

CITY OF PORTLAND

OPERATIONAL EFFICIENCIES OF PORTS / TERMINALS WORLD-WIDE Final Draft

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1. EXECUTIVE SUMMARY

1.1 Overview

Balancing the preservation of natural habitat space and shoreline ecology with the creation of public recreation areas and the development of an economically viable marine terminal is the principle goal guiding preparation of conceptual layout plans for development of West Hayden Island (WHI). Realizing this goal requires an efficient utilization of limited terminal development space for any of the possible marine terminal development options at WHI. Given this key development principle for WHI and previous market and economic estimates—which suggest that a terminal handling some combination of bulk commodities and automobiles would be the most appropriate type of terminal development at WHI—this study considers how existing terminals of these types in other parts of the world have been able to achieve high utilization rates through an efficient use of limited terminal operating space

In April 2010, BST Associates prepared a report which researched the market potential for a variety of cargo that currently ships through the Portland Harbor. Based on these forecasts and the current capacity of facilities, there is a reasonable assumption that growth may exceed terminal capacity for automobiles, grain and other dry-bulk cargo. This study formed the basic market information used in the preparation of this report on terminal operating efficiencies. Since the completion of this analysis, BST has produced an updated Harbor Lands Forecast in February 2012. This update reinforces the previous report's findings that these three types of cargo will exceed the capacity of the Portland Harbor.

1.2 Report Methodology

Drawing on cases studies of existing terminal operations for each of the candidate terminal types automobile, grain and dry bulk material-potash, this report presents what are considered to be the "best-in-class" performance factors, in terms of throughput tonnages per acre and rate of throughput, for the terminals studied. Terminal management practices and technological innovations associated with these high performing terminal operations are identified, and the relevance of these technology innovations to potential development proposed for WHI are discussed.

The terminals surveyed for the case studies were selected on the basis of their high performance record and for having physical or operating characteristics likely to be found on West Hayden Island as well. Available published information on the terminals, together with discussions with several of the terminal operators, is combined with the project team's industry knowledge and expertise to establish possible performance measures applicable to terminal development options for WHI. Information, data and recommendations contained in the report were collected from publicly available sources which



have not been independently verified, and their accuracy is limited to the time period and circumstance in which they were collected and processed.

1.3 Performance Parameters

In the preparation of alternative terminal development concepts for WHI, the efficiency factors, performance parameters and innovative operational practices found at other ports are used as reference benchmarks to determine which terminal type and land use configuration would best fit the WHI development principles. These measures also help to confirm the sufficiency of the developable footprint and potential operating throughput achievable in concept layout plans for alternative terminal developments at WHI.

The performance parameters as identified from the case studies indicate that:

- An import-based automobile terminal, utilizing both open yard and multi-deck (or high-bay) parking storage could achieve a throughput of 2,688 vehicles per gross acre per year, or a static capacity of 336 vehicles per acre, assuming a 45-day average dwell time as the upper limit. Also, an import / export and transit automobile terminal, utilizing up to 50% total parking storage as multi-deck or high-bay parking, could achieve a throughput of over 4,000 vehicles per gross acre per year, equivalent to a static capacity of about 530 vehicles per acre, again assuming a 45-day average dwell time (See Section 6.1 of this report for discussion of multi-deck / high-bay storage efficiencies.) Technically, a terminal that operates with a shorter dwell time than 45 days, as assumed in the previous benchmark calculations, could achieve higher vehicle throughput per acre than these benchmarks.
- A terminal with a rail-loop configuration would require a large terminal space to accommodate the loop tracks. Therefore, a stand-alone export grain terminal with a rail loop configuration would only achieve a throughput of 150,000 tons per gross acre, compared with a throughput of 330,000 tons per acre for a terminal with a rail spur layout, often with the storage tracks located outside of the terminal footprint, when they are available and could be utilized. For WHI, given the rail loop configuration, which is one of the required Advisory Committee's development criteria, the terminal should -handle compatible commodities, an option that allows the terminal to optimize land use efficiency. A turn ratio of 28 to 45 turns per year on the usage of terminal storage capacity is possible, depending on the number and mix of compatible commodities handled.
- An export bulk material-potash terminal handling a few basic grades of material (typically white and red potash) could realize a throughput of 230,000 tons per gross acre per year, and a possible turn ratio of 33 to 40 per year. As demand grows, accelerating handling speed to achieve a higher turn ratio (shorter dwell time) would be an option for the terminal to reach a higher throughput volume, given a constrained expansion capacity of the storage space.



To perform at these levels, when applicable, each of these terminals would take advantage of the technological innovations and operational efficiencies that accompany the use of high-capacity railcar receiving and unloading mechanisms allowing the direct loading from railcars to ocean vessels. These innovative technologies can be used to minimize the need of additional storage facility as the volume of material handled grows, and include the advanced design of storage facilities (e.g. vertical storage and circular storage dome) and automated operating, monitoring and control systems to optimize storage capacity utilization and to minimize the overall operating footprint of the terminal. For a rail loop configuration terminal, mixed land use to handle different compatible products is a common strategy to better utilize terminal space, especially for the area within the rail loop.

1.4 Strategic Innovations

The case studies presented in this report demonstrate how grain and bulk material terminals operating with higher throughput tonnages per acre optimize railway logistics and asset utilization by incorporating continuous high-capacity railcar receiving and unloading mechanisms, as well as advanced scheduling and control systems that enable "direct hit" operations – that is the direct loading from railcars to ocean vessels. These operations avoid the unproductive time consumed with the breaking-down and building-up of unit trains, a practice required with the use of rail spurs, and additionally create a capacity buffer that would allow the terminals to minimize the need for additional storage space as the volume of material handled grows with market demand. The case studies also demonstrate how automobile terminals utilize multi-deck parking to expand their vehicle handling capacity in order to accommodate growth within a constrained terminal land area.

Using these innovative strategies, terminals are able to:

- Plan for a higher percentage of direct railcar to vessel loadings that in turn reduce the need for additional storage capacity associated with the growth in market demand,
- Incorporate automated operating and control systems that permit a high degree of coordination between the rail and terminal operations through the advanced planning of unloading/loading operations,
- Make use of innovative designs for enclosed storage silos or circular domes and structured parking that accommodate higher throughput within a limit space and control dust pollution and improved aesthetics, and
- From an environmental perspective, the continuous unloading of railcars via a rail loop configuration and a bottom dumper pit reduces the noise level of terminal operations. Rail loops can also accommodate full unit trains, thereby avoiding the congestion caused by railcars blocking local streets.



1.5 Relevance to WHI Development

Achieving a balance between the conservation of natural habitat space and the creation of public recreation areas together with marine terminal developments is a key guiding principle for the WHI development. To realize this goal, efficient utilization of terminal space is critical for any potential marine development option at WHI. Direct loading from railcars to vessels and multi-deck parking operations have been identified through various case studies as possible strategies for terminals that handle dry-bulk and automobile to achieve higher throughput per acre of available terminal space. The implementation of these innovations, however, requires high level of planning and coordination throughout all the diverse operations within the terminal. Direct loading requires a high level of planning to coordinate the arrival and departure schedules of trains and vessels, as well as the loading rates of railcars and vessel. To be successful, planning for these operations must specifically consider vessel loading requirements as they relate to specific cargo types/grades, and the loading time window necessary for the total volume shipped. Planning for these operations is further complicated by the fact that the scheduling of rail and ship movements are generally beyond the immediate management control of terminal operators. Also, the successful implementation of these innovations often incur greater front-end costs, including the cost of improving or expanding the rail logistic supporting system, changes in operational practices, and the construction of multi-deck parking structures, in the case of an automobile terminal.

The conceptual terminal development plans for WHI requires a rail track loop sufficient for the operation of an entire unit train contained within the terminal footprint. With this concept, direct loading from railcars to vessels at WHI is possible, if desired and given sufficient support and capacity within the railway's mainline or system network. It is important to note that, as demonstrated by the case studies provided in this report, the direct loading from railcars to vessels has been utilized to cope with growing demand for storage in a constrained terminal space, and it is not intended to replace various functions of the storage yard facility. Combined loading from stock piles and directly from railcars to vessels would be possible, and this practice would allow the terminal to handle more tonnages per acre on the available terminal space. Also, the direct loading option becomes viable with improving market conditions and constrained operating requirements, allowing the terminal area required for storage to be smaller than otherwise for a given throughput volume.

The inclusion of a multi-deck parking structure is also possible within the preferred layout; however, as estimated by BST Associates, there are 2,058 acres of public and private land available for marine terminal development in the lower Columbia River region (including the Willamette River and an estimate for development on WHI). Given this proximate availability of developable land, the high cost associated with the construction and operations of a parking structure would cause the automobile terminal at WHI to be less competitive, diminishing its economic viability. Long term, however, in the event of a strong and growing market for automobiles imported through WHI, the use of a multi-deck parking could be an option allowing for expansion within the existing footprint and providing sheltered space for the provision of value-added services at the terminal.



The development of a multiple deck parking at WHI, however, would require a detailed financial analysis comparing the cost of developing an automobile terminal elsewhere along the Lower Columbia River. This analysis would include potential development sites that offer access characteristics sufficient to support a larger automobile terminal development, including required terminal space, room for landside infrastructure, and feasible environmental mitigations. At this point, it would seem premature to consider a parking structure in the initial phases of development at WHI, given the availability of land nearby that could be used for vehicle storage and detailed operating models for WHI are yet to be determined.

1.6 Conclusion of Report

The body of this report reviews the Project Advisory Committee's economic development criteria and consultant market forecasts, describes the methodology used in preparing performance parameters and operating practices for the candidate terminal types, and demonstrates how existing terminals are achieving performance levels that would benefit terminal operations at West Hayden Island.



2. INTRODUCTION

2.1 Title of Project

City of Portland / Port of Portland's West Hayden Island Concept Plan and Related Studies

Task 3: Port Efficiencies Worldwide

2.2 Objective and Overview

This Draft Report surveys a number of existing terminal operations world-wide to identify 'best-in-class' operating efficiencies for marine terminals handling automobiles and bulk materials, particularly grain and potash as the BST Market Study (April 2010) identified automobile and bulk terminals as the most likely terminal types for development on West Hayden Island to accommodate market demand through 2040. Measures of operating efficiency are developed in this report for each terminal type based on existing terminal characteristics, and the productivity of land and equipment are identified in the case studies. These efficiency measures are developed as reference benchmarks to determine which terminal type and land area configuration would best fit the WHI development principles, and to confirm the sufficiency of the developable footprint and potential operating throughput achievable in concept layout plans for alternative terminal developments at WHI. Also, terminal operating and management technologies associated with these operating efficiencies are identified, and the relevance of these innovations to the proposed development at WHI is discussed.

Following a presentation of the methodology used in preparing this report, a review of the economic development criteria developed by the Project Advisory Committee (AC), and the BST Associates market demand forecast for cargoes most likely to be attracted to new terminal capacity on WHI, the physical and operational characteristics of bulk material and automobile terminals are discussed in the framing of operating efficiencies for each type of terminal.

Case studies of existing terminal operations exemplifying operational practices and efficiencies most likely to be applicable to the WHI development are presented, and an analysis of the characteristics and performance of these terminals establishes preliminary land use efficiency benchmarks for the overall terminal area. This sets the stage for the subsequent elaboration of terminal development and configuration concepts capable of both meeting the anticipated market demand and satisfying the development principles established for the development of WHI.

As an initial step in the preparation of alternative development concept plans encompassing the entire 800 acres involved in the development of WHI, this report represents the consultant's best knowledge at the time of its writing and relies primarily on the collective knowledge and experience of the broader project team, along with publicly available data from different data points on existing terminal characteristics and operations, preliminary original research, and information provided by terminal operators.



For the potential automobile and bulk material terminal types being considered for development on WHI, the incorporation of a rail loop configuration and storage area often occupies a significant area of the terminal, in many cases comprising from 60 percent to 80 percent of the total terminal operating land area. Based on investigations of existing terminal operations, this report identifies preliminary area requirements for the landside operating components for automobile, grain and potash terminals. Other ongoing efforts as part of the overall concept layout are working to identify the land area and configuration requirements for rail and truck access and circulation, and berthing and wharf structures. As these remaining terminal and transportation components are defined, land use planning for the natural habitat and public access recreation areas will be incorporated along with environmental studies and analyses to shape the alternative conceptual development plans for WHI.

2.3 Methodology

This report focuses on key physical and market characteristics associated with the WHI development area, with a particular emphasis on (1) local / regional market demand, and (2) environmental and natural habitat preservation requirements. Based on these characteristics, a sample of automobile and bulk material terminals serving major markets in Europe, Asia and North America was selected and surveyed at an aggregate-level for performance statistics with relevance as efficiency factors applicable to WHI development options. The surveying of terminals was undertaken remotely through various publicly available reference sources, including information provided by port authorities; terminal operators and cargo handler's annual reports; maritime industry and cargo handling equipment manufacturer directories; and on-line mapping applications. Also, previous studies involving these ports and selected discussions with terminal representatives and industry partners familiar with the configuration and operations of these ports were used to augment available data sources. Information and data contained in the report were collected from publicly available sources which have not been independently verified, and their accuracy is limited to the time period and circumstance in which they were collected and processed

For the international terminals identified with physical and operational characteristics analogous with the WHI development area, further details on existing terminal characteristics, such as annual throughput; total terminal area inclusive of storage areas; maximum capacity and stockyard dimensions; quay lengths; and type, number and operational rated capacities of installed equipment are identified and used—together with standard industry performance parameters (rules of thumb) and relevant published sources—to establish terminal efficiency factors applicable to WHI development plans.

Building on these general characteristics and reference standards, a more detailed analysis of the selected terminals was prepared to highlight key innovations determining the land area requirements for efficient operations for each terminal type. Within the overall operating concept of a terminal, the components of particular interest in this regard are the configuration of rail facilities, throughput rates of



material handling and ship loading equipment, and the storage area required to sustain optimum volume performance.

Measurements of these key components establish performance parameters that are used to benchmark terminal operating efficiencies, which in turn indicate the mix of components required to accommodate both the forecasted throughput volume and terminal footprint. Particularly, in this report, the performance parameters for overall terminal land utilization and storage areas are developed.



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3. DEVELOPMENT ISSUES AND CRITERIA

The Advisory Committee, in conjunction with city staffs have developed a set of economic development criteria to guide decision making processes in the planning and evaluation of development alternatives for WHI. These criteria were used as a guide in selecting the case study terminals presented in this report; and in line with these criteria, any marine terminal development proposed for WHI should work to satisfy the following conditions:

- The terminal development boundary, including infrastructure supporting all terminal operations, should be within an area of 300 acres as defined by the City.
- Ultimate terminal developments should be market driven and commercially based (in that the type[s] of terminal proposed should be well supported by the market and generate sufficient resources to provide for the required level of environmental mitigation and the investment in, and application of, advanced technologies).
- Consider terminal type(s), especially marine structures, that minimize the impact on and preserve shallow water habitat, and are able to make maximum use of intermodal rail transport.
- Introduce marine terminal operational efficiencies with the potential to reduce the overall footprint (terminal types that allow the use of advanced technologies).
- Be flexible in terminal design and support viable terminal operations with the ability to ensure both short- and long-term job creation for the local community and region.
- Proposed terminal developments should include each of the following characteristics in relation to and in relative balance with other requirements:
 - Safety and homeland security.
 - Support restoration and recreation areas and activities.



4. REVIEW OF MARKET STUDY

The West Hayden Island Marine Cargo Forecast and Capacity Assessment Study, prepared by the BST Associates (April 2010), researched the market potential for automobile, grain and other dry-bulk cargo terminals along the Lower Columbia River (including the Willamette River) serving national and international markets. That study contends that these terminals are expected to maintain their dominant Pacific Northwest (PNW) market shares and pattern of growth through at least 2040. The BST work also projected that the throughput capacity of existing terminals presently handling these cargoes would be insufficient to accommodate projected demand, with the exception of grain where the assumption is that current capacity could decrease with the closure of inefficient terminals (see below).

Commodities	Units	its Current Capacity ('000		ed Capacit ard 2040 ('(ty Forecast 000 Unit)	Capacity Improvement Assessment	
		Units/year)	LOW	HIGH	LIKELY	Assessment	
Automobile	Vehicle	625	925	1,364	1,145	Improve and New Facility Required	
Grain	Metric Ton	7,100	5,647	7,059	6,477	Modernize and/or New Facility Required	
Dry Bulk	Metric Ton	8,200	6,547	10,018	8,524	Improve and New Facility Required	

Table A MARKET DEMAND FORECAST AND CURRENT CAPACITY ASSESSMENT^[1]

[1] Since the completion of this analysis, BST Associates has updated their cargo forecast for the Portland Harbor in February 2012. This update forecasts increased potential growth for grain and drybulk cargo which reinforces the need for a potential new facility. While the auto forecast is reduced around 12%, it still far exceeds current capacity for the Portland Harbor.

The following are summations of the market demand forecasts and handling capacities identified by BST Associate for each terminal type—Automobile, Grain, and Dry Bulk, through 2040:

4.1 Automobile

Portland is host to several major auto importers, including Hyundai, Honda, and Toyota, and serves as the primary automobile import center in the PNW. Second only to Long Beach on the U.S. west coast, Portland accounted for 60 - 70 percent of the PNW market over the past 10 years, and according to BST estimates, Portland's share of the PNW automobile market will remain more or less in the range of 50 percent (low case) and 70 percent (high case), with a most likely share of 60 percent. This translates into the forecast volume that ranges from 925,000 units (low) to 1.36 million units (high) in



2040, with a level of 1.14 million units noted as being most likely. Compared with the 464,000 units in 2006 (before the downturn in 2008), future volume will grow to double or triple the current volume by 2040, with BST calculating a higher annual growth rate (ranging from 5.1 to 5.3 percent) for the 2010-2035 period.

According to BTS, the Port of Portland has an existing automobile capacity of 625,000 units, with forecasts exceeding this capacity at each threshold of growth. Accordingly, the port will require additional acres for auto-terminal development to handle forecast volumes by 2040.

In line with market characteristics and demand estimates, an automobile terminal developed at WHI within the horizon of these market forecasts would be an import-based terminal for finished vehicles and RORO cargo—over-height and heavy weight project cargoes. Additionally this terminal would likely provide a range of value-added and logistics services, such as pre-delivery inspection (PDI), customization, minor repair and distribution of customizing automotive parts.

4.2 Grain

Columbia River terminals have historically handled nearly all of wheat and barley exports for the PNW region. Most of the wheat and barley exports are grown in the upper Midwest, with some local production found as well in Eastern Washington, Oregon, Idaho, Montana and Utah. Wheat from the Midwest is shipped to export elevators on the Columbia River by rail, and locally grown product arrives at the export terminal by both rail and barge. Portland export elevators primarily handle wheat and barley and a limited amount of coarse grain (corn and soybean for animal feed). BST Associates forecasts that Port of Portland grain exports will increase from about 5.3 million tons in 2009 to between 5.647 million tons (low) and 7.059 million tons (high) in 2040, with a most likely level of 6.477 million tons.

At the same time, capacity to handle grain at the Port of Portland is estimated by BST to be 7.1 million tons. However, most of these existing grain terminals are old and less efficient than modern terminals. Although there have been a number of improvement projects in recent years to increase the throughput level of these existing terminals, it is likely that a new grain terminal capable of taking full advantage of modern technologies and providing an efficient rail intake facility would be a desirable development approach. Moreover, industry trends now suggest that grain terminals providing value-added services, such as cleaning and grain segregation, will be in high demand as customers require special handling characteristics for specific types of grain, especially as the market for genetically modified crops continues to develop. The introduction of transgenic canola varieties and other identity preserved (IP) shipments of grain are also driving the expansion of value-added grain segregation capabilities and services.

In line with other grain export terminals along the Low Columbia River, such as the newly developed Export Grain Terminal (EGT) at Longview, a modern and versatile grain export terminal providing value-added capabilities and services could be developed at WHI within the horizon year of these



market forecasts. A grain terminal of this type with a throughput capacity in the range of 5 to 7 million tons per annum would meet with the market and customer demand forecasts.

4.3 Dry Bulk Serving Local / Regional and National / International Markets

Dry bulk exports presently being handled by harbor facilities in Portland comprise national/international cargoes that originate from the Rocky Mountains, the Midwest, or Canada, and are typically moved to the port facilities by unit trains. Other dry bulk shipments that originate from local and regional producers move by truck to the port facilities. The national / international cargoes include minerals, ores, and other like products. Most of the inorganic chemical volume is made up of exports of soda ash (mined in Wyoming) and potash (mined in Saskatchewan), bentonite clay (mined in Wyoming), and copper concentrates from Montana that are exported via the Port of Vancouver. Accordingly, a majority of national / international exports are shipped exclusively via facilities in the Portland harbor.

BST Associates believes that through the forecast horizon of 2040 the Port of Portland's share of PNW national / international (distant market) dry bulk traffic will range from 67 percent (low) to 95 percent (high), with the most likely level around 85 percent. The Port of Portland's national / international dry bulk traffic will be more than double the volume of 2.8 million tons recorded in 2009, with projected volumes of between 4.6 million tons (low) to 6.7 million tons (high) and a level of 6.0 million tons representing the most likely case.

Similarly, most of the local and regional dry bulk exports are handled via facilities in the Portland harbor, with 2.1 million tons being shipped in 2008. BST estimates that the Port of Portland's local / regional dry bulk traffic will increase from approximately 1.3 million tons in 2009 to between 2.0 million tons (low) and 2.8 million tons (high) in 2040, with a most likely level being 2.5 million tons. Combining international / national and local / regional dry bulk traffic, the Port of Portland's dry bulk traffic is projected to be in the range of 6.6 million tons (low) to 10 million tons (high) in 2040, with a likely throughput forecast of 8.5 million tons.

As such, the demand forecast likely exceeds existing capacities, suggesting that a new dry bulk terminal will be needed within the forecast horizon to handle dry bulk cargo such as potash, soda ash or copper concentrate.

4.4 Summary of Market Study

Based on the BST market study and our understanding of the existing and future forecast terminal capacity of the Port of Portland, the following terminal types and services were considered in selecting terminals developed as case studies in Section 6:

- a) Berthing capable of receiving Panamax-class vessels.
- b) Deep water export-based and processing gain terminal.



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- c) Deep water import-based auto and RORO (high and heavy cargo) providing added value logistics services.
- d) Deep water export-based dry bulk material terminal focusing on potash.

This report concurs with the BST study in suggesting that, for the Port of Portland to compete successfully in attracting private sector investment in a terminal development opportunity, the site would have to provide for a sufficient scale and offer developed characteristics that are equal to or better than those of competing ports, including the key aspects of technology and process innovation, and reliable access to landside railroad and highway networks.



5. SCOPE OF TERMINAL OPERATIONAL EFFICIENCIES

The primary components of automobile and bulk material terminals include a deep water marine wharf, open storage areas or enclosed storage sheds, railcar loading and unloading mechanisms, a conveyor or internal circulation system and systems for loading and unloading ships. Among these, the area required for the storage of vehicles or materials typically occupies a significant area of a terminal's operating space. Terminal landside area, including storage area requirements for each terminal type, is the primary focus of this preliminary investigation of terminal components.

At the terminal, operating efficiencies are established through a combination of (1) human resources (management and labor), (2) physical configurations and processes (layout, mode of distribution, external policies), and (3) capital investments in equipment and technology (terminal equipment and integrated management and control systems). Increasingly, these terminal efficiencies are coming to rely on the operational efficiencies and capacities of the entire supply chain for a given commodity. The supply chain for any particular commodity comprises all activities in the production, transport, marketing, and use or consumption of that commodity, from the production plants to the storage and distribution systems and markets / end users. This report focuses primarily on the operational efficiencies associated with operations at the terminal level. Distribution and logistics aspects of commodity supply chains are commented on when applicable and to the extent that efficiencies in these parts of the supply chain would have a significant impact on terminal operating efficiencies. In emphasizing terminal operating efficiencies, and in particular those related with storage areas, this report highlights key aspects regulating operational efficiency by drawing on relevant case studies with applicability to the potential development options. Accordingly, this report does not attempt to provide a complete detailing or explication of the entire supply chain for the commodities and terminal types addressed. It does, however, draw on the overall terminal performance concept to access the utilization of terminal resources, specifically evaluating how total terminal and storage areas are utilized to achieve the most practical, and sustainable, throughput of cargo(es) handled by the terminal.

For each of the potential terminal development types identified in Section 4, parameters of terminal efficiency are discussed below.

5.1 Automobile and RORO Terminal

Although it represents a relatively small market segment in terms of tonnage handled, the handling of automobiles and management of an automobile terminal is actually a highly specialized business operation in terms of the value of goods shipped and the service requirements of customers. In particular, the provision of value-added services—such as pre-delivery inspection, damage repair and product customization—by automobile terminal operators reflects a current industry trend that increases the efficiency of capital for operators while also creating well-paying direct and indirect jobs associated with the automobile handling business.



Vehicle terminal operations differ from those of a container terminal, which are typically supported by rule-based control systems. For example, the flow of containers through a terminal is often highly fragmented, whereas the flow of vehicles is more uniform and analogous to the flow of bulk cargoes. Containers are often relocated several times during their transit through a terminal, but, for vehicles, relocation on the terminal is avoided as much as possible to reduce potential damage to the vehicles and to minimize operating costs. Whereas containers can be stacked to reduce storage space, this option is not available for vehicles, absent structured parking or high-bay warehousing. Due to these operational characteristics, the storage area required for vehicles at a terminal can be relatively large, which in turn encourages the optimization of terminal logistics (also known as terminal work process). Accordingly, an efficient terminal layout is necessary to provide an optimal spatial distribution of operating and storage space (both for short- and long-term storage), as well as for the siting of vehicle service facilities. Minimizing the travel distance of vehicles between these different internal locations can have a significant impact on terminal area and manpower requirements, both of which represent important measures of automobile terminal operating efficiency.

Within an import automobile terminal, receiving areas, also known as the first point of rest, are typically located close to the dock for the efficient unloading / loading of vehicles via an unloading ramp. The amount and sizing of internal storage locations provided is determined by the number of tenants (e.g. transport logistics companies, vehicle processors or manufacturers). Terminals can handle a single or several vehicle brands, and the terminal functions and services provided can also vary depending on the customer or brand. For example, some automobile terminals function as a parking or storage area, serving as a buffer or staging space to balance customer demand and dealer forecasts. For terminals functioning in this manner, and given favorable market conditions where the terminal dwell time of vehicles can be relatively short, the throughput volume and storage area turnover ratio-a performance parameter measuring how many time in a year the storage capacity is productively in use-can be fairly high. Other terminals may function more as a logistical platform, providing a range of value-added services in addition to providing vehicle storage and a staging buffer, such as pre-delivery inspection (PDI), vehicle repairs and spare parts supply, damage repairs and vehicle customization. This logistical platform function, as part of the overall automobile and vehicle supply chain, is emerging as a growing trend in the automobile industry, and in many cases terminal operators are partnering with logistics and automobile service specialists to secure distribution and value-added service arrangements with vehicle manufacturers and marketing networks. Given its geographic and established auto market advantages, WHI would appear to be an attractive location for the development of this logistics platform model of automobile terminal.

Operating efficiency measures, such as those described above, vary according to a specific terminal and its business model. At this stage of conceptual development planning, our focus will be to explore a range of potential terminal land utilization efficiencies experienced by existing automobile terminals.



5.2 Dry Bulk Material (Potash) and Export Grain Terminals

Dry bulk material terminals, including grain terminals, are used worldwide as a buffer between an incoming flow and an outgoing flow of dry bulk commodities. Handling dry bulk at the terminal can be done via a network of conveyors belts, (wheel) loaders, unloaders, stackers / reclaimers, and, after receiving (or intake) from railcars or trucks, bulk cargo will be stored either in the open stockyard, in silos or circular domes, or directly loaded onto bulk vessels from railcars—an operational practice referred to as a "direct hit."

More specifically, for export grain terminals, after the unloading of a barge or road and rail vehicles, grains are typically held in intermediate storage in grain storage silos before onward conveying or processing and loading to an ocean-going vessel. The function of storage silos at the export terminal is to balance the flow of materials between the stages of materials reception (intake), value-added processing, and holding of the finished products prior to shipping. Logistically, storage silos enable transportation facilities with different schedules and rates of loading to function efficiently and independently of each other, avoiding delays cause by one facility having to wait for another. As the volume of trade and vessel sizes continue to increase, pressures on the terminals are building to expand storage capacity or achieve a higher percentage of "direct hit" transfers as a way to minimize required increases in storage capacity at the terminal.

The number and size of storage silos, and accordingly the total required storage footprint, depends on the number of grain types and grades that must be stored and transported separately, and also on the extent to which the terminal provides value-added services, such as cleaning, drying and grain segregation (segregation refers to separating the grain into categories that meet a buyers' specific quality requirements). A large volume of grain may be cleaned, conditioned and / or blended by terminal operators at the customer's request to improve efficiency in the overall commodity supply chain.

Operation efficiency indicators generally referenced by industry operators include:

- Total cost of moving grain.
- Terminal usage turns ratios.
- Railcar cycle times.
- Velocity of grain moving through the system.
- Terminal stock levels and total throughput.

These operating efficiencies vary significantly by terminal depending on the commodity being handled and the range of services provided. In most cases, these efficiencies can be improved by (1) enhancing the truck or rail receiving (intake) hopper and vessel loading system, (2) providing the appropriate number, type and capacities of storage equipment, (3) changing the storage layout and storage capacity, and (4) increasing total terminal area and annual throughput. These measures can



also be applied generally in the evaluation of terminals handling other types of bulk material, such as potash, soda ash or copper concentrate, with adjustments for the various material characteristics.

There are, however, a number of efficiency measures that are specific to a terminal that cannot be generalized. These are typically derived from proprietary operating data and commercially sensitive information. For the purposes of this report, the terminal information pertaining to (1) storage technology and storage footprint, (2) annual throughput volumes, and (3) total operating area has been collected for the export grain and potash terminals surveyed. In particular, land utilization, as determined by throughput tonnages per acre per year and the storage capacity turn ratio are used as performance measures for grain and potash terminals. The turn ratio measure reflects the number of times a year that a terminal's storage capacity cycles to receive and discharge the annual volume, and is calculated as the ratio between annual throughput and the total capacity of the storage sheds or silos.

The turn ratio measure is often used by the industry as a benchmark to gauge the amount of storage capacity required to achieve annual throughput targets.



6. TERMINAL CASE STUDIES

Consistent with the development criteria prepared by the Advisory Committee and the physical and environmental characteristics of WHI, a survey of existing terminals handling automobiles, grain, and potash was conducted for facilities serving major markets in Asia, Europe and North America. Through a wide-ranging initial survey of candidate terminals outside of the Pacific Northwest, a select set of terminals— including two (2) automobile, three (3) grain, and one (1) potash terminal(s)—was identified for detailed investigation. Each of the selected terminals displays either physical features analogous with WHI or operational practices and technologies with applicability to the development options under consideration. These selective attributes include:

- Terminal annual throughput capacity (Metric Tons or Units handle per Year) that is similar with the size or throughput target of potential terminal development at WHI.
- Overall terminal and storage areas that are relatively smaller than that of their peers.
- Terminal storage capacity turn-ratios that are higher than that of their peers.
- Industry recognition for some unique performance and use of advanced technologies.
- Some unique characteristics, such as location, terminal and rail loop configuration, and mixed land-use to handle different types of commodities.

In the following section, the applicable attributes of the selected terminals are discussed and form the basis for assessing terminal land-use efficiencies and associated technological innovations.

6.1 Automobile Terminal-IMPORT

Keying in on import-based automobile terminal operations as part of the international terminal survey, the following set of terminals was identified for initial operational investigation:

Case Study Model	Total Reported Area (Acre)	Reported Throughput (Vehicle / Year)	Vehicles / Acre / year	Vehicles per Acre*	Function
Colonel's Island-IAP, US	200	225,000	1,125	141	Import Base, common-user processing
Port of Antwerp, BE	606	1,260,000	2,079	260	Hub Center
Port of Tyne, UK	124	594,000	4,790	599	Exp., Imp., Transit port
Medway Port, UK	260	300,000	1,154	144	Import Base

Table B AUTOMOBILE TERMINAL CHARACTERISTICS AND PERFORMANCES



Case Study Model	Total Reported Area (Acre)	Reported Throughput (Vehicle / Year)	Vehicles / Acre / year	Vehicles per Acre*	Function
Colonel's Island AutoPort, USA	346	332,000	960	120	Import Base
Southampton, UK	247	664,000	2,688	336	Exp., Imp. port
Port of Bremerhaven	494	2,100,000	4,251	531	Hub Center

Note: * Assumes a typical upper level of 45-day dwell time or 8 turns per year for import-based automobile terminal

These selected terminals represent operations with significant RORO capabilities in Europe and the United States. A multi-case analysis of these terminals finds that:

- Automobile terminals typically operate as either a manufacturer-dedicated or a multi-user facility.
- Terminals have been designed to provide flexibility in the processing, handling and storage of cargo, and have convenient links to road, rail and short-sea feeder connections.
- Terminals provide a wide range of terminal services, including customs clearance, pre-delivery inspection (PDI), storage, re-forwarding and inland transport. Some terminals also have vehicle processing centers that offer additional value-added services such as product upgrades, body and paint repair, and accessory installation.
- Terminal space and services are increasingly being utilized to accomplish manufacturers inventory buffering, warehousing with PDI, and product or brand customization. With this they also require larger terminal supporting space to accommodate these expanding services over and above the conventional functions of an automobile terminal. These supporting spaces are located either within or adjacent to a terminal.
- The dwell time of vehicles at the terminal depends on market conditions, such as sales activities, dealers being placed on finance hold, stop orders, available space at the dealers to hold vehicles, and reliable transportation capacity. Given these market dynamics, having the flexibility to accommodate market conditions by providing additional buffer space represents an attractive efficiency factor to prospective tenants.
- Advanced inventory control and communication systems are used by the terminals to provide their customers with real-time information on the location of specific vehicles. This provides greater transparency within the logistics system and allows the terminal operator to better coordinate operations at the terminal.
- Terminal operators strive to attract multiple users (automobile manufacturers and distributors). Having multiple users at a terminal allows the ocean carriers to optimize their vessel utilization



and, in return, offer cost competitiveness to shippers that ship through the terminal. In addition, port tenants, shippers and vendors can share resources and acreage to streamline their import/export operations.

Table B (above) shows the total terminal area in acres and the throughput volume of automobile terminals surveyed. The terminal area of each port includes all functional landside aspects of terminal operations, such as vehicle storage, vehicle processing, internal road accesses, and truck and rail load-out areas. Based on these statics, the average number of vehicles handled per year per acre is calculated for each facility. Due to different functions of these auto terminals, the vehicle dwell times are varied. To attain a common parameter for comparing across the terminals, an assumption of a typical, upper limit dwell time of 45 days for an import based auto terminal is used to calculate the static capacity as measured by the number of vehicles per acre. As the table shows, the Port of Antwerp, Port of Type and the Port of Bremerhaven demonstrate a high number of Vehicles per Acre; however, these terminals function as large import / export and transshipment hub centers and are therefore less relevant to WHI. The next highest ranking ports by this measure are the Port of Southampton, Medway Port, and Colonel's Island AutoPort Terminal. These terminals function as an import-based or import and export terminal-the type of function more relevant to WHI. The Port of Southampton and Medway Port both are located in the United Kingdom. With Southampton demonstrating higher performance in both measures—number of vehicles per acre and number of vehicles per acre per year—Port of Southampton was chosen for further investigation, together with Colonel's Island AutoPort representing an automobile terminal in the United States.

The following case studies of automobile terminals demonstrate how these efficiencies and expanded services are being provided in the market place.

6.1.1 Colonel's Island AutoPort Terminal, Port of Brunswick, Georgia, United States

The Port of Brunswick is situated 15 nautical miles from the sea and offers a unique non-industrialized and environmental friendly automobile and RORO terminal. In addition to the loading and unloading of the finished vehicles, the terminal also offers an extensive range of value-added services out of several processing facilities. Colonel's Island Auto Terminal has been one of the fastest growing automobile terminals in the US over the past three years, with a 66 percent increase of US East Coast market share and a 72 percent increase in total US market share. The terminal is now ranked 6th of all US auto servicing ports. The terminal presently operates 24/7 for 360 days a year, and, looking forward, the terminal has 900 acres for further expansion. (See Photo C below for the Google image of AutoPort Terminal, located adjacent to the Colonel's Island Agri-bulk Terminal.)



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Vehicle Processing Center	Total Facility Area ^(a) (Acres)	Processing Facility Area (Acres)	Storage Capacity (Vehicles)
International Auto Processing (IAP)	200	5	30,000
Pre-Delivery Inspection (PDI)		3.5	
Parts Storage and Warehouse		0.7	
Repair and Paint Shop		0.5	
American Port Services (AMPORT)	93		
Volvo Vehicle Processing Center		2.9	30,000 ^(b)
Atlantic Vehicle Processors	80		
Jaguar Vehicle Processing Center		1.0	30,000 ^(c)
Mercedes-Benz dedicated Center	45		
Vehicle Processing Facility		1.6	25,000 ^(d)

Table C VEHICLE PROCESSING FACILITY CHARACTERISTICS

Note: ^(a) Total area under lease agreement

^(b) Volvo throughput per year

^(c) Jaguar throughput per year

^(d) Mercedes-Benz throughput per year

Operated by the Georgia Ports Authority, this terminal functions as a dedicated RORO facility, hosting two modern RORO berths and three on-terminal automobile handling entities operated by Amports, Atlantic Vehicle Processors Inc., and International Auto Processing Inc., (IAP). These companies prepare the vehicles for distribution to domestic and international dealerships. This operational focus has resulted in a customer base of more than a dozen automotive manufacturers, as well as a number of industrial and agricultural equipment manufacturers. Rail service is provided by CSX, Golden Isles and NS railroads The Colonel's Island Terminal location is served by two Class-I railroads and offers nearby interstate access.

The terminal operates effectively as a collection of specialized vehicle processing centers, serving dedicated manufacturers (Volvo, Jaguar, Mercedes-Benz) and also as a multi-customer processing facility, such as the one operated by the International Auto Processing Inc., (IAP).

IAP, a multi-customer processing facility, comprises a 3.5 acre processing facility and 30,000 units open parking storage, received and processed 223,000 passenger vehicles and light trucks in 2010, about 70 percent of the total number of vehicles handled by the Colonel's Island AutoPort terminal that year. Based on these statistics, this single multi-customer processing facility achieves a storage area turn ratio of 7.5, with an average vehicle dwell time of between 30 to 45 days. As a performance



measure, the facility has processed about 64,000 vehicles per acre in 2010 through its 3.5 acre processing facility.

Over all, with a total terminal area of 346 acres, including paved open storage, the Colonel's Island AutoPort terminal handled 332,100 units of automobiles and machinery in 2010, a 16 percent increase compared to the previous year. Based on these statistics, the terminal achieved an efficiency factor of about 960 units per acre per year and a turn ratio of 7.5 in 2010, as shown in Table B.

6.1.2 Port of Southampton, United Kingdom

As one of the UK's leading ports for vehicle imports and exports, handling all sizes of vessels and cargoes, including heavy-wheeled vehicles, the Port of Southampton services a wide range of car manufacturers that ship vehicles through the port's RORO facilities. The automobile terminal occupies an area of 247 acres including198 acres of dedicated vehicle storage areas and a distribution complex that is rail-connected to receive either regular or specialty car trains. These operations are adjacent to deep-water berths that can accommodate all sizes of RORO vessels and ramp configurations at any stage of tide. The terminal handled over 664,000 vehicles in 2009.

As demonstrated in Table B, the Southampton RORO terminal shows the highest level of performance in terms of vehicles per year per acre (2,688 units) of this set of import / export terminals. There are several reasons contributing to its high level of performance. The port offers both manufacturer-dedicated terminals and common-user facilities, and the terminal uses extensive multi-deck parking to accommodate more vehicles within its footprint. Basic characteristics of the port's key RORO facilities are shown in Table D.

Type of Facility Service	Facility Area (Acres)	Storage Capacity (Units)	Average Units / gross acre (static)	
Common-User Facility	2.5	3,120 ^(a)	1,248	
Honda's Dedicated Facility	15.5	3,000	194	
Ford's Dedicated Facility	67	6,700	100	
Common-User Facility	46	10,000	217	
Vehicle Processing Building	1.5	100,000 ^(b)	66,667	

Table D SOUTHAMPTON RO-RO TERMINAL CHARACTERISTICS

Note: ^(a) Terminal uses 5-deck vehicle storage structure

^(b) Capacity to process 100,000 vehicle per year

With its 4-story, 5 parking levels of structured parking, the common-user terminal (Southampton International Vehicle Terminal) is able to provide almost 12.5 acres of storage on a 2.5 acre footprint.



Similar to the IAP processing facility at Colonel's island AutoPort Terminal, the facility has the capacity to process about 67,000 vehicles per acre per year through its 1.5 acre foot print vehicle processing building.



Photo A Port of Southampton RORO Terminal, UK

Multi-level car terminals, like the Southampton International Vehicle Terminal, have been used increasingly in Europe and Asia for both common-user and manufacturer-dedicated terminals. Another example of this type of facility is the Hyundai export-based dedicated automobile terminal at the port of Chennai, India. Occupying an area of 10,000 m2 (2.5 acres) with a 6-level dedicated parking structure capable of holding 6,000 small cars and processing 300,000 cars per year. This translates into an impressive annual turn ratio of 50. Similarly, the Bremerhaven Auto Logistics Terminal in Germany— one of the largest vehicle export-import and transit hub in Europe, handled 2.1 million vehicles in 2007. Out of the terminal's 125,000 total vehicle storage capacity, about 50% of total parking storage capacity or 60,000 parking spaces are protected from the elements in a high-bay warehouse parking structure. These multi-level and high-bay warehouse parking structures have played a key role in increasing the handling capacity and therefore land use efficiency of these automobile terminals.



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6.2 GRAIN TERMINAL-EXPORT

Based on results of the initial worldwide survey of export-based grain terminals, basic features and characteristics of selected grain terminal are provided in Table E.

Terminal Name	Effective Area (Acre)	Throughput Capacity (Tons / Year)	Throughput (Tons / Year)	Storage Capacity (Tons)	Berth Length (ft.)	Draft (ft.)	Turn Ratio (Times / Year)	Targeted Turn Ratio (Times / Year)
Colonel's Island Terminal, Georgia, US	45	3,000,000	1,324,525	80,000	<u>1@925</u>	40	17	38
Westwego Elevator ,New Orleans, US	42	n/a	n/a	100,000	<u>3@1800</u>	49	n/a	n/a
Ilyichevsk Com. Seaport, II., Ukraine	20	4,500,000	3,000,000	200,000	<u>2@1049</u>	38	15	23
Transinvestserve (TIS), Odessa, Ukraine	22	5,000,000	n/a	380,000	<u>1@925</u>	46	n/a	13
Outer Harbor, Adelaide, AU	20	2,500,000	2,250,000	65,000	<u>2@1050</u>	46.5	35	38
Kembla Grain Terminal, Kembla, AU	21	5,000,000	n/a	260,000	<u>1@1033</u>	52	n/a	19
Port of Montreal, Quebec, CA	10	n/a	2,400,000	262,000	<u>1@700</u>	35	9	n/a
Cascadia Terminal, Vancouver, CA	15	10,500,000	5,000,000	280,000	<u>1@900</u>	49	18	38
Euro-Silo NV, Belgium	n/a	14,000,000	40,000 / day	650,000	n/a	n/a	22	n/a
Tilbury FreePort, Tilbury, UK	21	2,000,000	n/a	120,000	1@850	41	n/a	17
Sovena Oilseeds, Lisbon, Portugal	n/a	n/a	1,500,000	55,000	n/a	n/a	27	n/a

Table E GRAIN TERMINALS BASIC CHARACTERISTICS



Terminal Name	Effective Area (Acre)	Throughput Capacity (Tons / Year)	Throughput (Tons / Year)	Storage Capacity (Tons)	Berth Length (ft.)	Draft (ft.)	Turn Ratio (Times / Year)	Targeted Turn Ratio (Times / Year)
J. Richardson Int. Terminal Vancouver, CA	28	n/a	3,000,000	100,000	1@355	50	30	n/a

A multi-case investigation of these grain terminals finds that:

- Most terminals have sufficient berth / draft capacity to handle Panamax-plus size vessels.
- Most terminals are using enclosed conveyors and environmental friendly loading systems (cascade chute) that minimize dust during operations and to preserve commodity integrity.
- For compact terminals demonstrating a small footprint, about 60 percent to 80 percent of terminal area is occupied by storage facilities.
- Storage silos are often used for cargo processing and distribution functions in addition to
 functioning as transit sheds. Terminals that handle fewer types of grain can have a lesser
 number of bigger silos, whereas terminals handling more varieties of grain tend to have a greater
 number of smaller silos. Consequently, the land area used for storage tends to be larger for
 terminals that handle a variety of grains and that provide various types of value-added services.
 Moreover, productivity measures, such as turn ratio, for these terminals are directly proportional
 to throughput and the demand for value-added services, and are generally lower than those of a
 strictly transit terminal. And lastly, for terminals moving grains that require soft handling to
 preserve product integrity, processing system productivity as measured by tons / hour tends to
 be lower than that of terminals moving basic commodities, like wheat or barley, which do not
 require soft handling.
- An efficient railcar receiving (intake) in terms of tons per hour, and the ability to provide for the continuous receiving of grain from railcars, contributes significantly to high throughput performance.
- A capacity to provide direct loading from railcars to vessels (direct hit), can significantly reduce additional storage requirements at the terminal as cargo volume grow.
- Terminals that utilize automatic control systems, allowing the terminal to optimize its storage capacity and to coordinate the receiving of railcars with the loading of vessels well in advance of actual operations, tend to achieve higher throughput for a given storage capacity.

Based on information provided in Table E, performance measures related with land utilization associated with relevant physical and operational characteristics of these terminals are calculated and



summarized in Table F. In this Table, four performance measures are provided. These are (1) average throughput tonnages per acre (Tons / gross acre), (2) average throughput capacity per acre (Target Tons / gross acre), (3) Turns per year based on throughput volume (Turns / year), and (4) Turns per year based on throughput capacity per year (Targeted Turns / year). The rationale for using both the existing and targeted performance is to establish a range for the upper limit of performance potential for these terminals as a future development reference.

As noted in Section 5 above, operational efficiency measures are influenced by a range of terminal specific factors, so the relative comparisons made here reflects a high level of aggregation.

Terminal	Storage Capacity (Tons.)	Targeted Tons / Gross Acre	Tons / gross acre	Targeted Turn Ratio (Turns / year)	Turn Ratio (Turns / Year)
Colonel's Island Agri-bulk Terminal	80,000	66,667	29,434	37.5	16.6
Ilyichevsk Com. Seaport	200,000	225,000	150,000	22.5	15.0
Transinvestserve (TIS)	380,000	227,273	n/a	13.2	n/a
Outer Harbor	65,000	125,000	112,500	38.5	34.6
Kembla Grain Terminal	260,000	238,095	n/a	19.2	n/a
Port of Montreal	262,000	n/a	240,000	n/a	9.2
Cascadia Terminal	280,000	700,000	333,333	37.5	17.9
Euro-Silo NV	650,000	n/a	n/a	n/a	21.5
Tilbury FreePort	120,000	95,238	n/a	16.7	n/a
Sovena Oilseeds	55,000	n/a	<u>n / a</u>	n/a	27.3
J. Richardson Int. Term	100,000	n/a	107,000	n/a	30.0

Table F GRAIN TERMINAL LAND UTILIZATION MEASURES



As demonstrated in Table F, Cascadia Terminal demonstrates the highest tons / acre measure (333,000 tons/acre), followed by Outer Harbor Terminals that show a relatively high turn ratio of about 35 turns per year. These terminals, together with the Colonel's Island Agri-bulk Terminal representing a Grain Terminal in the United States, were chosen for further investigation as discussed in the following sections.

6.2.1 Cascadia Grain Terminal, Vancouver, BC, Canada

Cascadia Terminal occupies an area of about 15 acres of land on the south shore of the Bernard Inlet, Vancouver, BC. With 280,000 tons of storage capacity, Cascadia handled over 5 million tons of wheat, barley, canola seed and specialty products in 2010. Beside barley and canola, the terminal handles over 100 types of wheat grades and segregation products. Of the terminals surveyed, Cascadia has the highest performance in terms of land utilization measured by tons / acre per annum, operated at over 333,000 tons / acre in 2010, although the terminal's turn ratio is not as high as some comparable terminals.

Photo B Cascadia Grain Terminal, Vancouver, BC, Canada





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					Receiving Rate			
Area (Acre)	Throughput Capacity (Tons / Year)	Throughput (Tons / year)	Storage Capacity (Tons)	Berth (tph)	Rail (tph)	Truck (tph)	Berth Length (ft.)	Draft. (ft.)
15	6,000,000	5,000,000	282,000	3200	1300	NA	900	49

Table G CASCADIA GRAIN TERMINAL FEATURES:

Grains are delivered to the terminal only by railcars serviced by CP via two entry tracks running along the southern side of the terminal that feed directly to the two dumper pits. As observed in available aerial imagery of the terminal, the area associated with the length of these two feeder tracks is not considered to be a part of the terminal area calculations. This assumption is being confirmed with CP and Port of Metro Vancouver. At present, the terminal receives an average of 2 trains of 112 railcars per day via two receiving pits, each handling 1 railcar of 88 tons of grain at a time.

The vessels serviced by the terminal for the past two years have averaged around 50,000 DWT, and according to terminal staff interviewed, the terminal can accommodate vessels up to 80,000 DWT. Currently the terminal is loading roughly 100,000 tons of grain per week.

The terminal is fully automated with computer and graphic display systems that control and monitor all aspects of the operation from the receiving of grain from trains to the distribution of different commodities to storage bins. Vessel loading and inventory control are monitored, with operations planned well in advance of the trains arriving at the terminal. Real time monitoring of how much grain each storage bin has and how much bin space remains open for different types of commodities are monitored and updated. This storage control information feeds directly back to the train receiving plan in order to identify the storage bin destination for each type of grain. With this automated system, the terminal is able to strategically distribute grains received from the railcars to different storage areas, thereby optimizing storage capacity.

Similarly, for vessel loading operations, the system will automatically coordinate and direct flows of cargo from different shipping legs (vertical bucket elevators) to ensure continuous loading and fully loaded a vessels with a variety of products.

Currently, the terminal is not set up for direct loading from railcars to vessels. To plan this, what is referred to as a direct hit loading, a close coordination is required between the train and vessel schedules. The present uncertainty of train arrivals at the culmination of a 1,500 km journey further complicate any plans for direct vessel loading from railcars.

In comparison with other terminals as shown in Table G, the Cascadia terminal has a turn ratio of about 18 turns, according to 2010 performance statistics. This is somewhat lower than several of the other terminals surveyed for this report. Investigating this further, it appears that this lower turn ratio reflects the variety grains handled by the terminal: Cascadia handles over 100 grades of grain and



segregated products, whereas terminals achieving higher turn ratio of 30 turns per annum, which handles two to three grades. The Cascadia terminal is working toward a target of 700,000 tons / acre per year and to raise the turn ratio of its facility to 37.5 in the near future. According to the terminal, one key element in achieving this will be an improvement of reliability in the overall rail corridor. This greater reliability will allow the terminal to plan the coordinated operations between railway and vessel that are necessary to meet its target performance while minimizing the needs for expanding storage capacity.

6.2.2 Colonel's Island Agri-bulk Terminal, Port of Brunswick, Georgia, U.S.

The Colonel's Island Agri-bulk Terminal is located at the Port of Brunswick in Georgia, along the U.S. Atlantic coastline. As one of the fastest growing deep-water ports serving Midwest and Southeastern agribusiness, Colonel's Island features a dedicated agri-bulk berth and is capable of handling a wide range of grains, including soybean, soybean meal, barley malt, corn and wheat.

Comprising a total terminal area of 45 acres, the silos and flat storage areas are located within a 14,235 ft. on-terminal loop track (see Photo C) that is configured with two lead tracks of about 5,800 ft. each, or a total of 11,600 ft. in length. Grains are delivered to the terminal by railcars, trucks and barge operations 24 hours a day and seven days a week. Spatial analysis of aerial imagery calculates the area within the rail loop configuration of the terminal to be 63 acres. As shown in Photo C, this area is currently utilized for both grain and automobile processing operations.

The terminal has a combined storage capacity of 80,000 tons, with 30,000 tons provided by three metal silos of 10,000 tons each; 10,000 tons in 14 concrete silos of different sizes to accommodate various types and grades of grain; and 40,000 tons of flat storage that measures 110 ft. in width, 900 ft. in length, and 90 ft. in height.

	Throughput		Storage		Rece	eiving Rat	Berth		
Area (Acre)	Capacity (Ton / Year)	Throughput (Ton / Year)	Capacity (Tons)	Berth (tph)	Rail	Truck	Barge	Length (ft.)	Draft. (ft.)
45	3,000,000	1,324,525	80,000	1200	1200	1200	300	925	40

Table H COLONEL'S ISLAND GRAIN TERMINAL FEATURES:



Photo C Colonel's Island Terminal, Port of Brunswick, Georgia, United States



The rail loop is configured by two lead tracks, each with a holding capacity of 100 railcars that can be operated simultaneously for a 200 railcar capacity and typically serves unit trains of 100-ton railcars. In 2010, the terminal served over 10,000 rail cars carrying more than a million tons of grain. With the capacity to service Panamax-plus vessels, a high capacity rail receiving system the terminal has the capacity to handle up to 3 million tons of grain of different varieties as required to meet the demands of the market.

In operation, the terminal receives a variety of grains in railcars that are discharged via two receiving pits supported by two separate conveyor belts. The intake hopper can handle 10 to 12 cars per hour, or 1,000 to 1,200 tons of grain per hour. The terminal also has a berth for unloading grain barges at the rate of 300 tons / hour.

As shown in Table G, in terms of tonnage per acre and turn ratio efficiency measures, this terminal is not among the higher of the terminals surveyed; however, it does possess several characteristics of particular interest relative to the situation of WHI. The grain terminal operating area is surrounded a relatively large natural habitat area, and it is also adjacent to multiple automobile terminals.

Additionally, the dock structure is constructed to reduce impacts on the fronting shallow water habitat, and the terminal has the capability to receive grains from all modes of transport--rail, road and barge.



Factoring out these various land uses from the terminal's total area of 45 acres, the 15 acres footprint used for grain terminal operations demonstrates higher efficiency measures comparable among the other terminals surveyed.

Discussions with the terminal representative disclosed that with the high growth rate of grain handled by the terminal in 2010, larger storage space may not be necessary as the terminal has sufficient rail intake capacity and the scheduling of loads between the rail and berth operations are usually well-coordinated. Recently, strong market demand and efficient rail movements on the terminal and at the junction spurs, including the ability to operate bi-directional flows for the unit trains, have contributed to the high throughput capacity demonstrated by the terminal. As pointed out by the terminal representative, at this terminal the railroads can execute a centralized hub operation and avoid the need to retrieve cars from multiple locations, which works to improve rail operating efficiency. The terminal representative additionally noted that the deepening of the shipping channel to allow the loading of Panamax vessels represents another critical operating aspect for the port, allowing it to be competitive in unit costs relative to competing ports. All these factors demonstrate the importance of greater efficiency within the overall supply chain. With this, terminal operators will be able to streamline their operations through integration with the rail distribution network, and allow them to plan their operations efficiently in order to take advantage of growing market demand.

6.2.3 Outer Harbor Grain Terminal, Port of Adelaide, Australia

Located at the upper reaches of the Port River in Southern Australia, the Outer Harbor Grain Terminal of the Port of Adelaide is a purpose-built, deep-sea grain terminal that handles grain of all types, but primarily barley and premium Australian wheat. Since it commenced operations in 2009, the terminal has become the preferred export terminal for producers in southern Australia and the western districts of Victoria.

Through	Throughput	Throughput	Storage	Loadin	Berth			
Area (Acre)	Capacity (Tons / Year)	(Tons / Year)	Capacity (Tons.)	Berth* (tph)	Rail (tph)	Truck (tph)	Length (ft.)	Draught (ft.)
20	2,500,000	2,250,000	65,000	2000	2400	800	1050	46.5

Table I Outer Harbor Grain Terminal Features:



Photo D Outer Harbor Grain Terminal, Port Adelaide, Australia



Located within the area of 44 acres encircled by an 11,500 ft. rail loop, the gain facility occupies 20 acres of landside area. With 320 meters (1,050 ft.) of berth length and a navigable draft of 14.2 meters (46.5 ft.), the terminal can handle fully loaded Panamax (50,000-70,000 DWT) vessels and partially loaded Capesize (70,000-120,000 DWT) vessels with up to 80,000 tons of grain. With 8 silos of 7,500 tons and 2 silos of 2,500 tons, the facility has a storage capacity of 65,000 tons for a variety of grains. With the ability to operate 24 / 7 and its fully utilized automated control operating system—the BULKmetrix—this terminal has an annual throughput capacity of about 2.5 million tons.

The terminal loading wharf is equipped with a traveling inclined tripper conveyor gallery located on a three-meter high mound that is connected to the rather remote inland grain terminal by 850 meters (2,800 ft.) of an above-ground, enclosed conveyor system. An interesting layout feature of this facility is the large rail loop that is necessary for the landside receiving operation for grains. With one cascade chute / spout shiploader, the ship loading system has a capacity of 2,000 tons per hour.

As shown in Table G, Outer Harbor terminal has the highest performance in terms of turn ratio a year. With a storage capacity of only 65,000 tons, the facility handled over 2 million tons of grains in 2009. That means they operated at 35 turns that year and its targeted turn per year is 38 turns.

A particularly interesting feature of this terminal is the 3.5 kilometer (11,050 ft.) balloon rail loop that enables trains to bottom dump grain while continually moving at 1km / hr (0.62mile / hr). The rail intake



hopper has a 24-meter long grid that can receive grain from two rail cars at a time, unloading at 2,400 tons per hour. Also the road grid within the terminal can take A-double rigs (36.5 meter truck-trailer-trailer) unloading at a rate of 800 tons per hour. All together the facility can receive 3,000 tons of grain per hour from inland modes of transportation.

Another leading technology feature of this port is the installation of state-of-the-art BULKmetrix (BMX) control system that provides for seamless operation by integrating the control system with all facility operations, including a dynamic user interface; inventory management and anti-contamination control; unmanned road weighbridge; and automated rail data entry using Radio-Frequency IDentification (RFID) technology.

This terminal, with its capability to receive large vessels, its high capacity and efficient landside receiving capacity (both by rail and road), and its automated control and operation system, demonstrates how the integration of technology and operating practices can achieve high throughput performance while requiring less static storage area and a smaller overall terminal footprint.

6.3 Potash Terminal-EXPORT

Today, just twelve (12) countries produce the world's supply of potash and the major source of potash in the world is from the Devonian Prairie Evaporite Formation in Saskatchewan, which provides 11 million tons per year. Russia is second at 6.9 million and the USA (mostly from New Mexico) comes in third at 1.2 million tons per year. A dozen other countries in Europe, Middle East, and South America also produce potash from evaporate deposits.

Canpotex, Canada's largest exporter, exports over 10 million metric tons per year and performs terminal handling and load port services for its potash shipped through the port of Vancouver, B.C., and the Port of Portland. Canpotex forecasts that its shipments of this commodity through west coast ports in North America will continue to increase in the coming years.

The potash terminal selected for investigation as a case study here was chosen on the basis of market share and relevance to potential potash terminal development in a range of 5 to 10 million tons per year capacity at WHI. Potash production in Canada and the U.S. combine to form the world's largest potash production market, and Canpotex and Potash Corporation are the two major potash exporters. These companies also own and operate their export terminals, and are looking for opportunities to expand their export terminal capacities to meet expanding global demand, especially in the Asia-Pacific region.

The analysis of the selected Neptune potash terminal in Vancouver, B.C. finds that:

- Terminal has a high-rate rail receiving capacity and the capability to plan for direct loading from railcars to vessels.
- Storage capacity generally in the range of 4 percent to 5 percent of throughput capacity depending on the number of material grades the terminals handle. The storage capacity could



potentially be reduced to a minimum of 3 percent of annual throughput; however, accomplishing this would require an increased level of planning to ensure that material is available in the shed for ship loading, and that space is available in the shed for receiving trains.

• To accommodate larger vessels, additional storage capacity will be required to ensure the inventory level to fully load a vessel without delay, even for the case the annual throughput are more or less the same.

6.3.1 Neptune Terminal, Port Metro Vancouver, BC, Canada

Located on the north shore of the Burrard Inlet, Neptune Bulk Terminals is a multi-product bulk terminal that handles potash, steelmaking coal, bulk vegetable oils, fertilizers and agricultural products from Western Canada destined for markets around the world. Operating 24 hours a day, 7 days a week and occupying a total area of 71 acres of land, of which, about 30 acres is currently used to handle potash cargo, the terminal's facilities have the capacity to handle over 17 million tons of multiple bulk products a year.



Photo E Neptune Multi-bulk Terminals, BC, Canada



Table J NEPTUNE'SPOTASH FACILITY FEATURES

Throu Total ghput Area ('1000		Storage Capacity	Ave. Loading Rated Capacity (tph)			Loading Dock	Rail Receiving		
(Acres)	Tons /Year)	(Tons)	Vessel	Rail Receivin g	Length/ Draft (ft.)	Shiploader (SL)	Max DWT	# Cars	# Loops (ft.)
30	7,000	210,000		2,000		Cascade Chutes		282	4
Berth 2			3,500		755/50	2 Quadrant	120,00 0		(13,231)
Berth 3			2.500		820/49	1 Linear Traveling	65.000		

The entire facility has three berths. Berth 1 is used to handle steelmaking coal shipments. Berth 2 is dedicatedly used to handle potash. Berth 3 is used to handle potash and other fertilizers, as well as agricultural product shipments. Bulk vegetable oil shipments can access Berths 1 and 2 on a flexible basis. There are four continuous rail loop tracks, one full-outside loop for coal and the other three that can accommodate three potash unit trains of 141 rail cars each, or 14,500 tons per train. Potash rail



cars are received via two enclosed gravity-fed dumper pits that accommodate three railcars each, or 6 railcars combined and with maximum receiving rate of 30 railcars per hour per dumper. As shown in Photo E, most of the area (of approximate 45 acres) within the rail loops are utilized for Potash storage sheds (Green color) and open-stockpiles for coal facility.

The potash terminal has two large storage sheds of 110,000 and 100,000 tons, for a total storage capacity of 210,000 tons. One storage shed is fully automated using a portal reclaimer and stacker system. The terminal handled 5.5 million tons of potash in 2010, of which 30 to 35 percent was directly loaded from railcars via direct hit operations. The terminal currently has capacity to handle about 10.5 million tons of potash per annum. With the completion of rail corridor improvement projects underway to improve the reliability or consistency of trains arriving at the facility, along with a corresponding increase over the current direct hit ratio, the terminal is expected to increase its capacity to 11.5 million in 2012.

Based on its current storage capacity and 2010 throughput, the terminal has operated with an average 183,000 tons of potash per acre per year with an average turn ratio of 26 — a measure of how many times the storage capacity is fully used per year. With the volume handled to date in 2011, the terminal is set to achieve a turn ratio of about 35 for 2011. At this rate, the terminal will handle over 7 million tons of potash in 2011, with the support of the 210,000 tons storage shed. This storage capacity accounts for about 3% of annual throughput volume, given that the terminal currently handles 2 major grades of potash — white and red.

The terminal is targeting a turn ratio of 40. Accomplishing this will require an increased level of planning to achieve a higher percentage of direct loading and to ensure that material is available in the shed for ship loading, and also that space is available in the shed for receiving potash from railcars.



7. SUMMARY AND FINDINGS

Achieving a balance between the conservation of natural habitat space and the creation of public recreation areas, together with the development of an economically viable marine terminal, represent key goals and principles guiding the preparation of concept layout plans for the West Hayden Island development. To realize these goals, an efficient utilization of limited terminal development space is critical for any marine terminal development option at WHI. Accordingly, gaining an appreciation of how existing terminals in other parts of the world are able to achieve high utilization rates of terminal operating space, in terms of throughput tonnage per acre, and of what throughput rate is considered to be a terminals best performance, should be of particular value.

This report presents an initial step in the conceptual planning of potential terminal development options for WHI. Consistent with the development criteria established by the AC and the market demand forecasts prepared by BST Associates, alternative terminal types capable of satisfying the development principles and meeting market demand forecasts have been investigated to preliminarily gauge the land area requirements, or terminal footprint, that would be necessary for the development of an automobile, grain, or bulk material (potash) terminal.

For each potential terminal type, efficiency measures are identified by referencing material handling and logistic practices particular to each commodity. In this first step, these efficiencies represent a high-level assessment relying on readily available data sources and information available from public records and provided by terminal experts.

Setting parameters for the efficiency measures identified in this report involved a remote global survey of existing terminals of each potential type. Terminals of each type— automobile, grain, and bulk material-potash— were selected on the basis of reported operating performance and for displaying characteristics analogous with the situation of WHI. Case studies developed for each of the selected terminals focused on the total operating area, storage capacity, material handling rates and annual throughput statistics. Multi-case analyses of the terminals representing each potential terminal type provided the parameters used to calibrate the measures of operating efficiency.

Among the measures of operating efficiency examined, two key performance measures are highlighted: 1) Land Utilization in terms of throughput tonnages per acre per year, and 2) Overall System Performance as measured by the turn ratio—a measure calculated by the number of times storage capacity is cycled per year.

Regarding land use efficiency, as shown in tables L, M and N below, the land area and throughput estimates for each of these terminal types represent a highly aggregated figure derived solely for the purpose of preliminarily determining what size and annual throughput the different terminal types would be able to accommodate within the WHI development footprint. These estimates were made in reference to some of the best operating efficiencies achieved by terminals around the world in terms of



the high volume of materials or goods they handle per acre of terminal land. There is no attempt at this point, however, to explore the full range of details related with how a terminal should operate in order to achieve these target throughput volumes within the estimated terminal areas, or footprints.

Moreover, these estimates deal primarily with the landside operational areas of a terminal. In order to properly determine the terminal size, additional estimates concerning the type of wharf structure, rail and road access infrastructure should be incorporated into these estimates. Also, in anticipation of future growth and expanded product opportunities, additional area should be reserved as well.

Lastly, the estimates for each type of terminal were made with the assumption that the terminal would operate in isolation; however, it is possible that terminal development at WHI would involve a combination of two of these terminal types. In this case, the operational effects of a mixed-use terminal in optimizing the use of terminal area would have to be properly considered in the layout concepts.

Summaries of the land area estimates prepared for each terminal type are presented below.

7.1 Auto Terminal

As discussed in Section 5.1, the Southampton Automobile / RORO Terminal is a top performing terminal in terms of total volume handled per acre per year among import / export automobile terminals surveyed for this study. From this performance parameter, and assuming a dwell time of 45 days for vehicles on the terminal, the parameter as measured by vehicle per acre (static) is calculated at 336, as shown in Table C. Based on the performance achieved at Southampton, and referencing the industry benchmark for North American automobile terminals (160 vehicles / acre), estimates of the required terminal area for different throughput scenarios ranging from 300,000 to 1 million vehicles per year were prepared, differentiating for average vehicle dwell times of 30 days and 45 days. The results of these estimates are summarized in Table L. As these results suggest, a terminal operating at a performance level similar to that of the Southampton terminal would require much less terminal area than a terminal performing nearer to the industry benchmark. Likewise, a terminal targeting performance levels similar to that of the Port of Tyne (599 vehicles / acre) and Port of Bremerhaven (531 vehicles / acre), would require a much lesser terminal area; however, in this case the terminal would has to function as both an automobile import / export and transit center in order to take advantage of economies of scale and to operate with a faster turnaround (turn ratio) of its assets.

Table K AUTOMOBILE TERMINAL REQUIRED AREA ESTIMATES

Case Study Model	Vehicles /Acre	300,000 Vehicles/Year	500,000 Vehicles/Year	750,000 Vehicles/Year	1,000,000 Vehicles/Year	
		Estimate Required Terminal Area (Acre)				

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CITY OF PORTLAND
OPERATIONAL EFFICIENCIES OF PORTS / TERMINALS WORLD-WIDE

		30 Days Dwell Time						
US Industry Benchmark	160	156	260	391	521			
Southampton Model	336	74	124	186	248			
Bremerhaven Model	531	47	78	118	157			
			45 Days D	well Time				
Industry Benchmark	160	234	391	586	781			
Southampton Model	336	112	186	279	372			
Bremerhaven Model	531	71	118	177	235			

Also, depending on market conditions and the type of services a terminal provides, more terminal area would be required to absorb longer vehicle dwell times. Under the Southampton model, an automobile terminal would require a terminal area 248 acres to handle an annual throughput demand of 1 million vehicles, assuming a 30-day vehicle dwell time. This area requirement is almost half of the area that would be required for a terminal operating at the industry benchmark performance level. One of the reasons for better performance demonstrated by the Southampton terminal is the extensive use of a multi-deck, high bay warehouse for vehicle parking as discussed in section 6.1. Also, as suggested by the Bremerhaven model, an import / export and transit automobile terminal would require a terminal area of 235 acres to handle an annual throughput demand of 1 million vehicles under the 45-day vehicle dwell time scenario. Ultimately, these performance parameters vary depending on actual vehicle dwell time—the shorter dwell time the more vehicles can be handled annually, and how extensive multi-deck parking storage is utilized versus open parking storage to achieve higher static capacity of number of vehicles handled per acre of terminal space.

7.2 Grain Terminal

As discussed in Section 6.2, of the grain terminals investigated, Cascadia Grain and the Outer Harbor terminal represented the most efficient grain terminals. Cascadia performed best in terms of tons handled per acre per year, with 330,000 tons per acre in 2010. Outer Harbor demonstrates a high performance in terms of turnover ratio of storage capacity, with a turn ratio of 33 attained in 2010. Consistent with the terminal's use of large metal storage silos, it is our understanding that the Outer Harbor terminal handles fewer varieties of grain in comparison to Cascadia. Cascadia represents a good example of a terminal that handles a relatively large variety of grains. Based on the performance achieved by these terminals, estimates for the terminal area required for grain terminals performing at different throughput volumes are calculated in reference to a 330,000 tons / acre benchmark. These estimates are presented in Table L below.

For an alternative operating scenario, similar estimates have been calculated for a terminal handling fewer varieties of grain and therefore able to perform at a higher turn ration. Using the Outer Harbor 33



turns per year as a reference, the storage capacity that would be required for a terminal handling fewer grain varieties is also estimated. Results are presented at the end of Table M providing a comparison in terms of the difference in storage capacity that would be required between these two terminal operating models.

	Based on	Throughput Demand Per Year (Tons)							
Performance Measure	Cascadia	3 MTPY	4 MTPY	5 MTPY	6 MTPY	7 MTPY			
	Model	Required Total Terminal Area (Areas)							
Tons / Acre	330,000	10	13	15.5	19	22			
		E	stimate Required	Storage Capa	acity (Tons)				
Turns / Year	18	170,000	225,000	280,000	335,000	390,000			
Based on Outer Harbor Model									
Turns / Year	33	91,000	122,000	150,000	180,000	212,000			

Table L GRAIN TERMINAL AREA AND STORAGE CAPACITY REQUIREMENT ESTIMATES

As shown in Table L, a terminal operating similarly to the Cascadia model would require a terminal area of 22 acres and a storage capacity of 390,000 tons to handle a throughput demand of 7 million tons of grain varieties a year. By comparison, it would require just 212,000 tons of storage capacity for a terminal to handle the same throughput volume of 7 million tons if the terminal were to handle fewer varieties of grain and achieve the 33 turns per year benchmark as recorded for the Outer Harbor terminal in 2010.

7.3 Potash Terminal

The Neptune Terminal at Port Metro Vancouver in British Columbia performs the best among the terminals investigated (with a capacity in the range of 5 million tons or more) in terms of land utilization and turn-ratio per year. Based on the Neptune performance parameters of 230,000 tons per acre per year and 33 turns, the total terminal area, storage capacity, and shed dimension requirements have been estimated for a terminal achieving throughput volumes of 4, 5, 6, and 8 million tons per year. This is the broad range of throughput volume that would be anticipated for a potash terminal at WHI. The storage shed dimensions for a given storage capacity (tons) are based on a typical A- frame building with the storage pile width of 48 meters. However, as storage technology advances there will likely be different storage structures available, such as silo and circular dome utilizing specialized stacking and reclaiming equipment that could reduce the overall storage area footprint. These estimates are summarized in Table N. As suggested by these estimates, it would require an area of at least 35 acres



(37,500 square meters) and storage shed capacity of 240,000 tons to accommodate a potash terminal with total throughput capacity of 8 million tons per year.

Performance	Neptune	Required Total Terminal Area (Areas)							
Parameter	Model	4 MTPY	5 MTPY	6 MTPY	8 MTPY				
Tons / Acre	230,000	17	22	26	35				
Turns / Year	33		Required Storage Capacity (Tons)						
		120,000	150,000	180,000	240,000				
		Example of Total Shed Dimensions and Required Area							
		300 m long	369 m long	555 m long	575 m long				
		65 m wide	65 m wide	65 m wide	65 m wide				
		20,000 sqm	24,000 sqm	36,000 sqm	37,500 sqm				

Table M TERMINAL REQUIRED AREA AND STORAGE CAPACITY ESTIMATES

7.4 Discussions

In concluding this report, an interest in the operating practices currently found at grain and automobile terminals in the Portland area arose, and additional information was sought from Terminal 5 and 6 at the Port of Portland; Bulk Marine Terminal at the Port of Seattle; Auto Facilities at the Port of Tacoma, and the new grain terminal at the Port of Longview. Due to the labor issues presently occurring with the opening of the Longview Terminal, we were not able to gather additional information for that terminal on productivity and efficiency issues. For the grain and potash operations at Terminal 5, and the automobiles at Terminal 6 and at the Port of Tacoma, additional operating information was gathered through discussions with the operations managers, and primarily this additional input focused on the operational practices and practical scheduling challenges associated with the direct hit loading method or those with the application of multi-deck parking structures..

To successfully implement direct hit operations at either a grain or potash terminal, the balancing of material handling between the rate and volume that material can be received and unloaded from rail cars with the loading rate and a volume of an ocean vessel is critical. With currently available technology, the rate (measured by tons-per-hour [tph]) that material can be unloaded from railcars is often slower than the loading rate of ocean vessels. This differential in material handling rates between the rail unloader and ship loader, if not carefully planned and managed, can cause the ship loader to operate at a less than optimal rate, or make the ship loader have to start and stop operations waiting for material. Either of these events represents a loss in overall system capacity at the terminal.

In the case of Terminal 5, the Port of Portland's potash terminal handles about 3 million tons of potash per year. The facility of 95 acres includes a single A-frame storage shed of 135,000 tons capacity



together with three rail loops of approximate 7000ft each encircling an area of 81 acres. Based on its current storage capacity and throughput, the terminal has operated with an average 31,600 tons of potash per acre per vear and with an average turn ratio of 22. The terminal currently operates with a single Ship Loader (SL) that can load ships from either the storage shed or directly from rail cars, but not from both at the same time. The SL has a free - loading rate of 3,000tph. This vessel loading rate can be sustained with material drawn from the storage bins; however, direct rail unloading can provide material to the SL at a rate of just 1,500 to 2,000tph. With a single SL, it is more productive (in terms of tph) to load from storage shed. In contrast with Terminal 5, the Neptune terminal in Vancouver operates two SLs, allowing for ship loading from both direct rail and the storage shed at the same time. This operational flexibility is another reason that allows Neptune to use loading directly from rail when necessary, and lessens the critical need for close coordination between rail receiving and ship loading operations. At Neptune, if a train arrives during the loading window of a vessel, it can be directly loaded to the ship; if not, the rail cars can be unloaded to storage. In either case the rail cars are promptly unloaded and released back to the rail operator. At present for Terminal 5, with a single SL and the high degree of uncertainty in the arrival time of trains, it is easier and, most likely, more productive to plan for vessel loading from the storage shed.

Similarly, for the grain terminal at Terminal 5, organizing a direct hit operation involves the additional condition or complicating factor that the grain being received from the rail car and loaded on an ocean vessel must be appropriately clean and have cleared any inspection requirements prior to vessel loading. Food stocks for human consumption often have cleaning and inspection requirements. Frequently these processes are accomplished in the handling and storing of grains at the terminal facilities, so for direct hit operations these processes would have to be accomplished earlier in the logistic supply chain. According to one terminal manager interviewed, for a terminal like TEMCO at the Port of Tacoma, which handle feed stock products of corn and soybean for export, there is no need for cleaning and blending before loading, so direct loading from rail to vessel would be possible for grains of this type. In the future, however, as vessel sizes continue to increase and as trade volumes grow, planning for a dual loading system that can load from both storage and directly from rail would represent a good strategy for accommodating greater volumes at a terminal with limited space for expanding storage capacity.

Storage space can be expanded at an automobile terminal with the development of structured parking facilities. By using structured parking, or multi-deck (high-bay) parking storage, an auto terminal can increase its annual throughput volume and static storage capacity within its existing footprint, while frequently improving terminal aesthetics and dampening noise impacts as well. The inclusion of a multi-deck parking structure would be possible with the preferred layout identified for WHI; however, as identified in the BST Associates study, public and private land in the lower Columbia River region would be available for automobile storage. This proximate availability of developable land makes the relatively higher costs associated with structured parking facilities unattractive at present.



Naturally, the decision to develop multi-deck parking facilities at WHI would require a detailed financial and cost/benefit analysis. From discussions with automobile terminal operators at the ports of Tacoma, the cost of providing structured parking is presently 10-times greater than open parking options. In addition, the per vehicle dwell time now being experienced at these PNW terminals is a considerably short, about 7 to 15 days, with some cases reaching 60 days. This shorter dwell time, when applied for the automobile terminal developed at WHI, will allow the terminal to increase the performance parameters for both annual throughput and turnover ratio, thereby relieving any immediate expansion pressures. Long-term, however, in the event of a strong and growing market for automobiles imported through WHI, the use of a multi-deck parking could be an option. In that case, the parking structure would allow the terminal to handle more vehicles on its existing footprint, and also allow the terminal to provide special handling and services for niche markets, such as secure storage for high-end vehicles, custom detailing, or outlets required for charging electronic vehicles.



