PORT OF LONGVIEW
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Transportation Optimization Plan Report

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1. Executive Summary

1.1. Purpose, Goals and Objectives

The Transportation Optimization Plan (TOP) is expected to provide the Port with understanding of, and recommendations for, the ability to move unit and manifest rail services through the Port's current and proposed rail and road infrastructure.

The analysis included an assessment of current rail infrastructure and operations, planned improvements currently undergoing design and engineering, as well as potential infrastructure improvements and rail traffic growth that could occur as a result of growth or addition of industrial activities and operations at the Port. The primary objective of the TOP analysis was to determine how freight movement and efficiency could be sustained in a broad range of scenarios, while minimizing rail and vehicle/truck traffic conflicts internally and externally at the Port.

The TOP project included a detailed analysis of rail and motor vehicle movement through the Port, accounting for forecast growth in rail traffic volume and planned rail improvements, and develop recommendations on how to mitigate or limit impacts to customers, tenants, adjacent industrial properties, and local and state roadways. Rail and vehicle movements analyzed included:

- Rail movements from the Class 1 mainline / Longview Switching Company Yard through the Port's existing industrial rail corridor and the proposed industrial rail corridor expansion (IRCE);
- Rail movements from the IRCE to the Port's current internal rail infrastructure with the current customer usage;
- Rail movements from the IRCE to the Port's proposed internal rail infrastructure, reflecting multiple phases of infrastructure improvement and including projected growth in rail traffic from tenants/customers/adjacent property users, and the forecast rail usage of expanded or new developments at Bridgeview Terminal and Berth 4;
- Vehicle and truck movements for ingress, egress, and internal to, the Port's current, proposed, and future road systems in relation to the rail movements described above;
- Vehicle/truck movements to and from the local and state road network in consideration of the Port's current, proposal and future rail movements described above.

1.2. Existing Conditions

The Port is centrally located on a main rail line served by both BNSF and UPRR. Conflicts and inefficiencies that exist when operating the rail infrastructure at current utilization levels will be exacerbated by increased rail traffic to the Port, particularly with the addition of unit train operations.

The planning area for this study includes the 381-acre industrial area between the Columbia River and the existing track along the northern edge of the Port, as well as the roadway network within an area of approximately 72 acres between the Port and Industrial Way (State Route 432), and the Industrial Rail Corridor from the Port's industrial complex to the Longview Switching Company yard.

Generally, freight rail movements pass through two yards, Longview Interchange Yard (LIY) and Longview Switching Yard (LSY) after leaving the mainline and before entering the Port. Trains typically arrive and depart the Port via the Industrial Rail Corridor (IRC) which stretches west from the LSY to the Port. From the west end of the IRC, additional tracks provide access to port terminal and berth areas.

Movements to and from the Port are performed by the Longview Switching Company (LSC). Typically LSC moves cuts of railcars into and out of the Port, but individual Port tenants have the capability to move smaller cuts of railcars within certain areas of the Port (loading/unloading individual cars for example). Generally, LSC moves railcars to and from Bridgeview Terminal and Berth 5 using tracks along the north and west sides of the Port, and moves railcars to and from Berths 6, 7 and 8 using the S-curve tracks. LSC typically moves railcars to and from the Port once daily, generally in the afternoon between 3 PM and 5 PM.

1.3. Planning Scenarios

Multiple scenarios were developed to evaluate how a broad range of potential changes in rail operations, infrastructure and levels of rail traffic would affect rail and vehicular transportation at the Port. Scenarios were not based on the operating requirements of specific existing or potential Port tenants or users and the scenarios were not intended to identify a preferred outcome or scenario. Rather, the scenarios were developed to capture a range of potential but feasible outcomes.

In 2018 total rail traffic at the Port was 9.4 million tons. Planning scenarios evaluated in the TOP project included a range of potential growth that would increase total rail traffic by as much as 9.7 million tons, to a total of 19.1 million tons.

Planning scenarios also evaluated multiple potential configurations for on-terminal rail infrastructure improvement, and multiple scenarios for train arrival and departure operations.

1.4. Rail Modeling and Analysis

Demand for IRC tracks and timing of at-grade rail crossing blockages at International Way were assessed through creation of a 14-day dynamic simulation model for each of the planning scenarios. Each scenario incorporated a set of typical operating parameters derived from interviews with Longview Switching Company and Port of Longview staff, and historical train operations data. Simulation results based on typical operating conditions show that the peak demand for new IRC expansion tracks for the scenarios modeled varies from 3 to 4 over the two week modeling analysis period, indicating that a minimum of four new IRC tracks would be required to accommodate typical operating conditions for the scenarios evaluated. To accommodate occasional impacts to typical operating conditions such as delays in train departures or arrivals, mechanical issues affecting railcars or locomotives, or track maintenance activities, 5 or 6 IRC expansion tracks would be required.

1.5. Traffic Analysis

The planning scenarios would increase rail loading/unloading capabilities at the Port of Longview, and increase the number and frequency of train arrivals and departures. Full unit trains would block all the western access points to the Port of Longview - including Terminal Way, Panel Way and North Tie Road - for long periods of time while waiting to be unloaded. This would functionally close these access points and require traffic to enter and exit the Port area via International Way.

The at-grade track crossing at International Way would be blocked intermittently during train arrivals and departures. Full unit trains moving through the crossing would typically block vehicle traffic for 15 minutes. If all traffic has to use International Way, one full unit train crossing during the peak morning traffic period would cause traffic arriving to the Port to queue back onto SR 432, and likely result in unacceptable delays for vehicular traffic. Half-train cuts would cause queues beyond Columbia Boulevard, with much lower delays to traffic.

Based the results of our analysis, a grade-separated access to the Port of Longview is recommended for any rail operating plan that would typically include arrival and departure of full unit trains during daytime hours (about 6:00 A.M. to 7:00 P.M...). Until a grade-separated access is developed, full unit trains could be moved during overnight hours (between 7:00 PM and 6:00 AM), and half train cuts could be moved any time without creating unacceptable delays for vehicular traffic.

2. Introduction

2.1. Purpose, Goals and Objectives

The Transportation Optimization Plan (TOP) is expected to provide the Port with understanding of, and recommendations for, the ability to move unit and manifest rail services through the Port's current and proposed rail and road infrastructure.

The analysis included an assessment of current rail infrastructure and operations, planned improvements currently undergoing design and engineering, as well as potential infrastructure improvements and rail traffic growth that could occur as a result of growth or addition of industrial activities and operations at the Port. The primary objective of the TOP analysis was to determine how freight movement and efficiency could be sustained in a broad range of scenarios, while minimizing rail and vehicle/truck traffic conflicts internally and externally at the Port.

The Port is in the planning and engineering phase of an expansion of the Industrial Rail Corridor (IRC). The IRC expansion (IRCE) will supplement the existing two track corridor with the addition of up to six additional tracks in the IRC, increasing the number of tracks in the IRC to a maximum of eight. Additionally, the Port recently completed a rail planning effort and developed rail concepts for improvements throughout the internal rail system to improve current customer rail throughput and to accommodate a potential unit train served facility at Berth 4, this planning effort is documented in the Port of Longview Integrated Planning Grant (IPG) Redevelopment Strategy Report, April 2019. The rail planning effort also anticipates the removal of the Continental Grain silos to facilitate increased rail movement through the Bridgeview Terminal (Berth 2), and the development of a unit train served facility at Berth 2 as well. Port industrial tenants and adjacent industrial operations that utilize Port rail and road infrastructure are also anticipating increased volumes, and the Port is planning to relocate its main office and gate functions to a building known as the White House at 10 International Way, which will redirect a significant volume of roadway traffic at the Port.

The TOP project included a detailed analysis of rail and motor vehicle movement through the Port, accounting for forecast growth in rail traffic volume and planned rail improvements; and development of recommendations on how to mitigate or limit impacts to customers, tenants, adjacent industrial properties, and local and state roadways. Rail and vehicle movements analyzed included:

- Rail movements from the Class 1 mainline / Longview Switching Company Yard through the Port's existing industrial rail corridor and the proposed industrial rail corridor expansion (IRCE);
- Rail movements from the IRCE to the Port's current internal rail infrastructure with the current customer usage;
- Rail movements from the IRCE to the Port's proposed internal rail infrastructure, reflecting multiple phases of infrastructure improvement and including projected growth in rail traffic from tenants/customers/adjacent property users, and the forecast rail usage expanded or new developments at Bridgeview Terminal and Berth 4;
- Vehicle and truck movements for ingress, egress, and internal to, the Port's current, proposed, and future road systems in relation to the rail movements described above.

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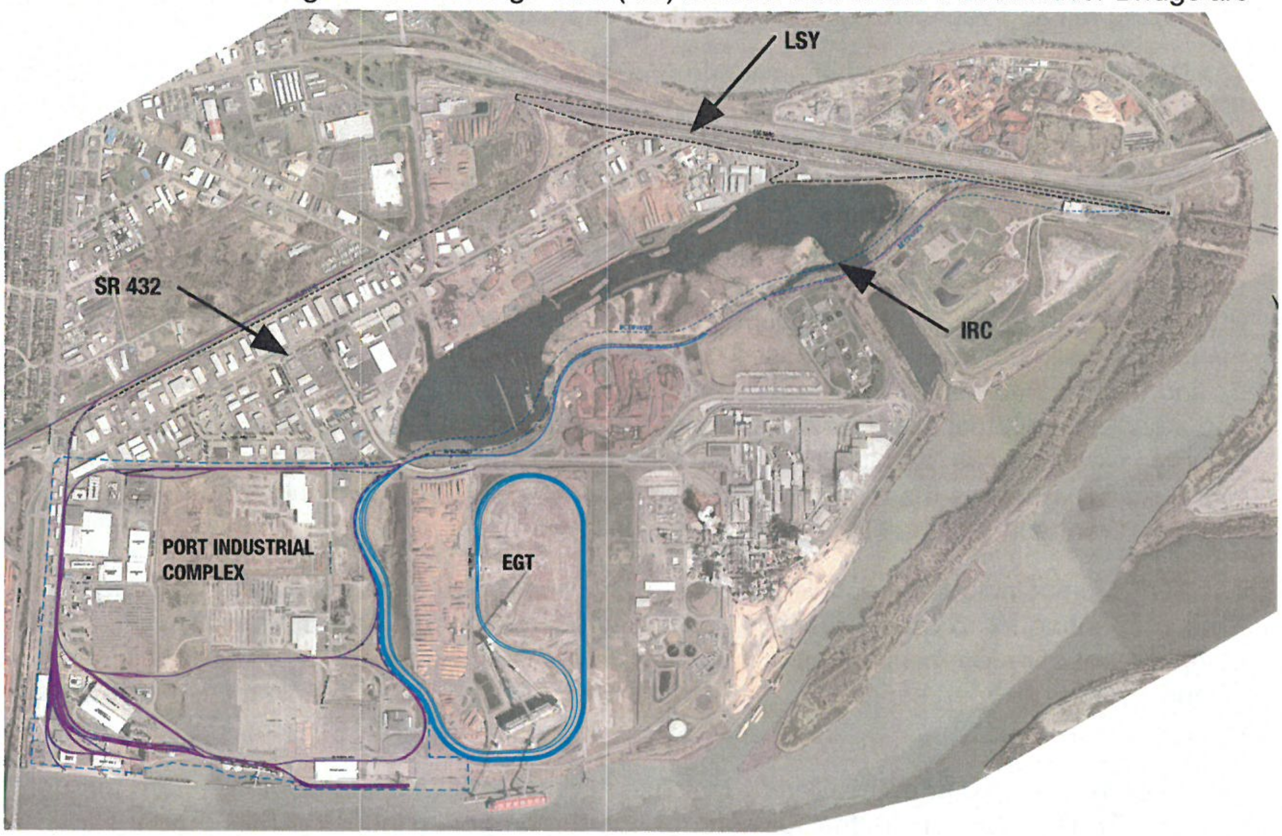
- Vehicle/truck movements to and from the local and state road network in consideration of the Port's current, proposal and future rail movements described above.

2.2. Planning Area

The planning area for this study includes the 381-acre industrial area between the Columbia River and the existing track along the northern edge of the Port, as well as the roadway network within an area of approximately 72 acres between the Port and Industrial Way (State Route 432), and the Industrial Rail Corridor from the Port's industrial complex to the Longview Switching Company yard. The Export Grain Terminal (EGT) is served by on-terminal loop tracks and the existing IRC tracks, and it is not directly affected by or included in the planning area. The limits of the Planning Area are depicted on Figure 1. The Longview Switching Yard (LSY) at the east end of the IRC and the Longview Interchange Yard (LIY) located east of the Cowlitz River Bridge are



not owned or operated by the Port and were not included in this study.

Figure 1: TOP Planning Area

2.3. Planning Process

The planning process for the TOP included:

Step One: Information Gathering. Collection and review of mapping and background information previously prepared by the Port, including Conceptual Rail Plans, and the Integrated Planning Grant Report (April 2019).

Information gathering meetings and interviews with Port staff and LSC staff were conducted to document:

- Existing conditions
- Opportunities and constraints
- Rail operating parameters
- Existing rail volumes, schedules and composition
- Potential growth or change in rail volumes, schedules and composition

Based on document review and meeting discussions, objectives to be used for the development of rail infrastructure concepts and operating scenarios were identified. Operating parameters and assumptions were identified for use in the analysis of rail activity, and performance indicators for evaluation of the scenarios were determined.

Step Two: Definition of Rail Concepts and Operations. Beginning with the multi-phase Conceptual Rail Plans developed for the Integrated Planning Grant, additional concepts for rail infrastructure within the Port were created based on the objectives and parameters set in Step One.

Based on the parameters for rail traffic established in Step One and the rail infrastructure and operating concepts created in Step Two anticipated operating procedures were defined for future train movements through and between the Class 1 railway mainline, existing IRC, IRCE, and the internal Port railway network.

Step Three: Analysis and Modeling of Rail Infrastructure and Operations. Multiple scenarios representing a range of potential development at the Port were modeled. Each scenario was assessed using a series of performance indicators including rail traffic volume, road blockages, train lengths, train frequency and train delay.

Step Four: Analysis and Modeling of Vehicle Traffic. Vehicle traffic data was collected and compiled to understand access and egress patterns by time of day and location, and to provide intersection turning movement counts needed to model traffic operations. Synchro traffic operations and SimTraffic simulation models were developed for the study area reflecting the existing conditions and future forecast conditions. Highest hourly traffic volumes were used along with forecast rail crossing blockages for each rail scenario to test roadway network improvements that would be required to maintain acceptable operating parameters (e.g., acceptable level of delay, queuing, etc.).

3. Existing Conditions and Operations

3.1. Existing Rail System

The Port is centrally located on a main rail line served by both BNSF and UPRR. Conflicts and inefficiencies that exist when operating the rail infrastructure at current utilization levels will be exacerbated by increased rail traffic to the Port, particularly with the addition of unit train operations.

Generally, freight rail movements pass through two yards, Longview Interchange Yard (LIY) and Longview Switching Yard (LSY) after leaving the mainline and before entering the Port. Trains typically arrive and depart the Port via the Industrial Rail Corridor (IRC). Two IRC tracks expand to seven and those seven are collectively referred to as the S tracks, and they provide access to the central Port complex along the eastern edge and to EGT. The IRC also connects to a pair of tracks just west of Fibre Way, and those tracks continue along the north side of the Port with siding connections to neighboring properties before turning south and continuing to Bridgeview Terminal, Berth 4 and Berth 5.

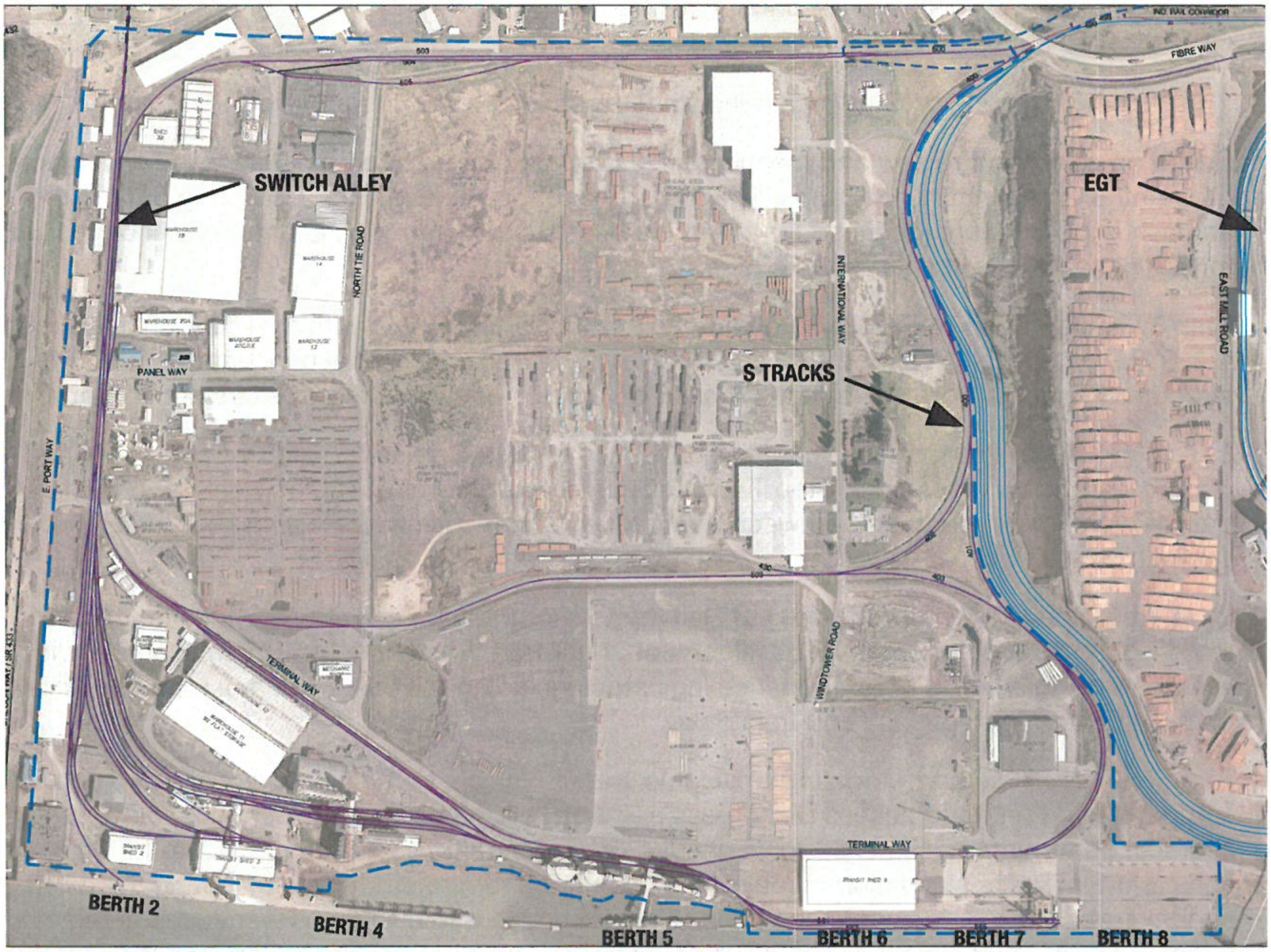


Figure 2: TOP Planning Area

The tracks along the west side of the Port are interconnected through a series of switches and crossovers known as "Switch Alley". There is a connection at the south end of Switch Alley to two tracks that run along the north perimeter of Warehouses 10 and 11. The remaining tracks continue south before splitting into the storage and working tracks that serve Bridgeview Terminal (Berths 1 and 2).

A total of seven relatively short storage tracks are located in the southwest corner of the Port near Berth 2. These tracks are stub-ended (thus limiting train movement on the tracks to push-and-shove) and blocked by the existing Berth 4 Silo Complex. Three tracks, north of the storage tracks, pass through the Berth 4 Silo Complex and join the two tracks that run north of Warehouses 10 and 11. These two tracks continue eastwards along Berth 5 and connect to the S tracks near Berth 8. Just east of Berth 5, one track connects to three on-dock stub-ended tracks on the waterside of Transit Shed 6 fronting Berths 6 and 7.

An additional rail runs north of the upland laydown area. The track connects just north of Warehouse 10 and splits into a wye as it crosses International Way where it connects to the S tracks.

3.2. Current Rail Operations

Movements to and from the Port are performed by the Longview Switching Company (LSC). LSC moves cuts of cars, but individual tenants have the capability to move smaller cuts within certain areas of the Port (loading/unloading individual cars for example). Generally, LSC moves railcars to and from Bridgeview Terminal and Berth 5 using tracks along the north and west sides of the Port, and moves railcars to and from Berths 6, 7 and 8 using the S-curve tracks. LSC typically serves the Port once daily, generally this occurs in the afternoon between 3 PM and 5 PM.

Unit trains are moved to and from EGT by Class I railroad crews and these trains remain intact (locomotives and cars) from arrival through unloading and departure. Generally, arriving EGT trains pass through the Longview Interchange Yard, continue west on the existing IRC tracks, and land on the arrival tracks within the EGT terminal area.

4. Planning Scenarios

Multiple scenarios were developed to evaluate how a broad range of potential changes in rail operations, infrastructure and levels of rail traffic would affect rail and vehicular transportation at the Port. Scenarios were not based on the operating requirements of specific existing or potential Port tenants or users and the scenarios were not intended to identify a preferred outcome or scenario. Rather, the scenarios were developed to capture a range of potential but feasible outcomes.

Each of the scenarios was evaluated to assess:

- How existing rail infrastructure could be used to support increased rail activity
- Utilization or demand for tracks in the Industrial Rail Corridor
- Impacts to vehicle transportation at the Port

4.1. Rail Traffic Growth Scenario

Recent annual rail carload volumes at the Port are summarized in Table 1 below:

Facility	Carloads								Tonnage (million tons)
	2011	2012	2013	2014	2015	2016	2017	2018	2018
Berth 2	2,454	1,834	4,262	3,889	5,178	2,371	5,846	5,604	0.56
Berth 4	0	0	0	0	0	0	0	0	0.0
Berth 5	7,740	6,383	8,145	8,231	8,259	8,318	8,008	7,458	0.74

Facility	Carloads								Tonnage (million tons)
	2011	2012	2013	2014	2015	2016	2017	2018	2018
EGT (Berth 9)	0	41,601	45,756	55,797	39,509	58,894	63,752	72,003	8.1
Total	10,194	49,818	58,163	67,917	52,946	69,583	77,606	85,065	9.4

Table 1: Recent Annual Carload Volumes

For use in evaluation of scenarios, a hypothetical forecast for growth in rail traffic was developed, reflecting modest growth at Berths 5 and 8, and the addition of unit train service at Berth 2/Bridgeview Terminal and Berth 4. The annual carloads and tonnages for the hypothetical forecast are summarized below in Table 2:

Facility	2018 Actual			Forecast				
	Tonnage (million tons)	Railcars	Trains/ Week (linear)	Tonnage (million tons)	Railcars	Trains/ Week (linear)	Peak Factor	Trains/ Week (Peak)
Berth 2	0.56	5,604	0.90	3.00	26,670	4.27	1.2	5.12
Berth 4	0.00	0	0.00	6.00	53,340	7.22	1.2	8.66
Berth 5	0.74	7,458	1.20	1.00	8,890	1.42	1.2	1.70
Berth 8				1.00	9,433	181 cars	1.2	217 cars
EGT (Berth 9)	8.10	72,003	11.54	8.10	72,000	11.54	2.0	23.08
Total	9.40	85,065	13.64	19.1	160,900	24.45		38.56

Table 2: Hypothetical Annual Carload and Tonnage Forecast

4.2. Infrastructure and Operations Scenarios

The **Base Case** scenario assumes that the following infrastructure and operations changes have occurred relative to the existing (2020) conditions:

- North Rail Connection project has been completed.
- Rail volumes at Bridgeview Terminal have increased to five, 142-car, unit trains per week using the existing dump pit B at Berth 2.
- Longview Switching crews deliver unit trains for Bridgeview Terminal using the existing IRC tracks (Siding 1A), trains are broken into half train cuts and pushed down switch alley to avoid blocking the at grade track crossing on International Way.

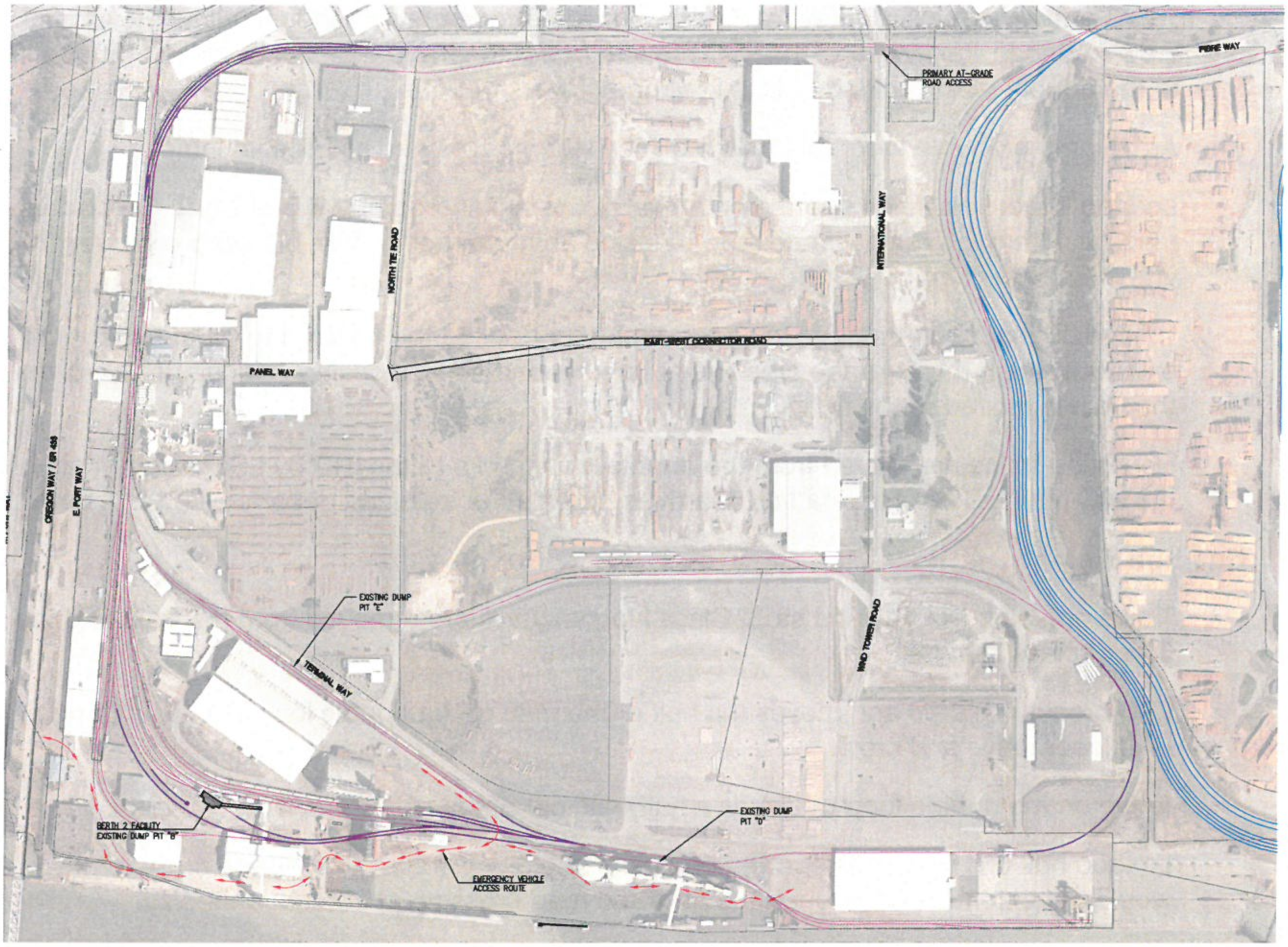


Figure 3: Base Case Scenario

The **Double Loop** scenario assumes that the following infrastructure and operations changes have occurred relative to the existing (2020) conditions:

- North Rail Connection project has been completed.
- Expansion of the IRC has been completed.
- Rail volumes at Bridgeview Terminal have increased to a peak of five, 142-car, unit trains per week using the existing dump pit B at Berth 2.
- A new bulk export facility has been developed at Berth 4, including a new dump pit and storage. During the peak period of the year, the Berth 4 facility receives nine, 142-car, unit trains per week.
- Double loop tracks have been constructed for handling of arriving and departing unit trains at Bridgeview Terminal and the Berth 4 Facility.

The **Double Loop** was analyzed for operation in two different modes, with intact unit trains and half unit trains. The differences in these modes are summarized as follows:

Intact Unit Trains

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- Trains arrive via the IRC, they may stop on the IRC for a crew change to allow the Class I crew to depart the train and the LSC crew to board the train. Trains are moved from the IRC to the double loop tracks by Class I railroad crews or LSC.
- Arrive on the double loop tracks with Class I locomotives and all rail cars intact.
- Loaded intact unit trains spotted on arrival at the existing dump pit B at Berth 2 would extend back through the at-grade road crossing at International Way, blocking vehicular traffic until train unloading begins.
- Unloaded intact unit trains spotted for departure beyond the new dump pit at Berth 4 would extend through the at-grade crossing at International Way, blocking vehicular traffic until the train is moved to the IRC.
- Departing trains are moved from the double loop tracks to the IRC by LSC, and remain on the IRC until a Class I railroad crew arrives, boards the train and departs with the train.

Half Unit Trains

- Trains arrive on the IRC and stop. Class I locomotives are removed from the train and the Class I crew departs.
- LSC breaks the train and moves the half of the train to the double loop tracks, utilizing a LSC locomotive and crew.
- Arrive on the double loop tracks as a half train cut of cars (approximately 71 cars).
- Loaded half unit train cuts spotted on arrival at either the Berth 2 or Berth 4 dump pits would not extend back through the at-grade road crossing at International Way.
- Unloaded half unit trains spotted for departure at either the Berth 2 or Berth 4 dump pits would not extend through the at-grade crossing at International Way.
- Unloaded half unit trains are moved from the double loop tracks to the IRC by LSC. When the second half of a train is unloaded and moved to the IRC, the train halves are coupled, braking system is charged with compressed air and tested, and the train is inspected.
- Following testing and inspection, the train is ready for departure. The train remains on the IRC until a Class I railroad crew arrives, boards the train and departs with the train.

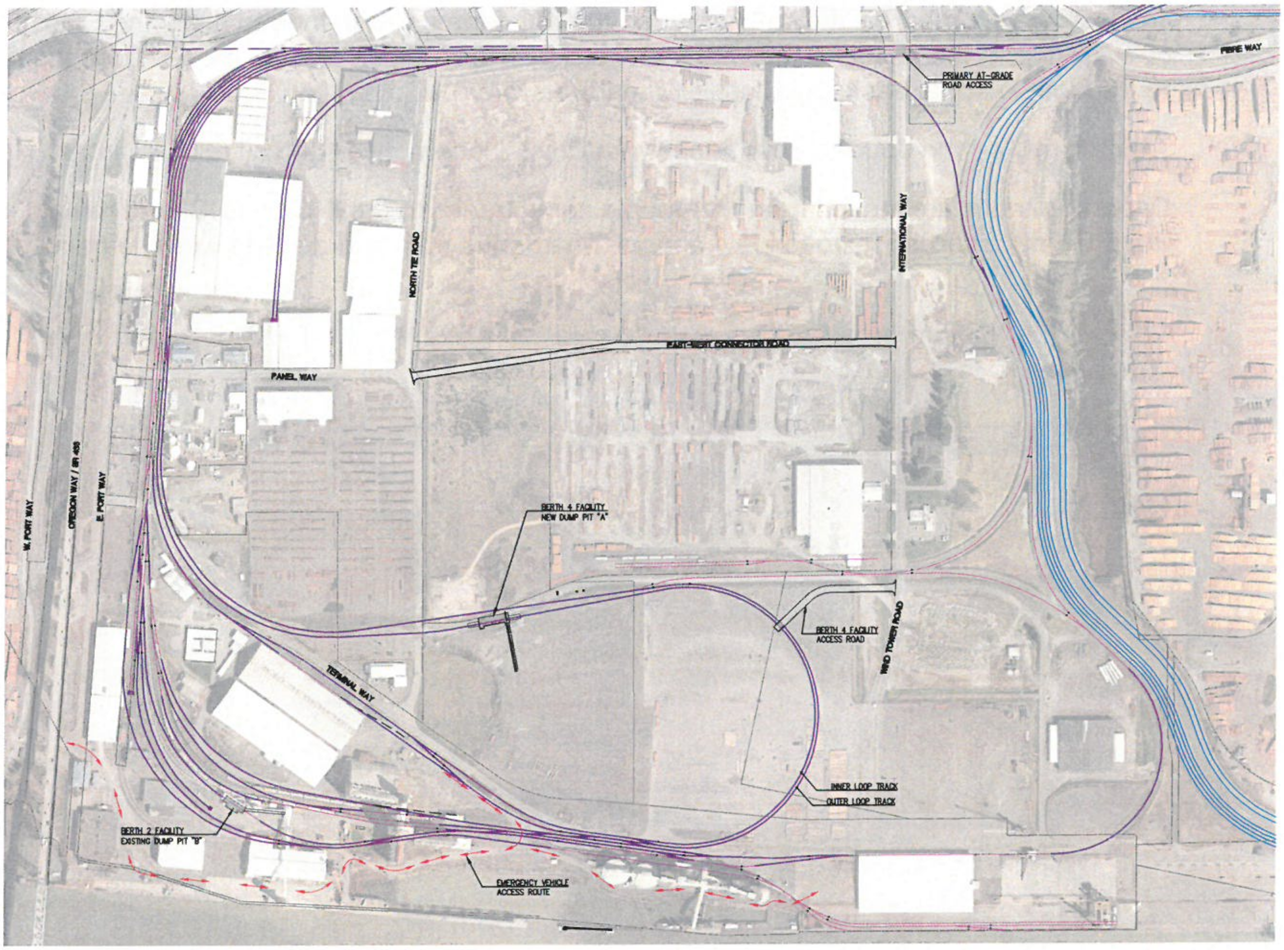

Figure 4: Double Loop Scenario

The **Double Spiral** scenario assumes that the following infrastructure and operations changes have occurred relative to the existing (2020) conditions:

- North Rail Connection project has been completed.
- Expansion of the IRC has been completed.
- Double spiral tracks have been constructed for handling of arriving and departing unit trains at Bridgeview Terminal and the Berth 4 Facility.
- Multiple tracks have been constructed north of Berth 5 to create a loop at the southern end of the S tracks. The S tracks and loop tracks are used for arrival and departure of trains serving Berths 5, 6, 7 and 8.
- Rail volumes at Bridgeview Terminal have increased to a peak of five, 142-car, unit trains per week using a new dump pit with storage.
- A new bulk export facility has been developed at Berth 4, including a new dump pit and storage. During the peak period of the year, the Berth 4 facility receives nine, 142-car, unit trains per week.

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- Trains arrive via the IRC, they may stop on the IRC for a crew change to allow the Class I crew to depart the train and the LSC crew to board the train. Trains are moved from the IRC to the double spiral tracks by Class I railroad crews or LSC.
- Trains arrive on the double spiral tracks with Class I locomotives and all rail cars intact.
- Departing trains are moved from the double spiral tracks to the IRC by LSC, and remain on the IRC until a Class I railroad crew arrives, boards the train and departs with the train.

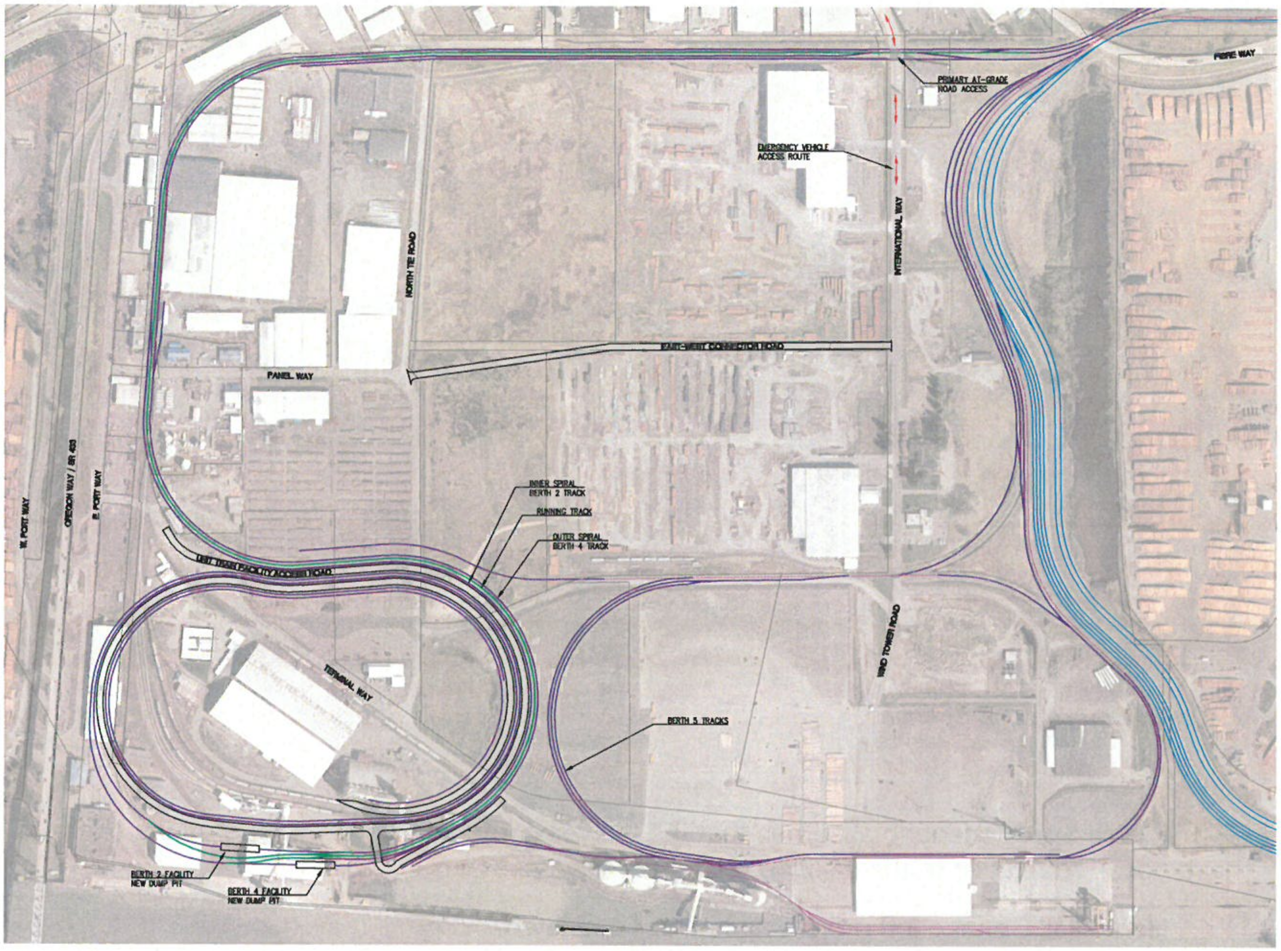


Figure 5: Double Spiral Scenario

5. Rail Modeling and Analysis

5.1. Analysis Objectives

Dynamic simulation modeling provides the ability to compare a variety of conceptual rail configurations and operating plans. For the Transportation Optimization Plan, the focus of the rail modeling is to measure Industrial Rail Corridor (IRC) requirements and the use of Port of Longview tracks for rail movements between the IRC and the terminals across a range of scenarios. Rail modeling includes the perspective of time and measures track usage by time of day. For the

Port of Longview, train arrival and departure patterns, labor work schedules and train unloading times significantly influence the timing and duration of track usage.

The IRC tracks are in close proximity to key at-grade rail and road crossings and the rail modeling effort provides an accounting of the timing and duration of crossing events. These events and timings were incorporated in detailed traffic modeling to measure vehicle hours of delay as rail volume is increased, as discussed in Section 6.2 of this report.

5.2. Analysis Approach

Dynamic simulation modeling was used for the analysis of the usage of IRC tracks and timing of switching requirements. A custom model was built upon AnyLogic, a commercially available simulation software program, that includes process and systems modeling and offers the flexibility to analyze different options for this study.

The primary use of the IRC track expansion is to support increased Unit Train service to Berths 2 and 4. The modeling supports the analysis objectives by including the movements and timings of Berth 2 and 4 unit trains between the IRC tracks including the timings of:

- Class I Rail Carrier: Arrival and departure of full length unit trains to and from IRC tracks or directly into terminal tracks (based on scenario)
- Longview Switching Company: Switching of intact unit or partial trains (based on scenario) between IRC and terminals using Port tracks
- Longshore Workers: Movement of intact or partial trains within terminal tracks

Modeling of rail movements across two weeks of operations included factors to replicate realistic variability associated with Class I Rail interactions. For the Class I Rail Carrier operations, the timings of train arrivals and departures were incorporated in the models as estimates with random variability of up to 2 hours.

The Longview Switching Company (LVSC) switching movements are based on time estimates to pull and deliver intact or partial trains between IRC tracks and hold points on Port tracks to interface with terminal longshore workers. The longshore worker steps to unload rail cars are based on berth unloading equipment average rates and estimates of timings to move trains/cars to hold points on Port tracks for interface with LVSC. The timing and availability of rail cars to be switched by LVSC is constrained in the models by the longshore work schedules and the rules for train delivery and departure outlined in the Model Assumptions below.

LVSC provides rail switching for Berths 5 through 8 from the Longview Switching Yard and are included as daily scheduled "jobs" that use IRC tracks as pass-through tracks to Port tracks and into their terminals. The estimated times for these jobs are included in the modeling and their need to use the IRC tracks.

Model Assumptions

The model is based on assumptions derived from interviews with Longview Switching Company and those discussed during Port of Longview interim project review meetings. The key assumptions used in the modeling include:

Unit Train Operations

- Target Unit Train turnaround time in Port is 24 hours.
- Unit trains are coordinated and managed by cooperatives and expected to have consistent and timely arrival for efficient unloading. Unit trains are not typically sent to Port in unmanageable bunches or stored at the Port.
- Typical unit train length is 8,500 feet including approximately 250 feet of locomotive length and up to 8,250 feet of car length. Half train movements were modeled to include up to 4,150 feet of car length.

Class I Rail Carriers

- The Class I Rail Carriers use the IRC or terminal tracks (depending on scenario) to arrive trains by their crews for Berths 2 and 4.
- For unit trains departing Berths 2 and 4, the Class I Rail Carrier are assumed to manage crew availability such that assembled outbound trains can depart within 3 hours.
- For unit trains arriving at Berths 2 and 4, the Class I Rail Carrier is assumed to have trains arrive with sufficient time for the trains to be spotted in position for unloading prior to the start of longshore working shifts.

Longview Switching Company (LVSC)

- LVSC operates 24 hours per day and 7 days per week, and availability of engines and crews is not considered a constraint to operations.
- Non-unit train movements (for Berths 5-8) are completed by LVSC and are timed to occur when trains are not being delivered or removed from Berths 2 and 4 in order to minimize the number of LVSC crews and engines required to support rail operations at the Port.
- LVSC cannot deliver trains to Berths 2 and 4 during longshore working periods due to safety and labor practices. To maintain productive unloading, inbound trains must be delivered prior to longshore working periods. If empty outbound empty cars have been staged on terminal tracks by Longshore crews, LVSC can pull those cars from terminal tracks during Longshore working periods.

Longshore Workers

- Longshore workers move trains within terminals for unloading railcars into pits at Berths 2, 4, and 5.
- Longshore crews are preferably operated across 2 shifts; 0800 to 1700, 1800 to 0300. A third shift is used for unloading only if necessary.
- Empty outbound cars can be staged on terminal tracks by Longshore crews, and subsequently pulled from Port tracks by LVSC crews during Longshore working periods.

IRC Tracks

- Operating assumptions for use of IRC tracks varies per scenario.
- New unit train movements use the IRC Expansion tracks, except in the Base Case which

was modeled without IRC expansion tracks. New unit train movements for the Base Case use the existing IRC tracks.

- EGT arrivals and departures use a dedicated existing IRC track and will not interfere with movements for Berths 2 through 8.
- Manifest trains (to/from Berths 5 - 8) will arrive and depart via the Longview Switching Company Yard and only pass through the IRC between the LVSC yard the Port. No spotting, switching and staging of manifest trains is assumed to occur on the IRC tracks.

Port Tracks

- Berths 6/7/8 are assumed to use the S-curve route to/from IRC tracks.
- Operating assumptions for use of Port tracks for Berths 2 and 4 varies for each scenario as described in Section 4.2 of this report.
- Maximum allowable speed on Port tracks is 10 mph. Train performance calculations estimate speed to/from IRC at dead stop across nearby International Way crossing is 6 mph.

5.3. Analysis Scenarios

Numerous scenarios representing different operation plans and Port infrastructure improvement options were analyzed using the rail model. Each scenario is characterized by a unit train volume, a conceptual operating plan and infrastructure configuration. Each scenario was analyzed to measure track usage, additional "stress test" variations for some scenarios were analyzed to quantify IRC track usage when there are impacts to operations that fall outside the typical operating conditions.

Description of Primary Scenarios

The primary analysis scenarios compare IRC track usage and International Way crossing frequency at increased volume and with different Port track improvement options. The following table outlines the key characteristics of each scenario:

No.	Scenario	Annual Volume (million tons per year)	Unit Train Movement Through Port	Port Track Layout	International Way Assumption
1	Base Case	3	Intact/Cuts	North Rail Connection	Grade Crossing
2a	High Volume-Intact Trains	12	Intact	Double Loop	Grade Separation
2b	High Volume-Half Trains	12	Half Trains	Double Loop	Grade Crossing
3	Higher Volume-Double Spiral	12	Intact	Double Spiral	Grade Separation

Table 3: Primary Scenario Key Characteristics

To achieve the annual volumes shown in Table 3, the "peak" day each week requires a schedule of 2 loaded trains for Berth 4 and 1 loaded train for Berth 2. The full weekly train roster for the scenarios is presented in Table 4:

No.	Scenario	Average Berth Unloading Rate	Unit Trains / Week
1	Base Case	Berth 2 at 800 tons/hr	Berth 2 at 7/week
2a	High Volume-Intact Trains	Berth 2 at 800 tons/hr; Berth 4 at 2200 tons/hr	Berth 2 at 5/week; Berth 4 at 9/week
2b	High Volume-Half Trains	Berth 2 at 800 tons/hr; Berth 4 at 2200 tons/hr	Berth 2 at 5/week; Berth 4 at 9/week
3	Higher Volume-Double Spiral	Berth 2 at 2200 tons/hr; Berth 4 at 2200 tons/hr	Berth 2 at 5/week; Berth 4 at 9/week

Table 4: Primary Scenario Weekly Train Arrival Assumptions

In Scenarios 2a and 2b, the berth unloading rate at Berth 2 is based on the current maximum sustainable unloading rate for the existing dump pit B, which is estimated to be 800 tons/hour. The unloading of trains at this rate does require more than 2 longshore shifts and the modeling assumes that extra time during the 3rd shift is needed to unload a full train and that train turn-around may exceed 24 hours.

During peak day activity, the switching schedule is aligned with supplying each berth with railcars to maintain unloading productivity and longshore schedules. Tables 5 and 6 outline the switching schedules were used for the full length and half train scenarios:

Time Interval	Berth 2 In (from IRC)	Berth 2 Out (to IRC)	Berth 4 In (from IRC)	Berth 4 Out (to IRC)
Before Shift 1: 0300 to 0500	Full Length Loaded Train 1		Full Length Loaded Train 1	
Shift 1 Break: 1200 to 1300				
Between Shifts 1/2:1700 to 1800			Full Length Loaded Train 2	Full Length Empty Train 1
Shift 2 Break: 2200 to 2300				
Shift 3: 0300 to 0800		Full Length Empty Train 1		Full Length Empty Train 2

Table 5: Berth 2/4 Switching Schedule for Intact Full Length Trains

Time Interval	Berth 2 In (from IRC)	Berth 2 Out (to IRC)	Berth 4 In (from IRC)	Berth 4 Out (to IRC)
Before Shift 1: 0300 to 0500	1st Half Loaded Train 1		1st Half Loaded Train 1	
Shift 1 Break: 1200 to 1300			2nd Half Loaded Train 1	1st Half Empty Train 1
Between Shifts 1/2:1700 to 1800	2nd Half Loaded Train 1	1st Half Empty Train 1	1st Half Loaded Train 2	2nd Half Empty Train 1
Shift 2 Break: 2200 to 2300			2nd Half Loaded Train 2	1st Half Empty Train 2
Shift 3: 0300 to 0800		2nd Half Empty Train 1		2nd Half Empty Train 2

Table 6: Berth 2/4 Switching Schedule for Half Trains

The operating plans for the scenarios are summarized as follows:

Scenarios 1: Baseline Scenario

Purpose: Measure existing IRC tracks use (no expansion) at current volume capacity with increased rail volume at Berth 2.

Port Terminal Routing for Unit Trains: Existing Port track operation, LVSC brings in full loaded unit trains, breaks the trains into two cuts of approximately 70 cars and spots the cuts in Switch Alley. LVSC pulls empty cars in 30 to 40 car cuts back to IRC for assembly and departure.

IRC Track Usage for Unit Trains: Arriving trains are delivered to the IRC by Class 1 railroads and moved from the IRC to Berth 2 by LVSC; Departing trains use IRC for assembly and wait for Class I Rail crew for departure.

Scenarios 2a and 2b: High Volume Double Loop Scenario

Purpose: Measure IRC Expansion track usage, scenarios 2a and 2b differ only by operating plans that switch full length intact or half trains to/from Berths 2/4 and the IRC tracks. As discussed in Section 6.2, scenarios such as 2a which incorporate intact unit trains would need to be supported by a grade separation, comparing scenarios 2a and 2b provides a demonstration of how IRC track demand would be affected with the addition of a grade separation that supports intact unit train operations.

Port Terminal Routing for Unit Trains: Trains arrive by passing across the north side of the Port then turning south through Switch Alley. The outer loop is used to serve Berth 2 and the inner loop is used to serve Berth 4 unit trains. The switching schedule for full, intact trains is used for scenario 2a; switching schedule for half trains is used for scenario for 2b.

IRC Track Usage for Unit Trains: In Scenario 2a, arriving trains can are delivered to Berths 2 and 4 by the Class 1 railroads, passing through IRC; departing trains are moved from the loop tracks to the IRC by LVSC and removed from the IRC by Class I rail crew.

In Scenario 2b, arriving trains are delivered to the IRC by Class 1 railroads, LVSC splits the train on the IRC and spots half train segments at Berth 2 and 4; departing trains are moved from the loop tracks to the IRC by LVSC, reassembled as a full train on the IRC, and removed from the

IRC by Class I rail crew.

Scenario 3: Higher Volume Double Spiral Scenario

Purpose: Measure IRC Expansion track usage and compare the IRC track usage of the Double Spiral configuration with the Double Loop

Port Terminal Routing for Unit Trains: Trains arrive by passing across the north side of the Port then turning south through Switch Alley, and proceeding onto one of two unloading tracks in the double spiral.

IRC Track Usage for Unit Trains: Arriving Trains pass through IRC and are delivered by Class I Rail crews direct to the spiral tracks for Berths 2 and 4. Departing trains are moved by LVSC to an outbound IRC tracks and wait for Class I rail crew for departure.

Primary Scenario IRC Track Usage Results

The IRC track usage over the two week modeling analysis period is the primary output. Table 7 summarizes the percentage of time during the two week modeling period when no tracks are in use, and percentage of time when one or more IRC tracks are in use. The peak usage of tracks for each scenario is highlighted.

No.	Scenario	IRC Track Usage, Percentage of Time Over a 2 Week Period					
		0	1	2	3	4	5
1	Base Case	59.7%	35.7%	4.5%	0.0%	0.0%	0.0%
2a	High Volume-Intact Trains	9.5%	24.7%	31.1%	31.3%	3.5%	0.0%
2b	High Volume-Half Trains	60.6%	33.9%	4.7%	0.8%	0.0%	0.0%
3	Higher Volume-Double Spiral	77.5%	12.4%	8.7%	1.4%	0.0%	0.0%

Table 7: IRC Track Usage Results Summary

Figures 6 through 8 provide a graphical visualization of IRC track usage through a week of typical operations for each scenario, including the peaks and duration of incremental track occupancy.

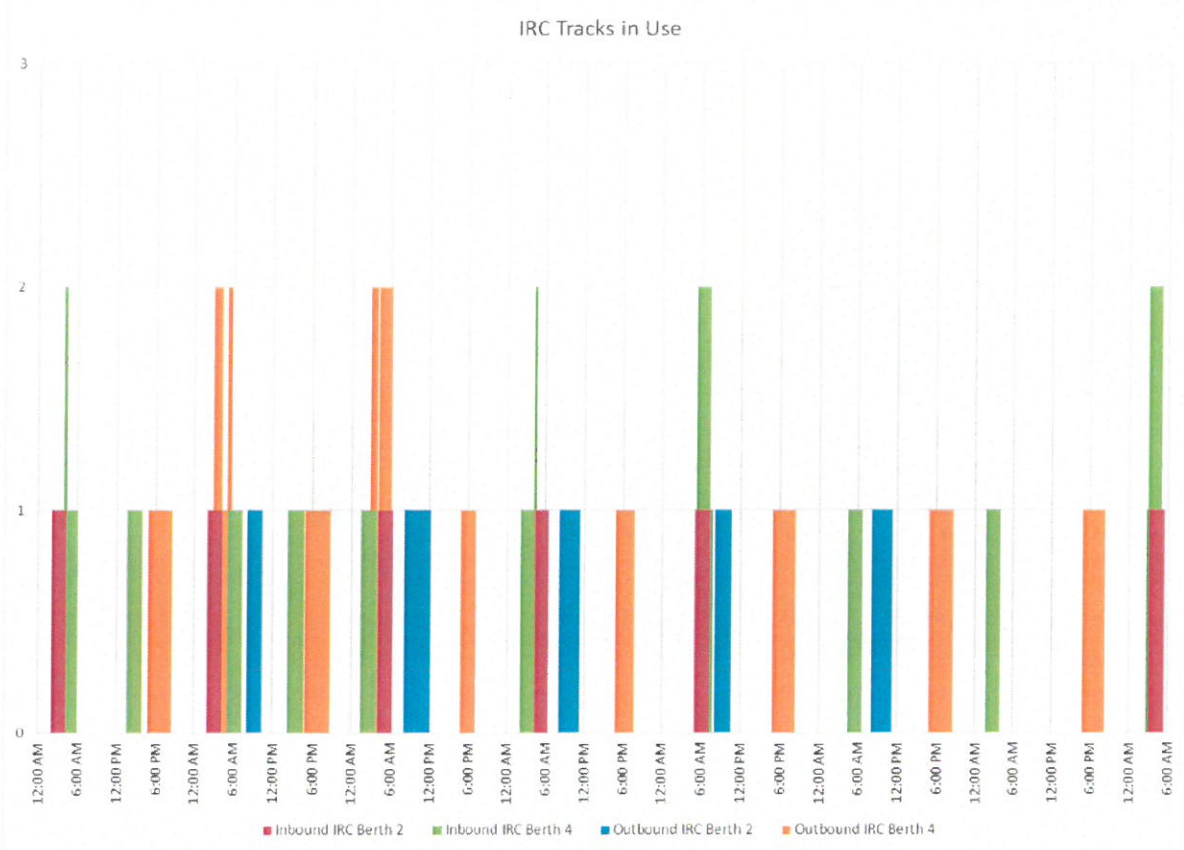


Figure 6: Scenario 2a - High Volume Intact Trains, New IRC Track Usage

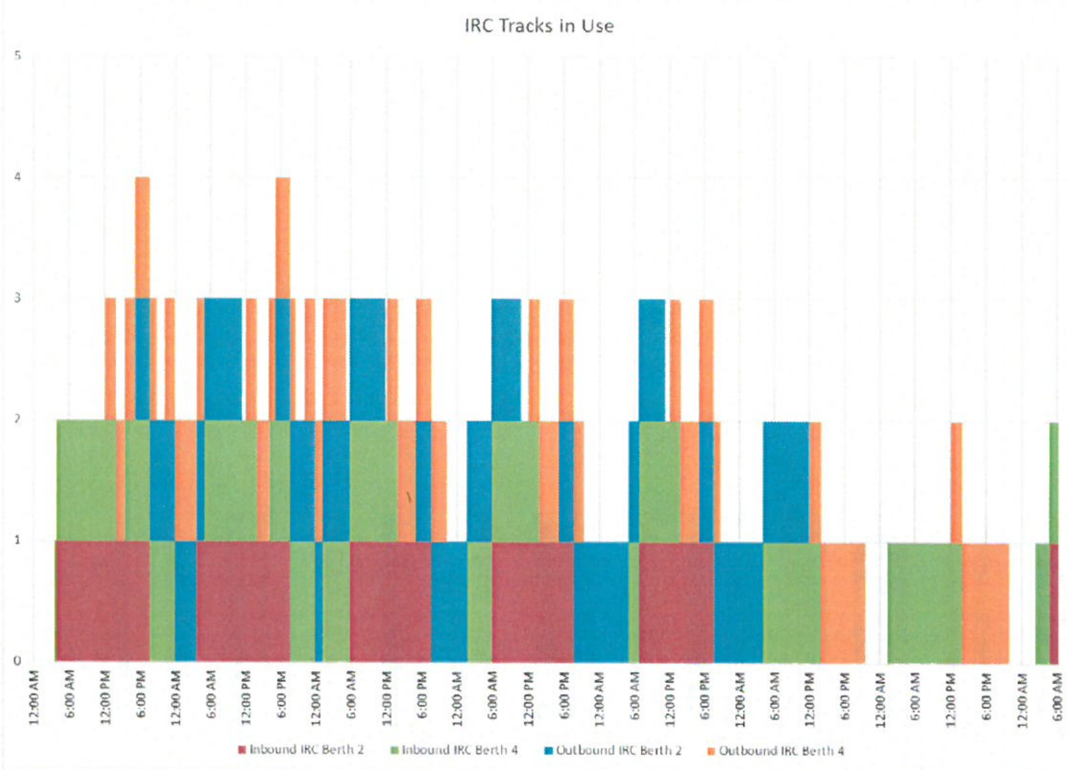


Figure 7: Scenario 2a - High Volume Intact Trains, New IRC Track Usage

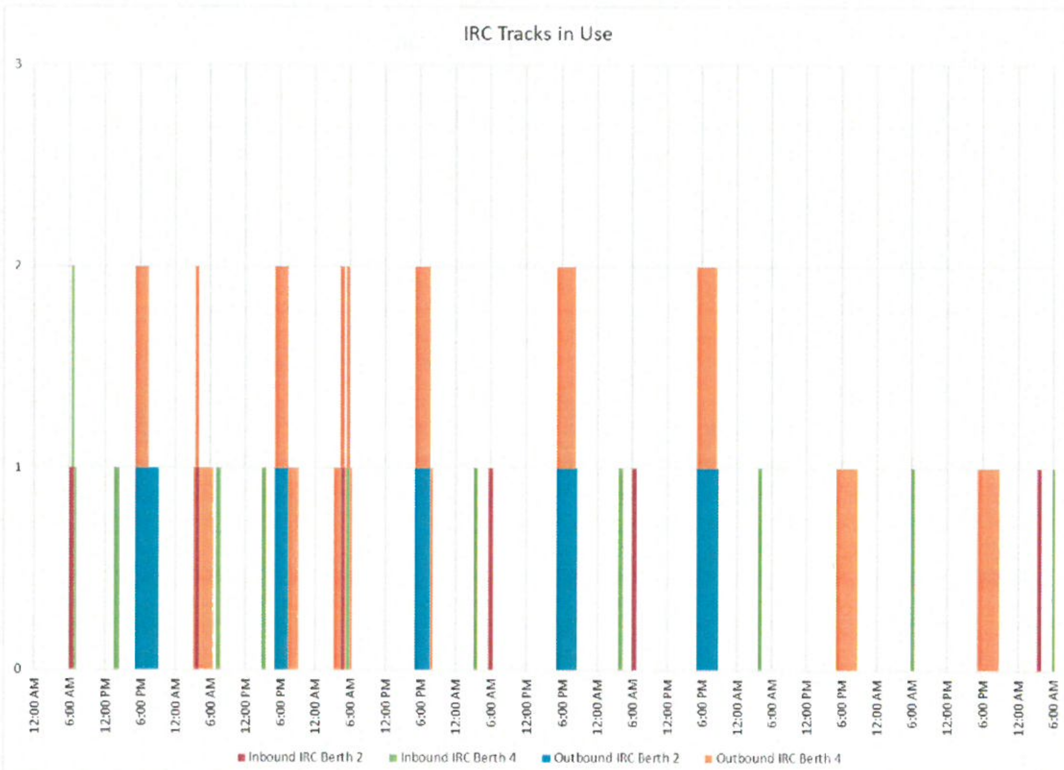


Figure 8: Scenario 3 - Double Spiral New IRC Track Usage

Rail Crossing Events at International Way

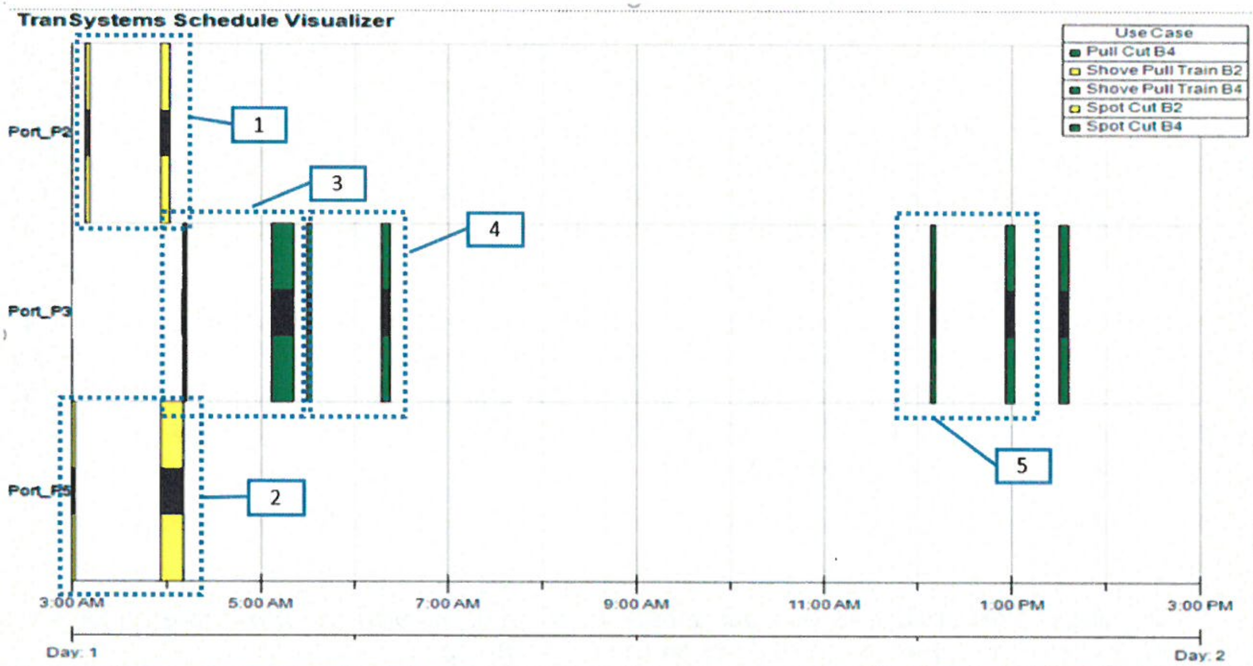
The High Volume scenario using half trains (Scenario 2b) was used to generate time-of-day and duration of rail movements across International Way. Other scenarios with full length, intact unit trains would block the International Way crossing for over 15 minutes each time an intact unit train passes through the crossing. Rail movements across International Way were not analyzed for these scenarios because this duration of traffic blockage would not be acceptable on a sustained or regular basis and a grade separation would be necessary to support these scenarios as described in Section 6.2 of this report.

The timing of rail movements across International Way is significantly influenced by longshore working periods and the objective of timing train arrivals to sustain high productivity of unloading during these work periods. Information for time-of-day and duration of rail movements across International Way was used for the Traffic Analysis modeling and correlated with area traffic counts to perform estimates of vehicle delays.

Train crossing times and durations are influenced by the following factors incorporated in the rail simulation model:

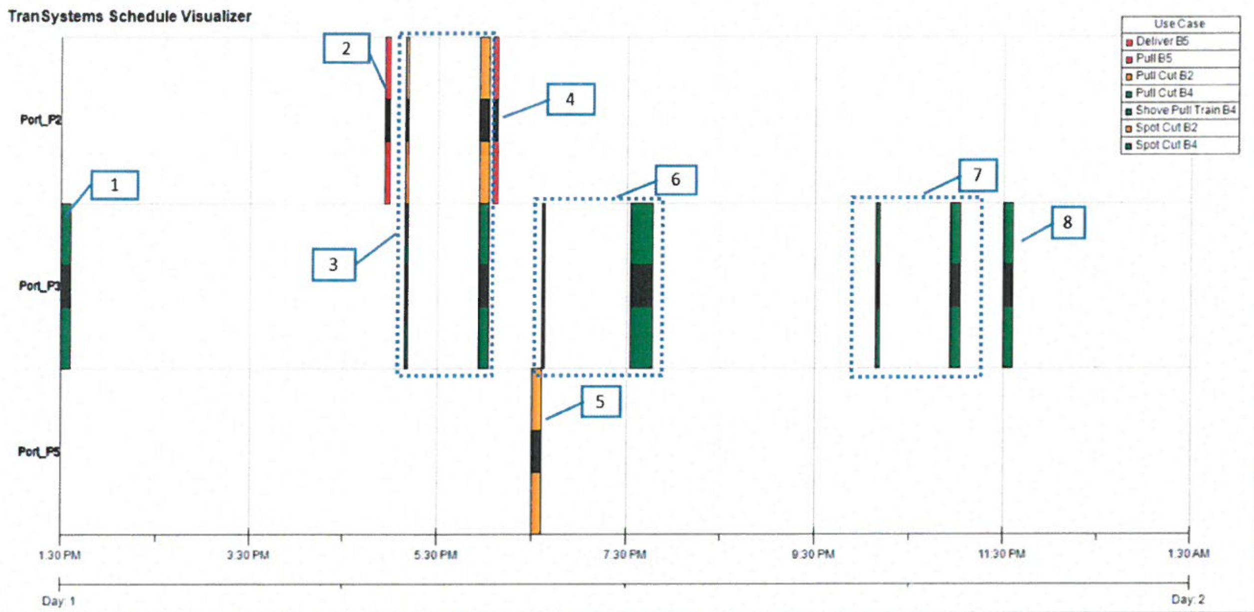
- The use of Port Lead 1 for outbound trains constrains the ability to cross International Way to one train at a time when a train is departing Berth 2 or 4.
- Light engines (engines with no rail cars) are included in the crossing movements and are estimated to take 2 minutes to cross (including 30 seconds before and after actual crossing of International Way to allow for lowering and raising of grade crossing barriers)
- Crossing times for trains are based on train performance calculations, which indicate that half-trains will achieve a speed of about 6 mph when at the crossing and will take 5 minutes to cross (including 30 seconds and before after actual crossing of International Way to allow for lowering and raising of grade crossing barriers)

Figures 9 and 10 show how the three Port tracks crossing International Way (Port_2, Port_3, and Port_5) would be occupied during morning and afternoon train switching activities. Movements shown in Figures 9 and 10 include trains arriving and departing Berths 2, 4 and 5, and light engine movements. Train movements to and from Berths 6/7/8 use the “S” tracks which do not cross at International Way.



Event	Description	Light Engine	Cut/Train Move
1	One crew spotting 4,125' cut from 1st train to Berth 2, light engine and cut move	3:09 to 3:11	3:56 to 4:02
2	One crew shoving Cut 1 from IRC to Cut 2 from Berth 2 while on crossing to make full 8,250' train. light engine and cut move.	3:00 to 3:02	3:56 to 4:10
3	One crew shoving Cut 1 from IRC to Cut 2 from Berth 4 while on crossing to make full 8,250' train. Light engine and cut move.	4:10 to 4:12	5:07 to 5:21
4	One crew spotting 4,125' cut to Berth 4 1st train. Light engine and cut move.	5:30 to 5:32	6:17 to 6:23
5	One crew pulling a 4,125' cut from Berth 4 to IRC	N/A	5:56 to 6:02
6	One crew spotting 4,125' cut to Berth 4 1st train. Light engine and cut move.	12:09 to 12:11	12:56 to 13:02

Figure 9: Morning Switching Movements Across International Way



Event	Description	Light Engine	Cut/Train Move
1	One crew pulling 4,125' cut from Berth 4 to IRC	N/A	13:30 to 13:36
2	One crew delivering cars to Berth 5	N/A	15:56 to 16:59
3	Two crew parallel crossing to support spotting of 4,125' cuts to Berth 2 and 4. Light engine and cut moves.	17:09 to 17:11	17:56 to 18:02
4	One crew pulling cars from Berth 5	N/A	18:05 to 18:08
5	One crew pilling a 4,125' cut from Berth 2 to IRC	N/A	18:30 to 18:36
6	One crew shoving Cut 1 from IRC to Cut 2 while on crossing to make full 8,250' train. Light engine and cut move.	18:36 to 18:38	19:32 to 19:46
7	One crew spotting 4,125' cut to Berth 4 2nd train. Light engine and cut move.	22:09 to 22:11	22:56 to 23:02
8	One crew pulling 4,125' cut from Berth 4 2nd train	N/A	23:30 to 23:36

Figure 10: Afternoon to Evening Switching Movements Across International Way

Delayed Trains on IRC Track Scenarios

"Stress test" conditions was applied to the dynamic simulation models to quantify the effect of occasional train departure delays on IRC track usage. Scenarios were analyzed with the assumption that one departing train per week would be delayed by 24 hours, or by 48 hours. Table 8 summarizes the IRC expansion track usage during the two week modeling period with these conditions applied, peak usage of tracks for each scenario is highlighted:

No.	Scenario	New IRC Track Usage, Percentage of Time Over a 2 Week Period					
		0	1	2	3	4	5
2a	High Volume-Intact Trains, 24 hour delay	51.1%	39.7%	7.7%	1.5%		
2b	High Volume-Half Trains, 24 hour delay	9.6%	23.9%	25.1%	31.3%	10.1%	
3	Higher Volume-Double Spiral, 24 hour delay	66.3%	22.7%	8.0%	2.8%	0.2%	
2a	High Volume-Intact Trains, 48 hour delay	42.5%	43.1%	12.5%	1.8%		
2b	High Volume-Half Trains, 48 hour delay	9.6%	17.5%	26.7%	33.6%	12.7%	
3	Higher Volume-Double Spiral, 48 hour delay	55.5%	31.6%	8.7%	3.9%	37.0%	

Table 8: Summary of New IRC Track Usage for Delayed Departing Train Scenarios

IRC Track Availability

The IRC track usage reports focus on peak track utilization; it also useful to think of IRC track availability for other activities than those to support the Port terminal movements (those potentially needed by the railroads, etc.). From review of usage of tracks, there are considerable periods when there are IRC tracks available for other uses. Model output reports show the availability of 2 hour time slots (an interval of time that is likely useful for other railroad tasks) on the IRC tracks.

No.	Scenario	Count of Concurrent Occupied IRC Tracks with 2 Hour Time Slot Available					
		0	1	2	3	4	5
2a	High Volume-Intact Trains	39.5%	48.3%	9.9%	2.3%		
2b	High Volume-Half Trains	8.0%	22.2%	25.0%	39.2%	5.7%	
3	Higher Volume-Double Spiral	28.3%	43.4%	21.4%	6.9%		

Table 9: Summary of New IRC Track Availability

For example, for High Volume-Intact Trains, during 39.5% of the two hour intervals across the analysis period of 14 days there are 0 IRC tracks occupied; 48.3% of two hour intervals where there is only 1 track occupied.

5.4. Summary of Rail Modeling Results

The rail modeling provides IRC track usage and rail support switching event timings as outputs to assist in planning the IRC expansion. The track usage metrics combined with the timing of rail movement events across International Way provide a method to evaluate tradeoffs between improvement options that include IRC expansion tracks, port rail infrastructure improvements, and rail grade separations. Together, the results of track usage and track availability demonstrate that the usage of IRC tracks for the scenarios modeled tends to be peak around the times of train arrivals and departures, which are closely linked to Longshore work shifts, however the peak periods of IRC track usage are relatively short in duration.

6. Traffic Analysis Summary

Detailed traffic analysis was performed to assess the potential effect of Industrial Rail Corridor (IRC) improvements on vehicle and truck access to the Port of Longview, and determine if roadway improvements would also be needed. Appendix A presents the detailed traffic analysis and traffic-related recommendations.

To support the traffic analysis, a detailed traffic data collection plan was developed in consultation with Port staff. The objective of the data collection plan was twofold, first, to better understand where and when traffic enters and exits the Port area, second, to understand traffic operations of key intersections along SR 432 that could be affected if additional traffic was diverted through those intersections by potential rail improvements. Data were collected at 11 locations in the Port vicinity the week between Thursday, October 31, 2019 and Wednesday, November 6, 2019. The results of that data collection effort are presented in Section 2 of Appendix A. Additionally, future traffic growth was estimated to be 50% over nearly 20 years based on year 2040 traffic volume forecasts presented in the Industrial Way Intersection Project Transportation Discipline Report.

Under future IRC improvement scenarios, trains would block all the western access points to the Port of Longview site for long periods of time while waiting to be unloaded. This would functionally close these access points and require traffic to access the site only via International Way, which could also be blocked intermittently during train arrivals and departures. For the purpose of our analysis, it was assumed that all of that traffic would be consolidated to the International Way access point.

Train movements across International Way would delay vehicles and create queues, both of which would increase based on the length of the train and the volume of traffic. Sensitivity analysis was performed to show how at-grade rail movements would affect roadway vehicular delay and queuing under different conditions. Several train operating scenarios were evaluated with potential blockage times at International Way ranging between 3 to 15 minutes. This analysis is presented in Section 3 of Appendix A.

In addition to sensitivity analysis, detail traffic operations analysis was performed for study intersections without accounting for downstream effects of the rail grade-crossing at International Way. This allows the effect of intersection operations to be separated from the effect of queue blockages that may be related to the train and that were considered in the sensitivity analysis. Traffic operations are described using level of service (LOS), which is a qualitative measure, and vehicle delay, a quantitative measure. Six letter designations, "A" through "F," are used to define level of service. LOS A is the best and represents good traffic operations with little or no delay to motorists. LOS F is the worst and indicates poor traffic operations with long delays. WSDOT's level of service standard for SR 432 is LOS D. The City of Longview generally considers intersections that operate at LOS C or better to be acceptable.

6.1. Levels of Service Analysis

Levels of service for study area intersections were determined using the Synchro 10.3 traffic operations analysis software and reported using the Synchro module, which is based on the Highway Capacity Manual (HCM), Sixth Edition. The results of this level of service analysis can be found in Section 4 of Appendix A. Traffic operations analyses were prepared for three conditions:

- **Existing (2019) Traffic Volumes** – These reflect the traffic volumes as counted in October 2019 and described in Section 2 of Appendix A. All access points to the Port were open and unblocked by trains during the count period.
- **Rerouted Existing (2019) Traffic** – This assumes that western access points to the Port of Longview site would be blocked by a train (or closed), and that all traffic would reroute to access the Port via International Way.
- **Future (Year 2040) with Rerouted Traffic** – This assumes growth in the Rerouted Existing Traffic volumes through year 2040. Future growth was estimated to be 50% over nearly 20 years.

6.2. Traffic Analysis Summary

The following summarizes the traffic analysis findings:

- The rail improvements would increase rail loading/unloading capabilities at the Port of Longview, and increase the number and frequency of train arrivals and departures. The improvements are intended is to allow full unit-trains to arrive and depart directly without needing to be stored in the IRC Yard, or cut into segments and switched to the site.
- Full unit trains would block all the western access points to the Port of Longview site for long periods of time while waiting to be unloaded. This would functionally close these access points and require traffic to enter and exit the Port area via International Way.
- International Way would be blocked intermittently during train arrivals and departures. Full unit trains would block this crossing for 15 minutes.
- Vehicular traffic to and from the Port of Longview has peaks in the morning and afternoon, and remains relatively high midday. If all traffic has to use International Way, one full unit train crossing during the peak morning arrival period would cause traffic arriving to the Port to queue back onto SR 432, and likely result in intolerable delays for vehicular traffic. Half-train cuts would cause queues beyond Columbia Boulevard, with much lower delays to traffic.
- Level of service analysis showed that the five signalized study intersections near the Port of Longview currently operate at acceptable levels of service. Additionally, all intersections would continue to operate at LOS C or better with rerouted traffic due to the train blockages on the west side of the port.
- With growth in traffic through 2040, however, the intersection at Oregon Way/SR 432 could degrade to LOS E during the AM peak hour. This result is similar to that in the IWOW study for the conditions with no improvements at that intersection. Growth in traffic destined to the Port would also cause the stop-controlled intersection at International Way/Columbia Blvd to operate at LOS F in the future without changes in traffic control.

Based the results of our analysis, a grade-separated access to the Port of Longview is recommended for any rail operating plan that would arrive and depart full unit trains during daytime hours (about 6:00 A.M. to 7:00 P.M.). Until a grade-separated access is provided, full unit trains could be moved during overnight hours (between 7:00 PM and 6:00 AM), and half train cuts could be moved any time.

The following two potential options for a grade-separated crossing structure were considered, both options connecting to SR 432 but at different locations. More details about these options can be found in Section 5 of Appendix A.

- Option A: At International Way; and
- Option B: A new connection between North Tie Road and H Street.

Level of service analysis for each access option was performed, and determined that either the SR 432/H Street or SR 432/International Way intersections could accommodate all Port of Longview traffic and no major changes would be required to lane configuration or signal operations. Both intersections would also accommodate growth in traffic through 2040 and continue to operate at acceptable levels of service (LOS C or better).

The most substantial benefits of the North Tie Road/ H Street overpass grade-separation option are that it could be constructed without disrupting traffic on the primary International Way access route and that the International Way route could be retained as a secondary access point to accommodate large loads such as windmills. The benefits and disadvantages of each option are presented in Table 10.

	Grade Separated Structure Connecting North Tie Road to H Street	Grade Separated Structure at International Way
Advantages	• Can be constructed without disrupting existing traffic on International Way • Retains at-grade access at International Way for secondary access and to accommodate large loads such as wind power components • Disperses traffic to intersections along SR 432, improving operations of that corridor • Structure can be connected to Columbia Boulevard improving access to Port for local business located north of the tracks	• Can be constructed within existing right of way • No property acquisition required
Disadvantages	• Requires property acquisition	• Primary port access route disrupted during construction • Provides only one access route to/from Port when all others are blocked by train(s) • Structure would need to be designed to accommodate oversize and overweight loads since no alternative routes would exist • Concentrates traffic at SR 432/International Way, intersection • Structure would likely need to also be grade-separated from Columbia Boulevard (due to close proximity to the tracks), which would extend the length and increase cost of the structure. Extended length may also affect local business access on International Way north of Columbia Boulevard

Table 10: Grade Separated Access Options

Appendix A - Technical Memorandum, Consolidated Traffic Analysis

DRAFT

TECHNICAL MEMORANDUM

Project: **Port of Longview Transportation Optimization Plan**

Subject: Consolidated Traffic Analysis

Date: May 19, 2020

Authors: Marni C. Heffron, PE, PTOE – Principal Transportation Engineer
Jose Machado, PhD Candidate – Transportation Engineer

The Port of Longview is evaluating future improvements to its Industrial Rail Corridor (IRC) and internal rail infrastructure to improve customer rail throughput and operations. The rail improvements are likely to affect vehicle and truck access to the Port and other properties. Detailed traffic analysis was performed to assess the potential changes and determine if roadway improvements will also be needed. This memorandum presents the detailed traffic analysis and traffic-related recommendations.

1. Summary of Findings

Traffic/Access Impact of Rail Improvements

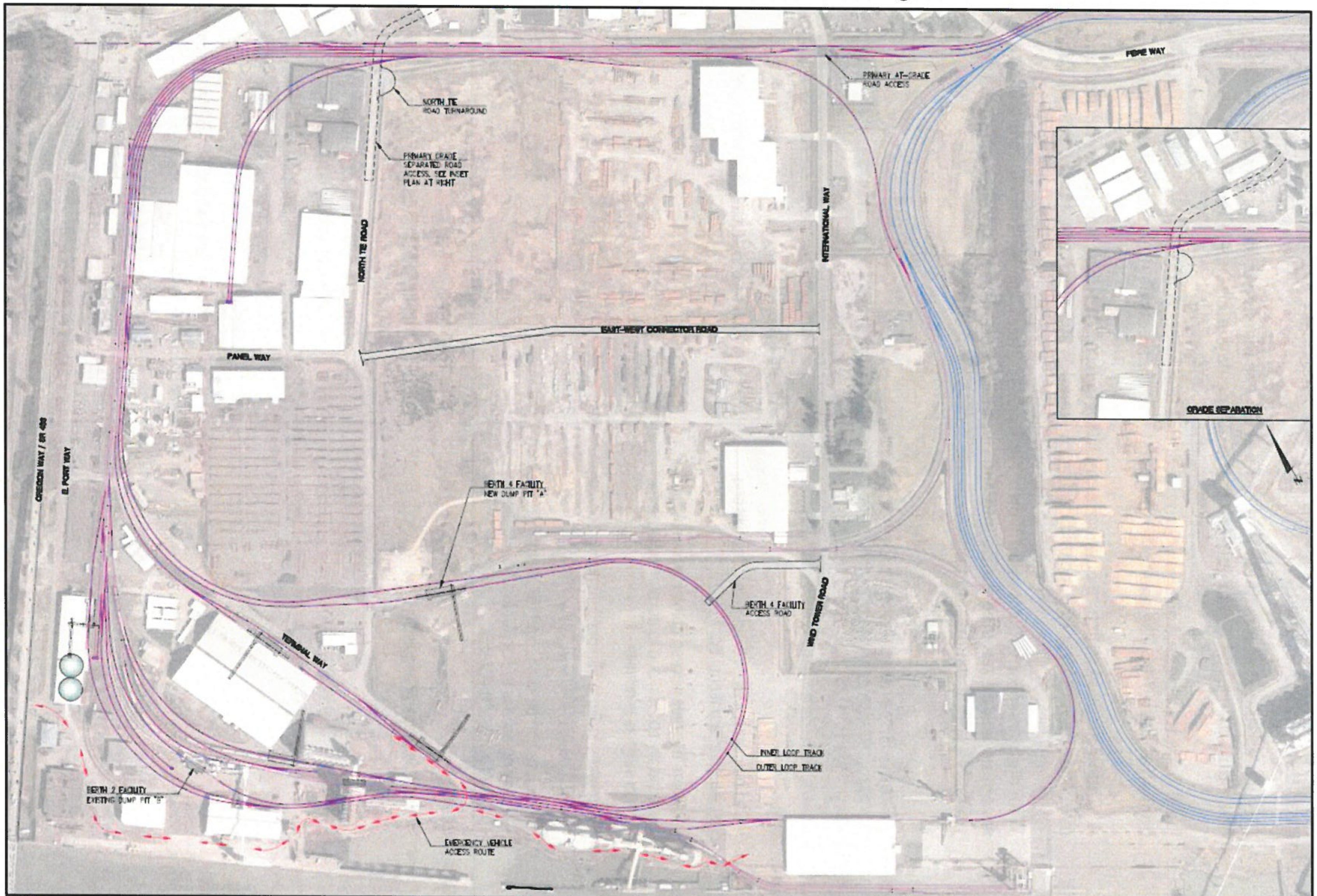
- The rail improvements would increase rail loading/unloading capabilities at the Port of Longview, and increase the number and frequency of train arrivals and departures. The improvements are intended is to allow full unit-trains to arrive and depart directly without needing to be stored in the IRC Yard, or cut into segments and switched to the site. The potential rail improvements are shown on Figure 1.

- Full unit trains would block all of the western access points to the Port of Longview site for long periods of time while waiting to be unloaded. This would functionally close these access points and require traffic to enter and exit the Port area via International Way.

- International Way would also be blocked intermittently during train arrivals and departures. Full unit trains would block this crossing for 15 minutes.

- Vehicular traffic to and from the Port of Longview has peaks in the morning and afternoon, but remains relatively high midday. If all traffic has to use International Way, one full unit train crossing during the peak morning arrival period would cause traffic arriving to the Port to queue back onto SR 432, and likely result in intolerable delays for vehicular traffic. Half-train cuts would cause queues beyond Columbia Boulevard, with much lower delays to traffic.

Figure 1. Potential Rail Improvements at Port of Longview



Source: KPFF, May 2020

Recommended Improvements

- A grade-separated access to the Port of Longview is recommended for any rail operating plan that would arrive and depart full unit trains during daytime hours (about 6:00 A.M. to 7:00 P.M.).
- Until a grade-separated access is provided, full unit trains could be moved during overnight hours (between 7:00 PM and 6:00 AM), and half train cuts could be moved any time.
- A grade-separated structure connecting North Tie Road to H Street is recommended and has many advantages over one located on International Way, which are summarized in Table 1.
- With a grade-separated access at North Tie Road/H Street, the roadway network would accommodate all rerouted traffic into and out of the Port, as well as forecast growth for 20 years. No additional off-site improvements would be needed.

Table 1. Grade-Separated Access Options

Grade-Separated Structure Connecting North Tie Road to H Street	Grade-Separated Structure at International Way
Advantages: • Can be constructed without disrupting existing traffic on International Way • Retains at-grade access at International Way for secondary access, and to accommodate large loads such as windmills • Disperses traffic to intersections along SR 432, improving operations of that corridor. • Structure can be connected to Columbia Boulevard improving access to Port for local businesses located north of the tracks.	**Advantages:** • Can be constructed in existing right of way.
Disadvantage: • Requires property acquisition.	**Disadvantage:** • Primary port access route disrupted during construction. • Provides only one access route to/from Port when all others are blocked by train(s). • Structure would need to be designed to accommodate oversize and overweight loads since no alternative routes would exist. • Concentrates traffic at SR 432/International Way, intersection. • Structure would likely need to also be grade-separated from Columbia Boulevard (due to close proximity to the tracks), which would extend the length and increase cost of the structure. Extended length may also affect local business access on International Way north of Columbia Boulevard.

2. Existing Traffic Volumes

To support the traffic analysis, detailed traffic volume data were collected in the Port vicinity to determine current traffic characteristics such as variations in traffic volumes by location, day of week, time of day, and type of vehicle. The results of that data collection effort are presented below.

2.1. Data Collection Effort

A detailed traffic data collection plan was developed in consultation with Port staff. One objective was to better understand where and when traffic enters and exits the Port area, particularly on streets that now or would cross potential rail lines. Another objective was to understand traffic operations of key intersections along SR 432 that could be affected if additional traffic was diverted through those intersections by potential rail improvements.

Seven-day vehicle classification counts were performed at 11 locations in the week between Thursday, October 31, 2019 and Wednesday, November 6, 2019. These dates were selected to capture a period when a log ship was in port along with other ship activity. Vessels in Port during the data collection week are summarized in Table 2.

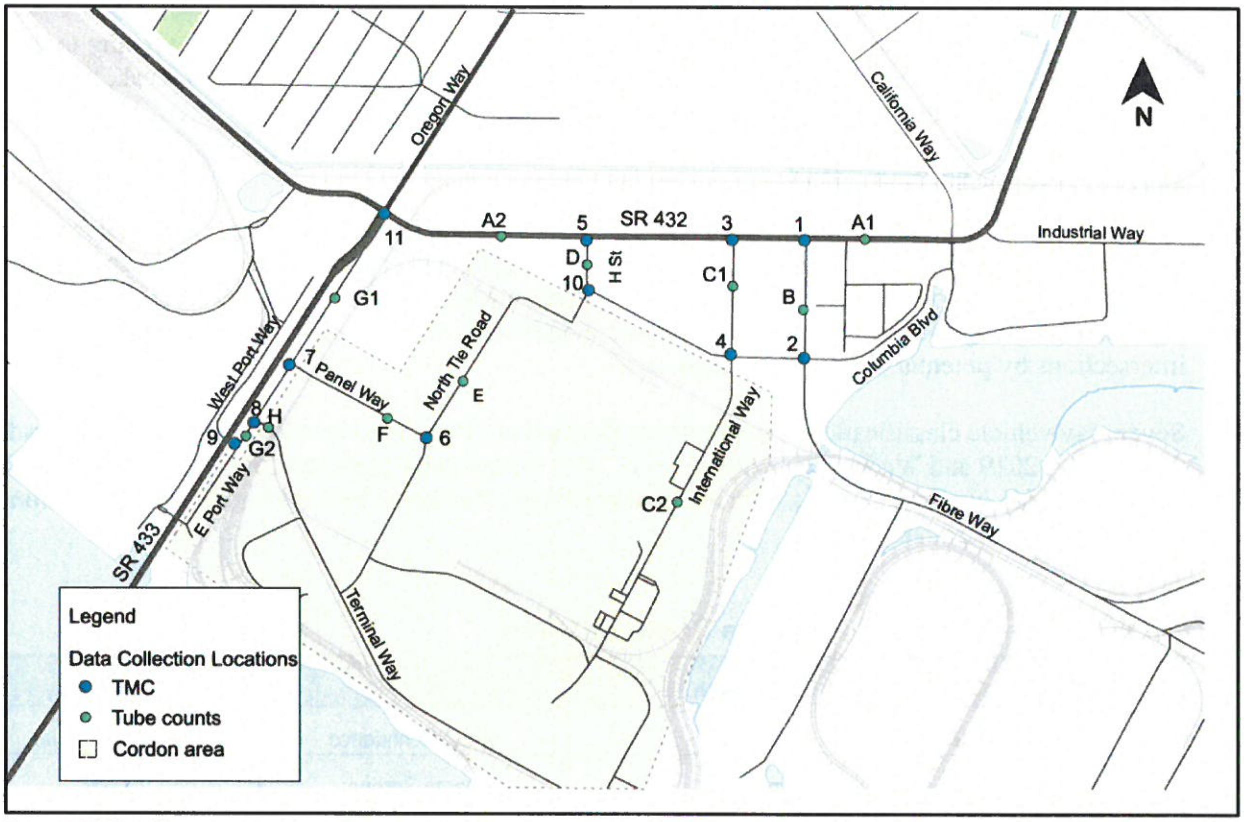
Table 2. Ship Schedule during Data Collection Week

Day/Date	Berth	Vessel	Commodity
Fri, 11/01/2019	5	Ljssel Confidence	Calcined Coke
Sat, 11/2/2019	8	Santa Serena	Logs
Sun, 11/3/2019	6	CP Nanjing	Steel
Tues, 11/5/2019	5	Silver Lake	Calcined Coke

Source: Port of Longview, October 23, 2019

On Wednesday, November 6, 2019, cameras were deployed at 11 intersections to capture vehicle turning movements. Intersection data were compiled for three peak periods (AM peak, Midday Peak, and PM Peak) which were determined based on the seven-day counts. The count locations are shown on Figure 2 and listed in Table 3.

Figure 2. Traffic Count Locations



Source: Heffron Transportation, Inc., November 2019.

Table 3. Traffic Count Locations

7-Day Machine Classification Counts Performed 10/31/19 – 11/6/2019	Intersection Turning Movement Counts Performed 11/6/2019 for Six Hours
A1. Industrial Way (SR 432) east of Fibre Way	1. Fibre Way / SR 432
A2. SR 432 east of Oregon Way	2. Fibre Way / Columbia Boulevard
B. Fibre Way	3. SR 432 / International Way (12-hour count)
C1. International Way south of SR 432	4. Columbia Boulevard / International Way
C2. International Way south of Columbia Blvd	5. SR 432 / H Street
D H Street / Paper Way	6. North Tie Road (Paper Way) / Panel Way
E. North Tie Road (Paper Way) north of Panel Way	7. Panel Way / E Port Way
F. Panel Way	8. E Port Way / Terminal Way
G1. E Port Way north of Panel Way	9. W Port Way / E Port Way
G2. E Port Way south of Terminal Way	10. H Street / Columbia Boulevard / North Tie Road (Paper Way)
H. Terminal Way	11. SR 432 / Oregon Way (SR 433)

Source: Heffron Transportation, Inc., November 2019.

2.2. Traffic Entering and Exiting Port Cordon

Machine (tube) count data for locations that represent a cordon into and out of the Port were compiled to isolate Port-generated traffic that could be affected by existing or future rail movements.
The Port's cordon gateways are shown on Figure 2 and include the following tube count locations:

- International Way (C2)
- Paper Way (E)
- Panel Way (F)
- Port Way south of Panel Way (G2)
- Terminal Way (H)

Figure 3 shows the total volume by day for the Port cordon (total entering and exiting traffic at count locations C2, E, F, G2, and H). These counts showed that the highest volume occurred on Tuesday (3,800 vehicles/day), which was about 400 vehicles higher (12% higher) than the daily volume on Wednesday and Monday (3,400 vehicles/day). Tuesday corresponded with a calcined coke ship event at Berth 5.

Figure 4 shows rolling hour volumes at the Port cordon throughout the week ("rolling hour" means that the hourly volumes are plotted for each time period in 15-minute increments). The AM peak volume occurred on Wednesday from 7:00 to 8:00 A.M. and Tuesday from 7:30 to 8:30 A.M. with approximately 350 vehicles per hour (veh/hr) among the four Port cordon gateways. The Midday peak volume occurred on Tuesday, Wednesday, and Thursday from 11:15 A.M. to 12:15 P.M. with 330 veh/hr. Large differences in PM peak volumes were observed between Tuesday and Wednesday. The PM peak hour on Wednesday started at 3:30 P.M. with approximately 250 veh/hr, while on Tuesday, the PM peak hour started at 3:45 P.M. with 330 veh/hr. These differences are likely due to a special shipment on Tuesday, that generated a higher volume of large trucks primarily using International Way.

Inbound and outbound flow patterns at the Port cordon on Wednesday are shown on Figure 5. Ingress and egress flows tend to be balanced until after the AM peak, with greater inbound volumes between 8:00 and 11:00 A.M. In the afternoon period, inbound flows start decreasing earlier than outbound flows resulting in greater outbound volumes between 1:00 and 6:00 P.M.

Figure 3. **Daily Volume** Entering/Exiting Port Cordon by Type of Vehicle

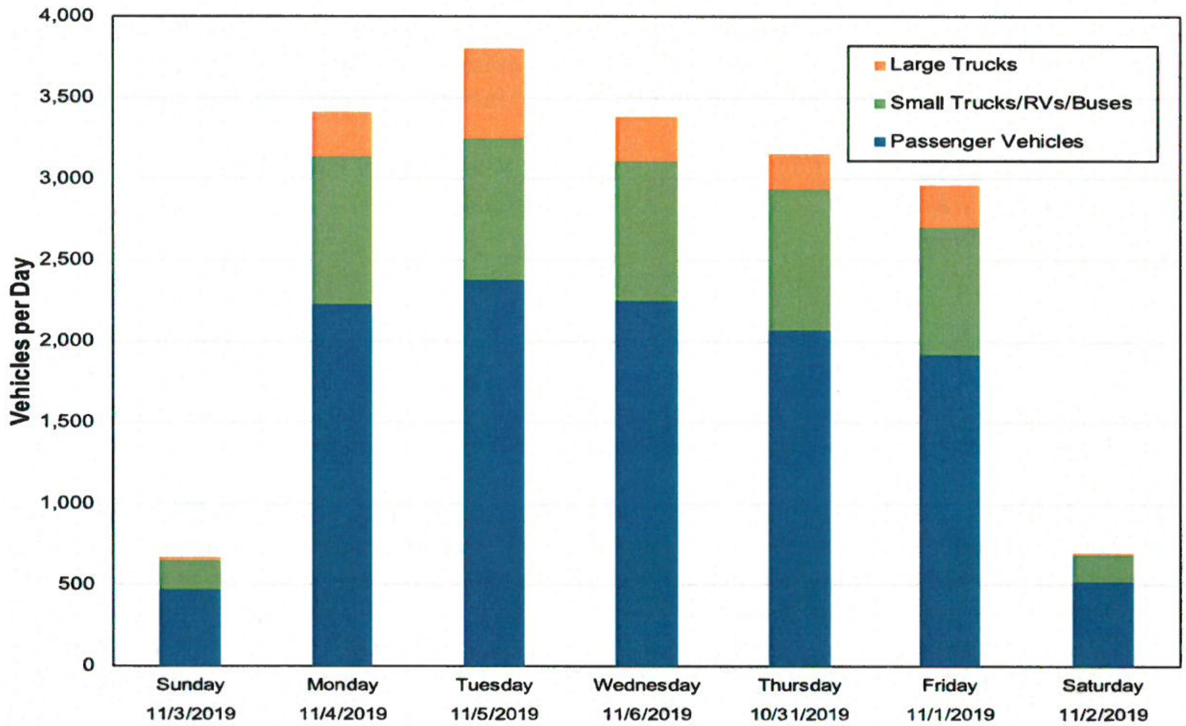
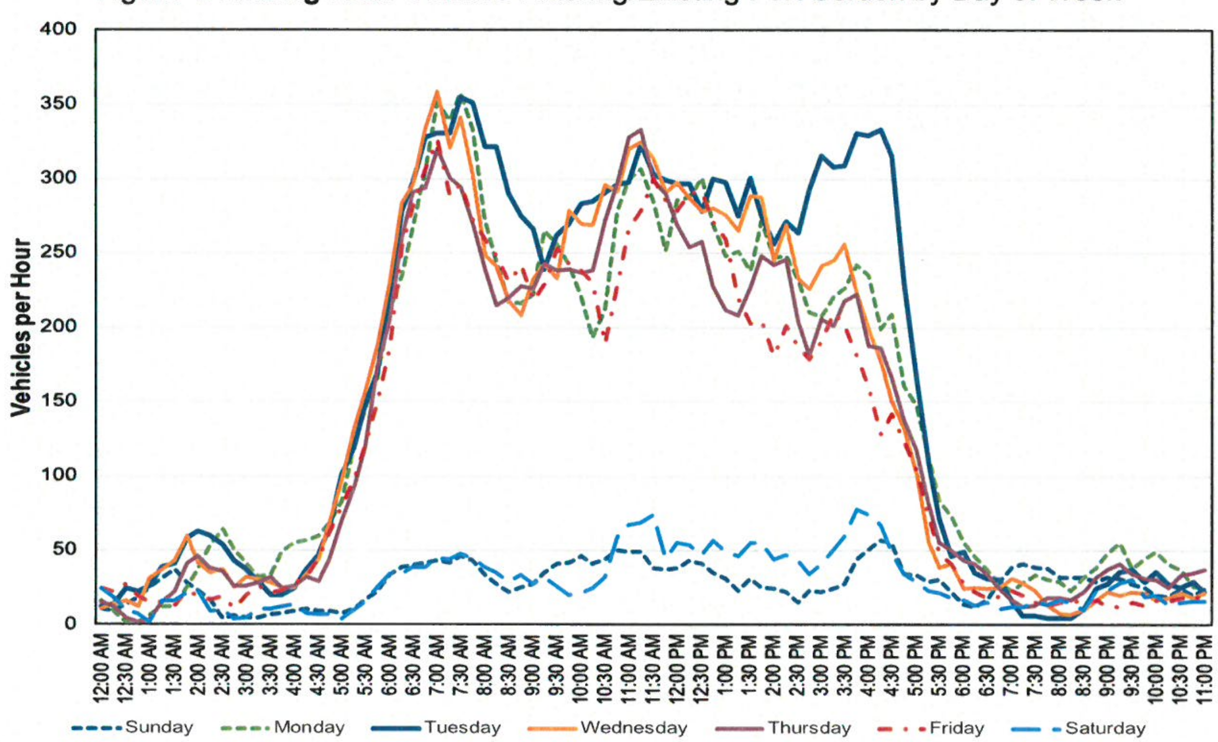
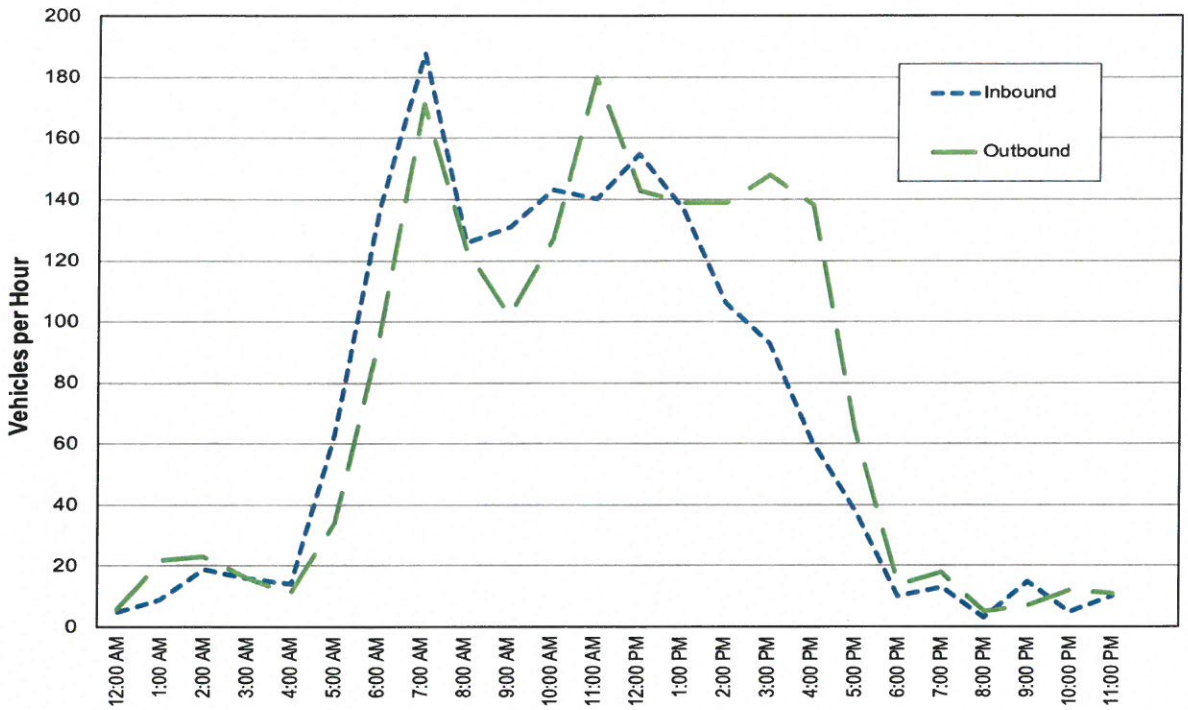


Figure 4. **Rolling Hour Volume** Entering/Existing Port Cordon by Day of Week



Source for both charts: Counts performed by IDAX, Inc. for the week of October 31 through November 6, 2019. Data compiled by Heffron Transportation, Inc. Charts are based on aggregated vehicle volumes at tube count locations C2, E, F, H and G2.
Figure 3 reflects "rolling hour" volumes for which the total volumes per hour are plotted for each 15-minutes period.

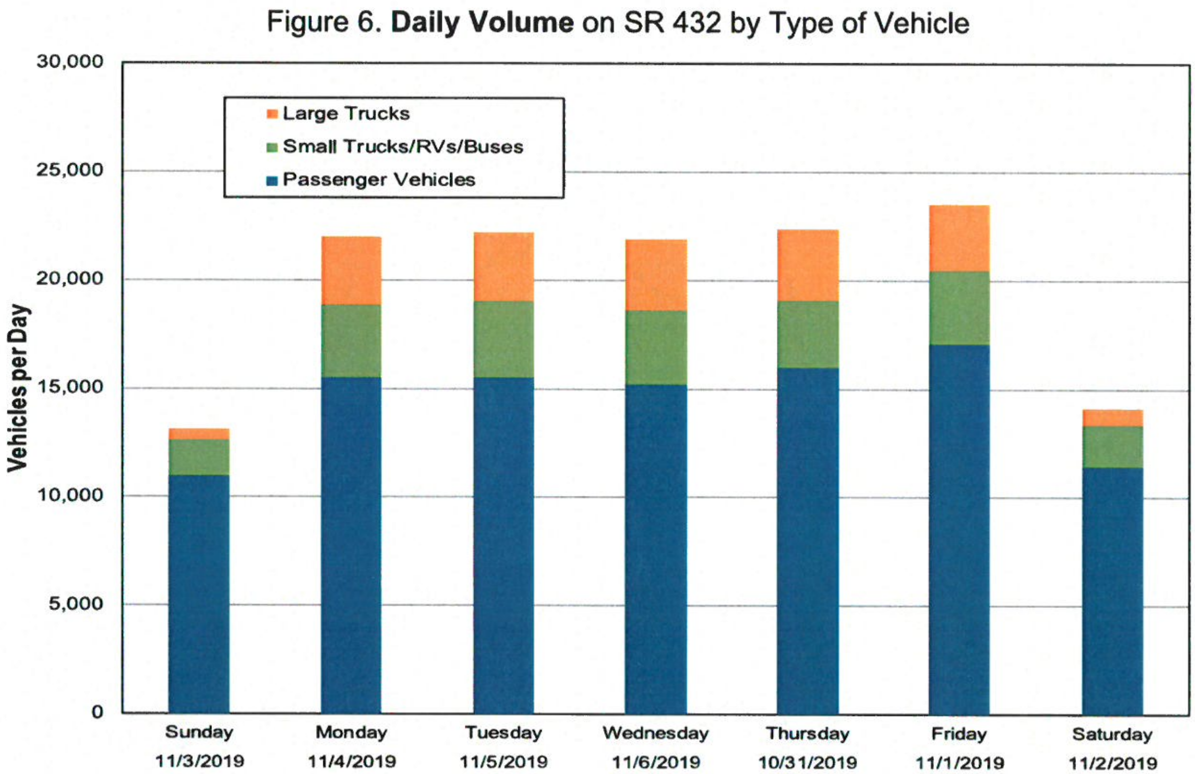
Figure 5. Port's **Inbound and Outbound Volume** on Wednesday 11/6/2019



Source: Counts performed by IDAX, Inc. for the week of October 31 through November 6, 2019. Data compiled by Heffron Transportation, Inc.
Note: The chart is based on aggregated vehicle volumes at tube count locations C2, E, F, H and G2.

2.3. Traffic Patterns on SR 432

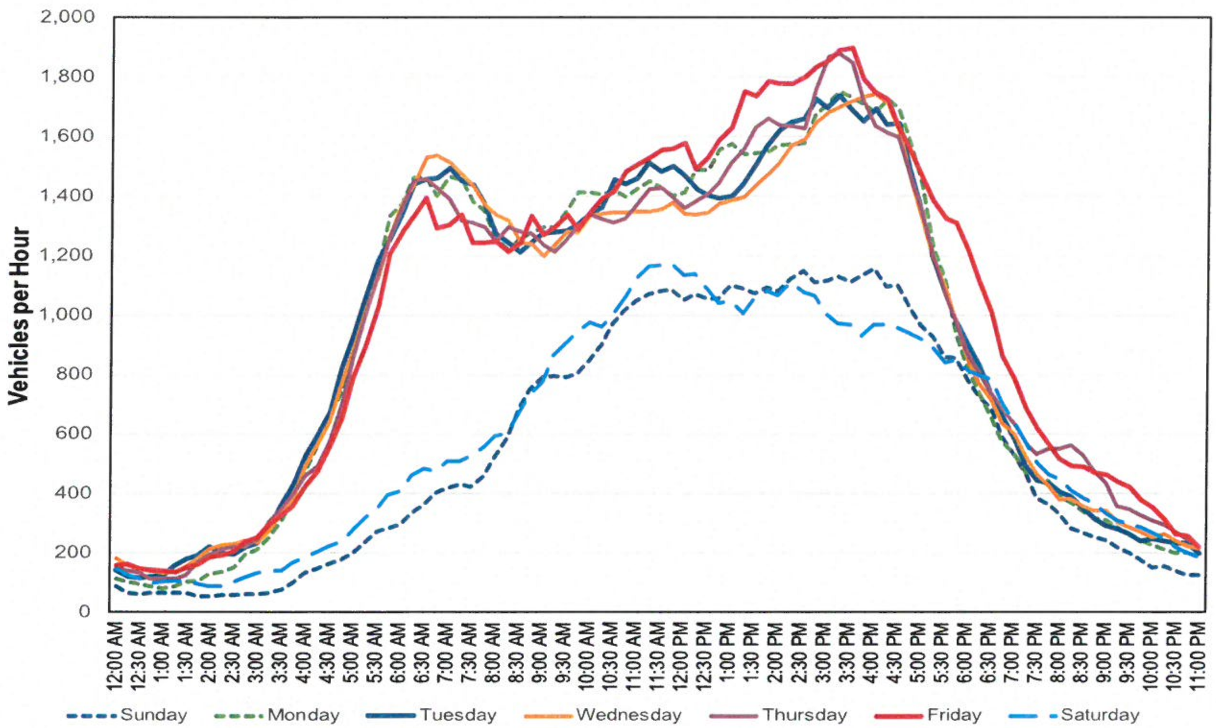
Figure 6 shows daily traffic volumes throughout the week on SR 432. As noted above machine counts were performed at two locations on SR 432, and the volumes in the chart reflect those taken at location A1, east of the Port. The highest daily traffic volume on SR 432 occurred on Friday (23,550 veh/day), which was about 6% higher than the average volume on the other four weekdays (average of 22,130 veh/day). The higher volumes observed on Friday are likely due to SR 432 being part of a route that weekend vacationers use to reach the destinations on the Washington and Oregon coasts; as shown, the difference between Friday and the other weekdays is nearly all attributable to increased passenger vehicle traffic.



Source: Counts performed by IDAX, Inc. for the week of October 31 through November 6, 2019. Data compiled by Heffron Transportation, Inc.
Note: The chart is based on tube count location A1.

Figure 7 shows rolling hour volumes at SR 432 throughout the week. The highest volume during the AM peak hour occurred on Wednesday between 6:45 and 7:45 A.M. with approximately 1,550 veh/hr. Friday had the highest Midday and PM peak hour volumes with 1,600 veh/hr between 12:00 and 1:00 P.M. and about 1,900 veh/hr between 3:30 and 4:30 P.M. As noted above, Friday volumes may reflect additional weekend vacation travel.

Figure 7. **Rolling Hour Volume** on SR 432 by Day of Week



Source: Counts performed by IDAX, Inc. for the week of October 31 through November 6, 2019. Data compiled by Heffron Transportation, Inc.
Note: The chart is based on tube count location A1.

The traffic patterns in the remaining local roadway network were compared to those of SR 432. Given that SR 432 volumes are so much higher than those of the other location streets, small differences in peak hours on those streets would not change the overall peak at the key intersections on the state route.

2.4. Intersection at SR 432 / International Way

The SR 432 / International Way intersection is currently a major access route to the Port, and could experience increased traffic in the future if rail improvements are made. For this reason, volume differences were investigated during the various peak hours at the Port cordon and the local and state roadway network. The data show that on Wednesday most of the streets in the area have a peak hour between 3:30 and 4:30 P.M. This intersection's peak hour, however, started later at 4:00 P.M. In addition, as previously noted, SR 432 had higher volumes on Friday that could be associated with vacation travel.

3. At-Grade Rail Crossing Traffic Impacts

This section presents high-level sensitivity analysis to show how at-grade rail movements would affect roadway vehicular delay and queuing under different conditions. This analysis was performed using relatively simple delay and queuing equations so that many potential scenarios could be tested.

The analysis utilizes train crossing duration information provided by KPFF and hourly roadway traffic volumes presented in Section 2 above.

3.1. Range of Train Move Types

Several train operating scenarios were evaluated. Each has different volumes, train configurations, and operations. To help assess the effect that each option could have on vehicular traffic, a range of potential crossing blockages of International Way were modelled. These included blockages caused by a light engine move, a half-train move where the train is broken east of International Way and pulled across International Way in two segments, and a full train move. The potential blockage times were derived by KPPF, and reflected 30 seconds of gate-closure time both prior to and after the crossing. The assumed street blockage times assessed are listed in Table 4.

Table 4. Train Crossing Blockage Times

Type of Train Move	Time Blocking International Way (from gate down to gate up)
Light Engine Move	3 minutes
Half Train Move	6 minutes
Full Train Move	15 minutes

3.2. Traffic Volumes

The inbound and outbound volumes for all points of access to the Port of Longview were previously shown on Figure 5. The data showed that cumulative volumes range up to about 190 veh/hr per direction of travel. Full unit trains would block all of the western access points to the Port of Longview site for long periods of time while waiting to be unloaded. This would functionally close these access points and require traffic to access the site via International Way. For the purpose of this analysis, it was assumed that all of that traffic would be consolidated to the International Way access point.

3.3. Queue Lengths and Upstream Blockages due to Train Crossings

Train movements across International Way would delay vehicles and create queues, both of which would increase based on the length of the train and the volume of traffic. The equations applied for this sensitivity analysis, which are based on the theories of traffic flow, are described in Appendix A.

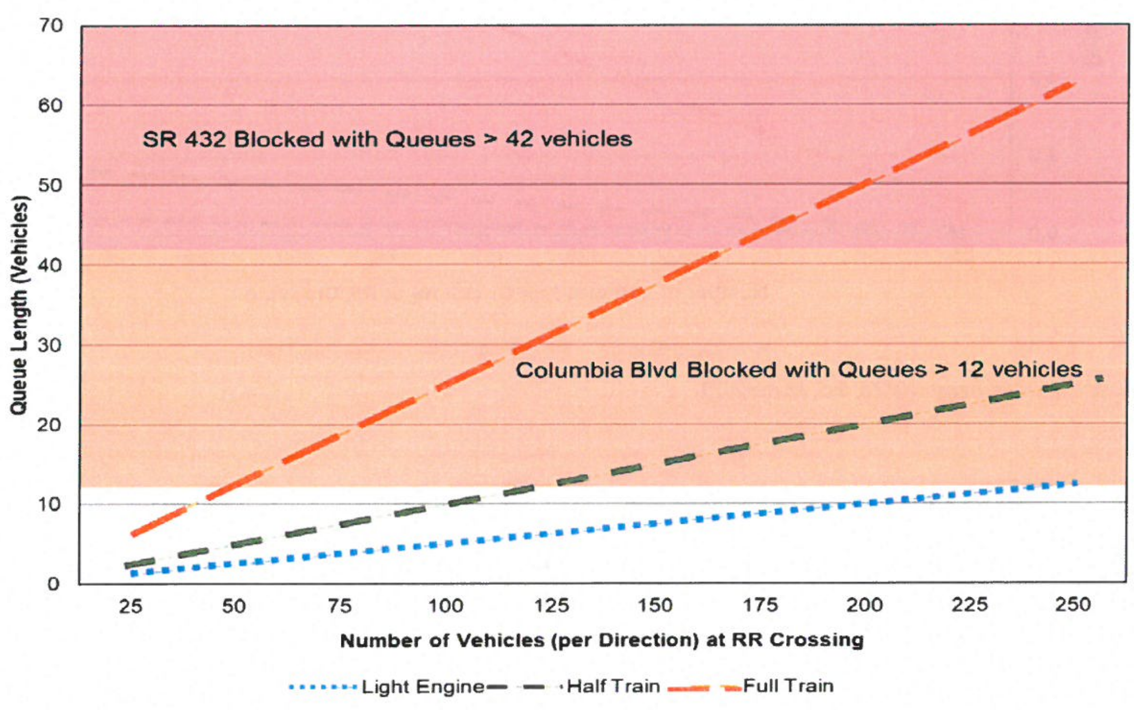
The sensitivity analysis determined that the most disruption to roadway traffic would occur if the queue approaching the International Way railroad crossing were to extend beyond nearby streets. This would be particularly acute for vehicles inbound to the Port, which if stopped for a train crossing, could back up and block nearby Columbia Boulevard (about 425 feet from the rail crossing) or worse, extend to SR 432 (and estimated 1,420 feet from the rail crossing).

Queue lengths were estimated based on an average vehicle length of 32 to 34 feet, which includes both the vehicle and space between vehicles. It assumes an average of 25 feet for each passenger vehicle, 35 feet for a single-unit (small) truck, and 70 feet for a semi-tractor trailer truck. The average weekday traffic counts showed 26% of the vehicles were small trucks, 10% were large trucks, and the remaining 64% were passenger vehicles. On the peak day (Tuesday), the percentage of trucks increased (23% small trucks and 15% large trucks). Based on these queue parameters, Columbia Boulevard would be blocked on the peak day when the queue length exceeds 12 vehicles; SR 432 would be blocked when the queue length exceeds 42 vehicles. Figure 8 shows the results of the queue length sensitivity analysis.

The analysis determined that light engine moves could occur at any time of day and not create queues that would block the nearby Columbia Boulevard. Half train moves would not block Columbia Boulevard during periods when inbound traffic volumes are less than 125 vehicles per hour, which extends from about 2:00 P.M. to 5:00 A.M. While inbound traffic to the port is relatively low after 4:00 P.M., half train movements in this afternoon hour would create long queues for vehicles leaving the port until after 5:00 P.M.

Full train moves could occur during a slightly smaller window—from about 5:00 P.M. to 4:00 A.M. when the volume of vehicles crossing the tracks would be low enough so that queues would not block nearby Columbia Boulevard. The analysis indicates that a full train crossing during the AM peak hour when the highest volume arrives at the port could cause the queue to extend onto SR 432. During other hours of the day, the queue could block many local business access driveways along that segment of International Way north of Columbia Boulevard.

Figure 8. Queue Lengths for Types of Train Moves and Vehicle Crossing Volumes

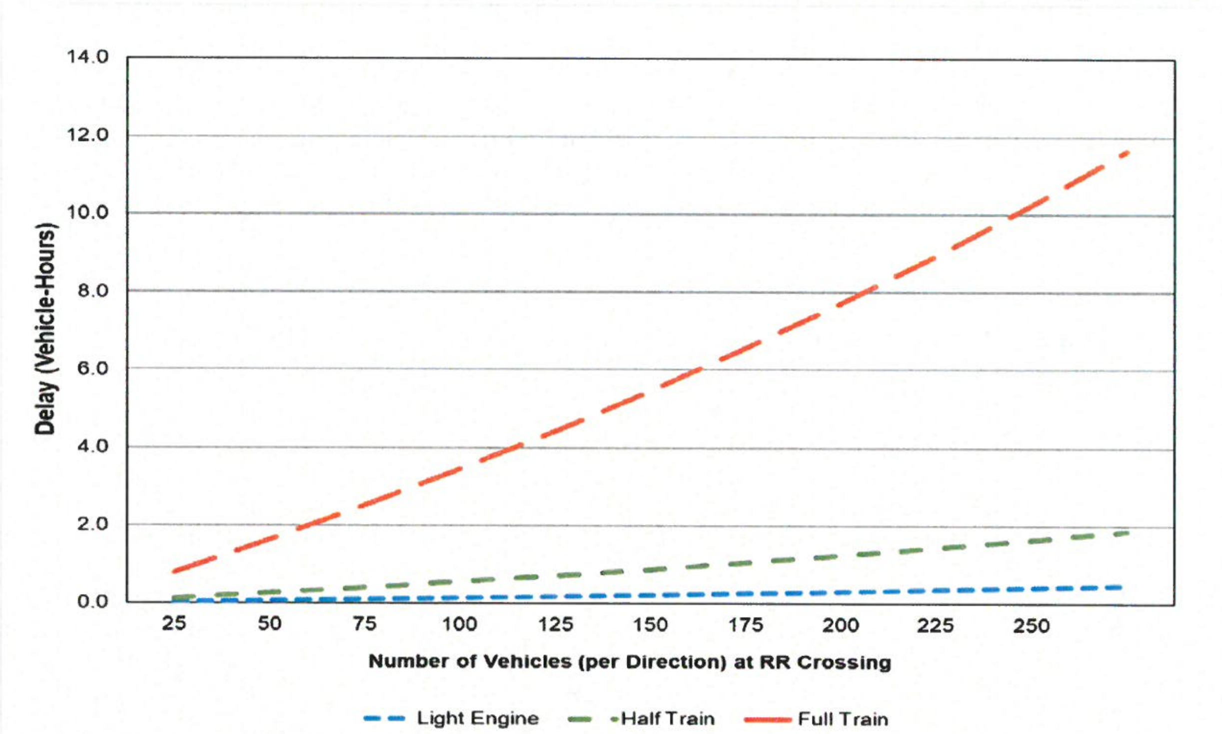


Source: Heffron Transportation, Inc., March 2020.

3.4. Vehicle Delay due to Train Crossings

Vehicle delay is also an important factor, since it affects the productivity of employees and trucks that travel to and from the Port of Longview. Figure 9 shows the estimated vehicle-hours of delay for the range of train moves and vehicular crossing volumes. Like the queue analysis, it shows that the light engine moves would create very little delay, even during periods when vehicular traffic is highest. A full train crossing would add substantial delay even when occurring at times with relatively low vehicle traffic volumes.

Figure 9. Vehicle-Hours of Delay for Types of Train Moves and Vehicle Crossing Volumes



Source: Heffron Transportation, Inc., March 2020.

4. Intersection Operations

Detailed traffic operations analysis was performed for intersections shown on Figure 2. Traffic operations are described using level of service (LOS), which is a qualitative measure, and vehicle delay, a quantitative measure. Six letter designations, "A" through "F," are used to define level of service. LOS A is the best and represents good traffic operations with little or no delay to motorists. LOS F is the worst and indicates poor traffic operations with long delays. WSDOT's level of service standard for SR 432 is LOS D.[1] The City of Longview generally considers intersections that operate at LOS C or better to be acceptable.[2]

Levels of service for study area intersections were determined using the *Synchro 10.3* traffic operations analysis software and reported using the *Synchro* module, which is based on the *Highway Capacity Manual (HCM), Sixth Edition.*[3] Traffic operations analyses were prepared for three conditions:

1 WSDOT, *Geospatial Open Data Portal,* accessed May 14, 2020.
2 City of Longview, *City of Longview 2019 Comprehensive Plan (Draft), July 2019.*
3 Transportation Research Board, 2016.

- **Existing (2019) Traffic Volumes –** These reflect the traffic volumes as counted in October 2019 and described in Section 2. All access points to the Port were open and unblocked by trains during the count period.

- **Rerouted Existing (2019) Traffic –** This assumes that western access points to the Port of Longview site would be blocked by a train (or closed), and that all traffic would reroute to access the Port via International Way.

- **Future (Year 2040) with Rerouted Traffic –** This assumes growth in the Rerouted Existing Traffic volumes through year 2040. Future growth was estimated to be 50% over nearly 20 years (reflecting an annual compound growth rate of approximately 2%) based on year 2040 traffic volume forecasts presented in the *Industrial Way Intersection Project Transportation Discipline Report.*[4]

Table 5 summarizes the intersection level of service results.

Table 5. Intersection Level of Service Summary

ID	Intersection	Control Type	Existing (2019) Conditions [a]		Existing Rerouted (2019) Conditions [b]		Future (Year 2040) with Rerouted Traffic [c]	
			LOS	Delay	LOS	Delay	LOS	Delay
AM Peak Hour								
1	Fibre Way / SR 432	Signal	B	12.8	A	7.2	A	10.0
2	Fibre Way / Columbia Blvd	Signal	A	7.0	A	7.2	A	8.9
3	International Way / SR 432	Signal	B	10.7	A	8.4	B	10.2
4	International Way & Columbia Blvd	TWSC [d]	B	10.4	B	13.3	C	20.0
5	H St & SR 432	Signal	A	7.6	A	4.7	A	7.6
11	Oregon Way & SR 432	Signal	C	28.8	C	27.1	E	56.2
PM Peak Hour								
1	Fibre Way / SR 432	Signal	A	8.7	A	4.4	A	5.9
2	Fibre Way / Columbia Blvd	Signal	A	6.3	B	14.3	C	22.8
3	International Way / SR 432	Signal	B	15.2	A	8.1	B	11.3
4	International Way & Columbia Blvd	TWSC [d]	B	13.8	C	17.7	F	74.9
5	H St & SR 432	Signal	B	10.3	A	7.9	A	9.4
11	Oregon Way & SR 432	Signal	C	30.9	C	26.6	D	41.5

Source: Heffron Transportation, Inc. Level of service and delay determined using Synchro 10.3.

a. These reflect the traffic volumes as counted in October 2019.

b. This assumes that western access points to the Port of Longview site would be blocked by a train (or closed), and that all traffic would reroute to access the Port facilities via International Way.

c. This assumes growth through year 2040. Future growth was estimated to be 50% between 2019 and 2040.

d. TWSC = Two-way stop- controlled intersection. The stop signs are on Columbia Blvd.

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4 WSP, February 2018.

The intersection analysis summarized above only evaluates the operations at the intersections and does not account for downstream effects of the rail grade-crossing at International Way. This allows the effect of intersection operations to be separated from the effect of queue blockages that may be related to the train. The analysis determined that the five signalized intersections near the Port of Longview currently operate at acceptable levels of service, and that all intersections would continue to operate at LOS C or better with rerouted traffic due to the train blockages on the west side of the port.

With growth in traffic through 2040, however, the intersection at Oregon Way/SR 432 could degrade to LOS E during the AM peak hour. This result is similar to that in the IWOW study for the conditions with no improvements at that intersection. Growth in traffic destined to the Port would also cause the stop-controlled intersection at International Way/Columbia Blvd to operate at LOS F in the future without changes in traffic control.

As described in Section 3 above, if a train were to block International Way during the AM peak hour, queues would extend from the rail tracks onto SR 432. It would cause both the intersections at International Way/Columbia Boulevard and International Way/SR 432 to operate at LOS F. The following section evaluates two potential options for a grade-separated crossing to eliminate those potential queue blockages.

5. Railroad Grade Separation Options

The rail improvements and resulting train operations could fully block the western access points to the Port of Longview for durations in excess of one hour. This would leave International Way as the only access to the Port, but it could also be blocked intermittently during train arrivals and departures. Full unit trains would block this crossing for 15 minutes per crossing. The queuing analysis determined that one full unit train crossing during the peak morning arrival period would cause traffic to queue back and onto SR 432. During daytime hours outside the morning arrival period, full unit trains would still create queues beyond Columbia Boulevard blocking driveways along the segment of International Way. Half-train cuts during the morning arrival period would cause queues beyond Columbia Boulevard, with much lower delays to traffic. For these reasons, a grade-separated access to the Port of Longview is recommended for any rail operating plan that would arrive and depart full unit trains during daytime hours (about 4:00 A.M. to 5:00 P.M.).

There are two potential options for a grade-separated structure (see Figure 1):

- Option A: At International Way; and
- Option B: A new connection between North Tie Road and H Street.

Both options would connect to SR 432 but at different locations. Option A would connect via International Way and Option B would connect at H Street. It is noted that the Option A alignment would likely also need to be grade-separated from Columbia Boulevard since the close proximity between the tracks and this street would not allow the structure to return to grade before reaching that intersection. Thus, the International Way grade-separation option would have more limited local connections than Option B via North Tie Road, since that option could bend to intersect at Columbia Boulevard at grade.

Level of service analysis for each access option was performed, and determined that either the SR 432/H Street or SR 432/International Way intersections could accommodate all Port of Longview traffic and no major changes would be required to lane configuration or signal operations. Both intersections would also accommodate growth in traffic through 2040 and continue to operate at acceptable levels of service (LOS C or better).

The most substantial benefits of the North Tie Road/ H Street overpass grade-separation option are that it could be constructed without disrupting traffic on the primary International Way access route and that the International Way route could be retained as a secondary access point to accommodate large loads such as windmills. The benefits and disadvantages of each option are presented in Table 6.

Table 6. Grade-Separated Access Options

Grade-Separated Structure Connecting North Tie Road to H Street	Grade-Separated Structure at International Way
Advantages: • Can be constructed without disrupting existing traffic on International Way • Retains at-grade access at International Way for secondary access, and to accommodate large loads such as windmills • Disperses traffic to intersections along SR 432, improving operations of that corridor. • Structure can be connected to Columbia Boulevard improving access to Port for local businesses located north of the tracks.	**Advantages:** • Can be constructed in existing right of way.
Disadvantage: • Requires property acquisition.	**Disadvantage:** • Primary port access route disrupted during construction. • Provides only one access route to/from Port when all others are blocked by train(s). • Structure would need to be designed to accommodate oversize and overweight loads since no alternative routes would exist. • Concentrates traffic at SR 432/International Way, intersection. • Structure would likely need to also be grade-separated from Columbia Boulevard (due to close proximity to the tracks), which would extend the length and increase cost of the structure. Extended length may also affect local business access on International Way north of Columbia Boulevard.

6. Recommendations

The following summarizes the recommendations to the Port of Longview based on traffic access needs.

- Create a grade-separated access to the Port of Longview for any rail operating plan that would arrive and depart full unit trains during daytime hours (about 6:00 A.M. to 7:00 P.M.).
- Until a grade-separated access is provided, full unit trains could be moved during overnight hours (7:00 PM to 6:00 AM), and half train cuts could be moved during any time.
- A grade-separated structure connecting North Tie Road to H Street is recommended, and has many advantages over one located on International Way, including the ability to construct it without disruption to the International Way access to the Port, and retention of the International Way access as a surface route for redundancy. The International Way access would also serve for large loads such as windmills, thus the structure would not need to be designed for oversized and overweight loads. The North Tie Road option also provides a better connection option between the Port and local industries located north of the tracks, since it could be built to intersect Columbia Boulevard.
- With a grade-separated access at North Tie Road /H Street, the roadway network would accommodate all rerouted traffic into and out of the Port, as well as forecast growth to 2040. No additional off-site improvements would be needed.

MCH/tsm/jlm

PoLV Transp Optimization Plan - Consolidated Traffic Analysis - DRAFT.docx

Attachment: Appendix A – Vehicle Delay and Queue Length Methodology

APPENDIX A

Vehicle Delay & Queue Length Methodology

Vehicular Delay at Railroad Crossings

The total delay incurred by roadway vehicles in queue at a railroad crossing was determined from the theory of traffic flow and the procedures listed in the section of signalized intersections in the *Highway Capacity Manual* (HCM). This methodology assumes that the railroad crossing operates similar to a signalized intersection with two phases. Since the typical blockage time caused by a train crossing is often much longer than "red time" at a signalized intersection, it is important to calculate the total delay which accounts for stopped delay as well as traffic queue-dissipation delay.

To calculate the total delay for all vehicles resulting from a crossing blockage, the Webster equation developed for signalized intersections was used (*Traffic Flow Fundamentals*, Adolf D May, 1990, pg. 144). The first term of the equation was manipulated to represent conditions at a railroad crossing since it represents delay for a particular approach assuming uniform arrivals at a fixed-time controlled intersection. Additionally, this term represents the case when the capacity of each green interval exceeds or equals the vehicle arrival rate, and the queue does not grow with each successive signal cycle. This term can be derived from deterministic queuing theory. The second and third terms of the Webster equation were not used for this methodology since they account and adjust for random traffic arrivals and represent relatively small components of the overall total delay. Much of the influence of random arrival would be lost during long train crossings. The resulting equation determines the total delay in vehicle-hours for a single roadway approach during one hour.

$$D = \frac{\lambda n \mu r^2}{2(\mu - \lambda)}$$

D	=	Total delay in vehicle-hours
λ	=	Arrival rate of vehicles (vehicles per hour)
μ	=	Queue dissipation rate (vehicles per hour)
r	=	Average blockage time at crossing (hours)
n	=	Number of blockages per hour (similar in magnitude)

When field saturation flow rate data is unavailable for capacity estimates, a typical default value for optimum driving conditions is 1,900 passenger cars per hour per lane (pcphpl). This value may be adjusted for several factors such as narrow lanes, steep grades, parking and large vehicles to estimate a saturation flow rate for a location. A review of the literature on saturation flow rates over at-grade rail crossings revealed recommendations of values much lower than the ideal 1,900 pcphpl. A more conservative estimate of 1,421 veh/hr was used in this traffic delay analysis for at-grade rail crossings based on the recommendation of a study of 17 at-grade rail crossings in Chicago, Illinois.[5]

The saturation flow rate was adjusted to consider the high percentage of heavy vehicles in the Port of Longview traffic by using a heavy vehicle adjustment factor (Fhv) as follows.[6]

5 CMAP (2015). Highway Capacity Measurements: Grade Crossing Saturation Flows. Draft Technical Update. Chicago Metropolitan Agency for Planning (CMAP). URL: https://www.cmap.illinois.gov/documents/10180/481346/GradeCrossingCapacityReport_20151020.pdf/c3520921-b26c-449b-a020-ffcc236fa7ba

6 Transportation Research Board (1997). *Highway Capacity Manual, 2000*

$$Fhv = 100/[100 + \%\, hv(Et - 1)]$$

Fhv	=	heavy vehicle adjustment factor
% hv	=	heavy vehicles for lane group volume
Et	=	2.0 passenger cars per heavy vehicle

It is noted that this sensitivity analysis only measures the vehicle delay associated with a single train crossing during each hour. In reality, two or more moves could occur in an hour (e.g., two half-trains moved in segments). The analysis accounts for the vehicles stopped by the train as well as those that are not, and is in effect a measure of probability that the vehicle will be delayed. For example, a half-train movement is estimated to block the railroad crossing for 6 minutes. During the course of an hour, there is a 10% chance that a vehicle would be stopped by the train. The Vehicle-Hours of Delay reported reflect the delay associated with one train movement.

Vehicle Queue Length

Resulting from the same theory and assumptions described above in the vehicular delay section, the equation to estimate maximum queue length (Qm) due to a crossing blockage is as follows:

$$Qm = \underline{\lambda r}$$

Qm	=	maximum queue length in vehicles
λ	=	Arrival rate of vehicles (vehicles per hour)
r	=	Average blockage time at crossing (hours)

This equation acknowledges that the maximum queue length will be observed at the end of the crossing blockage (*Traffic Flow Fundamentals*, Adolf D May, 1990, pg. 159).