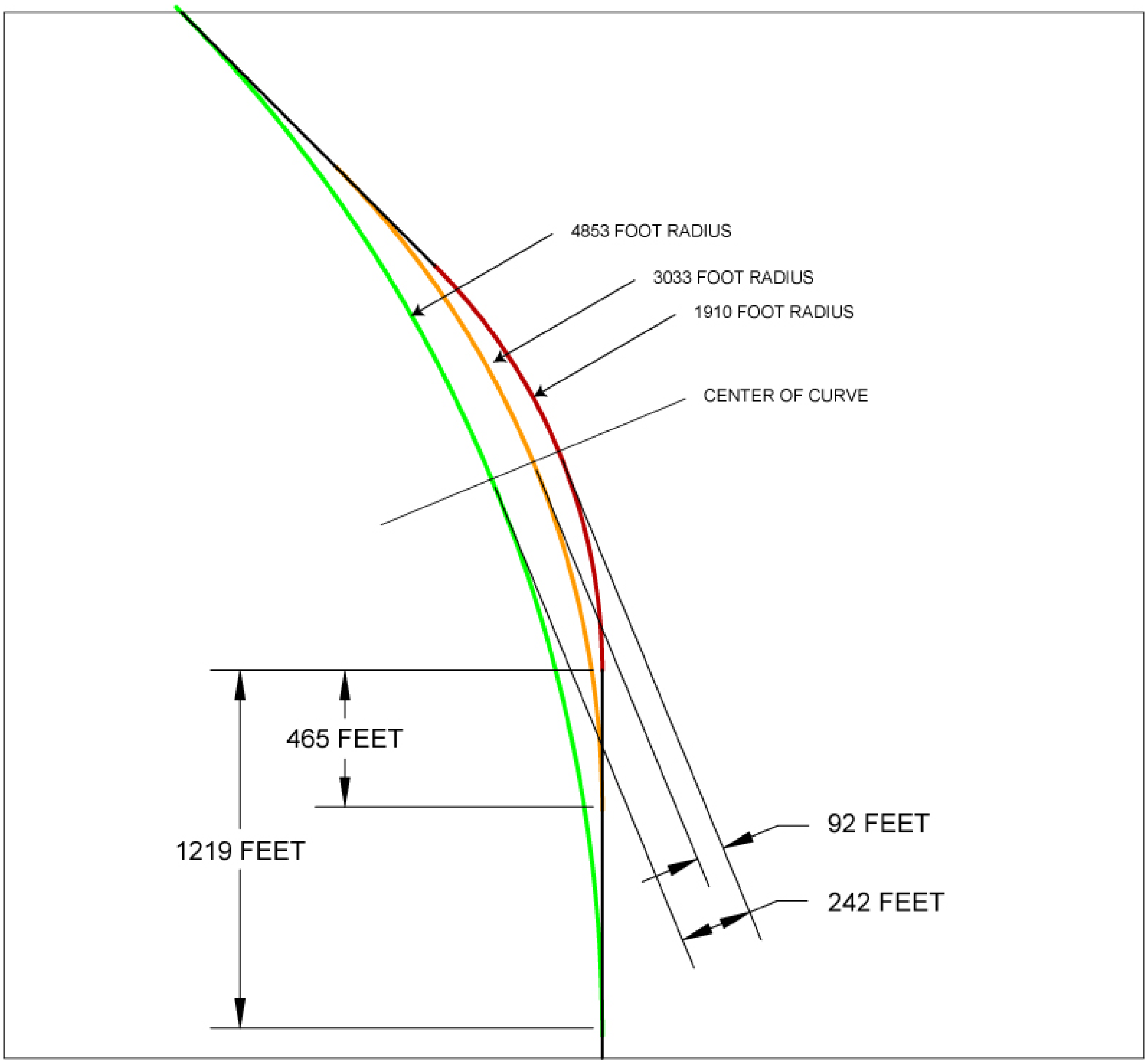
The current state of signal system technology introduces a degree of uncertainty into the Pacific Northwest Rail Corridor (PNWRC) plan. That an advanced signal system is required for operation at 80 mph or more is known and accepted. It is not possible to know what the system will be or how it will be implemented. Were meeting the technical requirements the only consideration, continuous cab signal equipment could be installed on the PNWRC immediately and passenger train speed could be increased to 90 mph over a significant part of the Vancouver-Seattle section of corridor and a significant part of the Everett-Blaine part of the corridor. Even were the funding available immediately, the speed increase to 90 mph would not be practical, however.

The continuous automatic cab signal system is available and could be installed, but BNSF has no locomotives equipped for the system. Tacoma Rail, a tenant on the line also has no locomotives equipped for continuous cab signals and the locomotives of tenant Union Pacific (which does have continuous cab signals on some of its lines) may require modification to be compatible depending upon the exact system installed. BNSF is testing a PTC system of its own design. Should BNSF make their system standard after development and testing are complete, it would be necessary to equip the locomotives used by Amtrak *Cascades* service with the new system.

Should the track intended for high speed operation be constructed with BNSF still not adopting an advanced signal system, there is a similar consideration that arises from the situation that caused the proliferation of 79 mph speed limits in the first place. BNSF has no need to operate trains in excess of 79 mph. If the entire line is equipped with an advanced signal system, it may be necessary for the Amtrak *Cascades* program to equip freight locomotives, a significant expense. If all of the operation at 80 mph or more is confined to tracks that freight trains do not use, there is no need for freight trains to be equipped for operation with the signal system used on the high speed tracks. This could result in significant savings for the Amtrak *Cascades* program, which would likely be required to pay for installation in freight locomotives and also for maintenance of the locomotive-borne equipment and the wayside equipment on the tracks used by freight trains.

There is precedent for this arrangement because the majority of railroad track in the US does not have an advanced signal system, yet there are many regularly used connections throughout the country with tracks that do. FRA's philosophy has been to disapprove of new versions of existing undesirable situations. In a way, the position is reasonable and admirable, but it may also not be practical. There is little difference between a BNSF freight train entering the Seattle-Portland line with an advanced signal system at Vancouver from the Spokane-Vancouver line that does not and the same train at a junction of equipped and non-equipped track at the end of a high speed track segment. Thus, it appears that if such an arrangement becomes necessary, there may be the possibility of negotiation. The Amtrak *Cascades* program plan does not include 110 mph operation until after the midpoint in the program because of the uncertainty in the application of advanced signal systems. The National Transportation Safety Board (NTSB) has been pursuing the application of such systems for many years. By the time that the Amtrak *Cascades* service is ready to operate at over 79 mph, the systems now in development may be ready for service, BNSF may have adopted their system that is in development and testing as their standard signal system, and/or the NTSB desire for application of advanced signal systems may be realized.

Exhibit 3
Curve Alignments



Tilting Trains on the Pacific Northwest Rail Corridor

This appendix considers the application of tilt train technology for the Amtrak *Cascades* Program.

The Effect of Geography on Train Speed

The geography of Western Washington and southern British Columbia imposes restrictions on railroad construction that makes moderate to high speed passenger service challenging. Hills, mountains, riverbeds, and shorelines generally require that the track be designed with curves with which to navigate the geographic features. Curves, however, can limit train speed. Twenty-five percent of the route between Portland and Vancouver BC is curved track that limits the speed of conventional passenger trains to less than the 110 mph goal speed limit of the Amtrak *Cascades* service. In addition, the longest section of tangent (straight) track on the route is 9.4 miles. Thirty-two percent of the corridor is tangent track of 2.3 miles or less in length, generally not enough distance to accelerate from a restricted speed curve to normal speed then brake to the speed limit of the next curve. Thus, about fifty-seven percent of the route is speed-restricted by geography with numerous curves.

Superelevation, Centrifugal Force, Gravity and the Effect on Vehicles and Passengers

The ability of a rubber-tired vehicle to stay on a curved road is governed by the friction between the tires and the pavement. If the sideways force (centrifugal force) is greater than the downward force (gravity), the vehicle slides sideways off of the road (Exhibit 4A Page K-33). Auto race tracks overcome this effect by banking the pavement in curves. A specific combination of speed and amount of banking will result in a force that is downward to the vehicle rather than sideways as it travels through the curve (Exhibit 4B Page K-33). Railroad wheels are prevented from sliding sideways by the flanges (Exhibit 5 Page K-34), so the safe speed for the vehicles on curved track is governed by the ability of the rail to remain in the correct position (Exhibit 6A Page K-35), and the resistance to overturning because centrifugal force is pushing the vehicle but the wheels remain within the rails (Exhibit 6B Page K-35). The effect of centrifugal force is compensated by superelevation, banking the track in a manner similar to the curves of an automobile race track (Exhibit 6C Page K-36). The safe speed for the passengers will be less than the safe speed for the vehicles as the centrifugal force will cause passengers discomfort or injury at a much lower speed than would cause a derailment (Exhibit

7A Page K-37). Superelevation also compensates for the effect of centrifugal force on the passengers. As a train “leans into” a curve, the passengers can feel the sensation that gravity is pushing directly in the direction that to them is down (Exhibit 7B Page K-37). Superelevation is expressed in inches, meaning the number of inches that the outside rail of the curve is higher than the inside rail.

If the speed and superelevation are exactly matched, the superelevation is balanced and the train is at equilibrium. The sideways and downward forces are exactly perpendicular to the track in the same amount as gravity would be on tangent track. Testing has shown that passengers feel uncomfortable if their eyes tell them that the train is turning and their body tells them that it is not. To overcome this sensation, passenger train speed limits in curves are set at an “unbalanced” speed; the train moves at a speed slightly faster than it would at equilibrium so that passengers feel some sensation of curved track to accompany what they see (Exhibit 7C Page K-38). The amount of extra speed added for passenger comfort is called unbalance, unbalanced superelevation, or cant deficiency. Unbalance is expressed in inches and means the amount of additional superelevation that would be needed for equilibrium (Exhibit 7D Page K-38). For example, a curve of 3,000 foot radius and one inch of superelevation has a speed limit of 27 mph at equilibrium and 55 mph at three inches of unbalance. Three inches of unbalance means that it is the equilibrium speed, if there were four inches of superelevation (the one inch of superelevation and the three inches of unbalance). The limit for unbalance for conventional trains in the US is three inches. This was established by tests in the 1950s of passenger comfort on a conventional passenger train of the era. This is among the lowest unbalance limits in the world. In Germany, for example, the limit is six inches and in France is it seven inches.

There is a significant difference between passenger cars in the US and passenger cars in Europe, however. US conventional passenger cars are much heavier and have a higher center of gravity than their European counterparts. Thus, the high unbalance authorized in other places may not be practical in the US.

There is also a practical limit as well as a regulatory limit on superelevation. The maximum superelevation allowed by federal regulation is seven inches. This is generally not acceptable on a track used by freight trains, for two significant reasons.

- The center of gravity of freight cars is generally higher than the center of gravity of passenger cars. If a heavy freight train is stopped on a heavily superelevated curve, it is possible to overturn the cars in the train when starting. Effectively, the pulling force transmitted from one car to the next is also pulling the cars sideways because of the curve (Exhibit 8A Page K-39). This is especially true if the curve is also on a grade requiring a great amount of power to start the train moving.

- Freight cars are much heavier than passenger cars and freight trains move more slowly. If they travel through a curve at less than equilibrium speed, a disproportionate amount of the weight is supported by the inside (low) rail of the curve. This increases the wear on the low rail significantly, thus increasing maintenance cost and the possibility of turning over the low rail (Exhibit 8B Page K-39). For example, the speed limit for a conventional passenger train (three inch unbalance) through a 600 foot radius curve with seven inches of superelevation is 39 mph. Equilibrium speed for this curve is 32 mph. A freight train traversing the curve at less than 32 mph is resting disproportionately on the low rail. Such sharp curvature is often associated with grades that result in trains in at least one direction traveling at a very low speed.

Tilting trains increase the amount of unbalance that can be used in setting the speed limit through curves. The body of each car tilts while traversing each curve, providing virtual superelevation for the occupants (Exhibit 9 Page K-41). A tilting train can operate at speeds equal to or greater than a conventional passenger train in the same curve. For example, in the example 600 foot radius curve, a tilting train using nine inches of unbalance can operate at 39 mph (the same speed as a conventional passenger train with seven inches of superelevation) with only 1.2 inches of superelevation. The equilibrium speed for this curve with 1.2 inches of superelevation is 13 mph, probably much lower than the continuous speed of the slowest freight train. If the typical freight train operates at 25 mph and the lowest speed is typically 18 mph, then 2.2 inches of superelevation would be appropriate. 2.2 inches of superelevation would allow a conventional passenger train to operate at 28 mph, less than the speed allowed with the maximum possible amount of superelevation. A tilting train using nine inches of unbalance can traverse this curve at 41 mph, two mph faster than a conventional train with maximum superelevation.

Weight is also important at high unbalance speeds. When the train is unbalanced, a disproportionate amount of the weight is borne by the outside (high) rail of the curve. This aggravates the lateral force acting on the rail. The effect is reduced by decreased weight is the optimum vehicle for a rail line with a large amount of restrictive curvature.

Implementation of Tilt Train Technology

The initial feasibility studies for the Pacific Northwest Rail Corridor recommended the use of tilting trains. Tilting trains are a simple concept but not a simple implementation. There were experiments conducted in the

US in the late 1930s and early 1940s, with some of the cars remaining in use through the 1950s. The tilting train concept was revisited in France in the 1950s when the concept of high speed trains was being developed. Tilting train implementation was not successful in France either, and they decided to develop entirely new rail lines specially suited to high speed trains of more conventional construction. Tilting train development came back to the US in the late 1960s with the United Aircraft *Turbo Train*. The Turbo trains operated in commercial service, but were not successful. Tilting train development continued in Europe, with successful implementations in Sweden and Italy.

Tilting train development in Spain followed a different path. Some people in the US railroad industry began to realize in the early 1950s that a change from the then-standard passenger cars would be necessary. Weight affected locomotive requirements, fuel consumption, purchase price, and track maintenance, all of which affected the cost of operating passenger service. There was also recognition that the size of the cars was related to air resistance, which was also related to locomotive requirements and fuel consumption. Several lightweight, low-profile special passenger trains were designed and tested during the early 1950s. Almost none were successful, partially because other forces were causing the demise of passenger trains faster than research could attempt to revive them.

One successful tilting train attempt was the Talgo (Tren Articulado Ligero Giocoechea Oriol-Train Articulated Lightweight of Giocoechea, the inventor, and Oriol, who financed the development) in Spain. The original concept was very lightweight, but strong, construction with a very low profile and very low center of gravity which would be able to operate through curves at a higher speed by virtue of those characteristics. To achieve the goals of the concept, the trains would be mechanically simple and thus reliable, and easy and inexpensive to maintain.

The first test train was constructed in Spain during World War II. The test was successful enough to warrant construction demonstration trains. Spain did not have the industrial facilities required for production, however, and the US corporation ACF was engaged to build demonstration sets in 1946. They were not successful in the US but they were successful in Spain. Two US-built trains were exported to Spain in 1950 and additional trains were built in Spain. Development continued through a second and third generation of Spanish trains. In the fourth generation of development, Talgo incorporated tilting.

By the time development of the Pacific Northwest Rail Corridor began in the early 1990s, Talgo tilting trains were successful in Sweden, Italy, and Spain. Talgo S.A., the Spanish manufacturer, was looking for a place to demonstrate their train in the US. The Pacific Northwest Rail Corridor needed a lightweight, reliable, tilting train. One part of the original Talgo concept, before tilting was added to the design of the trains, was that if the center of gravity very low and the cars very light, the mechanical limitations of unbalance could be greatly reduced. That is true; however, the effects on the passengers are not reduced. By combining tilting with their very light weight, very low center of gravity trains, Talgo addressed both problems.

Tilt Train Technologies

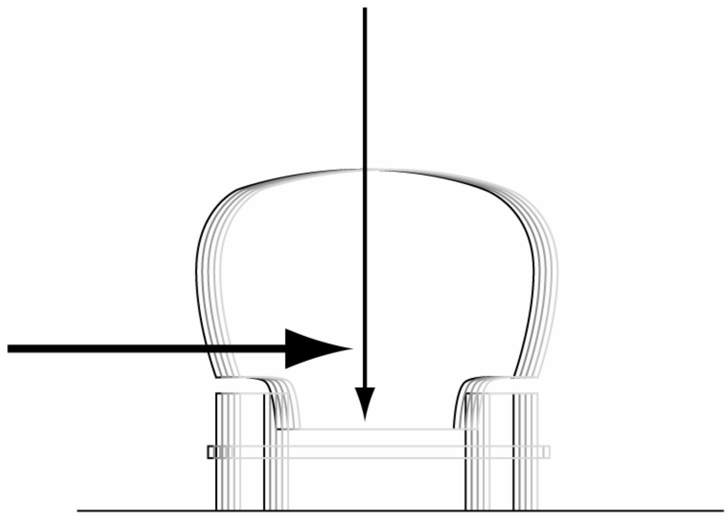
There are two types of tilting train, active tilt and passive tilt. Active tilt trains use sensors and a computer to determine the correct angle of the car for the curvature and speed, and motors to tilt the carbody (Exhibit 10A Page K-41). Passive tilt relies upon centrifugal force to tilt the carbody. The carbody is effectively suspended from the top, responding to the lateral force like a pendulum (Exhibit 10B Page K-41). Active tilt is more complex than passive tilt, is more maintenance-intensive than passive tilt, and has a probability of failure greater than passive tilt.

The amount of tilting, hence the amount of unbalance, is greater for active tilt than for passive tilt. There is a great advantage to active tilt under some conditions, regardless of complexity and maintenance expense. This is especially true of European railroads where axle loading (the weight per axle of a train) is low (less than 25 tons) and on the Northeast Corridor (Washington – Boston) in the US, where passenger trains are almost the only traffic. US regulations divide railroad track into classes. Each class has a specified tolerance for critical measurements and a specified maximum speed. High axle loading of freight trains in the US (as much as 36 tons), as opposed to heavy trains made up of lighter cars, has a significant effect on track condition, making the close tolerances needed for higher speeds difficult to maintain. Regardless of the benefits of operating at high unbalance speeds, the wheels must remain on the track. Thus, the track condition must be suitable for the speed of the train regardless of the amount of unbalance that the train makes possible. Active tilt trains increase the speed differential between freight and passenger trains, but are also likely to increase the speed differential sufficiently to change the required class of track. High axle loading freight trains can cause more damage to a class of track higher than they need than can be offset by the benefit of operating the passenger trains at a significantly higher speed. Active tilt trains would thus probably not provide sufficient value to offset the additional track maintenance needed to allow the higher speed on track shared with freight trains. For that reason, the Pacific Northwest Rail Corridor plan assumes that Amtrak *Cascades* trains will operate at six inches of unbalance on shared track rather than the nine inches that the trains are capable of. Track that is constructed specifically for passenger service will be designed for the capabilities of the equipment. Since the trackage with the greatest amount of restrictive curvature will be on track shared with freight trains, the benefits of active tilt technology over passive tilt technology can generally not be used. The disadvantages of complexity remain, however, and are not offset by advantages.

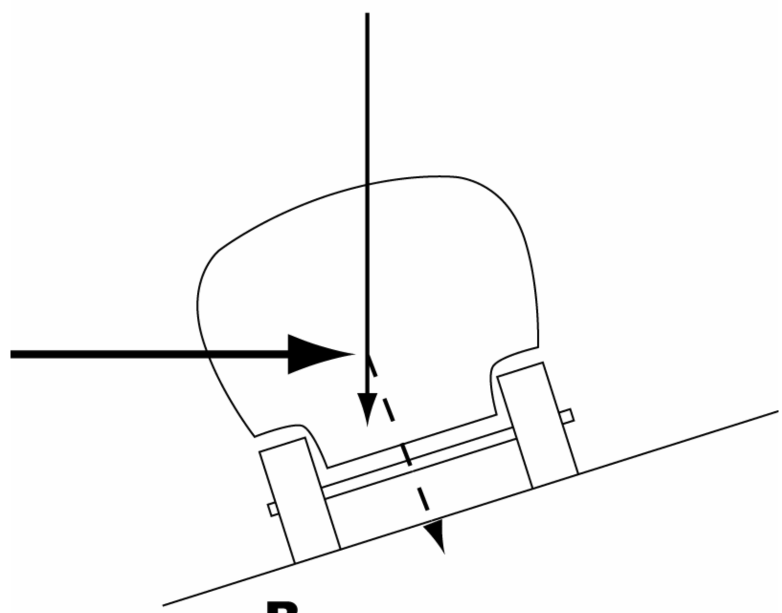
Tilting trains are also useful when constructing new track or changing the existing alignment to accommodate higher speeds. On existing track, tilting allows greater speed without changes to the track. On new track, tilting allows greater curvature for the same speed. Exhibit 11 (Page K-42) shows the existing alignment between Kelso and Vader, the alignment for the goal Amtrak *Cascades* train speeds with conventional equipment and for the goal Amtrak *Cascades* speeds with tilting equipment. The alignment changes that would be used with conventional equipment are more extensive and deviate farther from the existing alignment than those that would be used with tilting equipment.

Exhibit 4
Forces on Vehicles

Key to Exhibit:
A: Centrifugal Force > Gravity
B: A Banked Surface



A



B

Exhibit 5

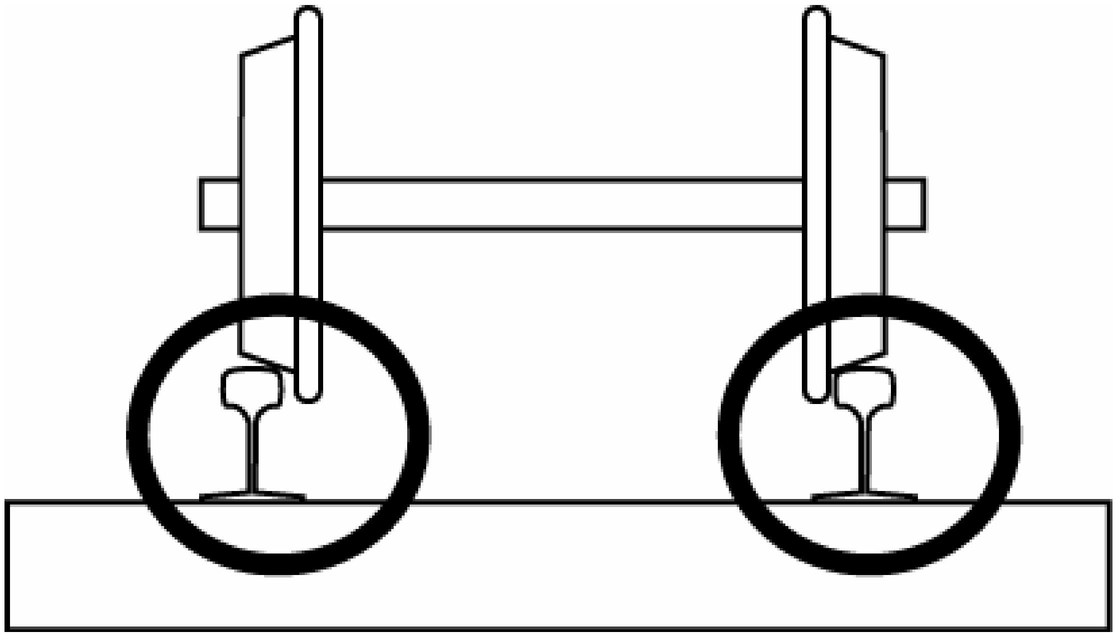


Exhibit 6
Rail Vehicles and Applied Forces

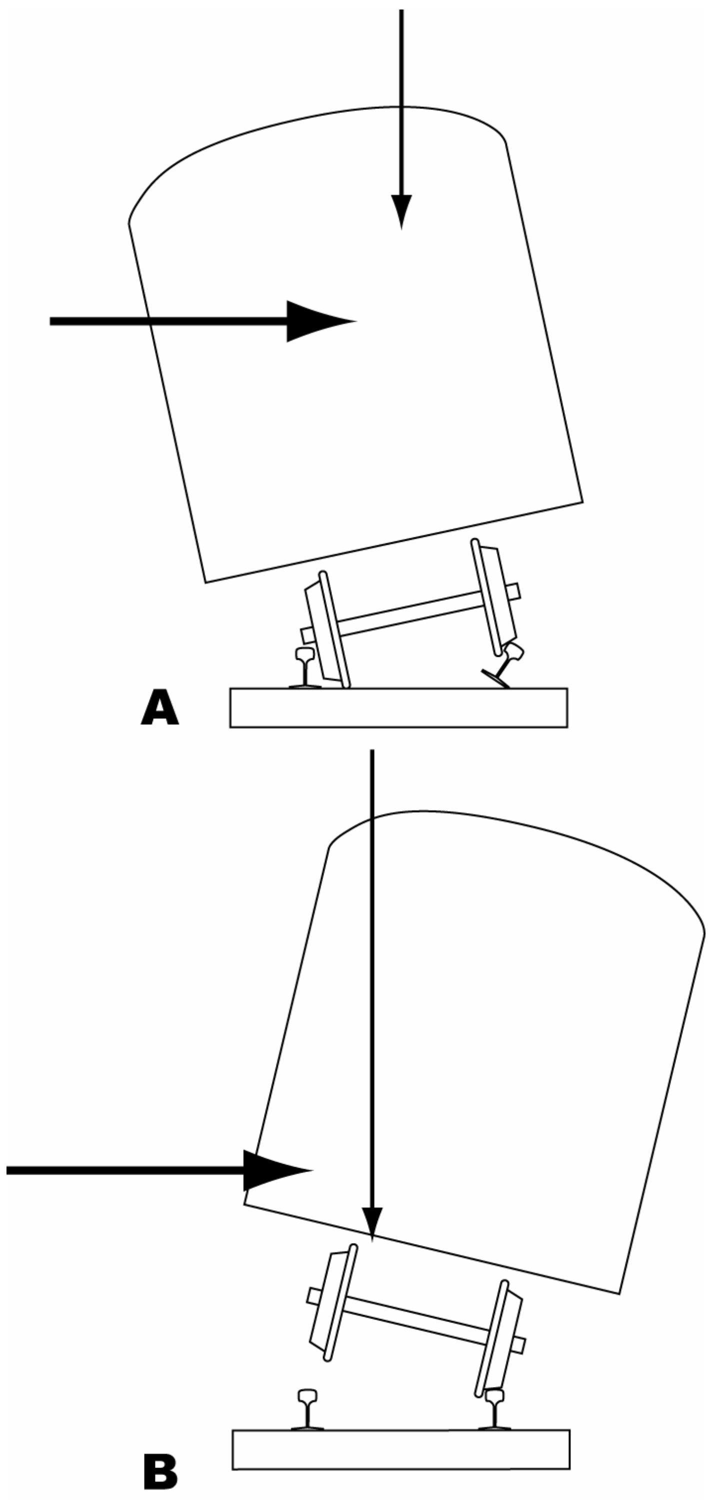


Exhibit 6 (Continued)
Rail Vehicles and Applied Forces

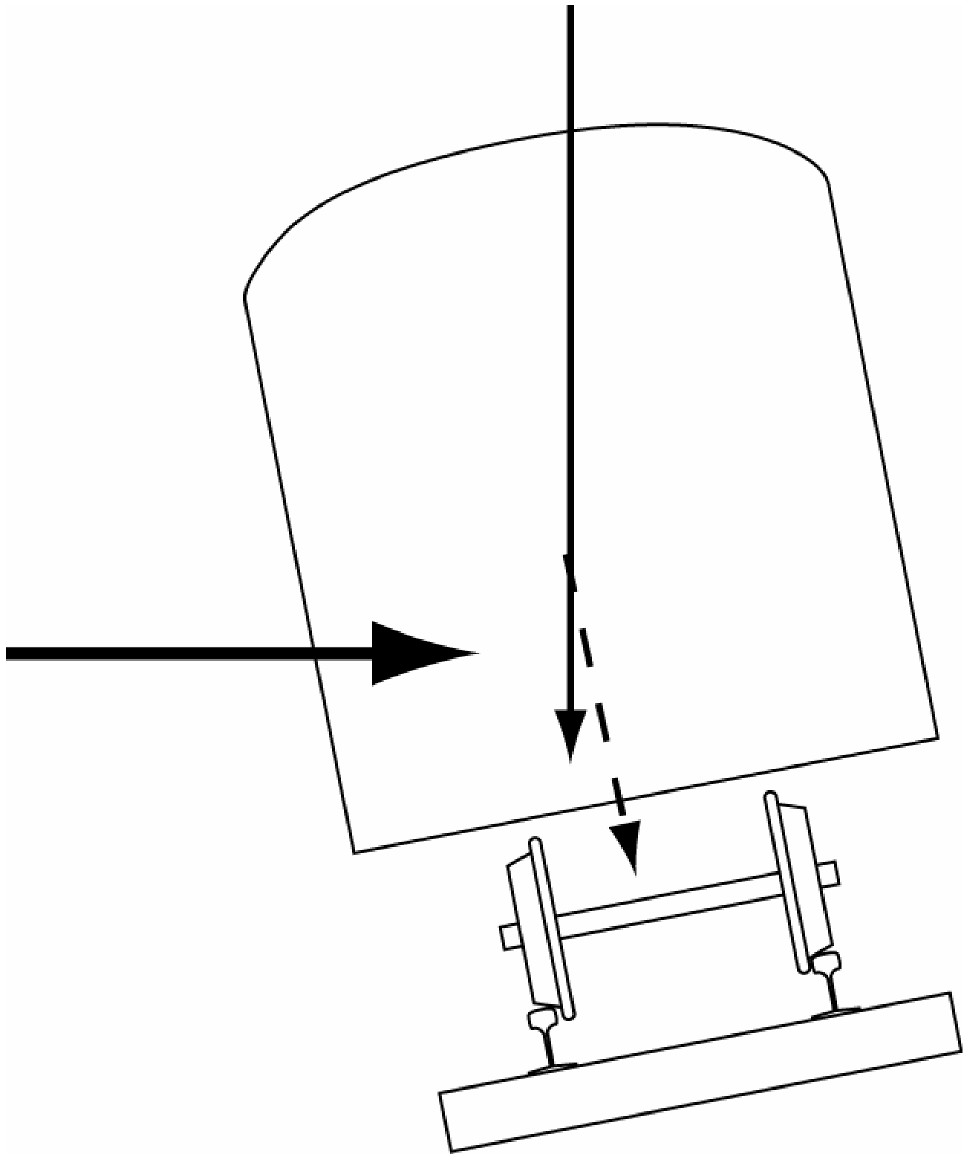


Exhibit 7
Forces on Rail Passengers

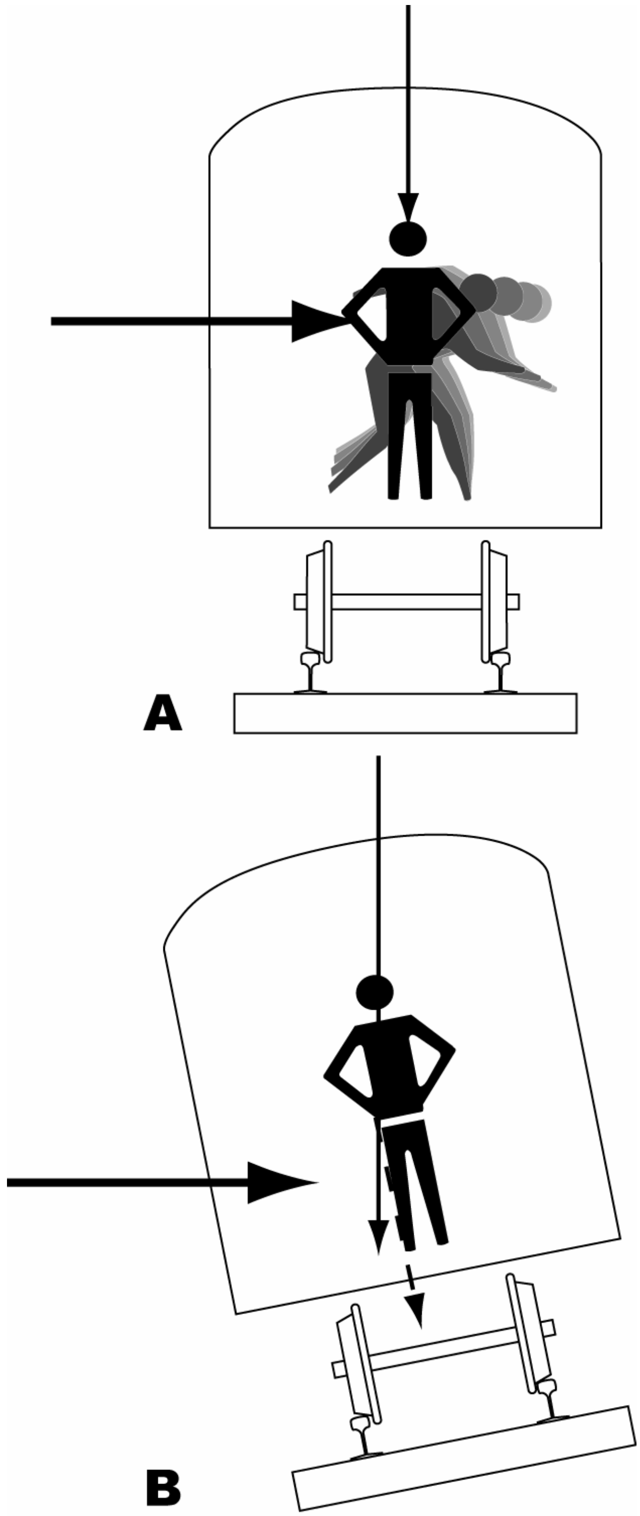
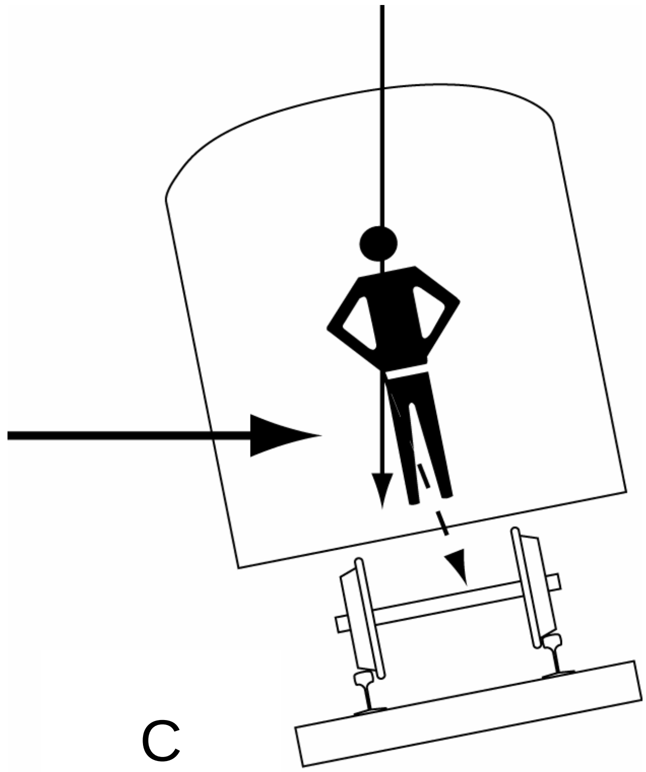


Exhibit 7 (Continued)
Forces on Rail Passengers



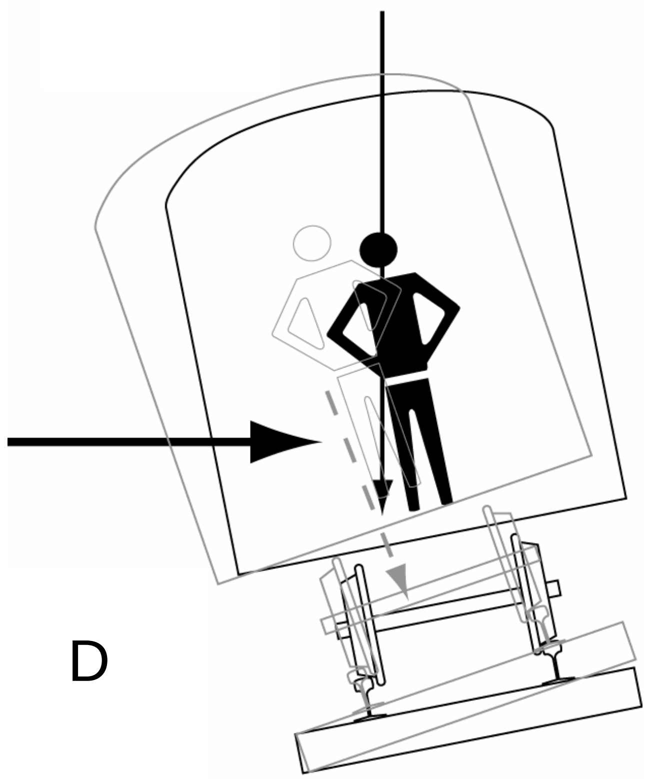


Exhibit 8
Forces on Rail Vehicles on Curves

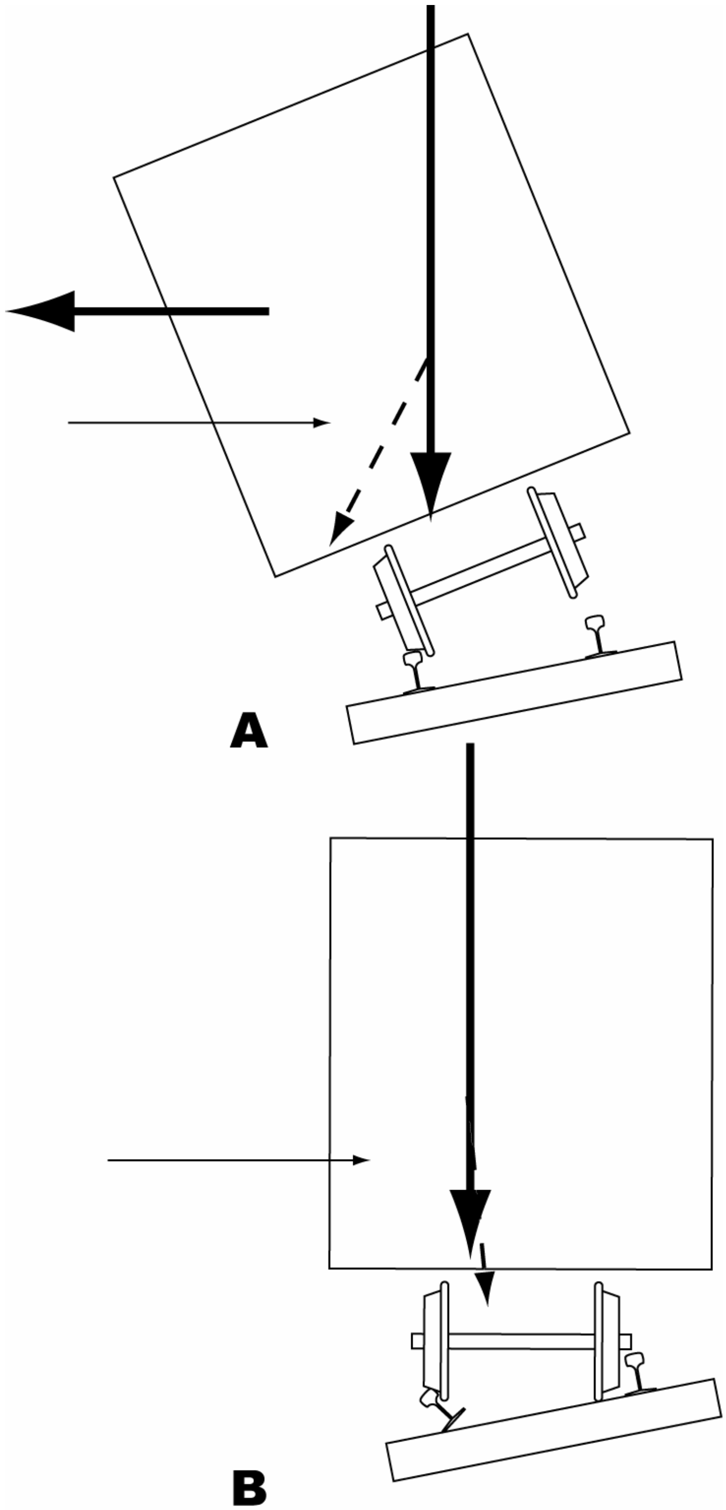


Exhibit 9
Tilting Rail Vehicles

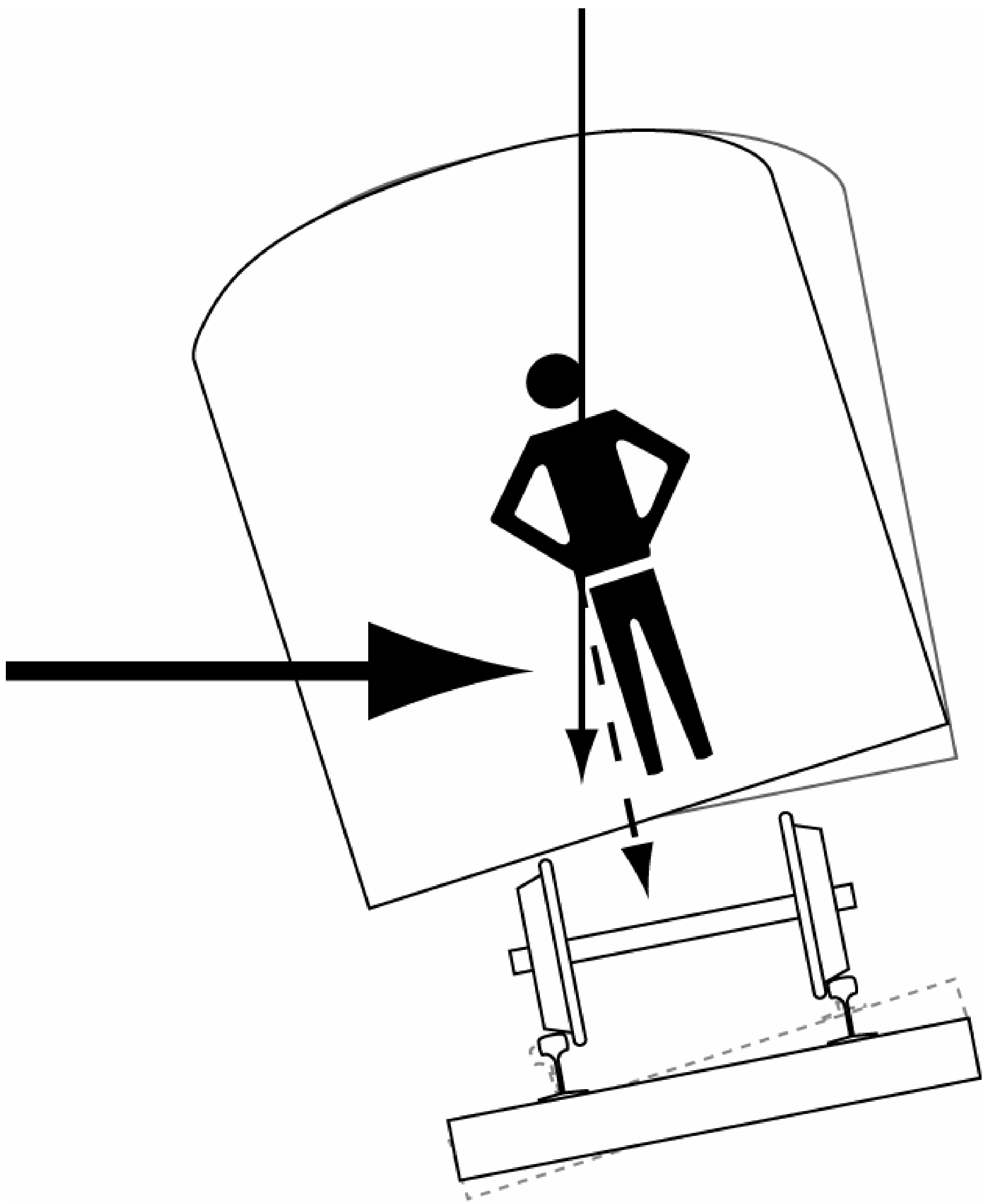


Exhibit 10
Active and Passive Tilt Technologies

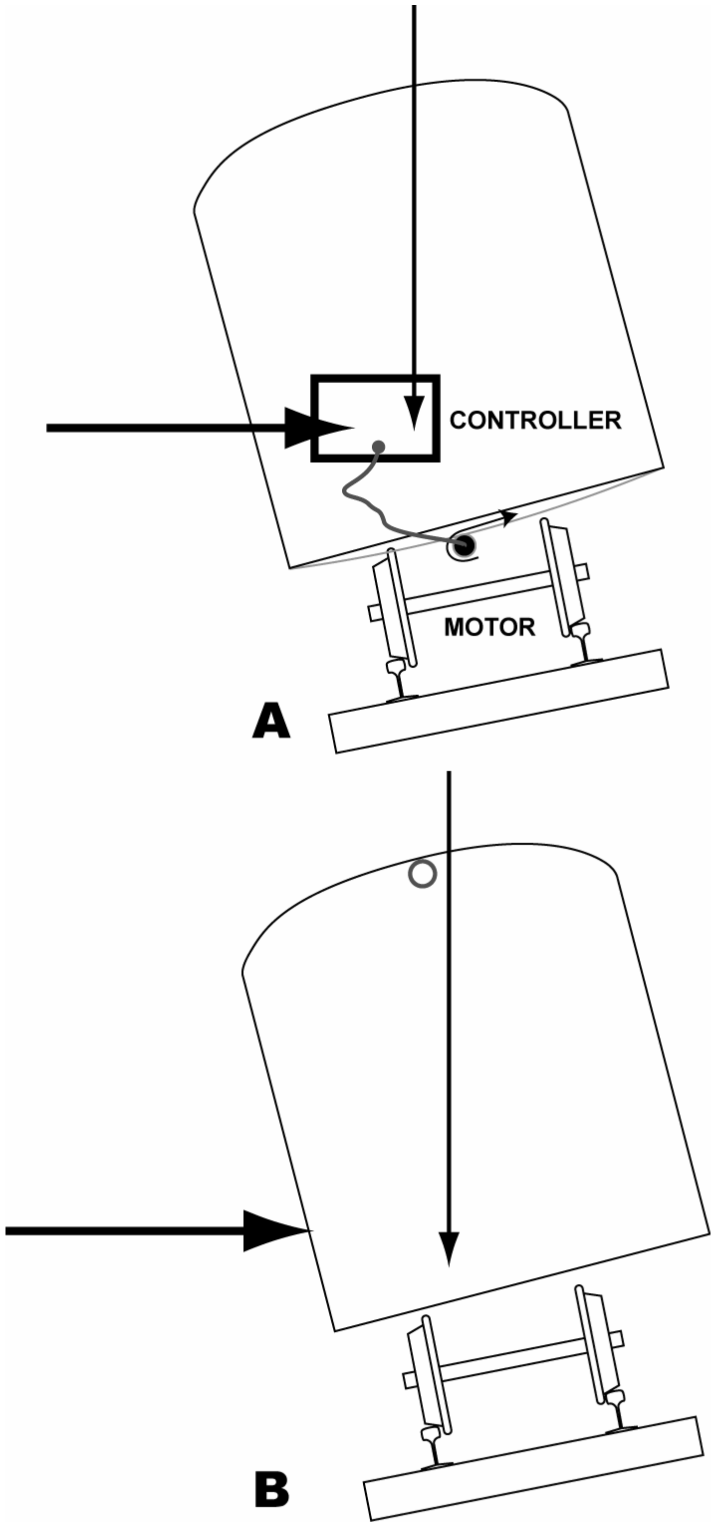
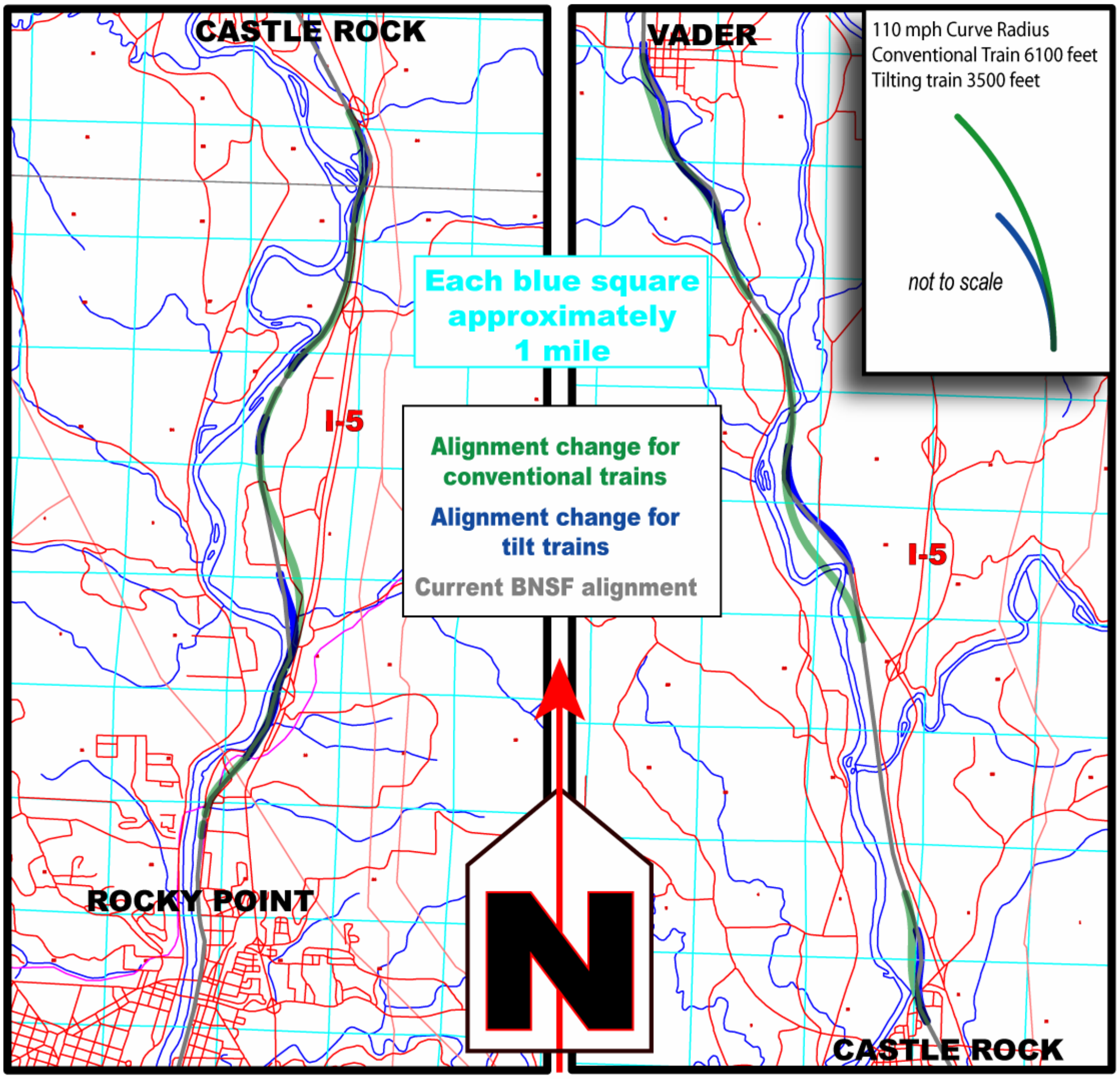


Exhibit 11
Curve Alignments for Conventional and Tilting Trains



Appendix L
Greater Vancouver, BC Terminal Options

Appendix L
Greater Vancouver, BC Terminal Options

The PNWRC program is dependent upon a high degree of passenger train reliability. Ridership depends upon reliable service, as does economy of infrastructure construction. The current Vancouver terminal access arrangement is not acceptable for continued use by Amtrak *Cascades* service.

The Vancouver, BC terminal is not in Washington; however, it is an integral part of the service between Portland and Vancouver, BC. The Washington segment of the corridor cannot be planned in isolation if the program is to be successful. WSDOT has conducted some of the planning in Oregon and British Columbia that is necessary to the current level of planning in Washington. This includes consideration of the Vancouver, BC terminal. This Greater Vancouver Terminal planning is based on research performed by the British Columbia Transportation Financing Authority in 1998.

Previous ridership projections upon which the PNWRC program plans have been based indicate that there will eventually be sufficient market for four Seattle – Vancouver, BC round trips per day with a schedule running time of less than three hours. The current ridership projections indicate that ridership will justify at least five round trips. The ridership projections assume that Pacific Central Station will be the Vancouver terminal of the Amtrak *Cascades* service.

Alternatives Study

In 1998, British Columbia Transportation Financing Authority explored alternative locations for the Vancouver station. There were several reasons for the study. A significant reason was the great infrastructure expense required to provide a dependable, moderate frequency service. There are two parts of the expense; the Fraser River crossing and the condition of the rail line between the Fraser River and Pacific Central Station.

Fraser River Bridge

The popularly known constraint is the Fraser River Bridge; owned by the Canada government and operated by Canadian National Railway. It is single track and 2,550 feet long, including 490 feet of frame trestle and 2060 feet of truss and girder spans. It includes a 380-foot swing span (drawbridge). The bridge was completed in 1904, and is only marginally adequate for modern traffic. The speed limit is fifteen mph for passenger trains and ten mph for freight trains, but the speed limit for all trains on the swing span is eight mph. In the past twenty-five years, the condition of the bridge has dictated speed limits as low as six mph. On BNSF, the south approach to the bridge is a 2,202-foot long single track pile trestle that joins the south end of the Fraser River Bridge at a ten mph turnout. The north approach of the bridge is on a combination of grade and timber trestle; 1.2 miles of single track with a twenty mph speed limit. A train crossing the bridge by way of the BNSF route north and either BNSF or CN south will occupy the single track approach and bridge section for about twenty minutes. Thus, the bridge and approach capacity is about three trains per hour.

Currently, a freight train has time to cross the bridge, provided it is not open for marine traffic, if an Amtrak *Cascades* train is just leaving the Vancouver terminal (southward), or has just left White Rock (northward). A train that is just short of enough time to cross will be delayed about forty minutes (two-thirds of the bridge capacity for an hour).

Marine traffic occupies a significant part of the capacity of the bridge. There are two elements affecting the amount of time that the bridge is open for marine traffic. The channel is difficult to navigate, requiring opening well in advance of a downstream vessel (the bridge has been struck several times and one span was destroyed in a collision about twenty years ago). Also, swing spans are closed and prepared for rail traffic more slowly than lift or bascule spans.

Ongoing study of the Fraser River crossing has not yet provided an acceptable alternative.

Capacity North of the Bridge

The Fraser River Bridge is only part of the impediment to reliable passenger service using Pacific Central Station. There are three significant capacity and reliability constraints between the Fraser River and Pacific Central Station. Most of the freight traffic, over forty trains per day, is operated by Canadian National. Most trains are 6,000 feet or more in length, many exceed 10,000 tons, and all operate at thirty mph or less. The possible effect of these trains on reliable passenger operation is exacerbated by three significant single track segments with very long transit times.

Thornton Yard to New Westminster

The length of the single track segment including the Fraser River Bridge is effectively extended by over a mile because of street crossings that must be kept clear. In many cases, a southward CN train cannot enter Thornton Yard until an opposing train leaves, using the single track segment between the yard and the bridge. The northward train can no longer operate twenty minutes ahead of a passenger train because both tracks would be occupied north of the Fraser River. The required time ahead of the passenger train becomes more than thirty-five minutes. The southward train will be delayed as much as one hour for the passenger train. Marine traffic can increase the delay by over twenty minutes.

The situation is aggravated by the connection to Canadian Pacific just north of the New Westminster BNSF station (at CP Junction.). This track has a speed limit of ten mph and is on a moderate grade ascending northward. A train entering or leaving the BNSF main tracks at CP Junction requires as much time in advance of a passenger train as a train crossing the Fraser River. Under the current conditions northward trains may stall, blocking one of the main tracks for over an hour.

Regardless of capacity calculations, negotiation, or contract requirements, Amtrak *Cascades* trains will be delayed because of these conditions. A railroad will not submit to such extensive delays. This situation is already evident in Oregon. The physical location of the passenger train at the time of the beginning of the delay, as opposed to the clock, is a very powerful force. When a train is stopped at New Westminster for a passenger train that has not yet come on duty in Vancouver or has not left the US at White Rock, it is easy to be convinced that the freight train has time to go.

A third track is needed north of Braid to accommodate a waiting southward train, leaving one track for a northward train from the Fraser River Bridge or the CP Line, and one track for the passenger train. Also, the second main track must be extended to the north end of the Fraser River Bridge, reducing the amount of single track to the minimum possible amount without constructing a double track bridge. There would be four street crossings in the double track section between Brunette and the bridge. The crossings can be kept clear when a southward train is waiting for a northward train without affecting the effectiveness of the extended double track. The southward train is instructed to begin moving south from the northernmost crossing at a time that will allow it to keep moving at the end of double track as if it had been waiting there for the opposing train.

Willingdon Junction to North Vancouver

The single track line between Willingdon Junction and Vancouver is on CN, not BNSF, but it has a significant effect on BNSF traffic. The line passes through a tunnel extending from Willingdon Junction to the Second Narrows Bridge (about two miles), crosses a 2,300-foot bridge over the Second Narrows of the Burrard Inlet, and an approach fill of about 1,000 feet before entering the North Shore yard. The single track length is 3.2 miles. The speed limit north of the bridge is fifteen mph, on the bridge twenty mph, and between the bridge and Willingdon Junction thirty mph. There is a moderate grade ascending from Second Narrows to Willingdon Junction.

The single track running time is about eight minutes, so the longest delay at Willingdon Junction should be about sixteen minutes. The Second Narrows drawbridge can change that significantly. The Second Narrows Bridge channel can be difficult to navigate. Throughout its history, it has been struck by vessels several times. Much of the marine traffic is ocean vessels that can require a significant amount of time to pass. Rail traffic may be held for an hour, depending upon the vessel and atmospheric conditions. A northward CN train on BNSF may wait at Willingdon Junction over an hour for an opposing train. The track arrangement is such that a southward train waiting for the single track at the Fraser River Bridge and a northward train waiting for the single track at Willingdon Junction cause single track operation from south of the Fraser River Bridge to north of Willingdon Junction, about ten miles and about forty minutes running time for a freight train.

Periodically, a northward CN train for the North Shore cannot enter the yard until a specific southward train has left. This situation aggravates the already significant problem. A short term solution has been explored but not implemented; replacing the Douglas Road crossing, 3,000 feet south of Willingdon Junction with a grade separation. It would allow northward trains to clear the Sperling CTC control point while waiting at Willingdon Junction. This would allow about 1.4 miles of double track operation between Piper and Sperling.

Similar to the Fraser River Bridge situation, regardless of capacity calculations, negotiation, or contract requirements, Amtrak *Cascades* trains will be delayed because of these conditions. A railroad will not submit to such extensive delays beyond the already extensive delays for their own traffic. The same potential for delay caused by perception of distance instead of time also applies in this situation.

The long term solution (more than two Seattle – Vancouver, BC trains) is a third track between Sperling and Willingdon Junction. A northward train for the North Shore can wait while allowing one main track clear for the opposing freight train and one main track clear for a passenger train.

Still Creek to Vancouver

The line between Still Creek and Vancouver is single track. Between CN Junction and Pacific Central Station, there is no main track. The track is within a yard and trains must line switches by hand for their route as necessary. The speed limit in this area is fifteen mph. The entrance to two CN yards is at CN Junction. Trains occupy the main track between Still Creek and CN Junction as much as 45 minutes when entering or leaving one of the yards. If a northward Amtrak *Cascades* train has left White Rock, a CN train may not have time to move the 1.3 miles between Still Creek and CN Junction. A freight train can be delayed up to ninety minutes waiting for a passenger train.

The same observation applies to delays on this segment as on the other two; the railroad will not accept such extensive delays and Amtrak *Cascades* trains will be delayed. A second track is required between Still Creek and CN Junction. Reliable operation will also require a CTC or interlocking traffic control system between CN Junction. and Pacific Central Station to eliminate the fifteen mph speed restriction and the need to stop repeatedly to hand throw switches.

Canadian National

Often, some degree of concession or cooperation is expected from a freight railroad. CN opposed the resumption of passenger trains service with the beginning of the Amtrak *Cascades* service. They have opposed the addition of a second train and have opposed a traffic control system between CN Junction and Pacific Central Station. A significant amount of negotiation has taken place thus far and CN may have made some concession toward the second train between Seattle and Vancouver. No concession toward maintaining reliable moderate frequency passenger train service can be expected, however. Unlike the other two passenger services on the line, VIA and Rocky Mountaineer Tours, a delay of only a few minutes to a Amtrak *Cascades* train is substantial. A significant delay because of congestion north of the Fraser River can affect service between Vancouver and Portland, and may result in train cancellation hundreds of miles and many hours distant. Reliable service cannot be expected without the infrastructure construction described. The three single track sections described here have the potential for either significant delay to freight trains or to Amtrak *Cascades* trains. The only alternative is construction of the additional tracks that have been described.

Geological Conditions

The subgrade condition of much of the line between the Fraser River and Pacific Central Station is poor. Between New Westminster and Willingdon Junction, the line passes along the Brunette River, Burnaby Lake, and Still Creek, through a park and conservation area and across wetlands and areas of poor soil conditions. New track must be constructed in these areas. The speed limit on tangent track between the Fraser River and Pacific Central Station is fifty mph because of these conditions. The subgrade problem is exacerbated by the high axle loading (as much as thirty-six tons per axle), of most of the freight trains on the line. Regardless of trackage constructed to accommodate delayed freight trains, the speed limits and running time between the Fraser River and Pacific Central Station will remain generally as they are now.

Other Factors

The population of Vancouver is approximately 560,000 (1999). Pacific Central Station is located in the northwest section of the city. Amtrak

Cascades trains enter the city in the southeast portion and pass through much of the populated area of Vancouver before reaching the station.

The population of Greater Vancouver is approximately two million. Of the population of the Greater Vancouver Regional District living outside of Vancouver, approximately 580,000 are located in Burnaby, New Westminster, and Surrey. A significant number of this population is served by Skytrain. Another 163,000 people live in Coquitlam and Port Coquitlam, just north of New Westminster. Each of these municipalities also has a large business district. Intercity rail service often makes suburban stops near large cities. Amtrak *Cascades* service does not have a suburban Vancouver stop because of the Customs and Immigration processing in the Vancouver station. For the population of the area south and east of the Vancouver business district, the time spent traveling the wrong direction to the station in Vancouver can be more effectively used to drive south instead.

The rail service passes by these municipalities because the Customs and Immigration inspections occur after the train has passed them when arriving and before the train has passed them when leaving. Customs and Immigration inspection at the Vancouver terminal station is important to the service. The previous service was terminated partially because of the exceedingly long time taken by customs and immigration inspection at the border. At the terminal, a person being detained for any reason does not delay the entire train, as is the case at an intermediate border station. Thus, a Scott Road station cannot be an intermediate station.

Greater Vancouver Terminal (Scott Road)

Among the alternatives explored by BCTFA, a terminal station at the Scott Road Skytrain station on the south bank of the Fraser River in Surrey appears most attractive.

The use of Scott Road as a greater Vancouver Terminal is not accepted by all involved parties. The most common reason for opposition to Scott Road as the Greater Vancouver terminal is that ridership is adversely affected by mode change. A common opinion is that if the terminal is not "in Vancouver" will have a dramatic negative effect on ridership. A second objection is that the Scott Road terminal location will cause unusual traffic conditions and additional vehicle trips on the local streets.

Heretofore, no ridership study has tested the theory. A Ridership study that makes an effective assessment must consider what a passenger does at Pacific Central Station after arriving, and the details of the proposed arrangement. The current station is not located at a destination for a significant amount of travel. It is located about 1.2 miles from the center of the downtown business district and one or more miles from the various cruise ship terminals. A mode change to private auto, taxi, bus, or

Skytrain is required upon arriving at the station. Acquisition of a rental car requires a mode change for travel to the downtown business district as well.

The running time of Skytrain between Scott Road and the current Vancouver passenger station is about two minutes longer than the expected running time for Amtrak *Cascades* trains. Skytrain, however, makes eleven stops in eastern Vancouver, Burnaby, and New Westminster, serving two business/commercial areas and a regional population of over 250,000 before reaching the Vancouver passenger station. Beyond the Vancouver passenger station, Skytrain has four stops in the Vancouver downtown business district.

In the opposite direction, Skytrain has three stops in the Surrey business district, all within seven minutes of the Scott Road station, in close proximity to some of the most densely populated area of northern Surrey and a large business district. Avoiding increased street traffic is an important reason for choosing the Scott Road location. The additional population that will be served has access to a fast reliable transit system that makes driving a poor choice.

The Cascade Gateway Rail Study published by Whatcom Council of Governments December 20, 2002 describes the scenario and consequences that are commonly envisioned. It recommends a circuitous low speed route of three times the direct distance between the BNSF line and the station location. The station is a separate facility, about five hundred feet form the Skytrain transit station. The Amtrak *Cascades* Scott Road station is effectively offered in the study as the destination of travel into Canada and the origin of travel leaving Canada. The opinion in the study is that a terminal station will dramatically reduce ridership. The opinion is probably correct, given the situation introduced by the study.

A terminal at Scott Road is not as simple as building a track to the vicinity of the Skytrain station and building a platform and Customs facility. To function as desired, the Scott Road terminal must have an unusual mode change; as transparent as possible to passengers:

- Skytrain loop or wye and separate station dedicated to Amtrak *Cascades* Skytrain service;
- Amtrak *Cascades* and Skytrain services use the same platform or adjacent platforms for cross-platform transfer;
- Customs processing on the platform between the trains or between platforms;
- Dedicated Skytrain equipment in a Amtrak *Cascades*-service-like color scheme, equipped consistent with the needs of Amtrak *Cascades* service passengers (such as more comfortable seating,

space for luggage, and signage specifically for people not familiar with the area);

- Several Skytrain vehicles are required to accommodate the passengers from one Talgo train. Thus, passengers need not wait long for a departure after leaving the customs facility;
- An attendant (perhaps Amtrak *Cascades* crewmembers traveling between the Scott Road terminal and a crew facility at Pacific Central Station) may be stationed in each of the Skytrain vehicles assigned to Amtrak *Cascades* service to assist passengers and provide information;
- Pacific Central Station performs its current function. The only difference is that the Amtrak *Cascades* trains arrive and leave on the Skytrain tracks. An enclosed passageway between the Skytrain platform and Pacific Central Station facilitates passenger transfers;
- Integrated Amtrak *Cascades*/Skytrain fare;
- Integrated Amtrak *Cascades*/Skytrain scheduling with published Amtrak *Cascades* times along the Skytrain route; and
- The terminal station must be named for Vancouver in some way (Greater Vancouver Terminal), not for the local area of the station (Scott Road or Surrey).

The planning work associated with the Amtrak *Cascades* operating plan update used the above assumptions for a single ridership study, and found that ridership increased by seven percent.

Full implementation of the Amtrak *Cascades* service using the current Vancouver station has some apparently significant disadvantages.

The cost of the Skytrain connection would likely be less than the cost of the infrastructure improvement needed for frequent passenger train service into Vancouver on the BNSF route. The cost would be about seventy-five million U.S. dollars including the track connections and station facility. This amount is less than half the amount required to extend the full Amtrak *Cascades* service to the current Vancouver passenger station (or approximately the same if the cost of the Fraser River Crossing is not considered a passenger service cost). An additional amount may be necessary for vehicles, but the full cost will remain less than the cost (including the cost of a new Fraser River Crossing) of using Pacific Central Station for the full implementation of Amtrak *Cascades* service.

Effect on Operation

The timetable, crew plan, and equipment plan are the same whether the terminal is at Scott Road or Pacific Central Station. The operating plan is the same for either terminal.