EVALUATING A LOGISTICS PROPOSAL AT THE PORT OF PRINCE RUPERT

by

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EXECUTIVE SUMMARY

Problem Definition

The Prince Rupert Port Authority (PRPA) is examining the feasibility of developing Ridley Island port land into a value added cluster of logistics service providers. At question is the kind of transportation model that could be created to link the Fairview Container Terminal and its deep sea container port capabilities to the logistics cluster on Ridley Island in a time and cost efficient manner.

Relevant Facts

The proposed Phase II container terminal expansion project will increase terminal throughput capacity by 400% from 0.5 million TEU (twenty foot equivalent units – an industry measure of capacity) to 2.0 million TEU and expand the intermodal marine to rail capacity. A new two lane private haul road is proposed as part of the project that would directly link Fairview Terminal with Ridley Island. The planned location of the logistics cluster and related developments is on Ridley Island as it is the only location approved for new large-scale industrial development in the Port. At present there is no firm decision on whether or not the new private haul road will be included in the scope of work for Phase II.

Project Scope

This project will only cover the addition of the new haul road and the equipment used to provide the transportation capacity to service the logistics cluster. The integration of operational processes, integrated information flows, warehouse operations and cost, logistics services, environmental footprint and related costs are not included.

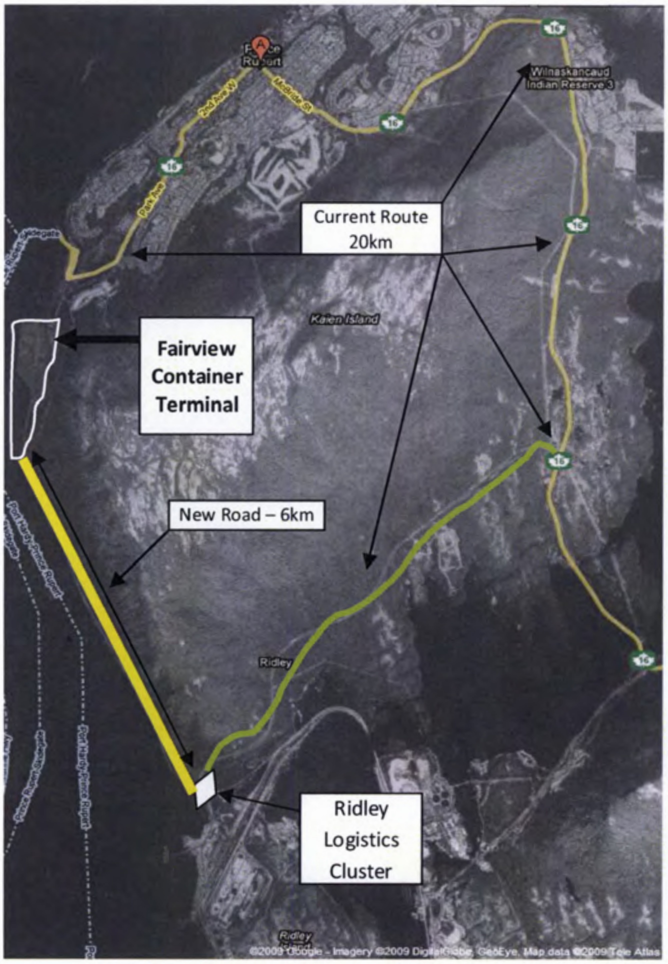

Figure 1 – Current & Future Truck Routes Map[1]

The construction costs of the project options outlined in Model I, Model II and Model III are based on estimated cost figures obtained from the PRPA. For example, the cost of the haul road, if added to the Phase II Fairview Terminal Expansion would be $4.5 million. If the road construction is to be undertaken as a stand-alone

[1] (Google - Imagery, DigitalGlobe, GeoEye, Map Data, Tele Atlas 2009)

project itself then the estimated cost would be close to $5.0 million. The potential cost of building a container depot on Ridley Island with truck access would be approximately $15.0 million dollars. If truck and rail access plus a full rail intermodal facility were added to the depot and new haul road, the cost could be $43.0 million dollars (construction estimates from the Prince Rupert Port Authority).

Project Methodology

The goal of this project is to outline, develop, compare and contrast the benefits to be gained by adding the two lane haul road over the current truck route that follows the provincial highway through the middle of the City of Prince Rupert.

This project involves the development of three transportation models. The first model, Model I, will outline the current route in place for hauling containers with trucks from Fairview Terminal to Ridley Island. The other two models, Model II and Model III, are based on the proposed construction of the new two-lane haul road. Model II is based on the use of the current truck and single trailer equipment configuration. The third model, Model III, is based on the use of a truck and double trailer equipment configuration (New to the Port of Prince Rupert).

The development of Model I will allow a demonstration of the current route mechanism along with its operational challenges and it also highlights the benefits of constructing the new haul road. The two new models, Model II and Model III, demonstrate the time and cost savings possible as compared to Model I.

Truck route speed and distance data related to the Model I route and the proposed truck route for Model II and Model III were collected. The measurement of truck route distances was done by using scale maps, preliminary road designs and vehicle odometer readings. Travel time for transportation operations was also determined and physically collected from container trucks travelling the current route. From this raw data the average travel time and the deviation in travel times were calculated. Theoretical estimates were made for the proposed new road used in Model II and Model III.

Analysis Summary

The current logistics model outlined in Model I shows that the current trucking route and logistics costs in terms of time and dollars are high and do not present a good service advantage. The findings of this project indicate that the port is at a disadvantageous position when trying to attract new investors or customers for the services at the logistics cluster. The cost for transporting a single container on a one way trip from Fairview Terminal to Ridley Island is approximately $135. This cost is considered high when compared with other West Coast ports as their average transport cost is $150 per container on a round-trip basis through more congested routes that take a greater amount of time to complete. (Transport cost source: Prince Rupert Port Authority)[2]

Another issue discovered during analysis is that the current truck route infrastructure is unable to support projected volume growth (if truck volumes maintain the current 6% of total container volume) when the terminal is expanded under the Phase II Expansion Plan to four times the size.

[2] Prince Rupert and West Coast Transport Cost averages from Prince Rupert Port Authority

As outlined in Model II, addition of the new haul road would reduce container transport costs by over 66% of the current costs of Model I. The reduction in truck travel distance would be more than 65% over Model I. Travel distance reductions coupled with a 36% reduction in the truck travel time for a complete round trip, creates enormous benefits. Not only does the transportation route become more efficient and cost effective, but it would benefit the environment by having fewer trucks travelling on the road to do the same amount of work. The reduction in distance and time to complete a round trip will also turn into greater than 56% efficiency and trucking capacity improvement as the number of trips a truck can make in a day will increase. This would be equal to an increase from under five trips per day in Model I to over seven in Model II with the same kind of trucking equipment. Model II also outlines that in order to handle the volumes from the terminal expansion and logistics cluster (conservatively estimated at the same 6% of total volume) the new haul road needs to be added.

This transportation alternative would also reduce overall fuel consumption and would produce fewer vehicle engine emissions. Based on mileage data from a local trucking company, the average fuel mileage on the current route is 5 miles per gallon of diesel or 47 litres per 100 kilometres (km). To travel the current route of 40km the average truck would use 18.8 litres of diesel. Travelling on the new haul road of 14km, and not counting elevation differences and fewer stop-and-go instances, the same truck would use only 6.58 litres of diesel. Comparing the diesel consumption of the current to the new haul road equals a 65% reduction in fuel usage to transport the same containers back and forth to the same locations.

Model III outlines a transportation solution based on single truck and multiple trailer combination vehicles capable of carrying two containers at a time. The efficiency of these units is maximized by operating them between the container terminal and a container depot. Combination vehicles are not well suited to short haul distances if the trailers need to be uncoupled and coupled. The addition of a depot with container handling equipment would allow for the quick unloading and loading of containers from the container trailer chassis without having to uncouple the trailers. By using these combination vehicles on the haul road the cost per container is reduced on a round trip basis to $35 that is a 74% cost reduction on Model I and a 22% improvement on the already efficient Model II.

The combination vehicles from Model III would also provide a cost effective and efficient way to move large volumes of containers from Fairview Terminal to a depot on Ridley Island. This would allow for the expansion of container storage capacity for Fairview Terminal by developing a storage depot on easier and cheaper to develop land at Ridley Island. The added benefit would be the potential to move the daily truck gate traffic to Ridley Island and buffer the container flows to and from Fairview Terminal.

Conclusion & Recommendations

In order to attract logistics service investors and related jobs to the Port and region a more attractive value proposition is needed with regards to the cost efficient support of a logistics services cluster at the port. The key piece of infrastructure that must be fully developed to enable this investment attraction is the new haul road.

The haul road will create opportunities to expand the use and efficiency of providing logistics services and possibly the handling capacity of the container terminal.

Without the haul road in place it will be very difficult to attract investors to the logistics cluster as the high transport costs and increased delivery time per container would deter warehouse and warehouse related investments. With the haul road in place, the expansion and development of logistics services and capacity can be added incrementally based on a revised demand and business case. There is no need to purchase a specialized truck fleet to service the logistics cluster in the short term. The existing truck fleet and service providers can be deployed more efficiently and effectively with the introduction of the new road. From detailed analysis there is also the risk that the Phase II Expansion truck volumes will overwhelm the current truck route infrastructure, which would hinder expansion plans. The new haul road would be able to accommodate significant increases in truck traffic. An added benefit of having the haul road would be the exclusion of heavy container truck traffic through the middle of the City of Prince Rupert. This will not only improve efficiency but also help maintain the local support for the expansion of transportation services in the Prince Rupert Port area.

Through the use of Process Flow and Queue Theory it has been determined that the new private haul road would be more beneficial to the Port. The long term benefits of the road can be reaped as soon as it is built and the benefits are:

- Increased trucking efficiency by 56%
- Reduced travel distance and cost by 65%
- Diversion of truck traffic out of the downtown core

- Creation of a competitive advantage to attract investment
- Incremental development model to grow with future volumes
- Cost effective increase of Fairview Terminal capacity with the addition of a new container depot serviced by LCV
- Reduced diesel fuel usage of 65%
- Reduced environmental waste and emissions from more efficient use of the trucking system

The new haul road will enable the initial incubation and future growth of the logistics cluster. The transportation model can be changed and capacity can be increased incrementally based on business demand.

The additional benefit of this haul road coupled with Model III transportation equipment is the expansion of container handling capacity of Fairview Terminal. The dwell time of containers at the terminal can be reduced through developing and using a hinterland container depot on Ridley Island (Used as an extension of the terminal to hold non-priority cargo, aged cargo and empty containers). Truck gate activity could also be diverted to the Ridley Island depot. This would create higher efficiency and turnover for the logistics cluster stakeholders through faster trucking turnaround times from the shorter haul distance.

INTRODUCTION

Reason for the Project

This document outlines and evaluates the transportation options to totally integrate a cluster of logistics service providers on Ridley Island to the new container terminal at the Port of Prince Rupert, BC, Canada. Advanced operational processes coupled with a flexible and cost effective inter-facility transportation logistics service will extend the capacity and service offering of Fairview Container Terminal (Fairview Terminal). This in tum will increase cargo traffic flow, velocity of the value added supply chain and add to the Port's value proposition for attracting new customers and investors. This project relates to the concept of the "Agile Port" introduced by Notteboom & Rodrigue (2008).

The purpose of this paper is to illustrate and demonstrate that the addition of the proposed new haul road from Fairview Terminal to Ridley Island will reduce cost and time while increasing efficiency. The new haul road will also be a key competitive advantage and selling point for further development and job creation in the Port area. The proposed haul road would run from the south end of Fairview Terminal, along the CN Rail right of way and connect to Ridley Island at the CN Rail road overpass (See Page 77).

To demonstrate that the proposed road would have a positive effect on Fairview and the Port in general, an analysis of the current transportation model, named Model I in this project, will be used as the control. This will be compared to the other models (Model II and Model III) that use the same trucking equipment over the new haul road to demonstrate the improvement over Model I.

Sponsor

The Prince Rupert Port Authority (PRPA) is the local authority that operates the Port of Prince Rupert and manages the development and use of the Crown land, harbour and coastline in and around the Prince Rupert Harbour. It is a non-shareholder, for-profit organization that is governed by a local (mostly) appointed Board of Directors that includes representatives from each level of government (Federal, Provincial and Municipal).

The PRPA is responsible for the overall planning, developing, marketing and managing of the port facilities in Prince Rupert that includes ensuring competitive, efficient and timely responses to customer and business opportunities.[3]

The Port of Prince Rupert is the second largest deep-sea gateway on the West Coast of Canada and it is also the shortest trade corridor between Asia and the Mid-West of North America. The PRPA is responsible for over 960 hectares of land, 14,000 hectares of harbour and 350 kilometres of coastline.[4]

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[3] From the Prince Rupert Port Authority Website www.rupertport.com
[4] Ibid

Industry Overview

Containers

The advent of the marine shipping container has drastically changed the nature of all industries and the ability of importers and exporters to reach new markets. Now products can be purchased and transported in piecemeal or small lot format versus large bulk orders. The cargoes also enjoy safe and secure shipment over long distances. The shipping containers used are International Standards Organization (ISO) standardized by length and height and also have a few standardized types of use.

The marine shipping containers are built around a standard length of twenty foot, forty foot and forty-five foot containers. The majority of the containers are forty foot with twenty foot containers making up the next largest portion and forty-five foot containers only a small portion of the total container inventory worldwide. Standard marine container heights are eight feet six inches and nine feet six inches.

A few types of standardized cargo carrying containers are; Dry Cargo, Refrigerated Cargo, Tank or Liquid Cargo, Bulk Cargo, and Over-sized cargo in Open Top and Flat Platform containers to name a few (see page 78, Appendix 3 – Marine Container Types).

The popularity of marine shipping containers is due to the fact that they are stackable either full or empty, can be used for a wide variety of cargo and is easy to handle with universally standardized handling equipment. They can be handled anywhere in the world with the same standardized type of handling equipment on vessels, at the container terminals, and on trucks and trains.

Container Terminals

Marine shipping containers are hauled on specialized ocean going vessels in a very time and cost efficient manner. These vessels need to unload and load their cargoes quickly and efficiently at specialized container handling terminals similar to the new one in the Port of Prince Rupert. Besides the specialized equipment to handle the containers, the vessels are also attracted to ports because of the hinterland connections they have by truck and rail so that the cargo can quickly and efficiently be delivered to market.

Figure 2 – Fairview Container Terminal Phase I – Prince Rupert
Source: Prince Rupert Port Authority

Terminals that are faster, more reliable and cost effective attract more cargo volume than ones that are lacking performance in any of these areas. The ability to deliver on speed, reliability and efficiency benefits everyone in the port community and the region as a whole through more local employment and direct investment.

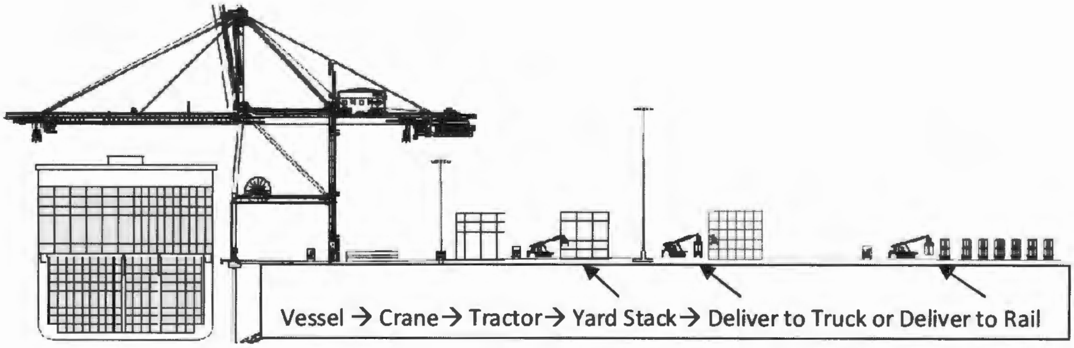

Figure 3 – Container Terminal Process Cross Section – Container Flow

The logistics services at a port add value to the supply chain and improve the value proposition for new customers that want to use the port. This service in turn can be marketed to increase containerized cargo flow through the port. These types of services help to feed more traffic opportunities to the port and all communities that belong to the gateway community. The logistics related services are unloading imported goods, loading export goods and warehousing activities. Logistics services can also include value added services to products such as labelling for different languages, bundling products with special offer add-ons and repackaging of items into more saleable packaging.

PROJECT SCOPE

This project will only cover the addition of the new haul road and the models and equipment to use in order to provide the transportation capacity to service the anticipated logistics cluster. The integration of operations processes between the container terminal, truckers and warehouse/logistics service providers, transportation modes, integration of information flows, detailed warehouse operations and cost, logistics services offerings and cost are not covered. The detailed cost design and capacity analysis of the new haul road is also out of scope for this paper. Each of these topics constitutes and requires a separate detailed study to develop and prove the best solution for each. As such these topics are out of scope for this study.

The construction costs of the haul road project options outlined in Model I, Model II and Model III are based on estimated cost figures obtained from the PRPA. For example, the cost of the haul road, if added to the Phase II Fairview Terminal Expansion would be $4.5 million. If the haul road was to be undertaken as a stand-alone project the cost would be close to $5.0 million dollars. The potential cost of building a container depot on Ridley Island with truck access only would be approximately $15.0 million dollars. If rail access and a rail intermodal facility were added to the depot, the total cost could be $43.0 million dollars (Estimates source: Prince Rupert Port Authority).

METHODOLOGY

Overview

The research methodology for this paper includes a logical construction of the process steps and actions involved to move containers from Fairview Container Terminal to the proposed logistics warehouse area on Ridley Island. The development of the three models, Model I, Model II and Model III, will allow a demonstration of the mechanism indicating operational challenges of the current route and to highlight the benefits of constructing the new haul road.

The first step was to collect truck route speed and distance data on the current Model I route and the proposed truck route for Model II and Model III. Every major change in the route speed or road condition is tracked and noted with distances to and from each logical action area and the time required to complete each part of the route. Each major landmark has been carefully added to provide benchmark locations that are comparable in each model on an equal basis. Having steps or events completed at different locations would not provide a true comparison of the advantages or differences in each model. The main landmarks are the Fairview container terminal and the CN Rail Overpass on Ridley Island as the logical start and finish destinations.

The measuring of truck route distances was done in two ways. For Model I, a combination of scale maps and vehicle odometer were used to trace and record the route. Landmark and container exchange locations were added as a route guide. In the case of the proposed new road used for Model II and Model III, scale measurements from preliminary maps and road designs were used.

The next step was the measurement of travel time on the current road. This required the capture of physical data from container trucks travelling the current route. Travel times to and from the proposed logistics facility are based on an average taken from forty truck trips to and from the terminal and the current warehouse facility on Ridley Island. The raw data on the truck trips can be found in Appendix 11 – Captured Truck Trip Raw Data found on page 86. The estimated travel times on the first line of the raw data sheet were captured as a physical measurement while travelling in a passenger vehicle at the posted speed limits to and from Fairview.

Dwell times for trucks at Fairview are based on actual captured dwell times from the truck trips. The average dwell time for trucks on the terminal are not expected to change and it is important to note that any changes at the terminal would equally affect all models as outlined further in this document.

Physical capture of truck movements on the current route in Model I have provided ample information to calculate the variability experienced by the service providers now under Model I. From this raw data, the average travel time and the deviation in real travel times are calculated. The travel time for the new road was calculated by simply using the distances and proposed travel speeds from the proposed road design plans.

Another indicator used is the cycle times and number of times a trucking asset can be used to perform a task in a fixed timeframe. We have used the best and worst case scenarios found to determine an upper and lower deviation in truck trip times.

A model capacity and queue theory analysis will also be made once all of the models are constructed. From the models a recommendation can be made as to the best model to use.

Transport costing has been added to each transportation event as applicable so that an accurate costing of the service can be calculated. Some of the costs are expressed in dollar terms while others are in terms of time. The transport costs are gained from a company currently involved in container transport in the Port.

LITERATURE REVIEW

Overview

There have been many articles written on how container terminals can and have become more cost and space efficient by improving the use of land area and optimizing the number and type of equipment and personnel used to move containers from vessel to yard and to a delivery mode of rail, barge or truck. There are however, very few articles that relate directly to the use of trucks and trailers to transport containers to and from a near dock area to expand the capacity of a container terminal. It goes as far as a statement in an article that said "To the best of our knowledge the number of papers focusing on trucks and trailers at container terminals is very limited" (Stahlbock and Vos 2007). This statement motivated the author to develop a model and processes for the transportation route, based on a variety of sources and findings, and piece them together for quantifying and evaluating this project.

The impetus for trying to create a relatively more cost effective and flexible solution for Prince Rupert comes from industry to improve the supply chain and increase the value-added services at the Port.

For this project the concept of the "agile-port" is used (Notteboom and Rodrigue 2008) where containers are transported by on-dock rail or barge to a nearby inland terminal or terminals where they can be sorted and re-directed to final destination. I proposed to extend this concept of the "agile-port" to the movement of containers from the container terminal to a near-dock container depot or logistics cluster that can provide value added services before being forwarded to their final destination.

Analysis

The variety of articles reviewed mostly came from Operations Management and Economics related papers dealing directly with supply chain logistics and maritime container terminal issues. Panayides (2006) expresses in his paper the importance of logistics and the aim of logistics to achieve high customer satisfaction (Panayides 2006). As per Panayides (2006), satisfaction is derived from receiving a high quality integrated service with low or acceptable costs for the service rendered. For the service to be considered successful it would have to provide for product possession at the right place at the right time and at the least cost. The central theme of an efficient and agile logistics offering is based on the concept of integration of all the pieces of the supply chain (Panayides 2006).

Why change the model?

In the Industry Canada sponsored report of the State of Logistics for 2008 (SCL and CME 2008) there are many references to the current and projected increase in fuel prices and the negative effect this may have on the trucking industry. The main costs associated with transportation are labour and energy, with both projected to rise over time on a unitary basis. While the two main variable input costs continue rising, the logistics industry demands more cost effective of lower cost transportation. How is this possible? According to the report the cost reduction and increase or maintenance of service levels will come from innovation.

One of the areas of innovation discussed is the concept of de-consolidation (SCL and CME 2008). This involves the unloading of cargo from marine containers and the loading of the cargo into domestic containers. The marine containers are standardized around twenty, forty and forty-five foot long containers. The domestic containers are fifty-three feet long (Also six inches wider than their marine container cousins) and this causes a conversion factor of three forty foot marine containers' contents fitting into two domestic containers (Maltz and Speh 2007);(Notteboom and Rodrigue 2008). Containers are transported by truck and rail on a cost-per-container basis. By converting three containers into two containers a transportation cost reduction of 33% can be realized. The total amount of savings depends on the cost and time efficiency of the warehouse that performs the marine to domestic conversion and the transportation cost from the terminal to the warehouse. Nevertheless a cost savings can be gained by converting the cargo from marine to domestic containers.

<u>Efficient Hinterland Connections</u>

The argument for making efficient hinterland connections to the ports or marine terminals comes from many different views.

One of the views (Magala and Sammons 2008) is that when logistics decisions are made the traditional model of port choice is made in isolation from the rest of the supply chain. This has led to disparate decisions that are based on each piece of the logistics chain but not on the total integrated supply chain value proposition. Magala and Sammons (2008) go further to propose a port choice model that examines the complete process of moving product from source to consumer with the port as a component of the logistics capacity and not as an entity unto itself (Magala and Sammons 2008). In my opinion this is one of the best ways to view the supply chain and the logic presented rings true. It will affect the way that logisticians view a supply chain gateway for their goods. A gateway with disjointed intermodal connections will be shunned in favour of a more integrated one. Integration of transport modes also leads to increased movement visibility. This model or similar models are in use as evidenced by the amount of time being spent to examine and quantify the hinterland transportation problems in Holland (Van Der Horst and De Langen 2008).

Van Der Horst and De Langen argue quite convincingly that not only do ports compete with each other for local traffic but also what they term "contestable" container cargoes. Their term refers to the cargoes that can easily switch from gateway to gateway as the hinterland connections allow this to happen easily. European ports are also graded and judged on their hinterland access (Van Der Horst and De Langen 2008) which is considered a key success criterion. Another curious finding of their study is that there is little attention paid to the coordination of hinterland activities in Europe even though this is an important key to success. They found that the majority of bottlenecks are in the hinterland and are caused by inadequate rail connections and congested truck routes. There have been many studies conducted on parts of the hinterland supply chain but all in isolation from the other parts of the chain. Another important fact is that the hinterland transport costs can far exceed the maritime costs (Van Der Horst and De Langen 2008) which should logically lead to more attention on the hinterland transport, however it does not. It is also suggested in the paper that the problems with hinterland coordination can be of a strategic nature where one company does not want to help the other or that one main player does not want to pay for all of the information infrastructure (IT systems) as other firms can leverage them to gain an advantage.

Another related paper about Australian ports (Robinson 2006) suggests that the port owner or port authority needs to take a holistic and strategic view of infrastructure development. Their focus on "value migration" from older logistics models in port development to new ones done in consultation with customers will better satisfy the customers and in turn lead to more business. Robinson (2006) also stresses that flexibility, scalability, and integration are important to the success of any new development. This advice can be easily integrated into the Prince Rupert Port area as the container facilities are in their infancy and future port development can be guided in the direction of flexibility. The time for easy and cost effective building of a flexible logistics capability exists now.

Warehouses that deal mainly with imported cargo have been shown to have problems with current and accurate information (Maltz and Speh 2007) which negatively affects their ability to deal with the influx of cargo. Typical imported items processing warehouses have to deal with huge peaks and valleys in their supply as their peak comes within hours of vessel arrivals and their valleys are the time between vessel calls at the terminals (Maltz and Speh 2007). When the vessel arrives the cargo must be moved very quickly from container terminal to warehouse to hinterland transport which could be done by truck or rail. The important point here is that the speed of the service is the selling feature. Successful planning and speedy outcomes depend on current and accurate information on cargo arrival and expected cargo volumes.

One of the best articles about this subject has come from Mr Notteboom and Mr. Rodrigue (2008) on the importance of integration in the supply chain from the point of view of ports and shipping networks (Notteboom and Rodrigue 2008). They contend that the gains in productivity at container terminals have mainly come from management know-how and systems at the terminal and from hinterland size. There have been no real gains or innovation in equipment or terminal capabilities other than some oversized equipment that has not really resulted in productivity gains. For all intents and purposes the equipment at each container terminal is the same as is the related inland movement equipment and modes: rail and truck. The current gains have come from new software management systems aimed at improving decision making and tracking at the container terminals. These systems and processes will not give a large gain in productivity at the terminal. The real place for improvement and innovation is from the management of the logistics system as a whole (Notteboom and Rodrigue 2008).

The result of massive container congestion at the Port of Los Angeles/Long Beach has been a search for more capacity and innovation (Notteboom and Rodrigue 2008) and that is the reason behind the initial building and current push to expand container handling facilities in Prince Rupert. This is the anchor point to an underutilized rail and trade corridor which has the proven ability to quickly and efficiently reach into the largest markets in the Midwest and East coast of the North American continent along the CN Rail mainline. Further in the paper the question is raised about whether or not ports and terminals can cope with the volumes if the hinterland transport can maintain delivery efficiency.

The concept of the "agile-port" is introduced where containers are transported by on-dock rail or barge to a nearby inland terminal or terminals where they can be sorted and re-directed to final destination. I propose to extend this concept of the "agile-port" to the movement of containers from the container terminal to a near-dock container depot or logistics cluster that can provide value added services. From these facilities the containers could still maintain their velocity and be delivered in a time-sensitive manner to cross continent rail delivery. The whole system would function in an integrated manner which would maximize customer visibility and increase the value proposition of the port in general. The most relevant validation of the need to study and develop hinterland capability is Van Der Horst and De Langen (2008) stating that "Ports and their hinterland transport systems can only attract and manage additional container volumes if the hinterland transport network is organized efficiently and effectively"(Van Der Horst and De Langen 2008).

Equipment Selection

An important consideration for any new infrastructure project is the type of equipment that may be used. In this case the proposal is to add a two lane road to link the Fairview Container Terminal and the development area on Ridley Island. The design of the road would be affected by the potential future use of it with regards to the layout of the road width, turning radius, grade of incline and inter-road connection areas (California Department of Transportation 1984).

The popularity of multiple trailer vehicles or longer combination vehicles (LCV) is rising (Mele 2009) as the transportation industry is trying to find innovative ways to cope with increasing costs and cargo volumes. At the same time there is a drive to find cost efficiency and environmental improvements in the trucking industry. The most obvious way to achieve the goal of cost efficiency is to haul more with the same rolling assets. Environmental improvements can also come from maintaining or reducing the number of trucks on the road while increasing their payloads.

What has been proposed by the trucking industry is to haul two domestic length trailers (fifty-three feet each) with one tractor unit. This reduces the labour cost portion by fifty percent and decreases the fuel cost by an estimated eight percent (Mele 2009). The other benefits are reduced road congestion and lower engine exhaust emissions. While the idea of hauling two domestic trailer loads with one truck is a good one, it can only be implemented on trips that have a longer or direct haul component with no stops between origin and destination as the trailers take time to manoeuvre and disconnect and reconnect. The units would not be suited to dense city routes, short haul, and door-to-door delivery due to the time required and difficulty in the trailer disconnect and connect process. The inner city, short haul and door-to-door delivery truck routes make up the bulk of trucking industry routing patterns. As a result, it is estimated that introducing these LCV units in America would only result in six percent fewer truck trips. The largest investment foreseen for implementing LCV units would be additional truck driver training.

The only group so far opposing the move to LCV units is the International Brotherhood of Teamsters which sees the LCV as a dangerous combination of length and weight which will increase accidents and cause further highway damage (Kilcarr 2008). The proponents of the LCV are trucking company owners and their customers (Kilcarr 2008) who would definitely see this as a way to reduce costs and improve their carbon footprint. A study has been commissioned and is being conducted now by the University of Michigan Transportation Research Institute to determine the benefits and disadvantages of different types of cost saving combinations.

The only study completed to date was one by the California Department of Transportation in 1984. They researched and field tested three different LCV types with triple twenty-eight foot long trailers, double forty eight foot long trailers and a forty eight foot long and twenty-eight foot long trailer matched together. Refer to Appendix 5 – Model III – LCV Equipment on page 80 for pictures of the triple twenty-eight and double fifty-three trailers.

The best results came from the double trailer combinations as the triple trailer combination wandered and was hard to slow down evenly. The units that relate the closest to the Prince Rupert project are the double forty-eight foot trailers. They found a one-hundred percent increase in capacity per driver and a reduction in the amount of fuel consumed. There was also an expectation of lower air emissions due to fewer trucks needed to haul the same freight. The negative points are the safety factor of these large units in traffic and damage to the road. The other concerns were infrastructure damage from the trailers taking more turning radius which could result in property damage and parking issues (Califomia Department of Transportation 1984).

There were some very good points drawn from this study that relate directly to the Prince Rupert project. The most important are that the LCV combinations work and can be operated with regular street traffic as long as the road infrastructure is built with the LCV units in mind. They recommended a ten foot wide road lane minimum with a 12 foot lane width ideal for the double forty-eight foot trailers. The other finding is that the off and on ramps and intersections need to be one-hundred feet in radius to allow the same handling characteristics as a standard single tractor trailer of forty-eight feet. As the Prince Rupert project proposes a purpose built port haul road, it can be operated in a private or traffic controlled manner to reduce or eliminate any regular street traffic and mitigate the safety concerns found in this study.

MODEL ANALYSIS

Logistics Models Overview

Each of the three models, Model I, Model II and Model III, is based on the infrastructure currently present or expected to be built for the Fairview container terminal under the Phase II expansion project. The last model, Model III, includes some blue sky interpretation of a possible next logical step in the progression of container terminal capacity development in the port with a container depot added at Ridley Island. It is not expected that Model III would be immediately financially viable given the current container volumes and need for the construction of a container depot.

Without a realistic projection of the volumes needed to justify the implementation of progressive models like Model III, there could be capital assets (specialized truck and trailer combinations) and infrastructure (container depot) added without any hope of fully realizing the incremental gains from its use. Over equipping the service would positively improve capacity but would increase the cost of service provided by the trucker, Fairview Terminal and the container depot operator if applicable. The expectation is that the capital assets and infrastructure employed would be added incrementally as the business and container volume demands.

Logistics Models Assumptions

Equipment

The equipment used in Model I and Model II are the standard highway capable tractor unit towing a container trailer chassis that is capable of hauling one twenty, forty or forty-five foot marine shipping container. Refer to the equipment pictures in Appendix 4 – Model I & Model II Equipment Used on page 79.

Model III is based on the use of a standard highway tractor coupled to a double trailer container chassis combination vehicle. This vehicle would be capable of hauling two containers of twenty, forty or forty-five foot length or any combination of two thereof. See the expected equipment in the second photo in Appendix 5 – Model III – LCV Equipment found on page 80. This type of combination vehicle would be able to haul twice the amount of the units used in Models I and II. The tractors used could be the same standard type as used in Model I and Model II, however higher horsepower rated tractor versions may be considered ideal by the trucking operator.

One of the advantages to the new road would be that it is considered to be a private road. As such the possibility exists to use even more specialized off-highway tractor trailer units that would be considered a non-standard configuration. The first type of equipment to consider would be the currently used container terminal tractors with single container "bomb cart" style trailer chassis. These trailer types are designed for quick load and unload times, fabricated with heavier steel and designed for enhanced durability. There are also other off-highway tractor trailer multiple combination vehicles in use that have the capacity for one driver and tractor to tow up to five fully laden forty or forty-five foot long containers. Some photos and drawings of these can be found in Appendix 6 – Model III – Off-Highway Equipment on page 81. These are also of a "bomb cart" style and example can be seen in use in three trailer configuration at Deltaport Container Terminal in Vancouver, BC, Canada for use on the container terminal only.

Distances

The distances travelled in each of the models are based on a round trip basis. This assumes that the truck travel starts and ends at the container terminal. A round trip assumes that the truck is coming to the terminal to receive a container, delivers it to a warehouse, and picks up another container from the warehouse and then returns to deliver it to the terminal.

Transit Time

One of the factors weighing heavily on the transit time is the distance travelled and the other is the speed at which the truck travels. Each model has different routing and factors affecting speed that create variability in the models. The one constant is the distance travelled and time spent at Fairview. This equally affects Models I and II. Model III is affected to a greater degree as more containers are handled on each trip to Fairview.

With Model II and Model III there exists the possibility that the speed limits can be raised beyond what is conservatively estimated now in the calculations. Once a final engineering design for the road is agreed there will have to be a recalculation of the capacity and speed of the route. An increase in speed is anticipated after final engineering is done which means the new road will perform even better than it is currently estimated to.

The time involved in processing or providing service on cargo in the containers at the warehouse is not included. The reason is that this does not directly relate to the ability to transport the containers to and from the terminal and warehouse or logistics service provider. The time taken to process would directly depend on the type of service required for the cargo in each container. The warehouse time spent is for dropping off the container trailer chassis and picking up another container on another container trailer chassis. Model III is purely based on turnaround times from the unloading and reloading of the multiple trailers at Fairview Terminal and the proposed container depot on Ridley Island.

Logistics Costs

The tangible costs are made up of container transport from Fairview Terminal to the logistics cluster and from the logistics cluster back to Fairview Terminal. The cost of transport has been gained from a trucking company that is currently involved in container transport in the Port of Prince Rupert. This company's cost figures represent a standard pricing basis for estimating the logistics cost. These trucking costs can be considered to the high end of average local trucking costs. Of course, depending on the overall trip frequency and container volume the rates could be negotiated and adjusted downwards by a special contract price.

The fee charged at Fairview Terminal for processing trucks through the truck gate is included in the ocean shipping rate charged by the steamship line or ocean carrier to the importer or exporter. As it is included in the rate all importers and exporters would be treated equally, which means we have zero rated the truck gate costs. For the purpose of this study these costs are standardized at zero and unaffected by each Model and their inherent differences. Multiple containers hauled in Model III would be assumed to be levied the same gate charge at Fairview Terminal. For the container depot a minimal charge per container of five dollars has been added as an estimated cost to process in their truck gate, handle, unload and load containers from the multiple combination trailers.

The cost of de-stuffing and stuffing cargo in the containers and logistics services at the warehouse are not considered in the costing exercise as this does not directly affect the transport costs. These costs would be directly related to the type of service and operation to be performed at the warehouse and would vary with the type of service and cargo varies. The costs would form part of a service agreement between the warehouse operator and the cargo owner.

The one intangible cost is the current social cost of a vocal opposition by some members of the community to the increased heavy industrial truck traffic routing through the middle of the City of Prince Rupert that has resulted from the container trucking to and from Fairview Terminal. There may be some form of delay and inconvenience that is experienced, but no facts or figures are available to substantiate a proper calculation or estimate of the cost.

Another cost is the opportunity cost of trucks waiting at Fairview Terminal for service. There are some estimates made of these costs based on Queue Theory and the anticipated wait times under certain container and truck volumes.

Truck Turns

The number of times a truck can make a round trip is directly affected by the distance travelled and the time it takes to travel. The operating hours of Fairview Terminal also have an effect on it. Currently the terminal operates from 0800 to 1630 Monday to Friday. During weekends and Statutory Holidays the truck gate is closed due to higher operating costs and low container truck volumes through the gate. The operating time of the terminal is currently seven and one half hours due to three nonworking break times: two fifteen minute coffee breaks and one thirty minute lunch break. The standard time used for all model calculations of truck turn time and truck gate capacity will be seven hours, as a conservative estimate of actual working time.

Model I – Current Truck Haul Route

This model outlines the current transportation logistics configuration which includes equipment used, truck travel distances, transit time and costs. All of these affect the system capabilities, efficiency and truck gate capacity. For a map of the corresponding route see Appendix 7 – Model I – Map on page 82.

Infrastructure Needed

As this model outlines the current transportation logistics situation the infrastructure is already in place and consists of a 20 kilometre route that goes from Fairview Terminal to British Columbia Provincial Highway #16 through the middle of the City of Prince Rupert out to the industrial land on Ridley Island. There are no expected infrastructure costs in the short term. The longer term of the Model I route indicates that with increased container traffic volume there will be the need for a larger truck staging or buffering area adjacent to Fairview Terminal.

Equipment Used

The equipment used in this model is based on the current highway capable tractors and container chassis used for local transport. They include one driver, one tractor and a single container chassis that can haul one twenty, forty or forty-five foot container. See the equipment pictures on page 79 in Appendix 4 – Model I & Model II Equipment Used.

Move Type	Action Step	Distance (km)	Speed (km/h)	Ave Time (minutes)	Cost
FROM TERMINAL	Fairview Gate to Yard back to Gate	0.5	2.7	11	
subtotal		***0.5***	***2.7***	***11***	***$ -***
TRANSIT TO	Fairview Gate to Park Avenue	1.3	39.0	2	
	Park Ave to McBride	2.7	32.4	5	
	McBride to Ridley Road	9.1	60.7	9	
	Ridley Road to Rail Overpass	5.9	88.5	4	
	Rail Overpass to Warehouse	0.5	30.0	1	
subtotal		***19.5***	***55.7***	***21***	***$ 135***
WAREHOUSE					
	Warehouse - Drop and Pick	0.5	1.5	26	$ -
subtotal		***0.5***	***1.2***	***26***	***$ -***
TRANSIT FROM	Warehouse to Rail Overpass	0.5	30.0	1	
	Rail Overpass to Ridley Road	5.9	88.5	4	
	Ridley Road to McBride	9.1	68.3	8	
	McBride to Park Ave	2.7	32.4	5	
	Park Ave to Fairview Gate	1.3	19.5	4	
subtotal		***19.5***	***53.2***	***22***	***$ 135***
TO TERMINAL	Fairview Gate to Container Yar	0.5	2.7	11	$ -
subtotal		***0.5***	***2.7***	***11***	***$ -***

TOTALS	**1 container pick up & 1 drop off**	**40.5**	**26.7**	**91**	**$ 270**
Containers Moved:	**2**	Cost per unit			$ 135

Figure 4 – Model I – Distance Speed Time Cost

Distances

The total distance travelled in this model on a round trip basis is almost 41 kilometres. This assumes that the truck travel starts and ends at Fairview Terminal. As previously stated these distances were gained by taking measurements from a scale map and through physical measurement of the route distance. The legs of the trip in this model are broken down into smaller segments so that an assessment of each part can be made at each major intersection. It also allows for an equal comparison with the other models at certain key landmarks. See the Flow Chart below in Figure 6.

The distances at Fairview Terminal remain constant at less than half of a kilometre as the standard trip varies little.

From Fairview Terminal to the intersection at Park Avenue the road is on port property and is controlled by a security checkpoint at the mid-point and a stop sign at Park Avenue. The distance from Park Avenue to McBride is significant as it passes through the middle of the town and encounters five uncontrolled intersections, five uncontrolled pedestrian crosswalks, one - four way stop, one two way stop and two traffic light controlled intersections. From McBride to Ridley Road there are only two traffic light controlled intersections and two uncontrolled pedestrian crosswalks on the over nine kilometre section. At the Ridley Road intersection there starts a simple unobstructed road of almost seven kilometres that is ended logically at the rail crossing overpass to create a common route measuring benchmark for Ridley Island. The distance from the Rail Overpass to the warehouse is the last physically measured portion and is estimated to be one half of one kilometre. There is no difference in the route travelled or the distances encountered for the return trip to Fairview as shown in Figure 4 above and Figure 5 below.

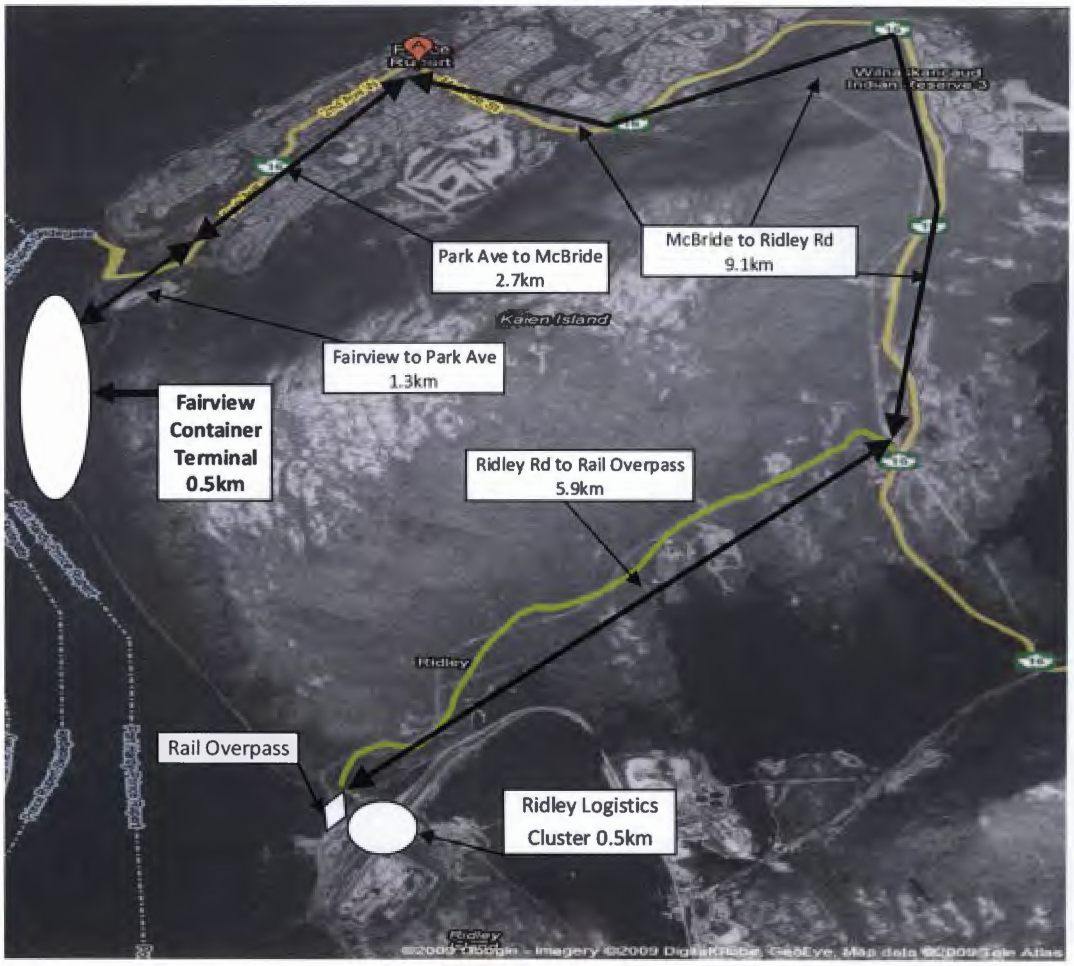

Figure 5 – Current Truck Flow Route Map[5]

Transit Time

In the case of this model the travel distance through the middle of a town is significant to note as the route consumes truck travel time. This leads to reduced speed regulations and makes the average speed of travel at the best case of thirty two kilometres per hour. A weighted total time calculation taking the distance travelled and the related speed zone gives an average time scenario of over ninety-

[5] (Google - Imagery, DigitalGlobe, GeoEye, Map Data, Tele Atlas 2009)

one minutes. The transit time is also heavily exposed to possible and probable delays caused by the congestion of slow moving town traffic, delays from vehicles parallel parking, numerous pedestrian crossings, traffic lights and traffic diversions from road work and accidents.

The variation in total trip time can be as much as twenty minutes on either side of ninety-one minutes. This is a great deal of unpredictability. On this route it is easy to add from three to seven minutes to the transit time one way just getting through the middle of the City of Prince Rupert. Adding in the expected variation or deviation from the average trip it is possible to have a round trip as short as seventy-one minutes and as long as one-hundred-eleven minutes.

Taking the average round trip time of ninety-one minutes without the potential delay of twenty minutes you can see how the process flows from the Flow Chart in Figure 6 below. This outlines the Model I process map associated with the complete round trip with each step and the time spent by the truck to move the containers.

Truck Turns

Given the average travel time in this Model and the deviation of twenty minutes from the average time there is the possibility of a truck making at best a total of almost five round trips in one operating day. If the truck experienced the worst case expected delay or variation from the average of an extra twenty minutes per round trip the truck could only expect to complete two and a half trips per day. This means the driver could lose two trips per day and the associated revenue. The percentage difference between the best and worst trip times is an amazingly high

MODEL I – FLOW CHART

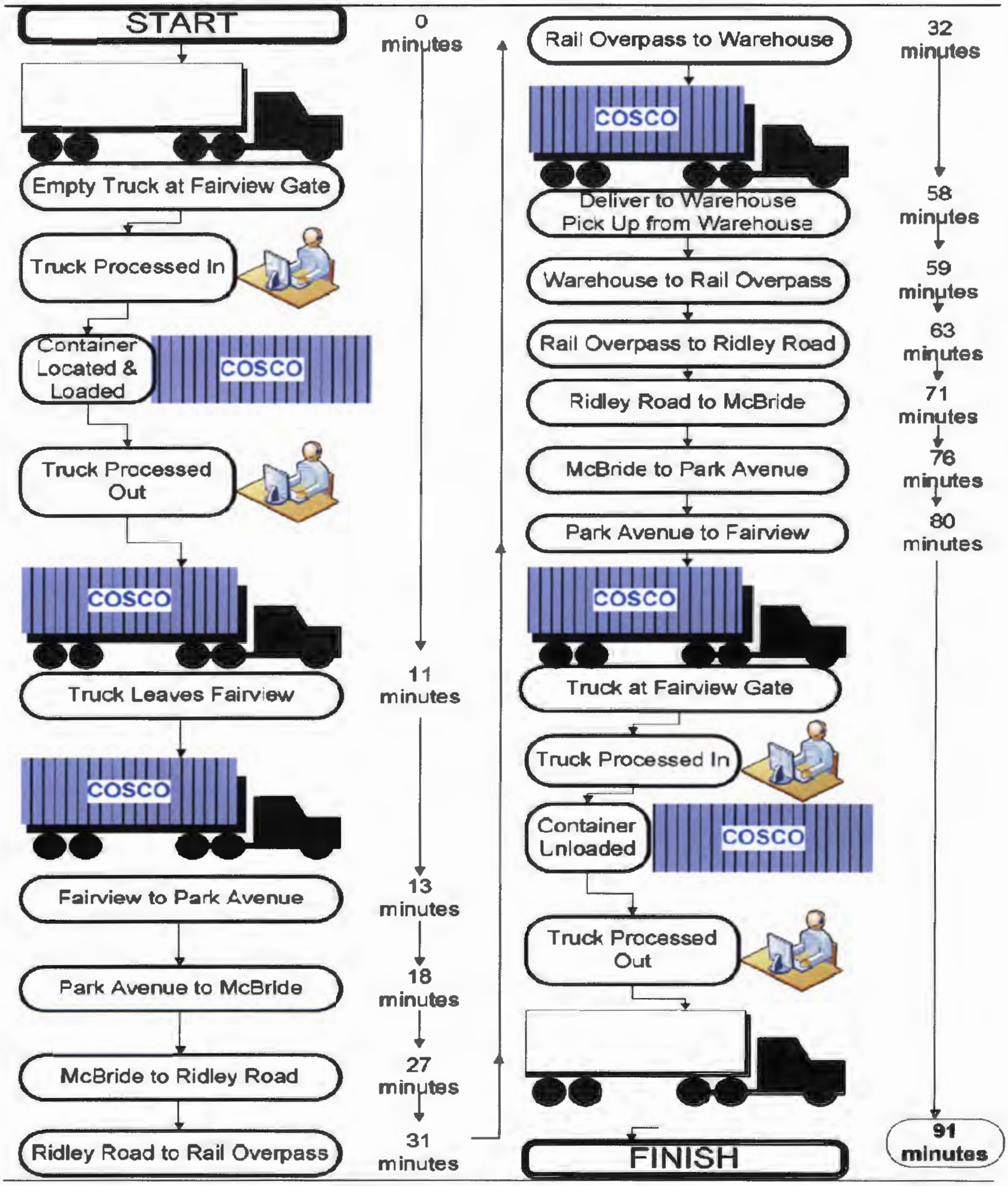

Figure 6 – Model I – Flow Chart

93% variation in results. This proves that the current route is unpredictable at best. You can see these results graphically in Figure 23 – Truck Turn Variability on page 63. The current transport route allows trucks to each move at best ten containers and at worst five containers in a day as illustrated on page 62 in Figure 22 – Truck Turns per Day Comparison.

Logistics Costs

The cost of transport is affected by the distance and time travelled. In this case the cost of a one way trip is $135 including the current fuel surcharges ($120 cost for truck, chassis and driver plus $15 fuel surcharge). This equates to a total transport cost of $270 for the round trip ($240 cost for truck, chassis and driver plus $30 fuel surcharge)

Logistics System Capacity

The capacity of Model I is based on the amount of traffic that Fairview Terminal can handle through the truck gate infrastructure. At present, the average number of trucks handled per day is 19.1 as outlined on page 85. On an annualized basis 4,956 trucks were serviced (19.1 trucks per day * 5 days per week * 52 weeks per year = 4,956). The current route follows the Provincial highway system (Highway 16) which can handle far in excess of the current truck volume. In fact, it could easily handle more than twice that amount of traffic.

A Queue Theory analysis has been done and the results can be seen on page 84. This shows that the terminal gate can easily handle the current volumes and is only at a little over 45% current handling capacity. If the terminal were to achieve its design capacity of 0.5 million TEU per year, then the estimated full future volume of 9,456 trips per year could also be easily handled. This assumes a prorated increase in truck trip volume of 5.9% of total terminal volume and the same container to truck visit ratio of 2009 (272,850 * 5.92%= 16,152 truck containers per year: 16152 * (4,956/8,465) = 9,456).

2009 Container Throughput-Actual			143,000
	20'	40'	Total
Containers	23,940	119,060	143,000
Ratio	17%	83%	100%
TEU			**262,060**

2009 Truck Container Throughput	8,465
2009 Truck Visits/Year	4,956
2009 Ave Trucks/Day	19.1
Ave. Trucks / Hr	2.7

FULL Container Throughput-Estimate			272,850
	20'	40'	Total
Cntrs	45,679	227,171	272,850
	17%	83%	100%
FULL TEU			**500,039**

FULL Truck Container Throughput	16,152
FULL Truck Visits/Year	9,456
FULL Ave Trucks/Day	36.4
Ave. Trucks / Hr	5.2

Figure 7 – Current & Estimated Full Capacity Throughput & Truck Visits

It is estimated that Fairview Terminal would have to add one more handler or Reach Stacker to maintain service to unloading and loading of the trucks. This would increase truck gate capacity to fourteen trucks per hour from six (refer to Figure 8 below and Appendix 10 on page 85). The calculated capacity of fourteen trucks per hour is the maximum capacity of the truck gate in the current configuration of the 0.5 million TEU terminal capacity. This maximum capacity guidance is gained from operational experience information from the Prince Rupert Port Authority in cooperation with the operator of the terminal.

	Capacity/Hr	Trucks/year	Containers/Year	
Gate Capacity - 1 Reach Stacker	6	10,920	21,840	*At 100% Utilization*
Gate Capacity - 2 Reach Stacker	14	25,480	50,960	
Gate Capacity - 3 Reach Stacker	22	40,040	80,080	

Figure 8 – Gate Capacity with Number of Reach Stackers

It is very important to note that when Phase II of the Fairview Terminal Expansion is complete, the terminal capacity will be 2.0 million TEU or 4 times the current capacity. If the present truck route is used, the current truck gate and route will not be able to handle the estimated traffic of 64,606 containers per year (estimated at 16,152 containers per year at 0.5 million TEU * 4 = 64,606 containers per year at 2 million TEU).

The estimated truck volume would be 20.8 trucks per hour (16,152 / 9,456 = 1.708 container to truck trip ratio; 64,606 containers / 1.708 truck trip ratio = 37,825 Truck Visits per year; 37,825 / 52 weeks per year / 5 days per week = 145 Trucks per day; 145 Trucks per day / 7 operating hours per day = 20.8 trucks per hour). As outlined in Figure 8 above, there would need to be 3 Reach Stackers deployed to try and handle the volume, which is not possible with the current truck gate infrastructure. The main bottleneck would be from Park Avenue to the Fairview Terminal truck gate.

An estimate of the cost of queues building and increased wait times is also helpful to justify the alternative haul route. Depending on the demand for service, the costs to the stakeholders could be large (in excess of $0.5 million per year if using 1 Reach Stacker to handle trucks and $30,000 per year using 2 Reach Stackers).

This is based on the lost opportunity cost to the trucker of a $270 transport round trip conducted in 91 minutes as outlined in the costing for Model I on page 33. Costs were calculated by using the round trip cost of $270 and dividing it by 91 minutes to get a cost per minute of $2.97. The cost per minute was then multiplied by 60 minutes to get an hourly rate of $178.02. The estimated wait time in hours for the year was then determined with results of Queue Analysis on page 84 and multiplied by the hourly rate to come up with the opportunity cost to the truckers.

Model II – New Haul Road to Ridley Island – Serviced by Single Trailers

Model II outlines the expected logistics configuration, equipment used, travel distances, transit time, costs and logistics capacity if the new haul road is built to the south of Fairview Terminal to connect to Ridley Island.

Infrastructure Needed

This model requires the construction of the new private haul road considered as part of the Phase II Fairview Container Terminal Expansion. See the new haul route below in Figure 9. The estimated cost of this project if undertaken as part of Phase II expansion is $4.5 million (source: Prince Rupert Port Authority). If this project is undertaken separately from the Phase II expansion it will cost more and is estimated to be as much as $5 million (source: Prince Rupert Port Authority).

Equipment Used

The truck transportation equipment used in this model is exactly the same used in Model I. See Appendix 4 – Model I & Model II Equipment Used on page 79.

Distances

The total distance travelled in this model on a round trip basis is 14 kilometres as shown in Figure 11 below, based on the assumption that the truck travel starts and ends at Fairview Terminal. Note that there is very little congestion on this route as the road is private and runs direct from Fairview Terminal to Ridley Island.

This routing is broken down into a few main milestones as the route is very simple and direct. The distance travelled at Fairview Terminal is the same standard under half of a kilometre that includes the distance from the gate to the location on the terminal to receive the container and back to the gate.

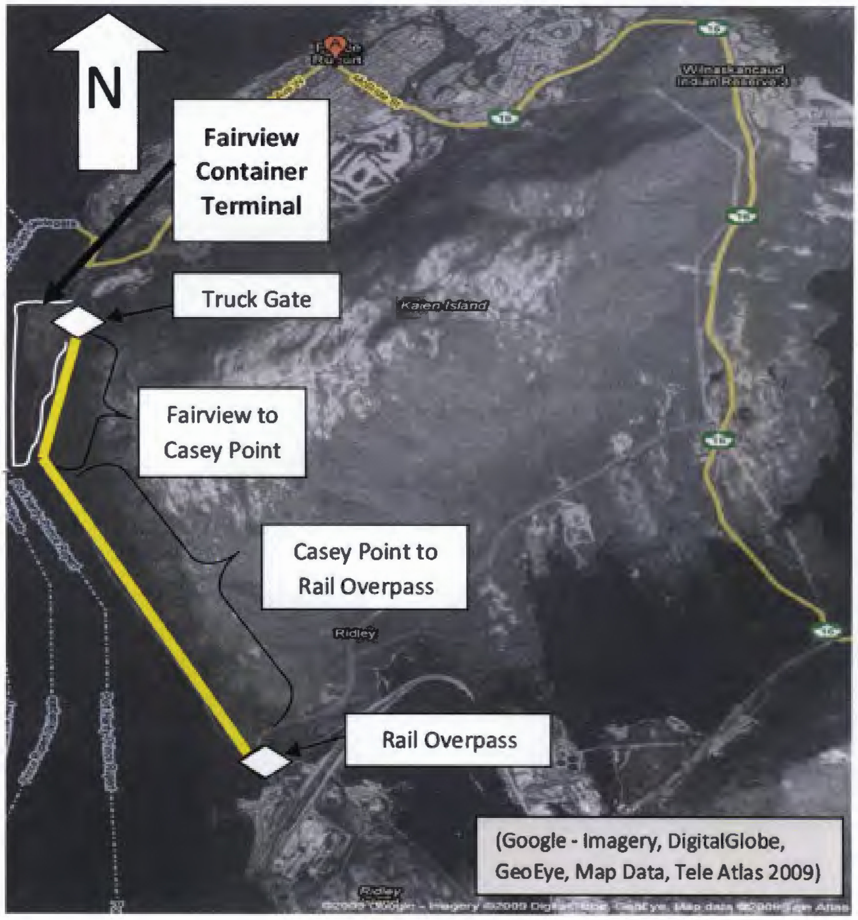

Figure 9 – New Proposed Private Haul Road

Once the truck leaves Fairview Terminal gate, it will travel to the end of terminal property which is estimated at a little over one kilometre to Casey Point on the current map (see Figure 10 below). At Casey Point the truck will drive due south for less than five kilometres following the CN Rail right-of-way until it meets the CN

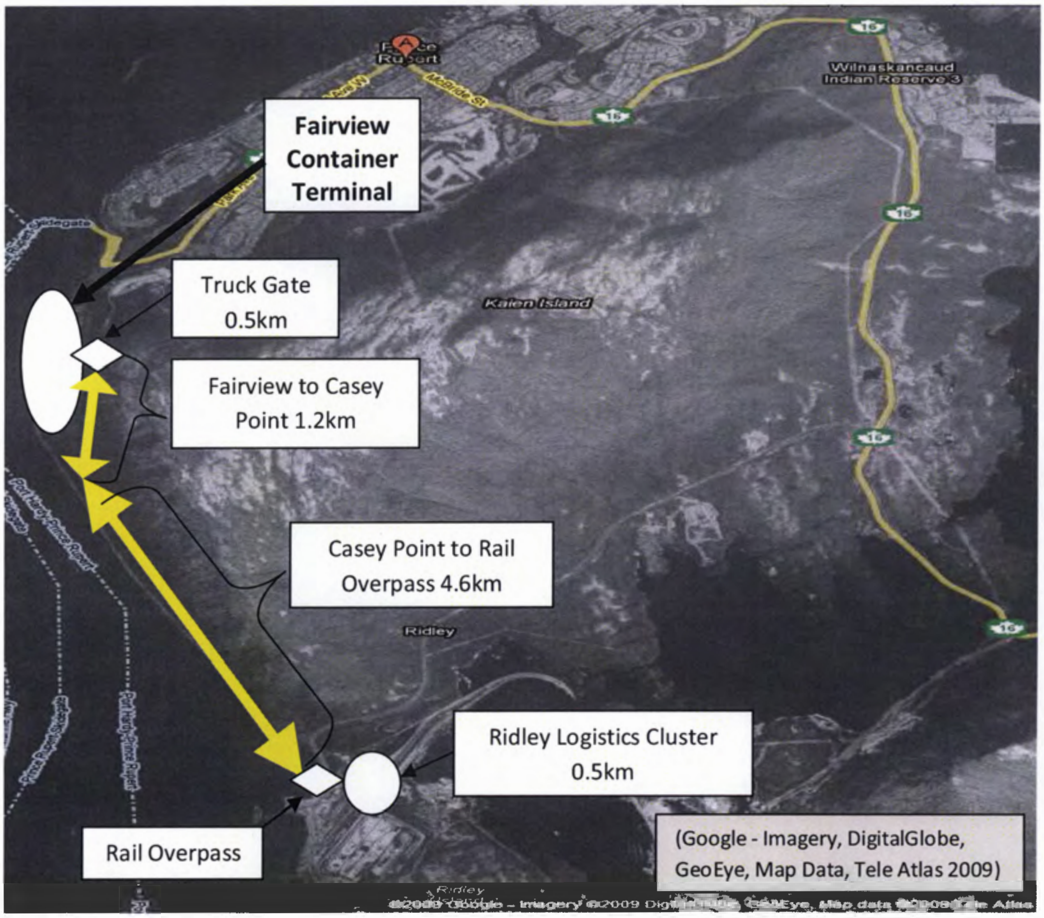

Figure 10 – New Proposed Truck Flow Route Map

Rail railway track overpass. As with the previous model the truck will then continue from the Rail Overpass to the logistics cluster or warehouse for a total distance of half of a kilometre. While at the warehouse the expected travel distance is one half of a kilometre. Once the truck has delivered the trailer and container and picked up the returning trailer and container the whole trip is repeated back to Fairview Terminal gate for a total round trip of just over fourteen kilometres.

Transit Time

This model produces a significant reduction in the travel distance over Model I. Based on preliminary design estimates from the Prince Rupert Port Authority; the travel speed along the majority of the new road will be a maximum of 60 kilometres per hour. By taking each "leg" or segment of the travel route and placing estimated travel speeds against the distances of each "leg" travel times are calculated. Then a weighted average of the distance is divided by the total travel time to reach the average travel speed (In this case 14.6 kilometres per hour).

Move Type	*Action Step*	*Distance (km)*	*Speed (km/h)*	*Time (minutes)*	*Cost*
FROM TERMINAL					
	Fairview Gate to Yard to Gate	0.5	2.5	12	
subtotal		***0.5***	***2.5***	***12***	***$ -***
TRANSIT TO	Fairview Gate to Casey Point	1.2	50	1.4	
	Casey Point to Rail Overpass	4.6	60	4.6	
	Rail Overpass to Warehouse	0.5	30	1	
subtotal		***6.3***	***53.7***	***7.0***	***$ 45***
WAREHOUSE	Warehouse processing - stuff/de	0		0	$ -
	Warehouse - Drop and Pick	0.5	1.5	20	
subtotal		***0.5***	***1.5***	***20***	***$ -***
TRANSIT FROM	Warehouse to Rail Overpass	0.5	30	1	
	Rail Overpass to Casey Point	4.6	60	4.6	
	Casey Point to Fairview gate	1.2	50	1.4	
subtotal		***6.3***	***53.7***	***7.0***	***$ 45***
TO TERMINAL	Fairview Gate to Container Yard	0.5	2.5	12	$ -
					$ -
subtotal		***0.5***	***2.5***	***12***	***$ -***
TOTALS	**1 container pick up and 1 drop o**	**14.1**	**14.6**	**58.1**	**$ 90**
Containers Moved:	**2**	Cost per unit			**$ 45**

Figure 11 – Model II – Distance Speed Time Cost

Once the exact specifications and engineering design of the road are created, it should be possible to increase the speed limit to 65 or 70 kilometres per hour along the main part of the route. This would significantly improve the already stellar performance of the new road over the current route. For the purposes of this paper we will assume a low speed limit (to be conservative). The transit time is only expected to be affected by the ability of the terminal to process the truck in and out in 12 minutes and that the time to complete the trailer and container exchange at the warehouse will only be 20 minutes.

The Flow Chart below in Figure 12 shows the expected process flow and time for the truck to complete the round trip process. This route may be affected by a 5 to 10 minute delay per round trip due to processing delays at either Fairview Terminal or Ridley Island warehouse. Taking 10 minutes delay for the worst case scenario, the total round trip could take 68 minutes versus the expected 58 minutes.

Truck Turns

Given the time and distance travelled in this Model, there is the possibility of a truck making at best a total of almost eight round trips in one Fairview Terminal operating day of seven and a half hours. If the truck experienced the worst case expected of an extra ten minutes per round trip the truck could expect to make six and a half trips per day. This means the driver would possibly lose one trip per day. The percentage of variability between the possible best and worst trip times is a low 17% variation. This shows that the new proposed route is very predictable and could provide very efficient results with each trip. You can see the expected truck turn results graphically for Model II in Figure 22 – Truck Turns per Day Comparison on page 62 and the expected truck turn variability in Figure 23 – Truck Turn Variability on page 63. The new haul road would allow one truck to move at best a predictable number of 15 containers per day, or as few as 13 containers per day.

MODEL II – FLOW CHART

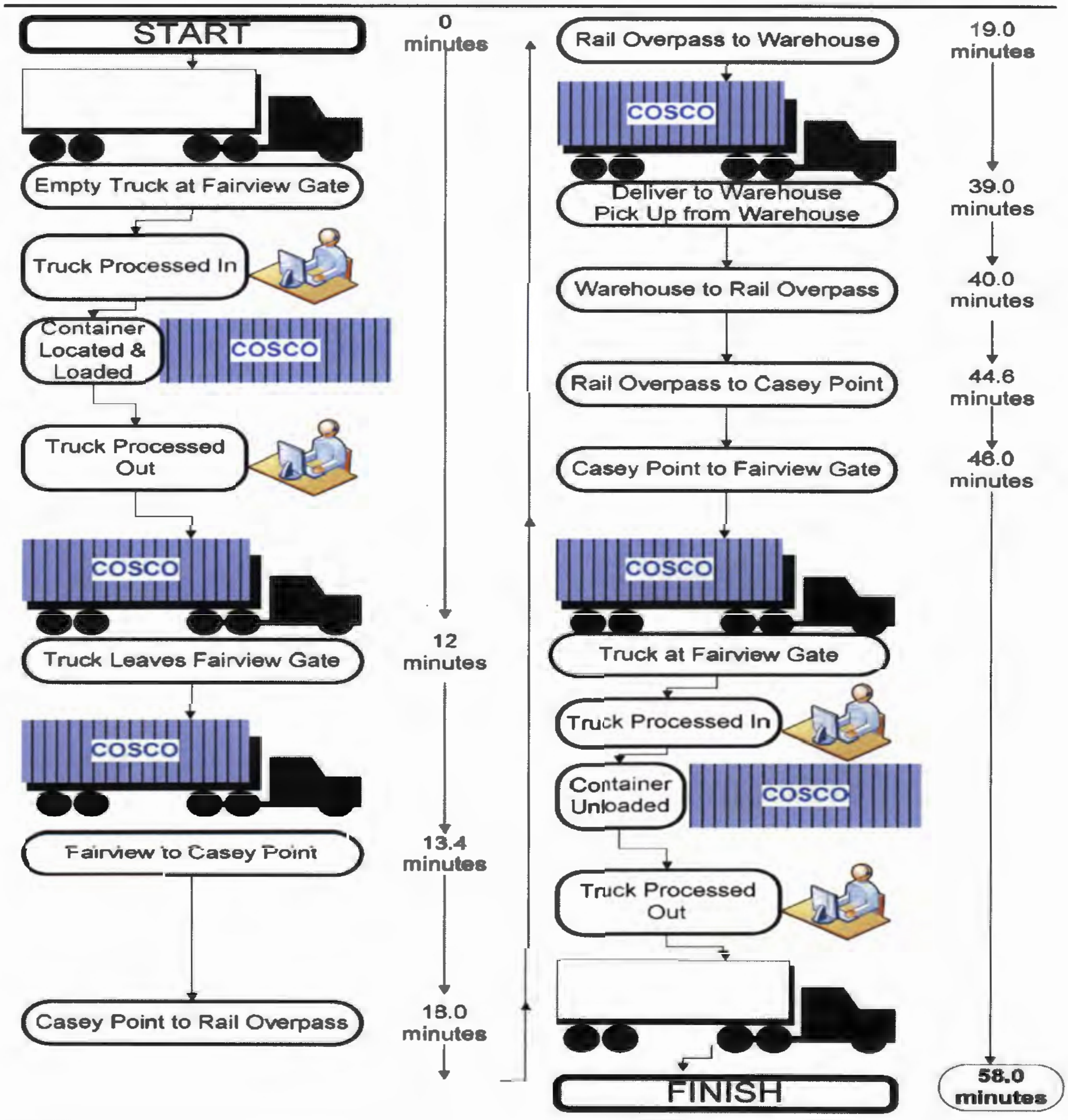

Figure 12 – Model II – Flow Chart

Logistics Costs

The time spent travelling the route is less than the current model which results in a one way trip cost of $45 including the current fuel surcharges ($40 cost for truck, chassis and driver plus $5 fuel surcharge). This equates to a total transport cost of $90 dollars for the round trip ($80 cost for truck, chassis and driver plus $10 fuel surcharge) also shown graphically in Figure 26 found on page 66.

Logistics System Capacity

The amount of traffic that this model can accommodate is based on the capacity of Fairview Terminal to handle the traffic. If appropriate changes are made to the size and layout of the truck gate as part of the Phase II Fairview Container Terminal Expansion then the terminal should be able to handle the estimated truck volume. The estimated truck volume after the Phase II Expansion might be as high as 37,825 truck trips per year or 21 trucks per hour, calculated by assuming a prorated truck traffic volume increase of 5.92% (current ratio of truck traffic) and multiplying by 1.09 million containers (number of containers to get 2.0 million TEU capacity of Fairview Terminal after Phase II) that equals the total yearly truck container volume of 64,606. This number is then divided by the 2009 container to truck visit ratio (1.708) to get the number of truck trips per year (64,606 / 1.708 = 37,825). The volume of 37,825 truck visits could be on the high end of an estimate.

Phase II Container-Estimate				1,091,400
	20'	40'	Total	
Cntrs	182,714	908,686		1,091,400
	17%	83%		100%
FULL TEU				2,000,086

Phase II Truck Container	64,606
Phase IITruck Visits/Year	37,825
Phase II Ave Trucks/Day	145.5
Ave. Trucks / Hr	20.8

Figure 13 – Phase II Estimated Capacity Throughput & Truck Visits

However, this estimate could be easily reached if the logistics cluster volumes start to climb. It is expected that Fairview Terminal would have to add one more Reach Stacker for a total of three, which would give calculated handling capacity of 22 trucks per hour to handle the estimated volume of 20.8.

	Capacity/Hr	Trucks/year	Containers/Year	
Gate Capacity - 1 Reach Stacker	6	10,920	21,840	*At 100% Utilization*
Gate Capacity - 2 Reach Stacker	14	25,480	50,960	
Gate Capacity - 3 Reach Stacker	22	40,040	80,080	

Figure 14 – Queue Theory Estimated Gate Handler Truck Visit Capacity

Model III – New Haul Road to Ridley – Serviced by Double Trailers

This model is based on the new direct access haul road and a container handling depot built on Ridley Island. The largest difference between Model II and Model III is the type of transportation equipment used. In Model III it is assumed that the new high capacity Longer Combination Vehicle (LCV) container trailer chassis can haul two containers at a time by using one truck or tractor and a driver. The distances travelled will be the same as in Model II, however, the type of equipment used is conservatively estimated to cause slower transit times and thus lower truck turns than Model II. The addition of this new equipment will increase the transportation system capabilities, efficiency and capacity while reducing the cost per container transported.

Infrastructure Needed

This model requires the construction of a new haul road outlined in Model II already. It is assumed that the new physical road infrastructure will accommodate the wider lanes, larger turning radius and weight capacity required for the LCV equipment used in this model. A very conservative approach has been used for this model as the performance data of the LCV is unknown for this type of application. It also requires the construction of a container depot terminal on Ridley Island.

The container depot will be designed similar to a container terminal but would be lacking a deep-sea vessel berth and associated dock gantry cranes for vessel unloading. The layout of the container storage yard and truck gate would be very similar to the one at Fairview Terminal. In an ideal scenario the depot would also have access to the CN Rail mainline through a rail spur so that an intermodal rail yard could be added either initially or later as volume and service demand increases.

Cost estimates for construction of the depot have been provided by the Prince Rupert Port Authority as follows: The container depot with truck access only could cost as little as $15 million (600 meter by 200 meter Land Area – including site development and servicing, hard surfacing and electrical lighting); If the container depot has truck and rail intermodal access it could cost as much as $43 million (1200 meter by 400 meter Land Area – including site development and servicing, hard surfacing, electrical lighting, rail tracks and switches) (Estimates source: Prince Rupert Port Authority).

Equipment Used

The equipment expected to be used in this model is based on the current highway capable tractors and container trailer chassis used for local transport combined into an LCV capable of carrying two containers per one-way trip. You can see an example of these units in the second image in Appendix 5 – Model III – LCV Equipment on page 80. A trailer is assumed to have a single chassis that can haul one container of twenty, forty or forty-five foot length. An alternative type of LCV capable of hauling multiple containers that could be used is the off-highway container terminal tractor trailer units manufactured by Magnum Trailer & Equipment in Abbotsford, BC, Canada. A picture of them is shown in Appendix 6 – Model III – Off-Highway Equipment on page 81. These units can carry from two to five containers per tractor-trailer combination.

Distances

The total distance travelled in this model on a round trip basis is 14 kilometres, which is exactly the same distance covered in Model II.

Transit Time

The use of LCV vehicles in this model increases the gross transit time due to longer loading and unloading time at Fairview Terminal and the container depot and slightly reduced transit speeds due to longer acceleration times. The estimated total transit time in a best case scenario is almost 72 minutes for the round trip.

Move Type	Action Step	Distance (km)	Speed (km/h)	Time (minutes)	Cost
FROM TERMINAL					
	Fairview Gate to Yard to Gate	0.5	1.7	18	
subtotal		***0.5***	***1.7***	***18***	***$ -***
TRANSIT TO	Fairview Gate to Casey Point	1.2	30	2.4	
	Casey Point to Rail Overpass	4.6	50	5.5	
	Rail Overpass to Container Depot	0.5	30	1	
					$ 45
					add 33%
subtotal		***6.3***	***42.4***	***8.9***	***$ 60***
CONTAINER DEPOT	UNLOAD Containers	0.25	1.7	9	$ 10
	LOAD Containers	0.25	1.7	9	$ 10
subtotal		***0.5***	***1.7***	***18***	***$ 20***
TRANSIT FROM	Container Depot to Rail Overpass	0.5	30	1	
	Rail Overpass to Casey Point	4.6	50	5.5	
	Casey Point to Fairview gate	1.2	30	2.4	
					$ 45
					add 33%
subtotal		***6.3***	***42.4***	***8.9***	***$ 60***
TO TERMINAL	Fairview Gate to Container Yard	0.5	1.7	18	$ -
					$ -
subtotal		***0.5***	***1.7***	***18***	***$ -***

TOTALS	**2 containers picked up and 2 droppe**	**14.1**	**11.8**	**71.8**	**$ 140**
Containers Moved:	**4**	Cost per unit			$ 35

Figure 15 – Model III – Distance Speed Time Cost

The speed travelled along the entire route averages to only 12 kilometres per hour as the expected LCV vehicle acceleration and braking will require more effort and take more time. This is again based on the expected maximum travel speed along the majority of the new road of only 50 kilometres per hour for LCV.

Also, the travel speed from the Rail Overpass to the container depot is anticipated to be reduced to 40 kilometres per hour to help in the safe manoeuvring of the LCV. Once the exact specifications and engineering design of the road are finalized it is probable that the speed limit can be increased to 60 or 65 kilometres per hour along the main part of the route and 50 kilometres per hour on Ridley Island as it is a private road.

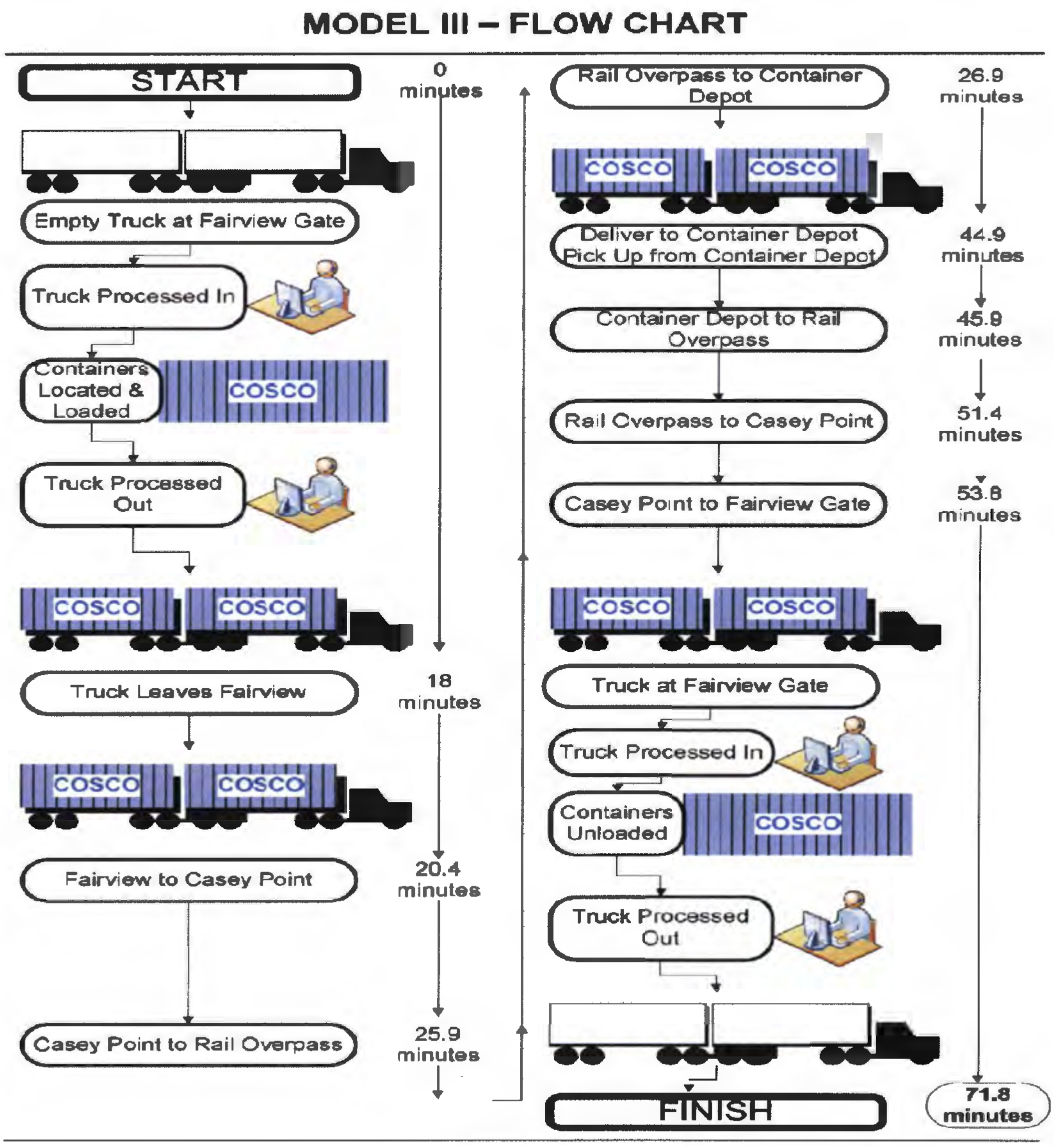

Figure 16 – Model III – Flow Chart

For the purposes of this paper we will assume a more conservative lower speed limit to cover the eventuality that the engineering results are very conservative also.

The transit time is only expected to be affected by the ability of the terminal to process the truck in and out in 18 minutes and that the time at the container depot to unload and reload the truck will also take only 18 minutes. This route may be affected by a total 5 to 10 minute delay due to loading and unloading delays at either end of the trip. At the worst case scenario of a 10 minute delay total the result would be an almost 82 minute round trip transit time.

At Fairview Terminal it is expected that the time to process the LCV truck in, load two containers and process it out the truck gate will be eighteen minutes. This accounts for the little extra time needed over the Model I and Model II scenario to load the second container to the LCV. The trip from Fairview Terminal gate to the container depot is expected to take less than 9 minutes as the travel speed will be reduced from Model II due to the expected reduction in truck performance and increased road safety considerations.

At the container depot the unloading and loading time is expected to be a total of 18 minutes even though there should be no gate processing required. As this project does not include the addition of a container depot operating model I will use the known times from experience at Fairview Terminal. Ideally the depot will be operated as an extension of the Fairview Terminal container terminal and will become just another part of the operating yard. In this manner the LCV is only completing a planned internal container terminal trip which can be treated like all other internal container movements which are planned in advance and do not require a time consuming in-gate or out-gate process.

The transit time back to Fairview Terminal is expected to be the same as the trip to the container depot and take a total of just over 10 minutes. The time to process the two containers and unload them into the Fairview Terminal container inventory will be the same time of 18 minutes (Refer to Figure 16 above).

Truck Turns

The distance travelled is the same as in Model II, but the trip time is greater in Model III. This creates the possibility of a LCV making at best a total of slightly over six round trips in one operating day of 7 hours. If the truck experienced the worst case expected delay of ten minutes per round trip the truck could only expect to make five and a half round trips per 7 hour day. It is important to note that by utilizing the double container combination vehicles the daily total of containers moved by this one truck would be as high as 25 containers to as low of 22.

Logistics Costs

For Model III the transport costs are expected to be approximately one-third higher than the Model II estimates. As such, the estimated cost of a one way trip is $60 including the current fuel surcharges ($50 cost for truck, chassis and driver plus $10 fuel surcharge). On a round trip basis this equates to a total transport cost of $120 for the round trip ($100 cost for truck, chassis and driver plus $20 fuel surcharge). The one added cost to this model is the handling charges estimated at the container depot. These charges could be $5 per container and would total $20 as two are unloaded and two are loaded back onto the truck at the depot.

Move Type	Action Step	Distance (km)	Speed (km/h)	Time (minutes)	Cost
FROM TERMINAL					
	Fairview Gate to Yard to Gate	0.5	1.7	18	
subtotal		***0.5***	***1.7***	***18***	***$ -***
TRANSIT TO	Fairview Gate to Casey Point	1.2	30	2.4	
	Casey Point to Rail Overpass	4.6	50	5.5	
	Rail Overpass to Container Depo	0.5	30	1	
					$ 45
					add 33%
subtotal		***6.3***	***42.4***	***8.9***	***$ 60***
CONTAINER DEPOT	UNLOAD Containers	0.25	1.7	9	$ 10
	LOAD Containers	0.25	1.7	9	$ 10
subtotal		***0.5***	***1.7***	***18***	***$ 20***
TRANSIT FROM	Container Depot to Rail Overpas	0.5	30	1	
	Rail Overpass to Casey Point	4.6	50	5.5	
	Casey Point to Fairview gate	1.2	30	2.4	
					$ 45
					add 33%
subtotal		***6.3***	***42.4***	***8.9***	***$ 60***
TO TERMINAL	Fairview Gate to Container Yard	0.5	1.7	18	$ -
					$ -
subtotal		***0.5***	***1.7***	***18***	***$ -***

TOTALS	**2 containers picked up and 2 dro**	**14.1**	**11.8**	**71.8**	**$ 140**
Containers Moved:	**4**	Cost per unit			$ 35

Figure 17 – Model III Estimated Truck Transportation Cost Per Round Trip

The charges at Fairview Terminal are assumed to remain the same as they are included in the ocean freight rate charged to each customer.

When the logistics costs are spread out over the full carrying capacity of the LCV of four containers on a round trip basis, the cost per container moved is low. The total transport cost per container is $35 on a round trip basis ($120 transport + $20 handling fee = $140 divided by 4 containers moved = $35 per container cost).

Logistics System Capacity

If the logistics cluster traffic grows then the truck visit volumes could climb quickly. The demand for extra container storage capacity from Fairview Terminal would also affect the amount of capacity needed. These demands on the transportation system could create enough demand for the LCV trucks to be used.

The final design of the haul road should contain a new truck gate design at Fairview Terminal to allow the handling of new anticipated volumes with LCV trucks to and from a container depot on Ridley Island.

Models Comparison & Application

Now that all three models, Model I, Model II and Model III, have been outlined a comparison needs to be made. The criteria for comparison will encompass; infrastructure needed, equipment used, distance, transit time, truck turns per day, containers per day, transport costs and logistics capacity.

Infrastructure Needed

Model I does not require any new infrastructure in the short to medium term based on current use and capacity. In the long run there may be the need to augment the staging or buffering capacity of the system with a series of extra road lanes built near or adjacent to the terminal to handle increased volume. There are no options to increase the capacity at the current approach and truck gate area due to physical constraints. At the current time, there are no detailed contingency plans agreed to for enhancing the current truck route.

Model II and Model III require the construction of the new private haul road being considered as part of the Phase II Fairview Container Terminal Expansion. It is suggested that the new road be designed to account for the possible use of LCV and accommodate wider lanes, larger turning radius and weight capacity required for the LCV equipment. The expected cost of building the new road if part of Phase II expansion is $4.5 million and is expected to be $5.0 million if undertaken as a stand-alone project (source: Port of Prince Rupert 2009).

Model III also requires the construction of a container depot terminal on Ridley Island. The container depot is estimated to cost as little as $15 million if it is a simple truck serviced design on leased PRPA property on Ridley Island and as much as $43 million if the full rail intermodal yard capacity is included (source: Port of Prince Rupert 2009).

To summarize the costs of infrastructure for the Models: Model I – no cost and cannot expand current usage to handle Phase II volumes; Model II - $4.5 million to $5 million for the new haul road; Model III - $15 million to add simple container depot and up to $43 million to add a fully intermodal container depot to the new haul road added in Model II.

Equipment Used

The equipment used in both Model I and Model II is based on the current highway capable tractors and container trailer chassis used for local container transport. They include one driver, one tractor and a single container trailer chassis that can haul one marine container. See the equipment pictures on page 79 in Appendix 4 – Model I & Model II Equipment Used. The current expected equipment cost would be zero for Model I and Model II as they rely on the use of existing trucks and containers chassis.

In Model III the equipment expected to be used is based on highway capable tractors and container trailer chassis combined into an LCV capable of carrying two containers per one-way trip. You can see an example of these units in the second image in Appendix 5 – Model III – LCV Equipment on page 80. The strength of this model as with the previous models, Model I and Model II, is that there is very little investment needed in specialized rolling stock to enable the immediate and medium term utilization of the new haul road. This enables the service providers to invest the least amount possible to start and provide a quality transportation service. Because of this use of existing equipment there is a lower barrier to hurdle in making the decision to build the road. Third party trucking can be used as it currently is; as-needed by customer demand.

The purchase and use of alternative types of LCV capable of hauling multiple containers in a specialized, off-highway configuration can be initially deferred and considered in the longer term when the full extent of customer need is better determined. These high capacity LCV units could carry from as many as five forty-five foot containers per tractor trailer LCV combination (refer to Appendix 6 – Model III – Off-Highway Equipment on page 81).

Distances

The current route in Model I on a round trip basis is twenty kilometres whereas the distance of the new road used in Model II and Model III is seven kilometres. This is a 65% savings in distance which relates directly to the overall trip time. This assumes that the truck trip starts and ends at Fairview Terminal. A graphic comparison chart is shown below.

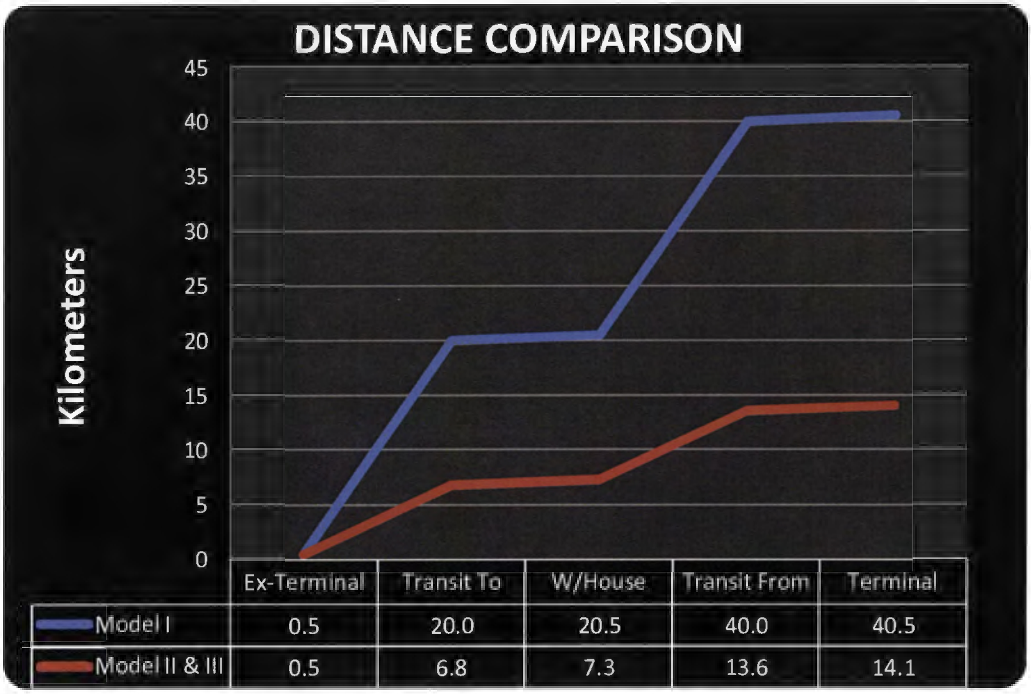

Figure 18 – Route Distance Comparison

The routing in Model I is broken down into a total of six main milestone time points on the one-way trip from Fairview Terminal to the warehouse as the route changes through its 20 kilometre path. Also see Figure 6 on page 37.

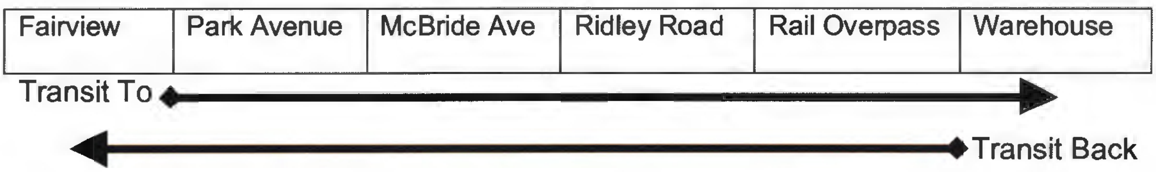

Figure 19 – Model I Route Milestone Comparison

In contrast the new road used in Model II and Model III only has four main milestone time points (see Figure 20 below) as the route is simpler, shorter (7.1 kilometre), and more directly linked (Refer to page 46 and page 52 for detailed flow charts of Model II and Model III respectively).

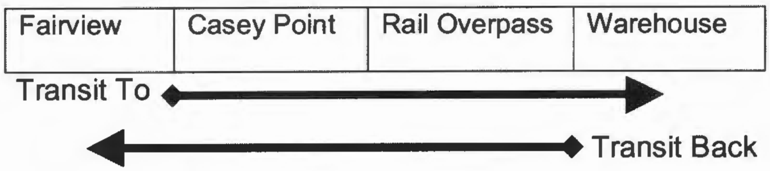

Figure 20 – Model II and Model III Route Milestone Comparison

The distance travelled while at Fairview Terminal and the warehouse is the same for all models at one half of a kilometre each.

Transit Time

Under the current model, Model I, the variability in the trip time creates problems with planning daily utilization of the trucks and predictability of the transportation route and correspondingly the number of containers hauled in a day. As can be seen in the chart below the transit time is significantly less in Model II than the Model I current experience. Of note is the difference between the Model I Worst and Average times above that shows the variability in the system of 33 minutes per round trip.

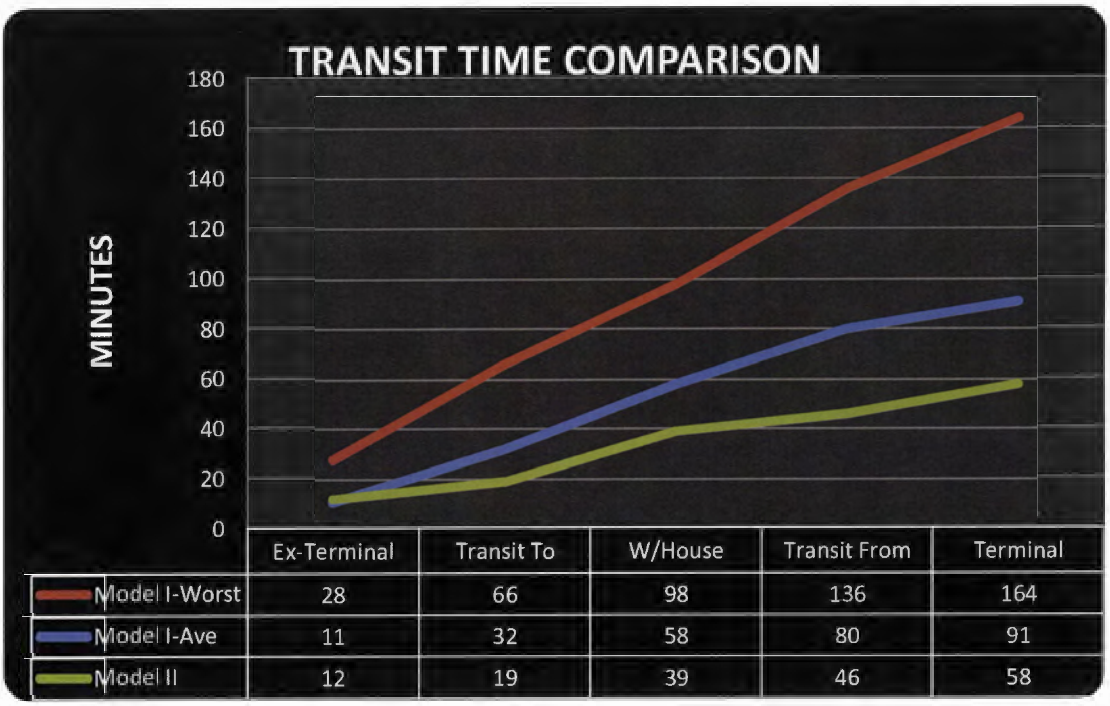

Figure 21 – Transit Time Comparison

The variability in trip times limits the ability to accurately predict the number of trips a truck can confidently complete in one day. This causes possible inefficiency and service issues as either too many or too few trucks are despatched to complete the required daily container movements. It is also interesting to note that the average speed in Model I is 26 kilometres per hour, whereas Model II is only based on 14.5. When the final road design specifications are completed the conservative speeds for the new haul road can be updated with the real values that are expected to be higher. This will improve not only the transit times but also the efficiency and hauling capacity of each truck and the logistics system. This will positively affect not only Model II but also Model III as they are both expected to benefit from higher travel speeds. For the purposes of this project a conservatively low speed limit was used.

In Model I and Model II it was estimated that the time at the warehouse to exchange trailers would only be ten minutes to complete and the Fairview Terminal truck gate processing time of twelve minutes would equally apply. Model III allows more time to process the containers at Fairview Terminal and the container depot as more containers are exchanged (Total of 4 in Model III versus 2 in Models I and II).

Truck Turns

Model I has the largest percentage and real variability in the number of possible trips in a day compared to Model II and Model III.

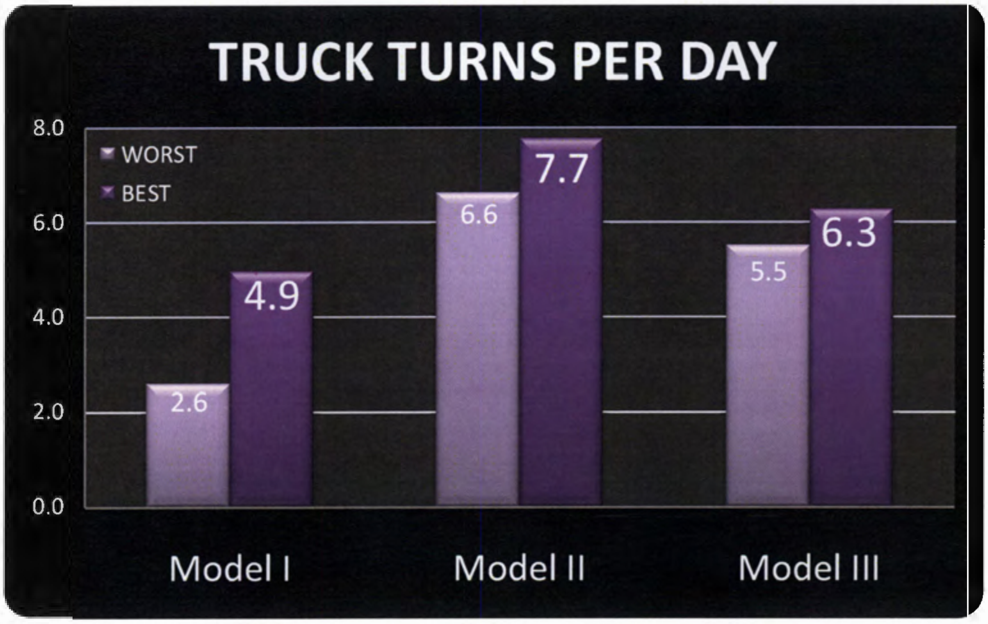

Figure 22 – Truck Turns per Day Comparison

Another way to view the variability is in the difference between the Best and Worst case scenario for trip times. As we do not have real data for the new models Model II and Model III an estimated delay time of 10 minutes has been added to each trip to arrive at the Worst from the Best or Average times.

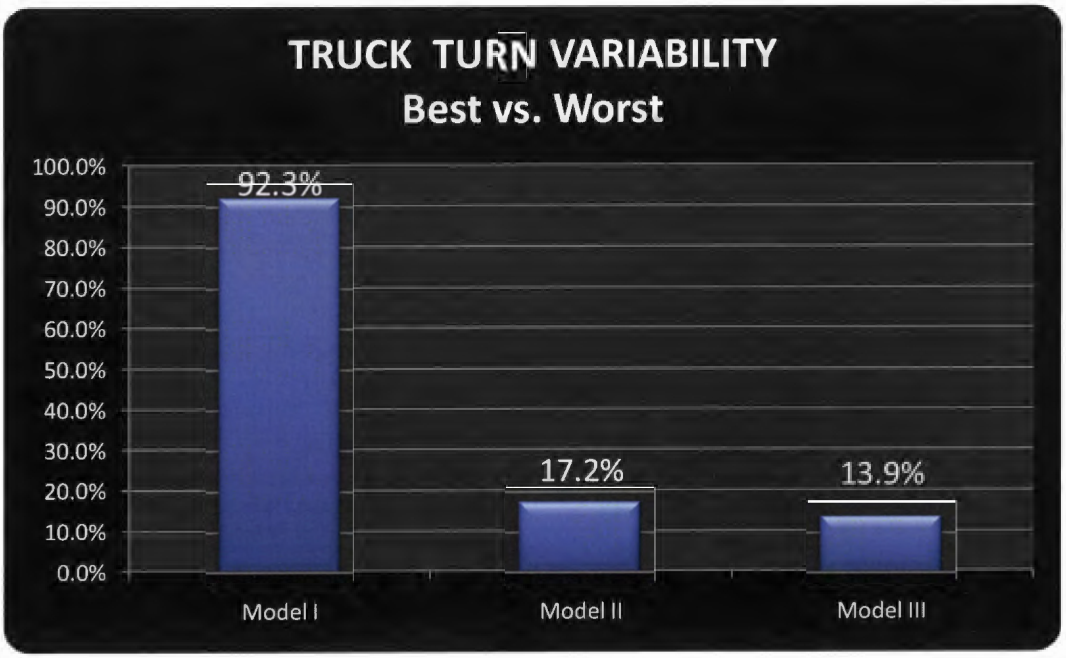

Figure 23 – Truck Turn Variability

A calculation of the variability in the number of truck turns (Best Case – Worst Case divided by the Worst Case: i.e. Model I values; 4.9 trips-2.6 trips / 2.6 trips = 92.3%) yields another comparative figure. As shown in Figure 23, Model I has 93% variability in the number of truck trips per day, while the other two models have a low variance of 17% and 14% for Model II and Model III respectively. Variability directly relates to the reliability and predictability of the service. The less variability, the more predictable and reliable the service will be which builds customer confidence in the transportation system.

One of the most important calculations done in this project is the total number of containers that a truck in each model can expect to transport in a given Fairview Terminal truck gate day of seven (7) hours. While the variability in the current model, Model I, is high it should be noted that most of the time the trucks servicing Fairview

Terminal can complete four trips per day with some completing as many as five in a day. Compare the total container count of 5 to 10 per day for a truck in Model I to the expected 13 to 15 per day with the same truck and the efficiency benefits of the new haul road are obvious.

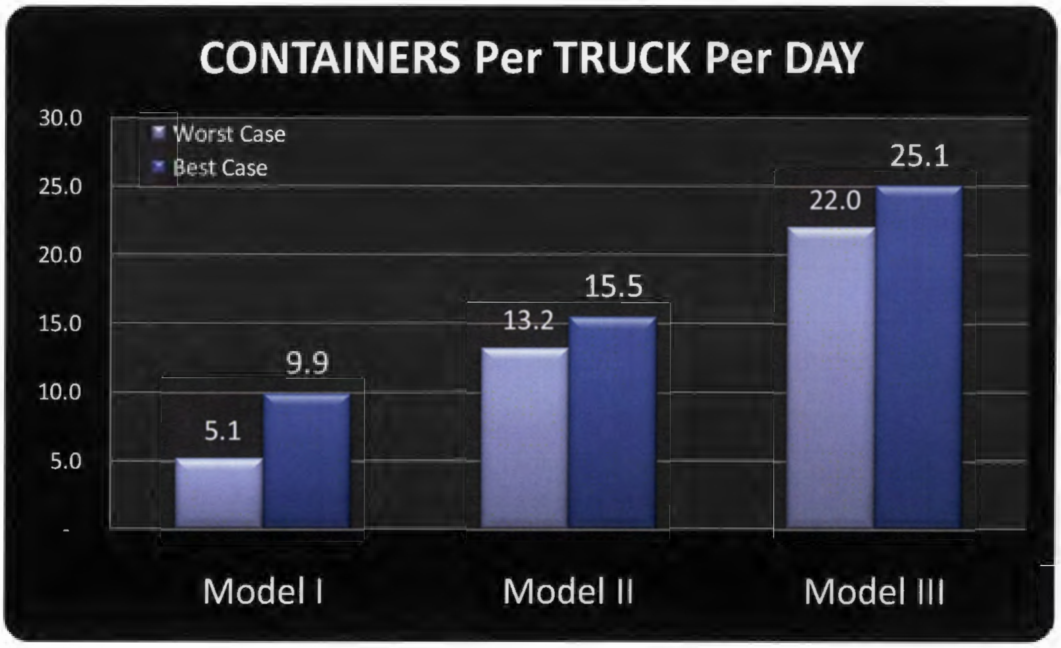

Figure 24 – Containers per Truck per Day Comparison

The most noticeable count in this graphic is the Model III performance of 22 to 25 containers per day with one driver. The multiple for containers moved by each truck turn per day for the LCV trucks is four times on a round trip basis. This is further evidence that the new road can easily be leveraged to greater volume and lower logistics costs with innovative high-capacity equipment.

Logistics Costs

The comparison in rates for each model is inversely related to the efficiency. It is interesting to note that with the addition of the new road it is possible to greatly reduce the transport cost per container and increase the capacity of the transportation system and increase the capacity of the current truck fleet.

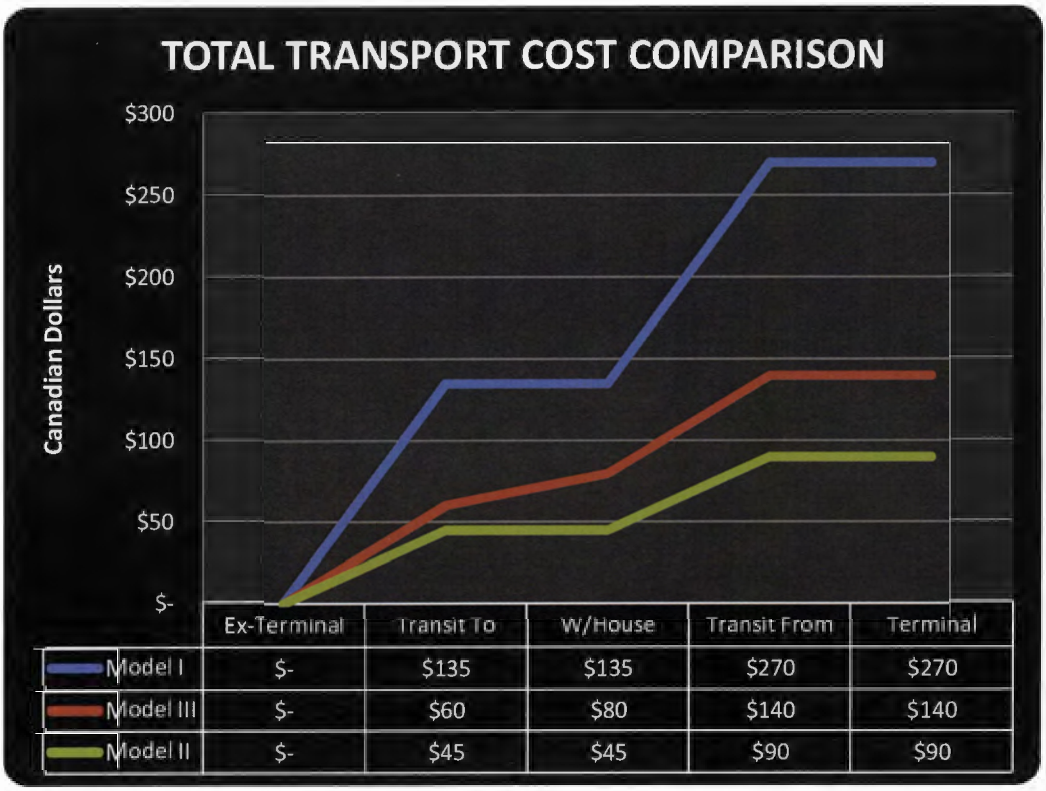

Figure 25 – Total Transport Cost Comparison

The cost for the entire round trip is higher in Model I and is spread over the trip payload of only two containers, which leads to a $135 transport cost. Note that Model II is the least expensive for a total cost per round trip basis and appears to be the best value and lowest cost. However, when the round trip payload capacity of Model III is used of four containers, Model III is the lowest cost per container at $35. This leaves Model II, the immediately applicable one once the road is built as the building block for the logistics cluster investment decision. With comparable West Coast transport rates at $150 it easily beats that at $45 per container. This is a 70%

cost reduction with Model II over comparable West Coast ports that makes a huge competitive advantage. That is the closest apples to apples comparison possible. If the Model III scenario was implemented it could create an even larger cost reduction of 77%.

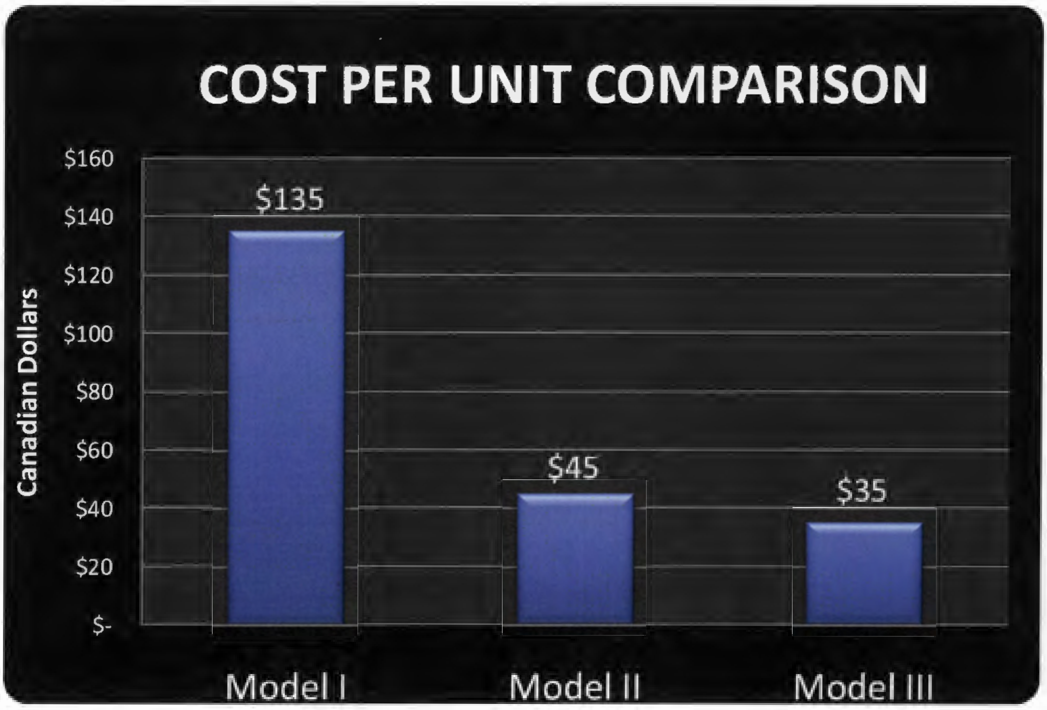

Figure 26 – Cost per Unit Comparison

As a comparison between the three models, Model II creates a 66% cost reduction over Model I and Model III creates a 74% cost reduction over Model I. Even Model III has an advantage over the fantastic Model II with a 22% logistics cost reduction.

Logistics System Capacity

The capacity of Model I is dependent on the amount of traffic that Fairview Terminal can handle through the truck gate. Fairview Terminal currently handles 19 truck trips per seven hour day on average as outlined in Appendix 10 – Fairview Terminal Gate Usage – Current & Future on page 85 or 4,956 visits per year. The current route follows the Provincial highway system (Highway 16) that can handle approximately twice the current truck volume.

The Queue Theory analysis results in Appendix 9 – Fairview Terminal Gate Capacity – Current & Future on page 84 show that the terminal can easily handle the current volumes of 4,956 trips and could handle 9,456 trips per year by adding one piece of handling machinery. This would increase truck gate operational capacity to fourteen trucks per hour from six.

The calculated capacity of fourteen trucks per hour is the maximum capacity of the truck gate in the current configuration of Model I. This maximum capacity guidance is gained from information about the current operational experience from the Prince Rupert Port Authority in cooperation with the operator of Fairview Terminal. As shown in Figure 27 below, this would mean that Fairview Terminal would only need to have 2 Reach Stackers to handle the volume. However, this is the maximum capacity of the current truck gate and could only be expanded if the new haul road is built as part of the Phase II Fairview Terminal Expansion.

	Capacity/Hr	Trucks/year	Containers/Year	
Gate Capacity - 1 Reach Stacker	6	10,920	21,840	*At 100% Utilization*
Gate Capacity - 2 Reach Stacker	14	25,480	50,960	
Gate Capacity - 3 Reach Stacker	22	40,040	80,080	

Figure 27 – Truck Gate Capacity Based on Volume

The new haul road must be built to handle the estimated truck gate volume of 20.8 trucks per hour (37,825 truck trips per year / 52 weeks per year / 5 days per week = 145 Trucks per day; 145 Trucks per day / 7 operating hours per day = 20.8 trucks per hour). This is based on the continuance of the same proportional truck traffic volume, which could actually increase at a faster rate as the logistics cluster grows and adds new business volume. There would need to be 3 Reach Stackers deployed to handle this estimated volume, which is not possible with the current terminal and truck gate infrastructure.

With an estimated queue delay opportunity cost of more than $0.5 million dollars per year if the gate were to run near operating capacity and the inability of the current infrastructure to handle the future traffic, the building of the $5 million road seems logical. The terminal cannot compensate by adding more handling capacity due to physical constraints and is limited to queue only 5 trucks at a time. It is also a concern that the limited capacity truck gate may not be able to efficiently handle the 9,456 truck visits estimated with full capacity volumes.

ESTIMATED FULL FUTURE GATE VOLUMES AND OPERATION

FULL Truck Container Throughput	16,152	Ratio: Truck Containers to Total Volume		5.92%	FULL Container Throughput-Estimate			272,850
FULL Truck Visits/Year	9,456	Ratio: Truck Laden Average (2 = 100%)	1.7	85%		20'	40'	Total
FULL Ave Trucks/Day	36.4		With 1 Reach Stacker	With 2 Reach Stackers	Cntrs	45,679	227,171	272,850
Ave. Trucks / Hr	5.2					17%	83%	100%
Ave. Cost per Truck/hour	$ 178.02	Used Gate Capacity	86.6%	37.1%	FULL TEU			500,039

# Reach Stackers	Capacity (trucks/hr)	Truck Buffer Capacity	Ave. Trucks/ Hr (R_a)	Service Time (T_s)	Overall Ave. Wait (W_q)	Ave. Queue Length (L_q)	Trucks in Queue / Hr	Trucks in Queue/Day	Waiting Probability	Truck Delay (Hr/Day)	Lost Time Cost/Day	Lost Time Cost/Year
1	6	5	5.2	0.183	0.45	2.1	4.7	33	82.8%	12.2	$2,166.8	$563,371
2	14	5	5.2	0.183	0.05	0.29	5.8	41	32.0%	0.6	$115.6	$30,067

Figure 28 – Full Future Truck Gate Volume

Fuel Usage Savings

The new haul road proposed in Model II will provide cost savings in fuel usage over the Model I current route for the trucks. This also provides a corresponding environmental benefit from lower vehicle engine emissions per container moved.

Based on mileage data collected from a local trucking company, the average fuel mileage on the current route is 5 miles per gallon of diesel or 47 litres per 100 kilometres (km). To travel the current route of 40km the average truck would use 18.8 litres of diesel to transport two containers. Using the new haul road of 14km, and not compensating for elevation differences or fewer stop-and-go instances, the same truck would use only 6.58 litres of diesel to transport two containers. Comparing the diesel consumption of the current to the new haul road equals a 65% reduction in fuel usage to transport the same containers to and from the same origin and destination. Using less fuel to move each container reduces the amount of engine emissions per container. The detailed calculation of the engine emission reduction is out of scope for this project.

Financial Analysis

Also beneficial is taking a financial view of the Lost Time costs for the truckers in the queue with a Net Present Value (NPV) calculation using 10% interest per year over a 10 year period. The Lost Time cost of $563,000 would exist for the truckers when only one Reach Stacker is used to process trucks, which would use 86% of gate capacity (see Used Gate Capacity in Figure 28 above) but would result in an 82% chance of waiting, and a total of 12.2 hours per day wasted in the queue.

If two Reach Stackers are deployed to reduce the wait time for the truckers, as is suggested in the Queue Theory modelling, the terminal operator takes on added cost for extra handling equipment and related expenses, and the trucker gets better service. However, the used gate capacity is only 37% (see Used Gate Capacity in Figure 28 above), which is an inefficient use of resources and the Lost Time cost is passed to the terminal operator from the trucker. Therefore, a conservative estimate is to keep the Lost Time cost the same at $563,000 per year in either scenario.

The Lost Time cost of $563,000 (see Figure 28 above) per year for 10 years calculates to a NPV of $3.46 million, which is money wasted on inefficiency, with no chance of a return. Taking the $5 million construction cost of building the road as a stand-alone project with 10% interest over 10 years gives a NPV of $4.55 million, which produces a higher efficiency model and an asset that can be used and leveraged for increased volume over more than 10 years.

PROJECT CONCLUSIONS

Summary

Through the analysis of process flow and queue theory it has been determined that the haul road should be built. The long term benefits of the road can start to be reaped as soon as it is built:

- Increased trucking efficiency by 56%
- Reduced travel distance and cost by 65%
- Diversion of truck traffic out of the downtown core

- ❖ Creation of a competitive advantage to attract investment
- ❖ Incremental development model to grow with future volumes
- ❖ Cost effective increase of Fairview Terminal capacity by the addition of a new container depot
- ❖ Reduced diesel fuel usage by 65%
- ❖ Reduced environmental waste and emissions from more efficient use of the current trucking system

The key investment that must be made to support these improvements is the new haul road that will connect Fairview Terminal and Ridley Island directly, bypassing the city center and providing an unbeatable competitive advantage. This is the kind of competitive advantage referred to by Mr. Notteboom and Mr, Rodrigue (2008) in their concept of the "agile-port" that is a real possibility in the Port of Prince Rupert. The Port is in a unique situation in that they have a large inventory of green field industrial land (over 400 hectares[6]) that can be quickly developed to meet the needs of the growing container port. The land is located away from the congestion of the city and population center, but is only readily accessible from the short private haul road proposed.

The new road will enable the initial incubation and future growth of the logistics cluster. The transportation models can be changed and blended to increase capacity incrementally as business demand dictates. Using a phased and incremental development approach will allow the logistics cluster to start operation at the lowest initial project cost. The use of existing third party trucking assets allows for the lowest initial cost of providing service.

[6] www.rupertport.com/idp.htm

An immediate added benefit of the haul road would be the exclusion of heavy container truck traffic from the middle of the City of Prince Rupert. This will not only improve efficiency but also help maintain the local support for the expansion of transportation services in the Prince Rupert Port area. Also the reduction in diesel fuel usage by the trucks will lower costs per container for truckers and shippers, while benefiting the environment through lower emissions per container.

The Short Term Future

The next logical extension of the service offering through Prince Rupert is the provision for value-added logistics services. The main user of value added logistics services are importers of high value products as they have higher sales margins to justify finishing the consumer preparation or packaging process with North American labour. They also have to fill inventory shortages in markets on short notice. The inventory in high value products needs to remain lean to avoid not only high carrying costs but also guard against product obsolescence. As a result of this pressure and the success of the new Gateway through Prince Rupert there have been requests to accommodate the provision of value added logistics services as the next stage in the evolution of the Port.

In order to meet this demand and ensure the expansion and continuance of the Port's success it is vital to establish time and cost efficient transportation services from Fairview Container Terminal to the proposed logistics cluster on Ridley Island. The new transportation services must be like Fairview Terminal itself; efficient, flexible, and cost effective. Meeting these objectives will require very little capital investment as this project has shown. As demonstrated in this paper it is possible to support a full service logistics offering by providing cost and time efficient transportation that is flexible to expand with the demands of the future. The model for the short term future, Model II, has an incremental quality that allows for the cost efficient expansion of services by first taking the large increase in capacity and productivity of 56% from deploying the current transport fleet on the new road.

The beauty of using Model II on the new haul road is that it simply increases the ability to handle estimated volumes, meet customer demands to grow new traffic volumes, and adds very little to the overall cost of the Phase II project which is estimated to cost $650 million (source: Prince Rupert Port Authority)[7]. There is not a need to purchase a specialized fleet of trucks and trailers as the efficiency gained from the new road more than compensates to reduce costs and cycle time to meet the transportation demands for the short and even medium term.

The Medium Term Future

The capacity requirements of future demand can be met with the implementation of the last and most innovative model, Model III, with a fleet of LCV units and the addition of the container depot.

It has been demonstrated in this paper that the new road can be leveraged far beyond the immediate use and efficiency of Model II with higher capacity transport units like the LCV proposed in Model III that haul two containers per one-way trip.

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[7] Source: Prince Rupert Port Authority - Phase II Fairview Container Terminal Expansion cost estimate

Imagine what the potential capacity of the new road would be with a fleet of LCV units capable of hauling five containers per trip were utilized.

The additional benefit of this haul road coupled with Model III transportation equipment is the expansion of container handling capacity of Fairview Terminal. The dwell time of containers at Fairview Terminal could be reduced by developing and using a hinterland container depot on Ridley Island as an extension of the terminal to hold non-priority cargo, aged cargo and empty containers. Truck gate activity could also be diverted to the Ridley Island depot for faster turnaround times as the haul distance and time would be even shorter. LCV units could then shuttle large volumes of priority traffic between the container depot and the container terminal as needed. This would allow the container terminal, truckers, and logistics cluster patrons to operate at higher efficiency by further reducing congestion and increasing productivity.

The Agile-Port extension

The concept of the "agile-port" as outlined by Mr. Notteboom and Mr. Rodrigue (2008) fits closely with the ideas and planning that has prevailed in the Port of Prince Rupert. From the beginning of the conceptualization of the container terminal and transportation logistics service design there has been an emphasis on the great value and velocity that cargo needs to have. Once the Phase I facility was built and commissioned it was time to deliver on the promise. This express movement of cargo through the Port on its journey through the global supply chain has not failed to impress even the greatest sceptics. Many people thought that it was too much to ask of a small Port with limited population base to support the opening and success of a new Gateway for Asian imported products that are destined largely for the American Midwest. What time and experience has shown is that the reliability of the service has created more interest and increased customer commitment.

The addition of the new road and the use of Model II will fulfill the concept of the “agile-port” as this transportation will help speed the movement of the container cargo from the port to the hinterland area. But this is just the beginning of the “agile-port” in Prince Rupert. With the evolution of the Port and volume, Model III will be implemented with the LCV fleet and the container depot on Ridley Island. This will reduce the demands placed on Fairview Terminal to provide truck gate and storage services to slower moving import and export cargo. The depot will absorb the demand and take the overflow that is transported on the LCV units.

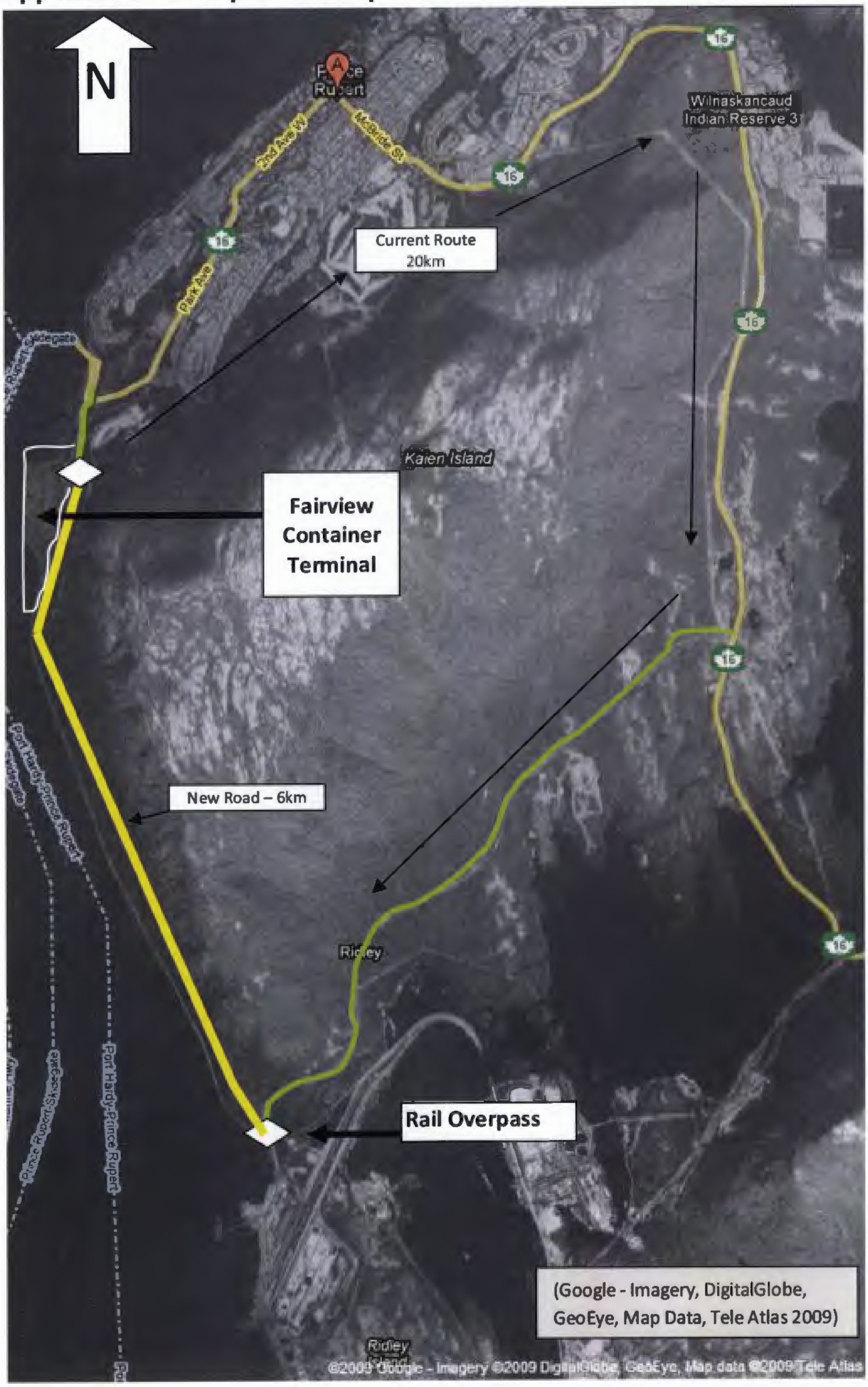
In the next logical extension of this “agile-port” concept and the inevitable expansion of the Port of Prince Rupert, a new intermodal rail facility will be added to the container depot, allowing any imported containers that make their way to the logistics cluster or the container depot to be delivered to the rail and their final destination without having to touch the ground at Fairview Terminal again. This will truly be the full evolution of the new road and its place in the future of the Port of Prince Rupert will remain as central then as it is to Phase II expansion.

APPENDICES

Appendix 1 – Map of Potential Fairview Terminal to Ridley Haul Road

Source: Prince Rupert Port Authority 2009

Appendix 2 – Comparison Map – Current & New Haul Road



Appendix 3 – Marine Container Types

40 foot Long by 8 foot 6 inch High Dry Cargo Container

40 foot Long by 8 foot 6 inch High Open Top Cargo Container

40 foot Long by 9 foot 6 inch High Refrigerated Cargo Container

20 foot Long by 8 foot 6 inch High Tank (Liquid Cargo) Container

Source for photos: www.cronos.com

Appendix 4 – Model I & Model II Equipment Used

TRACTOR AND CONTAINER CHASSIS (Empty or Bare Chassis)

TRACTOR AND CONTAINER CHASSIS (Loaded with 40' container)

Source for photos: Nathan Lauer photos 2009

Appendix 5 – Model III – LCV Equipment Used

LCV – Triple 28 foot trailer
UPS IH 9400 with a matching set of triples EB on I-80 in Indiana (Collection 2008)

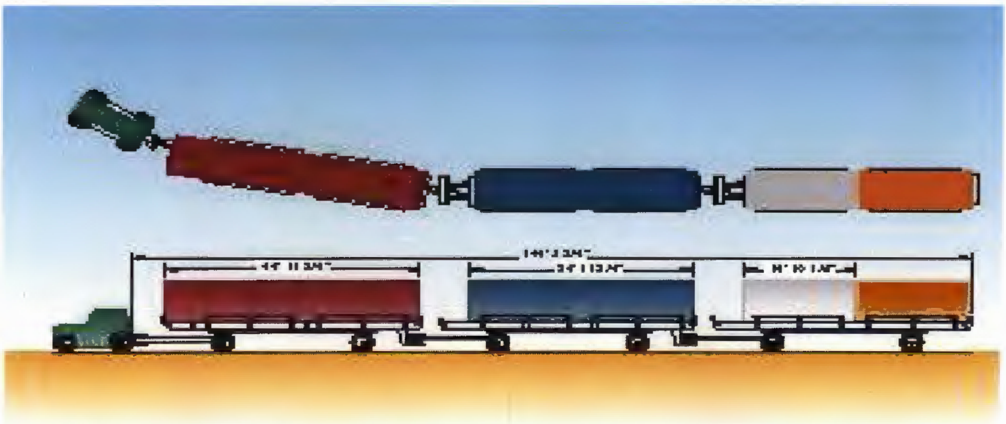
LCV – Double 53 foot trailer
USF Holland IH 9400 with a set of Turnpike Doubles EB on I-80 (Collection 2008)

Source for photos: www.hankstruckpictures.com (2008)

Appendix 6 – Model III – Off-Highway Equipment

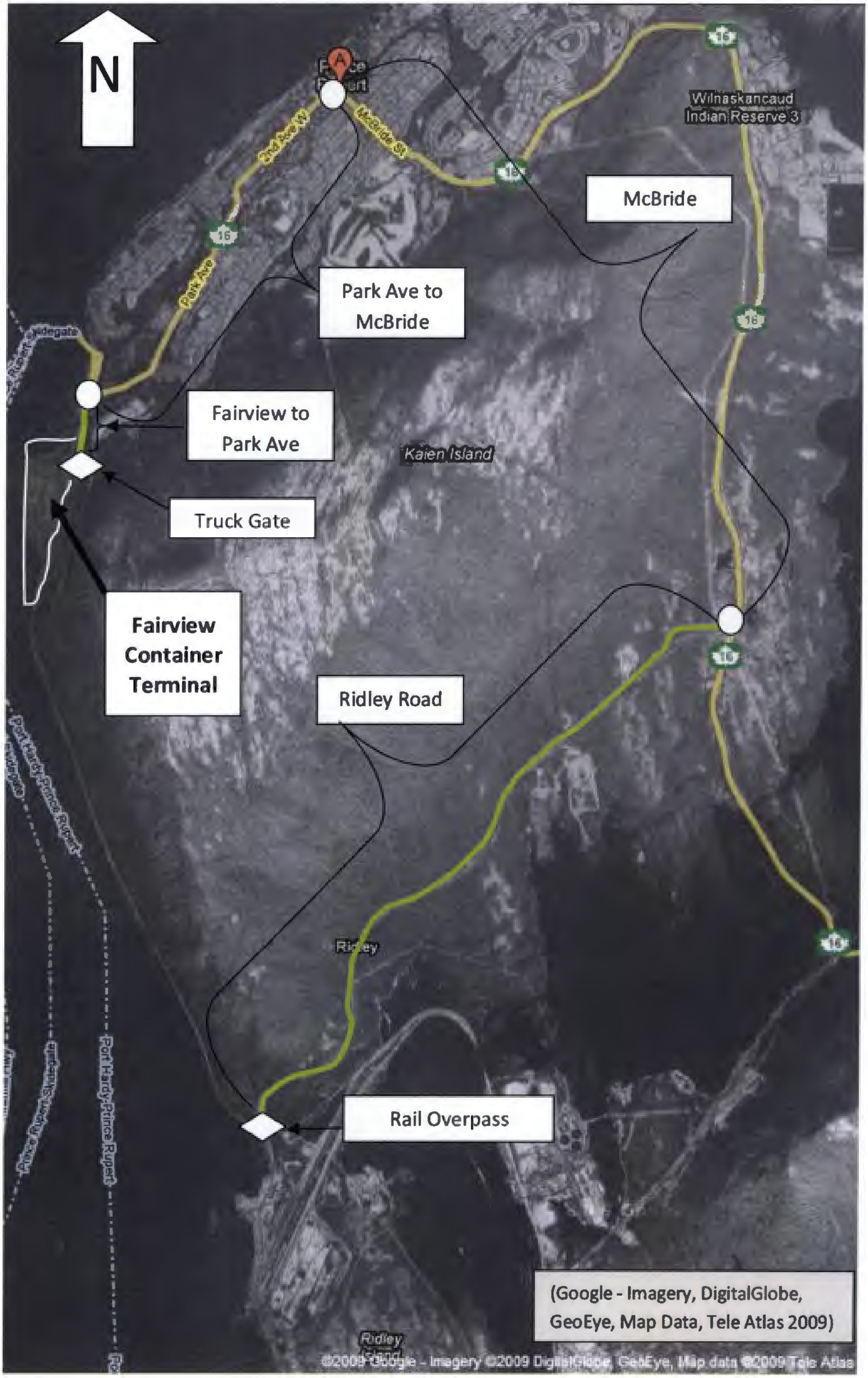
“BOMB CART” CONTAINER TRAILER (Magnum Trailer & Equipment Inc. 2009)

MULTI TRAILER SYSTEM 1-(Magnum Trailer & Equipment Inc. 2009)

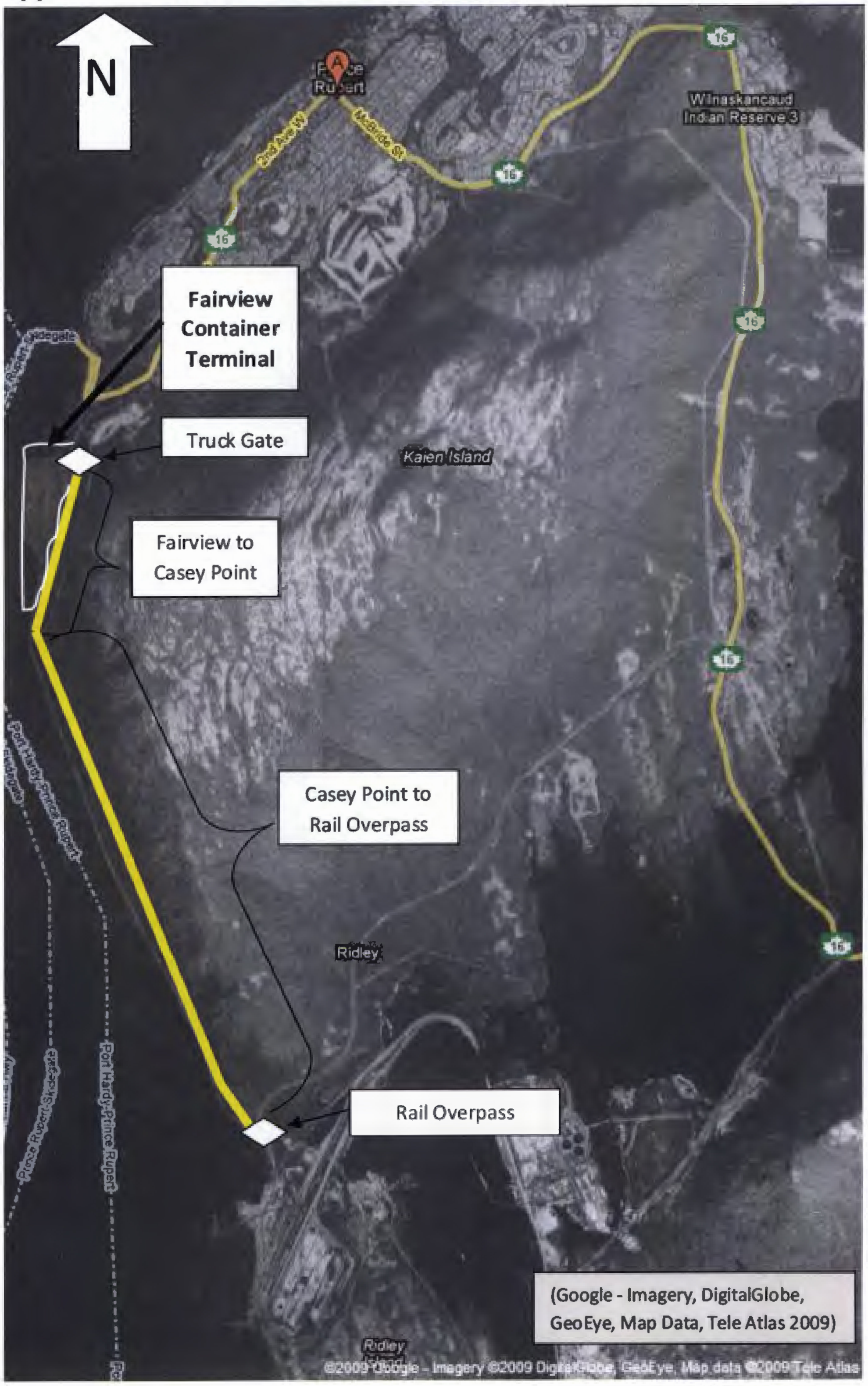


MULTI TRAILER SYSTEM 2- (Magnum Trailer & Equipment Inc. 2009)

Appendix 7 – Model I – Map



Appendix 8 – Model II & Model III – Map



Appendix 9 – Fairview Terminal Gate Capacity – Current & Future

Experiment #	Truck Arrivals per Hour (R_a)	Truck Service Time (T_s)	# of Reach Stackers (c)	Truck Line-up Capacity (K)	Ave Gate Utilization (ρ)	Probability of blocking (P(block))	Probability of waiting (if not blocked) (P(wait))	Ave # trucks in queue (I_q)	Overall Average wait (W_q)	Ave flow time (W)	Ave Truck Inventory (I)	Overall Ave Wait Time (Minutes)	Ave Flow time / Truck (Minutes)	Gate Visits per Day (Trucks)	Containers per Day (Containers)	Gate Visits per Week (Trucks)	Per week with return trips (Containers)
1	2.7	0.183	1	5	49%	0.7%	48.7%	0.44	0.16	0.35	0.9	9.8	20.7	18.9	37.8	94.5	189
2	2.7	0.183	2	5	25%	0.0%	9.8%	0.03	0.01	0.19	0.5	0.7	11.7	18.9	37.8	94.5	189
3	5.4	0.183	1	5	85%	13.8%	82.8%	2.10	0.45	0.63	3.0	27.1	38.0	37.8	75.6	189	378
4	5.4	0.183	2	5	49%	0.5%	32.0%	0.29	0.05	0.24	1.3	3.2	14.2	37.8	75.6	189	378

Average Truck Service Time:	11.0	Minutes

GATE HOURS PER DAY	7.0
GATE DAYS PER WEEK	5.0

Queue Theory Calculation Source used: QueuMMcK, (Mieghem 2002)

Appendix 10 – Fairview Terminal Gate Usage – Current & Future

ACTUAL GATE VOLUMES AND OPERATION

2009 Truck Container Throughput	8,465	Ratio: Truck Containers to Total Volume		5.92%	2009 Container Throughput-Actual			143,000
2009 Truck Visits/Year	4,956	Ratio: Truck Laden Average (2 = 100%)	1.7	85%		20'	40	Total
2009 Ave Trucks/Day	19.1		With 1 Reach Stacker	With 2 Reach Stackers	Containers	23,940	119,060	143,000
Ave. Trucks / Hr	2.7				Ratio	17%	83%	100%
Ave. Cost per Truck/hour	$ 178.02	Used Gate Capacity	45.4%	19.5%	TEU			262,060

# Reach Stackers	Capacity (trucks/hr)	Truck Buffer Capacity	Ave Trucks/ Hr (R_s)	Service Time (T_s)	Overall Ave. Wait (W_q)	Ave. Queue Length (L_q)	Trucks in Queue / Hr	Trucks in Queue/Day	Waiting Probability	Truck Delay (Hr/Day)	Lost Time Cost/Day	Lost Time Cost/Year
1	6	5	2.7	0.183	0.16	0.44	2.8	19	48.7%	1.50	$267.0	$69,427
2	14	5	2.7	0.183	0.01	0.03	3.0	21	9.8%	0.02	$3.7	$953

ESTIMATED FULL FUTURE GATE VOLUMES AND OPERATION

FULL Truck Container Throughput	16,152	Ratio: Truck Containers to Total Volume		5.92%	FULL Container Throughput-Estimate			272,850
FULL Truck Visits/Year	9,456	Ratio: Truck Laden Average (2 = 100%)	1.7	85%		20'	40	Total
FULL Ave Trucks/Day	36.4		With 1 Reach Stacker	With 2 Reach Stackers	Cntrs	45,679	227,171	272,850
Ave. Trucks / Hr	5.2					17%	83%	100%
Ave. Cost per Truck/hour	$ 178.02	Used Gate Capacity	86.6%	37.1%	FULL TEU			500,039

# Reach Stackers	Capacity (trucks/hr)	Truck Buffer Capacity	Ave Trucks/ Hr (R_s)	Service Time (T_s)	Overall Ave. Wait (W_q)	Ave. Queue Length (L_q)	Trucks in Queue / Hr	Trucks in Queue/Day	Waiting Probability	Truck Delay (Hr/Day)	Lost Time Cost/Day	Lost Time Cost/Year
1	6	5	5.2	0.183	0.45	2.1	4.7	33	82.8%	12.2	$2,166.8	$563,371
2	14	5	5.2	0.183	0.05	0.29	5.8	41	32.0%	0.6	$115.6	$30,067

PLANNING ASSUMPTIONS

	Capacity/Hr	Trucks/year	Containers/Year		Fairview Terminal Capacity	Operating hours per day	7
Gate Capacity - 1 Reach Stacker	6	10,920	21,840	At 100% Utilization	500,000 TEU	Days per week	5
Gate Capacity - 2 Reach Stacker	14	25,480	50,960		TEU=Twenty Foot Equivalent	Weeks per year	52
Gate Capacity - 3 Reach Stacker	22	40,040	80,080				

Source: Container Volume Information and Estimates from Prince Rupert Port Authority 2009

Source: Truck Gate Container Volume Information and Estimates from Maher Terminals Holding Corp 2009

Appendix 11 – Captured Truck Trip Raw Data

RECORD #	TRUCK ID & TRIP#	DATE & TIME	Line up to Maher	MIN	Time in Terminal	MIN	Maher Gate to Park Ave	MIN	Park Ave to McBride	MIN	McBride to Ridley Road	MIN	Ridley Road to Rail Over-pass	MIN	Rail Over-pass to W-house	MIN	*Time at W house*	MIN	W-house to Rail Over-pass	MIN	Rail Over-pass to Ridley Road	MIN	Ridley Road to McBride	MIN	McBride to Park Ave	MIN	Park Ave to Maher Gate	*TOTAL TIME*
	ESTIMATED			12		2		2		7		5.5		5.5		10		2		2.5		5.5		12		9		*1:25*
1	856L/7540	9-Sep-09	8:38	0:09	8:47	0:01	8:48	0:05	8:53	0:08	9:01	0:05	9:06	0:03	9:09	0:10	*9:19*	0:00	9:19	0:05	9:24	0:08	9:32	0:04	9:36	0:04	9:40	*1:02*
2	856L/7542	9-Sep-09	9:44	0:09	9:53	0:02	9:55	0:06	10:01	0:08	10:09	0:05	10:14	0:01	10:15	0:17	*10:32*	0:01	10:33	0:05	10:38	0:09	10:47	0:05	10:52	0:02	10:54	*1:10*
3	856L/7544	10-Sep-09	8:29	0:10	8:39	0:02	8:41	0:06	8:47	0:09	8:56	0:05	9:01	0:01	9:02	0:18	*9:20*	0:01	9:21	0:05	9:26	0:09	9:35	0:05	9:40	0:04	9:44	*1:15*
4	856L/7563	10-Sep-09	9:47	0:10	9:57	0:02	9:59	0:06	10:05	0:08	10:13	0:05	10:18	0:01	10:19	0:22	*10:41*	0:01	10:42	0:06	10:48	0:06	10:54	0:07	11:01	0:03	11:04	*1:17*
5	725L/7590	11-Sep-09	9:40	0:15	9:55	0:02	9:57	0:05	10:02	0:09	10:11	0:05	10:16	0:01	10:17	0:16	*10:33*	0:01	10:34	0:05	10:39	0:08	10:47	0:05	10:52	0:03	10:55	*1:15*
6	96/7589	11-Sep-09	9:35	0:17	9:52	0:02	9:54	0:05	9:59	0:09	10:08	0:04	10:12	0:01	10:13	0:31	*10:44*	0:01	10:45	0:04	10:49	0:05	10:54	0:06	11:00	0:03	11:03	*1:28*
7	725L/7592	11-Sep-09	10:55	0:14	11:09	0:02	11:11	0:05	11:16	0:09	11:25	0:04	11:29	0:01	11:30	0:26	*11:56*	0:03	11:59	0:03	12:02	0:10	12:12	0:04	12:16	0:25	12:41	*1:46*
8	96/7594	11-Sep-09	11:03	0:15	11:18	0:02	11:20	0:05	11:25	0:07	11:32	0:04	11:36	0:01	11:37	0:51	*12:28*	0:01	12:29	0:04	12:33	0:06	12:39	0:06	12:45	0:02	12:47	*1:44*
9	725L/7601	11-Sep-09	12:41	0:23	13:04	0:02	13:06	0:06	13:12	0:10	13:22	0:05	13:27	0:00	13:27	0:27	*13:54*	0:00	13:54	0:06	14:00	0:09	14:09	0:06	14:15	0:03	14:18	*1:37*
10	96/7602	11-Sep-09	12:47	0:21	13:08	0:02	13:10	0:05	13:15	0:07	13:22	0:06	13:28	0:01	13:29	0:21	*13:50*	0:04	13:54	0:04	13:58	0:07	14:05	0:06	14:11	0:02	14:13	*1:26*
11	6606LE/7829	28-Sep-09	9:15	0:07	9:22	0:03	9:25	0:06	9:31	0:09	9:40	0:05	9:45	0:01	9:46	0:35	*10:21*	0:01	10:22	0:04	10:26	0:08	10:34	0:05	10:39	0:05	10:44	*1:29*
12	856L/7833	28-Sep-09	10:44	0:09	10:53	0:03	10:56	0:04	11:00	0:08	11:08	0:05	11:13	0:01	11:14	0:08	*11:22*	0:01	11:23	0:04	11:27	0:07	11:34	0:06	11:40	0:06	11:46	*1:02*
13	856L/7838	28-Sep-09	11:46	0:01	11:47	0:03	11:50	0:07	11:57	0:09	12:06	0:06	12:12	0:01	12:13	0:01	*12:14*	0:01	12:15	0:03	12:18	0:06	12:24	0:04	12:28	0:04	12:32	*0:46*
15	856L/7837	28-Sep-09	12:32	0:08	12:40	0:04	12:44	0:06	12:50	0:08	12:58	0:05	13:03	0:01	13:04	0:31	*13:35*	0:01	13:36	0:03	13:39	0:06	13:45	0:06	13:51	0:05	13:56	*1:24*
15	856L/7834	28-Sep-09	13:56	0:08	14:04	0:03	14:07	0:04	14:11	0:08	14:19	0:05	14:24	0:01	14:25	0:35	*15:00*	0:01	15:01	0:03	15:04	0:06	15:10	0:07	15:17	0:06	15:23	*1:27*
16	856L/7845	29-Sep-09	8:32	0:11	8:43	0:04	8:47	0:08	8:55	0:13	9:08	0:07	9:15	0:01	9:16	0:09	*9:25*	0:01	9:26	0:04	9:30	0:13	9:43	0:07	9:50	0:04	9:54	*1:22*
17	6606LE/7846	29-Sep-09	8:40	0:08	8:48	0:05	8:53	0:08	9:01	0:13	9:14	0:06	9:20	0:01	9:21	1:01	*10:22*	0:01	10:23	0:04	10:27	0:09	10:36	0:04	10:40	0:05	10:45	*2:05*
18	856L/7848	29-Sep-09	9:54	0:12	10:06	0:04	10:10	0:08	10:18	0:12	10:30	0:06	10:36	0:01	10:37	1:36	*12:13*	0:01	12:14	0:05	12:19	0:10	12:29	0:05	12:34	0:04	12:38	*2:44*
19	6606LE/7850	29-Sep-09	10:45	0:05	10:50	0:02	10:52	0:07	10:59	0:19	11:18	0:05	11:23	0:01	11:24	0:55	*12:19*	0:01	12:20	0:06	12:26	0:07	12:33	0:07	12:40	0:04	12:44	*1:59*
20	856L/7854	29-Sep-09	12:38	0:19	12:57	0:02	12:59	0:05	13:04	0:10	13:14	0:05	13:19	0:01	13:20	0:16	*13:36*	0:01	13:37	0:05	13:42	0:07	13:49	0:07	13:56	0:03	13:59	*1:21*
21	856L/7857	29-Sep-09	13:59	0:10	14:09	0:02	14:11	0:06	14:17	0:09	14:26	0:04	14:30	0:01	14:31	0:22	*14:53*	0:01	14:54	0:06	15:00	0:06	15:06	0:06	15:12	0:03	15:15	*1:16*
22	856L/7869	1-Oct-09	8:09	0:09	8:18	0:02	8:20	0:06	8:26	0:10	8:36	0:04	8:40	0:01	8:41	0:46	*9:27*	0:01	9:28	0:06	9:34	0:10	9:44	0:07	9:51	0:03	9:54	*1:45*
23	856L/7871	1-Oct-09	9:54	0:05	9:59	0:02	10:01	0:06	10:07	0:07	10:14	0:04	10:18	0:01	10:19	0:40	*10:59*	0:01	11:00	0:06	11:06	0:09	11:15	0:05	11:20	0:04	11:24	*1:30*
24	856L/7872	1-Oct-09	11:24	0:10	11:34	0:02	11:36	0:08	11:44	0:08	11:52	0:04	11:56	0:01	11:57	0:26	*12:23*	0:01	12:24	0:05	12:29	0:09	12:38	0:05	12:43	0:03	12:46	*1:22*
25	856L/8001	14-Oct-09	8:35	0:12	8:47	0:02	8:49	0:06	8:55	0:09	9:04	0:05	9:09	0:01	9:10	0:16	*9:26*	0:04	9:30	0:06	9:36	0:09	9:45	0:05	9:50	0:03	9:53	*1:18*
26	856L/8005	15-Oct-09	8:33	0:10	8:43	0:02	8:45	0:09	8:54	0:10	9:04	0:04	9:08	0:01	9:09	0:25	*9:34*	0:01	9:35	0:05	9:40	0:08	9:48	0:05	9:53	0:02	9:55	*1:22*
27	856L/8003	15-Oct-09	9:55	0:12	10:07	0:02	10:09	0:05	10:14	0:08	10:22	0:05	10:27	0:01	10:28	0:25	*10:53*	0:01	10:54	0:05	10:59	0:08	11:07	0:06	11:13	0:03	11:16	*1:21*
28	856L/8008	15-Oct-09	11:16	0:10	11:26	0:02	11:28	0:05	11:33	0:10	11:43	0:05	11:48	0:01	11:49	0:44	*12:33*	0:01	12:34	0:06	12:40	0:08	12:48	0:06	12:54	0:04	12:58	*1:42*
29	856L/8050	19-Oct-09	8:45	0:10	8:55	0:02	8:57	0:05	9:02	0:09	9:11	0:05	9:16	0:01	9:17	0:17	*9:34*	0:01	9:35	0:04	9:39	0:09	9:48	0:06	9:54	0:02	9:56	*1:11*
30	856L/8054	19-Oct-09	9:56	0:08	10:04	0:04	10:08	0:05	10:13	0:09	10:22	0:04	10:26	0:01	10:27	0:30	*10:57*	0:01	10:58	0:05	11:03	0:07	11:10	0:07	11:17	0:04	11:21	*1:25*
31	96/8067	19-Oct-09	14:19	0:10	14:29	0:02	14:31	0:05	14:36	0:10	14:46	0:05	14:51	0:01	14:52	0:11	*15:03*	0:02	15:05	0:03	15:08	0:13	15:21	0:08	15:29	0:02	15:31	*1:12*
32	856L/8068	19-Oct-09	14:25	0:09	14:34	0:02	14:36	0:05	14:41	0:08	14:49	0:05	14:54	0:01	14:55	0:09	*15:04*	0:01	15:05	0:04	15:09	0:13	15:22	0:07	15:29	0:11	15:40	*1:15*
33	856L/8104	22-Oct-09	9:16	0:13	9:29	0:02	9:31	0:05	9:36	0:08	9:44	0:05	9:49	0:03	9:52	0:45	*10:37*	0:01	10:38	0:05	10:43	0:10	10:53	0:04	10:57	0:02	10:59	*1:43*
34	99/8186	3-Nov-09	8:33	0:07	8:40	0:02	8:42	0:04	8:46	0:09	8:55	0:04	8:59	0:01	9:00	0:11	*9:11*	0:01	9:12	0:03	9:15	0:11	9:26	0:04	9:30	0:09	9:39	*1:06*
35	856L/8190	3-Nov-09	9:30	0:04	9:34	0:02	9:36	0:04	9:40	0:08	9:48	0:04	9:52	0:01	9:53	0:11	*10:04*	0:01	10:05	0:04	10:09	0:09	10:18	0:04	10:22	0:07	10:29	*0:59*
36	95/8188	3-Nov-09	9:37	0:03	9:40	0:01	9:41	0:06	9:47	0:08	9:55	0:06	10:01	0:01	10:02	0:18	*10:20*	0:02	10:22	0:06	10:28	0:11	10:39	0:06	10:45	0:03	10:48	*1:11*
37	856L/8191	3-Nov-09	10:29	0:03	10:32	0:02	10:34	0:05	10:39	0:07	10:46	0:04	10:50	0:02	10:52	0:15	*11:07*	0:01	11:08	0:06	11:14	0:08	11:22	0:05	11:27	0:05	11:32	*1:03*
38	95/8189	3-Nov-09	10:45	0:05	10:50	0:01	10:51	0:06	10:57	0:07	11:04	0:06	11:10	0:01	11:11	0:09	*11:20*	0:01	11:21	0:05	11:26	0:09	11:35	0:06	11:41	0:07	11:48	*1:03*
39	856L/8196	3-Nov-09	11:32	0:08	11:40	0:01	11:41	0:05	11:46	0:11	11:57	0:06	12:03	0:01	12:04	0:26	*12:30*	0:01	12:31	0:05	12:36	0:08	12:44	0:06	12:50	0:04	12:54	*1:22*
40	856L/8199	3-Nov-09	12:54	0:10	13:04	0:01	13:05	0:07	13:12	0:08	13:20	0:04	13:24	0:01	13:25	0:09	*13:34*	0:01	13:35	0:06	13:41	0:08	13:49	0:07	13:56	0:03	13:59	*1:05*
	TOTAL TIME			6:39		1:30		3:50		6:06		3:16		0:44		17:21		0:48		3:09		5:39		3:47		3:01		7:50
	MAX			0:23		0:05		0:09		0:19		0:07		0:03		1:36		0:04		0:06		0:13		0:08		0:25		2:44
	AVERAGE TIME			0:09		0:02		0:05		0:09		0:04		0:01		0:26		0:01		0:04		0:08		0:05		0:04		1:23
	MIN			0:01		0:01		0:04		0:07		0:04		0:00		0:01		0:00		0:03		0:05		0:04		0:02		0:46
	MODE			0:10		0:02		0:06		0:08		0:04		0:01		0:09		0:01		0:06		0:09		0:06		0:04		1:22
	STANDARD DEVIATION			0:04		0:00:53		0:01		0:02		0:00:46		0:00:29		0:17		0:00:47		0:01		0:01		0:01		0:03		0:20

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