CITY OF PORTLAND BUREAU OF PLANNING AND SUSTAINABILITY

West Hayden Island Economic Foundation Study

FINAL

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PREPARED BY

ENTRIX

Down to Earth. Down to Business.

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INTRODUCTION

The City of Portland (City) is considering annexation and development of a long-range land use plan for West Hayden Island (WHI). This process requires not only annexing and zoning the property, but also an assessment of natural resources, potential conflicting land uses, and marine industrial and recreational uses. WHI is approximately 800 acres and is the undeveloped western portion of Hayden Island, located in the Columbia River near the confluence with the Willamette River. WHI is owned by the Port of Portland, and was added to the region's urban growth boundary in 1983 for marine industrial purposes. It is both a potentially important economic resource and an important natural resource, containing undeveloped open space in a location with habitat value. WHI is designated as Marine Industrial Land on METRO's 2040 Growth Concept Map, and as a Regionally Significant Industrial Area on the Title 4 map in the Urban Growth Functional Plan. WHI is also identified by METRO as a high value riparian area and a Habitat of Concern in the regional inventory, and as a Moderate Habitat Conservation Area in Title 13.

The WHI Economic Foundation Study will serve as a foundation study for the zoning and annexation of WHI and is intended to provide background information for the current planning process and future WHI studies. The objective of the study is to identify likely marine-related economic development opportunities and corresponding land needs over a planning period of the next 30 years. The land demand analysis will also inform the Economic Social, Environmental and Energy (ESEE) Analysis to be completed as part of the City land use plan for WHI.

This Economic Foundation Study provides information about marine-related industrial land needs relative to WHI and its surroundings over the next 30 years. A companion study, the Environmental Foundation Study, provides a detailed understanding of the condition, function, and value of WHI natural resources. A third recreation study describes recreation participation, development potential, and value on and around WHI. Together these studies provide information on the importance and potential contribution of WHI in three different land uses: habitat, marine-industrial use, and recreation. The studies also provide information on potential compatibility and conflicts with multiple land uses on WHI.

Broadly, the scope of this work is to 1) assess the opportunities for marine-related economic growth in Portland Harbor, 2) estimate the land acreage and site characteristics necessary to accommodate this growth, 3) compare the available land supply to the land demand to identify marine industrial land shortages, and 4) identify the potential role of WHI and other sites in meeting projected land shortages. The scope of the analysis is marine-related uses, which includes both marine cargo and marine industrial uses. Marine cargo refers to activity and facilities related to the movement of waterborne cargo while marine industrial refers to industrial activity and facilities requiring waterborne transportation. Marine industrial activities may include manufacturing, vessel repair and construction, and rail yards at marine terminal sites.

In terms of geographic scope, the analysis is focused on Portland Harbor, with a limited review of the availability and relative suitability of alternative marine industrial land sites in the Lower Columbia River. The planning timeframe for the analysis is a 30-year horizon through 2040. Due to time and resource constraints, the scope of the analysis is based on existing data and readily available information.

HISTORY AND ECONOMIC ROLES OF PORTLAND HARBOR

The purpose of this section is to provide planning and policy context for the WHI decision process by describing the economic history and regional role of marine-related activities and land needs in Portland Harbor and surrounding areas. Furthermore, the section describes the economic contribution of marine-related uses to the regional economy. This section is intended to portray the broader economic context of marine-related uses and their regional importance.

For over 140 years, Portland has been a successful port city and continues today in this role due to its location at the nexus of excellent rail infrastructure, including the Olympic oil pipeline, two interstate freeways, the Columbia River deepwater shipping channel, and the Upper Columbia/Snake Rivers barge system. Marine cargo terminals handle and transport freight that is vital to numerous other industries located throughout Oregon, Southwest Washington, and beyond. Cargo movement through the Portland Harbor has grown steadily over the past century, and recent trends indicate continued future growth. A wide web of industries rely on waterborne transportation, including wholesalers and retailers who import consumer products, manufacturers that import raw and intermediate goods, and manufacturers and natural resource industries that export products.

Portland Harbor serves as an economic engine for the metro regional economy. The Portland Harbor is home not only to transportation and distribution activities linked to marine terminals, but also manufacturing facilities that rely on marine transportation. These marine-related industries are linked to other industries located in Portland Harbor and elsewhere in the metro area, including wholesale trade, local and regional transportation firms, manufacturing firms, and retail firms. These businesses depend on the transportation hub at Portland Harbor either for transport of their products to international or regional markets, or for the provision of inputs of the wide variety of freight materials imported through Portland Harbor, whether petroleum, consumer apparel, automobiles, or raw materials.

These water-dependent industries are then linked to other industries in the harbor and elsewhere throughout the metro region. Past studies indicate that cargo and manufacturing activities dependent on waterborne transportation contribute significantly to the metro region's economy. These studies indicate that marine-related economic activity generates approximately 20,000 jobs and $1.4 billion in income, while economic activity in the overall harbor area may support approximately 100,000 jobs and $3.5 billion in regional income.

Although there are several other ports in the Lower Columbia River, including the ports of Kalama, Longview, St. Helens, and Vancouver, Portland is distinguished in the level of its transportation connections and its location in a large metropolitan area. The metro area provides a larger population of skilled labor and a larger local industrial base that can generate cluster benefits and additional opportunity for marine-related businesses. As part of the Portland metropolitan area, Vancouver also has this advantage over other Lower Columbia River ports. However, Portland is differentiated from Vancouver and all other Lower Columbia Ports because it is the only port that handles large volumes of all cargo types (specifically, it is the only port that generally handles containers). While some marine industrial uses could be suitable at any Lower Columbia River port, for certain land uses that rely on all types of transportation connections and a large population or industrial base, marine industrial land in the Portland metropolitan area (in Vancouver or Portland) may not be as easily substituted for lands elsewhere in the Lower Columbia. While locating in Portland may be more desirable for some marine-related uses, other ports appear to be less land constrained (and have larger contiguous, shovel-ready sites), and may have less contamination.

Key findings from this section are summarized below:

- **Long-Term Leading Port.** From the late 19th century, Portland has been a leading West Coast port due to its position on the confluence of the Willamette and Columbia Rivers, its multi-modal transportation infrastructure, and its proximity to areas producing substantial natural resources (primarily timber and grain) and associated finished products.

- **Continued Land Absorption for Marine-Related Activities**. Marine-related activities have experienced continued growth in Portland, with particular growth occurring during the world wars and continuing today. From 1960 to 1997, an annual average of 21 acres has been developed for river-dependent industrial uses in the Portland and Vancouver harbor area.
- **Marine-Related Activities Contribute Significantly to City's Economy.** Past studies indicate that cargo and manufacturing activities dependent on waterborne transportation contribute significantly to the region's economy. These studies indicate that river-dependent economic activity generates approximately 20,000 jobs and $1.4 billion in income, while economic activity in the overall harbor area may support approximately 100,000 jobs and $3.5 billion in income.
- **Regional Reliance on Marine-Cargo Activities**. A wide web of industries rely on waterborne transportation, including wholesalers and retailers who import consumer products, manufacturers that import raw and intermediate goods, and manufacturers and natural resource industries that export products.
- **Substitutability of Marine-Related Lands in Portland vs. Other Ports.** Portland is differentiated from other Lower Columbia Ports because it accommodates all cargo types (it is the only port that handles container cargo) and is closer to the population centers that utilize consumer goods that are shipped by marine freight. Additionally, as a metropolitan area Portland has a larger population of skilled labor and a larger local industrial base that can generate cluster benefits and additional opportunity for marine-related businesses; this advantage is also shared by the Port of Vancouver. Other ports, however, appear to be less land constrained (and have larger contiguous, shovel-ready sites), and may have less contamination. In general, Lower Columbia ports are distinguished by having access to two competing rail lines, which ensures more competitive rail rates.

GENERAL ECONOMIC AND MARINE INDUSTRIAL TRENDS

The purpose of this section is to identify the level of marine industrial economic activity likely to occur within Portland Harbor. The analysis consists of a 30-year (to the year 2040) forecast of job and cargo growth associated with marine industrial development opportunities. A review of economic and demographic trends is first provided, followed by a discussion of employment and land use trends more specific to marine industrial opportunities in Portland Harbor. These subsections rely on data from interviews as well as published data to provide historical and current context to the marine cargo and employment growth forecasts. A final subsection provides the marine cargo and job-growth forecast. The forecasts are based on different assumptions about the types of marine industrial development that could occur over the planning horizon, resulting in a low, medium, and high estimate of job growth. The three scenarios reflect uncertainty regarding overall economic growth, business location decisions, magnitude of cargo movement, and the Portland Harbor cargo market share.

Prior to the current recession, economic and population growth in the Portland metro region outpaced growth elsewhere in the nation. Economic activity is expected to begin recovering in 2010, with employment and population growth expected to average 1.4 percent and 1.5 percent, respectively, through 2030. A primary source of past economic growth in Portland has been marine-related economic activity, including marine industrial and marine cargo uses. These uses are projected to continue to grow over the next 30-years, with particular growth forecasted in the marine cargo and related transportation, warehousing, utility, and wholesale trade sectors.

The forecasts for cargo and employment have low, most likely, and high estimates, and yet still exclude the significant uncertainty represented by future markets development. New markets are perhaps the most uncertain area since a new market can develop rapidly as a result of global economic forces, new technologies, and policy developments. Interviews with planners, industry representatives, and commodity forecasters, indicates that new markets are the most difficult to predict factors for both cargo and marine industrial growth, and the most important.

Growth in marine cargo over the 30 year planning horizon to 2040 is expected to vary by cargo type, but is projected to grow on a most likely average annual rate of between 0.2 percent for breakbulk to 3.3 percent for automobiles. Together, the marine cargo types measured in tonnage (dry bulks, grain, liquid bulks, and breakbulk) are expected to grow at a most likely average annual rate of 0.6 percent (average annual growth rate weighted by current tonnage), while containers are expected to increase at an annual rate of 2.4 percent for containers, and automobiles at a rate of 3.3 percent annually.

Growth in marine-industrial employment is expected to roughly mirror economic growth trends in the region, as some elements are expected to grow less slowly (manufacturing), while others are expected to grow more rapidly (transportation and warehousing). Growth rates in marine industrial employment are projected to vary from between 0.7 percent to 1.7 percent, with total employment estimated to increase by 2,100 jobs to 6,000 jobs.

As identified in the 2006 trade capacity analysis, availability of marine industrial land and adequate freight handling and transportation system infrastructure are critical to the growth of marine-related employment. Development of additional lands and facilities will likely be necessary to meet the projected growth in these sectors. If so, land availability for marine industrial development on West Hayden Island may be able to play a critical role in providing the infrastructure and lands necessary to take advantage of growth in these industries. These issues will be addressed in subsequent sections of this study.

Key findings from the general trend assessment are summarized below:

- **General Global Economic Outlook**. The current recession has caused a short-term decline on local cargo and employment, but this trend is expected to be reversed in 2010, with annual growth forecasted to be positive through 2040.
- **Population Growth.** Population growth in the Portland metro area has outpaced state and national growth, averaging 2.5 percent annually from 1980 to 2007. Annual growth from 2000 to 2060 is forecasted to average 1.2 percent, with growth to 2030 forecasted at the higher annual rate of 1.5 percent.
- **General Employment Growth.** Since 1981, Oregon has experienced average employment growth of 2 percent annually (compared to 1.7 percent nationally). Portland metro area employment is expected to nearly mirror population growth rate. Employment is forecasted to grow at an annual average rate of 1.2 percent from 2000 to 2060, with a higher annual growth rate of 1.4 percent expected through 2030. METRO forecasts employment growth of approximately 23,600 jobs in the Columbia Harbor area from 2010 to 2035.

Key findings from the cargo and employment forecasts are summarized below:

- **Cargo Forecasts.** Three cargo forecasts completed for the region were assessed: one for the Puget Sound and Columbia River system completed in 2009 for the Washington Public Ports Association, and two for Portland Harbor completed in 2009 (one by the Oregon Department of Transportation and one for the Port of Portland). Of these, the forecast completed for Portland Harbor (done for the Port of Portland) was utilized as it is the most recent, the most conservative, and utilized sound methodology. This forecast estimates growth in each cargo type in Portland Harbor through 2040, with estimated growth rates from 2007 to 2040 varying from 0.2 percent for breakbulk to 3.7 percent for automobiles. A recent trade capacity analysis for the Portland/Vancouver area indicates that this forecasted growth is feasible given the infrastructure in the region, since it is less than the doubling of freight volumes that the study suggested was possible (though challenging) for the region.

- **Marine and Rail-Dependent Industrial Job Forecast.** Data collected by the City of Portland indicates that in Portland Harbor there are 212 firms employing approximately 8,400 workers. Based on general population and employment growth trends in the region, these jobs are forecast to grow at an average annual rate of 1.2 percent a year. Barring constraints to growth such as land availability, this suggests that total employment in the Harbor area dependent on the multi-model transport system may increase to 12,000 jobs by 2040.

MARINE-RELATED SITE SUITABILITY

The purpose of this section is to provide an understanding of site suitability and constraints for marine-related uses, including both marine cargo and marine industrial uses. Site suitability is assessed for six marine cargo types: automobiles, liquid bulk, grain dry bulk, other dry bulk, containers, and breakbulk. Site suitability is also assessed for two marine industrial types: vessel related services and marine-dependent manufacturing.[1] Requirements for a given marine-related use vary depending on site and use-specific needs. This section is intended to provide a general sense of the site size, water access, and intermodal infrastructure requirements for each of these marine-related uses. Where available, information on trends in these requirements is presented. A brief discussion is also provided on site constraints for marine-related use related to natural resources and environmental contamination. The information presented in this section is used in later sections to assess the suitability of vacant, waterfront lands in Portland to meet the requirements for marine-related uses, and to assess the suitability of West Hayden Island (WHI) and other lands in the Lower Columbia River.

Marine-related uses share similar site requirements, including 1) zoning (industrial), 2) flat and contiguous lands with shoreline access of 400 feet or more, and 3) proximity to multimodal infrastructure (water, truck, and rail). Differences arise in acreage and water depth requirements, with marine cargo uses typically requiring more acreage and deeper water. Specifically, marine cargo facilities are usually sized at 50 acres or more (with the exception of local/regional dry bulk and liquid facilities that can be as small as five acres) and require a minimum draft depth of 35 feet. Marine industrial uses vary considerably in their site size requirements, but are typically at least five acres in size and can be as large as several hundred acres. A draft depth of 20 to 30 feet is required for most marine industrial uses.

Regarding site limitations, marine cargo and marine industrial uses alike face constraints related to sensitive natural resources and brownfield contamination. The presence of either can limit site usage or increase site acreage requirements for mitigation, and increase site development costs.

Table ES-1 summarizes the site characteristics of each marine-related use described above. **ES-1** is not an exhaustive analysis of specific businesses that fall into marine cargo and marine industrial classifications. Rather, the intended purpose of **Table ES-1** is to summarize general characteristics and potential requirements of marine cargo and marine industrial sites, based upon representative businesses in Portland Harbor as well as in other west coast ports.

In general, the table indicates that cargo facilities require sites that are typically 50 acres or larger, with the exception of local/regional dry bulk and liquid bulk facilities that may be much smaller. It is important to note that while many existing grain facilities are relatively small, industry trends show that newer facilities are larger to accommodate larger vessels and longer unit trains (to ensure competitive railroad rates). Many of the acreage sizes indicated in **Table ES-1** indicate the core terminal operation footprint, which excludes the rail infrastructure and ancillary structures and operations. Furthermore, the site sizes in **Table ES-1** do not include any acreage required for onsite mitigation or environmental protection. Total acreage, including

[1] Marine or vessel related services include barging, cargo handling services, and naval/coast guard services. Marine dependent manufactures are those firms that require marine facilities for the transport of raw and finished product.

rail infrastructure and support operations, for new marine cargo facilities handling containers, automobiles, national/international dry bulks, and grain are typically 100 acres or more.

All cargo facilities require minimum draft depths of 35 feet, with a deeper draft more suitable for many cargo types. Berth lengths of most cargo facilities are at least 550 feet, with many larger than 1,000 feet. As noted above, these lengths do not include dolphins, which extend the shoreline length for mooring vessels. This emphasizes the need for sites with at least 400 feet of shoreline length.

Marine industrial sites vary significantly in their requirements, both in terms of acreage, berth length, and channel depth. However with the exception of some vessel-related services, most marine industrial sites require at least a 20-foot draft and a five acre site. Nearly all marine industrial uses require a site with at least 400 feet of riverfront to accommodate a berth, and nearly all require access to rail and truck routes.

Table ES-1 Summary of Site Characteristics for Marine-Related Land Uses

	Acreage Approximation		Water Frontage Approximation		Berth Depth Requirement within 150' of Shore[2]	Rail Infrastructure Requirements
Site Type	Portland Harbor	Other West Coast Harbors	Portland Harbor	West Coast Ports		
Cargo						
Automobile	75 - 120	95 - 168	414' - 1,000	1,040' – 1,300'	35' or greater	Rail Ramp & Nearsite Rail Yard (5+ acres)
Container	193	50 - 385	Total of 2,850' (3 berths)	1,100' – 6,380'	40' or greater	Intermodal Yard (Onsite or Nearby Rail Yard) & Mainline Access
Breakbulk	20 - 50	15 - 75	2005' (2 berths)	600' – 1,750	35' or greater	Nearby Rail Yard & Mainline Access
Grain	40 – 100	40 - 100	327' – 928'	715'	40' or greater	Spur/loop & Nearby Rail Yard & Mainline Access
Dry bulk National/International	25 – 120	34 – 136	740'- 900+'	550' – 1,900	40' or greater	Spur/loop & Nearby Rail Yard & Mainline Access
Dry Bulk Local/Regional	5 – 27	5 – 23	N/A	550' – 1900'	40' or greater	Spur
Liquid bulk	5 – 45	10 - 20	700'	700' – 1,980'	35' or greater	Spur
Industrial						
Vessel Related Services	5 - 60		175' – 3,900'	150- - 1,400'	20' or greater	Spur / None
Marine dependent manufacturing	10 - 170 acres		994' – 1,800'	500' – 875'	20' or greater	Spur

Key findings from the suit suitability assessment are summarized below:

- **General Site Requirements.** Sites for marine industrial use must be zoned for industrial use, and be located on the waterfront with access to adequate channel depth—at least 20 feet for marine industrial sites and at least 35 feet water depth for marine cargo sites. Most marine-related uses require this draft depth for a length of 400 feet within 150 feet of shore, with depth close to shore most desirable. Marine cargo and marine industrial sites also both require easy access to rail and truck transportation routes.

[2] This distance from shore is based upon PHILS study, City of Portland, Portland Harbor Industrial Lands Study, February 2003, Prepared by E.D. Hovee & Company.

- **General Acreage Requirements.** Acreage is required not only for the footprint of the marine terminal or marine industrial operations, but also for infrastructure such as access roads and rail lines. Acreage requirements differ by use, but in general, marine terminals require more acreage due to the large rail facilities required for many cargo facilities and associated warehousing and distribution facilities. Existing marine cargo terminals generally range in size from 20 acres to over 100 acres, while marine industrial sites typically range between 5 acres and 100 acres.
- **Variation in Specific Site Requirements.** Site size and configuration vary significantly based on specific use, operational requirements, site constraints, and local market conditions. An examination of just one use, such as container cargo terminals, will reveal very different site sizes and configurations at different ports and even at the same port.
- **Trends in Marine Cargo Facilities.** Ship size is increasing for most cargo types, resulting in larger desired berth lengths and deeper river depth. The trend towards unit trains for grain and international/national dry bulk cargoes means that larger sites (100+ acres) that can accommodate multiple unit trains are expected to be necessary for future competitiveness. Trends in Asia and other land-constrained areas are to minimize terminal footprint through a variety of methods; in general, these methods are costly, respond to specific local market conditions, and have not been implemented at Lower Columbia ports. The tradeoffs between cost and site efficiency, and the resulting impact on competitiveness and economic viability is not addressed in this analysis.
- **Natural Resources Site Constraints.** Waterfront areas often have sensitive natural resources. Local, state, and national regulations protect sensitive resources, and often require mitigation and avoidance of impact for development in areas with these resources. In addition to requiring lands to be set aside for environmental purposes, developing in areas with sensitive resources may increase site development cost and limit suitability.
- **Contamination Site Constraints.** By raising site development costs and raising long-term liability concerns, contamination in waterfront areas can reduce the market feasibility of a site for marine industrial use.

INVENTORY OF SUITABILITY MARINE-RELATED SITES

Following a brief overview of current land use in Portland Harbor, this section provides an inventory of vacant, waterfront lands in the industrial districts in Portland. The lands inventoried for this study are located along the Willamette River downstream of the Fremont Bridge and eastward along the Columbia River to Interstate 5. The purpose of the section is to provide an understanding of the available supply of industrial waterfront land in Portland Harbor, and the characteristics of the land supply relative to the site suitability requirements for marine-related uses outlined above. The section concludes with a comparison of site characteristics required for marine-related uses versus the characteristics of the available waterfront lands in Portland. The focus is an inventory of lands in Portland Harbor; the next section includes an overview assessment of the availability of industrial lands suitable for marine-related uses in other ports on the Lower Columbia River.

The site suitability analysis discussed above identified the desired or required site characteristics for each type of marine industrial use. As noted in that section, most marine cargo uses require channel depth of 35 feet or more and sites that are 60 to over 100 acres in size. There are no sites that meet these requirements currently vacant in Portland Harbor. Assuming that future dredging enables deep draft access to all sites, there are still no sites that are large enough to accommodate a new, modern marine cargo facility. The possible exceptions are liquid bulk and local/regional dry bulk facilities that may require a smaller site.

Marine industrial uses and their site size requirements are quite varied. However, it is expected that most marine industrial uses desire sites of at least five acres, draft of 20 feet within 150 feet of shore, and a shoreline length of at least 400 feet. As indicated above, however, many marine industrial uses require large sites of over 100 acres. There are 11 sites in Portland Harbor that are five acres or more with shoreline length of 400 feet, of which nine have depth of 20 feet or more within 150 feet of shore. All but one of these sites are constrained as suspected brownfields. **Table ES-2** summarizes the number of available sites that may be potentially suitable for each type of marine-related use.

Waterfront vacant land suitable for marine cargo and marine industrial use is limited by site size and configuration, natural resource constraints, and contamination. There are 31 sites with 300 acres of vacant, waterfront industrial lands, of which 20 sites are smaller than five acres in size. No vacant sites are larger than 60 acres in size, which precludes development of many marine cargo uses and some marine industrial uses. There are, however, 11 sites larger than five acres that with channel deepening could become appropriate for local/regional market dry bulk or liquid bulk cargo or for marine industrial uses. All but one of these sites is a suspected brownfield, however, which constrains its suitability. Suitability of these sites for each use will depend on use-specific site requirements as well as the tolerance of the user for the potentially large liability associated with the Superfund site and upland brownfield contamination.

Table ES-2 Available, Potentially Suitable Sites by Marine-Related Use

Marine-Related Use	Number of Available, Potentially Suitable Sites	Notes
Cargo		
Automobile	0	No vacant sites large enough to accommodate new automobile terminal and associated infrastructure.
Container	0	No vacant sites large enough to accommodate new container terminal and associated infrastructure.
Breakbulk	0	No vacant sites large enough to accommodate new breakbulk terminal and associated infrastructure.
Dry Bulk (National/International)	0	No vacant sites are large enough to accommodate a new grain or international dry bulk commodity terminal and associated infrastructure.
Liquid Bulk	0-6	There are six sites that are larger than ten acres that are located in the Northwest industrial district proximate to the Olympic pipeline. All of these sites have suspected upland contamination. Only one of these sites (it is 13.5 acres in size and is owned by Northwest Natural Gas) currently has a draft of 35 feet.
Dry Bulk (Regional/Local)	1-11	There are 11 sites in Portland Harbor that are larger than five acres and have shoreline access of 400 feet. Only one of these sites does not have suspected upland contamination, and is owned by the Port of Portland. Only one other site (it is 13.5 acres in size and is owned by Northwest Natural Gas) currently has a draft of 35 feet.
Industrial		
Vessel Related Services	1-11	There are eleven vacant sites larger than five acres in size with adequate riverfront access, of which nine sites have draft depth of 20 feet or more. Only one site does not have potential upland contamination, and is owned by the Port of Portland.
Manufacturing	0 – 11	There are eleven vacant sites larger than five acres in size, and only two sites larger than 50 acres in size. Of these sites, nine sites have draft depth of 20 feet or more. There are no vacant riverfront sites larger than 60 acres in size. All sites larger than 15 acres are affected by upland contamination.

Key points from this site inventory include:

- **Marine cargo.** The industrial districts in Portland Harbor downstream of the Steel Bridge cover 5,932 acres of land in taxlots.[3] This land encompasses river-dependent marine industrial and marine cargo activities and facilities, as well as rail-dependent uses that are not directly dependent on water access but that utilize the intermodal transportation facilities available in the Harbor area.
- **Available, Vacant Lands.** In 2009, the Economic Opportunity Analysis (EOA) completed for the City of Portland inventoried the industrial lands available for development throughout the City. This study estimated the vacant industrial land supply at approximately 3,000 acres, of which approximately 1,900 acres are located in the Columbia Harbor area (which includes lands along the Willamette River downstream of the Fremont Bridge and eastward along the Columbia River to 82nd Street). Of all vacant industrial lands (as classified by the 2009 Economic Opportunities Analysis or EOA), only 33 sites in the Columbia Harbor geography are adjacent to the waterfront. Nearly all of these sites are located in Portland Harbor, but nine are located in the Rivergate industrial district with access to the Columbia River. Redevelopment of non-vacant lands was not examined in this analysis.
- **Size of Available Land.** There are a total of 300 acres on the 33 sites, with the average site size approximately 10 acres. Over 65 percent of sites are less than 5 acres in size, less than the minimum typically required for marine-related uses. Ten sites are larger than 10 acres, and three sites are larger than 30 acres. Adjacent parcels (including upland parcels) with the same landowner have been grouped into one 'site', as have been parcels with different land owners that may be feasible to aggregate. This aggregation results in 31 sites being analyzed (rather than 33 sites).
- **Waterfront Characteristics**. Twenty-five sites have the minimum waterfront access (400 feet) required by most marine-related uses, with 11 sites having minimum waterfront access that are larger than 5 acres. Only one site larger than 5 acres has access to deep draft channel depth of 35 feet, but access to deep draft waters will be increased once dredging resumes again on the Willamette River (currently dredging is suspended pending the outcome of the Portland Harbor Superfund cleanup).
- **Natural Resource Constraints.** All vacant waterfront sites are affected by at least one natural resource constraint. Of the 300 acres of vacant, waterfront lands, over half (170 acres) are affected by some level of natural resource constraint based on City of Portland overlay zoning. These constraints can affect the costs and required acreage for development, but do not prohibit development. It is expected that all waterfront lands suitable for marine industrial use will be affected by natural resource constraints, whether located in Portland Harbor or elsewhere.
- **Contamination.** The Willamette River in Portland Harbor has been identified by the Environmental Protection Agency as a Superfund site. This designation affects all waterfront acreage from Columbia Slough to the Fremont Bridge, and presents a challenge to the transfer and lease of property in the harbor. As assessed by Oregon Department of Environmental Quality (DEQ), nearly one-half of the 31 vacant, waterfront properties in Portland Harbor have potential upland contamination. This contamination can present costly clean up requirements and may limit the lease or sale of these properties.
- **Overall Summary**. There are no sites currently vacant on the waterfront that are suitable for marine cargo development, with the exception of liquid or small dry bulk facilities. There are 11 vacant sites larger than 5 acres with appropriate shoreline access, there are no sites available larger than 60 acres.

[3] Portland Bureau of Planning, 2003, Portland Harbor Industrial Lands Study Part One: Inventories, Trends and Geographic Context.

LAND ABSORPTION AND NEEDS FORECAST

This section concludes the economic foundation study, and provides a forecast of land absorption demand by marine-related uses in Portland Harbor together with a discussion of the potential role of WHI. The section draws from all preceding economic sections to evaluate the demand for additional lands for marine uses, and the potential role of WHI to meet this demand. The first two subsections forecast the land need for marine-related uses in Portland Harbor, including marine cargo and marine industrial uses. The forecast for marine cargo lands is based on an assessment of current capacity compared to forecast cargo volume. The forecast for marine industrial lands is based on past land absorption trends of marine industrial land combined with an existing forecast of land absorption in the Portland Harbor area. The final subsections focus on the availability of existing lands in Portland Harbor to meet demand compared to the suitability of WHI land and lands available at other Ports.

Provided there is adequate terminal infrastructure and land, marine cargo volume is projected to grow over the next 30 years in Portland, as is marine industrial land use. However, projected growth will not be realized if suitable lands are not available. In particular, lack of available, large developable sites suitable for marine industrial development constrains growth opportunities for marine cargo or large marine industrial manufacturers. As noted in METRO's 2009 urban growth report, the region must decide how it will accommodate forecasted population and employment growth and what investments we are willing and able make in transportation corridors and employment areas to support long-term employment growth.[4]

Forecasted demand for marine-related land uses (both marine cargo and marine industrial) ranges from 220 acres in the low forecast to 980 acres in the high forecast. Of this acreage, up to 130 acres may be accommodated on smaller parcels in the harbor area (potentially 55 acres of regional/local dry bulk terminal and liquid bulk terminal and up to 75 acres of marine industrial). This figure is based on the available lands in the harbor area and the proportion of brownfield sites that may be available for development.

WHI is the only parcel suitable in Portland Harbor for new uses that require 100 acres or more. Development of WHI for marine terminal use would likely allow Portland to capture the forecasted potential cargo opportunities, and associated jobs and income. Forecasted acreage demand that can not likely be satisfied in the harbor area ranges from 150 acres in the low scenario to 850 acres in the high scenario. Development on WHI for marine cargo purposes may also lead to more available lands in Portland Harbor for other industrial uses, if some existing cargo operations such as grain are consolidated at larger marine terminals. Growth in these marine-related industries is a major engine for the local economy, and has implications across a variety of sectors.

Key points in this section related to marine cargo land needs include:

- **Cargo Forecast**. Cargo is forecasted to increase in all cargo categories, but is concentrated in the automobile (growth of 280 percent by 2040) and container (growth of 212 percent by 2040) cargoes. Tonnage of all other cargoes is expected to grow by 22 percent by 2040 under the most likely scenario.
- **Cargo Forecast vs. Existing Capacity.** Capacity of existing Portland cargo facilities is shown in Table 1, as determined by the Port of Portland. As highlighted in grey in **Table ES-3**, in the most likely forecast scenario there is not adequate existing capacity for automobile, and there may not be adequate future capacity for grain cargo.

[4] METRO. 2009. 20 and 50 year Regional population and employment range forecasts. accessed online at: http://library.oregonmetro.gov/files/appendix_12_forecast.pdf.

Table ES-3 Forecast Cargo Volume versus Annual Cargo Capacity of Existing Terminals in Portland Harbor

Cargo	Units	Current Practical Maximum Capacity	Cargo Forecast by 2040: Low	Cargo Forecast by 2040: Most Likely	Cargo Forecast by 2040: High	Potential Capacity Shortfall
Automobiles	Units	675,000	925,000	1,145,000	1,364,000	350,000 – 700,000
Containers	TEU	700,000	379,000	585,000	744,000	0 - 50,000
Breakbulk	MT	2,100,000	1,010,000	1,181,000	1,295,000	0
Grain	MT	4,100,000 - 7,100,000	5,647,000	6,477,000	7,059,000	0 – 3,000,000
Dry Bulk National/international	MT	8,200,000	4,650,000	6,054,000	9,733,000	0 – 1,500,000
Dry Bulk Local / Regional	MT	2,500,000	2,089,000	2,471,000	2,852,000	0 – 500,000

Source: BST Associates, 2009 and 2010, Port of Portland Marine Terminal Master Plan, Personal communication with the Port of Portland and BST Associates.

- **Land Needs for Cargo Growth**. An important assumption is that future marine-related development in Portland will be similar in size and site requirements to new marine-related developments at other west coast and Lower Columbia ports. Also, to meet growing demand, ports throughout the United States have typically increased throughput capacity by building new terminals requiring new land for development. Ports around the world have also worked to increase efficiency and increase throughput at existing facilities by changing operating standards and implementing such practices as off-site storage and more efficient cargo management systems. While reducing acreage requirements in marine areas, these practices can substantially increase operating costs and reduce competitiveness of a port. There are thus tradeoffs associated with cost competitiveness and land use efficiency.
- **Marine Cargo Land Absorption Forecast**. Based on the size trends of new terminals being constructed on the west coast, the forecasted land need through 2040 for the Port of Portland to retain and attract potential cargo clients ranges from approximately 150 acres (low forecast for only automobiles) to approximately 680 acres (high forecast), with a most likely land need of approximately 425 acres. These forecasts indicate that this land would be required to build modern, operationally-efficient terminals to accommodate all projected cargo growth, but does not signify that these terminals would be operating at capacity.
- **Land Needs compared to Vacant Inventory**. Marine cargo land need is forecast to range from 150 acres to 680 acres, primarily in parcels larger than 100 acres. It is anticipated that up to 55 acres in the high forecast and 25 acres in the most likely forecast could be met by vacant lands available in the Portland Harbor. The remaining land need for marine cargo (150 acres in the low scenario, 400 acres in the most likely scenario, and 625 in the high scenario), is expected to be for parcels larger than 100 acres to accommodate rail access and ensure competitiveness. As discussed above, there are no vacant parcels of this size available in Portland Harbor. To accommodate these new marine terminals in Portland given the currently available land supply, it is expected that the Port of Portland would need to develop land on WHI.

Key points related to land need for marine industrial growth:

- **Existing River-Dependent Land Use and Employment**. River dependent uses were classified by the City, and were further divided for this study into marine cargo and marine industrial uses based ownership and existing use of the site. There are 47 parcels in Portland Harbor identified by the City as river-dependent, with a total of 1,790 acres. Of the 47 river-dependent parcels, there are 29 with available employment data. Data for these parcels indicate 2,780 employees in river-dependent uses, of whom approximately 77 percent (2,140 employees) are employed in marine industrial uses with the remaining 23 percent (640 employees) employed in marine cargo uses.

- **Marine Industrial Land Absorption.** Based on the City of Portland Economic Opportunities Analysis (EOA) job forecasts and proportion of land in marine industrial uses, a range of 70 to 300 acres is the forecasted land need for marine industrial uses.

Key points related to marine-related land need and vacant land supply:

- **Land Needs compared to Vacant Inventory**. Vacant parcels are available in Portland Harbor for marine industrial uses requiring less than 60 acres. There are 11 parcels (263 acres) of vacant lands in Portland Harbor that are larger than five acres and have adequate shoreline length. However, only one of the 11 potential sites (19 acres) does not have potential upland contamination, the presence of which carries significant costs and risks. Thus, while Portland Harbor has available brownfield sites for redevelopment that will accommodate smaller-sized marine industrial uses, it lacks sites for large river-dependent manufacturers and has limited opportunities for uses requiring uncontaminated sites on the river.
- **Suitability of WHI.** WHI has the land size, deepwater access, and proximity to rail and interstate infrastructure necessary for a marine terminal location. If marine terminal development were to take place on the island it is expected that a bridge for vehicular access would be constructed connecting WHI with Marine Drive in Portland. It is also expected that rail access would be developed by integrating with the existing BNSF rail bridge on the eastern limits of the WHI. The primary constraint to WHI development is expected to be impact to natural resources.
- **Concept Designs.** A recent study conducted for the Port of Portland provides some general design guidelines for potential marine terminal development of WHI.[5] This preliminary study analyzed terminals for automobiles (75 to 140 acres), dry bulk (110 to 175 acres), liquid bulk (125 to 155 acres), and container cargo (95 to 140 acres). Conceptual designs, include rail infrastructure, were generated for these terminals. Berths for each terminal type were described, and vary from floating platforms to split-level fixed berths to a traveling loader system. All berths would be located on the north side of the island.
- **Alternative Rail Layouts**. Two general design concepts were developed, one with a long track traversing east-west along the island parallel to the shoreline, and one with the tracks approximately extending only as far west as the power line corridor. Limiting the rail footprint to the east side the BPA power line corridor increases the amount of time for trains to enter or exit the mainline tracks by approximately 25 percent due to increased curvature in the track configuration. Other operational constraints would result from this configuration, including increased labor for train handling and maneuvering, and providing only one loop track of the desired 8,000 to 10,000 feet length which would require increased coordination between terminals.
- **Available Lands at Other Lower Columbia Ports.** At the Port of Vancouver there are 718 acres available, of which 218 acres are in the planned Terminal 5, and 350 to 400 acres are in the planned Columbia Gateway. At the Port of Longview, the only available parcels for additional marine terminal development are privately owned, but include approximately 730 acres.

CONCLUSIONS

Portland Harbor has been a leading west coast port for over 100 years, transporting and handling marine cargo products that sustain businesses and economic activity in the metro area and the greater region extending through Oregon, Southwest Washington, and into Idaho and beyond. Marine industrial activity in the Portland Harbor has also been an important component of the Portland economy, and includes businesses

[5] HDR Engineering, Inc. 2009. West Hayden Island Terminal Site and Operation Requirements and Addendum 1. Prepared for Port of Portland. Accessed at http://www.portlandonline.com/bps/index.cfm?a=279953&c=51508.

highly interdependent on each other and on the cargo handled at marine terminals in the area. As the Portland Harbor has continued to develop over the last century, land use needs have expanded with approximately 21 acres being developed every year from 1960 to 1997. Future growth is anticipated, particularly in the marine cargo sectors and the transportation, logistics, and distribution industries.

While there is uncertainty associated with the magnitude of marine cargo and marine industrial growth over the 30-year planning horizon, the current market position of Portland and historical and recent trends indicate significant growth opportunities. Based on the marine cargo and employment growth rates forecasted to 2040, marine-related land needs to accommodate growth are expected to exceed land supply in Portland Harbor. Land needs are forecasted to range from a low of 220 acres to a high of 980 acres, reflecting uncertainty in new market opportunities and rates of overall economic growth.

As in numerous past studies (Portland Harbor Industrial Lands Study, Trade Capacity Assessment, Economic Opportunities Analysis), this study finds that marine industrial land is limited in the region, particularly for large sites of 60 acres or more needed for marine terminals and large marine industrial operations. Furthermore, marine industrial redevelopment opportunities on the available land are constrained by both the Portland Harbor Superfund Site and the upland contamination present on many sites. Liability concerns and redevelopment costs affect the marketability of these sites to prospective buyers or new tenants.

In summary, to capture economic growth opportunities in marine-industrial land uses, Portland will need to provide large parcels for marine industrial growth. Barring considerable redevelopment and reconfiguration of existing sites in Portland Harbor, Portland will need to look to new sites such as WHI to ensure large site availability for significant growth opportunities. If WHI is not developed, it appears that the existing and planned terminals at ports located on the Washington side of the Lower Columbia River may be able to meet the forecasted cargo demand for the Lower Columbia. Under this scenario, however, it is expected that Portland would lose opportunities to expand marine-related economic activity and would forfeit the associated jobs and income. Additionally, if WHI is not developed, it is expected that fewer lands will be available for marine industrial uses in Portland Harbor, potentially resulting in less job growth in marine-related manufacturing and other sectors dependent on marine cargo activities.

SECTION 1

Introduction

1.1 BACKGROUND

The City of Portland (City) is considering annexation and development of a long-term land use plan for West Hayden Island (WHI). This process requires not only annexing and zoning the property, but also an assessment of natural resources, potential conflicting land uses, and marine industrial and recreational uses. WHI is approximately 800 acres and is the undeveloped western portion of Hayden Island, located in the Columbia River near the confluence with the Willamette River. WHI is owned by the Port of Portland, and was added to the region's urban growth boundary in 1983 for marine industrial purposes. It is both a potentially important economic resource and an important natural resource, containing undeveloped open space in a location with habitat value. WHI is designated as Marine Industrial Land on METRO's 2040 Growth Concept Map, and as a Regionally Significant Industrial Area on the Title 4 map in the Urban Growth Functional Plan. WHI is also identified by METRO as a high value riparian area and a Habitat of Concern in the regional inventory, and as a Moderate Habitat Conservation Area in Title 13.

1.2 PURPOSE

The WHI Economic Foundation Study will serve as a foundation study for the zoning and annexation of WHI and is intended to provide background information for the current planning process and future WHI studies. The objective of the study is to identify likely marine-related economic development opportunities and corresponding land needs over a planning period of the next 30 years. The land demand analysis will also inform the Economic Social, Environmental and Energy (ESEE) Analysis to be completed as part of the City land use plan for WHI.

This Economic Foundation Study provides information about marine-related industrial land needs relative to WHI and its surroundings over the next 30 years. A companion study, the Environmental Foundation Study, provides a detailed understanding of the condition, function, and value of WHI natural resources. A third recreation study describes recreation participation, development potential, and value on and around WHI. Together these studies provide information on the importance and potential contribution of WHI in three different land uses: habitat, marine-industrial use, and recreation. Collectively, the studies also provide information on potential compatibility and conflicts with multiple land uses on WHI.

1.2.1 WHI Public Planning Process

The City of Portland's Bureau of Planning and Sustainability (BPS) is leading a collaborative public process to evaluate alternative long-term uses for West Hayden Island (WHI). To help the City in determining future plan designations on West Hayden Island, the City has created a Community Working Group (CWG). This study is intended to provide information for the Community Working Group (CWG), which is tasked with advising the Portland City Council on "how marine industrial, habitat, and recreational uses might be reconciled on West Hayden Island (WHI); and if the CWG determines that a mix of uses is possible on WHI, to recommend a preferred concept plan."[6]

The CWG is made up of stakeholders with diverse backgrounds and interests in WHI land use. CWG members include representatives of local businesses and industries, non-profit organizations, surrounding neighborhoods, and staff with the City of Portland, Metro Region, and the Port of Portland. Reaching agreement on a planning framework for the site will allow planning, management and enhancement efforts to proceed. The City will coordinate this effort with planning work currently being done on the Columbia River Crossing (CRC) project and East Hayden Island.

1.3 SCOPE

Broadly, the scope of this work is to 1) assess the opportunities for marine-related economic growth in Portland Harbor, 2) estimate the land acreage and site characteristics necessary to accommodate this growth, 3) compare the available land supply to the land demand to identify marine industrial land shortages, and 4) identify the potential role of WHI and other sites in meeting projected land shortages. The scope of the analysis is marine-related uses, which includes both marine cargo and marine industrial uses. Marine cargo refers to activity and facilities related to the movement of waterborne cargo while marine industrial refers to industrial activity and facilities requiring waterborne transportation. Marine industrial activities may include manufacturing, vessel repair and construction, and rail yards at marine terminal sites.

In terms of geographic scope, the analysis is focused on Portland Harbor, with a limited review of the availability and relative suitability of alternative marine industrial land sites in the Lower Columbia River. The planning timeframe for the analysis is a 30-year horizon through 2040. Due to time and resource constraints, the scope of the analysis is based on existing data and readily available information.

1.4 LIMITATIONS

The study is intended to utilize the best available data to forecast the economic growth and associated land needs of marine industrial lands. To accomplish this scope of work within the allotted timeframe and resources, certain assumptions were necessary. Furthermore, the study is limited by the existing data and information collected from interviews, further data collection was not included in the scope of work. Summarized below are the key study assumptions used in the analysis as well as the data gaps that were identified.

1.4.1 Study Assumptions

This study is based on economic forecasts of marine cargo and marine industrial economic activity, including employment growth, land needs, and cargo tonnage. While based on the best available data, forecasts are derived using numerous assumptions which affect the certainty of the forecast. The certainty of marine industrial and marine cargo forecasts is also influenced by the fact that marine-related land uses require large sites of 60 to 100 acres. The development of one site can consequently dramatically alter the balance of available land supply and demand in the region, making projections of land need highly sensitive to assumptions regarding new market or growth opportunities.

The following assumptions were utilized to develop cargo and employment forecasts and associated land need forecasts:

[6] From the West Hayden Island Community Working Group Charter, March 17, 2009.

- Economic growth will resume in 2010, and employment and cargo growth will resume during that timeframe and will, on average, be positive through 2040.
- Portland will continue to invest in the road and rail infrastructure necessary for it to thrive and grow as a marine cargo port and marine industrial center.
- Current economic conditions and historical trends are a good indicator of future economic and trade growth and associated land needs.
- The proportion of land use and employment that is marine industrial will remain fairly constant into the future.
- Future marine-related development in Portland will be similar in size and site requirements to new marine-related developments at other west coast and Lower Columbia ports. In other words, current site requirements are a good indicator of future site requirements for marine-related uses, including acreage size requirement for a given cargo type and annual cargo throughput.

1.4.2 Data Gaps

The study is also limited to existing, readily available data. The following key data gaps were among those identified during the course of the study:

- Lack of comprehensive information on marine-related employment in Portland Harbor and an associated lack of comprehensive studies on the total economic contribution of marine-related uses in Portland Harbor.
- Lack of uniform, comprehensive data on the characteristics of marine-industrial sites at ports. This information is confidential or unpublished, with entities reluctant to share information publically.
- Limited detailed information on the operation and cost tradeoffs associated with infrastructure design and footprint size of marine terminal and marine industrial sites. Information of this nature is very limited as these tradeoffs are specific to a particular market, cargo, and tenant rather than widely applicable across uses.

To compensate for these data gaps, the study utilized interviews with the City of Portland, Portland Development Commission, Port of Portland, industry professionals, and other consultants to augment available, published information.

1.5 REPORT ORGANIZATION

Following this introduction, there are six additional sections to this report. **Section 2** addresses the economic history and contribution of Portland Harbor, including information regarding the economic impact of marine-related land uses. **Section 3** addresses economic trends that will affect the growth in marine cargo and marine industrial uses, and provides cargo and employment forecast through 2040. **Section 4** identifies the characteristics that make a site suitable for marine cargo and marine industrial land uses, while **Section 5** inventories the available lands in Portland Harbor to identify which sites may be suitable for marine related uses. **Section 6** concludes the study by drawing from all previous sections to identify the land need in Portland Harbor to meet forecasted growth in marine-related uses, and to identify the land availability and suitability in Portland Harbor, West Hayden Island, and other Lower Columbia River sites to meet this demand. References are provided in **Section 7**, while **Appendix A** provides data and analysis related to **Section 2.**

SECTION 2

Economic History and Contribution of Portland Harbor

The purpose of this section is to provide planning and policy context for the WHI decision process by describing the economic history and regional role of marine-related activities and land needs in Portland Harbor and surrounding areas. Furthermore, the section describes the economic contribution of marine-related uses to the regional economy. This section is intended to portray the broader economic context of marine-related uses and their regional importance.

2.1 OVERVIEW OF DATA SOURCES

Data sources for this section include general sources about the history of land uses in Portland Harbor prepared for and by the City of Portland, interviews with Portland Harbor businesses, geospatial data on lands uses in Portland Harbor provided by the City of Portland, as well as employment data. Additionally, the section on the economic contribution of Portland Harbor businesses and marine-related uses draws from a variety of existing economic impact studies that have been prepared for the City of Portland, the Port of Portland, and other regional entities. Finally, the section also utilizes information from other ports in the area to compare the characteristics of Portland Harbor to other Lower Columbia River ports.

2.2 ECONOMIC HISTORY AND REGIONAL ROLE OF PORTLAND HARBOR

From the late 19th century, Portland Harbor has been a leading west coast port due to its position on the confluence of the Willamette and Columbia Rivers, its multi-modal transportation infrastructure, and its proximity to areas producing substantial natural resources (primarily timber and grain) and associated finished products. From its earliest days, the majority of Portland's exports have been raw materials (agricultural products, lumber, metals, and potash while imports are more likely to be finished products (autos, consumer materials) for distribution throughout the northwest and Midwest. Today, Portland Harbor is a 40-foot deep-water port that includes the lower 12 miles of the Willamette River and two miles along the Columbia River. Located at the nexus of excellent rail infrastructure, the Olympic oil pipeline, two interstate freeways, the Columbia River deepwater shipping channel, and the Upper Columbia/Snake Rivers barge system, Portland Harbor has continued to serve as an important gateway for the movement of goods to and from businesses located in Oregon, southwest Washington, Idaho, and further afield. In addition to regional domestic trade, Portland serves as an international gateway, particularly with respect to Asian markets. At the turn of the 21st century, Portland has become a 'trans-shipment center', with more goods moving through Portland to national and international destinations than are consumed locally in the region.[7]

Discussed below are the key developments in the history of Portland over the past 140 years as a significant shipping location. These include steps to ensure regular dredging and the creation of public docks, as well as the continued development of additional lands for expanding maritime industries. Lands to the north of downtown were filled in during the 1920s to create the Guilds Lake and Swan Island industrial areas, while port lands continued to be expanded to the north through the 1970s with the development of the Rivergate

[7] City of Portland, Bureau of Transportation, 2006, Freight Master Plan.

area. Portland's continued expansion to the north was due in part to the larger size of ships but also was due to the large parcels of vacant land that were available in these areas. Portland's harbor continues to be a major economic engine in the region and has experienced substantial growth in the past 40 years.

2.2.1 Economic History

True to its name, Portland has become a major port for the west coast, eclipsing other ports along the Lower Columbia, and competing with Seattle and Tacoma in Washington and Oakland and Los Angeles/Long Beach for a portion of the global trade market. This summary provides a history of Portland Harbor, the reasons behind its growth, and the subsequent growth of the city.

The dependably deep shoreline along Portland's waterfront was preferred for ocean-going vessels over the harder-to-navigate shallow water area adjacent to Ross Island. In 1846, Captain John Couch moved his operations from Oregon City to Portland, helping to establish Portland as a port city, where the first harbor facilities were privately-owned docks in the area now known as Tom McCall Waterfront Park. When gold was discovered in California in 1848, the resultant building boom created a demand for lumber to be transported to San Francisco. Portland was ideally situated near the confluence of the Willamette and Columbia Rivers and had close access both to large stands of timber and nearby wheat farms. The dominant export from Portland, from the mid nineteenth century into the 1930s, was lumber and wood products, and the Columbia River, the fourth largest river in the United States, provided an east/west passage through the adjacent mountain ranges.

2.2.1.1 Further Development at the End of the 19th Century

In the 1880s OSN (now the Oregon Railway and Navigation Company OR&N) set up a freight terminal in Albina, connecting with the east coast in 1882 and to San Francisco in 1887. While the completion of these rail lines altered how goods were moved within the country, they also gave Portland strength as a transfer point between rail and shipping modes. Industry growth paralleled trade growth. With the availability of raw timber, saw mills sprouted on both sides of the Willamette, as did other industries using wood products. Companies making furniture, windows and doors, architectural features and crates grew from the area along the downtown waterfront south to the Brooklyn neighborhood and SW Fulton Street and north to Linnton and St. Johns.

2.2.1.2 Portland in the Early 20th Century

The Lewis and Clark Centennial Exposition in 1905 brought thousands of visitors to the area, many of whom decided to move to Portland. Portland's population more than doubled during the decade, reaching 207,214 by 1910. This influx of people, combined with the increased rail connections (ten lines served the Portland area), resulted in a surge of industrial growth in the trade and transportation sectors as well as manufacturing. This growth included creation of many woolen textile firms including Jantzen, Pendleton, and the Portland Woolen Mills in St. Johns. Other major new businesses included the Swift and Company meat packing plant near the Columbia River rail bridge, which employed 1,500 workers. Portland was considered the number one lumber shipping and manufacturing center in the world according to *Harper's Weekly* in 1913. The city also emerged as the nation's number one wheat port in the 1910s.

The end of the first decade also brought about changes that ultimately resulted in the establishment of the Portland Dock Commission, which was a part of City of Portland government. In 1909, Portland voters approved the sale of $500,000 in dock bonds to address neglect of private docks beginning to fall into disrepair. The mission of the Portland Dock Commission was to construct and maintain municipally-owned docks, leading to development of Terminal 1 along NW Front Street between 14th and 17th Avenues, featuring a 955-foot dock intended to receive overseas ships. Soon after, Terminal 2, a smaller terminal, opened at the foot of Washington Street on the east side, with a frontage of 525 feet. Meanwhile, the Federal Rivers and Harbors Act of 1912 granted the Port of Portland the responsibility for maintaining a channel depth of 35 feet in the Portland Harbor.

2.2.1.3 Growth after World War I

World War I created a surge in shipbuilding, as German U-boats were destroying cargo ships faster than they could be built. From 1917 through 1919, Portland shipyards launched 227 vessels, 96 of them steel ships. Shipyard employment climbed to 28,000 by the end of 1918. Ship building facilities ranged from the Northwest Steel Company at SW Sheridan Street, to the Grant-Smith-Porter yard in St. Johns.

The Portland Dock Commission continued to expand, constructing Terminal 3 in St. Johns with 540 feet of harbor frontage (later removed to make way for the St. Johns Bridge in 1931) and Terminal 4, along the north edge of St. Johns, completed in 1920. This terminal was the largest and most important of the municipal terminals with 3,035 feet of harbor frontage with three slips and five piers which could accommodate large shipments and storage of grain. Terminal 1 included a grain elevator, warehouses, additional covered and open storage, and bulk oil tanks. The completion of this terminal encouraged the growth of neighboring St. Johns, supported by development of a trolley line.

As of 1920, Portland's population had increased to 258,288, the 20th largest city in the US. The City of Portland continued to be a major manufacturing and shipping center. Also in 1920 Portland was the largest lumber manufacturing city in the world, and second in the shipping of wheat (which it became the leading shipper of by 1921) and wool. In addition, Portland was the largest flour manufacturing city on the Pacific Coast, the largest furniture manufacturer west of the Mississippi, and the largest livestock and meat packing center on the Pacific Coast. These industries contributed to the primary exports of lumber, wheat, flour, agricultural products, wool, livestock, meats, canned fruits, vegetables, and salmon.

The 1920s also brought a new mode of transportation to the Portland Harbor. In 1922, the Portland Dock Commission bought Swan Island, using the island to receive dredge spoils from the river and connecting it to the mainland. With this newly created land, the Port of Portland built the city's first airport in 1928, which operated as the City's airport until completion of a new airport at the current Columbia River site in 1941. During this time, the Portland Dock Commission also sent channel spoils to Guilds Lake (site of the Lewis & Clark Exposition) which opened this area for later industrial development.

2.2.1.4 The End of the Boom and the Depression Years

The end of the 1920s and the 1930s brought a general slowdown in activity and construction, though the City removed the aging docks and constructed a seawall in 1929. Reductions in the price of lumber and wheat were experienced in the 1920s and, along with the market crash, reduced exports and imports at many municipal ports. The longshoremen strike of 1934 and its ripple effect threw over 50,000 workers out of work, demonstrating the multiplier effect of maritime industries on the City. The Depression also brought Works Progress Administration (WPA) projects to the region, including construction of several major dams, including Bonneville. The resultant cheap power generated by these facilities would help encourage industries reliant on consistently inexpensive energy, such as aluminum smelters.

2.2.1.5 The Influence of World War II on Portland

In 1940, the Portland Dock Commission leased 80 acres north of Terminal 1 to the Oregon Shipbuilding Corporation for a shipyard and Swan Island was converted to a shipbuilding facility, where 147 T-2 tankers were constructed, creating opportunities for other metal industries. At its peak in 1943 and 1944, 140,000 workers were part of the metropolitan defense industries, including 92,000 employed by Henry Kaiser. Once war was declared, the War Department took over much of the operations of Terminal 4 and designated it as "The Portland Sub-Port of Embarkation." Civilian maritime shipping was shifted to Terminals 1 and 2. Eventually, Terminal 2 was taken out of the public maritime portfolio when it was leased to Columbia Industries to use in airplane parts manufacturing from 1942 to 1945.

The influx of jobs also attracted a large number of workers who came to settle in Portland, and also in the separate city of Vanport, on the north edge of Portland (current location of Portland International Raceway and Delta Park). Before being flooded in 1948, Vanport was Oregon's second largest city in population, with many of its residents involved in the shipbuilding industry. Portland's population reached 373,628 in the 1950 census. Portland's population would remain stagnant for the next three decades as the region's population growth shifted to the suburbs and unincorporated areas, with the 1980 census population of 366,383. But, similar to many urban areas in the country, the metropolitan Portland region did see a large increase in population growing from 501,000 in 1940 to 889,000 in 1989.

Much of the manufacturing base remained in Portland, and the influx of skilled workers helped many of the evolving manufacturers that specialized in construction materials, transportation equipment, machinery and tools. Many of these firms, such as Schnitzer Steel, Hyster, and Precision Castparts are familiar names today.

2.2.1.6 Post World War II and Shifts in Port Activity

After the war, Swan Island remained the only ship repair yard available on the west coast, establishing a marine construction and repair industry associated with the ship yard. The remainder of Swan Island was developed into an industrial park in 1957. The migration of docks and shipping activity continued to move downstream, as construction of many downtown bridges slowed boat traffic on the Willamette River. The removal of shipping facilities in the downtown area led to the Portland Dock Commission's decision to maintain the dredge channel only downstream from the Broadway Bridge. The Portland Dock Commission renovated Terminal 4 after its return from the War Department, funded through a $6.5 million bond measure in 1954. Between 1945 and 1955, imports increased from 40,594 tons to 227,139 tons, and exports increased from 141,219 tons to 854,281 tons. This compares to 1925 volumes of 577,211 tons of imports and 580,219 tons of exports. By 1957, Portland was the leading dry cargo port of the Pacific Coast.

2.2.1.7 Changes in Transportation Infrastructure

Just as Portland's position made it a logical crossroads for trade and for the growth of railroads in the 1800s it provided an ideal place for the intersection of major north/south and east/west roadways. This growth started with the development of the U.S. Highways, where Highway 99 became the major north/south highway between Vancouver, British Columbia and Los Angeles, California, and U.S. Highway 30 provided a convenient, low-elevation linkage between Astoria on the coast through Portland and into the heartland of Eastern Oregon and Washington, and many mountain states. The Interstate Highway system, begun in 1956 paralleled these routes with Interstate 5 following U.S. 99 and Interstate 80N (now Interstate 84) following U.S. 30 through the Columbia Gorge. These highways augmented existing railroads to help encourage the increase in container shipping that was to come.

Additionally, the dam building on the Columbia and Snake Rivers changed shipping patterns by facilitating development of the barge system that enabled river-borne transport of agricultural and wood products, metals, and other commodities from as far east as Lewistown, Idaho to Portland's marine terminal facilities. Growth in barge traffic has played a large role in riverfront development, marine transportation, and growth of agricultural production in the Columbia River watershed.

2.2.1.8 The 1960s and Port Expansion

This period brought the emergence of new goods that were shipped through Portland facilities as Portland began receiving imported cars. This development corresponded with the opening of a Portland Dock Commission office in Tokyo, Japan. By the mid 1960s, approximately 1,000 autos per month were handled through Portland Dock Commission terminals, including almost all Volkswagens destined for the Northwest. A 400-foot floating automobile dock was installed at Terminal 4, helping to make Portland the busiest auto import terminus in the Pacific Northwest. Portland's favorable rail connections, with good service throughout the Northwest and more transcontinental rail service than any other West Coast port, increased the attractiveness of Portland as an auto importer.

Seeking land for future public port facilities, as well as areas to place dredge material, 2,000 acres were purchased in 1965 near the confluence of the Willamette and Columbia Rivers (an area which would eventually increase to 3,000 acres with subsequent purchases). Mostly ranchland and other lowland floodplain, this area within unincorporated Multnomah County beyond the border of the St. Johns district and Terminal 4 would eventually become the Rivergate Industrial area.

2.2.1.9 Port of Portland

In addition to maintaining the Columbia and Willamette River navigation channels, the Port of Portland had assumed a greater role as a development agency since the acquisition of Swan Island as the City's first municipal airport. The Port of Portland was created in 1891, and had been unrelated to the Portland Dock Commission until in 1971 the Port of Portland acquired the assets and function of the Portland Dock Commission. The Oregon legislature amended the Port's charter to "promote the maritme, shipping, aviation, commercial and industrial interests of the Port." In 1973, the Oregon Legislature expanded the Port of Portland to serve Washington and Clackamas counties, in addition to Multnomah County.

2.2.1.10 Development of Rivergate Area

Development of the Rivergate area became the responsibility of the Port of Portland, which expanded terminal operations, taking advantage of the large amounts of vacant land and its ideal location on the lower Willamette and Columbia Rivers which provided better river access for the now-larger container ships. Portland continued to be a major exporter of wheat, and one of the first maritime developments approved, after land in the Rivergate area was filled, was a new grain terminal with a capacity of 40,000 tons held in eight 140-foot concrete silos, allowing the more efficient movement of larger volumes of wheat. At about the same time, the Port began working on Terminal 6 featuring three container cranes, direct rail service, a container distribution center, and two berths on 1,800 feet of berth space. The first port facility with Columbia River frontage, it was located along the Oregon Slough, next to the western tip of Hayden Island.

As much of this area was under Multnomah County's jurisdiction and not zoned for industrial use, the Port needed to work first with the County, and later the City to rezone and annex the land into the City of Portland. The properties were annexed in 1979 and re-zoned under a 1976 master plan. The land mass of the Rivergate area allowed inclusion of new maritime activities with designated sites for complementary industrial activities as well as environmental mitigation and wetlands preservation. The process of development at Rivergate differed significantly from the previous harbor development process where wetlands such as Guilds Lake and the area near Terminal 4 were indiscriminately filled. The Rivergate area was the first terminal area to be developed under recently passed environmental guidelines, preserving and—in-some cases—augmenting Kelly Point Park, Columbia Slough, and the Smith & Bybee Wetlands.

Terminals at Rivergate have been expanded several times in the past 30 years, including expansions to the elevator system at Terminal 5 and expansions in container facilities and auto handling capacity at Terminal 6. Rivergate also was laid out for other industrial uses, with many of the sites now being used by industries that complement the terminal activities including materials manufacturing such as steel, and several warehouse, distribution, and trucking companies.

2.2.2 Local Maritime Trends of the Last 20 Years

Unlike many mature cities, Portland's industrial base has shown steady growth over the past 20 years. Some of this growth may be due to the strong land use policies instigated by Metro and the City to ensure the preservation of industrial lands, allowing job growth in many industries, particularly electronic manufacturing, the construction trades, air transportation and wholesale trade.

Portland Harbor has kept much of its land in service for river industrial uses with some exceptions, such as the absorption of Terminal 1, just north of the Fremont Bridge and the area between it and the Steel Bridge, into the Central City—now making up the waterfront area for the new residential towers of the River District. This area was rezoned for housing as part of the Central City Plan in 1988, in order to allow Central City expansion and accelerate the housing development in the Central City and throughout the City, which are both regional growth management goals. In the early 1990s Portland adopted the goal that it would capture at least 20 percent of the region's growth. The dividing line at the Steel Bridge between the mixed use/higher density Central City and Portland Harbor Industrial districts was refined in the 2001 Guild's Lake Plan and the most recent Northwest District Plan. Other factors related to the conversion of Terminal 1 for mixed uses include the fact that the area did not have sufficient rail access for modern operations and was also located adjacent to Front Avenue, which prohibited expansion. In general, the absorption of Terminal 1 and the development of the Rivergate area highlight the overall trend of port facilities moving farther downstream on the Willamette River.

South of Downtown, much of the "South Waterfront" area has been rezoned for mixed use, and is being developed with condominiums and an expansion of medical facilities. The area still has Zidell Marine (a ship builder) and some other smaller industrial uses, but is undergoing transition, as was anticipated in the Central City Plan. Outside of the Central City, the area along the east bank of the Willamette River, between the University of Portland and the St. Johns Bridge is largely vacant, and some of the property has been purchased by the University of Portland.

However, most of the other harbor lands on the Willamette River between downtown and the confluence with the Columbia River have been preserved for industrial use. In the 1980s the City of Portland created industrial sanctuaries to encourage industrial growth and protect industrial districts from incompatible uses such as housing, high density uses, and high traffic uses. The Willamette Greenway Plan (1987) created this zone, better known as the River Industrial Zone.

Many of the older harbor industrial areas north of downtown house river-related industry. In 2000, a survey of businesses within Guild's Lake and Lower Albina areas revealed that 65 and 70 percent respectively of the river frontage is in river-dependent industrial use. The areas upland from these riverfront properties include two of Portland's four rail yards as well as a concentration of industrial uses that can supplement the river-dependent uses. The city anticipates that the tank farms will also be looking to expand their operations as new biofuels are anticipated. Overall, there have been $450 million of completed or funded capital investments made on 30 harbor area sites from 2004 to 2007. Many of these sites have river, rail and road access and use all three for portions of their activities. River-dependent industrial land (as defined in the river plan) along the Portland and Vancouver harbors has had an average absorption rate of 21 acres between 1960 and 1997. More recently, of the 232 acres that were vacant in 1990 and occupied by 1997 (including Port properties), 105 acres were developed as marine cargo uses, 43 acres as marine industrial, and 20 acres as marine infrastructure.

Marine cargo tonnage handled at Portland Harbor increased by 253 percent between 1960 and 2000, driven largely by growth in exports. Between 1985 and 2000, Portland captured an increased share of West Coast marine cargo in dry bulks, autos, and breakbulks. Portland, Seattle, and Tacoma had declining shares of West Coast container cargo between 1985 and 2000, as an increasing share concentrated at the Los Angeles and Long Beach harbors. However, since 2000, Los Angeles has been experiencing capacity problems causing movement in the harbor to suffer. Portland dominates cargo volume for the Columbia River deepwater seaports, handling 66 percent of the total marine cargo tonnage in 2000.

Although truck traffic has become the dominant mode for delivery of goods to and from Port facilities, proximity of rail has continued to influence modal choice. Rail is a major mode of transportation for ocean-bound cargo, handling 37 percent of all tonnage in the metro area, in 1997. Twenty-one percent is handled by barge, and 42 percent by truck. Rail tonnage increased by 1.8 percent annually in the decade from 1993 through 2003. Both truck and rail tonnage is expected to grow approximately 2.5 percent annually, while barge is expected to become a smaller percentage of overall tonnage with forecast annual growth of 0.29 percent.

If the trends continue into the future, it is anticipated the Portland will continue to increase its cargo volume. Since these marine terminals have a fairly large multiplier effect in job creation, expansion of the port would also expand opportunities for various other industries.

2.2.3 Portland Harbor and Other Lower Columbia River Ports

Other ports along the Lower Columbia also provide potential sites for marine cargo and marine industrial businesses. However, differences between these ports influence a business decision to locate at one port over another. This section contrasts the characteristics of the Port of Portland to the other Lower Columbia ports, including the Ports of Kalama, Longview, and Vancouver. The available land at these sites and the associated facilities and future plans for each port are also discussed to provide context for the relative availability and substitutability of land at different ports in the Lower Columbia River.

Interviews were conducted with several businesses within the Portland Harbor. The purpose of these interviews was to determine the importance of marine industrial developments to businesses now and in the future. In addition, these interviews were used to verify results from previous research. Businesses interviewed included an automotive import company, a rail service provider, liquid bulk company, dry bulk company, and a representative from a rail consulting firm.

Interview topics covered current operations, future plans, issues of future uncertainty, and site suitability requirements. Common themes from these interviews were the importance of intermodal connections, commercial trends, and possible constraints for future growth. For example, every person interviewed spoke to the importance of rail and the advantages of multiple rail service providers within Portland Harbor. Many noted that the presence of two rail service providers results in beneficial rates for harbor businesses.

2.2.3.1 Portland Harbor Distinguishing Features and Cargo Types Handled

The Lower Columbia River Ports at times work cooperatively to maintain the healthy transportation economy that serves the region, but at times also compete with one another to attract a new client or new service area. Through published research and personal interviews, the advantages and disadvantages of each of the ports in the Lower Columbia are described below in order to portray the degree to which available land at one port can substitute for available land at another port in the region. This analysis is intended to merely identify the potential for substituting land at one port for another, and should not be interpreted as an assessment of which ports would be most suitable for different kinds of marine industrial expansion. A wide variety of factors influence final decisions on where to locate industrial activities, including uncertain future national and international economic drivers, availability of funding, private negotiations, and public permitting processes. Still, an overview of the differences can provide foundational information for planning in the Portland Harbor.

In general, Portland is distinguished as being the most significant transportation hub on the Lower Columbia River. Portland is located at the nexus of two interstate freeways (Interstate-5 and Interstate-84), the confluence of the Willamette and Columbia Rivers, the intersection of the north-south and east-west Class I rail lines, and also has an international airport. Due to its proximity to Portland, the Port of Vancouver has easy access to this transportation system. While all of the Lower Columbia ports (with the exception of St. Helens) are located on or near Interstate-5 and are located near the north-south lines of both Class I rail lines, the Ports of Vancouver and Portland are thus differentiated in their level of access to truck, rail, and air transportation.

As summarized in **Table 2-1**, Portland is further differentiated in that it is the only port on the Lower Columbia River that handles large quantities of all types of cargo. In particularly, Portland is distinguished in that container traffic on the Columbia River is centered at the Port of Portland. This is due to the fact that many of the inbound and outbound containers either originate or are destined for locations in the Portland metropolitan area. The Ports of Vancouver and Portland are also the only ports on the Lower Columbia River that handle liquid bulk (primarily petroleum products) and automobile cargoes. Location in a metropolitan area is not only important for attracting these cargo types, but it is also important to attract marine industrial businesses. These businesses benefit from the access to a large, highly skilled labor force as well as proximity to local suppliers and buyers. Interviews with Portland Harbor businesses attest to the fact that the industry clusters in the Harbor are highly interrelated and contribute to the overall success of the area.

Portland is thus differentiated from other Lower Columbia Ports because it handles large volumes of all types of cargo. Additionally, Portland has a larger population of skilled labor and a larger local industrial base that can generate cluster benefits and additional opportunity for marine-related businesses, particularly marine industrial businesses. However, the benefits of being located in a major metropolitan area are also enjoyed by the Port of Vancouver. The benefits of a metropolitan location may not be as important for such cargoes as grain, dry bulks, and breakbulk, as evident in the fact that these cargoes are handled at nearly all Lower Columbia ports. Depending on the specific cargo, its handling requirements, and its local transportation modes, marine industrial land in Portland may be highly substitutable for marine industrial lands at other Lower Columbia ports. For other marine cargo and marine industrial uses, marine industrial land in the Portland metropolitan area (in Vancouver or Portland) may not be as easily substituted for lands elsewhere in the Lower Columbia.

While locational considerations make lands in Portland more desirable for certain marine-related uses, other ports appear to be less land constrained and have less contamination. The Port of Portland has three sites available: the Suttle Road Site at Terminal 6 has approximately 30 acres available which could be suitable for expansion of the automobile terminal, the T-4 Pier 1 site is approximately 35 acres and could be suitable for liquid bulks or local/regional dry bulk use, while the 6.5 acres located at the upstream end of Toyota at Terminal 4 could be used to expand the Toyota facility. As summarized in **Table 2-1**, Portland has no large, shovel-ready sites, while several other ports do have such lands available. Furthermore, known contamination of in-water and upland areas is limited at other ports, while Portland Harbor is listed as a superfund site due to in-water contamination and many upland areas surrounding the harbor have suspected contamination. This contamination carries significant costs in terms of potential future liability as well as development costs that may deter marine-related use.

Table 2-1 Land and Cargo Characteristics of Lower Columbia River Ports

Characteristic	Port of Kalama	Port of Longview	Port of Vancouver	Port of St. Helens	Port of Portland
Cargo Handled					
Containers	No	No	Yes (Very Limited)	No	Yes
Automobiles	No	No	Yes	No	Yes
Breakbulk	Yes	Yes	Yes	No	Yes
Grain	Yes	Yes	Yes	No	Yes
Dry bulk	No	Yes	Yes	Yes	Yes
Liquid bulk	No	No	Yes	No	Yes
Land Availability					
Total shovel ready acreage over 100 acres	Yes	No	Yes	Yes	No
Shovel ready contiguous sites over 50 acres	1	0	3	1	0
Access to adjacent additional/undeveloped land	Yes	No	Yes	Yes	Yes
Undeveloped sites greater than 100 acres	No	No	1	1	1
Contamination					
Contaminated sites	No	Limited (on private land not port property)	Limited (groundwater contamination on acquired site)	Limited (1 site has some contamination from previous owner)	Yes (Portland Harbor Superfund Site, Upland Contamination on Private lands)

2.3 ECONOMIC CONTRIBUTION AND VALUE OF MARINE-RELATED USES

As described above, economic development of the City of Portland and the region as a whole has always been closely linked with marine-related industry in Portland Harbor. The degree to which marine-related uses currently contribute to the regional economy (defined as the four-county area of Clackamas, Multnomah, Washington, and Clark County) can be analyzed using two related factors:

1. **Number and strength of the linkages between marine-related economic sectors and other economic sectors in the regional economy.** Linkages can be based on purchase of inputs for the marine-related sector (goods and services produced by other sectors) and purchase of outputs from the marine-related sectors (goods and services required by other sectors). The more numerous the industries connected to the marine-related uses, and the stronger the linkages and interdependencies, the greater the economic importance of the marine-related uses in the regional economy.
2. **Job and income impact of marine-related economic activity.** The relative size of employment and income in the marine-related economic sectors as well as the size of employment and income in closely related sectors dependent on marine-related uses indicates the overall economic importance of marine related uses.

This section discusses the existing studies and data that provide information on the degree of economic dependency and importance of marine-related uses in Portland. Although there are numerous existing studies to draw from, and several that estimate employment and income in marine-related industries, data gaps prevent full quantification of the total economic contribution in terms of jobs and income in sectors closely linked to marine-related uses. Given these data gaps, the intent of the section is to characterize the linkages between marine-related uses and other economic sectors in Portland to give a sense of the potential total jobs and income contribution of marine-related activity in all sectors.

2.3.1 Overview of Economic Links

Marine-related industrial and marine cargo uses are linked to a great number of other industrial activities within Portland and the region. Marine industrial uses are situated on the river in order to utilize water transportation for import or export of their primary or finished goods. These marine industries are linked to other industries located in Portland Harbor and elsewhere in the region, including wholesale trade, local and regional transportation firms, manufacturing firms, and retail firms. Marine cargo terminals handle and transport freight that is vital to numerous other industries located throughout Oregon, Southwest Washington, and beyond. These businesses depend on the transportation hub at Portland Harbor either for transport of their products to international or regional markets (such as grain, steel, or minerals), or for the provision of inputs of the wide variety of freight materials imported through Portland Harbor, whether petroleum, consumer apparel, automobiles, or raw materials.

To identify these links, this section first discusses the primary marine-related sectors operating in Portland Harbor, including water transportation, warehousing and wholesale trade, metals manufacturing, and transportation equipment firms. The related, linked industries that are associated with these industries are then discussed. As a starting point, this analysis assesses the economic sectors that are linked with water transportation activities, as an indicator of which sectors depend on water-borne transportation provided by Portland Harbor. Following the linkages further, we find that all sectors in the Portland metro area and beyond are linked in some way to sectors that rely on water transportation. The challenge is to identify those industries that are most dependent on water transportation, and gain a sense of their economic importance in the region. This analysis is intended to verify and expand the body of economic impact research on the economic importance of marine-related uses in the Portland Harbor to help inform the question of how the annexation of West Hayden Island for marine industrial uses could help sustain a healthy future economy for the City.

There are some 1.3 million jobs across a range of industries in the Portland Metropolitan region, which are explored more fully in section 3 of this report. This section of the report reviews the activities of the Portland Harbor, and the Transport by Water industry within the harbor. This overview is intended to provide the context of the harbor-related activities within the region and the linkages of that activity to the rest of the region's economy.

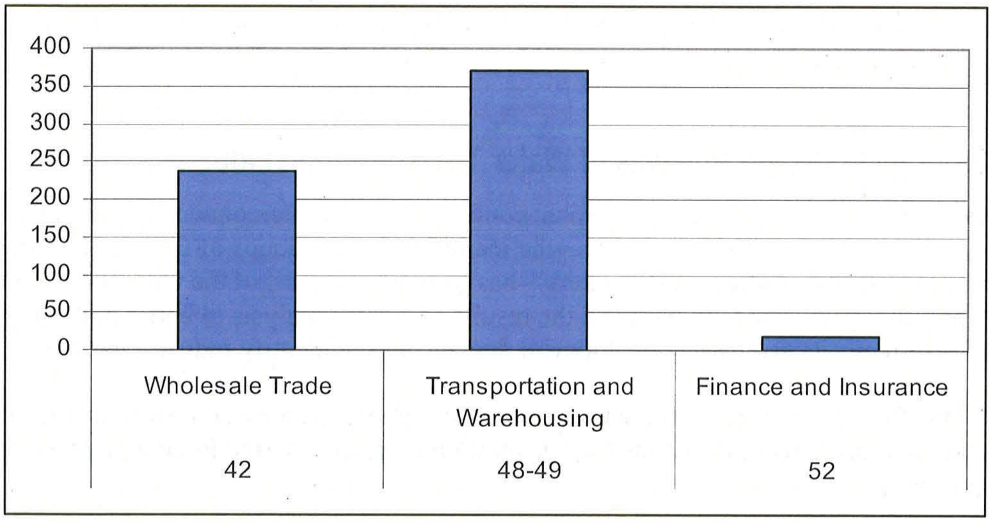
2.3.1.1 Primary Sectors & Clusters Dependent on Marine Transportation

Employment by industry in Portland Harbor is analyzed using geospatial data provided by the City of Portland on 993 parcels totaling 5,979 acres. This data is from the City's Working Harbor analysis conducted in 2004; the working harbor geography is the same as the Portland Harbor geography. Employment data from the 2008 Quarterly Census of Employment and Wages is available for 481 parcels (4,334 acres), with an estimated 35,000 jobs. Excluding parcels designated as residential uses, there are 5,953 acres in 897 parcels in the Portland Harbor. Among these, 117 parcels are designated as river-dependent, rail-dependent, or both river- and rail-dependent. These lands comprise just over one-half of the total land area, and account for just under 24 percent of the area's estimated 35,000 employees. As employment data were not available for all parcels, the analysis is limited to those parcels for which complete data were available.

River dependent uses are defined in the *Portland Zoning Code* as "a use which can be carried out only on, in, or adjacent to a river because it requires access to the river for waterborne transportation or recreation." River dependent uses were classified by the City, and were further divided for this study into marine cargo and marine industrial uses based on ownership and existing use of the site. There are 46 parcels identified by the

City as river-dependent, which aggregate to a total of 1,787 acres. Of the 46 river-dependent parcels, there are 28 with available employment data. Data for these parcels indicate 2,707 employees in river-dependent uses, of whom approximately 76 percent (2,067 employees) are employed in marine industrial uses with the remaining 24 percent (640 employees) employed in marine cargo uses. **Figures 2-1** and **2-2** display the employment distribution and the job categories for parcels designated as marine cargo.

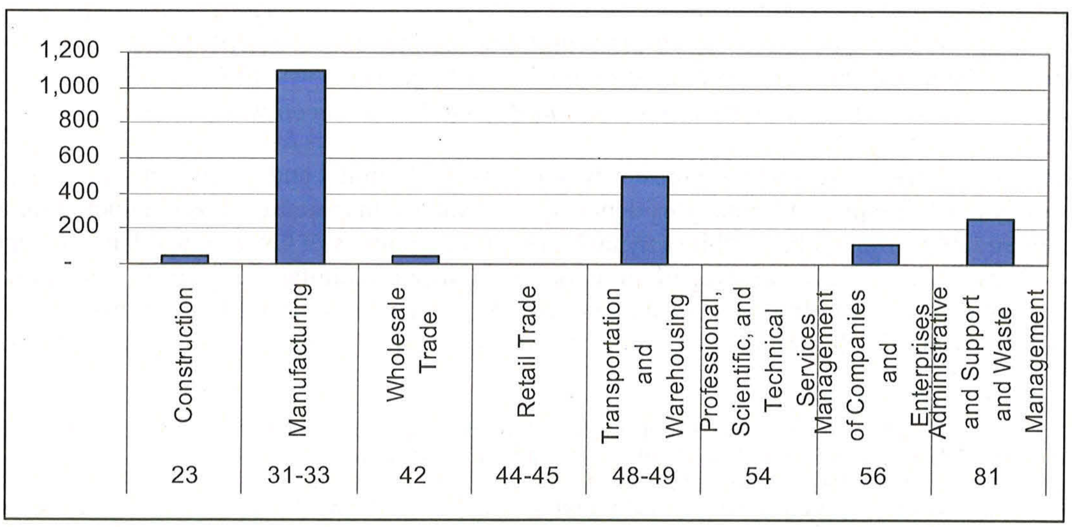
As would be expected, jobs on parcels classified as marine cargo are mostly in the wholesale trade and transportation and warehousing categories. Employment classification on marine industrial land uses is much more diverse. Of the 755 acres of marine industrial land, employment data are available for 542 acres that provide employment for 2,067 workers across a range of industries. Over half of these employees (1,098 jobs) are classified as working in Manufacturing, another 504 jobs in Transportation and Warehousing, and the remainder classified as a range of service, and construction jobs.



Note: Excludes parcels for which no employment data were available.

Source: Oregon Employment Division, 2008 Quarterly Census of Employment and Wages, City of Portland GIS, merged by ENTRIX, and tabulated by Bonnie Gee Yosick LLC.

Figure 2-1 Employment Distribution for Parcels Classified as Marine Cargo



Note: Excludes parcels for which no employment data were available.

Source: Oregon Employment Division, 2008 Quarterly Census of Employment and Wages, City of Portland GIS, merged by ENTRIX, and tabulated by Bonnie Gee Yosick LLC.

Figure 2-2 Category of Jobs for Parcels Classified as Marine Industrial

For the 1,524 acres of land designated as river-dependent for which employment data area available, there are an estimated 2,700 employees across a range of industries. Over one-third are classified as transportation equipment manufacturing.

According to the employment data from the 2008 Quarterly Census of Employment and Wages, over one-third of the employment on the rail-dependent parcels is in the railroad rolling stock manufacturing industry, most likely Oregon Iron Works. The economic impact of these 1,009 jobs in the railroad rolling stock manufacturing sector is quantified later in this report, as is the economic impact of the Transport by Water industry.

Within the context of the Portland Metropolitan region, these harbor jobs represent a small fraction of total employment within the region, but they are intricately linked to the overall economic activity of the region. As has been noted in numerous other reports, the region's economy is heavily dependent on the traded sectors, and all forms of transportation are integral to sustaining these economic sectors. Some of the connections are explored below.

2.3.1.1.1 Cluster and Linkage Analysis of Water Transportation Industry

Industry clusters are generally defined as geographic concentrations of interconnected companies and institutions in a particular field. Cluster analysis—the identification of groups of firms or industry sectors that share similar suppliers, skills, markets, and workers—has been used as part of the City of Portland economic development efforts for years. The City has used the results of cluster analysis to better understand the regional economy, to focus its economic development agenda, and to identify industry partners.

Cluster efforts typically analyze various traded sectors. According to a paper on how to include economic impact information into investment decisions for transportation projects by the Economic Development Research Group (2008),[8]

> *The traded industries serve as a primary generator of wealth by producing more than can be consumed locally. However, from a transportation perspective, traded industries are important because their products are traded and hence depend on long-distance transportation connections to customers in national or international markets. As a result, any major reduction in access to customers outside the region can have serious implications for many traded industries (and therefore the broader economy). Thus, transportation's support for traded industries not only enables those industries to generate wealth for the region, but transportation becomes an important determinant of their future economic prospects.*

There are several industry clusters that are most reliant on marine terminal and harbor activities. A cluster and linkage analysis of five primary industries dependent on water transportation was conducted for a four-county area, including Multnomah, Washington, and Clackamas counties in Oregon, and Clark County in Washington. These industries are handling of automobiles, transport manufacturing (including barge manufacturing companies), handling of steel slab, petroleum, and paper and cartons. The analysis uses the IMPLAN[9] 2007 dataset. In addition to being one of the most commonly used tools in economic impact

[8] Economic Development Research Group, Inc. 2008. Use of Freight and Business Impact Criteria for Evaluating Transportation Investments, Executive Summary. Prepared for the Portland Business Alliance and Port of Portland, Available at www.portofportland.com/.../Trade_Trans_Studies_EDR_ExecSmry.pdf.

[9] IMPLAN is a static equilibrium input-output model first developed in 1979 by the U.S. Forest Service in cooperation with the Federal Emergency Management Agency and the U.S. Bureau of Land Management to assist the Forest Service in land and resource planning and management. The program has been updated and improved over subsequent years and is now one of the most commonly-used economic modeling tools for measuring the economic impacts of development projects.

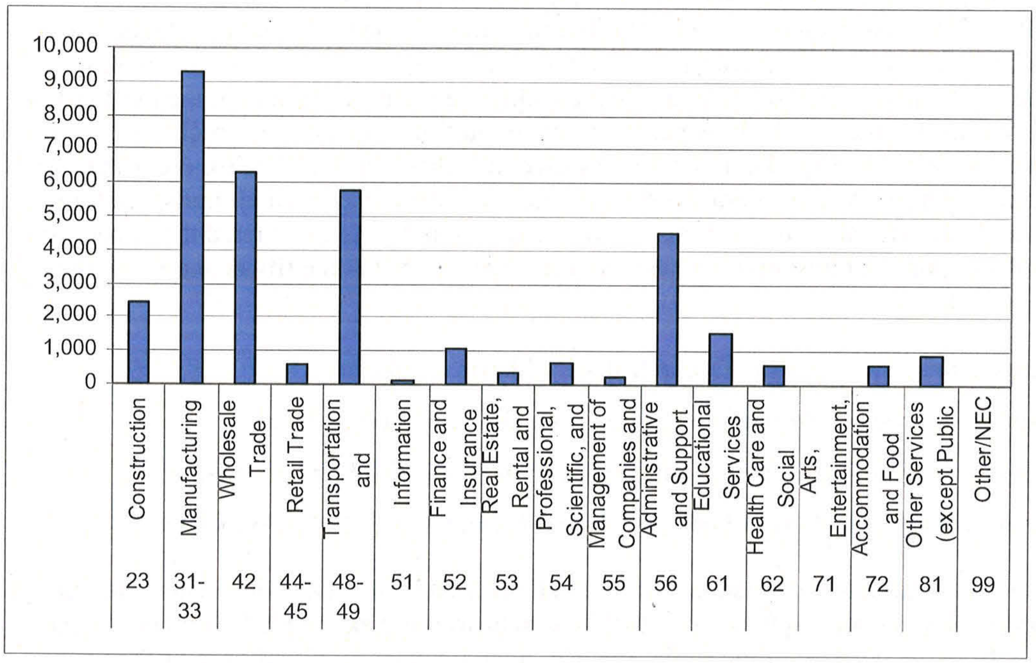
analysis; IMPLAN is also frequently used for cluster analysis, by examining the relationships of industries to their buyers and suppliers. The structure of the model mimics the monetary transactions for consumption within an economy, allowing a detailed examination of the effects of transactions between businesses and between businesses and final consumers.

Findings from the cluster analysis indicate that employees in these water transportation-dependent sectors have higher than average employee compensation. All of these sectors are also strongly linked with other manufacturers as well as wholesale trade, indicating the importance of trade and movement of goods to these industries. Detailed findings from the analysis are provided in **Appendix A**.

2.3.1.2 Other Sectors & Clusters Dependent on Multi-Modal Transportation

In addition to the industries analyzed above, there are other industries not strictly defined as marine dependent which benefit from the multi-modal transport available in the harbor. These industries, indirectly supported by the marine transport, might not locate in the harbor were it not for the combined multi-modal transport.

The industries with the greatest employment in the Portland Harbor include Manufacturing, Wholesale Trade, Transportation and Warehousing, Administrative and Support Services, and Construction. The distribution of employment provided by the Quarterly Census of Employment and Wages is shown in **Figure 2-3** below. Industries are shown by 2-digit NAICS code (for example, construction is NAICS sector 23).



Note: Excludes parcels for which no employment data were available.

Source: Oregon Employment Division, 2008 Quarterly Census of Employment and Wages, City of Portland GIS, merged by ENTRIX, and tabulated by Bonnie Gee Yosick LLC.

Figure 2-3 Employment Distribution by Sector in Portland Harbor

2.3.2 Regional Jobs and Income Impacts

Regional economic impact studies analyze how one or more sectors of an economic system ripple through a larger economy due to the interconnectedness of economic activity such as water transportation. Economic activity within the sector that is the focus of the study is called a direct effect. The economic 'ripple' that occurs when the economic activity within the study sector (i.e., water transportation) increases demand in related economic sectors that either supply inputs to water transportation or utilize water transportation outputs is called the indirect effect. Another effect typically reported in impact studies is the induced effect that occurs when the change in economic activity affects incomes to workers and proprietors, which then increases their household spending, thus stimulating economic activity in retail, real estate, and other consumer-related sectors.

As described above, water transportation is an integral component to many industries located in the Portland Harbor. These water-dependent industries are then linked to other industries in the harbor and elsewhere throughout the metro region. This section describes existing economic impact studies as well as new analysis conducted for this study that quantifies elements of the economic activity supported by marine transportation. These studies were conducted for a range of purposes, and most limit their analysis to parts of single industries. None of the analyses attempt to quantify the overall economic impacts of the harbor activities. Similarly, the objective of this current assignment is to provide context for the many inter-related industries functioning in the harbor, rather than attempt to provide an overall analysis of economic impact from harbor-related activities.

2.3.2.1 Previous Studies

The impacts of Portland Harbor on the regional economy have been studied at different geographic scales focusing on different industry sectors. Previous studies have focused on the impact of Portland Harbor industry activity in the Portland economy for a number of different purposes including industrial land use planning. Other studies have focused on water transportation and marine terminal activity in an attempt to isolate the benefits of the harbor itself. Still other studies have addressed the idea that one of the most critical economic benefits of the harbor facilities is that it is part of a linked multimodal water/rail/truck transportation system that collectively attracts commerce. As such, it is difficult to isolate (or credit) any one element of that transportation system with economic results because it is the presence of all transportation modes that serves to attract economic activity. For this reason, some research has considered the impacts of industries that are dependent upon the transportation system. Previous efforts to quantify economic impact related to Portland Harbor include:

- A 2003 economic impact analysis of distribution industry by Martin Associates
- A 2003 economic impact analysis of Portland Harbor by E.D. Hovee & Company; and
- A 2003 economic impact analysis of Portland Harbor freight rail by Cambridge Systematics
- A 2007 economic impact analysis of Port of Portland Marine Terminals by Martin Associates

Approaches for this previous research have varied both in methodology and data. Data differences include differences in source, geographic scope, and the degree to which industries are aggregated. Methodological differences tend to follow from the purpose of the study, the way interdependence of harbor industries is handled, and the level of economic impact estimated (e.g. jobs, gross revenues, direct and indirect impacts, etc.). These studies are discussed below and then summarized in **Table 2-3**.

2003 Study of the Economic Impacts of Distribution Industry

One economic impact study was completed in 2003 by Martin Associates and estimates the economic impacts of the distribution industry on the Portland regional economy.[10] The research is based on 67 interviews with local business leaders within the Portland Harbor distribution industry including wholesale trade, warehousing, and transportation sectors. This information is then analyzed in an input-output model called

[10] Martin Associates, 2003, 'The Economic Impacts of the Value Added Regional Distribution Industry in the Portland area.'

IMPLAN. This study defines the Portland region as the counties of Clackamas, Clark, Multnomah, and Washington (p. 2). Impacts estimated include direct, indirect, and induced jobs and income, as well as state/local taxes (see **Table 2-2**).

Table 2-2 Economic Impacts of Value Added Distribution Industry on Portland Regional Economy

	Economic Impact
Jobs	17,242
Direct	7,864
Induced	4,283
Indirect	5,095
Personal Income	$809,811
Direct	$278,287
Induced	$363,723
Indirect	$167,801
State/Local Taxes	$88,600
State Taxes	$60,300
County/Local Taxes	$21,000
Tri-Met Tax	$7,300

Note: Dollars in Thousands
Table Source: Martin Associates, 2003.

2003 Bureau of Planning Study of the Economic Impacts of Portland Harbor

In 2003, the Portland Bureau of Planning[11] and E.D. Hovee & Company[12] completed the Portland Harbor Industrial Lands Study. Based on the five-county region of Clackamas, Columbia, Multnomah, Washington, and Yamhill Counties (Portland Metropolitan Statistical Area, or Portland MSA), this study uses multipliers estimated by the Bureau of Economic Analysis through the Regional Input-Output Modeling System to find that the harbor is responsible for one in eight regional jobs in 2000 accounting for almost 100,000 jobs in the metro area with a payroll of $3.5 billion. At the water transportation level, employment grew 1.6 percent annually between 1980 and 2000. Over that same time period, the Portland MSA share of total national water transportation employment increased from 0.76 percent to 1.11 percent, a substantial shift. Additionally, the report indicates the water transportation industry employee earnings are 43 percent higher than the average employee earnings for all sectors in Multnomah County in 2000. At the transportation industry level, the report finds that every transportation employee in the harbor study area results in 2.4 jobs in the Portland MSA totaling 15,341 jobs (direct, indirect, and induced job impacts) with a payroll of $459.1 million.

2003 Study of the Economic Impacts of Portland Harbor Freight Rail

A study by Cambridge Systematics, titled *The Freight Rail and the Oregon Economy Study* reports that of the 10.5 million tons ($11.2 billion in value) that were shipped to or from the Port of Portland in 2002, fully 6.2 million or 59 percent arrived or departed by rail. The majority of these tons, 5.7 million, were loaded onto

11 Portland Bureau of Planning. 2003. Portland Harbor Industrial Lands Study Part One: Inventories, Trends and Geographic Context.
12 E.D. Hovee & Company. 2003. Portland Harbor Industrial Lands Study Part Two: Interviews and Analysis.

ocean going vessels and approximately 530,000 tons of rail shipments were loaded from marine vessels onto trains. If a similar percent of the of 1997 marine terminal tonnage (59 percent of 10.8 million tons in 1997) were assumed to have been moved by rail, this calculation would represent 6.35 million tons. When matched with the statewide volume of 55.2 million tons of rail moved in 1997, this volume suggests that roughly 11.5 percent of all rail movement in the state also moved by water through Portland Harbor. The study also found that Multnomah County, the location of the Port of Portland, ships 41 percent of all rail tonnage in the state and receives 69 percent of all rail tonnage, further strengthening the fact that transportation connectivity is a driver of economic activity.

With the connectivity between rail and water transportation in mind, the impacts from industries that are rail dependent are further examined. The study by Cambridge Systematics analyzes the Commodity Flow database to identify top commodities (ranked by weight) originating and terminating in the Portland Metropolitan region, focusing attention on the movement of specific commodities, including mineral bulks, grains, automobiles, containers, and breakbulk cargo. The study further analyzes USDOT data on estimated rail expenditures by industry group for the Portland Metro region and the state as a whole, noting that the lumber, wood, and paper product industry spent $159 million on rail service in 2002. With annual output of $2.9 billion, this industry supported 12,000 jobs. In addition, the second largest purchaser of rail service, the transportation equipment industry, spent $106 million on rail service. This industry produces $4.9 billion and supported a total of 11,200 jobs in 2002. The wholesale trade industry was found to spend $49 million on rail service and the industry's output was $15.2 billion which supported 55,600 jobs. The primary metals industry also spent a large amount of funds on rail, approximately $30 million in 2002. This industry's output was $1.4 billion and it supported 7,700 jobs. The chemical industry was the fifth largest purchaser of rail freight and spent approximately $13 million on rail, which supported an industry output of $777 million and 2,358 jobs.

2007 Study of the Economic Impacts of Port of Portland Marine Terminals

A later study also by Martin Associates focuses on the Port of Portland. Titled the *Local and Regional Economic Impacts of the Port of Portland*,[13] the study estimates the regional economic impacts generated by the cargo and vessel activity at marine terminals in Portland Harbor. The results suggest economic impacts of nearly $996 million and 6,568 jobs as a direct result of the Portland Harbor through public and private terminal activity in 2006. The analysis further estimates an average salary of $47,760 for the jobs directly attributable to marine terminal activity, nearly $996 million in business revenue, $1.4 billion in personal wage and salary income and local consumption expenditures, and nearly $146 million in state and local tax revenue. Including direct, indirect, and induced jobs, the study estimates total employment attributable to marine terminal activity at 19,036 jobs. This analysis was based on a survey of 295 employers with operations in Portland Harbor, and publicly-available data from the Census Bureau. The analysis also disaggregates employment impact by geography of residence and by type of commodity handled.

The analysis categorized the impact into five broad categories:

- Surface transportation;
- Maritime services;
- Port of Portland;
- Banking/Insurance/Law; and
- Shippers/Consignees.

[13] Martin Associates. 2007. The Local and Regional Economic Impacts of the Port of Portland, 2006.

Surface transportation is further divided into rail and truck, while the maritime services category is disaggregated into terminals, International Longshore and Warehouse Union (ILWU), towing, pilots, agents, surveyors/chandlers/maritime services, forwarders, warehouse & container repair, government, maritime equipment/construction, and barge. The information below summarizes findings from this report by cargo type handled by marine terminals. The Transport by Water industry analyzed corresponds roughly to the Terminals subcategory within Maritime Services in the Martin analysis. Other categories in the Martin analysis correspond to other industry sectors. As noted in the Martin report, some jobs cannot be accurately attributed to a particular commodity or industry.

- **Containers** -- In 2006, 1.5 million short tons of containerized cargo, or about 123,000 containers were moved on vessels calling the Port of Portland, creating 846 direct jobs. All containerized cargo was handled by Port of Portland facilities, the majority via Terminal 6. Three hundred one jobs were created in the local trucking industry. In addition to the truck impact, other key employment categories include members of the ILWU (173 full-time equivalent workers) and 180 jobs with warehouse and container repair firms. There are also 115 jobs with freight forwarders/customhouse brokers booking the freight and clearing imports through U.S. customs.
- **Breakbulk** -About 76,000 tons of breakbulk cargo moved via the Port of Portland terminals in 2006, creating 75 direct jobs, the majority of which are with members of the ILWU.
- **Soda Ash** -- 2.4 million tons of soda ash exports originate in Wyoming, arriving via unit train directly to the bulk loading facility. A total of 131 direct jobs were generated by this export move. The majority of these jobs are held by ILWU and rail employees.
- **Grain** -- The majority of the 6.4 million tons of grain exported via the Portland Harbor consists of wheat originating in Oregon, Washington and the Dakotas. Three elevators move this grain, two of which are private terminals, while the third elevator is located on Port of Portland property. About 60 percent of the grain is exported via the grain elevator leased from the Port of Portland. About 60 percent of the 840 direct jobs are with the railroads moving the grain.
- **Potash** -- The 1.9 million tons of potash exported from the Port of Portland facilities, creating 94 direct jobs, are primarily with ILWU and the railroads moving the potash from Canada.
- **Dry Bulk** -- Dry bulk commodities consist of cement, limestone, fertilizer, and sand and gravel. Nearly 4 million tons of dry bulk cargoes move via barge in the Portland Harbor and support 943 direct jobs with local truckers, terminal operations and barge operations.
- **Liquid Bulk** -- In 2006, 99,000 tons of other liquid bulk cargoes such as fertilizers and food oil moved via the Portland Harbor. These cargoes supported 47 direct jobs, primarily with local terminal operators and trucking firms
- **Autos** -- The Port of Portland is the leading automobile import port in the Pacific Northwest. In calendar year 2006, the Portland auto facilities handled 464,000 import and export automobiles. The handling of automobiles generated 796 direct jobs, of which 44 percent are with terminal operators and automobile processing facilities. About 30 percent of the direct jobs are in the surface transportation sector, and about 57 percent of the surface transportation sector jobs generated by the transport of automobiles are with the trucking firms, and the balance by rail. The movement of automobiles generates 161 full time jobs for the ILWU.
- **Iron and Steel** -- The 836,000 tons of steel slab imports and 148,000 tons of steel via the public marine terminals generated 727 direct jobs. These jobs are primarily associated with the receipt of slab, and the employees of the local steel mill importing the slab. The majority of this cargo is trucked to the local mill or to direct importers
- **Petroleum** -- About 5.8 million tons of petroleum products moved to and from the private terminals along the Columbia River System. The 5.8 million tons of petroleum generated 562 direct jobs, of which

60 percent is with local truck distribution from the river terminals handling the products. Other key job impacts are with barge operations distributing the petroleum products up-river, as well as bunkering activity.

- **Forest Products** -- The 214,000 tons of cartons and paper moved in the Portland Harbor by barge, creating 191 direct jobs, the majority with the local importer and distribution firms.

This analysis is the best estimate of the impact of economic activities occurring within Portland Harbor. However, the analysis is limited to cargo and marine-related activity, and does not include the marine-related industrial activity described in the previous section.

Summary of Previous Studies of Economic Impact

Even with their methodological differences, and differences in scope, findings from these previous analyses can inform this effort, including:

- The Portland Harbor is linked to a range of industries, particularly wholesale trade, transportation and warehousing, and other forms of transport.
- The multipliers result in higher numbers of jobs and output linked to the river than just direct jobs
- The movement of goods link the various transport-related industries (Transport by Rail, Transport by Water, Transport by Air, and Transport by Truck)

An overview of the different studies that have been completed including the different geographies, different approaches, and different purposes, is provided in **Table 2-3** below.

Table 2-3 Summary of Studies of Impacts of Portland Harbor Industry on Portland Metro Area

			Portland Metro Area Impacts				Portland Metro Area (Counties)					
Study	Industries	Study Area of Industries	Direct Jobs	Total Job	Total Earnings	Model	Clackamas	Clark	Multnomah	Skamania	Washington	Yamhill
Martin Associates, 2003	Wholesale Trade, Transportation, and Warehousing	Entire Portland metro region	7,864	17,242	$809,811	Implan	X	X	X		X	
Portland Bureau of Planning, 2003	Transportation	Harbor, Industrial Districts downstream of the Steel Bridge	6,460	15,341	$495,100	RIMSII	X	X	X		X	X
Portland Bureau of Planning, 2003	All Industry	Harbor, Industrial Districts downstream of the Steel Bridge	34,272	99,783	$3,510,000	RIMSII	X	X	X		X	X
Cambridge Systematics, Inc.	Freight Rail	Portland Metro, Freight Rail Dependent Industries		88,850	$355,000 Rail, $11,200,000 total	N/A	X		X	X	X	X
Martin Associates, 2007	Transportation, Marine Services, Banking, Government, Marine Construction	Portland Harbor	6,568	19,036	$1,426,777	Excel	X	X	X	X	X	

Note: Dollars in Thousands

2.3.2.2 Estimates of Impact of Marine-Related Uses in Portland Harbor

As noted above, the 2007 Martin Associates study presents the most comprehensive estimate of the impact of marine-related economic activities occurring within Portland Harbor. However, the analysis underestimates total economic impacts, as it is limited to cargo and marine-related activity and does not include the direct or total economic contribution of marine industrial activity. The 2003 Bureau of Planning study estimated the economic impact of all industry within the Portland Harbor, which likely results in an overestimate of the impact of marine-related uses, since not all harbor area industries depend on marine transportation. The total regional economic impacts of marine-related uses are thus estimated to range between the values from these two studies: total (direct, indirect and induced) employment is estimated to range from 19,000 to 100,000 jobs, while total income generated from these jobs is estimated to range from $1.4 billion to $3.5 billion annually.

Transport by Water

One critical component of marine-related activity is the Transport by Water industry, which enables and enhances the other terminal and marine-related industrial activities. This section of the analysis explores in more detail the economic impact of the Transport by Water industry. With only 834 direct employees, it accounts for less than 13 percent of the direct employees attributed to marine terminal activity in the Martin report. As such, it is important to note that the Transport by Water industry is but one small component of the employment and economic activity in the Portland Harbor.

Using a 2007 data set specific to the four-county Portland Metro region, an analysis using IMPLAN indicates that Transport by Water has 834 direct employees and approximately $540 million in output (see **Table 2-4**). This estimate is comparable—though slightly less than—the 976 employees estimated in terminal employment in maritime services from the Martin study.

Table 2-4 Economic Impact of Transport by Water Industry, 2007

	Direct	Indirect	Induced	Total
Output	$540,000,000	$247,709,000	$116,976,000	$904,685,000
Employment	830	2,020	1,010	3,860
Employee Compensation	$77,747,000	$89,809,000	$35,104,000	$202,660,000
Average Compensation per Employee	$93,200	$44,600	$34,700	$52,500

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

The estimated $540 million in direct economic output generates an additional nearly $248 million in indirect output and nearly $117 million in induced output for a total estimated economic output of nearly $905 million from transport by water.

The direct employment of 834 jobs and $540 million output in the Transport by Water industry supports over 2,010 indirect employees in a range of related industries, and another 1,010 employees from induced spending for a total impact of 3,860 jobs. Again, the Martin analysis estimated 976 in terminal employment in maritime services in 2006, but did not disaggregate the output and personal income impacts of those terminal employees from the total, so a direct comparison is not possible.

Finally, of the $540 million in Transport by Water output, nearly $78 million is direct employee compensation. Adding employee compensation to employees in direct and indirectly impacted industries results in total employment of nearly 3,900 jobs supported by the Transport by Water industry. As noted earlier, average compensation for the water transport industry sector is higher than the average for all industries. The resulting values generated by this analysis are different than those generated by the Martin report due to definitional and methodological differences in the analyses. In particular, much of the terminal-related employment resulting from this analysis may not be as adequately captured as in the Martin study. This is because many of the pilots, towers, forwarders, and others are not categorized in the Transport by Water sector in the IMPLAN data. In these cases, the Martin study should have covered these types of firms, while the IMPLAN data would not. As such, the higher impact values from the Martin report are potentially consistent with the IMPLAN results presented here.

2.4 SUMMARY

This section has provided an overview of the economic history and regional economic contribution of Portland Harbor and marine industrial land uses. For over 140 years, Portland has been a successful port city and continues today in this role due to its location at the nexus of excellent rail infrastructure, including the Olympic oil pipeline, two interstate freeways, the Columbia River deepwater shipping channel, and the Upper Columbia/Snake Rivers barge system. Marine cargo terminals handle and transport freight that is vital to numerous other industries located throughout Oregon, Southwest Washington, and beyond. Cargo movement through the Portland Harbor has grown steadily over the past century, and recent trends indicate continued future growth. A wide web of industries rely on waterborne transportation, including wholesalers and retailers who import consumer products, manufacturers that import raw and intermediate goods, and manufacturers and natural resource industries that export products.

Portland Harbor serves as an economic engine for the metro regional economy. The Portland Harbor is home not only to transportation and distribution activities linked to marine terminals, but also manufacturing facilities that rely on marine transportation. These marine-related industries are linked to other industries located in Portland Harbor and elsewhere in the metro area, including wholesale trade, local and regional transportation firms, manufacturing firms, and retail firms. These businesses depend on the transportation hub at Portland Harbor either for transport of their products to international or regional markets, or for the provision of inputs of the wide variety of freight materials imported through Portland Harbor, whether petroleum, consumer apparel, automobiles, or raw materials.

These marine-related industries are then linked to other industries in the harbor and elsewhere throughout the metro region. Past studies indicate that cargo and manufacturing activities dependent on waterborne transportation contribute significantly to the metro region's economy. These studies indicate that marine-related economic activity generates from 20,000 to 100,000 jobs and from $1.4 to 3.5 billion annually in regional income.

Although there are several other ports in the Lower Columbia River, including the ports of Kalama, Longview, St. Helens, and Vancouver, Portland is distinguished in the level of its transportation connections and its location in a large metropolitan area. The metro area provides a larger population of skilled labor and a larger local industrial base that can generate cluster benefits and additional opportunity for marine-related businesses. As part of the Portland metropolitan area, Vancouver also has this advantage over other Lower Columbia River ports. However, Portland is differentiated from Vancouver and all other Lower Columbia Ports because it is the only port that handles large volumes of all cargo types (specifically, it is the only port that generally handles containers). While some marine industrial uses could be suitable at any Lower Columbia River port, for certain land uses that rely on all types of transportation connections and a large population or industrial base, marine industrial land in the Portland metropolitan area (in Vancouver or Portland) may not be as easily substituted for lands elsewhere in the Lower Columbia. While locating in Portland may be more desirable for some marine-related uses, other ports appear to be less land constrained (and have larger contiguous, shovel-ready sites), and may have less contamination.

SECTION 3

Trends and Forecasts for Marine Related Uses

The purpose of this section is to identify the level of marine industrial economic activity likely to occur within Portland Harbor. The analysis consists of a 30-year (to the year 2040) forecast of job and cargo growth associated with marine industrial development opportunities. A review of economic and demographic trends is first provided, followed by a discussion of employment and land use trends more specific to marine industrial opportunities in Portland Harbor. These subsections rely on data from interviews as well as published data to provide historical and current context to the marine cargo and employment growth forecasts. A subfinal section provides the marine cargo and job-growth forecast. The forecasts are based on different assumptions about the types of marine industrial development that could occur over the planning horizon, resulting in a low, medium, and high estimate of job growth. The three scenarios reflect uncertainty regarding overall economic growth, business location decisions, magnitude of cargo movement, and the Portland Harbor cargo market share.

3.1 OVERVIEW OF DATA SOURCES AND KEY ASSUMPTIONS

This section covers a review of relevant trends and data related to the economic environment, employment in general, population growth, and other factors that can support the marine industrial forecasts. The data and research presented in this section has been gathered from a variety of sources and is intended to provide a broad understanding and interpretation of the Portland economy. For this reason, data and information are not always comparable in terms of geography and classification. For example, much of the information pertains to the larger economic region known as the Portland Metropolitan Statistical Area (PMSA) which includes five Oregon counties plus Clark and Skamania counties in Washington State. Yet other information is presented at the county level, with a particular focus on Multnomah County, while other information is presented for the Oregon portion of the PMSA. Another example is that the classification of different types of industries varies from research organization to organization, and/or annual data may have been collected at different points in the year causing some discrepancy between sources. In all cases an attempt has been made to identify the geographic boundary of the information presented. Also, an effort has been made to calculate wherever possible average annual growth rates (AGRs). Annual growth rates allow for trend data to be compared in terms of the rate of growth or decline, and may be calculated for annual changes in any kind of time-series data.

Several elements of the approach to forecasting marine industrial cargo and employment are similar. These are:

- Both forecasts are developed under the assumption that public infrastructure is continually developed over the forecast horizon to accommodate increases within the sector.
- Both forecasts were developed by considering the larger regional growth within the sector, and then anticipating the share of the larger growth that would likely occur within the Portland Harbor.
- Both forecasts were developed by another organization, and reviewed and adjusted by the ENTRIX team for the purpose of this report.

- Both provide low, high, and most likely scenarios to accommodate uncertainty stemming from a variety of factors including overall economic growth, commodity flows, timing of the economic recovery, and competition from other regional and local marine industrial facilities.

3.2 GENERAL EMPLOYMENT AND POPULATION TRENDS

The recent economic downturn has had a substantial effect on employment in Portland and the region. Oregon's unemployment stands at 11.3 percent [14] as of October, 2009 compared with a rate of 7.2 in October of 2008, and 5.2 in 2007. For the Portland Metropolitan Statistical Area (PMSA), which covers seven counties including Clark and Skamania Counties in Washington State, seasonally adjusted unemployment was at a rate of 11.6 in October of this year, up from 6.8 at the same time last year, and 4.9 in 2007.

Businesses will expand more slowly than originally forecast and it will take some time for employment in the area to recover to 2007 levels. As yet it is unclear what effect this will have on population growth in the area. Fewer people are moving throughout the country because home prices have dropped and those who might have moved may be less likely to if there is a risk of losing money on their homes. On the other hand, with unemployment rates high throughout the country, some people may move in hopes of finding new opportunities, and the general redistribution of workers may mean that in migration continues to the area unabated.

In general, the current recession has caused a short-term decline on local cargo and employment, but this trend is expected to be reversed in 2010, with annual growth forecasted to be positive through 2040. The Portland metro region has grown faster in both employment and population than other areas of the country, and this trend is expected to continue in the immediate future, with growth slowing after 2030.

- **Population Growth.** Population growth in the Portland metro area has outpaced state and national growth, averaging 2.5 percent annually from 1980 to 2007. Annual growth from 2000 to 2060 is forecasted to average 1.2 percent, with growth to 2030 forecasted at the higher annual rate of 1.5 percent.
- **General Employment Growth**. Since 1981, Oregon has experienced average employment growth of 2 percent annually (compared to 1.7 percent nationally). Portland metro area employment is expected to nearly mirror population growth rate. Employment is forecasted to grow at an annual average rate of 1.2 percent from 2000 to 2060, with a higher annual growth rate of 1.4 percent expected through 2030. Metro forecasts employment growth of approximately 23,600 jobs in the Columbia Harbor area (which includes Portland Harbor but is a larger geographic area) from 2010 to 2035.

3.2.1 Employment

Non-farm employment in the PMSA includes significant industries such as health care and social assistance (10.2 percent), retail trade (10.2 percent), and manufacturing (9.9 percent). These employment levels are consistent with the state and national levels as detailed in **Table 3-1**. The PMSA has slightly greater employment concentrations in wholesale trade, and professional and technical services than the nation or the state. The region also has slightly lower concentrations of employment in accommodations and food services, government, and retail trade than the state or nation. Multnomah County, which is home to Portland Harbor and the majority of marine industrial employment, has a slightly higher concentration of employment in Transportation and Warehousing; Finance and Insurance; Professional, Scientific and Technical Services; and Management when compared to the state and nation.

[14] Oregon Employment Department. 2009. Unemployment Rates. accessed at www.qualityinfo.org.

Table 3-1 Employment by Non-Farm Industry, 2006

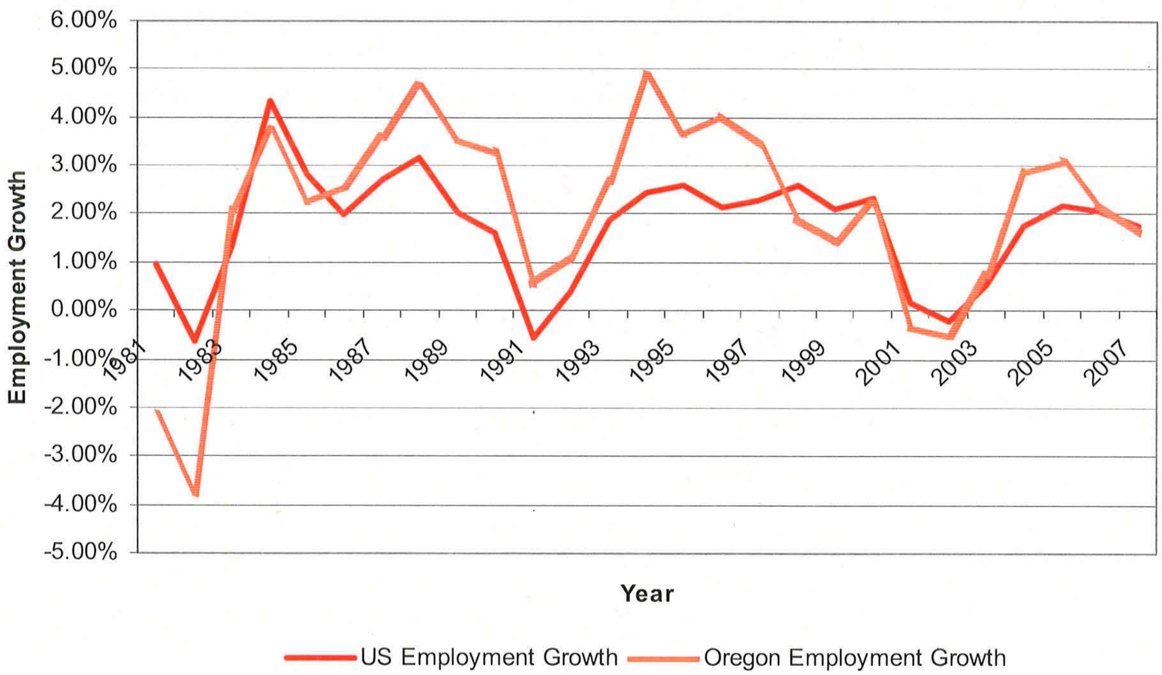
	Portland MSA		Multnomah		Oregon		US	
	Employees	%	Employees	%	Employees	%	Employees	%
Forestry, fishing, related activities, and other			N/A		35,770	1.6%	1,014,400	0.6%
Mining	1,700*	0.1%	N/A		3,681	0.2%	984,900	0.6%
Utilities	N/A*		1,618	0.3%	4,964	0.2%	576,500	0.3%
Construction	89,371	6.7%	29,534	5.1%	150,561	6.7%	11,641,100	6.5%
Manufacturing	132,671	9.9%	40,343	6.9%	217,114	9.6%	14,512,000	8.1%
Wholesale trade	67,334	5.0%	26,995	4.6%	89,537	4.0%	6,657,800	3.7%
Retail trade	137,704	10.2%	50,299	8.7%	255,349	11.3%	19,282,000	10.8%
Transportation and warehousing	37,200*	2.8%	25,524	4.4%	68,813	3.1%	5,887,700	3.3%
Information	29,740	2.2%	14,206	2.4%	42,724	1.9%	3,537,000	2.0%
Finance and insurance	61,041	4.5%	28,333	4.9%	85,602	3.8%	8,429,700	4.7%
Real estate and rental and leasing	59,203	4.4%	23,817	4.1%	89,921	4.0%	8,142,400	4.6%
Professional, scientific, and technical services	91,977	6.8%	46,647	8.0%	128,427	5.7%	11,866,300	6.7%
Management of companies and enterprises	23,682	1.8%	14,753	2.5%	31,849	1.4%	1,965,200	1.1%
Administrative and waste services	81,271	6.0%	32,770	5.6%	125,923	5.6%	11,180,300	6.3%
Educational services	37,688	2.8%	19,904	3.4%	50,770	2.3%	3,833,000	2.2%
Health care and social assistance	136,913	10.2%	63,409	10.9%	242,233	10.8%	18,204,900	10.2%
Arts, entertainment, and recreation	31,318	2.3%	15,778	2.7%	51,204	2.3%	3,736,900	2.1%
Accommodation and food services	90,382	6.7%	42,853	7.4%	161,529	7.2%	12,253,000	6.9%
Other services, except public administration	73,196	5.4%	31,404	5.4%	125,347	5.6%	10,140,700	5.7%
Government and government enterprises	143,743	10.7%	71,586	12.3%	291,065	12.9%	24,257,000	13.6%
Total Non-Farm	**1,343,510**	**98.7%**	**580,688**	**100%**	**2,252,383**	**100%**	**178,102,800**	**100%**

* For some categories, data were not available to avoid disclosure of confidential information, but he estimates are included in the total number of employees. In the case of transportation, warehousing, and utilities, and as well for mining, data from the Oregon Employment Department, and the category included utilities as well as transportation and warehousing. For mining, the category includes both mining and logging.

Source: Bureau of Economic Analysis, Regional economic Accounts accessed at www.bea.gov/regional/reis

National employment experienced rapid growth over the 1980s followed by reduced growth in the 1990s.[15] This decade has seen significantly less employment than the previous decades with the September 11th induced recession and the current global recession. Employment growth in Oregon since 1981 has outpaced has outpaced National employment growth averaging 2.04 percent compared with 1.72 percent nationally. The employment growth trend echoes the business cycle with Oregon having greater variance during the peak and trough phases than the national levels. The changes in employment for Oregon and the nation on an annual basis are presented in **Figure 3-1**.

15 Bureau of Economic Analysis. Regional Economic Accounts. Table CA25N.



Source: Bureau of Economic Analysis, Regional Economic Accounts accessed at www.bea.gov/regional/reis

Figure 3-1 Oregon and US Employment Growth, 1981 to 2007

The recent preliminary Urban Growth Report[16] for Portland reports that employment growth within the PMSA is expected to increase substantially by 2030. Forecasts of employment growth predict as much as 1.87 percent annual growth in Portland area employment through 2030. Employment growth is forecasted in a range to account for uncertainty in variety of factors that influence employment including population growth, regional macro-economic issues, and national economic growth. The lower bound employment growth is predicted at 0.84 percent over the same time period. The range of forecast values is based on a 90 percent probability that employment growth will lie within the range of forecasted values presented in **Table 3-2**, and shown graphically in **Figure 3-2**.

Table 3-2 Portland Forecasted Employment Growth (PMSA)

Year	Low	Medium	High
2000	973,000	973,000	973,000
2030 (*average annual increase from 2000*)	1,252,200 (0.8%)	1,476,100 (1.4%)	1,700,000 (1.9%)
2060 (*average annual increase from 2000*)	1,648,400 (0.9%)	2,024,200 (1.2%)	2,400,000 (1.5%)

Source: METRO, Preliminary 2009, 2030 employment urban growth report, p.27.

16 METRO. 2009. *Preliminary Urban Growth Report 2009 – 2030 Employment.* May.

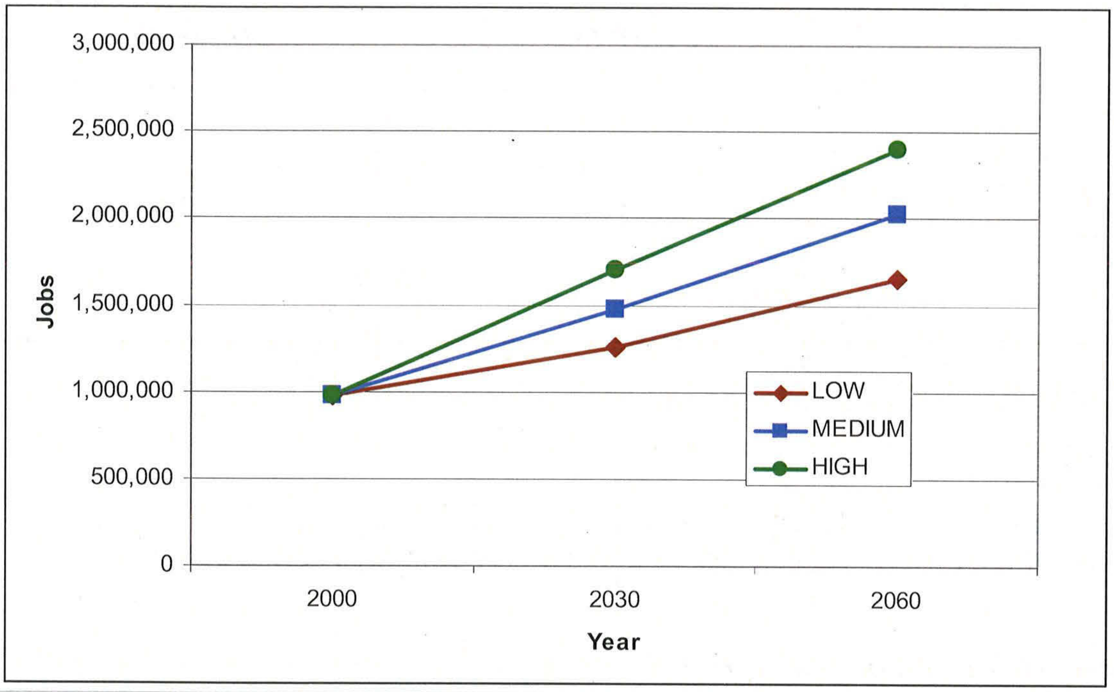


Figure 3-2 Portland Forecasted Employment Growth

The following table shows the range of employment growth rate by key industry for the Portland region. The annualized percentage growth rate range is within the 90 percent confidence interval for each sector. Total non-farm employment growth is forecasted to range from 0.7 percent to 1.8 percent annually for the next 40 years. As indicated in the table, most growth is expected to occur in the trade, transportation, and service industries.

Table 3-3 Annualized Wage and Salary Employment Growth Forecast in Portland Region 2008 - 2040

Industry Sector (NAICS)	High Growth Rate	Low Growth Rate
Nonfarm total employment	1.80%	0.70%
Manufacturing, total	0.60%	-1.10%
Durable Goods, total	0.60%	-1.20%
Wood Products	0.20%	-1.80%
Primary Metals	-0.80%	-3.70%
Fabricated Metals	-0.10%	-0.90%
Machinery	-0.50%	-1.00%
Electronics	1.00%	-0.90%
Transportation Equipment	0.70%	-1.50%
Nondurable Goods, total	0.40%	-0.80%
Nonmanufacturing, total	2.00%	-0.90%
Construction	2.00%	-2.50%
Wholesale Trade	1.50%	1.20%
Retail Trade	1.00%	0.20%
Transport., Warehousing, Utilities	1.70%	1.40%
Information Services	2.20%	0.50%

Industry Sector (NAICS)	High Growth Rate	Low Growth Rate
Financial Activities	1.80%	1.20%
Business Services	2.40%	0.60%
Education & Health Services	2.70%	2.20%
Leisure & Hospitality	1.60%	1.30%
Other & Personal Services	2.40%	1.10%
Government, civilian total	1.10%	0.80%
Federal	0.00%	-0.20%
State & Local	1.30%	1.00%

Source: METRO, 2009, Urban Growth Report, appendix 12: Population and Employment Forecast

3.2.2 Population

The PMSA has historically experienced greater population growth than the state or nation averaging an annual rate of 2.5 percent since 1980 compared with 1.5 percent for Oregon and 1.2 percent for the nation (see **Table 3-4**).

Table 3-4 Population Growth, 1980 to 2007

Geographic	Population (1,000s)								Average
Location	1980	1985	1990	1995	2000	2005	2006	2007	AGR
US	227,225	237,924	249,623	266,278	282,172	295,561	298,363	301,290	1.2%
Oregon	2,641	2,673	2,860	3,184	3,431	3,622	3,681	3,736	1.5%
Portland MSA	1,347	1,391	1,536	1,749	1,936	2,087	2,126	2,166	2.3%

Source: Bureau of Economic Analysis, Regional Economic Accounts, accessed online at www.bea.gov/regional/reis/.

Population growth in the PMSA is expected to outpace forecasted growth in Oregon and the US. Annual population growth is forecasted around 0.9 percent for the US, 1.16 percent for Oregon, and between 1.28 and 1.7 for the Portland metro region, depending on the source of the forecast. **Table 3-5** displays different annual population growth rates based on varying geographic areas and forecast sources.

Table 3-5 Population Growth Forecasts, 2000 to 2030

Geography	Growth Rate (APR)	Source
	2000 to 2030	
US	0.85%	Census
US	0.95%	Global Insight
Oregon	1.14%	Global Insight
Oregon	1.16%	US Census
Oregon	1.18%	OR OEA
Portland Metro, 3 Counties	1.28%	OR OEA
Portland Metro, 7 Counties	1.40%	Global Insight
Portland Metro, 7 Counties	1.37%	Metro
Portland Metro, 7 Counties	1.70%	Metro

Source: Metro, March 2009 draft, '20 and 50 year Regional population and employment range forecasts.'

The recent Urban Growth Report for Portland reports that population growth within the seven county PMSA is expected to increase substantially by 2030. Population growth is forecasted in a range to account for uncertainty in variety of factors that influence population growth, including regional macroeconomics, availability of housing, and national economic growth. The lower bound population growth rate is predicted at 1.4 per year to 2030, with growth slowing to 1.1 percent per year to 2060. There is a 90 percent probability that population growth will lie within the range of forecasted values presented in **Table 3-6**. **Figure 3-3** shows the projected population estimates graphically.

Table 3-6 Portland Forecasted Population Growth (PMSA)

Year	Low	Medium	High
2000	1,927,881	1,927,881	1,927,881
2030 (*average annual increase from 2000*)	2,903,300 (1.4%)	3,051,400 (1.5%)	3,199,500 (1.7%)
2060 (*average annual increase from 2000*)	3,609,300 (1.1%)	3,992,700 (1.2%)	4,376,100 (1.4%)

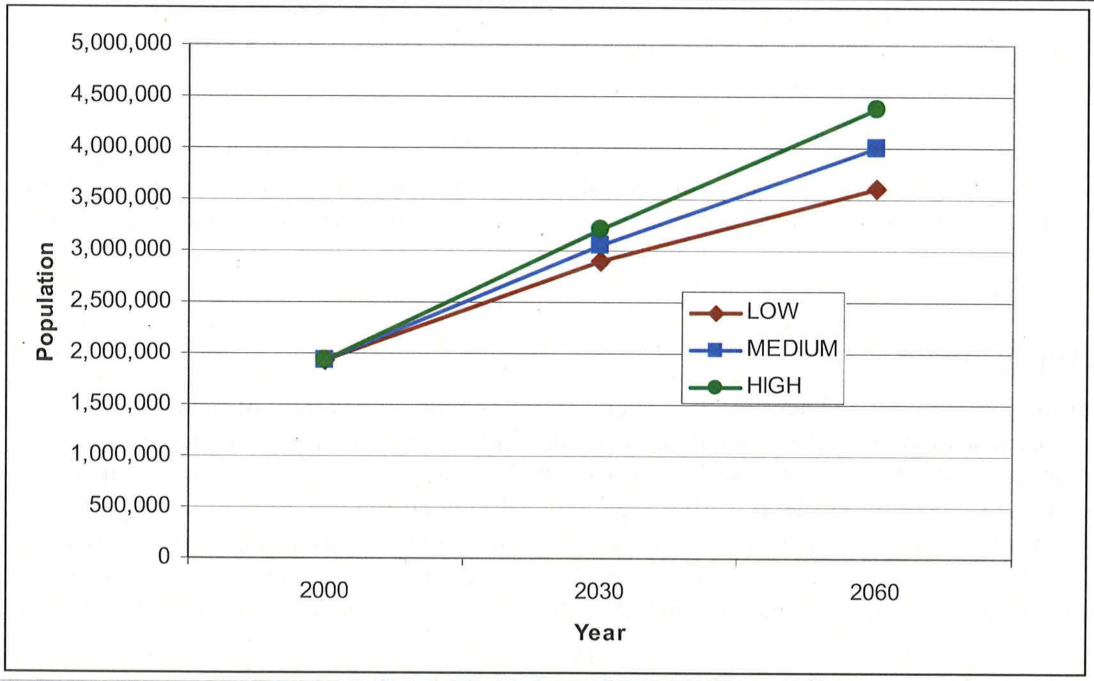


Figure 3-3 Portland Forecasted Employment Growth

Another source for population forecasts is the Oregon Office of Economic Analysis, which prepared forecasts in 2004. These forecasts to the year 2040 suggested an annual growth of 1.25 percent for the combined three counties of Washington, Multnomah, and Clackamas, with much faster growth rates expected toward the beginning of the forecast period. The period of analysis was between 2000 and 2040. For the three county area, the forecasts suggest that between 2000 and 2040, the population would grow by over 900,000 people in total, with nearly 57 percent expected to result from net in-migration versus natural population growth. This represents over 500,000 people expected to move to the three counties by 2040. The remainder of the growth results from natural growth –the number of expected births in a given year exceeds the number of expected deaths in that year.

3.3 MARINE-RELATED TRENDS

This section covers the relevant data and trends within the marine industrial sector that will influence the anticipated future marine-related activity within Portland Harbor. Factors influencing growth in marine-related uses include trends in domestic and international waterborne trade, capital intensiveness versus labor intensiveness of marine businesses, and overall growth rate of the regional, national, and international economies. Trends of marine-relate employment, regional trade capacity, and land use are discussed in preparation for the next section, which presents forecasts of employment and marine cargo trade.

Regarding marine industrial trends, many of the private marine-industrial firms in Portland Harbor have recently made site improvements that imply their continued investment in the area. These firms include Advanced American Diving, Ash Grove Cement, and Rinker (a concrete batch plant). US Barge has made improvements to their Portland Shipyard site and both Schnitzer Steel and Gunderson have made dock improvements. Overall, there have been $450 million of completed or funded capital investments made on 30 harbor area sites from 2004 to 2007. However, in the long-term, as identified in the 2003 Portland Harbor Industrial Lands Study, medium-larger firms anticipate minimal demand for more industrial land for expansion. Additionally, businesses note that Superfund uncertainty and competitive multi-modal transport are key determinants of business investment.

While marine cargo volumes have grown, across the United States maritime employment in marine cargo handling has declined over the past several decades due to increasing capital-intensiveness of marine terminal operations. Thus, the relationship between employment and land needs is changing due to technological advances.

3.3.1 Employment Trends

As discussed in **Section 2**, marine-related activity in Portland Harbor occurs in a variety of industrial sectors. The main sectors include distribution (transportation and warehousing), wholesale trade, and metals and equipment manufacturing. Past employment growth from 1976 to 2000 in these sectors is presented in **Table 3-7**. All of the predominant sectors in Portland Harbor grew more slowly during this period than the average rate of private employment growth of 3.2 percent. However, all grew at a healthy annual rate of between 1.2 to 2.3 percent, with the fastest growing sectors being wholesale trade (2.3 percent growth) and trucking and warehousing (2.0 percent growth). Water transportation also grew at a fast rate, with 1.7 percent growth.

Table 3-7 Selected Sector Employment Growth 1976 – 2000 in Portland MSA (Oregon Portion)

Sector	1976	1980	1985	1990	1995	2000	Annual Growth Rate 1976 to 2000
Private Sector Employment	353,416	440,145	440,581	555,117	643,902	747,378	3.2%
Water Transportation	1,492	1,696	1,194	1,224	1,513	2,223	1.7%
Wholesale Trade	54,846	67,269	65,926	78,927	89,850	94,051	2.3%
Trucking and Warehousing	9,536	10,560	11,529	14,463	17,242	15,389	2.0%
Manufacturing	88,700	108,320	95,584	107,006	115,870	128,275	1.5%
Transportation Equipment	9,104	9,209	6,974	9,980	10,260	12,126	1.2%
Primary Metal Industries	4,881	6,908	6,057	7,776	6,466	7,453	1.8%

Source: Oregon Labor Market Information System. Covered Employment and Wages, Industry Report, accessed online at: http://www.qualityinfo.org/olmisj/CEP.

3.3.1.1 Transportation and Warehousing Employment

One of the main sectors dependent on marine transportation is the Transportation and Warehousing (T&W) sector. This sector employs 37,800 employees within the PSA and 55,800 within Oregon.[17] This figure corresponds to 4.1 percent of the workforce in the PMSA area and 3.9 percent of the total Oregon workforce. Employees within the PMSA transportation and warehousing industry earn $42,260 annually compared with $46,570 across all industries (see **Table 3-8**). Employment in the transportation and warehousing industry within Portland has grown from 30,600 employees in 1992 to 37,800 employees in 2008, a growth of 24 percent. Oregon employment in the same sector grew 32 percent from the 1992 level of 42,200 to 55,800 in 2008. Within this sector, the subsector of Water Transportation represents just one to two percent of the total sector jobs. In these sectors, as for most employment sectors, the PMSA represents the majority of jobs. For all industries, the PMSA accounts for 64 percent of statewide jobs. In transportation and warehousing, the PMSA represents 68 percent of all jobs, and for water transportation, the PMSA represents 85 percent.

Table 3-8 Employment in the Water Transportation Industry, 2008

	Water Transportation	Transportation and Warehousing	All Industries
Oregon			
Employment	692	55,783	1,445,462
Average Salary	$63,648	$39,531	$41,700
Portland MSA			
Employment	589	37,812	930,387
Average Salary	$64,380	$42,258	$46,570

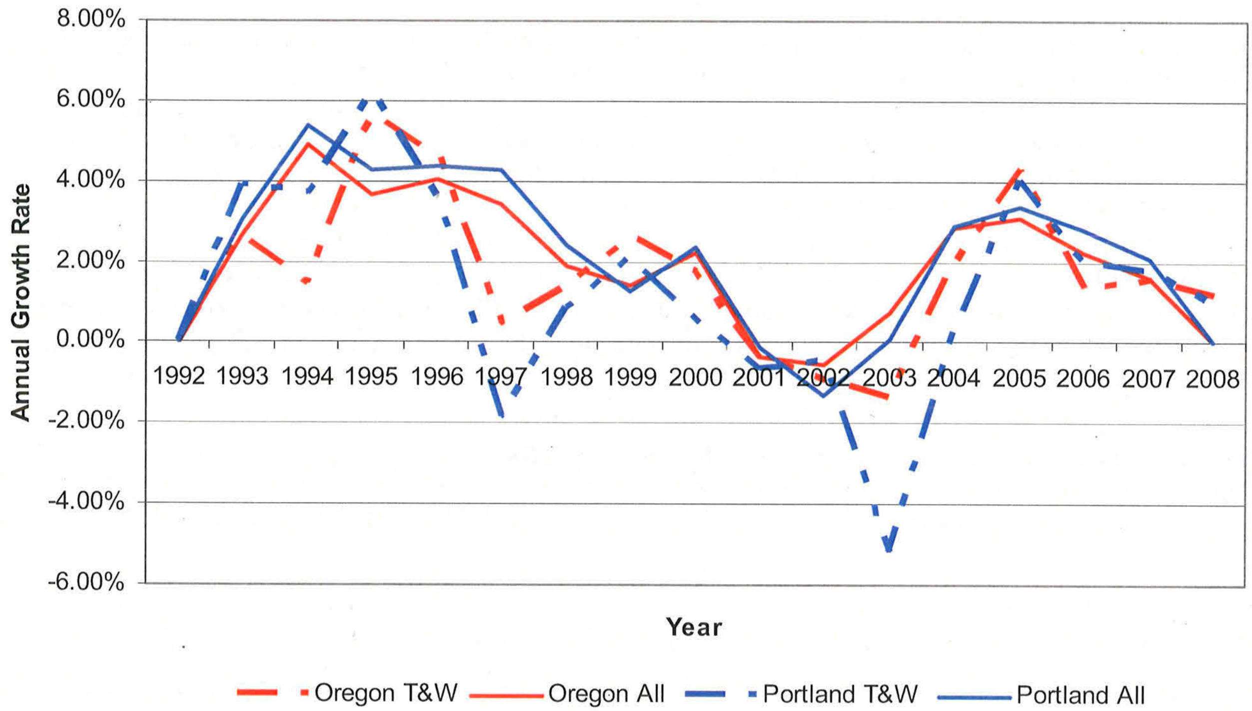
Source: U.S. Census Bureau, Local Employment Dynamics, accessed online at http://lehd.did.census.gov/led/datatools/qwi-online.html.

Note: No water transportation employment information is reported for the WA portion of Portland MSA

Though total employment in the water transportation industry is limited, employee salaries are significantly higher than the average industry salary. In 2008, he average annual salary for water transportation employees in Portland is $64,380 and $63,648 in the state.

Historic employment growth in the transportation and warehousing industry sector is show in **Figure 3-4** below for the period between 1992 and 2008. The dotted red and blue lines both show transportation and warehousing sector employment change, while the solid lines represent all sector employment growth. It is noticeable that transportation and warehousing tends to follow a similar pattern of growth as all sectors, although transportation and warehousing saw more severe declines in employment in 1997 and in the period between 2001 and 2004, than did the all sectors combined. All sectors saw declines in employment in 2001 and 2002.

[17] U.S. Census Bureau. Local Employment Dynamics, Average for 2007 Q4 through 2008 Q3. accessed online at http://lehd.did.census.gov/led/datatools/qwi-online.html.



Source: U.S. Census Bureau. Local Employment Dynamics. accessed online at http://lehd.did.census.gov/led/datatools/qwi-online.html.

Figure 3-4 Employment Growth in the Transportation and Warehousing Industry, 1992 to 2008

The Transportation, Warehousing, and Utilities (TW&U) industries are expected to grow substantially over the next five years both nationally and statewide. Annualized TW&U growth is expected to average 2.9 percent between 2010 and 2015 in Oregon and 3.7 percent nationally. This forecasted growth comes after a period of average declining employment since 2000. **Table 3-9** presents these figures below.

Table 3-9 Employment in the Transportation, Warehousing, and Utilities Industries, in 1000s

	1990	1995	2000	2005	2010	2015
US						
Total Nonfarm	109,489.8	117,306.6	131,793.6	133,699.2	131,441.9	142,911.9
Annualized Nonfarm Growth		1.4%	2.5%	0.3%	-0.3%	1.7%
Transportation, Warehousing, and Utilities	4,216.3	4,505.1	5,013.1	4,917.7	4,810.8	5,709.1
Annualized TW&U Growth		1.4%	2.3%	-0.4%	-0.4%	3.7%
Oregon						
Total Nonfarm	1,255.6	1,428.1	1,617.9	1,654.4	1,624.8	1,805.4
Annualized Nonfarm Growth		2.7%	2.7%	0.5%	-0.4%	2.2%
Transportation, Warehousing, and Utilities	46.9	54.6	57.6	57.2	53.8	61.5
Annualized TW&U Growth		3.3%	1.1%	-0.1%	-1.2%	2.9%

Source: Office of Economic Analysis, Employment by Industry: 1990 to 2015, accessed at http://www.oea.das.state.or.us/DAS/OEA/economic.shtml.

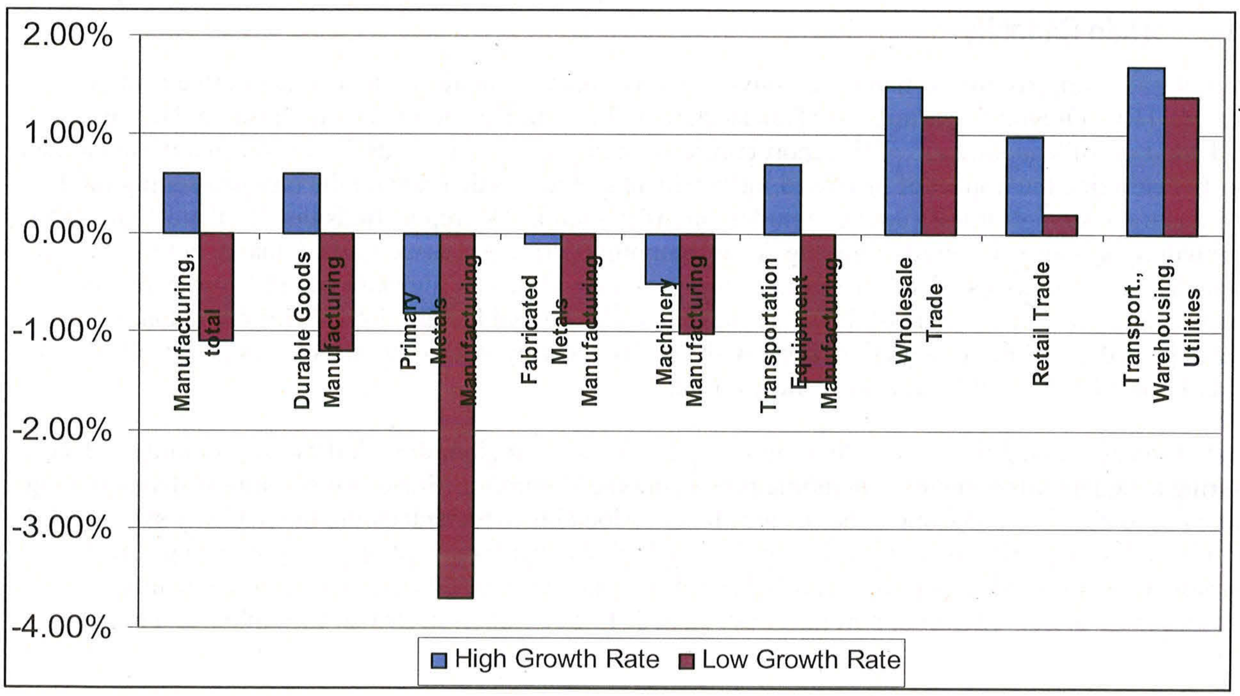
The TW&U industry is expected to outpace general growth in nonfarm employment both statewide and nationally. Forecasted total nonfarm employment is expected to grow annually by only 1.7 percent nationally and 2.2 percent statewide.

Employment growth within the transportation and warehousing industry was consistent across the nation, state and Multnomah County between 2002 and 2007 (see **Table 3-10**). Data from before the 2001 is not comparable to the 2001 to 2007 data since transportation and utilities employment was not recorded.

Table 3-10 Transportation and Warehousing Employment Growth, 2001 to 2007

	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
Multnomah	-2.6%	-2.4%	1.3%	1.4%	3.6%	4.0%
Oregon	-0.4%	-1.0%	3.3%	3.4%	2.4%	1.2%
US	-2.4%	-0.9%	2.1%	3.6%	2.6%	2.4%

This short-term pattern is reinforced by the long-term growth rates forecasted by METRO and presented above in **Table 3-3**. **Figure 3-5** below presents high and low forecasted growth rates for selected sectors in Portland. As indicated in the table, employment growth is forecasted in trade, transportation, and warehousing industries, while employment is expected to decline in manufacturing industries across the metro area. In particular, the transportation, warehousing, and utilities sectors are forecasted to grow by 1.4 to 1.7 percent annually and wholesale trade is expected to grow by 1.2 to 1.5 percent annually over the next thirty years.



Source: METRO, 2009, Urban Growth Report, appendix 12: Population and Employment Forecast

Figure 3-5 Selected Sectors: Annualized Wage and Salary Employment Growth Forecast in Portland Region 2008 - 2040

3.3.2 Marine Cargo Trends

Statistics from the U.S. Army Corps of Engineers indicate that waterborne cargo volume handled at ports in the Lower Columbia River has grown at a compound annual growth rate of 2.9 percent from 1962 to 2007.[18] Marine cargo movement on the Columbia River is dominated by the Port of Portland. In Portland Harbor, between 1960 and 2000 marine cargo tonnage shipped through Portland Harbor increased by 253 percent.[19] To accommodate this growth in marine cargo, from 1974 to 2010 there have been 1,297 acres of land developed for marine terminal uses in the Lower Columbia River, or 36 acres annually.[20] Of this acreage, 55 percent, or 719 acres, have been developed during this timeframe in Portland Harbor.

As discussed in **Section 1**, Portland has a competitive advantage in rail distribution of marine freight that has allowed the region to grow as a gateway for imports for the U.S. consumer market, such as automobiles, as well as exports, such as minerals and feed products. Growth in marine cargo thus depends not only on economic conditions in the local market, but also on broader regional, national, and international (particularly Pacific Rim) economic conditions.

International trade growth tends to be an amplified response to economic growth: when economic growth slows trade growth tends to decelerate even more, while when economic growth accelerates, trade growth accelerates even faster.[21] The current economic recession has substantially slowed international trade, but it is expected that trade will start to recover in 2010 with strong long-term growth. As a percent of world GDP, imports have been increasing to about 35 percent in 2008 and are expected to rise as high as 40 percent by 2040 (compared to 20 percent in the period 1980 to 1995).[22] This growth in trade will result in increased marine cargo transport.

3.3.2.1 Trade Capacity

The overall trade capacity for Portland/Vancouver area was recently analyzed in a collaborative fashion between METRO, Oregon Department of Transportation, Portland Development Commission, Port of Portland and Port of Vancouver.[23] This report comprises analyses by several different consultants and authors in order to determine the impact of increased international and domestic trade on the regional supply (and demand for) trade support infrastructure including industrial land. The report finds that Portland/Vancouver has a growth opportunity as rapidly growing Asian economies drive increased trade demand, but the area may face capacity strains in terms of industrial land supply, and the ability of highway and rail system to handle additional volumes. A component of the study, developed by Global Insight, Inc. identified regional population growth, workforce migration, trade with rapidly growing Asian states, as factors that will favorably impact the Portland/Vancouver trade future.

The study forecasts a doubling of freight volumes by 2035 for the region, though these opportunities depend on ensuring adequate infrastructure, including preserving the Columbia –Snake River barge system, creating short line rail to alleviate congestion and to carry local carload business, enhancing the roadway system, and preserving land for logistics operations. Improving the highway network capacity and preserving land for transportation/logistics industry were identified as actions that could be taken by the regional planners to avoid losing trade to new emerging port gateways such as Prince Rupert in British Columbia, and Punta

18 BST Associates. 2010. West Hayden Island Marine Cargo Forecasts and Capacity Assessment. Prepared for the Port of Portland.

19 E.D. Hovee & Company. 2003. Portland Harbor Industrial Lands Study. February. Prepared for City of Portland, Bureau of Planning, Portland Development Commission and Port of Portland.

20 BST Associates. 2010. West Hayden Island Marine Cargo Forecasts and Capacity Assessment. Prepared for the Port of Portland.

21 Ibid.

22 Ibid.

23 METRO, Oregon Department of Transportation, Portland Development Commission, Port of Portland and Port of Vancouver. 2006. Portland and Vancouver International and Domestic Trade Capacity Analysis.

Colonet in Baja California were identified as challenges in the region. The study also notes that while marine industrial land is a scarce commodity in the region due to particular location and size requirements, additional land may need to be developed for marine terminals to capture trade growth opportunities.

3.3.2.2 Energy and Transportation Costs and Freight Transport Mode

As energy costs rise, shippers and supply-chain managers are increasingly trying to keep freight on the most energy efficient forms of transportation – rail and sea transport – longer. As a result, one strategy being considered is to move more freight to smaller regional distribution centers such as Portland, according to a recent study by Cushman and Wakefield completed for NAIOP, a national commercial real estate association.[24] This paper suggests that by using smaller, albeit more costly distribution centers such as Portland, the additional costs of smaller trucks (known as LTL – less than load) that deliver to individual facilities can be reduced. The article also states that a move to lower cost modes of transport would benefit the largest ports and the inland hubs with the best rail access. Southern California and Seattle/Tacoma could see an increase in loads that are headed for the traditional inland hubs of Chicago, Atlanta, and Dallas via rail. A more sea-oriented approach would bring more goods through the canals – Panama and Suez – straight to the major East Coast ports of New York/New Jersey, Hampton Roads, and Savannah. Recent investments in intermodal hubs and rail routes could give some advantage to Kansas City and Columbus, Ohio.

3.3.3 Portland Harbor Land Need Trends

Drawing on economic analysis coupled with 80 in-depth interviews with harbor area industry leaders and two focus groups, the Portland Harbor Industrial Lands Study identifies thirteen industries that possess a competitive advantage in Portland Harbor. The study determines that the harbor is in transition shifting towards wholesale-distribution and transportation activities and away from manufacturing. The expansion of foreign trade continues to be a primary driver of land development for marine cargo uses. The study identifies that limited land availability may constrain future growth opportunities, particularly for large industrial or marine cargo uses.

The study reports that 10,460 jobs are forecasted to be added to the Portland Harbor area between 2000 and 2020. Using a job density of eight jobs per acre, the current harbor area employment density, the study determines a need for 1,310 acres of new buildings to accommodate the additional 10,460 employees by 2020. Businesses interviewed suggested they would reconfigure layouts or add an additional shift to accommodate employee growth and very few indicated plans to expand. Historically, 20 acres per year have been developed in the Harbor area to accommodate maritime activities. Continuing this trend to 2020 (from 2000) results in a demand of 400 acres of riverfront industrial property.

Business interviews conducted by the Portland Development Commission (PDC) in 2006[25] of industry leaders in Portland Harbor suggest that industries are reinvesting in the harbor districts through building, equipment, rail, and dock improvements. These interviews imply industry leaders demand warehouse and truck distribution space, close-in industrial service space, and rail access. Limited land supply is seen as a limiting factor for growth. Available sites are viewed as requiring large investment related to environmental liability or other uncertainty which many businesses are not willing to accept. Interviews identified rail congestion and road congestion as areas requiring capital investment to reduce costs to businesses. Increased rail capacity is the most pressing need identified

[24] The New Age of Trade: The Americas (2009) Submitted by: Maria T. Sicola, Executive Managing Director, Research, Cushman & Wakefield, Inc. Research conducted for the NAIOP, available at: http://www.naiop.org/foundation/completedresearch.cfm.

[25] Portland Development Commission, 2006, Working Harbor Reinvestment strategy Business Interview Results.

The Portland Economic Opportunities Analysis (EOA) Summary Report,[26] completed in 2009 also analyzes employment and development trends. The study area for the report is Portland proper, but nine sub-areas within the Portland city boundary are created based on geographic location and industry or commercial focus for forecasting future trends. The study uses six focus groups with 58 participants were used to provide input on land demand topics including emerging trends and business location needs. This study identifies Columbia Harbor as a geographic sub-area, which includes Portland Harbor, the Columbia waterfront industrial zone to 82nd, and some of East Hayden Island. The Columbia Harbor sub-area is primarily geared towards manufacturing and distribution with sixteen percent of all jobs within Portland accounting for 64,000 jobs: the most of any sub-area.

The study identifies the vacant land supply for potential development. Much of the land in the Columbia Harbor region has constraints (such as environmental contamination) limiting potential growth decreasing the total land included in the vacant land supply. For example, only 476 acres of vacant, partially vacant, or re-developable land are available in Columbia Harbor with no natural resource zoning or other constraints of a total 1,910 acres of vacant land in the Harbor. Including non-employment related land demand of an estimated 640 acres for marine terminals (390 acres), rail infrastructure (200 acres), and airport expansion (50 acres), the study concludes there is a shortage of industrial land from 100 acres to 800 acres. If these regional transportation land needs are not included, the study estimates that there is sufficient available vacant acreage in the low and mid scenarios with a shortage of 170 acres in the high scenario. The data from the EOA on available lands needs is utilized in **Section 5** of this study to assess the availability and suitability of vacant waterfront lands in Portland Harbor specifically for marine-related uses.

3.4 MARINE-RELATED FORECASTS FOR PORTLAND HARBOR

This section presents 30-year forecasts for marine cargo and marine industrial employment in Portland Harbor.

3.4.1 Marine Cargo Forecasts

Three cargo forecasts completed for the region were assessed: one for the Puget Sound and Columbia River system completed in 2009 for the Washington Public Ports Association, and two for Portland Harbor completed in 2009 (by the Oregon Department of Transportation) and in 2010 (for the Port of Portland by BST Associates). Of these, the forecast completed by BST Associates for Portland Harbor was utilized as it is the most recent, the most conservative, and utilized sound methodology. This forecast estimates growth in each cargo type in Portland Harbor through 2040, with estimated growth rates from 2007 to 2035 varying from 0.2 percent for breakbulk to 3.7 percent for automobiles. A recent trade capacity analysis for the Portland/Vancouver area indicates that this forecasted growth is feasible given the infrastructure in the region, since it is less than the doubling of freight volumes that the study suggested was possible (though challenging) for the region.

The forecasts presented below represent the expected flow of cargo through Portland Harbor assuming that there is adequate marine industrial land available and adequate transportation infrastructure, including in marine terminals, rail and road infrastructure, and the barge system. The forecasts are for six primary cargo types: dry bulk, liquid bulk, grain, breakbulk, containers, and automobiles. Bulk cargoes are commodities that are transported unpackaged in large quantities, and can be in dry or liquid form. Grain is a dry bulk commodity that is large enough to merit its own forecast. Breakbulk are commodities that must be loaded individually, and are often palletized or in bales. Bulk and breakbulk cargoes are measured in metric tons (MT). Container cargoes are products that are transported in truck-size intermodal containers, known as

[26] E.D. Hovee & Company. March 2009 draft. City of Portland Economic Opportunities Analysis: Summary Report.

twenty foot equivalents (TEU). Automobiles are typically fully assembled vehicles that can roll on and roll off RO/RO of vessels; growth in auto cargoes is measured in units with each vehicle equal to one unit.

It is important to note that the cargo mix and mode of shipment of different cargo types is fairly dynamic and responds quickly to market factors. While past forecasts have predicted overall growth levels in cargo, the cargo commodities with the most growth have frequently been different than anticipated. An example of this is the largely unanticipated movement from breakbulk to containerized cargo that led to declines in breakbulk cargo but resulted in dramatic growth in the new cargo type of containers. In addition to technological change, as growth in cargo reflects overall economic activity, the cargo mix will change based on which economic sectors decline and grow and the subsequent change in the region's mix of imports and exports. Thus, there is more certainty regarding overall cargo volume than the specific future cargo mix that will be handled in Portland Harbor.

Also, as noted in the 2006 trade capacity analysis, growth in trade in Portland is likely to alternative between periods of slow to moderate growth and period of rapid expansion. This is due to Portland's relatively small market size, which makes it more strongly dependent on external forces in national and international markets.

3.4.1.1 Previous Cargo Forecasts

In 2009, a marine cargo was completed for the Washington Public Ports Association that projected cargo growth in Puget Sound and the Columbia River.[27] Although completed after the 2008 economic downturn, the results were developed prior to more recent assessments that suggest a global slowdown of trade. These results were developed for both the Puget Sound region, and for the Lower Columbia region broken into the Washington portion and the Oregon portion. **Table 3-11** shows the results for all areas. After each region, there is a column showing the average annual growth rate of that cargo from the year in the preceding row. For example, between 2002 and 2007, the Puget Sound region increased cargo volumes by an average of 3.8 percent per year; between 2007 and 2010, the forecast suggests that the same region will increase on average by 0.7 percent annually. The forecast for all regions shows a significant slowdown in annual growth between 2007 and 2010 due to do the global economic decline, but similarly all regions are forecast to see increases in the following years.

Table 3-11 Summary Forecasts for Puget Sound and Columbia River System in 1,000 metric tons

Year	Puget Sound	Annual Growth Rate	Columbia River - WA	Annual Growth Rate	Columbia River - OR	Annual Growth Rate
2002	66,639		12,481		18,051	
2007	80,396	*3.8%*	16,209	*5.4%*	20,765	*2.8%*
2010	82,208	*0.7%*	17,759	*3.1%*	20,837	*0.1%*
2015	90,720	*2.0%*	19,070	*1.4%*	22,460	*1.5%*
2020	99,859	*1.9%*	19,885	*0.8%*	24,099	*1.4%*
2025	110,958	*2.1%*	20,745	*0.9%*	25,895	*1.4%*
2030	120,202	*1.6%*	21,406	*0.6%*	27,665	*1.3%*
2007-2030		*1.8%*		*1.2%*		*1.3%*

Source: BST Associates and IHS Global Insight and Mainline Management Inc. (2009), 2009 Marine Cargo Forecast, Technical Report, prepared for Washington Public Ports Association, March.

[27] BST Associates and HIS Global Insight and Mainline Management Inc. (2009). 2009 Marine Cargo Forecast, Technical Report. Prepared for Washington Public Ports Association. March 23.

Another forecast is currently under development for the Oregon Department of Transportation for marine cargo to the year 2040. Preliminary results are shown below by type of cargo (see **Table 3-12**). Annual growth rates are shown for each commodity type in two ways. The first shows the 2010 – 2040 annual increases expected, and the second row shows the growth rate beginning with 2007, which was a recent high. The purpose of the second row of growth rates is to show that net increases are still anticipated, but are smaller when calculated to include the slowdown. Average annual growth rates provide a quick way to compare increases across both regions and commodities, and also provide a sense of what is expected into the future.

Table 3-12 Oregon Department of Transportation Forecast for Portland Harbor Cargo to 2035

Year	Breakbulk	Dry bulk	Liquid bulk	Grain	Total Bulk and Grain	Containers	Autos
2002	772,966	4,032,277	6,353,987	3,899,745	15,058,975	255,745	394,776
2007	1,125,955	5,402,217	6,448,519	5,992,325	18,969,016	260,128	449,307
2010	740,586	5,257,522	6,874,514	7,328,792	20,201,414	235,630	538,496
2020	935,919	6,239,386	7,104,274	7,696,568	21,976,147	306,539	755,427
2030	1,105,032	7,160,800	7,131,710	8,226,960	23,624,501	412,046	1,058,000
2035	1,205,762	7,710,395	7,145,865	8,505,712	24,567,733	487,093	1,252,086
2010-35	*2.0%*	*1.5%*	*0.2%*	*0.6%*	*0.8%*	*2.9%*	*3.4%*
2007-35	*0.2%*	*1.3%*	*0.4%*	*1.3%*	*0.9%*	*2.3%*	*3.7%*

Source: Oregon Department of Transportation in conjunction with PBWorld and IHS Global, October 2009.

3.4.1.2 Marine Cargo Forecast Utilized in this Study

The marine cargo forecast presented below was developed by BST Associates for this study. This cargo forecast is the potential cargo volume that could flow through Portland Harbor, assuming that there is adequate terminal capacity. The BST Associates forecast is the forecast utilized in this study for the following reasons:

1. **Most Recent Forecast**. The BST forecast was finalized in April, 2010 and is the most recent marine cargo forecast for Portland Harbor. This forecast considered the short and long-term economic effects of the economic recession that started in December, 2007.
2. **Geographic Area**. The BST forecast focuses on the Portland Harbor geography, which is the relevant area for this study.
3. **Conservative**. Compared to the ODOT forecast, the BST forecast is generally more conservative in estimating cargo growth in Portland Harbor. The BST forecast considers the short and long-term economic effects of the economic recession that started in December, 2007.
4. **Sound Methodology.** BST Associates has been conducting marine cargo forecasts since 1991 for a variety of public agencies in the Pacific Northwest. BST cargo forecasts have been accepted by regional agencies since at least 2002 when BST prepared the 2002 METRO Commodity Flow Forecast for METRO, Oregon Department of Transportation, Port of Vancouver, Regional Transportation Council, and Port of Portland.

The forecasts are based on a bilateral trade model developed by Global Insight. The forecast is by type of commodity, and the data provided by Global Insight has been adjusted by BST Associates according to the most up to date information available. The forecasts do not, however, cover new market opportunities which may well have the most profound influence on future trade. Instead, these estimates are based primarily on the historic growth trends in each cargo type in the Pacific Northwest, the Portland Harbor market share, as well as regional, national, and domestic macroeconomic variables and trade patterns. For each type of commodity, a forecast has been developed for the Pacific Northwest region, and then market share estimates were developed for the Portland Harbor. For more information, the BST Associates report contains the complete forecast rationale for each commodity.

Growth in cargo is typically based on tonnage. For dry bulks, grain, liquid bulk, and breakbulk, trade growth is measured in metric tons (MT). Containers are measured by twenty-foot equivalent units (TEU), which is the standard container dimension. Finally, automobile cargo is measured by units, with each vehicle representing one unit.

Table 3-13 shows the most likely cargo forecasts, with a low and high forecast shown in **Table 3-14** and **Table 3-15** respectively. In addition to the forecasted growth of existing cargo types shown in **Tables 3-13** through **3-15**, BST Associates notes that new market opportunities of new cargo types may develop, particularly for dry bulks and containers. These opportunities may be in the magnitude of 3 million MT of dry bulk, and 150,000 TEU of containers.

Consistent with previous forecasts of marine cargo in Portland Harbor, the BST Associates forecast indicates that cargo tonnage will increase in nearly all cargo categories over the next 30 years. Over the forecast period, autos, containers and dry bulk cargos are expected to expand faster than the other types of cargoes. In particular, automobiles are expected to expand most rapidly, with compound annual growth from 2008 to 2040 expected to average from 2.6 to 3.8 percent, with a most likely average annual growth rate of 3.3 percent. Portland continues to be the number two in the west coast for imports of automobiles, and the forecast for continued imports is favorable in the wake of US automobile production declines.

Containers are expected to grow at the second fastest rate from 2008 to 2040, expected to range between 1.4 to 2.9 percent, with a most likely average annual growth rate of 2.4 percent annually. Containers are expected to continue to have an advantage for products that also experience competitive barge rates on the Columbia-Snake river system, container market share expansion is limited in the future because although the Columbia river channel has recently been deepened to 43-feet, more and more container ships will require 44-feet to 46-feet depths in the future. However, smaller container vessels, or vessels that are not fully loaded, can still navigate the 30-foot channel and there are opportunities for container growth. As evidence of this, since the BST forecast was finalized, the Port of Portland recently finalized a 25-year lease of container and breakbulk facilities at Terminal 6, to a new container terminal operator that specializes in small to mid-size terminals in niche markets. This new lease agreement is expected to increase container growth at Portland Harbor.

Dry bulk cargoes in the most likely forecast are also expected to continue to increase by 0.8 percent to 1.0 percent annually, in part due to stronger Asian currencies demanding exports of soda ash, potash, minerals ores, chemicals, and fertilizers. This growth is expected in the national/international dry bulk markets, which in Portland Harbor are currently dominated by mineral exports, as well as the local/regional dry bulk markets, which include construction materials as well as agricultural fertilizers.

Table 3-13 Most Likely Marine Cargo Forecast for Portland Harbor to 2040

Year	Breakbulk (1,000 MT)	Dry bulk National/International (1,000 MT)	Dry bulk Local/Regional (1,000 MT)	Liquid bulk (1,000 MT)	Grain (1,000 MT)	Containers (TEU)	Autos (Units)
Past							
2004	892,115	3,915,790	1,719,395	6,353,987	6,305,047	274,609	358,682
2006	1,057,375	3,426,618	1,856,345	6,143,518	5,045,963	214,484	463,557
2008	977,232	4,671,739	1,788,611	6,378,481	5,676,287	245,459	407,803
Forecast							
2010	440,476	2,373,000	1,315,000	5,948,000	5,129,000	195,000	248,000
2020	1,006,000	4,602,000	2,164,000	6,946,000	6,030,000	280,000	562,000
2030	1,091,000	5,317,000	2,331,000	7,558,000	6,306,000	394,000	844,000
2035	1,135,000	5,673,000	2,401,000	7,565,000	6,391,000	467,000	983,000
2040	1,181,000	6,054,000	2,471,000	7,571,000	6,477,000	520,000	1,145,000
2010-2035	*3.9%*	*3.5%*	*2.4%*	*1.0%*	*0.9%*	*3.5%*	*5.7%*
2008-2040	*0.6%*	*0.8%*	*1.0%*	*0.5%*	*0.4%*	*2.4%*	*3.3%*

Source: BST Associates. 2010. West Hayden Island Marine Cargo Forecasts and Capacity Assessment., Final Report. Prepared for Port of Portland.

Table 3-14 Low Marine Cargo Forecast for Portland Harbor to 2040 in 1,000 MT

Year	Breakbulk (1,000 MT)	Dry bulk National/International (1,000 MT)	Dry bulk Local/Regional (1,000 MT)	Liquid bulk (1,000 MT)	Grain (1,000 MT)	Containers (TEU)	Autos (Units)
Past							
2004	892,115	3,915,790	1,719,395	6,353,987	6,305,047	274,609	358,682
2006	1,057,375	3,426,618	1,856,345	6,143,518	5,045,963	214,484	463,557
2008	977,232	4,671,739	1,788,611	6,378,481	5,676,287	245,459	407,803
Forecast							
2010	411,199	2,152,000	1,220,000	5,557,000	5,046,000	157,000	209,000
2020	855,000	3,750,000	1,854,000	6,521,000	5,276,000	220,000	468,000
2030	933,000	4,197,000	1,985,000	6,998,000	5,498,000	299,000	693,000
2035	971,000	4,418,000	2,037,000	6,955,000	5,572,000	347,000	801,000
2040	1,010,000	4,650,000	2,089,000	6,912,000	5,647,000	379,000	925,000
2010-2035	*3.50%*	*2.90%*	*2.10%*	*0.90%*	*0.40%*	*3.20%*	*5.50%*
2008-2040	*0.10%*	*0.00%*	*0.50%*	*0.20%*	*0.00%*	*1.40%*	*2.60%*

Source: BST Associates. 2010. West Hayden Island Marine Cargo Forecasts and Capacity Assessment., Final Report. Prepared for Port of Portland.

Table 3-15 High Marine Cargo Forecast for Portland Harbor to 2040

Year	Breakbulk (1,000 MT)	Dry bulk National/International (1,000 MT)	Dry bulk Local/Regional (1,000 MT)	Liquid bulk (1,000 MT)	Grain (1,000 MT)	Containers (TEU)	Autos (Units)
Past							
2004	892,115	3,915,790	1,719,395	6,353,987	6,305,047	274,609	358,682
2006	1,057,375	3,426,618	1,856,345	6,143,518	5,045,963	214,484	463,557
2008	977,232	4,671,739	1,788,611	6,378,481	5,676,287	245,459	407,803
Forecast							
2010	455,256	2,690,000	1,378,000	6,208,000	5,389,000	221,000	287,000
2020	1,107,000	5,212,000	2,474,000	7,229,000	6,595,000	321,000	656,000
2030	1,197,000	5,976,000	2,678,000	7,932,000	6,872,000	458,000	995,000
2035	1,245,000	6,343,000	2,765,000	7,971,000	6,965,000	547,000	1,165,000
2040	1,295,000	6,733,000	2,852,000	8,011,000	7,059,000	614,000	1,364,000
2010-2035	*4.10%*	*3.50%*	*2.80%*	*1.00%*	*1.00%*	*3.70%*	*5.80%*
2008-2040	*0.90%*	*1.10%*	*1.50%*	*0.70%*	*0.70%*	*2.90%*	*3.80%*

Source: BST Associates. 2010. West Hayden Island Marine Cargo Forecasts and Capacity Assessment, Final Report. Prepared for Port of Portland.

As noted above, the 2010 most likely marine cargo forecast prepared by BST Associates and presented in **Table 3-13** above is conservative compared to the 2009 ODOT (presented in **Table 3-12**). **Table 3-16** below compares the two forecasts in terms of annual average growth between 2007 and 2035. As indicated in the table, the BST Associates forecast projects lower annual cargo growth rates for all cargo types in Portland Harbor except liquid bulk and containers.

Table 3-16 Comparison of Cargo Forecasts for Years 2007 – 2035, Average Annual Compound Growth Rate

Cargo Type	BST Associates for Port of Portland	ODOT
Breakbulk	0.03%	0.20%
Dry Bulk	0.51%	1.30%
Liquid Bulk	0.90%	0.40%
Grain	0.23%	1.30%
Containers	2.11%	0.90%
Autos	2.84%	3.70%

3.4.2 Marine Employment Forecast

This section draws from general employment forecasts conducted for the metro region, as well as for the sub area of the metro region (Columbia Harbor sub area) that includes the Portland Harbor. In particular, the analysis draws from the Economic Opportunities Analysis (EOA) that developed employment forecasts for the City by sub area to the year 2035 for the purpose of understanding employment land demand and supply. These sub area employment forecasts are, in turn, based on the total employment forecast by 2035 conducted by METRO for the seven county Portland Metropolitan Statistical Area. For the transportation, warehouse and utilities sector, total employment is expected to grow to 57,700, 61,350, and 65,010 jobs respectively for the low, medium, and high forecast scenarios. Citywide capture of the jobs in this category also varies in the estimation, assuming that 57, 63, and 68 percent respectively in this sector are located in the City. This represents a reduction in the current city capture of these jobs, which is closer to 74 percent.

Using these estimates, the EOA job forecast for the city ranges from a low of 32,889, to a high of 44,206, with the midpoint being 38,650 jobs forecast by 2035 for the City. The forecast was developed using an overall growth rate of 1.7 percent annually, identified as the medium scenario forecast from METRO at the time. These numbers are consistent with other current estimates of transportation and warehousing employment in Multnomah County, which was 25,524 in 2007.[28] At the 1.7 percent growth rate, the medium forecast of 38,650 is attained in 2035 if jobs in this sector were 25,359 in 2010. While all of the transportation and warehousing sector jobs are not marine industrial jobs, these jobs are linked to the intermodal transportation system which depends in part upon the marine transportation.

Another source of information about marine industrial jobs in the Portland Harbor is the Working Harbor data developed by the City. These data account for the types of economic activity in the based on whether the firm located in the harbor is dependent on marine transportation, dependent on rail facilities or dependent upon both. This provides yet another way to consider the employment related to marine transportation. Of the 212 firms located in the harbor, 47 firms with just under 2,000 employees are dependent on both the river and rail transportation while another 23 firms with 660 employees are dependent on the river but not necessarily the rail. This totals to 70 firms dependent on marine transportation, with approximately 2,625 employees. There are also 142 firms that employ over 5,800 people that are dependent on the rail transportation facilities. **Table 3-17** below shows this firm and employment information.

Table 3-17 River and Rail Dependent Firms and Employment in the Portland Harbor

Type of Industrial Facility	Number of Firms	Number of Employees
Both River and Rail Dependent	47	1,969
River Dependent Only	23	656
Rail Dependent Only	142	5,817
Both River and Rail Dependent	47	1,969
Total	**212**	**8,442**

Source: Data provided by the Bureau of Planning and Sustainability

It is expected that this employment information is incomplete as many firms have operations in the harbor area but may have main office locations elsewhere that results in undercounting of harbor area employment. For example, as discussed in Section 1, the Martin and Associates 2007 study of the economic impact of Portland Harbor marine terminals estimated that there are 6,570 jobs in Portland Harbor directly dependent on public and private marine terminals. This results in an estimate of river dependent jobs nearly three times higher than the Working Harbor data. This estimate even undercounts the total river-dependent employment as marine industrial facilities with docks are not classified as marine terminals in the Martin and Associates analysis.

As illustrated in **Table 3-17**, not all Portland Harbor businesses are directly dependent on the river and water transportation. However, as discussed in **Section 1**, businesses in the harbor area are highly interdependent and it is challenging to isolate the economic activity and jobs that are dependent upon the marine transportation network. Based on the interdependence of all Portland Harbor employment as well as the uncertainty associated with the number of marine industrial jobs that are in fact dependent on water transportation, this analysis bases the projection of marine industrial employment growth on the 8,440 river

[28] Office of Economic Analysis, Employment by Industry: 1990 to 2015, accessed at http://www.oea.das.state.or.us/DAS/OEA/economic.shtml.

and/or rail dependent jobs presented in **Table 3-17**. Growth rates in marine industrial employment will be based on the overall economic and population growth of the region and the nation, growth rate in international trade, and the local growth rate in marine-related industries such as heavy manufacturing and warehousing and distribution. As noted previously in this section, employment growth rates in manufacturing industries are expected to be slow or negative, while growth rates in transportation, warehousing, and distribution are expected to outpace growth in other industries. This analysis projects that marine industrial employment growth rates will be at a low rate of 0.7 percent per year, a medium growth rate of 1.2 percent per year, and a high growth rate of 1.7 percent per year. These growth rates are based on the following data points:

- Forecasted metro employment growth rate of 0.7 to 1.8 percent through 2040,
- Forecasted metro employment growth rate of 1.4 to 1.7 percent growth in transportation and warehousing through 2040,
- Projected population growth rate in the metro area of 1.4 to 1.7 percent through 2030, and
- Forecasted combined tonnage growth rate of 0.6 percent for dry bulks, liquid bulks, grain; and higher tonnage growth rates of 2.4 percent for containers and 3.3 percent for automobiles.

Assuming a low growth rate of 0.7 percent per year, a medium growth rate of 1.2 percent per year, and a high growth rate of 1.7 percent per year, the future marine industrial employment can be expected to increase to just over 12,370 jobs by 2040 under the most likely scenario, 10,550 under the slow growth scenario, and 14,480 jobs for the high growth scenario (see **Table 3-18**).

Table 3-18 Marine Industrial Employment Forecast for the Portland Harbor

Year	Low (0.7 % Growth Rate)	Most Likely (1.2 % Growth Rate)	High (1.7 % Growth Rate)
2008	8,440	8,440	8,440
2020	9,180	9,740	10,330
2030	9,840	10,980	12,230
2040	10,550	12,370	14,480

3.5 SUMMARY

Prior to the current recession, economic and population growth in the Portland metro region outpaced growth elsewhere in the nation. Economic activity is expected to begin recovering in 2010, with employment and population growth expected to average 1.4 percent and 1.5 percent, respectively, through 2030. A primary source of past economic growth in Portland has been marine-related economic activity, including marine industrial and marine cargo uses. These uses are projected to continue to grow over the next 30-years, with particular growth forecasted in the marine cargo and related transportation, warehousing, utility, and wholesale trade sectors.

The forecasts for cargo and employment have low, most likely, and high estimates, and yet still exclude the significant uncertainty represented by future markets development. New markets are perhaps the most uncertain area since a new market can develop rapidly as a result of global economic forces, new technologies, and policy developments. Interviews with planners, industry representatives, and commodity forecasters, indicates that new markets are the most difficult to predict factors for both cargo and marine industrial growth, and the most important.

Growth in marine cargo over the 30-year planning horizon to 2040 is expected to vary by cargo type, but is projected to grow on a most likely average annual rate of between 0.2 percent for breakbulk to 3.3 percent for automobiles. Together, the marine cargo types measured in tonnage (dry bulks, grain, liquid bulks, and breakbulk) are expected to grow at a most likely average annual rate of 0.6 percent (average annual growth rate weighted by current tonnage), while containers are expected to increase at an annual rate of 2.4 percent for containers, and automobiles at a rate of 3.3 percent annually.

Growth in marine-industrial employment is expected to roughly mirror economic growth trends in the region, as some elements are expected to grow less slowly (manufacturing), while others are expected to grow more rapidly (transportation and warehousing). Growth rates in marine industrial employment are projected to vary from between 0.7 percent to 1.7 percent, with total employment estimated to increase by 2,100 jobs to 6,000 jobs.

As identified in the 2006 trade capacity study, availability of marine industrial land and adequate freight handling and transportation system infrastructure are critical to the growth of marine-related employment. Development of additional lands and facilities will likely be necessary to meet the projected growth in these sectors. If so, land availability for marine industrial development on West Hayden Island may be able to play a critical role in providing the infrastructure and lands necessary to take advantage of growth in these industries. These issues will be addressed in subsequent sections of this study.

SECTION 4

Marine-Related Site Suitability

The purpose of this section is to provide an understanding of site suitability and constraints for marine-related uses, including both marine cargo and marine industrial uses. Site suitability is assessed for six marine cargo types: automobiles, liquid bulk, grain dry bulk, other dry bulk, containers, and breakbulk. Site suitability is also assessed for two marine industrial types: vessel related services and marine-dependent manufacturing.[29] Requirements for a given marine-related use vary depending on site and use-specific needs. This section is intended to provide a general sense of the site size, water access, and intermodal infrastructure requirements for each of these marine-related uses. Where available, information on trends in these requirements is presented. A brief discussion is also provided on site constraints for marine-related use related to natural resources and environmental contamination.

The information presented in this section will be used to assess the suitability of vacant, waterfront lands in Portland to meet the requirements for marine-related uses (**Section 5**), and to assess the suitability of West Hayden Island (WHI) and other lands in the Lower Columbia River (**Section 6**).

4.1 OVERVIEW OF DATA SOURCES AND KEY ASSUMPTIONS

Sources drawn from include interviews with ports in the Lower Columbia River, master planning documents for the Port of Portland, interviews with river-dependent businesses, interviews with marine transportation planning consultants, and characteristics of marine-related sites in Portland and other ports.

For this analysis, information from a variety of ports regarding terminal characteristics was reviewed to provide generalized information on site requirements common to all marine related uses, as well as information on how site characteristics and requirements differ based on different cargo uses and local market conditions. Port-provided documents, including the rail analysis and conceptual site design for WHI conducted by HDR provide information on infrastructure requirements and a reference point for potential future development considerations for WHI. The recommendations from HDR were analyzed and found to be consistent with terminal size and infrastructure characteristics at other ports, and so were presented as one option for development on WHI.

Apart from review of the HDR conceptual plans, the current analysis does not include identification of WHI development options or an analysis of the tradeoffs associated with different facility sizes. Rather, the analysis presented in this section is a catalog of the range of sites suitable for marine-related uses likely to expand or locate in the study area. The purpose of the analysis is to provide an understanding of the types of sites needed to meet potential marine-related growth. Recognizing the desire for information regarding site design tradeoffs, available information on operational and cost tradeoffs associated with infrastructure design and footprint size is provided. Information of this nature, however, is very limited as these tradeoffs are specific to a particular cargo and tenant rather than widely applicable across uses.

Furthermore, the analysis assumes that characteristics of existing terminals and operating practices are a good predictor of future site requirements. It can be difficult to predict innovations and/or emerging markets in commodity forecasts. It is not part of the scope of this analysis to predict the viability of potential

[29] Marine or vessel related services include barging, cargo handling services, and naval/coast guard services. Marine dependent manufactures are those firms that require marine facilities for the transport of raw and finished product.

technological innovations, either here or abroad. The Port of Portland is in competition with other West Coast ports for market share. Innovations in Europe and Asia indicate what is operationally possible in those environments to increase efficiency, but it does not indicate what is economically or operationally feasible for Columbia River ports. The Port of Portland operates in a very different market, with different labor, land, and infrastructure constraints than those for European and Asian ports.

It is important, however, to recognize that port operating practices and technology are evolving and are improving land use efficiencies at ports worldwide. These practices include expansion of operating hours, smoothing of peak seasonal volumes, increasing capital and labor, and using off-site transfer and storage yards.[30] Such efforts can increase throughput, but also increase operating costs, which can lead shippers to find alternative locations.

4.2 GENERAL SITE SUITABILITY

In general, marine cargo site requirements differ from marine industrial site requirements due to the need for deeper vessel drafts and larger sites. However, the following general site characteristics are required for both marine cargo and marine industrial uses:

- **Sites must be zoned appropriately.** In Portland, appropriate zoning is heavy industrial (IH) or general industrial (IG).
- **Sites need to be relatively flat with contiguous acreage**, preferably in consolidated rectangular shape, with riverfront length of at least 400 feet and depth from the waterfront of at least 400 feet.[31]
- **Sites need to have sufficient draft depth within 150 feet of shore** For a site to be suitable for marine cargo, it typically needs to be able to accommodate vessels with draft depths of 40 feet or more, with minimum draft depth of 35 feet.[32, 33] The predominant trend is towards bigger vessels, with correspondingly deeper loaded vessel drafts and longer berth requirements. This compares to marine industrial uses that rely on barge transportation that require a 20 to 30-foot draft depth.
- **Marine cargo and marine industrial sites both require easy access to water as well as to rail and truck transportation routes.** Businesses interviewed for this analysis spoke repeatedly of the importance of intermodal transportation for their organization (see **Section 2**). Nearly all marine-related uses must be located on a truck route that provides easy access to an interstate highway network, such as Interstate 5 and Interstate 84. Additionally, many marine-related uses need access to an airport. All sites in Portland Harbor have this access with the nearby presence of Portland International Airport. Marine cargo facilities tend to have a greater need for intermodal transportation than that of marine industrial businesses because these facilities handle greater volumes of product. Therefore, marine cargo facilities tend to require land that can sustain a large quantity of rail, often configured as a rail yard or a loop to contain unit trains (in which all cars in the train carry the same cargo). A rail yard, or railroad yard, is a complex series of railroad tracks for storing, sorting, or loading/unloading, railroad cars and/or locomotives. Railroad yards have many tracks in parallel for keeping rolling stock stored off the mainline, so that they do not obstruct the flow of traffic. A site with multiple rail providers is preferred, since competition between rail companies helps to assure lower freight prices.[34]

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30 METRO, Oregon Department of Transportation, Portland Development Commission, Port of Portland and Port of Vancouver. 2006. Portland and Vancouver International and Domestic Trade Capacity Analysis.
31 E.D. Hovee & Company and City of Portland. February 2003. Portland Harbor Industrial Lands Study.
32 E.D. & Hovee and City of Portland. February 2003. Portland Harbor Industrial Lands Study.
33 BST Associates. 2008. Waterfront Lands Analysis. Prepared for the City of Tacoma.
34 Scher, Ben. Automotive Warehouse Company. October 12, 2009. Personal communication with Lee Elder, ENTRIX, Inc.

- **Acreage requirements** for marine cargo sites also tend to be larger than for marine industrial due to the large rail facilities required for many cargo facilities and associated warehousing and distribution facilities.
- **Constraints to both marine cargo and marine industrial development include environmental contamination and requirements to protect natural resources**. For example, it is preferable to have less than 30 percent of a site be covered by wetlands and less than 10 percent of a site within the flood plain.[35] Upland and in-water environmental contamination is also a limitation in that it is costly and often carries high risk of future liability.
- **Security**. Many industrial sites, including marine cargo and marine industrial facilities, require separation with fences or other barriers from public areas for both security of materials and also for public safety. Furthermore, security measures required by the Security and Accountability for every Port Act of 2006 may slightly increase the footprint required for marine terminals sites. For example, random searches of containers by the Coast Guard may slow the movement of cargo through ports. In the future, the Container Security Initiative may also slow the movement of cargo from a foreign port.

Following a discussion of trends in railroad operations and vessel size, this section provides a brief overview of each type of marine related use, together with a discussion of the general characteristics of land use and infrastructure requirements, including draft depth, berth length, and rail access. Existing facilities in Portland and other Lower Columbia and west coast ports are described to provide a sense of existing facility parameters.

4.2.1 Trends

Several rail infrastructure and vessel trends are affecting marine industrial sectors. In general, changes in Class I railroad operations towards longer, unit trains and increasing sizes of marine vessels result in greater infrastructure and site size requirements for marine-related uses, but particularly for marine cargo uses.

4.2.1.1 Rail Requirements

The combined access to rail, marine, and road transportation is critical for many businesses located in Portland Harbor. Portland has a competitive advantage over many other west coast ports as it is served by two Class I railroads, Union Pacific and BNSF (Burlington Northern Sante Fe) Railways, that both have west coast and east-west continental rail lines. Portland is also served by several short line railroads, which serve local customers and also distribute freight to and from the Class I railroads. The east-west rail lines that serve Portland cross the Cascade Range through the Columbia Gorge at river elevation, compared to the more expensive railroad routes from the Puget Sound that cross the Cascade Range through Stevens Pass and Stampede Pass.

Four main line rail routes converge in Portland: 1) BNSF north to Seattle and Vancouver, British Columbia, 2) BNSF east to Chicago via Kansas City, 3) Union Pacific south to Oakland and Los Angeles, then across the Southwest to New Orleans, and 4) Union Pacific east to Chicago via Salt Lake City and Denver. Access to this rail infrastructure is a key requirement for many marine industrial and marine cargo uses, but the type of access and associated site requirements varies by use as will be described below. However, several trends affecting nearly all marine-related uses are noteworthy.

First, the railroads are using longer trains. BNSF has required that all of their intermodal trains will be 8,000 feet in length, which allows them to increase the amount of freight that can be handled on the mainlines

[35] E.D. Hovee & Company and City of Portland. February 2003. Portland Harbor Industrial Lands Study.

without having to increase the number of trains.[36] Use of these longer trains requires additional rail yard capacity to assemble and hold the longer trains and longer sidings to permit trains to meet and pass.

Second, due to increased demand on Class I railroads and resulting congestion, the railroads are changing their business model to become more wholesale carriers and focusing on long-haul trains with intermodal containers or unit trains with bulk commodities such as grain.[37] These types of cargoes are typically hauled long distances with few stops, putting the least pressure on the rail networks, thereby minimizing costs and congestion. Railroads have focused on mainline 'hook and haul' service; this requires short line railroads and truckers to consolidate shipments in larger terminals as the railroads have started declining requests to service smaller carload traffic (2, 5, or 10 cars).[38] For shippers that are located on a mainline that do not assemble unit trains, the railroads are requiring that the facility have siding tracks off of the mainline for loading and unloading and that all trains must enter and leave the sidings at relatively high speeds.

Unit trains are typically 8,000 to 10,000 feet long, and typically require storage track off of the main rail line near the terminal where trains can be 'chambered' until needed at the terminal. Also needed at the terminal are loop tracks or long working tracks for loading and unloading. As today's unit trains are typically 110-cars of 62 feet, working tracks plus track through the loading/unloading area requires approximately 3 acres of land without any at-grade crossings. Based on design specifications from BNSF and UPRR, the design of an industrial loop track for loading and unloading would require a footprint of approximately 1 mile long and over one-quarter of a mile wide.[39] Shorter tracks require doubling or tripling over into multiple tracks, which undesirably breaks the unit train.

These shifts towards longer trains and 'hook and haul' service of unit trains have consequences for the suitability of sites for both marine cargo and marine industrial uses. Marine cargo uses such as dry bulk, container, and auto should have access to on-site or adjacent rail facilities for loading unit trains; this requires more acreage than older facilities. Marine industrial uses will also require more services from short line railroads and also rail capacity to assemble their carloads.

4.2.1.2 Vessel Size

For nearly all cargo types, vessels are becoming larger, with deeper draft and longer berth requirements. **Table 4-1** summarizes forecasted vessel lengths and associated loaded drafts for existing and forecasted future vessels. This is particularly true for container vessels, as summarized in **Table 4-1**. Container vessels currently operating are classified as Panamax and Post-Panamax. The draft depth of 43 feet in the Lower Columbia River channel can accommodate Post-Panamax vessels up to 6,000 twenty foot equivalents (TEU), with a length of 1,001 feet. Vessels for automobiles, dry bulk, and liquid bulk cargoes are also expected to increase. Some of the largest vessels, if fully loaded, have deeper drafts than accommodated by the 43-foot Columbia River navigation channel. Thus, the largest vessels in the commercial fleets will either not carry cargoes through Portland, or will not be fully loaded.

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36 HDR Engineering, Inc. 2006. Trade Capacity Study, Task 3 Growth Opportunities Assessment, Outlook on Rail.

37 METRO, Oregon Department of Transportation, Portland Development Commission, Port of Portland and Port of Vancouver. 2006. Portland and Vancouver International and Domestic Trade Capacity Analysis.

38 HDR Engineering, Inc. 2006. Trade Capacity Study, Task 3 Growth Opportunities Assessment, Outlook on Rail.

39 Ibid.

Table 4-1 Existing and Forecasted 30-Year Future Vessel Lengths and Loaded Drafts (Feet)

	Vessel Overall Length (feet)		Vessel Loaded Draft (feet)	
Cargo Type	Existing	Future (30-year forecast)	Existing	Future
Container	965	1,200	39.5	50.0
Auto	640	760	32.2	37.1
Dry Bulk	738	805	42.0	44.9
Liquid Bulk	804	935	42.98	47.9

Table source: HDR Engineering, 2009, West Hayden ISloand Marine Terminal Site and Operation Requirements.

This increasing vessel size has implications for site suitability as larger vessels require longer berth lengths. For example, existing auto vessels require a berth length of approximately 400 feet (assuming local availability of barges for use as floating dock platforms), while the forecasted future auto fleet will require a berth of up to 480 to 500 feet in length.[40] Additionally, larger vessel sizes indicate a greater spike in cargo volumes handled with each incoming or outgoing vessel.. This, in turn, increases terminal capacity requirements, as more infrastructure and space is required to handle larger volumes of cargo at a given time.

4.3 MARINE CARGO SITE SUITABILITY

Marine cargo uses are assessed for six cargo types (similar to **Section 3**): automobiles, liquid bulk, grain dry bulk, other dry bulk, containers, and breakbulk. The text below describes specific characteristics of each of these marine cargo facility types. Site requirements differ amongst cargo types due to the differences in vessel size used for each cargo type, which affects berth length and draft depth requirements. A vessel's overall length (LOA) largely determines the berth length requirement, which in turn determines the shoreline length of acreage required at a site. Additionally, rail infrastructure and associated acreage requirements differ by cargo type. Following the narrative discussion of each cargo type, a summary section provides a table of general site requirements by cargo type (see **Section 4.6**).

Ranges are provided for site suitability characteristics. Even for one cargo type, site suitability depends on a wide range of factors, based on the specific cargo being handled, the operational characteristics of the terminal, labor market conditions and agreements, and specific site and local market considerations. An examination of just one use, such as container cargo terminals, will reveal very different site sizes and configurations at different ports and even at the same port.

As noted above, trends in marine cargo transportation that may affect the suitability of sites include larger vessels that have deeper drafts and longer unit trains that require larger rail yards. A recent report completed for the Port of Portland recommends that future terminal sites have a rail capacity to hold a minimum of an 8,500- foot train, and have working track lengths in the 2,500 to 3,500 foot range.[41]

It is also important to note that marine terminals typically require acreage not only for specific marine terminal operations for each cargo type as described below, but also for access roads, rail lines, maintenance areas, administrative buildings, and terminal storage space. For example, the Port of Portland's Terminal 6 has 522 acres. Of this acreage, there is a container terminal of 200 acres, of which 17 acres is presently used for breakbulk operations and two automobile terminals totaling 227 acres. The remaining acreage is used for rail, road, and general terminal operations, or is presently used for non-marine cargo (Suttle Road site). The

40 HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal Site and Operation Requirements.
41 HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal Site and Operation Requirements.

data on total acreage for all terminal operations was not available for many marine terminals, therefore acreages listed in the sections below often represent the size of core terminal operations, as noted in the text.

Finally, the berth lengths listed below typically represent the dockface length only and do not include berthing and mooring dolphins that extend the length of the berth or provide a mooring point. These dolphins can extend the dockface by 300 feet (150 feet on both ends of the dock).

4.3.1 Automobile

Automobiles are classified as roll on-roll off (RO/RO) cargo since they are driven on and off of transport ships. West coast ports serve as gateways for Asian automakers importing vehicles into the United States. Portland is the largest volume auto import port along the west coast, with Toyota, Hyundai, and Honda using Port of Portland facilities (Terminals 4 and Terminal 6).[42]

The Port of Portland is a desirable location for automobile importers due to lower rail rates and the fresh water environment, which results in less salt damage to the automobiles than in seawater ports. In addition, Portland is the gateway to the west for rail, and most automobiles imported through the Port of Portland are transported overland via rail.[43] Newer automotive rail ramps are double ended and can accommodate two blocks of five to seven cars. A rail design for a potential automotive terminal for the Port of Portland recommended 12 load lines of approximately 180 feet in length, and requiring five acres. Regarding draft requirements, automotive transport vessels that make calls to the Port of Portland typically require at minimum a draft depth of 32 feet (e.g. Toyota) and future vessels may require 37 feet.[44]

Automobile facilities at Port of Portland range in size from 75 to 120 acres. The Toyota facility has two berths, one that is 410 feet and another that is 950 feet. Other west coast ports with automobile imports, such as Long Beach, Vancouver, and Tacoma, have similarly sized automobile facilities. The Port of Long Beach Toyota facility is 168 acres in size and includes 110 acres of open storage area, 18 acres of rail facilities, four acres of warehousing/processing, 15 acres of truck staging, and 20 acres of employee parking.[45] The depth of this facility's docking area is 38 feet and the berth length is 1,300 feet.[46] The Subaru facility at the Port of Vancouver covers 90 acres and has a 1,040-foot berth.[47] The Marshall Avenue Auto Facility at the Port of Tacoma is approximately 165 acres in size and can handle 25,000 vehicles at any given time.[48] The acreage includes buildings covering 148,000 square feet (3.4 acres), as well as 72 dedicated railcar spots.[49]

Automobile manufacturers differ in how they operate their port facilities, which affects vehicle movement, number and type of employees (and associated parking requirements), building location and type, and overall site size requirements. For example, in Portland Harbor some automobile manufacturers such as Toyota and Honda aim to transport their vehicles from the harbor shortly after arrival by vessel, while others such as Hyundai store their vehicles at Port facilities for longer periods.[50] Site requirements also differ as Toyota adds accessories after manufacturing at their site, while Honda does not. Most automobile manufacturers also

42 Port of Portland. Fast Facts. Website (http://www.portofportland.com/fastfacts_marine.aspx) accessed December 31, 2009.
43 Seher, Ben. Automotive Warehouse Company. October 12, 2009. Personal communication with Lee Elder, ENTRIX, Inc.
44 Ibid.
45 Freeman, Audie. Toyota Logistics Services, National Logistics Manager. May 7, 2000. Personal communication with ENTRIX staff.
46 Port of Long Beach, Toyota Logistical Services. Website (http://www.polb.com/economics/cargotenant/bbroro/toyotalogistics.asp) accessed January 2, 2010.
47 Port of Vancouver, Autos. Website (http://www.portvanusa.com/marine-terminals/autos) accessed January 2, 2010.
48 Ibid.
49 Elmaleh, Andre, Director of Auto Imports. May 7, 2010. Personal communication with ENTRIX staff.
50 This is due to differences in supply chain management. Toyota operates on a pull strategy, in which shipments respond to consumer demand and 'pulls' the product through the supply chain. Honda operates on a 'push' strategy that is based on products being pushed through the supply chain based on manufacturing production levels set in accordance with historical demand from retailers.

desire space to have a facility to do repairs and touchups to the imported automobiles, and also require a fueling station to provide gasoline for newly arrived cars.[51]

Operational differences between manufacturers result in different land requirements for a given automobile throughput, but at a minimum, a large parcel of approximately 100 acres is required for an automobile cargo terminal. Automotive terminal design requirements completed recently for the Port of Portland recommend a terminal of 75 to 125 acres.[52] This design includes a marshalling area to manage cargo flow, 5 acres of loading and unloading area, a multimodal rail yard, and a processing center for offices, vehicle repairs and cleaning, employee parking, and a truck gate area. Total acreage requirement is 140 acres for the terminal area and 30 acres for the intermodal rail yard.

4.3.2 Container

The containerization of shipments began in 1960 and allows for greater ease in transferring goods between ships, docks, trucks and rail. Containers are standardized rectangular boxes used in the transport of cargo, with a width of eight feet, a height of either 8.5 feet or 9.5 feet, and a length of 10 feet to 40 feet. Goods transported by container are varied, including such products as tennis shoes and tires. The throughput capacity of a container terminal is measured in twenty foot equivalents (TEUs) and is equal to one 20 feet x 8.5 feet x 8 feet container. Containers are moved to and from ships with cranes, and are moved in the storage yard with a variety of stacking equipment.

Marine vessels for container cargo are currently in the 965 to 985 feet range and have a loaded draft requirement of 39.6 to 42.7 feet. Vessel size is expected to continue to grow, partly due to the planned construction of two sets of locks at the Panama Canal to accommodate larger container cargo ships. Future Panamax and Post-Panamax vessels will be in the 1,100 to 1,200 feet range with a draft requirement of approximately 46 to 50 feet.[53] Post-Panamax vessels are super-sized ships capable of carrying three times more cargo than ships now transiting the canal.

As the size of container vessels are increasing, many ports are taking the necessary steps to accommodate the larger vessels. For example, the Port of Oakland is dredging to achieve a draft of 50 feet and redeveloping the foundations of their wharf to sustain the weight of increased loads. The Port of Prince Rupert is anticipating expansion of their container facilities by 80 acres, and plans to add one berth that is 1,443 feet in length in water that is 59 feet deep. In total, this will bring the total acreage of this container facility to 139 acres.[54] This container terminal is relatively smaller than many other terminals as all containers at this facility go directly onto rail; there is no trucking or intermodal facility.

West coast container terminals range in size from approximately 50 to 400 acres. The Port of Portland has a container terminal at Terminal 6 that is 232 gross acres, including 20 acres of rail yard and 7 acres for road access. Approximately 193 of the Terminal 6 acres are for container terminal operations. The on-dock intermodal rail yard has annual capacity for 1,100 trains. The Port of Tacoma has six container terminals. Each has a draft depth of 51 feet and all but one has two berths, with each berth having a length of 1,100 to 1,300 feet.[55] The APM container terminal at the Port of Tacoma has 135 acres, but utilizes an intermodal rail yard that is an additional 32 acres.

51 Seher, Ben, Automotive Warehouse Company. October 12, 2009. Personal communication with Lee Elder, ENTRIX, Inc.

52 HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal site and Operation Requirements.

53 Ibid.

54 Prince Rupert Port Authority. January 2, 2010. The Prince Rupert Container Facility Development – Phase 2, Website (http://www.rupertport.com/container2.html).

55 Port of Tacoma, Container Terminals, Website (http://www.portoftacoma.com/Page.aspx?nid=102) accessed January 2, 2010.

The Port of Long Beach has seven container terminals ranging in size from 70 acres to 385 acres, with rail infrastructure occupying a large proportion of terminal acreage.[56] Of the container terminals in Long Beach, all but two have rail onsite or are located near rail yards, and these two terminals are currently expanding to have rail.[57] The terminal that is 70 acres in size does not have rail, so containers are moved to their destination via truck, which is the appropriate mode for the products handled at this terminal.[58] Each of the container terminals at Long Beach also has a truck queue area that requires additional space at the terminal. Additionally, customs officers inspect the containers two to three times each day, and require an inspection area of 100 square feet. Total berth lengths for these container terminals are between 1,800 and 6,379 feet and the design depths for the berths are between 36 and 55 feet.[59]

In the past, increases in container terminal throughput volumes were typically accomplished by expanding wharfs and increasing the amount of land within the container yard. As port land has become increasingly scarce, other methods of increasing throughput have been employed based on economic considerations related to local labor agreements/practices, scarcity of land, mix of intermodal rail versus local truck/barge transport, and capital costs.[60] These methods include the reduction of container dwell time, the use of 'off-dock' facilities, and by increasing container storage density.[61] As the ground space density increases, the labor costs of stacking operations also climbs, making these operations uncompetitive once density exceeds 200 to 300 TEU per acre.[62] The technology at the Port of Los Angeles and Long Beach container terminals require more labor and an increase in unproductive lifts. Therefore, higher ground space productivity is more suitable in ports where labor is relatively inexpensive and land costs are high.

Another method to reduce waterfront land requirements is to move containers to an offsite storage yard, although this creates an additional cost of transporting containers to the offsite yard. For example, the Port of Hong Kong and the Port of Long Beach are using a remote container yard to improve capacity.[63] At the Port of Hong Kong, imported containers are immediately loaded onto a train and moved to a sorting yard off of the terminal site. Export containers are directly delivered to the terminal by truck or rail. This reduces the amount of container storage space required within the container terminal, but does increase the handling time to transport the containers.[64] However, while such operations are competitive in the Long Beach and Hong Kong markets, ports in the Lower Columbia River face very different market factors including different levels of land constraints, labor conditions, and cargo products.

A recently completed Port of Portland report suggests a future container terminal with a 140-acre footprint.[65] This footprint includes the acreage required for a loop track to accommodate a unit train. Portland's competitive advantage for container traffic is its excellent rail service. Intermodal infrastructure that enables assemblage and storage of unit trains helps to compensate for the additional time required for traveling up the Columbia River from the ocean. The acreage required for a container cargo terminal and associated land uses varies based on configuration and throughput, but when evaluating acreage requirements for container

[56] Martin, Caroline, Vice President of Customer Service International Transportation Service Inc. (Pier G). May 7, 2010. Personal communication with ENTRIX Staff.

[57] Martin, Caroline, Vice President of Customer Service International Transportation Service Inc. (Pier G). May 7, 2010. Personal communication with ENTRIX Staff.

[58] Baird, Ryan, SSA Marine-Terminal C. May 7, 2010. Personal communication with ENTRIX staff.

[59] Port of Long Beach. Containerized. Website (http://www.polb.com/economics/cargotenant/containerized/default.asp) accessed January 2, 2010.

[60] Ports and Marine, Inc. and Port of Portland. January 2003. Marine Terminal Master Plan.

[61] Ports and Marine, Inc. and Port of Portland. January 2003. Marine Terminal Master Plan.

[62] Le-Griffin, Hanh D. and Melissa Murphy. February 2006. Experiences at the Ports of Los Angeles and Long Beach. NUF Conference Proceedings.

[63] Ibid.

[64] Ports and Marine, Inc in association with Van Sickle Allen & Associates, Inc, JWD Group, HDR Engineering, Inc. January 2003. Marine Terminal Master Plan.

[65] HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal site and Operation Requirements.

facilitates at west coast ports, at a minimum, 100 acres are required for a container cargo terminal and associated infrastructure.

4.3.3 Breakbulk

Breakbulk cargo is shipped in units such as bags, bales, barrels, boxes, cartons, drums, and pallets. In the past, breakbulk products shipped from the Pacific Northwest included forest and agricultural products. However, increasingly these products have been containerized. Many cargoes can be shipped as either breakbulk or container cargo, with the predominant mode being determined by pricing and shipping frequency. Now, the primary breakbulk cargo handled at the Port of Portland is inbound steel used by area manufacturers and the Class I railroads.

Port of Portland breakbulk facilities include Terminal 2 and portions of Terminal 6 used for breakbulk steel cargo.[66] Terminal 2 covers 49 acres, of which 28 acres are dedicated to breakbulk open storage. The remaining acreage is used for a covered warehouse, cranes, a truck lane, and other services.

There are nine breakbulk terminals at the Port of Long Beach that range in size from 15 to 22 acres. The Cooper/T. Smith (CTS) breakbulk Terminal (Pier F) has 21 acres, of which 4.1 acres are covered storage and the rest is open yard. At this facility, almost 100 percent of their product is shipped by truck as rail is less suitable for the goods they handle. In the past they utilized rail for timber/lumber, but they rarely handle this type of product now. The truck queue system for breakbulk is very different from container and requires much less space.[67] The berth lengths for these breakbulk terminals are between 600 and 1,985 feet and have a draft depth of between 32 feet and 43 feet (with the majority being 36 feet deep).[68]

The Port of Vancouver has two existing sites dedicated to breakbulk. There is a 40-acre site and a 70-acre site, with docks 1,250 feet and 1,750 feet in length, respectively, and a draft depth of 40 feet.[69] The Port of Vancouver also has a planned breakbulk facility at Terminal 5 that would be 218 acres.

As indicated above, site size for breakbulk varies substantially depending on the cargo and whether it will be transported by rail or by truck, as well as other operating considerations. Regarding rail infrastructure, to increase operational efficiency, a breakbulk terminal would have a loop track and on-dock track connectivity.[70] In general, sites for breakbulk cargo require a minimum of 20 acres if rail is not required, to up to 70 to 100 acres for cargoes requiring rail access. No designs for a breakbulk terminal have recently been completed for the Port of Portland.

4.3.4 Dry Bulk

Dry bulks include grain, potash, bentonite clay, copper, zinc, soda ash, and a variety of minerals. Typically dry bulks are separated into grain cargo and other dry bulk goods, a convention which is followed in this analysis. Other dry bulk goods can be further separated based on point of origin and destination into local/regional dry bulks and national/international dry bulks.

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66 Ports and Marine, Inc. and Port of Portland. January 2003. Marine Terminal Master Plan.

67 Viner, Ed, Assistant Vice President and Manager of Operations, Cooper/T. Smith (CTS). May 7, 2010. Personal communication with ENTRIX staff.

68 Port of Long Beach. Breakbulk and RO/RO. Website (http://www.polb.com/economics/cargotenant/bbroro/weyerhaeuser.asp) accessed January 2, 2010.

69 Ibid.

70 Ports and Marine, Inc. and Port of Portland. January 2003. Marine Terminal Master Plan.

4.3.4.1 Local/Regional Dry Bulk

The local/regional dry bulks are typically smaller volume dry bulks that are imported/exported in support of industry located in the immediate region of the terminal. Examples here include cement, salt, gypsum, aggregates, etc. These terminals are usually a mix of rail and truck and do not need to support train activity on-site. They therefore tend to have smaller footprints.

The Port of Long Beach has seven terminals that specialize in local/regional dry bulks. Five out of these seven terminals are less than ten acres in size and do not have rail facilities. The largest of the seven is a 23-acre terminal that handles petroleum coke, coal, potash, borax, soda ash, and a variety of other minerals. This facility has rail capacity for two 100-car unit trains. The majority of these terminals have berths in the 550 to 650 feet range; however, two of the terminals have total berth lengths of 1,100 feet and 1,900 feet.[71] Among other facilities, local/regional dry bulks are handled at the 27-acre Simplot facility in Portland Harbor. Construction materials are handled at other local/regional dry bulk terminals in Portland Harbor. The Port of Vancouver, USA has a five-acre dry bulk terminal that has a berth 800 feet in length and a depth of 40 feet.

As indicated by the size of these facilities, local/regional dry bulk marine terminals can be quite small relative to other marine terminals, with footprints that vary from less than 10 acres to 30 acres in size. Their smaller size is due in part to the fact that they do not depend as heavily on rail infrastructure as national/international dry bulk terminals.

4.3.4.2 National/International Dry Bulk

The national/international terminals serve cargos that are railed in from other parts of the US or Canada in unit trains. These terminals require larger footprints to support terminal rail infrastructure. National/international dry bulks exported through the Port of Portland include potash mined in Saskatchewan (Terminal 5) and soda ash mined in Wyoming (Terminal 4).[72] The potash terminal at Terminal 5 is 120 acres, and has rail capacity for 220 tank cars on loop tracks. The soda ash terminal is 25 acres, but this acreage footprint does not include much of the rail and road acreage used to support terminal operations. National/international dry bulks typically arrive by barge and train at the Port of Portland, and are then transferred to dry bulk vessel, or freighters. Freighters are currently 738 feet LOA and require drafts of 42 feet. By 2040, it is anticipated that dry bulk vessels will increase to 805 feet LOA and have a draft requirement of 45 feet.[73]

At the Port of Vancouver, dry bulks such as copper concentrate and bentonite clay are exported through Terminal 2. Approximately 34 acres of this terminal are dedicated to dry bulk operations, but this acreage does not include rail infrastructure. The terminal includes a loop track capable of handling 104-car unit trains, bulk sheds with approximately 160,000 square feet of space, and a recently added 72,000 square foot storage facility for copper concentrate.[74] The Port of Prince Rupert has a state-of-the-art 136-acre dry bulk facility that handles coal. This facility is considered a world leader as it has sufficient rail infrastructure to efficiently transfer coal between marine vessels and unit trains.[75]

A study recently conducted for the Port of Portland anticipates that a future national/international dry bulk facility in Portland would require between 125 and 155 acres, including rail infrastructure with an overall

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71 Port of Long Beach. Dry Bulk, Website (http://www.polb.com/economics/cargotenant/dry/picrg.asp) accessed January 2, 2010.

72 BST Associates and Washington Public Ports Association and Washington Stage Department of Transportation. March 23, 2009. 2009 Marine cargo Forecast Technical Report.

73 HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal site and Operation Requirements.

74 BST Associates. 2010. West Hayden Island Marine Cargo Forecasts and Capacity Assessment. Prepared for the Port of Portland.

75 Prince Rupert Port Authority. Riley Terminal: Most Advanced of Its Kind. Website (http://www.rupertport.com/ridleyterminals.htm) accessed January 12, 2010.

track length of 7,000 to 10,000 feet. [76] The terminal rail loop would be multi-tracked to provide adequate track length depending on the operation.

4.3.5 Grain

The Columbia River is the third largest grain exporting region in the world and Portland Harbor is the number one exporter of wheat along the Columbia River.[77] The majority of grain exported from the Port of Portland is wheat with barley, with increasing amounts of feed grains (corn and soybeans) from the mid-western United States also being exported. Grain is exported by three grain terminals in the Portland Harbor including Columbia Grain at Terminal 5 and Cargill Louis Dreyfus (CLD) Pacific Grains at Irving, and the LDC Berth or "O" Dock.[78] The CLD grain terminal berth is 327 feet in length and the Columbia Grain terminal is 928 feet in length.[79]

Approximately 40 percent of grain delivered to Portland arrives by barge, with the remainder delivered by rail.[80] Grain is moved by rail on unit trains, which are trains that comprised of cars with the same cargo. Bulk grain rail loading and unloading ideally requires a loop train that can handle a 110-car train in six to eight hours.

A new 108-acre grain terminal is being constructed at the Port of Longview. A unique feature of the terminal is the ability of the facility to hold four 110-unit trains simultaneously.[81] Similar to the existing Kalama Export Company terminal in Kalama, the new Longview terminal will be able to handle both wheat/barley and feed grains (corn and soybeans). Feed grains are shipped in unit trains from the Midwest. The relatively new grain terminal at the Port of Prince Rupert is 100 acres and has a draft depth of 48 feet. The older grain terminal at the Port of Vancouver USA is 45 acres. This terminal has a berth length of 715 feet and a draft depth of 40 feet.[82]

As previously described, existing dry bulk vessels are typically 738 feet and have a draft of 42 feet. It is anticipated that dry bulk vessels will increase to 805 feet in length and have a draft of 45 feet.[83] In addition to the need to accommodate larger vessels, new grain terminals such as the terminal at the Port of Longview are being constructed to handle unit trains. This capacity is necessary to ensure that a facility can efficiently load and unload trains according to the Class I railroads 'hook and haul' procedures, and also ensure the most cost effective rail rates. A grain terminal with loop tracks sufficient to have capacity for unit trains is expected to require a footprint of 100 acres or more.

4.3.6 Liquid Bulk

Waterborne liquid cargo is transported via a tanker or a tank ship. Typically tankers carry hydrocarbons, chemicals, water, and agricultural products. A liquid bulk vessel or tanker is approximately 804 feet in length and draws 43 feet of draft when loaded. It is anticipated that over the next 30 years, liquid bulk vessels will

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76 HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal site and Operation Requirements.

77 Port of Portland. Fast Facts. Website (http://www.portofportland.com/fastfacts_marine.aspx) accessed December 31, 2009.

78 Port of Portland. January 2003. Marine Terminal Master Plan, Prepared by Ports and Marine, Inc.

79 Columbia River Pilots. River Docks. Website (http://www.colrip.com/pages/Docks.aspx) accessed January 12, 2010.

80 Carrtracks. International Container and Port Statistics, Website (http://www.carrtracks.com/portstat.htm) accessed December 31, 2009.

81 *Seattle Times*, Joint Venture to Build Longview Grain Terminal, Website (http://seattletimes.nwsource.com/html/businesstechnology/2009287598_weblongview01.html) accessed January 2, 2010.

82 Port of Vancouver. Dry bulk. Website (http://www.portvanusa.com/marine-terminals/dry-bulk) accessed January 2, 2010.

83 HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal site and Operation Requirements.

increase in size to 935 to 1,000 feet in length and will have a loaded draft of 48 feet.[84] In many respects, a liquid bulk terminal is configured and operated similarly to that of a dry bulk terminal.[85]

Liquid bulk facilities tend to be smaller than other cargo facilities. Port of Portland's Terminal 4 has a liquid bulk facility that is six acres in size and handles liquid fertilizer. Kinder Morgan's Linnton and Willbridge Cove liquid bulk operations are, respectively, located on 17 and 44-acre sites.[86] The vast majority of the liquid terminals in the Portland Harbor are petroleum terminals that are located along the western bank of the Willamette River in the Linton or Willbridge Cove area, because this area is adjacent to the Olympic Pipeline, which transports petroleum.

The Port of Long Beach has seven liquid bulk terminals with six of these being less than 11 acres in size and the largest being 18 acres. The range of berth length at these terminals ranges between 700 feet and 1,980 feet with depths between 36 feet and 52 feet.[87] The Port of Vancouver, USA liquid bulk terminal, operated by NuStar is 14 acres and has a berth of 400 feet in length and a berth depth of 40 feet.

Due to the potential environmental contamination associated with an oil spill, terminals that handle petroleum require a physical separation of their operations from the public. Ideally, operators of these facilities would desire their facilities to be remotely located and isolated from public spaces. However, liquid bulk facilities, including those handling petroleum product, are often located in areas that have only fences separating the facilities from public streets or recreation paths. As oil products are not typically explosive, the primary public safety risk is environmental contamination.[88]

A study recently conducted for the Port of Portland anticipates that a future, large liquid bulk facility in Portland could require between 125 and 155 acres, including rail infrastructure, truck loading, product blending, and tank storage areas. [89] This size of terminal could accommodate refining and pipeline operations within a rail storage loading loop. Terminal layout and size, however, would vary substantially based on the business operations and the type of product handled. Operations similar to existing facilities in Portland Harbor would utilize much less acreage, within the range of 10 to 50 acres.

4.4 MARINE INDUSTRIAL SITE SUITABILITY

A 2004 City of Portland study evaluated the businesses that are located along the Willamette River and rely on water access. In addition to marine cargo facilities, these river-dependent businesses include marine and vessel related services and marine-dependent manufactures.[90]

Marine or vessel-related services include barging, cargo handling services, and naval/coast guard services. Marine-dependent manufactures are those firms that require marine facilities for the transport of raw and finished product. The characteristics and general site requirements of these marine industrial businesses are discussed in greater detail below.

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84 HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal site and Operation Requirements.
85 Ibid.
86 Kinder Morgan. Pacific Operations. Website (http://www.kindermorgan.com/business/products_pipelines/terminals_W_willbridge.cfm) accessed January 12, 2010.
87 Port of Long Beach. Liquid Bulk. Website (http://www.polb.com/economics/cargotenant/liquid/default.asp) accessed January 2, 2010.
88 U.S. Army Corps of Engineers. Pacific LA Marine Terminal LLC, Crude Oil Terminal Draft Project: Environmental Review. Accessed at http://www.portoflosangeles.org/EIR/PacificLAMarine/SEIR/_Overview.pdf.
89 HDR Engineering and Port of Portland. October 2009. West Hayden Island Marine Terminal site and Operation Requirements.
90 E.D. Hovee & Company and City of Portland. February 2003. Portland Harbor Industrial Lands Study.

4.4.1 Marine and Vessel-Related Services and Operations

Barging is the process of pulling or pushing a flat bottom floating platform with the assistance of a tug boat. Much of the barge traffic along the Lower Columbia River is supplying grain from eastern Washington and Oregon to terminals in the Port of Portland, Port of Vancouver, Port of Kalama, and the Port of Longview. Approximately 40 percent of the grain that these terminals receive is transported via barge. Barge companies require access to water in order to provide this service to grain elevators and to other companies. For example, Tidewater operates facilities in the Port of Vancouver USA and Foss Maritime operates a 10-acre site in Portland. The berth length at both of these facilities is 700 feet.[91]

Commercial barge traffic on the Columbia River upstream of Portland includes tugs and barges for the movement of commodities.[92] Typical commodities moved downstream include agriculture products and the upstream movement of goods includes petroleum, fertilizer, and chemicals. There are three to four tons of cargo moved downstream for every ton moved upstream.

Barges on the Columbia-Snake River system typically use one tug for multiple barges. These barges are based upon the size of the locks on the Columbia-Snake River system, and are typically 42 feet wide (with doublewides 84 feet in width). Individual barge lengths vary between 150 feet and 300 feet. Fully loaded barges on the Columbia River typically draw 13.5 feet of water.[93] Additional tug activity for the Port of Portland involves ship assist. In Portland, the business that operates these tugs is Foss Maritime.[94]

Other vessel-related services include shipyards that repair and build ships. Typical site characteristics of shipyards include docking facilities, dry docks, floating dry docks and onsite storage for boats while they are cleaned and repaired. Portland Shipyard is operated by Cascade General and is one of the world's largest ship repair facilities. It is located on a 60-acre site in the Swan Island area of Portland Harbor. It has two dry docks, one 661 feet long by 112 feet wide and the other is 598 feet long by 88 feet wide.[95] The berth lengths available at the Cascade General yard are between 780 feet and 3,900 feet.[96] The Port of Seattle has the Todd Pacific Shipyard and it occupies a 46-acre site and has multiple berths ranging from 590 feet through 1,400 feet.[97]

Finally, marine industrially uses include facilities to preserve marine safety. In Portland, the Coast Guard marine safety site is located on an eight-acre site in the Swan Island area, and has two berths, one is 175 feet and the other is 330 feet.[98] Other federal government presence occupying river frontage is that of the Army Corp of Engineers dredging base, which is located at the Port of Portland Terminal 2.

4.4.2 Marine-Dependent Manufacturing

There are a number of manufacturing firms that require deep water access to perform business operations. Some examples of this are barge manufacturing, recyclers, and steel product manufacturing. For example, Oregon Steel Mills previously used its docking facilities to unload material, but recently began using

91 Army Corp of Engineers. Total Waterborne Commerce, Columbia River Basin, OR, WA, and ID. Website (http://www.iwr.usace.army.mil/ndc/lpms/pdf/bydist/portland.pdf) accessed January 12, 2010.

92 PB Ports and Marine and Southwest Washington Regional Transportation Council. March 2003. SR-35 Bridge Feasibility Study.

93 Ibid.

94 Washington Business Magazine. Member Profile - FOSS MARITIME: Pulling Their Weight at Sea. Website (http://www.awb.org/articles/magazine-sepoct2005/member_profile_foss_maritime_pulling_their_weight_at_sea.htm) accessed January 6, 2010.

95 Cascade General. Portland Shipyard. Website (http://www.casgen.com/profile/portland_shipyard/index.htm) accessed January 3, 2010.

96 Army Corp of Engineers. Total Waterborne Commerce, Columbia River Basin, OR, WA, and ID. Website (http://www.iwr.usace.army.mil/ndc/lpms/pdf/bydist/portland.pdf) accessed January 12, 2010.

97 Todd Pacific Shipyards. The Todd Story, Website (http://www.toddpacific.com/company/todd_story.php) accessed January 12, 2010.

98 Army Corp of Engineers. Total Waterborne Commerce, Columbia River Basin, OR, WA, and ID. Website (http://www.iwr.usace.army.mil/ndc/lpms/pdf/bydist/portland.pdf) accessed January 12, 2010.

Terminal 6 for receiving. Schnitzer Steel disassembles machinery and other metal fabrication to send to Asia on barges for recycling into new metal components.[99] Schnitzer Steel is approximately 150 acres in size and has three berths with lengths between 600 and 700 feet, while Oregon Steel Mills is 170 acres in size and has 994 feet of berth space.[100] The Schnitzer Steel sites in the Port of Oakland and in the Port of Tacoma are 30 and 20 acres, respectively.[101] The Port of Oakland facilities have three berths sized at 500 feet, 700 feet, and 875 feet.[102]

Marine barges are typically larger than those that travel within the Columbia-Snake River system and are built to deal with rough seas. A typical marine barge can be 300 feet or larger.[103] Portland Harbor is the home of multiple marine barge manufactures including Gunderson and Zidell. These firms use deep water access to ship finished barges to clients. Zidell Marine Corporation builds marine barges up to 90 feet wide and up to 900 feet long.[104] The Zidell shipyard is located near the Ross Island Bridge, further upstream than the Steel Bridge. Gunderson is located on approximately 70 acres near Terminal 2.

4.5 SITE CONSTRAINTS

Two significant constraints to marine-related development in Portland Harbor frequently cited in recent studies are the sensitive natural resources and the environmental contamination that are frequently in riverfront areas. This section provides an overview of the constraints to marine-related development when these features are present.

4.5.1 Environmental Contamination Constraints

This section describes how upland contamination and Superfund contamination affects the suitability of sites for marine industrial development.

4.5.1.1 Brownfields

A brownfield is a site where environmental contamination or the possibility of contamination is preventing that property's redevelopment.[105] The Oregon Department of Environmental Quality tracks upland contamination, both from potentially leaking underground storage tanks and from other sources. Several studies on Portland Harbor have included interviews of local industrial land users about brownfield development.[106] These studies have found that industry representatives view the costs and the long term liability of these sites as a major constraint. Most of the industry representatives were interested in brownfield development, but were concerned about liability and financing of brownfield site purchase. Many people interviewed stated that brownfield development requires appropriate financial incentives and limited liability.

99 Van Der Voo. Lee, August 27, 2007. *Portland Tribune*. Harbor Growth Stalls.

100 Army Corp of Engineers. Total Waterborne Commerce. Columbia River Basin, OR, WA, and ID. Website (http://www.iwr.usace.army.mil/ndc/lpms/pdf/bydist/portland.pdf) accessed January 12, 2010.

101 Broughton, Anne Clair. September 1995. Website (http://www.sdbmagazine.com/articles/article.asp?ID=3917&CatID=23&SubCatID=73) assessed January 12, 2010.

102 US Army Corp of Engineers. Navigational Data Center. Website (http://www.ndc.iwr.usace.army.mil/ports/ps/psbooks.htm) accessed January 12, 2010.

103 GlobalSecurity.org. Barges. Website (http://www.globalsecurity.org/military/systems/ship/barge.htm) accessed January 12, 2010.

104 Zidell Marine Corporation. Website (http://www.zidellmarine.com/index.htm) accessed January 12, 2010.

105 Portland Bureau of Environmental Services. Portland Brownfield Program. Website (http://www.portlandonline.com/bes/index.cfm?c=35008) accessed January 6, 2010.

106 Working Harbors Reinvestment Strategy. April 18, 2008. Website (http://www.portlandonline.com/bps/index.cfm?c=42598) accessed January 6, 2010. Portland Bureau of Planning. 2003. Portland Harbor Industrial Lands Study Part One: Inventories, Trends and Geographic Context. Davis and Hibbitts. 1998. Report on Industrial Lands Focus Groups.

The primary constraint associated with purchase or lease of a brownfield site is the clean up cost and potential liability for past contamination. **Table 4-2** below illustrates a recent case study comparing the costs of developing a brownfield site to that of developing a greenfield site. The study compared high tech manufacturing, industrial parks, warehouse distribution and general manufacturing business development on both brownfields and greenfields within the Portland area. In every situation the costs of redeveloping a brownfield for a new business venture exceeded the costs of developing a new greenfield site.

Table 4-2 Case Study of Brownfield Development verses Greenfield Development

Characteristics and Costs	High Tech Manufacturer		Industrial Park		Warehouse Distribution		General Manufacturing	
	City of Portland		City of Tualatin		City of Portland		Clackamas County	
	Brownfield	Greenfield	Brownfield	Greenfield	Brownfield	Greenfield	Brownfield	Greenfield
Acreage	37.95	53.20	45.50	44.50	37.95	25.91	37.75	37.95
Building size			630000	630000	400,000	400,000	450,000	450,000
High tech	250,000	250,000						
Office	60,000	60,000						
Cubical	40,000	40,000						
Parking	725 spots	725 spots	1,130 spots	1,130 spots	200 cars & 275 trailers	201 cars & 275 trailers	1,100 spots	1,100 spots
Development Costs								
On site	$127,080,000	$126,000,000	$27,703,800	$30,060,000	$13,722,300	$13,008,000	$25,029,000	$25,200,000
SDC's	$1,383,000	$1,782,663	$1,846,243	$1,713,209	$715,907	$730,069	$1,212,343	$868,675
SDC Credits	-$249,062	$0	-$25,368	$0	-$75,858	$0	-$249,062	$0
Off-Site	$24,000	$1,452,500	$558,000	$5,739,167	$735,000	$290,500	$24,000	$1,347,000
Remediation Costs	$11,100,000	$0	2190000	$0	$1,270,000	$0	$11,100,000	$0
Other Remediation	$16,927,441	$0	$6,558,863	$0	$6,551,776	$0	$11,880,451	$0
Total Costs	$156,265,379	$129,235,163	$38,831,538	$37,512,376	$22,919,125	$14,028,569	$48,996,732	$27,415,675

Source: Port of Portland, Portland Development Commission, City of Portland, METRO, December 2004, Brownfield/Greenfield Development Cost Comparison Study. Prepared by the Mackenzie Group.

4.5.1.2 Superfund

Vacant lands in Portland Harbor are not only potential brownfields with upland contamination, but they also lie adjacent to the Portland Harbor Superfund site. Starting in 2000, a six mile section of the Willamette River, the actual water body, was added to the Superfund site list. A Superfund site is an uncontrolled or abandoned place where hazardous waste is located, possibly affecting local ecosystems or people.[107] Currently, the lower 10 miles of the Willamette River from the Columbia Slough to the Fremont Bridge are within the Portland Harbor Superfund area.

4.5.2 Natural Resource Constraints

Lands bordering the Willamette and Columbia Rivers that may be appropriate for marine industrial uses often contain significant natural resources. Many of these natural resources are regulated by federal, state, regional and local agencies and those regulations can constrain development opportunities. In particular, site design to

[107] EPA. Superfund. Website (http://www.epa.gov/superfund/sites/) accessed January 6, 2010.

avoid impacts on natural resources can increase the cost of development or the amount of land required. Likewise, mitigation for impacts to natural resources may also increase the cost of development and land requirements. Development on sites located along the Columbia River will have to obtain multiple permits under various local, state, regional and federal regulations; however, some sites, due to the type and characteristics of the natural resources, may be more constrained than others.

Over the past 20 years, the City of Portland has identified specific significant natural resources within the city limits and applied overlay zones that require development to generally avoid and minimize impacts to natural resources and to mitigate unavoidable impacts. There are three types of environmental overlay zones in the Portland: protection (p-zone), conservation (c-zone), and river environmental (e-zone). These require protection of "some resources and function values that have been identified by the City as providing benefits to the public".[108] The p-zone provides the highest level of protection, and development will only be approved in this zone for a narrow set of circumstances (e.g., access). Within the c-zone, development is allowed but must avoid and minimize impacts to natural resources to the maximum extent practicable and mitigate unavoidable impacts. Regulations apply not only to development, but also to land divisions and property line adjustments, removal of native vegetation, planting of non-native vegetation, enhancement of resources, or changing of topography through grading, excavating or filling.

In the River Plan/North Reach, a new river environmental overlay (e-zone) is proposed. The e-zone applies in high and medium ranked riparian resource areas. The e-zone is similar to the c-zone, in that it requires avoiding, minimizing, and mitigating impacts, but the e-zone contains specific exemptions and standards for marine industrial development. Regulations that would apply to every proposal include a 50-foot setback for all non river-related/dependent development, enhancement requirements, balanced cut and fill, erosion control, and storm water management. [109]

Other regulations that apply to development along and within the rivers include: Federal Emergency Management Agency (FEMA), Endangered Species Act (ESA), Rivers and Harbors Act, and the Oregon Removal-Fill Law and Clean Water Act (CWA). Under FEMA, development must occur on elevations above the 100-year floodplain. For elevations below this level, fill is required, which must be offset by equivalent cut elsewhere. This cut and fill requirement thus increases costs of development within the 100-year floodplain. Under the federal ESA, federal agencies must ensure that their actions, including any actions they authorize, do not jeopardize listed species or adversely affect their critical habitat. If the project design and implementation plan are deemed adequate, applicants would need permits from state and federal agencies that may include conditions to avoid, minimize, or mitigate expected impacts of the proposed project.

Section 10 of the Rivers and Harbors Act of 1899 also regulates all activities in or over navigable waters of the United States, which extends to the 'ordinary high water mark' or the high tide line. All activities must be permitted that may affect the course, location, condition, or capacity of navigable waters. The Oregon Removal-Fill Law and Section 404 of the federal CWA protect waterways and wetlands in the State of Oregon by regulating the discharge of dredged and fill material into waters of the United States, including wetlands. Finally, the CWA sets standards for point sources of water pollution.

4.6 SUMMARY OF SITE SUITABILITY AND CONSTRAINTS

Marine-related uses share similar site requirements, including 1) zoning (industrial), 2) flat and contiguous lands with shoreline access of 400 feet or more, and 3) proximity to multimodal infrastructure (water, truck, and rail). Differences arise in acreage and water depth requirements, with marine cargo uses typically

[108] Portland Bureau of Development Services. 2007. Title 33, Planning and Zoning Chapter 33.430, Environmental Zones. Accessed online at: http://www.portlandonline.com/bds/index.cfm?c=43093.

[109] Industrial Development and Natural Resources Integration Task Group, March 20, 2008, Meeting #10.

requiring more acreage and deeper water. Specifically, marine cargo facilities are usually sized at 50 acres or more (with the exception of local/regional dry bulk and liquid facilities that can be as small as five acres) and require a minimum draft depth of 35 feet. Marine industrial uses vary considerably in their site size requirements, but are typically at least five acres in size and can be as large as several hundred acres. A draft depth of 20 to 30 feet is required for most marine industrial uses.

Regarding site limitations, marine cargo and marine industrial uses alike face constraints related to sensitive natural resources and brownfield contamination. The presence of either can limit site usage or increase site acreage requirements for mitigation, and increase site development costs.

Table 4-3 summarizes the site characteristics of each marine-related use described above. **Table 4-3** is not an exhaustive analysis of specific businesses that fall into marine cargo and marine industrial classifications. Rather, the intended purpose of **Table 4-3** is to summarize general characteristics and potential requirements of marine cargo and marine industrial sites, based upon representative businesses in Portland Harbor as well as in other west coast ports.

In general, the table indicates that cargo facilities require sites that are typically 50 acres or larger, with the exception of local/regional dry bulk and liquid bulk facilities that may be much smaller. It is important to note that while many existing grain facilities are relatively small, industry trends show that newer facilities are larger to accommodate larger vessels and longer unit trains (to ensure competitive railroad rates). Many of the acreage sizes indicated in **Table 4-3** indicate the core terminal operation footprint, which excludes the rail infrastructure and ancillary structures and operations. Furthermore, the site sizes in **Table 4-3** do not include any acreage required for onsite mitigation or environmental protection. Total acreage, including rail infrastructure and support operations, for new marine cargo facilities handling containers, automobiles, national/international dry bulks, and grain are typically 100 acres or more.

All cargo facilities require minimum draft depths of 35 feet, with a deeper draft more suitable for many cargo types. Berth lengths of most cargo facilities are at least 550 feet, with many larger than 1,000 feet. As noted above, these lengths do not include dolphins, which extend the shoreline length for mooring vessels. This emphasizes the need for sites with at least 400 feet of shoreline length.

Marine industrial sites vary significantly in their requirements, both in terms of acreage, berth length, and channel depth. However with the exception of some vessel-related services, most marine industrial sites require at least a 20-foot draft and a five acre site. Nearly all marine industrial uses require a site with at least 400 feet of riverfront to accommodate a berth, and nearly all require access to rail and truck routes.

Table 4-3 Summary of Site Characteristics for Marine-Related Land Uses

	Acreage Approximation		Water Frontage Approximation		Berth Depth Requirement within 150' of Shore[110]	Rail Infrastructure Requirements
Site Type	Portland Harbor	Other West Coast Harbors	Portland Harbor	West Coast Ports		
Cargo						
Automobile	75 - 120	95 - 168	414' - 1,000	1,040' – 1,300'	35' or greater	Rail Ramp & Nearsite Rail Yard (5+ acres)
Container	193	50 - 385	Total of 2,850' (3 berths)	1,100' – 6,380'	40' or greater	Intermodal Yard (Onsite or Nearby Rail Yard) & Mainline Access
Breakbulk	20 - 50	15 - 75	2005' (2 berths)	600' – 1,750	35' or greater	Nearby Rail Yard & Mainline Access
Grain	40 – 100	40 - 100	327' – 928'	715'	40' or greater	Spur/loop & Nearby Rail Yard & Mainline Access
Dry bulk National/International	25 – 120	34 – 136	740'- 900+'	550' – 1,900	40' or greater	Spur/loop & Nearby Rail Yard & Mainline Access
Dry Bulk Local/Regional	5 – 27	5 – 23	N/A	550' – 1900'	40' or greater	Spur
Liquid bulk	5 – 45	10 - 20	700'	700' – 1,980'	35' or greater	Spur
Industrial						
Vessel Related Services	5 - 60		175' – 3,900'	150- - 1,400'	20' or greater	Spur / None
Marine dependent manufacturing	10 - 170 acres		994' – 1,800'	500' – 875'	20' or greater	Spur

110 This distance from shore is based upon PHILS study, City of Portland, Portland Harbor Industrial Lands Study, February 2003, Prepared by E.D. Hovee & Company.

S E C T I O N 5

Inventory of Portland Harbor Sites for Marine-Related Uses

Following a brief overview of current land use in Portland Harbor, this section provides an inventory of vacant, waterfront lands in the industrial districts in Portland. The lands inventoried for this study are located along the Willamette River downstream of the Fremont Bridge and eastward along the Columbia River to Interstate 5. The purpose of the section is to provide an understanding of the available supply of industrial waterfront land in Portland Harbor, and the characteristics of the land supply relative to the site suitability requirements for marine-related uses outlined in **Section 4**. The section concludes with a comparison of site characteristics required for marine-related uses versus the characteristics of the available waterfront lands in Portland. The focus is an inventory of lands in Portland Harbor; **Section 6** includes an overview assessment of the availability of industrial lands suitable for marine-related uses in other ports on the Lower Columbia River.

5.1 OVERVIEW OF DATA SOURCES AND KEY ASSUMPTIONS

The primary data sources for this section are the GIS and site inventory data from the Economic Opportunities Analysis completed in 2009 for the City of Portland that identifies the vacant land inventory in the City and the level of availability of these lands based on site constraints. Additional data sources include GIS data on designated truck routes from the City of Portland Freight Master Plan and GIS data on Willamette River depths from the Lower Willamette Group. A key assumption in the analysis is that future site requirements will be similar to existing site requirements.

5.2 CURRENT PORTLAND HARBOR LAND USE

The industrial districts in Portland Harbor downstream of the Steel Bridge cover 5,932 acres of land in tax lots.[111] This land encompasses river-dependent marine industrial and marine cargo activities and facilities, as well as rail-dependent uses that are not directly dependent on water access but that utilize the intermodal transportation facilities available in the Harbor area. Land use in Portland Harbor was categorized as river-dependent and/or rail-dependent by the City of Portland for the Working Harbor Reinvestment Strategy. Data from the City indicates that approximately one-third of all employers (33 percent) and jobs (31 percent) in the Portland Harbor are river-dependent, with approximately 1,790 acres in river-dependent uses in 2004.[112]

5.3 INVENTORY OF AVAILABLE LANDS FOR MARINE-RELATED USES

In 2009, the Economic Opportunity Analysis (EOA) completed for the City of Portland inventoried the industrial and commercial lands available for development throughout the City.[113] This analysis classifies

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111 Portland Bureau of Planning. 2003, Portland Harbor Industrial Lands Study Part One: Inventories, Trends and Geographic Context.

112 Oregon Employment Division, 2008 as provided by Metro.; WH_taxlots010610: Multnomah County Assessment & Taxation(2010), as provided by City of Portland, Bureau of Planning & Sustainability; wkhrbr_Rail_User_sites datasets: City of Portland, Bureau of Planning, 2006; WH_sites_2004Atlas.shp: Prepared by City of Portland Bureau of Planning & Portland Development Commission.

113 E.D. Hovee and Company, 2009, City of Portland Economic Opportunities Analysis: Task 2/3 – Supply and Demand, Prepared for the City of Portland Bureau of Planning and Sustainability.

lands based on their level of vacancy as well as the constraints on these sites due to the City of Portland's environmental overlay zoning and/or potential contamination. Vacancy is defined based on the proportion of the site that is vacant. Sites over 90 percent vacant are classified as vacant, while sites that are less than 90 percent vacant are classified as partially vacant. All vacant or partially vacant parcels larger than 0.5 acres are included in the analysis.

The EOA study estimated the vacant industrial and commercial land supply in the City of Portland at approximately 3,000 acres, of which 1,910 acres are located in the Columbia Harbor area (which is a geography broader than the Portland Harbor area, and includes lands along the Willamette River downstream of the Fremont Bridge and eastward along the Columbia River to 82nd street). The EOA data classifies industrial, employment, and commercial lands into five tiers depending on the proportion vacant, environmental protection constraints based on City of Portland environmental zoning, and potential contamination. Of the 1,910 acres of available land in the Columbia Harbor area, nearly half (46 percent, or 877 acres) were classified as potential brownfields based on data from the Oregon Department of Environmental Quality (DEQ). As indicated in **Table 5-1**, 21 percent of available land (396 acres) is over 90 percent vacant and has no environmental zoning constraints, while another 4 percent (80 acres) is partially vacant land that has no environmental zoning constraints. The remaining 29 percent of vacant lands (391 acres that are over 90 percent vacant, plus 167 acres that are partially vacant) have some environmental zoning constraints.

Table 5-1 EOA Classification of Available, Vacant Lands in the Columbia Harbor Area

Parcel Classification	Acreage	Proportion of Available Acreage
Over 90% Vacant, No Environmental Zoning Constraints	396	21%
Over 90% Vacant, Environmental Zoning Constraints	391	21%
Partially Vacant, No Environmental Zoning Constraints	80	4%
Partially Vacant, Environmental Zoning Constraints	167	9%
Vacant, Potential Brownfield	877	46%
Total	1,910	100%

Source: E.D. Hovee and Company, LLC, 2009, Economic Opportunities Analysis Task 2/3 – Supply and Demand.

The EOA dataset includes all lands classified as vacant (including vacant and partially vacant) by the City of Portland as of January, 2009. As marine-related uses require waterfront access, a small subset of the Columbia Harbor lands analyzed in the EOA were identified and assessed for this study. In this analysis of lands available for marine-related uses, the focus is industrial lands bordering the Willamette or Columbia Rivers in the Portland Harbor. Of all vacant industrial lands identified in the EOA, only 35 sites in the Columbia Harbor geography are adjacent to the waterfront in the Portland Harbor.[114]

Of these 35 waterfront sites, 33 are evaluated in this analysis. Two larger parcels, the 41-acre McCormick and Baxter site and the 28-acre Triangle Park site, which are adjacent sites located to the northwest of the University of Portland (Sites 13 and 15 on **Map 5-1**, both indicated with hatch marks), are not anticipated to be available for industrial development due to zoning and expected use for expansion by University of Portland.[115] The Triangle Park site is owned by the University of Portland,

[114] The EOA data on vacancy is by tax lot. Often, adjacent tax lots with the same owner are included in one site (Based on spatial data from WH_sites_2004Atlas.shp: Prepared by City of Portland Bureau of Planning & Portland Development Commission by aggregating taxlots with coincident ownership). Each site, as defined by the Working Harbor Atlas data, may be larger than the sum of vacant tax lots as some of the tax lots on a site may be occupied. To assess vacant site size, this analysis only includes the acreage in vacant tax lots in each site.

[115] As identified in the City's 2001 Site Reuse Assessment Report for the McCormick and Baxter site, the redevelopment costs contamination liability, property encumbrances, and infrastructure requirements exceed market value for industrial uses. Additionally, site access to both sites is limited to streets used for residential access. Truck transportation from an industrial site would negatively impact local neighborhoods. Based on these considerations, the City in 2001 recommended that the McCormick and Baxter site be utilized for recreational purposes.

and is intended for use as athletic fields and a waterfront trail based on settlements between EPA, University of Portland, and the previous owner, Triangle Park LLC.[116] The McCormick and Baxter site is also intended for recreational uses based on the City of Portland's Site Use Assessment Report conducted in 2001, and the University of Portland has shown interest in acquiring this site as well.[117] These properties are removed from consideration (and highlighted in black in the **Table 5-2** below), leaving 33 vacant, waterfront sites. All of these 33 sites are zoned for industrial use.

Table 5-2 Summary of Vacant, Waterfront Sites in Portland Harbor

Site ID	Ownership	Acreage	Waterfront Length (Feet)	River Depth 150 feet from Shore (Feet)	Access to Olympic Pipeline	Acreage Not Zoned E / C / P or within Floodplain	Potential Brownfield Site
1	Becker Land Llc	2.0	1600	15	No	1.8	No
2	Union Pacific Railroad Co	1.1	505	30	No	1.1	No
3	Ash Grove Cement Co	2.8	2500	30	No	2.8	No
4	Sause Bros Inc	1.2	110	15	No	1.2	No
5	Portland City Of	8.3	600	5	No	7.3	Yes
6	Zidell Emery N Tr &	1.5	1800	15	Yes	1.5	No
7	Tanker Basin Llc	1.2	340	25	Yes	0.7	No
8	Atc Leasing Co Llc	1.1	335	20	No	1.0	Yes
9	Port Of Portland	2.8	1005	20	No	2.3	No
10	Gatx Terminals Corp	1.8	410	25	Yes	1.7	No
11	Genstar Roofing Co Inc	0.9	580	20	Yes	0.9	No
12	Atofina Chemicals Inc	59.4	3050	20	Yes	9.3	Yes
13	Triangle Park Llc	27.6	2600	20	No	13.4	Yes
14	Siltronic Corp	37.5	1450	30	Yes	27.2	Yes
15	Mc Cormick & Baxter Creosoting	40.9			No	6.4	Yes
16	Northwest Natural Gas Co	13.5	1205	35	Yes	7.0	Yes
17	Transloader International	2.3	620	35	Yes	1.7	Yes
18	Langley St Johns Llc	7.2	550	20	No	2.9	Yes
19	Port Of Portland	6.5	590	25	No	2.9	No
20	Linnton Plywood Assn	22.6	1850	25	Yes	5.5	Yes
21	Babcock Land Company Llc	1.3	560	10	Yes	1.2	No
22	R K Storage &	1.1	540	5	Yes	1.1	Yes
23	Owens Corning Roofing &	12.2	1030	20	Yes	6.8	Yes
24	Lacamas Laboratories Inc	0.4	340	15	No	0.4	No
25	Portland General Electric Co	1.4	75	10	Yes	1.1	No
26	Morrison Oil Co	1.1	420	15	No	1.1	No
27	Schnitzer Invest Corp	8.3	1400	30	No	12.4	Yes
28	Rhodia Inc	13.2	1750	20	No	12.1	Yes
29	Time Oil Co	43.4	560	30	No	35.7	Yes
30	Portland General Electric Co	11.4	1140	5	Yes	10.0	Yes
31	Port Of Portland	19.1	980	20	No	7.8	No

116 EPA, Superfund, Website (http://www.epa.gov/superfund/sites/) accessed January 6, 2010.

117 Bureau of Planning. City of Portland. 2001, McCormick and Baxter Site Reuse Assessment: Final Report.

Site ID	Ownership	Acreage	Waterfront Length (Feet)	River Depth 150 feet from Shore (Feet)	Access to Olympic Pipeline	Acreage Not Zoned E / C / P or within Floodplain	Potential Brownfield Site
32	Port Of Portland	4.8	940	20	No	4.8	No
33	Graphic Packaging	2.5	2130	20	No	2.5	Yes
34	Inland Holdings Inc	1.3	865	20	No	1.3	No
35	Private	3.3	160	10	Yes	2.5	Yes

Sites 13 and 15 highlighted in black are not available for industrial development based on expected recreational land use.Nearly all of the 33 vacant sites are located in Portland Harbor, but a few are located in the Rivergate industrial district with access to the Columbia River (for simplicity, hereafter all 33 sites will be referred to as Portland Harbor sites). To assess suitability for specific marine-related uses, these sites were further assessed based on the suitability characteristics identified in **Section 4**: size, access to infrastructure (rail, truck routes, and pipelines), waterfront characteristics (channel depth and shoreline length), natural resource constraints, and contamination.

The suitability of the 33 available sites for marine-related use is assessed below using the spatial dataset developed for the EOA as well as supplemental information on transportation infrastructure, channel depth, and waterfront access. Site characteristics related to size, ownership, waterfront access, proximity to infrastructure, environmental zoning constraints, and brownfield development constraints are summarized below.

5.3.1 Site Size

Based on the EOA data, there are 33 sites of vacant, waterfront land in Portland Harbor.[118] As indicated in **Map 5-1**, there are a few vacant waterfront sites that are located close to each other that could potentially be aggregated into larger sites.[119] Several were identified that could be aggregated to existing sites, these include two sites (Sites 18 and 19) that could be aggregated to the Port of Portland's Terminal 4. One of these sites (Site 19) is already owned by the Port, while the other site is currently owned by Langley St. Johns LLC (Site 18) and could potentially also be aggregated to Terminal 4.[120] Together, these two sites represent 14 acres of vacant property. Two other sites with aggregation potential for the Port of Portland include the Time Oil site (Site 29) and a property owned by Schnitzer Investment Corporation (Site 27), which together represent nearly 52 acres. Henceforth in this analysis, these sites remain aggregated into two sites of 14 and 52 acres (rather than 4 individual sites) such that the analysis considers 31 sites.

One other site with aggregation potential is the Linnton Plywood site (Site 20), which may potentially be acquired by Arco/BP and aggregated with its adjacent, existing terminal operation located to the south. As this site would be aggregated to a developed site, rather than aggregated with another vacant site, it was not aggregated for the purposes of this analysis.

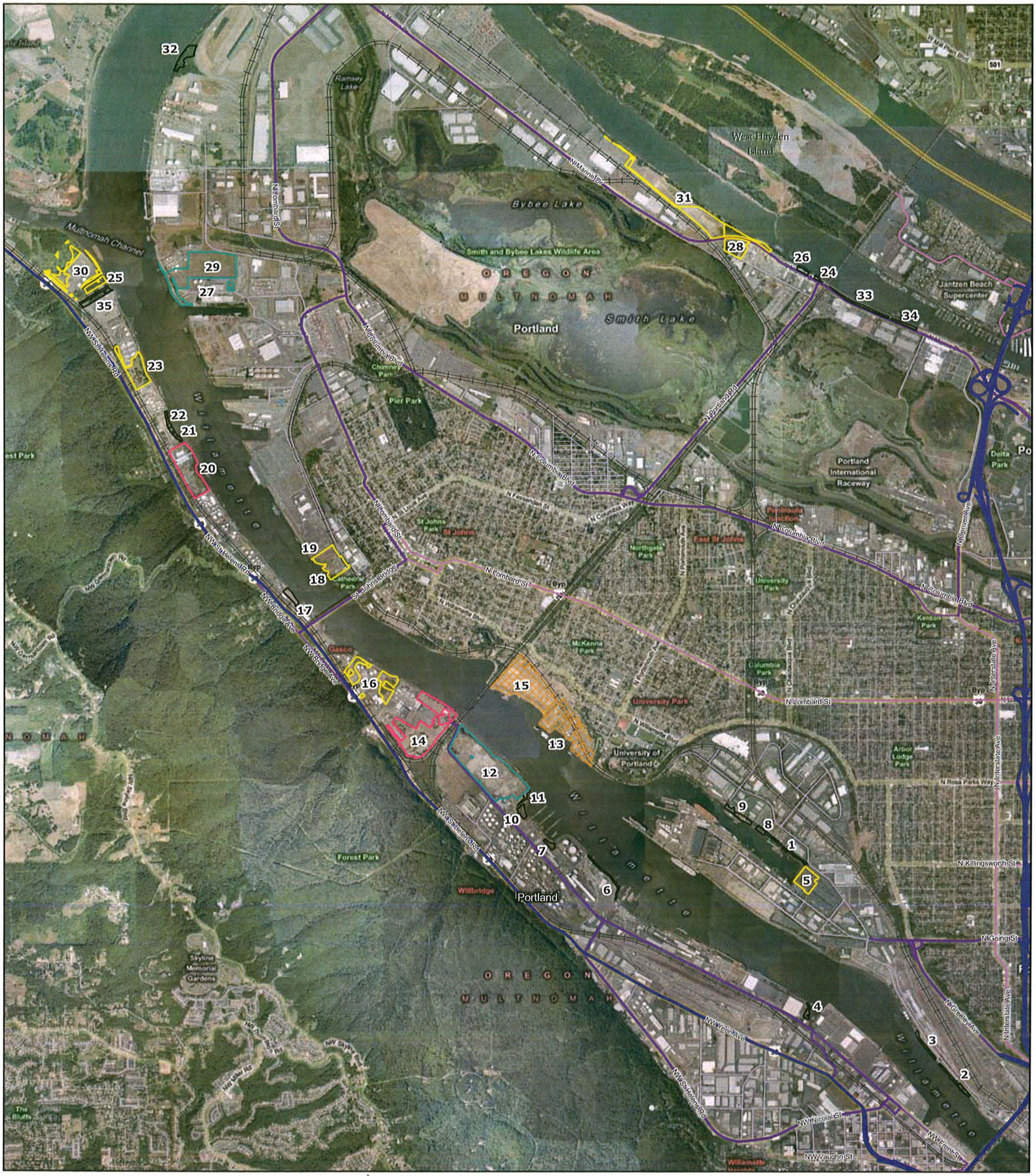
On the 31 vacant waterfront sites in Portland Harbor, there are a total of 300 acres. The average site size is approximately 10 acres. However, 65 percent of all sites are less than 5 acres in size, less than the minimum typically required for marine-related uses. Ten sites (31 percent) are larger than 10 acres, and three sites (nine percent) are larger than 30 acres. No sites are larger than 60 acres, which is less than the size suitable for most marine cargo uses as described in **Section 4**.

Figure 5-1 presents the size distribution of the 31 sites of vacant, waterfront industrial lands in Portland Harbor. **Table 5-3** presents summary statistics for each size category. **Map 5-1** provides an overview of the location and size of these sites.

[118] Note that the there are 39 tax lot parcels in the EOA data that are vacant and located on the waterfront. These tax parcels, and adjoining vacant tax parcels with common ownership as indicated by the site number from the working harbor GIS dataset, were joined together to form 33 sites.

[119] Kountz, Steve, City of Portland Planner. March 11, 2010. Personal communication with ENTRIX, Inc.

[120] Theisen, Greg, Port of Portland. May 13, 2010. Personal communication with ENTRIX staff.



0 0.2 0.4 0.8 1.2 1.6 Miles

0 0.75 1.5 2.25 Kilometers

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Legend

< 5 acres	Regional Truckway
5 - 20 acres	Priority Truck Street
20 - 40 acres	Major Truck Street
40 - 60 acres	Truck Access Street
University of Portland Not Considered Industrial	Freight District Street
	Railroad Main Line

Map 5-1
Distribution of Vacant Waterfront Parcels by Size

West Hayden Island Economic Foundation Study

July 2010

ENTRIX
12009 NE 99th St., Suite 1410
Vancouver, WA 98682
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fax (360) 883-0292
www.entrix.com

Map Projection: Mercator, WGS84

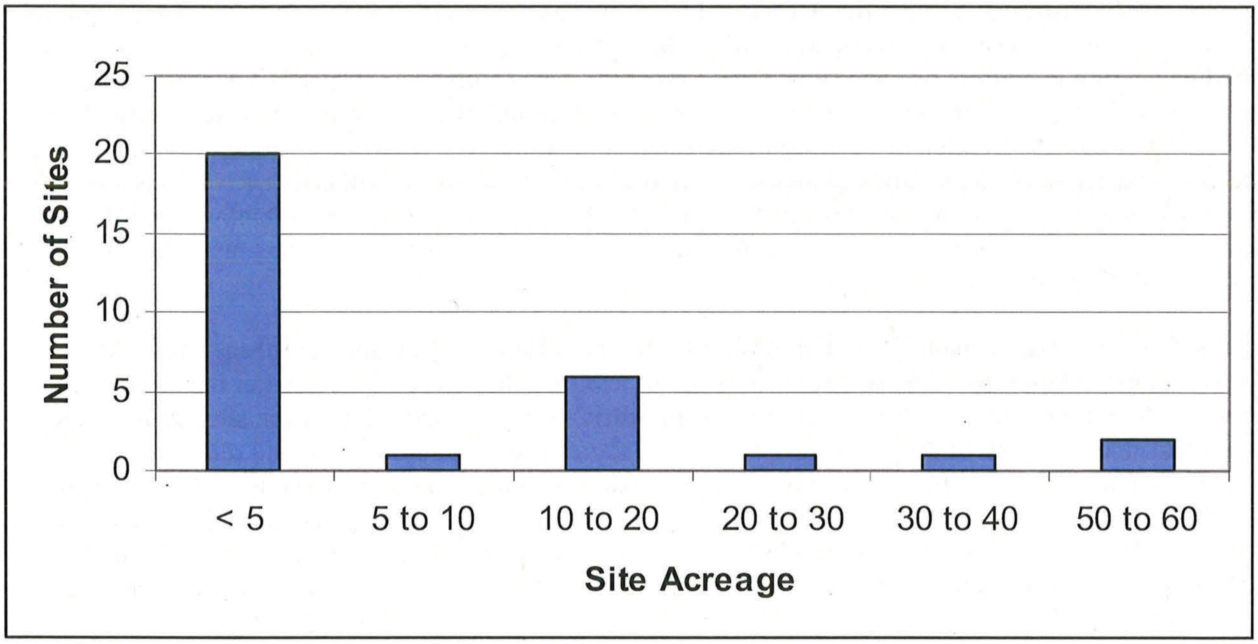


Figure 5-1 Size Distribution of Vacant, Waterfront Sites in Portland Harbor

Table 5-3 Vacant, Waterfront Parcels in Portland Harbor

Acreage Classification	Number of Parcels	Proportion of Parcels	Total Acreage	Average Size (Acres)
< 5 acres	20	65%	35.9	1.8
5 to 10 acres	1	3%	8.3	8.3
10 to 20 acres	6	19%	83.1	13.9
20 to 30 acres	1	3%	22.6	22.6
30 to 40 acres	1	3%	37.5	37.5
50 to 60 acres	2	6%	111.1	55.6
Total	31	100%	298.5	9.6

Source: Economic Opportunities Analysis Data prepared by Real Urban Geographics, ENTRIX analysis. Ownership

Ownership is also a factor for some marine-related users, and indicates whether a site would be available for sale or lease. During interviews, several Portland Harbor businesses stated that it is often more desirable to own a site, rather than lease from the port or another entity. The inventory of lands in Portland Harbor indicates that most vacant areas are owned by the private sector. A few smaller parcels are owned by the Port, the City (Bureau of Environmental Services), Utilities (Portland General Electric), or Railroads.

5.3.2 Waterfront Characteristics

The length of the waterfront and the depth of the adjacent channel are important characteristics for marine-related development. As identified in **Section 4**, waterfront of 400 feet is required for most marine-related uses, while water draft depth of at least 35 feet is required for most marine cargo uses while a draft depth of at least 20 feet is required for most barge uses.

The federal navigation channel on the Columbia River extends 11.6 miles into the Willamette River to the Broadway Bridge in Portland. The Willamette River is routinely dredged, but the last channel deepening was in 1997. Historically, the Army Corps of Engineers has dredged 500,000 to 700,000 cubic yards of sediment from the lower Willamette navigation channel every three to five years. Other than an interim dredging action to address one site (Post Office Bar), the Army Corps has suspended dredging operations pending the outcome of the Portland Harbor Superfund cleanup. The lack of maintenance dredging over the last 13 years has resulted in shoaling of the channel, with many areas of the channel less than 40 feet deep.[121] Based on the uncertainty associated with dredging of the lower Willamette River, this analysis presents the current draft depth near vacant, waterfront areas. It is important to note however, that the channel depth at these sites could be deepened in the future, thereby increasing site suitability from a channel depth perspective.

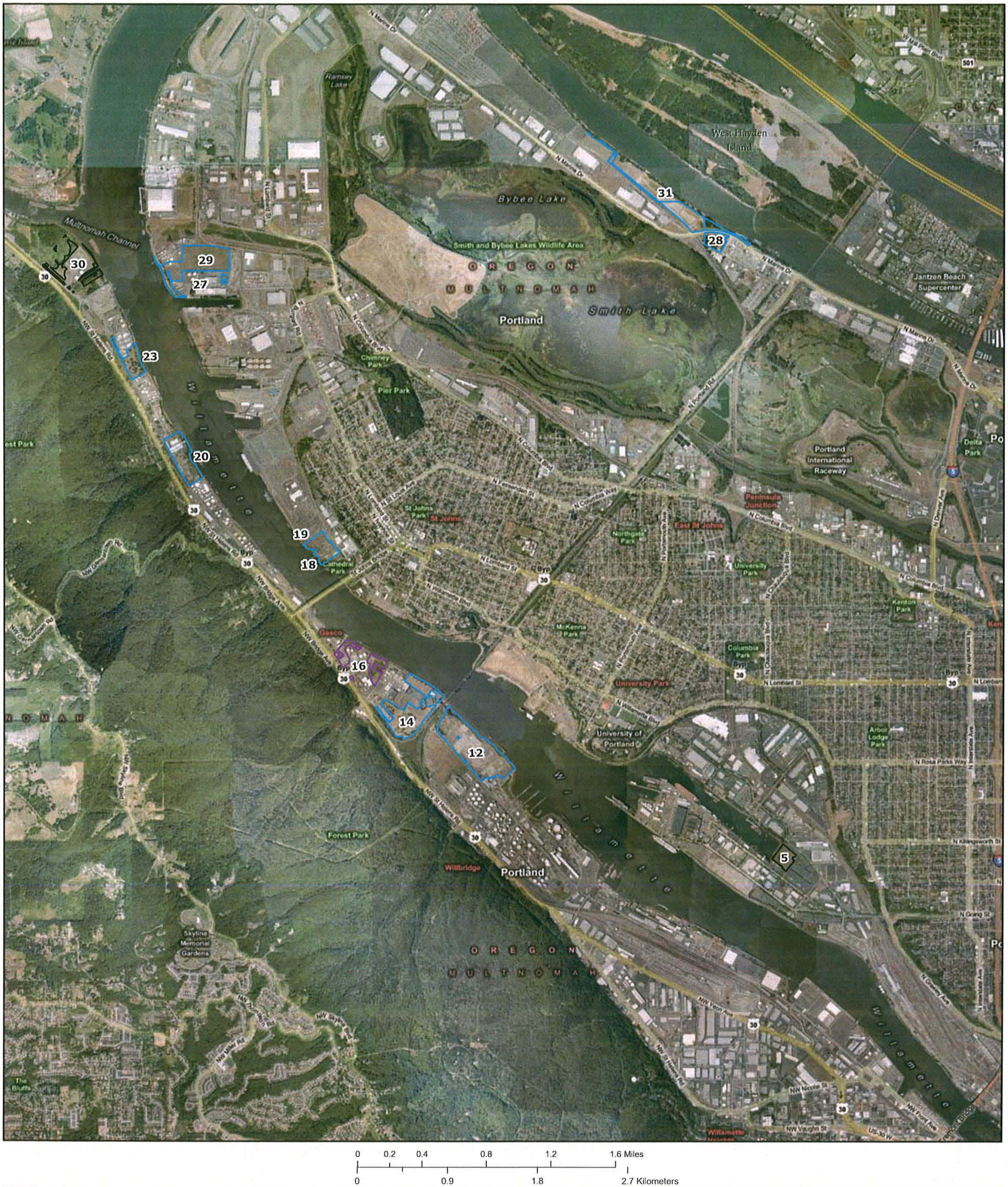
Table 5-4 summarizes channel depth and waterfront length for the 31 vacant waterfront sites. As indicated in the table, six sites have river frontage of less than 400 feet and are smaller than 5 acres in size, rendering them unsuitable for most marine industrial uses. An additional seven sites do not have access to channel depth of 20 feet within 150 feet of shore, but future dredging could remedy this shortfall. Currently, only two vacant sites have deep draft depth of 35 feet suitable for marine terminal use (one site is 2.3 acres in size while the other is 13.5 acres). **Map 5-2** presents the 11 sites indicated in the shaded area of the table that are larger than five acres and have water frontage greater than 400 feet. Of these 11 sites, nine sites currently have channel depth of 20 feet or more suitable for barge access.

Table 5-4 River Access at Vacant, Waterfront Areas (Channel Depth Measured at 150 feet from Shore)

Acreage Classification	Deep Draft Depth (Channel Depth > 35 feet River Length > 400 feet)	Barge Depth (Channel Depth > 20 feet River Length > 400 feet)	Depth Constraint (Channel Depth < 20 feet, Shoreline > 400 feet)	Shoreline Constraint (Shoreline < 400 feet))
< 5 acres	1	8	5	6
5 to 10 acres			1	
10 to 20 acres	1	4	1	
20 to 30 acres		1		
30 to 40 acres		1		
50 to 60 acres		2		
Total	2	16	7	6

Source: Economic Opportunities Analysis Data prepared by Real Urban Geographics, Lower Willamette Group GIS data, ENTRIX analysis.

121 U.S. Army Corps of Engineers, Willamette River Dredged Material Management Plan Project, online at http://www.portlandonline.com/bps/index.cfm?&c=42601&a=145503. Port of Portland, Willamette River Dredged Material Management Plan, online at: http://www.portofportland.com/Prj_Mar_DMMP_Home.aspx.



Legend

- < 20' deep
- > 20' deep
- > 35' deep

Map 5-2

Sites Larger than 5 Acres with Shoreline Greater Than 400 feet

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Map Projection: Mercator, WGS84

5.3.3 Proximity to Infrastructure

As noted in **Section 4**, proximity to intermodal transportation infrastructure is important for nearly all marine-related uses. All 31 sites in the harbor area provide good access to multi-modal transportation facilities. As noted throughout this analysis, access to intermodal transportation is a primary reason that many businesses locate in the harbor area. All of the sites identified as waterfront, vacant lands are located near a truck route and a rail line access point. In general, sites on the east side of the Willamette River are better served by rail, as they are closer to the mainline Class I rail roads running south-north and east-west from Portland.

Nearby access to freight truck routes is important for both marine cargo and marine industrial facilities. High truck volumes and tractor-trailer activity characterize industrial-serving freight movement, so efficient access to regional/interstate freight movement corridors is required. The Freight Master Plan developed by the City of Portland Office of Transportation has classified a hierarchy of five types of truck routes in Portland. As defined in the Freight Master Plan, these are:

- **Regional Truckway.** Routes for interregional and interstate movement of freight. Serves both industrial and commercial land uses via access ramps.
- **Priority Truck Street**. Principal route for truck mobility in Freight Districts, and between Freight Districts, and Regional Truckways. Provides truck access and circulation to industrial and employment land uses.
- **Major Truck Street**. Principal route for truck mobility between commercial centers and corridors. Provides truck access and circulation to regional main streets.
- **Truck Access Street.** Route for distribution of truck trips in neighborhoods. Provides truck access and circulation for delivery of goods and services to commercial and residential uses.
- **Local Truck Street.** Routes for local truck access and circulation to residents and businesses outside of the freight districts.

As illustrated in **Map 5-1**, all 31 sites in Portland Harbor have access to a priority truck street that leads to Interstate-5, which is a regional truckway. This access as well as the proximity to Interstate-5 varies by site. Sites on the east side of the Willamette River have better access to Interstate-5, and thus are preferred for those uses that rely heavily on truck transportation. Furthermore, some sites are constrained by the local level of congestion and ease of site ingress and egress. For example the Siltronic site (Site 14) has access issues, both with limited road capacity as it is at the end of a dead end road and upon exiting the site all traffic must flow back to Kittridge through the tank farms to reach Highway 30. This site of employee access constraint currently affects all westside waterfront locations, although options have been considered to construct an overcrossing to increase access to these sites.

In addition to road and rail connections, liquid bulk facilities that handle petroleum typically require access to the Olympic Pipeline which crosses the Multnomah Channel and then runs southward along the western shore of the Willamette River in the Northwest industrial district. Fifteen of the 31 vacant areas are located here, and as such are expected to have access to this pipeline. As indicated in **Table 5-5**, size of these vacant areas located near the pipeline ranges from 59 acres to just over one acre, with most sites sized less than five acres. As indicated in the shaded area of the table, six sites proximate to the Olympic pipeline are larger than 10 acres and have shoreline of at least 400 feet. One of these sites, with site size of 13.5 acres, currently has a draft depth of 35 feet that may be able to accommodate liquid bulk cargo vessels.

Table 5-5 Vacant, Waterfront Areas with Pipeline and Appropriate Shoreline Access

Acreage Classification	Number of Sites	Number of Sites with Shoreline > 400 feet
< 5 acres	9	6
10 to 20 acres	3	3
20 to 30 acres	1	1
30 to 40 acres	1	1
50 to 60 acres	1	1
Total	**15**	**12**

Source: Economic Opportunities Analysis Data prepared by Real Urban Geographics, Lower Willamette Group GIS data, ENTRIX analysis.

5.3.4 Natural Resource Constraints

As noted in **Section 4**, there are numerous types of requirements for proposed development in areas with significant natural resources and/or are located in the floodplain, which can affect the costs and required acreage for development. Analogous with the EOA study, this analysis utilizes the environmental overlay zoning by the City of Portland combined with mapping of the 100-year floodplain as an indicator of the level of natural resource constraint on development (although it is recognized that these are not the only regulations that may constrain the use of these sites). It is important to note that the City of Portland's environmental overlay zones do not prohibit development on these lands, but rather can affect the cost of development. The level of natural resource constraint is one factor among many that may affect where industrial development may occur. Every site on the river has some form of constraint, and all sites have to undergo multiple permits under various local, state and federal regulations to place development on, or near the river. Therefore, no available sites are removed from consideration due to natural resource constraints.

All vacant, waterfront sites are affected by at least one natural resource constraint. In fact, of the 300 acres of vacant, waterfront lands, over half (170 acres) are affected by some level of natural resource constraint. Sixteen sites are constrained on 90 percent or more of the site, while another five sites are constrained on 75 percent or more of the site. **Table 5-6** indicates that there are only four sites that are constrained on less than 50 percent of their area.

Table 5-6 Site Area Affected by Natural Resource Constraints

Acreage Classification	90% Constrained	75% to 90% Constrained	50% to 75% Constrained	25% to 50% Constrained	Less than 25% Constrained
< 5 acres	15	3	2		
5 to 10 acres		1			
10 to 20 acres	1	1	2	2	
20 to 30 acres					1
30 to 40 acres			1		
50 to 60 acres			1		1
Total	**16**	**5**	**6**	**2**	**2**

Source: Economic Opportunities Analysis Data prepared by Real Urban Geographics, ENTRIX analysis.

5.3.5 Portland Harbor Superfund

As noted in **Section 4** the Willamette River in Portland Harbor has been identified by the Environmental Protection Agency (EPA) as a Superfund site. According to the EPA, "more than a century of historical industrial use has resulted in Willamette River sediments being contaminated with many hazardous substances, such as heavy metals, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAH), dioxin/furans, and pesticides".[122] This designation affects all waterfront acreage from Columbia Slough to the Fremont Bridge, and presents a difficult challenge to the transfer and lease of all waterfront property in the harbor until a final cleanup plan and allocation of liability is determined. As discussed in the Portland Harbor Industrial Lands Study, many firms are reluctant to invest in riverfront and related sites until Superfund liability is resolved.

The All Appropriate Inquiries (AAI) rule establishes standards for environmental due diligence that will encourage more urban redevelopment by protecting purchasers of sites from liability for past contamination. However, the major unresolved issue with this rule is that the EPA does not review the due diligence performed by the prospective buyer. The Harbor Redevelopment Initiative (Harbor ReDI) is working to ensure that businesses can purchase sites within Portland Harbor and reduce the purchaser's liability to the Superfund site. Harbor ReDI is a multi-agency project that is aimed at developing processes and tools for restoring at least one or more contaminated sites along the Willamette River to productive industrial use with at least one site under development by 2013.[123]

Currently, the Harbor ReDI team is working with a company in the acquisition of a vacant Portland Harbor site and educating this business in the due diligence process to meet the AAI rule. Given that this business meets this AAI rule, it should separate the business's liability from in-river contamination within the water body (EPA authority) from liability for upland contamination (State authority).[124] It is hoped that this purchase will occur in the next nine months and serve as an example that the risk can be mitigated for waterfront sites along Portland Harbor.[125] However, until Superfund liability is resolved, in-water contamination will remain a limitation to redevelopment in Portland Harbor.

5.3.6 Brownfield Contamination and Redevelopment Potential

In addition to the Superfund site, there is upland contamination in the harbor area that is assessed by the Oregon Department of Environmental Quality (DEQ). The DEQ classifies a site as a brownfield if expansion on the property is complicated by actual or perceived environmental contamination. This analysis classifies a site to be a potential brownfield site if it is listed on the Environmental Cleanup Site Information (ECSI) database, the Leaking Underground Storage Tank (LUST) database, or is listed as a Portland Potential Contaminated Unit (PCU).

A site is listed in the ECSI database if there is a known or suspected contamination from a hazardous material. All sites in the ESCI database have documented, suspected, or remediated hazardous substance contamination in the groundwater, surface water, soil, and/or sediment. The DEQ adds sites to the ECSI when DEQ becomes aware of contamination or potential contamination from hazardous substances such as solvents, metals, PCBs, or petroleum hydrocarbons.[126] LUST is a listing of sites with reported releases of petroleum products from regulated underground storage tanks, unregulated underground storage tanks, and home heating oil tanks.

[122] Environmental Protection Agency. Region 10 Cleanup: Portland Harbor Website. Accessed at http://yosemite.epa.gov/R10/Cleanup.nsf/4ca19cd6a0fc79d588256cc90061cca7/75c7f27bd108f3cb88256f4a007ba018!OpenDocument.

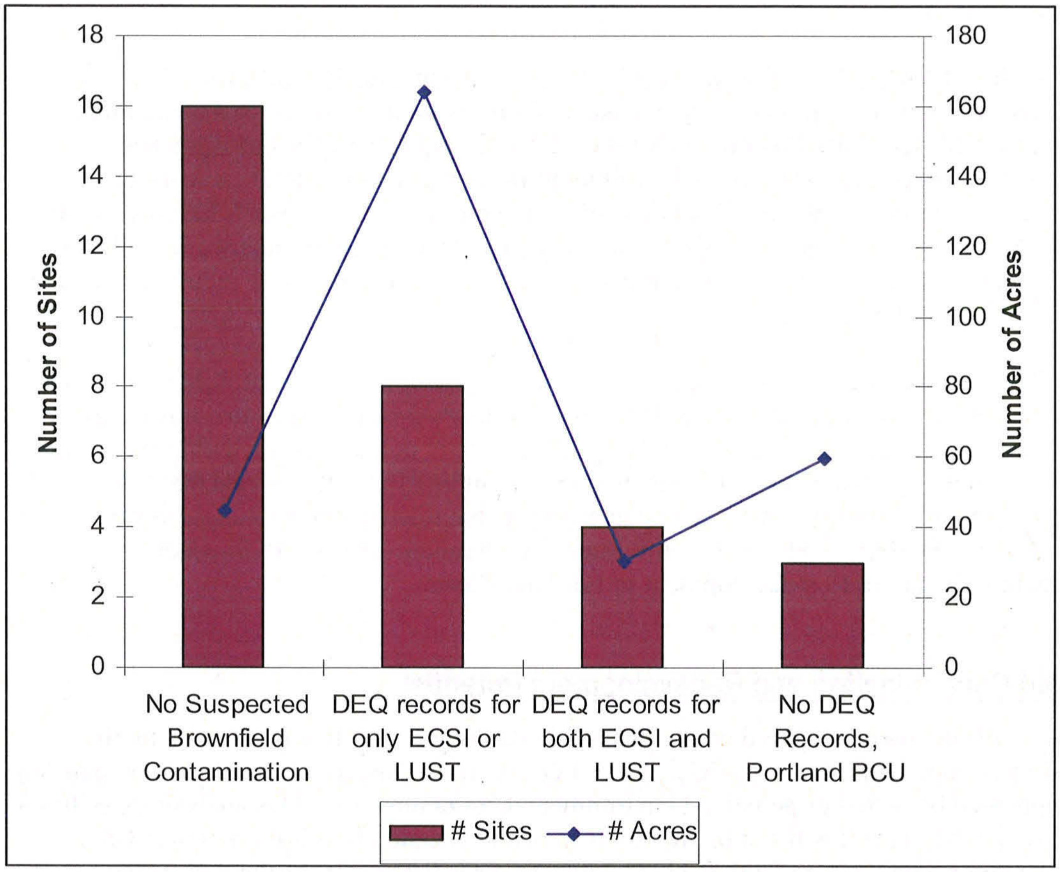
[123] Portland Development Commission. Portland Harbor Redevelopment Initiative. Website (http://www.pdc.us/ura/willamette-industrial/harborredi.asp) accessed January 5, 2010.

[124] Henry, Clark, City of Portland, Portland Brownfield Program, Personal communication with Lee Elder, ENTRIX, Inc., January 5, 2010.

[125] Ibid.

[126] Oregon Department of Environmental Quality, Land Quality: Environmental Cleanup site Information (ECSI). Accessed at www.deq.state.or.us/lq/ecsi/ecsi.htm.

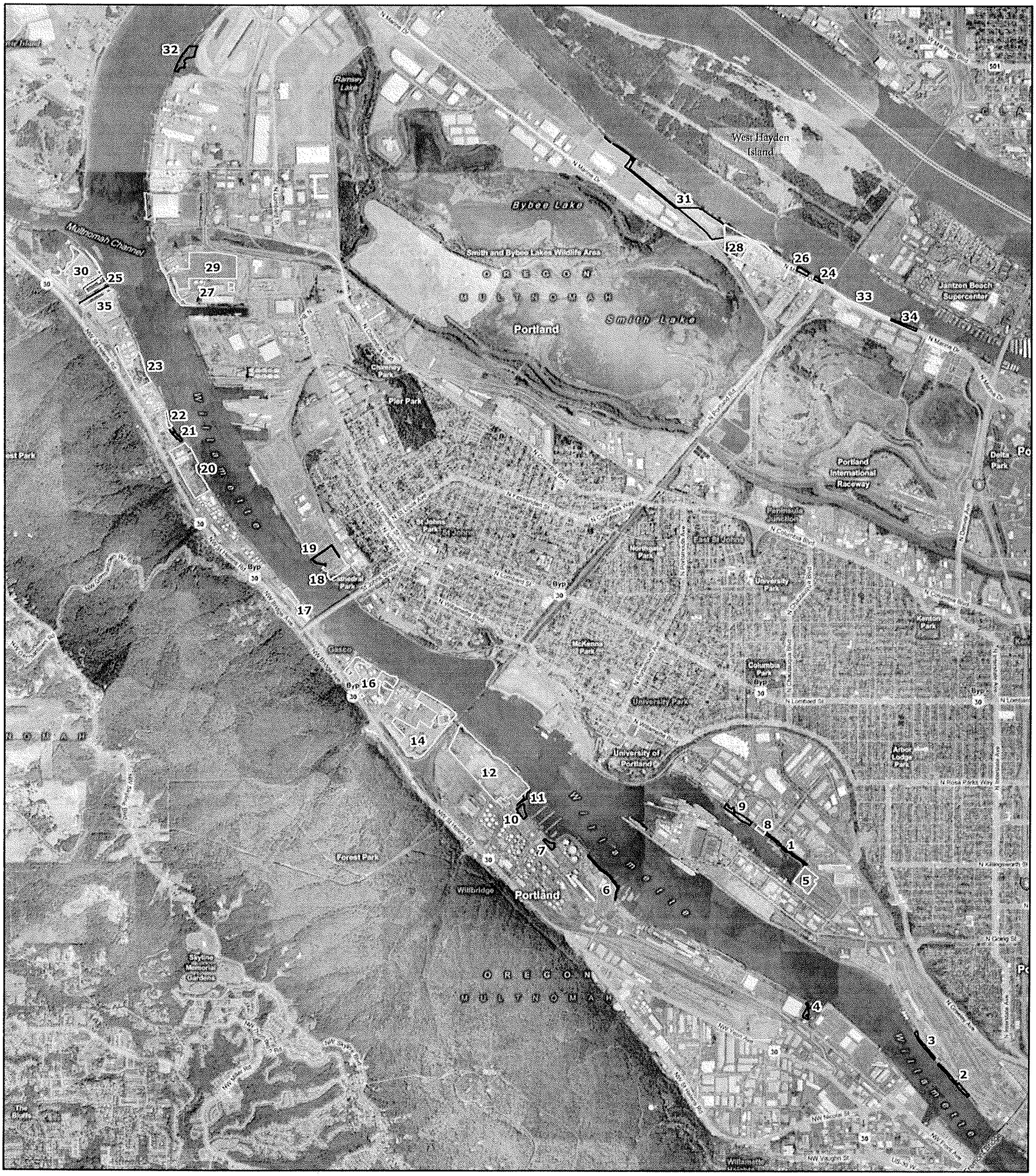
The DEQ databases do not provide information on the degree of potential upland contamination, but rather the presence of a site in the database indicates that there is potential for contamination to exist at the site. As presented in **Figure 5-2** and **Map 5-3**, 15 of the 31 vacant properties, representing over 250 of the 300 available acres in Portland Harbor, are potential brownfields. For the 16 sites and 50 acres without suspected upland contamination, only one site is larger than 5 acres (Site 31), and it is owned by the Port of Portland.



Source: Economic Opportunities Analysis Data prepared by Real Urban Geographics, ENTRIX analysis.

Figure 5-2 Sites and Acreage of Contamination on Vacant Portland Harbor Sites

While there are very few vacant lands available in the Portland Harbor, particularly of any great size relative to need, liability issues surrounding the acquisition of brownfield sites limits redevelopment. Sites that are least constrained and are the easiest to develop, are typically developed first. However, as noted in the EOA, more constrained sites may be developed as they become the only options available. The EOA forecasts that in the entire Columbia Harbor geography (which includes many upland vacant sites that are not located on Portland Harbor), approximately 20 to 45 percent of sites with suspected brownfield contamination will be available for development by 2035. Assuming this same proportion of land is available for development in Portland Harbor, up to approximately 115 acres of the 270 acres in brownfield sites may be available for development.



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Legend

- No Suspected Upland Contamination
- Potential Brownfield

Map 5-3
Brownfields

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5.3.7 Summary of Site Inventory

As has been described in many prior documents (Portland Harbor Industrial Lands Study, Trade Capacity Analysis, Economic Opportunity Analysis), marine industrial land is in short supply in the region. In particular, large sites of 50 acres or more are rare. **Table 5-7** summarizes the characteristics of vacant waterfront sites with waterfront length of 400 feet or more. As indicated in the table, there are only eleven sites that have this access, and only four such sites that are larger than 20 acres. All four of these larger sites are identified as having not only potential Superfund liability, but also upland contamination. All of the sites also have natural resource constraints. The only two sites of 50 acres or larger are the aggregated Schnitzer/Time Oil site (Site 27 and Site 29) and the Atofina Chemicals site (Site 12). The Schnitzer/Time Oil site is 51.7 acres, with natural resource constraints on 74 percent of the property. The Atofina Chemicals site is 59.3 acres, with 9.5 acres constrained by environmental overlay zoning and floodplain restrictions. Both sites are listed in the ECSI database and are also a Portland PCU.

There is only one vacant site larger than 5 acres that is not listed as a potential brownfield due to upland contamination (Site 31). This site is owned by the Port of Portland and is 19.1 acres, and has conservation overlays and floodplain constraints on 7.8 acres.

Table 5-7 Summary of Available Sites Potentially Suitable for Marine-Related Uses

Site Size	Number of Vacant Sites Shoreline > 400 feet	Number of Vacant Sites Shoreline > 400 feet Not a Suspected Brownfield
5 to 10 acres	1	
10 to 20 acres	6	1
20 to 30 acres	1	
30 to 40 acres	1	
50 to 60 acres	2	
Total	11	1

Of the 11 sites potentially suitable for marine-related uses, there are nine sites with access to channel depths of 20 feet or more. One of these sites has access to channel depth of 35 feet or more within 150 feet of shore. This site is 13.5 acres and is owned by Northwest Natural Gas (Site 16, **Map 5-1**). Over half of the site is affected by floodplain and environmental zoning overlay restrictions, and the site is also listed as a PCU.

5.4 POTENTIAL ABSORPTION OF LAND BY NON-INDUSTRIAL USES

The State of Oregon passed legislation in the early 1970s as part of the statewide land use planning program that created urban growth boundaries to try and reduce urban sprawl.[127] In the 1980s the City of Portland created industrial sanctuaries to encourage industrial growth and protect industrial districts from incompatible uses such as housing, high density uses, and high traffic uses. The Willamette Greenway Plan (1987) created this zone, better known as the River Industrial Zone.

This zone limits the use of riverfront lands to river-dependent and river-related industry within Portland Harbor. The Willamette Greenway Plan stipulates that no building, structure, parking lots, or fills are to be

[127] City of Portland, Portland Development Commission. August 16-17, 2007. Portland Industrial Land Sanctuary Area.

located within the setback unless it can be proven to be necessary to the functioning of a river-dependent or river-related use.[128] Uses that are not river dependent or related must obtain a Greenway Goal Exemption.

Industrial sanctuary zoning does not allow housing and limits standalone retail, service, and office uses to 3,000 square feet per site or up to 25,000 square feet per site with a conditional use permit for those businesses serving industrial needs.[129] Due to this zoning, it is expected that there will be limited absorption of land by non-industrial uses in the Portland Harbor. Exceptions may include cases where brownfield or Superfund liability may preclude industrial development, or where other significant site constraints for industrial development apply (such as transportation access for the Triangle Park and McCormick and Baxter sites as discussed above).

5.5 SUMMARY OF LAND AVAILABILITY FOR MARINE USES

Section 4 identified the desired or required site characteristics for each type of marine industrial use. As noted in that section, most marine cargo uses require channel depth of 35 feet or more and sites that are 60 to over 100 acres in size. There are no sites that meet these requirements currently vacant in Portland Harbor. Assuming that future dredging enables deep draft access to all sites, there are still no sites that are large enough to accommodate a new, modern marine cargo facility. The possible exceptions are liquid bulk and local/regional dry bulk facilities that may require a smaller site.

Marine industrial uses and their site size requirements are quite varied. However, it is expected that most marine industrial uses desire sites of at least five acres, draft of 20 feet within 150 feet of shore, and a shoreline length of at least 400 feet. As indicated in **Section 4**, however, many marine industrial uses require large sites of over 100 acres. There are 11 sites in Portland Harbor that are five acres or more with shoreline length of 400 feet, of which nine have depth of 20 feet or more within 150 feet of shore. All but one of these sites are constrained as suspected brownfields. **Table 5-8** summarizes the number of available sites that may be potentially suitable for each type of marine-related use.

Waterfront vacant land suitable for marine cargo and marine industrial use is limited by site size and configuration, natural resource constraints, and contamination. There are 31 sites with 300 acres of vacant, waterfront industrial lands, of which 20 sites are smaller than five acres in size. No vacant sites are larger than 60 acres in size, which precludes development of many marine cargo uses and some marine industrial uses. There are, however, 11 sites larger than five acres that with channel deepening could become appropriate for local/regional market dry bulk or liquid bulk cargo or for marine industrial uses. All but one of these sites is a suspected brownfield, however, which constrains its suitability. Suitability of these sites for each use will depend on use-specific site requirements as well as the tolerance of the user for the potentially large liability associated with the Superfund site and upland brownfield contamination.

[128] Bureau of Planning. November 1987. Willamette Greenway Plan.
[129] City of Portland, Portland Development Commission. August 16-17, 2007. Portland Industrial Land Sanctuary Area.

Table 5-8 Available, Potentially Suitable Sites by Marine-Related Use

Marine-Related Use	Number of Available, Potentially Suitable Sites	Notes
Cargo		
Automobile	0	No vacant sites large enough to accommodate new automobile terminal and associated infrastructure.
Container	0	No vacant sites large enough to accommodate new container terminal and associated infrastructure.
Breakbulk	0	No vacant sites large enough to accommodate new breakbulk terminal and associated infrastructure.
Dry Bulk (National/International)	0	No vacant sites are large enough to accommodate a new grain or international dry bulk commodity terminal and associated infrastructure.
Liquid Bulk	0-6	There are six sites that are larger than ten acres that are located in the Northwest industrial district proximate to the Olympic pipeline. All of these sites have suspected upland contamination. Only one of these sites (it is 13.5 acres in size and is owned by Northwest Natural Gas) currently has a draft of 35 feet.
Dry Bulk (Regional/Local)	1-11	There are 11 sites in Portland Harbor that are larger than five acres and have shoreline access of 400 feet. Only one of these sites does not have suspected upland contamination, and is owned by the Port of Portland. Only one other site (it is 13.5 acres in size and is owned by Northwest Natural Gas) currently has a draft of 35 feet.
Industrial		
Vessel Related Services	1-11	There are eleven vacant sites larger than five acres in size with adequate riverfront access, of which nine sites have draft depth of 20 feet or more. Only one site does not have potential upland contamination, and is owned by the Port of Portland.
Manufacturing	0 – 11	There are eleven vacant sites larger than five acres in size, and only two sites larger than 50 acres in size. Of these sites, nine sites have draft depth of 20 feet or more. There are no vacant riverfront sites larger than 60 acres in size. All sites larger than 15 acres are affected by upland contamination.

SECTION 6

Land Absorption and Needs Forecast

This section concludes the economic foundation study, and provides a forecast of land absorption demand by marine-related uses in Portland Harbor together with a discussion of the potential role of WHI. It draws from all preceding economic sections to evaluate the demand for additional lands for marine uses, and the potential role of WHI to meet this demand. **Section 2** described the history and economic role of the Portland Harbor area and provides the context and trends of land use and absorption by both marine cargo and marine industrial facilities. **Section 3** presented and discussed the specific cargo forecasts and associated employment that may be expected through the end of the planning period in 2040; these forecasts provide the basis for the land absorption forecast presented in this section. Furthermore, the information provided in **Sections 4 and 5** regarding the site requirements for marine-related land uses and the available land supply in Portland Harbor provide the information necessary to determine where and how growth may be accommodated.

The first two subsections forecast the land need for marine-related uses in Portland Harbor, including marine cargo and marine industrial uses. The forecast for marine cargo lands is based on an assessment of current capacity compared to forecast cargo volume. The forecast for marine industrial lands is based on past land absorption trends of marine industrial land combined with an existing forecast of land absorption in the Portland Harbor area. The final subsections focus on the availability of existing lands in Portland Harbor to meet demand compared to the suitability of WHI land and lands available at other ports.

This section focuses on the industrial lands expected to be required to meet the forecasted growth, and does not address the potential tradeoffs associated with these land uses. A discussion of these tradeoffs is provided in the Integrated Summary of the Environmental and Economic Foundation Studies.

6.1 OVERVIEW OF DATA SOURCES AND KEY ASSUMPTIONS

Key data sources for the marine cargo land absorption forecast include the 2010 BST Associates cargo forecasts and capacity assessments for Portland Harbor, as well as interviews with the Port of Portland regarding terminal capacity and future adjustments to terminal operations to meet cargo growth. Data sources for the marine industrial land absorption forecast include the 2009 Economic Opportunities Analysis (EOA) completed for the City of Portland, and the Portland Harbor Industrial Lands Study (PHILS) completed for the City of Portland in 2003.

An important assumption carried over from **Sections 4 and 5** is that future marine-related development in Portland will be similar in size and site requirements to new marine-related developments at other west coast and Lower Columbia ports. Another assumption is that the proportion of land use that is marine industrial will remain fairly constant into the future.

6.2 FORECAST OF LAND NEED FOR MARINE CARGO

Marine cargo land needs are directly related to future cargo volumes. **Table 6-1** summarizes the cargo volumes that could be expected to flow through Portland Harbor facilities by 2040, with the key assumption that there is adequate and efficient marine terminal capacity. These cargo forecasts are drawn from the forecast completed in December 2009 by BST Associates for the Port of Portland, as presented in **Section 3**. For existing cargo categories, three estimates provide (low, most likely, and high) a range of possible cargo volume. These estimates have been supplemented by BST Associates to indicate the potential volume of cargo in containers and dry bulk if new market opportunities arise for new commodities.[130] For containers, these new markets are expected to be tied to increased intermodal traffic for regional markets, with containers handled in Portland transported to a broader market of the United States via rail. For dry bulk, these new markets would most likely be coal, iron ore, and like bulk materials that are not currently handled in Portland Harbor.

Table 6-1 Forecast Cargo Volumes for Portland Harbor

		Existing Cargo Products			New Cargo Products
Cargo	**Units**	**Low**	**Most Likely**	**High**	**Potential Opportunity**
Automobiles	Units	925,000	1,145,000	1,364,000	
Containers	TEU	379,000	520,000	614,000	130,000
Breakbulk	MT	1,010,000	1,181,000	1,295,000	
Grain	MT	5,647,000	6,477,000	7,059,000	
Dry Bulk	MT	6,739,000	8,525,000	9,585,000	3,000,000
National / International	*MT*	*4,650,000*	*6,054,000*	*6,733,000*	*3,000,000*
Local/Regional	*MT*	*2,089,000*	*2,471,000*	*2,852,000*	
Liquid Bulk	1,000 MT	6,912,000	7,571,000	8,011,000	

Source: BST Associates, 2010

6.2.1 Forecast Cargo Volume vs. Existing Capacity

Terminals and facilities handling marine cargo in Portland Harbor are located on both Port of Portland land and privately owned lands. The Port of Portland operates four marine cargo terminals (Terminals 2, 4, 5, and 6). These terminals handle all primary cargo categories. Terminals on private lands primarily handle liquid bulk, local/regional dry bulk, and grain cargoes. Data on capacity at these existing facilities is summarized in **Table 6-2**. The capacity estimated in **Table 2** takes into account that the annual sustainable practical capacity at terminal facilities is typically 75 to 85 percent of a terminal's maximum capacity. This is due to adjustments necessary to accommodate peak flows and seasonal variations in cargo flows, as well as recognizing that due to safety and economic considerations, terminals cannot operate at maximum capacity at all times. This practical capacity is utilized to estimate land needs based on projected cargo growth.

As liquid bulk facilities are often operated on private lands and data is difficult to obtain, the cargo volume versus capacity for this cargo type is not analyzed in the same manner for this cargo. Additionally, the annual growth forecast for liquid bulk, 0.5 percent, is lower than other cargoes, so additional capacity may not be needed for that cargo type.

[130] BST Associates. 2010. West Hayden Island Lower Columbia Port Capacity Assessment.

Table 6-2 Acreage and Annual Cargo Capacity of Existing Terminals in Portland Harbor

Cargo	Capacity in Portland Harbor	Marine Terminal Acreage in Portland Harbor
Automobiles	675,000 Units	314
Containers	700,000 TEU	193
Breakbulk	2,100,000 MT	41
Grain	7,100,000 MT	42 (Public terminals only)
Dry Bulk	10,700,000 MT	188+
National / International	8,200,000 MT	161
Local/Regional	2,500,000 MT	27+[131]
Liquid Bulk	N/A	N/A

Source: BST Associates, 2009 and 2010, Port of Portland Marine Terminal Master Plan, Personal communication with the Port of Portland and BST Associates.
Abbreviations: TEU is twenty-foot equivalent units, MT is metric tons.

Comparing the cargo forecasts in **Table 6-1** with the estimated sustainable practical capacities in Portland Harbor does not represent the complete picture of the ability of existing facilities in Portland Harbor to meet increased demand. First, the capacity estimates in **Table 6-2** represent the likely maximum practical capacity of facilities and terminals in Portland Harbor, but do not reflect the operating constraints at these facilities that may render them uncompetitive in the future. As discussed in Section 4, trends in the marine cargo industry are for larger, more efficient facilities than those that exist in Portland Harbor. This is particularly the case for the grain and dry bulk facilities that may become outdated. Second, the capacities in **Table 6-2** represent the capacity of handling the same type of cargo being currently handled, when in reality future growth may occur in different commodities that may require different facilities and separate terminals.

The capacity for each type of cargo category (**Table 6-2**) compared to the cargo forecasted (**Table 6-1**) is discussed below.

6.2.1.1 Grain

The Port of Portland estimates the capacity of grain terminals in Portland Harbor at 7.1 million metric tons per year (MTPY). The two private grain cargo facilities in Portland Harbor are older facilities that are smaller and less efficient, and may not be able to continue competitively operating into the future.[132] These facilities have a maximum practical capacity of approximately 3.0 million MTPY. If these facilities cease operation, then the potential grain cargo through Portland Harbor may exceed capacity of grain facilities by 2020.

The new Longview grain terminal, which will have an estimated an annual practical capacity of 8 million MT when complete, is larger and more cost competitive than existing Portland Harbor terminals. The Longview terminal is located on over 100 acres and can accommodate four unit-trains, allowing for lower shipping rates from the railroads and more cost competitive overall operations. The new Longview grain terminal has a similar size, throughput capacity, and rail capability as the Kalama Export Company elevator in Kalama, previously the newest export elevator on the Columbia River.

131 Note that this is the acreage of the JR Simplot marine cargo terminal, which receives both anhydrous ammonia from gas tank ships as well as urea from bulk transport ships and barges. There are other private dry bulk cargo terminals operating in Portland Harbor.

132 Ports and Marine Inc, Van Sickle Allen & Associates, JWD Group, and HDR Engineering, 2003, Marine Terminal Master Plan 2020, Volume 3: Planning Inputs, Prepared for the Port of Portland. Personal communication with Paul Sorenson with Barbara Wyse on January 15, 2010.

6.2.1.2 Dry Bulk

Dry bulk cargo can be differentiated into two classes based on whether the cargo originates and terminates in a local/regional market or in a national/international market. Local/regional market dry bulks include cement, gypsum, aggregates, steel scrap, and fertilizers. The national/international market dry bulks include minerals, ores, and like products that originate or terminate in the Rocky Mountains, Midwest, or Canada. These national/international cargoes typically move by unit train to/from the Port while local/regional cargoes typically move by truck.

National/international dry bulk cargo is handled at Port of Portland Terminals 4 and 5. Soda ash is exported through Kinder-Morgan's facility at Terminal 4, while potash is exported through the Canpotex facility at Terminal 5. There are smaller, private terminals also operating in Portland Harbor handling the local/regional products such as aggregates and other materials used by the construction industry and agricultural fertilizers. One private terminal, owned and operated by Schnitzer Steel, exports shredded metal scrap in bulk form.

Total annual practical capacity is estimated at 10.7 million MTPY. There is an estimated capacity of 8.2 million MTPY at terminals handling the potash and soda ash national/international cargo, and an estimated 2.5 million MTPY practical maximum capacity at terminals handling local/regional cargo.[133] This compares to a forecasted volume of 4.7 to 9.7 million MTPY of national/international cargo by 2040 and a volume of 2.1 to 2.9 million MTPY of local/regional cargo. As noted above, these cargoes are handled by separate types of terminals and therefore should be evaluated separately.

For the national/international cargoes, volume is forecasted to exceed capacity only in the high forecast scenario in which Portland attracts a new cargo type. In this scenario, demand could exceed capacity as early as 2030. Potential new dry bulk markets include coal, iron ore, or like materials that may add another 3.0 million metric tons in dry bulk volume through Portland if terminal space is available. To attract these new markets, it is expected that additional land would be required for a new terminal. For the local/regional cargoes, volume is similarly forecasted to exceed capacity (by approximately 0.5 million MTPY) only in the high forecast scenario.

6.2.1.3 Automobile

There are three automobile terminals at the Port of Portland, with a combined annual throughput capacity of 675,000 units. There is a 100-acre Toyota facility at Terminal 4, which has a capacity of 250,000 units. Terminal 6 has two separate auto terminals for Honda and Hyundai. Honda has a 60-acre facility with a capacity of 190,000 units, while Hyundai has a 120-acre facility with annual capacity of 235,000 units. Capacity at these terminals is largely dependent on the storage capacity at the terminal as well as the length of time that vehicles stay at the terminal. Thus, suitable intermodal connections that allows efficient transfer of vehicles from the terminal is a key factor affecting capacity.

Actual throughput in 2008 at Port of Portland automobile terminals is estimated at approximately 408,000 units, down from a peak of 464,000 units in 2007.[134] Even under the low forecast scenario, potential total volume of auto imports to the Port of Portland is expected to exceed existing capacity by 2030. However, it is important to note that auto cargo volume may increase not just through increased imports by Toyota, Honda, and Hyundai, but also through other Asian automakers starting import operations in Portland. As multiple automakers do not typically operate at the same terminal, new facilities for other automakers may be required before cargo volumes reach 675,000 units.

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133 Cargo volume peaked in 2007. In that year, it is estimated that the private terminals in Portland handled 2.3 million MT local/regional cargo, and that this volume was near practical maximum capacity. Therefore, maximum practical capacity at these terminals is estimated at 2.5 million MTPY.

134 BST Associates. 2010. West Hayden Island Marine Cargo Forecasts and Capacity Assessment, Prepared for the Port of Portland.

The date that auto cargo volumes may exceed terminal capacity largely depends on when and whether Portland attracts a new automaker. Attracting a new automaker to Portland would result in a large, sudden increase in auto imports rather than a gradual annual increase. To accommodate a new auto account in Portland Harbor, additional land would likely be required for a new terminal.

6.2.1.4 Container

The Terminal 6 container facility at the Port of Portland has an estimated annual capacity of 700,000 TEUs. Portland currently is not a large intermodal gateway for container imports railed to other parts of the country, but rather serves as a container port for the regional area. Even under the high forecast scenario, container volume for this market area is estimated to reach 614,000 TEUs by 2040. However, if Portland attracts intermodal container traffic destined for more distant markets, an additional 130,000 TEUs may be expected by 2040.[135] In this scenario, container volumes by 2040 could exceed the capacity of Terminal 6 due to constraints at the berth. If container cargo increases to the level forecast in the high scenario, then it is likely that container operations at Terminal 6 would expand into Berth 603, which is currently serving breakbulk. Breakbulk would then either be consolidated at Terminal 2, or would be handled in areas currently serving auto cargo at Terminal 6. This would either reduce the capacity of breakbulk to the 1.1 million MTPY handled at Terminal 2, or reduce the capacity of auto terminals. With the use of Berth 603, the maximum capacity for containers at Terminal 6 would increase to at least 1 million TEUs.

6.2.1.5 Breakbulk

Breakbulk cargoes are primarily handled at Port of Portland's Terminal 2 (capacity 1.1 million MTPY) and Terminal 6 Terminal 6 (capacity 1.0 million). Maximum practical capacity at these terminals is estimated at 2.1 million MTPY. The 2040 forecast for breakbulk volumes in Portland Harbor ranges from 1.0 to 1.3 million MTPY; thus potential cargo volume is not expected to exceed sustainable practical throughput capacity by 2040. However, as noted above, in the high container cargo growth forecast, demand for new container capacity could be met by converting Berth 603 from breakbulk to container use and relocating breakbulk operations either to Terminal 2 or to an area in Terminal 6 presently used by auto cargo.[136] In this case, space for breakbulk would need to be identified, likely at Terminal 6, potentially reducing acreage currently used in auto terminals. If this option were not available, then a new breakbulk facility could potentially be necessary.

6.2.1.6 Liquid Bulk

Liquid bulk facilities in Portland Harbor handle liquid chemicals such as fertilizer, but primarily consist of the petroleum bulk terminals concentrated on the west side of the Willamette River in the Linnton and Willbridge areas. This area has access to the Olympic Pipeline as well as marine, rail, and truck transportation, which are all important modes of transporting petroleum products to Oregon. The throughput capacity of these facilities to handle petroleum products is not known. However, industry interviews indicate that most facilities are fairly built out, with relatively small amounts of land available for expansion. Several operations have invested in infrastructure to increase site efficiency, including constructing pipelines between different companies operating in close proximity. Some operations are looking to expand on their existing properties. In the past, BP/ARCO has sought to purchase and expand their operations on the adjacent Linnton Plywood site, but due to the cost of remediation and potential Superfund liability, has not purchased the site. Though limited, the potential for facilities to expand on their existing acreage combined with the relatively low forecasted liquid cargo volume growth of 0.5 percent annually through 2040 indicates that there is limited

[135] BST Associates. 2010. West Hayden Island Lower Columbia Port Capacity Assessment.

[136] Daly, Jim, Port of Portland. January 20, 2010. personal communication with Barbara Wyse, ENTRIX, Inc..

additional land needed to meet projected liquid bulk cargo growth. Based on the interest shown by BP Arco to purchase the 23-acre Linnton Plywood site, the land demand for petroleum liquid bulk facilities in the energy cluster area of Linnton is estimated at approximately 25 acres.

6.2.1.7 Summary of Capacity vs. Forecasted Cargo Volume

Comparison of forecasted cargo volumes for Portland Harbor by 2040 compared to capacity at existing Portland marine terminal facilities indicates that additional lands will be required for Portland to retain and attract its full potential cargo market share. While there is still capacity for growth in most cargo areas, by 2040 cargo volumes of each type may reach the limits of existing facilities' practical capacity. Automobile cargo terminals are the most constrained, with maximum practical capacity potentially being reached as early as 2020 under the high forecast scenario. Other cargo types particularly limited are grain and dry bulk facilities. Grain is limited by the age and small size (and potential lack of competitiveness) of existing facilities, while growth in new dry bulk markets would be limited by lack of terminal capacity to accommodate a new operator. Finally, growth in container cargo for a broader regional market using intermodal transport may be limited by existing terminal capacity.

Table 6-3 summarizes existing capacity versus forecasted cargo volume. New market opportunities provided in **Table 6-1** are incorporated into the high cargo volume forecast, and one-half of the forecast new market opportunities are incorporated into the "most likely" forecast. The highlighted areas of the table indicate cargo volumes that exceed practical capacity of existing Portland cargo terminals.

Table 6-3 Forecast Cargo Volume versus Annual Cargo Capacity of Existing Terminals in Portland Harbor

			Cargo Forecast by 2040			
Cargo	Units	Practical Maximum Capacity	Low	Most Likely	High	Potential Capacity Shortfall
Automobiles	Units	675,000	925,000	1,145,000	1,364,000	250,000 – 700,000
Containers	TEU	700,000	379,000	585,000	744,000	0 - 50,000
Breakbulk	MT	2,100,000	1,010,000	1,181,000	1,295,000	0
Grain	MT	4,100,000 - 7,100,000	5,647,000	6,477,000	7,059,000	0 – 3,000,000
Dry Bulk National/international	MT	8,200,000	4,650,000	6,054,000	9,733,000	0 – 1,500,000
Dry Bulk Local / Regional	MT	2,500,000	2,089,000	2,471,000	2,852,000	0 – 500,000

Source: BST Associates, 2009 and 2010, Port of Portland Marine Terminal Master Plan, Personal communication with the Port of Portland and BST Associates.
Abbreviations: TEU is twenty-foot equivalent units, MT is metric tons.

The acreage of land potentially needed to accommodate and attract the cargo growth opportunities shaded in grey in **Table 6-3** is explored in the next section.

6.2.2 Marine Cargo Forecasted Land Need

Facility development for marine cargo uses requires long-range planning and flexibility to meet changing market conditions, including development of new markets and change in cargo volumes. To meet growing demand, ports throughout the United States have typically increased throughput capacity by building new terminals requiring new land for development. Ports around the world have also worked to increase efficiency and increase throughput at existing facilities by changing operating standards and implementing such practices as off-site storage and more efficient cargo management systems. While reducing acreage requirements in marine areas, these practices can substantially increase operating costs and reduce competitiveness of a Port.

To retain and attract marine cargo tenants and customers, the Port of Portland must not only offer facilities that meet long-term operational requirements, but it must offer competitive and economically-efficient facilities. Additionally, to attract new tenants, the Port must be able to demonstrate that it has available facilities and land. Recently, several potential clients (such as the operator of the new grain terminal in Longview) have turned to competing ports due to the lack of large, available sites in Portland Harbor. To attract these clients, the Port likely needs to have land available for development – potentially before the specific client is known. Due to permitting processes, land designated for marine industrial uses has a long lead time to bring it into productive use. This makes it difficult to respond to markets and potential clients in a timely and flexible manner if lands are not available.

Thus, in addition to the marine cargo forecast, there are several important factors to consider when forecasting land needs for marine cargo uses. First, as suggested above, there is a feedback loop in developing new lands for marine cargo uses, as building a terminal can itself generate additional demand from new markets and new clients. Second, land need for marine terminal uses is not a gradual absorption as with most industrial land uses, but rather a sudden large absorption. A new marine terminal and associated facilities (including rail) should be constructed according to projected long-term needs and not just to satisfy short-term needs. Third, new cargo handling facilities are sometimes constructed as strategic, long-term investments by private businesses before demand exceeds capacity. Based on these factors, potential land absorption by marine cargo uses was not forecast for each year or decade, but rather forecast for the duration of the entire planning period to 2040.

A low, most likely, and high acreage need for marine cargo uses by 2040 is forecasted. This forecast is based on the marine terminal and associated infrastructure acreage that would be needed for Portland to capture its potential cargo market share as presented in **Table 6-1**. (**Section 6.4** below evaluates the availability of lands in Portland Harbor and other ports in the Lower Columbia to meet this potential need.)

As indicated in Table 3, under the low cargo forecast, automobiles are the only cargo for which cargo volume exceeds capacity. In this low forecast, potential auto cargo by 2040 exceeds capacity by 250,000 units. Existing auto import facilities at the Port of Portland and other ports have an average capacity of approximately 2,000 vehicles per year per gross acre.[137] These figures indicate that, at a minimum, approximately 150 acres (including rail yard) would be required to provide adequate terminal capacity to meet the forecast shortage of 250,000 units by 2040. This would be the total potential shortage of terminal acreage under the low cargo forecast.

Using the same methodology for the most likely and high cargo forecast scenarios, respectively, land requirements for automobile terminals by 2040 would be 260 and 370 acres. However, it is unlikely that automobile imports will grow at the same rate for each auto manufacturer. There is a need to allow for some automakers to grow faster than others, and therefore allow for the fact that some automakers may need to expand prior to others reaching capacity. Therefore, the total acreage to accommodate forecasted auto cargo growth is slightly increased for the most likely and high scenarios to 300 and 400 acres, respectively.

Under the most likely cargo forecast scenario, additional land would likely be required for automobiles (300 acres as described above) and grain. In the most likely scenario for grain cargo, it is expected that the grain terminals on private lands in Portland Harbor would cease operations during the planning period due to their age and the fact that they are very rail constrained. The grain facility at Terminal 5 will most likely remain

[137] This is slightly more annual throughput capacity per acre than recommended by recent work completed for the Port of Portland by HDR Engineering. This work assumed an annual throughput capacity of 2,000 vehicles per storage acre per year, plus additional space to accommodate terminal operations. This analysis indicated that approximately 125 acres would be required for an annual throughput of 200,000 cars.

competitive as it is a relatively modern elevator served by a major off-terminal railyard at South Rivergate, enabling it to be competitive despite a relatively small terminal footprint. Retirement of the two private grain facilities would result in a shortage of 2 to 3 million MTPY of grain cargo capacity compared to forecasted demand.

The most likely scenario would be that a new, larger grain terminal would replace the two older, private terminals that are rail constrained. These elevators handle wheat and barley but do not handle feed grains (corn and soybeans). New grain facilities are typically 100 or more acres in size and provide sufficient land for four unit trains, similar to the new facility in Longview. A new facility of this size, though necessary to provide the sufficient efficiency, would likely provide more capacity than initially required. However, other private grain terminals elsewhere in the Northwest may face similar age constraints (not accounted for in the grain cargo forecast for Portland Harbor), resulting in additional grain being handled through Portland if a new facility were constructed. Grain terminals can still be profitable when not operating at full capacity.

Under the most likely scenario, it is also anticipated that additional land would be demanded for liquid bulk facilities. As noted above, the interest shown by BP Arco to purchase the 23-acre Linnton Plywood site indicates a land demand for petroleum liquid bulk facilities in the energy cluster area of Linnton. Therefore, liquid bulk land demand is estimated at approximately 25 acres in the most likely and high scenarios.

Finally, under the high demand forecast, cargo volume is forecast to exceed capacity for cars, containers, grain, and dry bulk. As estimated above, approximately 400 acres is required to provide capacity for forecast automobile cargo. If Portland attracts new container traffic for a broader geographic area, then additional capacity could be required at Terminal 6 to handle this additional volume. As noted above, this additional capacity would likely be handled by converting Berth 603 to container use and re-locating the breakbulk cargo to another area at Terminal 6. One possible option would be to reduce acreage at one of the Terminal 6 auto terminals. Furthermore, the new lease of Terminal 6 prevents the Port of Portland from developing a new container terminal for the next 15 years.

Grain is forecast to rise to 7 million MTPY in the high forecast. A new grain facility of approximately 100 acres, as described in the most likely forecast, would provide sufficient capacity for this volume of grain.

While the volume of dry bulk cargo in the most likely forecast could be handled by existing terminals, under the high forecast a new, large terminal would be required to accommodate a new market opportunity in the national/international market. New dry bulk terminals with capacity of 5 to 8 million MTPY would likely require between 110 and 175 acres (125 acres used in **Table 6-4** below), including the associated rail infrastructure.[138] Additionally, in the high forecast scenario, growth is forecasted to exceed capacity. Depending on the product composition of the cargo increase, one or two additional small dry bulk facilities would likely need to be developed to meet this growth. Acreage requirements would likely be one or two parcels totaling approximately 30 acres of land.

Total forecasted land needs for marine cargo uses are summarized in **Table 6-4**. The forecasted land need through 2040 for the Port of Portland to retain and attract potential clients ranges from approximately 150 acres (low forecast) to approximately 665 acres (high forecast), with a most likely land need of approximately 400 acres. Though forecast by cargo type, this analysis indicates a general shortage of marine terminal land in Portland Harbor to meet cargo growth opportunities across the spectrum of waterborne products. The forecast should be interpreted as a general indication of land need across marine cargo types.

[138] HDR Engineering, Inc. 2009. West Hayden Island Terminal Site and Operation Requirements, Prepared for Port of Portland.

Table 6-4 Forecast Cargo Volume versus Annual Cargo Capacity of Existing Terminals in Portland Harbor

	Terminal Land Need Forecast by 2040 (Acres)		
Cargo	Low	Most Likely	High
Automobiles	150	300	400
Containers			
Breakbulk			
Grain		100	100
Dry Bulk National/International			125
Dry Bulk Local/Regional			30
Liquid Bulk		25	25
Total	150	425	680

This forecasted land need is relatively conservative when compared with historical marine cargo land absorption in Portland Harbor. As noted in Section 3, there have been 719 acres of land absorbed in Portland Harbor from 1974 to 2010 for marine terminals, or 20 acres annually. Assuming this same rate of land absorption over the next 30 years, there would be 600 acres of land absorbed for marine cargo uses by 2040.

6.3 FORECAST OF LAND NEED FOR MARINE INDUSTRIAL

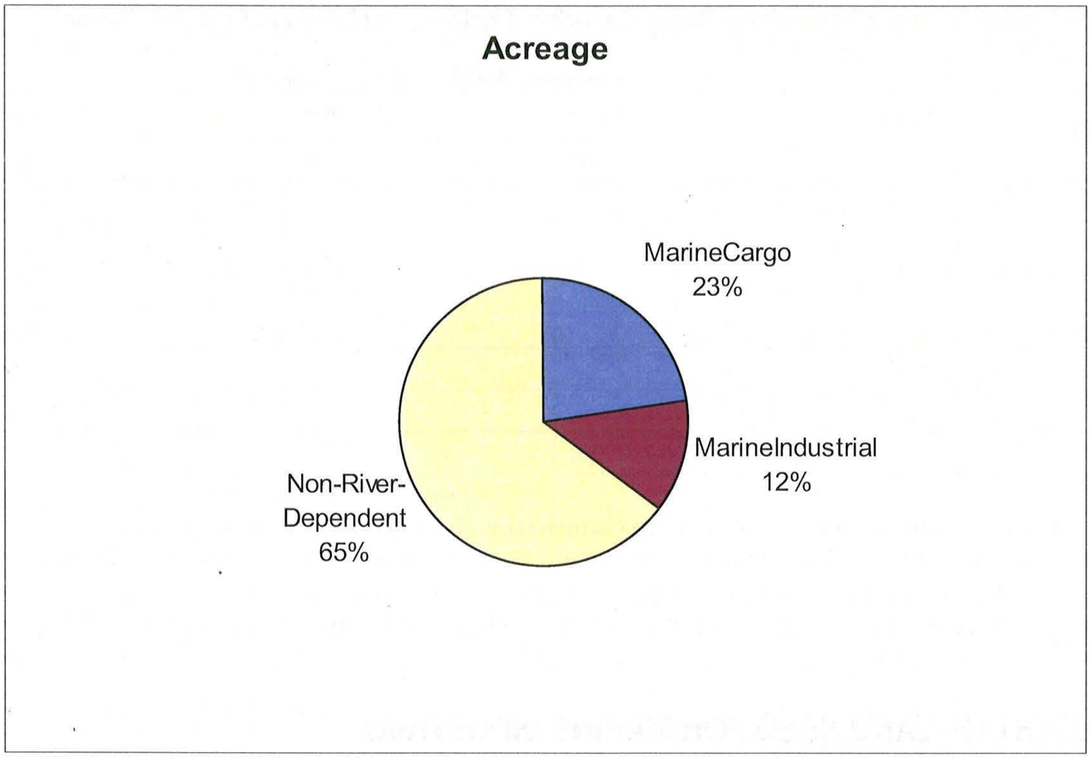
Land demand is forecast for marine industrial uses in this section. This forecast is based on the proportion of industrial lands in the Portland Harbor that are river-dependent (marine-related) as well as the employment land needs forecast in the 2009 Economic Opportunities Analysis (EOA) for the Columbia Harbor geography.

Four factors that influence which marine industrial uses will locate in the harbor area are: multimodal distribution infrastructure, industry clusters, heavy industrial character, and central urban location.[139] Between 1960 and 1997, an average of 5.6 acres annually of marine industrial development occurred, or 1 percent annual growth.[140] As identified in the Portland Harbor Industrial Lands Study, Portland is strongly competitive for 13 industrial sectors, of which four are already located in Portland Harbor. The future rate of growth in marine industrial lands will depend on the growth of specific industries as well as the availability of suitable waterfront land. The rate of absorption of lands will also depend on which industries are attracted to Portland Harbor, as site size varies radically amongst industry groups.

6.3.1 Marine Industrial Lands and Employment in Portland Harbor

As noted in section 2, the consultant team received geospatial data and employment data within the Portland Harbor. **Figures 6-1** and **6-2** summarize the employment and acreage in river-dependent uses and/or rail-dependent uses and other uses. **Table 6-5** displays the proportion of river-dependent acreage (henceforth, river dependent uses includes uses dependent only on river and uses dependent on both river and rail) and employment that is in marine industrial and marine cargo uses.

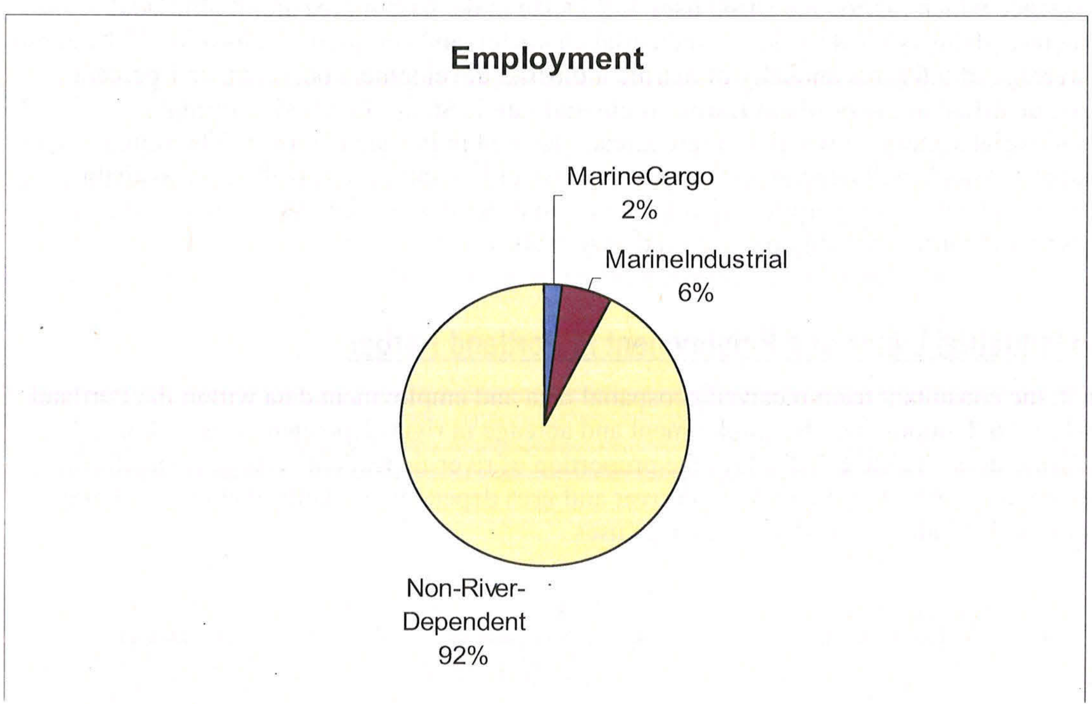
139 Portland Bureau of Planning, 2003, Portland Harbor Industrial Lands Study, Part One: Inventories, Trends, and Geographic Context.
140 Ibid.



Note: Excludes parcels for which no employment data were available.

Source Oregon Employment Division, 2008 Quarterly Census of Employment and Wages, City of Portland GIS, merged by Entrix, and tabulated by Bonnie Gee Yosick LLC.

Figure 6-1 Acreage for Portland Harbor Lands by Margo Cargo, Marine Industrial, and Other



Note: Excludes parcels for which no employment data were available.

Source: Oregon Employment Division, 2008 Quarterly Census of Employment and Wages, City of Portland GIS, merged by Entrix, and tabulated by Bonnie Gee Yosick LLC.

Figure 6-2 Employment for Portland Harbor Lands by River and Rail Dependency

As noted earlier, jobs on parcels classified as Marine Terminal are mostly classified as freight, with a small proportion classified as heavy manufacturing. The job density of these jobs is very low, averaging less than one job per acre, as shown in **Table 6-5**.

Table 6-5 Job Density Marine Terminal Uses

	Acres	Jobs	Job Density
Freight	978	598	0.61
Heavy Mfg	6	42	7.00
Total	984	640	0.65

Note: Excludes parcels for which no employment data were available.
Source: Oregon Employment Division, 2008 Quarterly Census of Employment and Wages, City of Portland GIS, merged by Entrix, and tabulated by Bonnie Gee Yosick LLC.

Classification of employment on land classified as marine industrial is much more diverse. Of the 751 acres of marine industrial land, employment data are available for 538 acres that provide employment for 2,067 workers across a range of industries. Over half of these employees (1,105 jobs) are classified as working in heavy manufacturing, another 644 jobs as freight, and the remainder classified as heavy transportation, services, and construction jobs. In general, parcels designated as marine-industrial are less employment-dense (average of 3.84 jobs per acre) as parcels not designated as river-dependent (average of 11.50 jobs per acre). Though not responsible for large numbers of employees, the most job-intensive of the marine-industrial categories included Services (at an average job density of 21.50 jobs per acre) and Heavy Transportation (at an average job density of 20.60 jobs per acre).

Table 6-6 Job Density Marine Industrial Uses

	Acres	Jobs	Job Density
Construction	11	67	6.09
Freight	325	644	1.98
Heavy Gov't/Public	18	4	0.22
Heavy Mfg	97	1,105	11.39
Heavy Transportation	5	103	20.60
Heavy Utilities	41	42	1.02
NOEmpsites	5	11	2.20
Services	4	86	21.50
Vacant	33	7	0.21
Total	538	2,067	3.84

Note: Excludes parcels for which no employment data were available.
Source: Oregon Employment Division, 2008 Quarterly Census of Employment and Wages, City of Portland GIS, merged by ENTRIX, and tabulated by Bonnie Gee Yosick LLC.

Table 6-7 Job Density Non-Marine Industrial Uses

	Acres	Jobs	Jobs per Acre
Construction	33	1,232	37.33
Freight	728	3,532	4.85
General Mfg	199	3,847	19.33
Gov't/Public	39	198	5.08
Greater 95	2	72	36.00
Heavy Gov't/Public	42	1,491	35.50
Heavy Mfg	451	4,358	9.66
Heavy Transportation	52	110	2.12
Heavy Utilities	10	73	7.30
Heavy Wholesale	117	1,380	11.79
Heavy mfg	5	1	0.20
M/T 2-3	202	3,018	14.94
MT_4_Plus	196	5,802	29.60
NOEmpsites	101	1,011	10.01
Repair, Rental, Laundry & Janitorial S	40	146	3.65
Retail	14	186	13.29
Services	22	419	19.05
Transportation	137	1,710	12.48
Utilities	8	61	7.63
Vacant	174	160	0.92
Wholesale	236	3,483	14.76
Total	2,808	32,290	11.50

Note: Excludes parcels for which no employment data were available.

Source: Oregon Employment Division, 2008 Quarterly Census of Employment and Wages, City of Portland GIS, merged by ENTRIX, and tabulated by Bonnie Gee Yosick LLC.

6.3.2 Forecasted Land Need

The City of Portland Economic Opportunities Analysis (EOA) forecasts an additional 16,360 jobs in the Columbia Harbor area by year 2035, with an associated requirement of 880 acres. This estimate is based on standards of square feet of space per employee (ranging from 350 square feet for office uses to 926 square feet for general industrial and 1,263 square feet for warehousing uses) and a 0.30 Floor-Area Radio (FAR).

According to the inventory, the Columbia Harbor currently contains 1,910 acres of vacant land. Using GIS data from the EOA and the City's Working Harbor analysis, it is estimated that the Portland Harbor contains 856 acres of vacant land, or approximately 45 percent of all vacant land within the Columbia Harbor area.

This analysis applied two methods to estimate land forecast for marine industrial use:

1. Apportioning EOA forecasted land need in Columbia Harbor by assuming that development occurs evenly throughout the Columbia Harbor with 45 percent occurring in Portland Harbor, and
2. Apportioning EOA forecasted land need in Columbia Harbor by assuming that 75 percent of development occurs in Portland Harbor, and

3. Apportioning EOA job forecast in Columbia Harbor to marine industrial employment based on current proportion of employment in river-dependent use, and then converting to land absorption based on job density currently observed in Portland Harbor marine industrial uses.

For both methods, intensification of development is likely as jobs and land uses become more water-dependent in the Portland Harbor.

The first way of estimating land development assumes vacant land across the Columbia Harbor geography is evenly developed. Based on this assumption, approximately 400 acres (45 percent of 880 acres) in Portland Harbor are expected to be developed by 2035 for both marine industrial and other non-river dependent uses (acreage for marine terminals is not included in the 880 acres EOA forecasted land need). As marine industrial accounts for 16 percent of the all land uses, it is estimated that approximately 60 acres (16 percent of the 400 acres forecast to be developed in the Portland Harbor) may be absorbed by marine industrial uses by 2035; this represents a low estimate of marine industrial land absorption in Portland Harbor by 2035.

With the urbanization and intensification of land uses in the Portland Harbor, as well as the greater land use per employee in Portland Harbor industries, the Portland Harbor may likely absorb a greater proportion of the forecast land development in the larger Columbia Harbor area. A high estimate of land absorption by marine industrial uses assumes that 75 percent of all land absorption in the Columbia Harbor geography occurs in Portland Harbor, or 660 acres. Assuming again that 16 percent of this is for marine industrial uses, provides a higher forecasted land absorption of approximately 100 acres for marine industrial uses by 2035. This estimate represents a 0.3 percent to 0.5 percent annual increase in industrial land use through 2035. This is still likely a conservative estimate, as attracting just one large manufacturing firm to the area could absorb this amount of land. For example, the Portland Development Commission is currently working to attract manufacturing businesses associated with the wind turbine industry that would likely require waterfront access.

A third method relies not on the land forecast from the Economic Opportunities Analysis, but on the jobs forecast of 16,350 new jobs by 2035 in the Columbia Harbor. Holding the proportion of marine industrial jobs constant in the Portland Harbor (about 6 percent of jobs estimated as marine industrial) yields about 980 marine industrial jobs by year 2035.[141] The currently observed average job density of 3.84 marine industrial jobs per acre suggests 250 acres of land in Columbia Harbor needed to accommodate these jobs. Given that the bulk of land in Columbia Harbor appropriate for marine industrial development is located within Portland Harbor, no apportionment of Columbia Harbor development to the Portland Harbor is necessary.

These methodologies suggest a range of land needs ranging from 60 to 250 acres for marine industrial activities by 2035. This corresponds to an average annual land demand of 2.4 to 10 acres. Assuming the same annual growth rate through 2040, then land needs are expected to range from 70 to 300 acres. The Portland Harbor Industrial Lands Study notes that average annual land absorption from 1960 to 1997 was 5.6 acres. If this rate were projected forward, it would suggest land need of approximately 170 acres by 2040, which falls within the range of projected land needs based on EOA forecasts.

141 Note that this marine industrial employment growth is slightly lower than the combined marine industrial and marine terminal employment growth forecasted in Section 3.

Table 6-8 Forecast Land Need for Portland Harbor Development (Acres)

Timeframe	Low (land based)	Medium (land based)	High (jobs based)
Annual Demand	2.4	4	10
Total Demand by 2035	60	100	250
Total Demand by 2040	70	120	300

Source: Oregon Employment Division, 2008, Quarterly Census of Employment and Wages, E. D. Hovee & Company, ENTRIX, and Bonnie Gee Yosick LLC.
Note: Land projection is through 2035 as this is the time period analyzed in the Economic Opportunities Analysis.

6.4 LAND NEEDS COMPARED TO AVAILABLE LANDS INVENTORY

The discussion below compares land needs for marine cargo and marine industrial development in the Portland Harbor forecasted above to the inventory of suitable sites completed in **Section 5**.

6.4.1 Marine Cargo

Marine cargo land need is forecast to range from 150 acres to 680 acres, primarily in parcels larger than 100 acres. In the high forecast scenario, up to 30 acres of land may be required to accommodate growth in local/regional dry bulk cargo, such as aggregates or agricultural chemicals. Depending on the type of cargo product, this level growth may be accommodated in one larger or two smaller parcels. It is likely that the land requirement for this cargo type could be met by vacant lands available in the Portland Harbor, as long as business opportunities are willing to develop suspected brownfield sites with potential Superfund liabilities. As described in Section 5, the vacant lands in the harbor area include parcels of 30 acres in size, though many of them are potential brownfield sites and may be subject to liability associated with the Superfund site. Additionally, the most likely and high forecast scenarios indicate demand of approximately 25 acres for liquid bulk expansion in the Linnton area of the Portland Harbor. This demand is also subject to constraints related to contamination.

The remaining land need for marine cargo (150 acres in the low scenario, 400 acres in the most likely scenario, and 625 in the high scenario), is for parcels larger than 100 acres to accommodate rail access and ensure competitiveness. As discussed in Section 5, there are no parcels of this size available in Portland Harbor. To accommodate these new marine terminals given the currently available land supply, it is expected that the Port of Portland would need to develop land on WHI.

6.4.2 Marine Industrial

Marine industrial land need through 2035 is forecast to range from 70 to 300 acres. As discussed in Section 4, parcels for marine industrial development vary in size from 5 acres to more than 100 acres and require barge access. There are 11 parcels (263 acres) of vacant lands in Portland Harbor that are larger than five acres and adequate shoreline length. However, only one of the 11 potential sites (19 acres) does not have potential upland contamination, the presence of which carries significant costs and risks as discussed in Section 4. As noted in **Section 4,** the EOA forecasts that up to 45 percent of brownfield sites will be available for development by 2035. This indicates that in addition to the 19-acre site that is not contaminated, there may be up to 110 acres of brownfield sites that may be available, for a total of 130 acres. Thus, while Portland Harbor has available brownfield sites for redevelopment that will accommodate smaller-sized marine industrial uses, it lacks sites for large river-dependent manufacturers or other opportunities requiring uncontaminated sites on the river. This may make it difficult to attract new businesses to the region unless additional lands are available on WHI.

6.4.3 Summary of Unmet Land Needs

Forecasted demand for marine-related land uses (both marine cargo and marine industrial) ranges from 220 acres in the low forecast to 980 acres in the high forecast. Of this acreage, up to 130 acres may be accommodated on smaller parcels in the harbor area (potentially 55 acres of regional/local dry bulk terminal and liquid bulk terminal and up to 75 acres of marine industrial). Forecasted acreage demand that can not likely be satisfied in the harbor area ranges from 150 acres in the low scenario to 850 acres in the high scenario.

6.5 AVAILABILITY AND SUITABILITY OF LOWER COLUMBIA SITES

Marine cargo and marine industrial uses that desire to locate in the Portland metro area may also consider sites at other locations along the Columbia River (see **Section 2.2.3**). While the forecast of land needs is specific to Portland Harbor and does not include all Lower Columbia River forecasted land need, this section describes the suitability of WHI compared to other potential Lower Columbia marine industrial sites.

6.5.1 WHI

WHI consists of more than 800 acres of relatively undeveloped land on the western portion of Hayden Island. Hayden Island is located in the Columbia River just east of the confluence with the Willamette River. The main, deepwater channel of the Columbia River is on the north side of Hayden Island, while the North Portland Harbor is located on the south side. The Port of Portland acquired the land in 1993 for the purpose of marine industrial development. The land was designated in 1995 as Regionally Significant Industrial Area as well as a Regionally Significant Natural Area.

WHI has the land size, deepwater access, and proximity to rail and interstate infrastructure necessary for a marine terminal location. Interstate 5 bisects Hayden Island, as does the Burlington Northern Sante Fe (BNSF) mainline. As direct access to I-5 is difficult from WHI, if marine terminal development were to take place on the island it is expected that a bridge for vehicular access would be constructed connecting WHI with Marine Drive in Portland. It is also expected that rail access would be developed by integrating with the existing BNSF rail bridge on the eastern limits of the WHI. WHI is identified as regionally significant natural area and provides a large expanse of relatively undeveloped natural area within the Columbia River riparian corridor. Consequently, the primary constraint to WHI development is expected to be impact to natural resources, which is evaluated in the companion study to this economic foundation study.

A recent study conducted for the Port of Portland provides some general design guidelines for potential marine terminal development of WHI.[142] This preliminary study analyzed terminals for automobiles (75 to 140 acres), dry bulk (110 to 175 acres), liquid bulk (125 to 155 acres), and container cargo (95 to 140 acres). Conceptual designs, include rail infrastructure, were generated for these terminals. Berths for each terminal type were described, and vary from floating platforms to split-level fixed berths to a traveling loader system. All berths would be located on the north side of the island.

If the area is developed, rail infrastructure required for efficient and competitive terminals would vary by terminal type, but would include working track lengths (2,500 to 3,500 feet), storage tracks, and a railcar storage area. Regional market advantage can be achieved with rail infrastructure including 8,500 to 10,000-foot tracks. An intermodal railyard of 30 acres is included in the design concepts . Loop tracks of 8,500 feet for dry bulk facilities are also included in the design concepts for the dry bulk, liquid bulk, and grain

[142] HDR Engineering. Inc. 2009. West Hayden Island Terminal Site and Operation Requirements and Addendum I. Prepared for Port of Portland. Accessed at http://www.portlandonline.com/bps/index.cfm?a=279953&c=51508.

terminals. Additional landside facilities that would be required on WHI include a gate complex (control point for cargo entering or leaving the terminal by road).

Two general design concepts were developed, one with a long track traversing east-west along the island parallel to the shoreline, and one with the tracks approximately extending only as far west as the power line corridor (see Addendum 1 to the Technical report). Limiting the rail footprint to the east side the BPA power line corridor increases the amount of time for trains to enter or exit the mainline tracks by approximately 25 percent due to increased curvature in the track configuration. Other operational constraints would result from this configuration, including increased labor for train handling and maneuvering, enable only one loop track of the desired 10,000 feet length, and require increased coordination between terminals.

6.5.2 Available Land at Other Lower Columbia Ports

There are four other ports located on the Lower Columbia River: St. Helens in Oregon, and Vancouver, Longview, and Kalama in Washington. Each of these ports has land available for marine terminal expansion as summarized in **Table 6-9**. The suitability of these sites for marine terminal purposes depends on the associated infrastructure, the size of the sites, natural resource constraints, and the intended land use for the sites.

Table 6-9 Lands Available for Marine Terminal Development at Other Columbia River Ports

	Available Lands		Available for Marine Terminals
Port	Port Lands	Private Lands	
Vancouver	568 - 618		718
Longview		600	600
Kalama	80 – 100		
St. Helens	200 – 450		

This analysis focuses on lands in the Ports of Longview and Vancouver as lands available at Kalama and St. Helens are unlikely to be used for marine terminal development. In Kalama, there are 80 to 100 acres vacant, but the Port is seeking users generally associated with manufacturing or processing. The St. Helens port has 200 acres available for development, but this acreage is in an energy park at Port Westward that is controlled by Portland General Electric. As such, it is not considered suitable for marine terminal development.

At the Port of Vancouver there are 718 acres available, of which 218 are in the planned Terminal 5, and 350 to 400 are in the planned Columbia Gateway. The planned Terminal 5 is located just to the west of the Port of Vancouver facilities and is expected to serve bulk and breakbulk cargoes on 140 acres. The Port is expecting that much of this facility will be used to handle increased volumes of wind turbine cargo. To serve this terminal with rail access, a unit train track is expected to be complete in 2010, which is a portion of the West Vancouver Rail Access Plan that is intended to be completed in 2017.

Another property owned by the Port of Vancouver, the Columbia Gateway property, is a 1,106-acre property, of which 350 to 400 acres may include marine terminals. A 2005 concept design for this property includes two auto facilities of 116 and 85 acres, respectively, as well as a dry bulk or grain facility on 110 acres.[143] The Port is expecting to use the Columbia Gateway site by 2018.

[143] Port of Vancouver. 2005. Developing Our Future. Vancouver Lake Watershed Partnership Power Point Presentation. Accessed at http://www.cityofvancouver.us/PublicWorks/vancouverlake/MapsMaterials/VLWP_PortPresentation_61505.pdf.

The Port of Longview is developing a new grain facility on more than 100 acres that is expected to have a capacity of 8 million MTPY. The only available parcels for additional marine terminal development are privately owned. The Chinook Ventures property has 416 acres and a dock, and may be used for cement production or other uses. It is not known if this site would potentially be available for marine terminal development. Another available, private property, Barlow Point is a private, greenfield property in Longview that is 318 acres and has rail connections to BNSF. This property has been available for sale for the last several years, and it is not known what constraints may apply to the site.

6.5.3 Summary and Comparison of Site Availability and Suitability

There are available lands and several planned facilities to accommodate forecasted growth in Columbia River cargo, including those at WHI. Land on WHI would be able to accommodate two marine cargo terminals, and would likely enable the Port of Portland to capture its potential cargo growth opportunities presented in **Section 3**. WHI provides the deepwater access, parcel size, proximity to rail and truck infrastructure, and configuration required for modern, efficient marine terminal facilities. WHI is also very suitable for marine industrial uses as it separates industrial use from residential areas and reduces the likelihood of incompatibilities or encroachment by non-industrial uses such as residential areas.

If WHI is not developed, it appears that the existing and planned terminals at ports located on the Washington side of the Lower Columbia River may be able to meet the forecasted cargo demand for the Lower Columbia (see **Table 6-10**). Under this scenario, however, it is expected that Portland would lose market share in marine cargo and associated jobs and income. Additionally, if WHI is not developed, it is expected that fewer lands will be available for marine industrial uses in Portland Harbor, resulting in less job growth in river-dependent manufacturing and other sectors dependent on marine cargo activities.

Table 6-10 2040 Cargo Forecast for the Lower Columbia River

		Portland Harbor Forecast 2040			Lower Columbia River, WA		Total Lower Columbia River
	Units	Low	Most Likely	High	2030[b]	2040[c]	Most Likely 2040
Automobiles	Units	925,000	1,145,000	1,364,000	118,000	123,000	1,268,000
Containers	TEU	379,000	520,000	614,000			520,000
Breakbulk	MT	1,010,000	1,181,000	1,295,000	294,000	295,000	1,476,000
Grain	MT	5,647,000	6,477,000	7,059,000	5,928,000	5,946,000	12,423,000
Dry Bulk	MT	6,547,000	8,524,000	1,018,000	4,355,000	4,377,000	12,901,000
Liquid Bulk	1,000 MT	6,912,000	7,571,000	8,011,000	1,282,000	1,297,000	8,868,000

a/ BST and Global Insight 2009 WHI Marine Cargo Trends and Forecasts
b/ BST and Global Insight 2009 Marine Cargo Forecast for Washington Public Ports Association
c/ Assuming growth rate from 2030 to 2040 is the same as from 2025 to 2030

6.6 SUMMARY AND IMPLICATIONS OF MARINE-RELATED DEVELOPMENT AT WHI

Provided there is adequate terminal infrastructure and land, marine cargo volume is projected to grow over the next 30 years in Portland, as is marine industrial land use. However, projected growth will not be realized if suitable lands are not available. In particular, lack of available, large developable sites suitable for marine industrial development constrains growth opportunities for marine cargo or large marine industrial manufacturers. As noted in METRO's 2009 urban growth report, the region must decide how it will accommodate forecasted population and employment growth and what investments we are willing and able make in transportation corridors and employment areas to support long-term employment growth.[144]

Forecasted demand for marine-related land uses (both marine cargo and marine industrial) ranges from 220 acres in the low forecast to 980 acres in the high forecast. Of this acreage, up to 130 acres may be accommodated on smaller parcels in the harbor area (potentially 55 acres of regional/local dry bulk terminal and liquid bulk terminal and up to 75 acres of marine industrial). This figure is based on the available lands in the harbor area and the proportion of brownfield sites that may be available for development, as discussed in **Section 6.4.2**.

WHI is the only parcel suitable in Portland Harbor for new uses that require 100 acres or more. Development of WHI for marine terminal use would likely allow Portland to capture potential cargo opportunities forecast in **Section 3**, and associated jobs and income. Forecasted acreage demand that can not likely be satisfied in the harbor area ranges from 150 acres in the low scenario to 850 acres in the high scenario. Development on WHI for marine cargo purposes may also lead to more available lands in Portland Harbor for other industrial uses, if some existing cargo operations such as grain are consolidated at larger marine terminals. As discussed in **Section 2**, growth in these marine-related industries is a major engine for the local economy, and has implications across a variety of sectors.

In summary, to meet all projected cargo growth, particularly automobile, and provide large parcels for marine industrial growth, Portland is expected to need to develop WHI. (This assumes that there is not significant redevelopment and/or consolidation of land uses in Portland Harbor and also assumes similar future site requirements for marine cargo). If WHI is not developed, it appears that the existing and planned terminals at ports located on the Washington side of the Lower Columbia River may be able to meet the forecasted cargo demand for the Lower Columbia. Under this scenario, however, it is expected that Portland would opportunities to expand marine-related economic activity and would forfeit the associated jobs and income. Additionally, if WHI is not developed, it is expected that fewer lands will be available for marine industrial uses in Portland Harbor, potentially resulting in less job growth in marine-related manufacturing and other sectors dependent on marine cargo activities.

[144] Metro. 2009. 20 and 50 year Regional population and employment range forecasts. accessed online at: http://library.oregonmetro.gov/files/appendix_12_forecast.pdf.

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APPENDIX A

Marine Industrial Cluster and Linkage Analysis for Selected Industries

Cluster analysis—the identification of groups of firms or industry sectors that share similar suppliers, skills, markets, and workers—has been used as part of the City of Portland economic development efforts for years. The City has used the results of cluster analysis to better understand the regional economy, to focus its economic development agenda, and to identify industry partners.

Industry clusters are generally defined as geographic concentrations of interconnected companies and institutions in a particular field. They may include:

- Suppliers of specialized inputs, machinery, and services;
- Distribution channels and customers;
- Manufacturers of complementary products;
- Companies related by skills, technologies or common inputs; and
- Related institutions such as research organizations, universities, training entities, others.

Cluster efforts typically analyze various traded sectors. According to a paper on how to include economic impact information into investment decisions for transportation projects by the Economic Development Research Group (2008),[145]

> *The traded industries serve as a primary generator of wealth by producing more than can be consumed locally. However, from a transportation perspective, traded industries are important because their products are traded and hence depend on long-distance transportation connections to customers in national or international markets. As a result, any major reduction in access to customers outside the region can have serious implications for many traded industries (and therefore the broader economy). Thus, transportation's support for traded industries not only enables those industries to generate wealth for the region, but transportation becomes an important determinant of their future economic prospects.*

[145] Economic Development Research Group, Inc. 2008. Use of Freight and Business Impact Criteria for Evaluating Transportation Investments, Executive Summary. Prepared for the Portland Business Alliance and Port of Portland. Available at www.portofportland.com/.../Trade_Trans_Studies_EDR_ExecSmry.pdf.

As maritime services are not an export in and of themselves, the intent of this exercise is to explore and quantify those industries most reliant on marine terminal and harbor activities. The analysis uses the IMPLAN[146] 2007 dataset and defines the region as the four-county area, including Multnomah, Washington, and Clackamas counties in Oregon, and Clark County in Washington. In addition to being one of the most commonly used tools in economic impact analysis; IMPLAN is also frequently used for cluster analysis, by examining the relationships of industries to their buyers and suppliers. The structure of the model mimics the monetary transactions for consumption within an economy, allowing a detailed examination of the effects of transactions between businesses and between businesses and final consumers.

The top 30 industrial purchasers of water transportation services are shown in tabular form in **Appendix A** with the IMPLAN industry code and the percent represented of all industry-based intermediate commodity demand (see **Table A-1**). These results show that the two largest industrial "customers" of water transportation services are the scientific research and development services industry and flour mill and malt manufacturing industry, together accounting for over half of the intermediate industrial-based water transportation services demand. This reflects the fact that grain produced in the region relies heavily on water transportation to reach their global customers. Again, a primary challenge of this data is the fact that it is limited to the intermediate demand generated by other industrial users within the four-county region. In as much as the majority of demand is final demand from consumers and foreign and domestic trade, the conclusions derived from this data are limited.

A reverse type of analysis demonstrates the sectors upon which water transportation depends. These suppliers of intermediate inputs to the water transportation sector are linked in that some portion of their business depends upon the water transportation sector. For example, water transportation depends on fuel, and other supplies that are purchased when ships dock on the harbor. The top 30 suppliers (by gross value of goods and/or services provided) to the water transportation industry are also shown in tabular form in Appendix B along with the IMPLAN industry code and the percent the industry represents of all intermediate inputs to the water transportation industry (see **Table A-2**). Many of the industries represented in the list of suppliers are not well represented regionally. Consequently, much of the economic benefit of those purchases 'leaks' outside the region. To correct for this phenomenon, another review covers regional inputs estimated from Regional Purchase Coefficients, yielding a list more relevant to the region (**Table A-3**). The largest supplier to industries providing water transportation is Scenic and Sightseeing Transportation and Support Activities for Transportation, followed by Real Estate Services, the US Postal Service, and Couriers and Messengers.

Cluster analysis concepts were applied to the following industries in Portland Harbor that are dependent on water transportation:

- Handling of Automobiles;
- Transport Manufacturing, including barge manufacturing companies in the harbor, such as Gunderson and US Barge;
- Handling of Steel Slab;
- Petroleum; and

[146] IMPLAN is a static equilibrium input-output model first developed in 1979 by the U.S. Forest Service in cooperation with the Federal Emergency Management Agency and the U.S. Bureau of Land Management to assist the Forest Service in land and resource planning and management. The program has been updated and improved over subsequent years and is now one of the most commonly-used economic modeling tools for measuring the economic impacts of development projects.

- Paper and Cartons.

An analysis of the buyers and suppliers to these sectors shows how they are linked to the rest of the Portland economy.

Handling of Automobiles: According to the Martin report, the handling of autos accounted for 796 employees in 2006. In IMPLAN, these activities might be captured as motor vehicle parts manufacturing which accounted for nearly 2,000 employees and nearly $623 million in economic output. At nearly $61,000, its average employee compensation is about eight percent higher than the all-industry average of about $56,500. The top 30 industrial purchasers of motor parts manufacturing services are shown in **Appendix A** along with the IMPLAN industry code and the percent represented of all industry-based intermediate commodity demand (see **Table A-4**). The largest industrial "customers" of motor vehicle parts manufacturing services are the related industries of truck manufacturing and automotive repair and maintenance. The largest supplier to motor vehicle parts manufacturing industries is wholesale trade, reflecting the importance of trade and the movement of goods to this industry (see **Table A-5**).

Transport Manufacturing: Barge manufacturers in the harbor include Gunderson and US Barge. Classified as NAICS code 332312, this industry is included in IMPLAN industry group 186, described as "Plate Work and Fabricated Structural Product Manufacturing" which has 1,926 employees and nearly $572 in economic output. Earnings per worker average nearly $61,000, about the same as observed in handling of autos. The top purchasers of Plate Work and Fabricated Structural Product Manufacturing are two different sectors of Nonresidential Construction (commercial / health care structures and other nonresidential structures), followed by Transport by Water. Like Handling of Autos, a top supplier is Wholesale Trade, followed by Iron and Steel Mills.

Handling of Steel: One key element of the marine terminal activities is the handling of steel such as Schnitzer and Oregon Steel. According to the Martin report, the handling of steel slabs accounted for 676 employees in 2006, and the handling of steel breakbulk another 51. In IMPLAN, these activities might be captured as metal foundries which accounted for over 3,300 employees and over $860 million in economic output. At nearly $85,000, its average employee compensation is higher than the all-industry average of about $56,500, as was observed in transport by water and handling of autos. The largest industrial "customers" of metal foundries manufacturing services are generally durable good manufacturers, including motor vehicle parts manufacturing, pump equipment manufacturing, and equipment handling manufacturing (**Table A-6**). They might include employers in the harbor area such as Tube Forgings of America, Sulzer Pumps, NW Copper Works, Harmer Steel, and Gunderson. The largest supplier to metal foundries manufacturing industries is wholesale trade (**Table A-7**).

Handling of Petroleum: Chevron, Conoco Phillips, KinderMorgan, NuStar Energy, Northern Resources, and Western States Petroleum all operate facilities in Portland Harbor. According to the Martin report, the handling of petroleum accounted for 562 employees in 2006. In IMPLAN, these activities might be captured as petroleum distribution (which includes retail gas stations) which accounted for nearly 4,500 employees and over $540 million in economic output. At less than $20,000, its average employee compensation is just about 65 percent lower than the all-industry average of about $56,500. However, the inclusion of retail gasoline stations in the category is likely to pull down the average, despite a strong probability that compensation for employees at the private terminals handling the receipt of petroleum product is higher. The largest industrial "customers" of petroleum distribution services are the construction sectors (**Table A-8**). This phenomenon is due, in large part, to the inclusion of retail gas stations in this sector. The largest supplier to petroleum distribution manufacturing industries is real estate establishments, though these are probably lease/rent agreements for the retail gasoline stations included in this sector (**Table A-9**).

Paper and Cartons: Georgia Pacific in Rivergate and Smurfit on North Burgard Way have large operations in the harbor. According to the Martin report, the handling of paper accounted for 70 employees in 2006, and the handling of cartons another 99. In IMPLAN, these activities might be captured as the paperboard container industry which accounted for over 1,180 employees and over $405 million in economic output. At nearly $71,500, its average employee compensation is 26 percent higher than the all-industry average of about $56,500, as was observed in transport by water, handling of autos, and the handling of steel. The largest industrial "customers" of paperboard manufacturing services are other manufacturers, including a range of food and food product manufacturing, such as fruit and vegetable processing manufacturing, breweries, cookie/cracker/pasta and snack manufacturing, and some durables, such as cutlery/utensils/pot/pan manufacturing (Table A-10). The largest supplier to paperboard manufacturing industries is the wholesale trade sector, again highlighting the importance of trade and movement of goods to this industry (Table A-11). Other suppliers might include companies like Western Machine Works on North Burgard Way, which manufactures products for the pulp and paper industry

Table A-1 Industrial Buyers of Water Transportation Services, Ranked by Value

Rank	Industry Code	Description	Percent of all Intermediate Commodity Demand
1	376	Scientific research and development services	28.46%
2	43	Flour milling and malt manufacturing	23.24%
3	170	Iron and steel mills and ferroalloy manufactu	3.58%
4	37	Construct new residential permanent site sing	2.64%
5	427	US Postal Service	2.62%
6	243	Semiconductor and related device manufacturing	2.29%
7	332	Transport by air	2.19%
8	430	* Not unique commod (S&LG passenger transit)	1.77%
9	335	Transport by truck	1.68%
10	36	Construct other new nonresidential structures	1.62%
11	39	Maint & repair construct of nonresident struc	1.43%
12	388	Services to buildings and dwellings	1.33%
13	179	Ferrous metal foundries	1.25%
14	31	Electric power generation- transmission- and	0.96%
15	319	Wholesale trade businesses	0.95%
16	63	Cookie- cracker- and pasta manufacturing	0.92%
17	34	Construct new nonresidential commercial and h	0.87%
18	66	Coffee and tea manufacturing	0.86%
19	38	Construct other new residential structures	0.80%
20	105	Paper mills	0.70%
21	54	Fruit and vegetable canning- pickling- and dr	0.68%
22	161	Ready-mix concrete manufacturing	0.63%
23	413	Food services and drinking places	0.62%
24	381	Management of companies and enterprises	0.56%
25	6	Greenhouse- nursery- and floriculture product	0.56%
26	432	Other state and local government enterprises	0.56%
27	174	Aluminum product manufacturing from purchased	0.54%
28	10	All other crop farming	0.53%
29	173	Secondary smelting and alloying of aluminum	0.49%
30	65	Snack food manufacturing	0.48%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-2 Suppliers to the Water Transportation Industry Ranked by Gross Value of Goods/Services Supplied

Gross Rank	Commodity Code	Description	Percent of Gross Inputs
1	338	Scenic and sightseeing transportation and sup	15.30%
2	186	Plate work and fabricated structural product	11.71%
3	433	* Not an industry (Used and secondhand goods)	10.78%
4	360	Real estate establishments	10.16%
5	290	Ship building and repairing	6.24%
6	427	US Postal Service	5.94%
7	357	Insurance carriers	5.38%
8	339	Couriers and messengers	5.22%
9	356	Securities- commodity contracts- investments-	3.76%
10	390	Waste management and remediation services	3.10%
11	197	Coating- engraving- heat treating and allied	2.19%
12	383	Travel arrangement and reservation services	2.13%
13	377	Advertising and related services	2.07%
14	381	Management of companies and enterprises	1.99%
15	335	Transport by truck	1.28%
16	340	Warehousing and storage	1.22%
17	382	Employment services	0.93%
18	85	All other textile product mills	0.93%
19	31	Electric power generation- transmission- and	0.90%
20	351	Telecommunications	0.77%
21	374	Management- scientific- and technical consult	0.73%
22	319	Wholesale trade businesses	0.70%
23	384	Office administrative services	0.68%
24	367	Legal services	0.55%
25	389	Other support services	0.49%
26	368	Accounting- tax preparation- bookkeeping- and	0.40%
27	33	Water- sewage and other treatment and deliver	0.40%
28	332	Transport by air	0.38%
29	32	Natural gas distribution	0.37%
30	388	Services to buildings and dwellings	0.36%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-3 Suppliers to the Water Transportation Industry, Ranked by Value of Goods/Services Supplied Regionally

Regional Rank	Gross Rank	Commodity Code	Description	Percent of Regional Inputs
1	1	338	Scenic and sightseeing transportation and sup	21.85%
2	4	360	Real estate establishments	14.49%
3	6	427	US Postal Service	8.80%
4	8	339	Couriers and messengers	7.45%
5	7	357	Insurance carriers	6.94%
6	10	390	Waste management and remediation services	4.77%
7	9	356	Securities- commodity contracts- investments-	4.65%
8	13	377	Advertising and related services	3.11%
9	14	381	Management of companies and enterprises	3.07%
10	12	383	Travel arrangement and reservation services	3.04%
11	15	335	Transport by truck	2.61%
12	16	340	Warehousing and storage	2.10%
13	19	31	Electric power generation- transmission- and	1.67%
14	17	382	Employment services	1.43%
15	22	319	Wholesale trade businesses	1.43%
16	11	197	Coating- engraving- heat treating and allied	1.09%
17	3	433	* Not an industry (Used and secondhand goods)	0.91%
18	24	367	Legal services	0.90%
19	21	374	Management- scientific- and technical consult	0.85%
20	20	351	Telecommunications	0.83%
21	27	33	Water- sewage and other treatment and deliver	0.82%
22	25	389	Other support services	0.75%
23	29	32	Natural gas distribution	0.73%
24	26	368	Accounting- tax preparation- bookkeeping- and	0.64%
25	30	388	Services to buildings and dwellings	0.55%
26	2	186	Plate work and fabricated structural product	0.53%
27	28	332	Transport by air	0.36%
28	34	369	Architectural- engineering- and related servi	0.26%
29	33	375	Environmental and other technical consulting	0.26%
30	35	386	Business support services	0.25%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-4 Industrial Buyers of Motor Parts Manufacturing Services, Ranked by Value

Rank	Industry	Description	Percent of all Intermediate
1	278	Heavy duty truck manufacturing	43.37%
2	414	Automotive repair and maintenance- except car	10.18%
3	283	Motor vehicle parts manufacturing	6.14%
4	319	Wholesale trade businesses	4.21%
5	335	Transport by truck	3.97%
6	294	All other transportation equipment manufactur	2.36%
7	430	* Not unique commod (S&LG passenger transit)	1.89%
8	37	Construct new residential permanent site sing	1.56%
9	34	Construct new nonresidential commercial and h	1.53%
10	336	Transit and ground passenger transportation	1.48%
11	280	Truck trailer manufacturing	1.46%
12	427	US Postal Service	1.19%
13	38	Construct other new residential structures	1.16%
14	36	Construct other new nonresidential structures	0.88%
15	320	Retail Stores - Motor vehicle and parts	0.71%
16	390	Waste management and remediation services	0.58%
17	413	Food services and drinking places	0.58%
18	243	Semiconductor and related device manufacturin	0.55%
19	324	Retail Stores - Food and beverage	0.55%
20	381	Management of companies and enterprises	0.53%
21	20	Extraction of oil and natural gas	0.51%
22	329	Retail Stores - General merchandise	0.51%
23	39	Maint & repair construct of nonresident struc	0.49%
24	388	Services to buildings and dwellings	0.49%
25	205	Construction machinery manufacturing	0.48%
26	228	Material handling equipment manufacturing	0.47%
27	362	Automotive equipment rental and leasing	0.47%
28	415	Car washes	0.46%
29	282	Travel trailer and camper manufacturing	0.43%
30	327	Retail Stores - Clothing and clothing accesso	0.33%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-5 Suppliers to the Motor Vehicle Parts Manufacturing Industry, Ranked by Value of Goods/Services Supplied Regionally

Regional Rank	Gross Rank	Commodity Code	Description	Percent of Regional Inputs
1	3	319	Wholesale trade businesses	20.43%
2	4	381	Management of companies and enterprises	14.17%
3	1	283	Motor vehicle parts manufacturing	10.03%
4	12	335	Transport by truck	4.37%
5	10	149	Other plastics product manufacturing	3.44%
6	20	31	Electric power generation- transmission- and	2.64%
7	28	147	Urethane and other foam product (except polys	2.11%
8	8	195	Machine shops	2.07%
9	2	170	Iron and steel mills and ferroalloy manufactu	2.05%
10	23	243	Semiconductor and related device manufacturin	2.00%
11	11	247	Other electronic component manufacturing	1.98%
12	24	376	Scientific research and development services	1.98%
13	26	356	Securities- commodity contracts- investments-	1.48%
14	38	39	Maint & repair construct of nonresident struc	1.41%
15	9	196	Turned product and screw- nut- and bolt manuf	1.11%
16	51	32	Natural gas distribution	0.99%
17	42	377	Advertising and related services	0.95%
18	43	380	All other miscellaneous professional- scienti	0.93%
19	41	360	Real estate establishments	0.93%
20	31	246	Printed circuit assembly (electronic assembly	0.90%
21	14	197	Coating- engraving- heat treating and allied	0.82%
22	50	388	Services to buildings and dwellings	0.79%
23	48	333	Transport by rail	0.78%
24	57	320	Retail Stores - Motor vehicle and parts	0.75%
25	56	366	Lessors of nonfinancial intangible assets	0.64%
26	66	413	Food services and drinking places	0.59%
27	6	180	Nonferrous metal foundries	0.58%
28	64	340	Warehousing and storage	0.57%
29	67	414	Automotive repair and maintenance- except car	0.56%
30	69	362	Automotive equipment rental and leasing	0.53%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-6 Industrial Buyers of Metal Foundries Manufacturing Services, Ranked by Value

Rank	Industry Code	Description	Percent of all Intermediate Commodity Demand
1	283	Motor vehicle parts manufacturing	14.42%
2	226	Pump and pumping equipment manufacturing	9.55%
3	228	Material handling equipment manufacturing	6.84%
4	207	Other industrial machinery manufacturing	5.47%
5	333	Transport by rail	4.23%
6	209	Semiconductor machinery manufacturing	3.49%
7	170	Iron and steel mills and ferroalloy manufactu	3.46%
8	216	Air conditioning- refrigeration- and warm air	3.26%
9	198	Valve and fittings other than plumbing manufa	3.21%
10	202	Other fabricated metal manufacturing	2.92%
11	205	Construction machinery manufacturing	2.73%
12	195	Machine shops	2.71%
13	306	Surgical appliance and supplies manufacturing	2.22%
14	186	Plate work and fabricated structural product	2.13%
15	201	Fabricated pipe and pipe fitting manufacturin	2.00%
16	184	Cutlery- utensil- pot- and pan manufacturing	1.69%
17	222	Turbine and turbine generator set units manuf	1.67%
18	225	Other engine equipment manufacturing	1.65%
19	233	Fluid power process machinery manufacturing	1.60%
20	187	Ornamental and architectural metal products m	1.55%
21	273	Wiring device manufacturing	1.28%
22	294	All other transportation equipment manufactur	1.24%
23	229	Power-driven handtool manufacturing	1.19%
24	179	Ferrous metal foundries	1.09%
25	227	Air and gas compressor manufacturing	1.03%
26	185	Handtool manufacturing	1.01%
27	230	Other general purpose machinery manufacturing	1.00%
28	292	Motorcycle- bicycle- and parts manufacturing	0.98%
29	253	Electricity and signal testing instruments ma	0.91%
30	215	Heating equipment (except warm air furnaces)	0.88%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-7 Suppliers to the Metal foundries Manufacturing Industry, Ranked by Value of Goods/Services Supplied Regionally

Regional Rank	Gross Rank	Commodity Code	Description	Percent of Regional Inputs
1	2	319	Wholesale trade businesses	18.00%
2	5	31	Electric power generation- transmission- and	12.68%
3	6	381	Management of companies and enterprises	10.01%
4	4	434	* Not an industry (Scrap)	4.93%
5	7	32	Natural gas distribution	4.72%
6	11	39	Maint & repair construct of nonresident struc	3.82%
7	13	335	Transport by truck	2.93%
8	8	356	Securities- commodity contracts- investments-	2.72%
9	1	170	Iron and steel mills and ferroalloy manufactu	2.40%
10	12	333	Transport by rail	2.32%
11	14	388	Services to buildings and dwellings	2.06%
12	15	380	All other miscellaneous professional- scienti	2.05%
13	10	246	Printed circuit assembly (electronic assembly	1.95%
14	18	370	Specialized design services	1.63%
15	23	414	Automotive repair and maintenance- except car	1.52%
16	21	369	Architectural- engineering- and related servi	1.38%
17	9	195	Machine shops	1.33%
18	24	417	Commercial and industrial machinery and equip	1.25%
19	25	367	Legal services	1.24%
20	26	386	Business support services	1.16%
21	27	377	Advertising and related services	1.09%
22	28	243	Semiconductor and related device manufacturin	0.99%
23	29	390	Waste management and remediation services	0.99%
24	30	382	Employment services	0.94%
25	37	413	Food services and drinking places	0.93%
26	35	340	Warehousing and storage	0.89%
27	20	354	Monetary authorities and depository credit in	0.83%
28	38	389	Other support services	0.72%
29	39	368	Accounting- tax preparation- bookkeeping- and	0.72%
30	31	351	Telecommunications	0.65%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-8 Industrial Buyers of Petroleum Distribution Services, Ranked by Value

Rank	Industry Code	Description	Percent of all Intermediate Commodity Demand
1	37	Construct new residential permanent site sing	41.77%
2	38	Construct other new residential structures	13.55%
3	39	Maint & repair construct of nonresident struc	5.76%
4	361	Imputed rental activity for owner-occupied dw	4.57%
5	36	Construct other new nonresidential structures	3.94%
6	40	Maint & repair construct of residential struc	2.92%
7	414	Automotive repair and maintenance- except car	2.58%
8	34	Construct new nonresidential commercial and h	2.42%
9	413	Food services and drinking places	2.16%
10	319	Wholesale trade businesses	1.89%
11	335	Transport by truck	1.86%
12	326	Retail Stores - Gasoline stations	1.80%
13	397	Private hospitals	1.04%
14	294	All other transportation equipment manufactur	0.98%
15	283	Motor vehicle parts manufacturing	0.89%
16	394	Offices of physicians- dentists- and other he	0.74%
17	419	Personal care services	0.69%
18	295	Wood kitchen cabinet and countertop manufactu	0.39%
19	20	Extraction of oil and natural gas	0.37%
20	396	Medical and diagnostic labs and outpatient an	0.35%
21	253	Electricity and signal testing instruments ma	0.34%
22	388	Services to buildings and dwellings	0.32%
23	70	Soft drink and ice manufacturing	0.30%
24	362	Automotive equipment rental and leasing	0.30%
25	205	Construction machinery manufacturing	0.28%
26	355	Nondepository credit intermediation and relat	0.28%
27	423	Religious organizations	0.25%
28	280	Truck trailer manufacturing	0.24%
29	418	Personal and household goods repair and maint	0.23%
30	138	Soap and cleaning compound manufacturing	0.21%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-9 Suppliers to the Petroleum distribution Manufacturing Industry, Ranked by Value of Goods/Services Supplied Regionally

Regional Rank	Gross Rank	Commodity Code	Description	Percent of Regional Inputs
1	1	360	Real estate establishments	19.91%
2	2	377	Advertising and related services	11.88%
3	3	31	Electric power generation- transmission- and	5.96%
4	5	319	Wholesale trade businesses	5.38%
5	7	340	Warehousing and storage	4.21%
6	4	357	Insurance carriers	3.46%
7	8	381	Management of companies and enterprises	3.21%
8	11	335	Transport by truck	3.11%
9	9	427	US Postal Service	2.98%
10	6	354	Monetary authorities and depository credit in	2.18%
11	18	39	Maint & repair construct of nonresident struc	1.97%
12	12	386	Business support services	1.88%
13	10	351	Telecommunications	1.86%
14	13	339	Couriers and messengers	1.72%
15	23	413	Food services and drinking places	1.52%
16	17	388	Services to buildings and dwellings	1.49%
17	19	382	Employment services	1.45%
18	14	355	Nondepository credit intermediation and relat	1.45%
19	20	368	Accounting- tax preparation- bookkeeping- and	1.43%
20	21	389	Other support services	1.34%
21	22	380	All other miscellaneous professional- scienti	1.29%
22	15	374	Management- scientific- and technical consult	1.27%
23	26	367	Legal services	1.06%
24	25	366	Lessors of nonfinancial intangible assets	1.02%
25	28	373	Other computer related services- including fa	0.96%
26	29	149	Other plastics product manufacturing	0.87%
27	35	414	Automotive repair and maintenance- except car	0.83%
28	32	338	Scenic and sightseeing transportation and sup	0.75%
29	34	417	Commercial and industrial machinery and equip	0.74%
30	30	326	Retail Stores - Gasoline stations	0.74%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-10 Industrial Buyers of Paperboard Manufacturing Services, Ranked by Value

Rank	Industry Code	Description	Percent of all Intermediate Commodity Demand
1	54	Fruit and vegetable canning- pickling- and dr	6.71%
2	319	Wholesale trade businesses	4.38%
3	184	Cutlery- utensil- pot- and pan manufacturing	4.34%
4	70	Soft drink and ice manufacturing	4.12%
5	413	Food services and drinking places	3.39%
6	71	Breweries	3.21%
7	63	Cookie- cracker- and pasta manufacturing	3.07%
8	55	Fluid milk and butter manufacturing	3.02%
9	278	Heavy duty truck manufacturing	2.92%
10	105	Paper mills	2.81%
11	149	Other plastics product manufacturing	2.53%
12	69	All other food manufacturing	2.47%
13	65	Snack food manufacturing	2.39%
14	66	Coffee and tea manufacturing	2.34%
15	111	Sanitary paper product manufacturing	2.25%
16	62	Bread and bakery product manufacturing	1.76%
17	158	Glass container manufacturing	1.32%
18	51	Confectionery manufacturing from purchased ch	1.32%
19	246	Printed circuit assembly (electronic assembly	1.11%
20	58	Ice cream and frozen dessert manufacturing	1.03%
21	138	Soap and cleaning compound manufacturing	0.94%
22	248	Electromedical and electrotherapeutic apparat	0.89%
23	295	Wood kitchen cabinet and countertop manufactu	0.88%
24	243	Semiconductor and related device manufacturin	0.85%
25	113	Printing	0.82%
26	36	Construct other new nonresidential structures	0.79%
27	179	Ferrous metal foundries	0.78%
28	110	Stationery product manufacturing	0.74%
29	170	Iron and steel mills and ferroalloy manufactu	0.73%
30	107	Paperboard container manufacturing	0.68%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-11 Suppliers to the Paperboard Manufacturing Industry, Ranked by Value of Goods/Services Supplied Regionally

Regional Rank	Gross Rank	Commodity Code	Description	Percent of Regional Inputs
1	3	319	Wholesale trade businesses	33.87%
2	4	381	Management of companies and enterprises	10.10%
3	5	335	Transport by truck	8.15%
4	6	333	Transport by rail	4.28%
5	7	31	Electric power generation- transmission- and	4.27%
6	8	360	Real estate establishments	3.23%
7	15	39	Maint & repair construct of nonresident struc	2.25%
8	9	140	Printing ink manufacturing	2.12%
9	18	32	Natural gas distribution	1.97%
10	13	243	Semiconductor and related device manufacturin	1.77%
11	20	369	Architectural- engineering- and related servi	1.53%
12	25	413	Food services and drinking places	1.53%
13	19	377	Advertising and related services	1.47%
14	21	388	Services to buildings and dwellings	1.36%
15	24	149	Other plastics product manufacturing	1.26%
16	12	246	Printed circuit assembly (electronic assembly	1.26%
17	27	362	Automotive equipment rental and leasing	1.22%
18	16	351	Telecommunications	1.16%
19	11	137	Adhesive manufacturing	1.09%
20	33	414	Automotive repair and maintenance- except car	0.90%
21	30	368	Accounting- tax preparation- bookkeeping- and	0.86%
22	31	367	Legal services	0.84%
23	38	340	Warehousing and storage	0.74%
24	34	417	Commercial and industrial machinery and equip	0.74%
25	36	366	Lessors of nonfinancial intangible assets	0.73%
26	32	411	Hotels and motels- including casino hotels	0.66%
27	23	195	Machine shops	0.59%
28	40	365	Commercial and industrial machinery and equip	0.59%
29	42	376	Scientific research and development services	0.52%
30	28	354	Monetary authorities and depository credit in	0.48%

Source: IMPLAN 2007 dataset, analyzed by Bonnie Gee Yosick, LLC.

Table A-12 Output Multipliers for Selected Industries, 2007

	Description	Type I	Type SAM Multiplier
34	Construct new nonresidential commercial and h	1.347818	1.695824
35	Construct new nonresidential manufacturing st	1.247283	1.572419
43	Flour milling and malt manufacturing	1.631547	1.812872
65	Snack food manufacturing	1.448068	1.605882
71	Breweries	1.466957	1.616010
73	Distilleries	1.282784	1.398359
93	Footwear manufacturing	1.404488	1.678583
107	Paperboard container manufacturing	1.327725	1.549690
115	Petroleum refineries	1.092528	1.151862
127	Plastics material and resin manufacturing	1.398903	1.541699
150	Tire manufacturing	1.318137	1.489358
179	Ferrous metal foundries	1.343446	1.640516
180	Nonferrous metal foundries	1.270487	1.564891
283	Motor vehicle parts manufacturing	1.385245	1.593363
290	Ship building and repairing	1.320907	1.634519
291	Boat building	1.339129	1.662660
292	Motorcycle- bicycle- and parts manufacturing	1.348357	1.532602
319	Wholesale trade businesses	1.313395	1.635329
329	Retail Stores - General merchandise	1.279351	1.629770
331	Retail Nonstores - Direct and electronic sale	1.204307	1.407589
332	Transport by air	1.381406	1.610460
333	Transport by rail	1.429962	1.679158
334	Transport by water	1.458720	1.675343
335	Transport by truck	1.372363	1.702793
336	Transit and ground passenger transportation	1.367757	1.662726
337	Transport by pipeline	1.200305	1.593843
338	Scenic and sightseeing transportation and sup	1.241495	1.667490
339	Couriers and messengers	1.141520	1.551702
340	Warehousing and storage	1.274571	1.686170
360	Real estate establishments	1.165514	1.298856
367	Legal services	1.267554	1.664331
380	All other miscellaneous professional- scienti	1.187127	1.320582
381	Management of companies and enterprises	1.406640	1.784543
388	Services to buildings and dwellings	1.286740	1.610395
394	Offices of physicians- dentists- and other he	1.279680	1.725709
411	Hotels and motels- including casino hotels	1.366223	1.666700
413	Food services and drinking places	1.373507	1.668029
414	Automotive repair and maintenance- except car	1.329171	1.654244

Source: IMPLAN 2007 dataset for the four-county Portland METRO region.