SCREENING ANALYSIS OF CONTAINER TERMINAL OPTIONS
Part 2 : Evaluation of Options
FOR THE PORT OF LONG BEACH
August 28, 2007
PORT OF LONG BEACH

SCREENING ANALYSIS OF CONTAINER TERMINAL OPTIONS

Part 2: Evaluation of Options

Prepared for:
PORT PLANNING DIVISION

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Appendix B – Calculations in Support in of Option 3
The purpose of this document is to evaluate, to the extent practical, various approaches to handling the volumes of container cargo forecasted to arrive at the Port of Long Beach (Port or POLB) in the next 20 to 30 years. These approaches are being considered as options to the types of terminal development projects that are generally pursued by North American ports. This document is Part 2 of the Port’s evaluation of options. Its companion document, “Introduction to Goods Movement and the Port Industry”, forms Part 1 and supports these analyses by providing background information on world trade, the goods movement industry, terminal operations, and the economic impact of the port industry.

This analysis of development options considers general issues related to origins and destinations of cargo bound to and from North America. The analysis starts by considering whether cargo could go elsewhere than Southern California, then considers other Southern California locations outside Long Beach, and finally considers a number of options for handling cargo in Southern California that may have potential to reduce the environmental impacts of containerized cargo handling through the Port. Note that the options considered in this document are not “alternatives” in the sense that term is used by the National Environmental Policy Act (NEPA) or the California Environmental Quality Act (CEQA). They are, rather, general concepts that are being evaluated at a screening level to identify the major opportunities and constraints represented by each as well as their relative environmental impacts.

Figure 1. Location of the North American Ports Used in This Analysis

1. **Forecasted Growth: The Need for More Cargo Handling Capacity**

The evaluation of other options for handling cargo must be based on a demonstrated need for such options, i.e., whether existing and planned marine terminal facilities will be able to handle the future volumes of cargo. Accordingly, this section presents forecasts of future cargo volumes and an overview of future terminal capacities in the United States as a whole and for
the West Coast (including San Pedro Bay) and East Coast/Gulf Coast ports (Figure 1 depicts the ports considered in this analysis). The forecasts were generated by applying reasonable growth rates to recent actual cargo volumes. The capacity estimates have been developed by applying expected terminal productivity rates to publicly available information on existing and planned port expansion and redevelopment programs throughout North America. POLB’s capacity is described in Section 2 in order to illustrate the relationship between future capacity and future cargo volumes that is the basis for POLB’s proposed development program. Capacity issues for West Coast ports other than POLB are addressed in Part II, Section 1, which discusses the ability of other ports to handle POLB’s cargo. 

Note that this study considers the need to handle U.S. cargo only, so that it does not consider cargo with origins and destinations in Canada and Mexico. Generally speaking, those volumes are thought to be a small fraction of the U.S. volumes, but it is important to keep in mind that a significant fraction of Canadian and Mexican port capacity must be devoted to domestic cargo. It is also true that a small fraction of U.S. port capacity serves Canadian and Mexican markets.

1.1 U.S. Forecast

The volume of containerized cargo being handled by North American ports has risen steadily every year for the past 20 years; the growth rate between 1996 and 2005, depicted in Figure 2, was 10%. In 2005 North American ports handled approximately 39 million TEUs (twenty-foot equivalent units, see Part 1 for a description of TEUs).

![Figure 2. Total U.S. Forecast versus Total U.S. Capacity](image)

Figure 2. Total U.S. Forecast versus Total U.S. Capacity
(based on 10,800 TEU/acre/year for West Coast terminals and 8,000 TEU/acre/year for East/Gulf Coast terminals)
In order to present a range of future possibilities this study developed two estimates for future U.S. containerized cargo volumes (Figure 1-2) that can be regarded as forecasts, although they are not based on econometric analysis. The first is a Moffatt & Nichol (M&N) extrapolation to 2030 of actual growth from 1996 to 2005 at 4% Compound Annual Growth Rate (CAGR). That rate represents the historic East Coast growth in cargo volumes and is also roughly equivalent to the growth in Gross National Product in recent years. It is considerably lower than both the actual 1996 – 2005 growth rate of U.S. cargo of 10% and also the future rate that most economists currently predict and is, therefore, very conservative. The second is a M&N extrapolation at 6% CAGR, which is the low end of the range of West Coast forecasts (e.g., Mercer 1998). That rate of growth is considered low by most economists for the period up to 2015, but it represents a reasonably conservative approach to estimating farther into the future.

Figure 2 also shows this study’s estimate of U.S. port capacity for existing terminals and known, currently planned projects. The assumptions of potential terminal productivity per acre on which these estimates are based are described fully in Section 2 of this study, but they are very aggressive, representing a 130% increase over the 25-year study period.

Figure 2 shows that, even assuming conservative growth rates, U.S. cargo volumes may triple by 2030, so that North American ports will need to handle at least 100 million TEUs, and more likely as much as 168 million TEUs, of U.S. cargo. Even with realization of all planned expansions of container ports and aggressive densification of terminal operations to increase productivity, North American ports could experience a significant capacity shortfall by 2030. If port expansion and terminal productivity increases fall short of the assumptions in this study, the shortfall would occur well before 2030.

### 1.2 West Coast Forecast

The volume of cargo arriving at the West Coast ports bound for U.S. destinations in 2005, not including Mexican ports, was over 23 million TEUs (Figure 3). The “San Pedro Bay Ports Long-Term Cargo Forecast” (Mercer 1998) predicted that West Coast container throughput demand would grow at approximately 6.6% from 1996 through 2020.

For this study, the forecast for West Coast containerized cargo growth (Figure 3) was developed by extrapolating the 2005 cargo volume to 2030 using a 6% CAGR. Note that this extrapolation assumes a constant growth rate, i.e., no fundamental shift in world trade patterns. That assumption may turn out not to be true, but as historic cargo volumes have always exceeded base-case forecasts, it is a reasonable assumption at this point. As in the case of the U.S. forecast, this is a very conservative growth rate: the actual West Coast growth rate from 1996 to 2005 (Figure 3) was 13.5%. Figure 3 also shows West Coast port capacity for existing terminal acres and known, currently planned expansion projects.

Figure 3 shows the future growth in trade, driven by increasing population and decreasing costs of international transport, is expected to result in approximately 56 million TEUs passing through the West Coast ports in 2020, well over twice the 2005 volume, and approximately 100 million in 2030. Even with the assumption of conservative growth rates, aggressive expansion of all container ports, and dramatic increases in terminal productivity, therefore, West Coast ports could experience a capacity shortfall well within the 2030 time frame. Without the planned expansion projects, the shortfall could occur before 2015.
1.3 San Pedro Bay Forecast

The San Pedro Bay ports of Long Beach and Los Angeles are a subset of the West Coast ports, but as they handle around two-thirds of the cargo coming through the West Coast it is worthwhile to examine their forecasts and capacities independently. As described in Part 1, in 1998 the two San Pedro Bay ports released a new cargo forecast prepared by Mercer Management Consulting and DRI/Standard & Poor’s (Mercer 1998). That study included several scenarios using different assumptions about Asia’s recovery from the economic crisis occurring at the time and employing different rates of cargo growth.

Following the release of the 1998 forecast, San Pedro Bay experienced several years of record growth in container shipments. The ports revisited the forecast in 2001, with the help of Mercer Management Consulting, and found that the economies in Asia, especially China’s, were recovering more rapidly than expected. The Asian Crisis scenario that underpinned the 1998 cargo forecast was clearly no longer valid and the most likely scenario was the High Growth Forecast from the 1998 study with a revised empty containers component. That forecast generated 36.2 million TEUs by 2020 for San Pedro Bay, and is the forecast used today to plan port facilities as the base case. Joint port analyses of relative capacities apportioned the forecast between the two ports, assigning approximately 17.3 million to POLB and 18.9 to POLA; as a note, in 2006 approximately 7.3 million TEUs passed through the POLB. The modified Mercer forecast is a market demand forecast, meaning that it is not constrained by the ability of the ports to handle that much cargo, but rather uses economic factors to predict how much cargo would arrive at the ports if their capacity was unlimited.

Recent environmental documents use a planning horizon year of 2030, but no econometric forecasts of cargo volumes through the San Pedro Bay ports have yet been developed for 2030. In the interim, the two ports recently retained JWD (2006) to develop an analysis of future cargo
volumes based on the maximum capacity of the ports. The resultant figure of approximately 42.5 million TEUs in 2030 (POLB’s share being 20.3 million) is a constrained forecast that represents the maximum possible capacity of all existing and planned terminal developments operating at an average productivity of 10,800 TEUs per acre per year.

1.4 East Coast/Gulf Coast Forecast

There is no market-based forecast for the East/Gulf Coast ports comparable to the Mercer forecast, and its updates, for the West Coast. To estimate future cargo volumes, therefore, the simplest approach is to assume that the historic growth rate (4.4%) can be applied to future years. As will be discussed below, however, there are a number of factors that may confound the forecast, including increased use of the Panama and Suez canals to deliver Asian cargo by the all-water route (see Part 1) and fundamental shifts in world economic conditions.

From Figures 2 and 3, the difference between the U.S. as a whole and the West Coast is approximately 16 million TEUs, which is a reasonable estimate of cargo volumes through the East Coast/Gulf Coast ports in 2005. Growing that cargo volume by 4.4% per year yields a 2020 forecast of approximately 30 million TEUs and a 2030 forecast of approximately 46 million TEUs.

Table 1 summarizes all the various forecast and capacity numbers already mentioned as well as others that will be considered later in this document. In the table, “existing” means the capacity of terminals in their current configurations operating at the highest throughput currently being achieved (6,500 TEUs/acre/year on the West Coast, 5,500 on the East/Gulf Coast), “without construction” means capacity that could be achieved by increasing efficiency without physical modifications to the terminals, and “with construction” means the capacity that could be achieved with certain physical modifications such as installing rail-mounted gantry cranes and improved gate complexes. “Expanded acres” means the capacity that could be achieved if planned port expansion projects by the various port authorities were constructed and the expanded terminals were operated at maximum capacity (10,800 TEUs/acre/year on the West Coast, 8,000 TEUs/acre/year on the East/Gulf Coast).

<table>
<thead>
<tr>
<th>SUMMARY TABLE</th>
<th>FORECAST in Millions of TEUs</th>
<th>CAPACITY in Millions of TEUs</th>
</tr>
</thead>
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<td></td>
<td>2005 ACTUAL 2020 2030</td>
<td>WITH EXISTING ACRES</td>
</tr>
<tr>
<td></td>
<td>85 NA NA 131</td>
<td>WITHOUT CONSTRUCTION</td>
</tr>
<tr>
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<tr>
<td>LOCAL</td>
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<td>9 11 14 20</td>
</tr>
<tr>
<td>SAN PEDRO BAY</td>
<td>7 17 20</td>
<td>9 11 14 20</td>
</tr>
<tr>
<td>POLB</td>
<td></td>
<td>9 11 14 20</td>
</tr>
</tbody>
</table>

Table 1. Summary of Forecast and Capacity Numbers
2. **Port of Long Beach Container Terminal Capacity**

Most of the POLB’s seven container terminals (Figure 4) are nearly fully developed, with the exception of the Pier S terminal, which has not yet been built. As explained in Part 1, while the POLB owns the land on which the terminals are located, the various terminals are operated by private companies under long-term leases as tenants of the POLB. Part of the POLB’s mission is to provide state-of-the-art seaport facilities, which includes land and infrastructure, to enhance the region’s economic vitality (POLB 2006a). The tenants, for their part, strive to optimize their equipment and operational practices in order to improve efficiency and reduce costs.

The seven terminals range in size from the 60-acre terminal on Pier C to the 350-acre terminal on Pier T. They total nearly 1,350 acres with over 27,000 feet of wharves and 70 ship loading/unloading cranes; all but two small terminals (Pier C and Pier E) have modern intermodal railyards in the terminals (on-dock rail). The Port’s master plan designates all or portions of piers A, C, E, F, G, J, S, and T for container cargo, and sets as a goal the modernization of terminal facilities on those piers as necessary to accommodate anticipated growth.
increases in container cargo volumes.

The POLB’s analysis of the future capacity of its container terminal facilities (JWD 2006) used an analytical protocol, developed by the Port in consultation with port design experts, that sets forth the elements of the analysis and the assumptions to be made about a wide variety of terminal throughput variables (e.g., container yard density; berth activity; vessel sizes; equipment types, numbers, and productivity; empty/load mix; rail/truck mode split). The analysis assumed a number of significant improvements in port facilities in order to accommodate future cargo volumes, including:

- Maximizing use of existing land;
- Increasing terminal operating efficiencies;
- Optimizing existing terminal configurations by constructing (currently unpermitted) expansions for the existing terminals (see below);
- Building one new terminal on currently vacant land on Pier S.

The effects of optimizing terminal configurations and increasing operating efficiencies are assumed to double terminal productivity from a current port-wide average of 5,000 TEUs/ac/year to an average of 10,800 TEUs/ac/year. To optimize its facilities the Port has identified several near-term projects, only one of which has received the necessary permits:

1. Expand Pier G to approximately 300 acres (this project is in construction)
2. Consolidate Piers E and F into a 340-acre marine terminal
3. Expand the Pier J Marine Terminal to 370 acres
4. Expand the existing Pier A Marine Terminal to over 300 acres

These expansions and reconfigurations are the ones assumed in the JWD (2006) study.

It is important to note that increased cargo volumes through the POLB are inevitable even without those terminal expansions and reconfigurations because many of the increases in operating efficiencies described in the JWD report can and will happen, albeit at increased operating costs, without capital improvements. Those operating efficiency increases will result in higher throughputs per acre at the existing terminals, and they can be accomplished without new permits or changes to the existing terminal leases. Because no permits would be needed, the Port would have no mechanism for instituting the advanced environmental controls envisioned in the San Pedro Bay Clean Air Action Plan (CAAP) and Green Port program via CEQA mitigation and leases, so that the terminals could continue to work with technology that merely meets state and federal regulatory standards.

The operating changes that would be needed to achieve productivity beyond approximately 6,500 TEUs/acre/year would include decreasing “dwell time” (the length of time containers are allowed to stay in the terminal before being picked up), increasing stacking density through use of denser rubber-tired operating modes and higher stacks, eliminating wheeled storage and chassis, improving the efficiency of gate operations through additional automation, and substantially increasing the proportion of containers leaving and arriving via rail (rail capacity is expected to be the constraining element in the near term).

The present study estimates that through these methods POLB terminals with their current acres could achieve an average productivity of approximately 8,000 TEUs/ac./year without physical modifications (and without advanced environmental controls, as mentioned above); that level of productivity is designated “Enhanced Capacity” in Figure 5. At that level of throughput
the POLB’s capacity would be approximately 10.8 million TEUs (see also Table 1-3); the cargo forecast suggests that the volume of cargo through POLB will reach that figure in approximately 2012.

![POLB Forecast vs. Capacity](image)

**Figure 5. Temporal Relationship Between Increased Capacity From Terminal Development and Increased Cargo Volumes**  
(M&N estimates from data in JWD 2006; see text for explanation of “Enhanced” and “Planned”)

The JWD study concluded that if the Port were permitted to undertake the projects described above and its terminals adopted the assumed changes in operations, it could handle a maximum of approximately 20 million TEUs per year in 2025. That level of productivity corresponds to “Planned Capacity” in Figure 5, and equates to approximately 10,800 TEUs/ac/yr. It would be achieved by, in addition to the operating changes described above, making physical changes to the terminals, for example, increased automation, optimizing terminal configurations, and the switch to rail-mounted gantries for stacking operations.

The JWD capacity figure is similar to the forecast for 2020 of 17.4 million TEUs, indicating that even with the planned expansions and productivity improvements the Port will reach its container handling capacity sometime between 2020 and 2025. That prediction is based on the assumption that all of the reconfigurations and expansions factored into the JWD study actually get permitted and built by 2020; if that does not occur, the Port will reach capacity sooner than 2020. Figure 5 shows there would be an extended timeframe to achieve planned capacity increases, showing all of the capacity improvements will be needed in order to keep pace with projected growth. Growth beyond the 2025 to 2030 timeframe will necessitate the construction of new terminal facilities in the long term in addition to the expansion and reconfiguration of existing terminals in the shorter term assumed in the JWD study.
Note that even if all the terminal projects listed are completed, the POLB would still need additional facilities, such as increased roadway and intermodal rail capacity, in order to accommodate forecasted volumes by the normal mechanism of expanding and adding container terminals within the Long Beach Harbor District.

The improvements assumed in the JWD study and being planned by the Port are, with the one exception of Pier S, complex projects involving modifications to existing operating terminals. They have long lead times, and it needs to be recognized that even if the projects were to be permitted relatively soon there are likely to be discrepancies between when the terminals come on line and when their capacity is actually needed. Shortfalls in capacity between now and 2020 are likely even under the most optimistic scenarios of terminal development.

3. The Port of Long Beach in International Trade

This analysis of terminal development options must be considered in the context of the Port’s place in international trade. Part 1 of this study, which described international trade patterns and growth and showed why so much cargo comes through the San Pedro Bay ports, provides a basis for the screening analysis.

The Los Angeles/Long Beach population base is one of the largest in the United States. There are approximately 10 million people within just 25 miles of the Port, and approximately 32 million people within 350 miles of the Port (Journal of Commerce, 2007a). Because of this large population base, approximately 50% of the containerized cargo arriving at the San Pedro Bay ports from overseas is actually consumed locally, and its arrival at those ports is obviously the most efficient approach. The rest is destined for national distribution beyond Los Angeles/Long Beach and is commonly referred to as discretionary cargo because its shippers have, at least in theory, a certain amount of discretion concerning which port to send their cargo through.

There are several components that make up the relationship of the POLB to international trade (Figure 6):

1. The centroid of manufacturing is located on China’s Pacific coast;
2. The point in Asia that is equidistant from the West Coast and the East/Gulf coasts (the equilibrium point) in terms of voyage duration is much farther west, on the Indian Ocean;
3. It is currently cheaper to send discretionary cargoes from the centroid of manufacturing destined for anywhere in the U.S. across the Pacific to the West Coast rather than westward via the Suez Canal to the East/Gulf coasts;
4. Discretionary cargo leaving Long Beach will first make its way to the large Intermodal rail hubs in the central U.S., such as Chicago, IL.;
5. The major U.S. rail carriers can bring import cargo from either the West Coast or East Coast of the U.S. to the Midwestern intermodal hubs.
For discretionary cargo the consideration of distance (origin to destination) is important. Increased cargo travel time requires equipment – ships, trains, trucks -- to be deployed longer, and the longer the deployment, the greater the cost (and generally, the greater the pollution per unit of cargo delivered). Additionally, many cargoes such as perishable goods and assembly parts are time sensitive and seek the quickest route.

4. Evaluation Methodology

POLB staff, recognizing the desirability of cargo-handling options that may have fewer environmental impacts than traditional terminal development, developed six options, including several suggested in public comments on port environmental documents. A seventh approach suggested in the public comments, namely the use of non-truck-based technology such as maglev/monorail systems to move containers from port terminals to inland destinations, is currently being evaluated by separate studies and is not, therefore, analyzed here. The six options listed below were evaluated for feasibility by a team of engineers, planners, and economists.

1. Increased Use of North American Ports Outside Southern California
2. Expansion of Southern California Terminals Outside the Port of Long Beach
3. Offsite Backland Facilities In and Near the Port of Long Beach
4. Increased Use of Off-Dock Intermodal Railyards
5. Inland Port


Two of the options evaluate the feasibility of limiting increases in containerized cargo at the Port of Long Beach by encouraging cargo to use other ports. Three options consist of alternative approaches to managing containers so as to reduce the need for terminal space at the waterfront (i.e. more cargo could be handled by less land), and one option explores the possibility of increasing terminal efficiency through increased automation.

It is important to note that, given the complexity of the issue, it was necessary to make some simplifying assumptions in order to be able to establish a reasonably consistent basis for comparing the various options. This is especially true for quantitative comparisons such as air emissions and number of trips. Basic assumptions used in this analysis include:

1. Scenarios outside the Port would involve diverting cargo to existing or planned facilities in other ports, not building a new terminal in one or more of those ports. This assumption reflects the reality that the Port has no legal authority to implement a terminal project outside its boundaries.

2. Except in the case of other Southern California ports and the Port of Oakland, the cargo to be diverted would not be cargo that would ultimately make its way back to Long Beach. In other words, only cargo bound for destinations outside the Los Angeles/Long Beach metropolitan area was assumed to be diverted.

3. The destination of the diverted cargo (except in the cases of Southern California and Oakland) was assumed to be Chicago, in order to provide a consistent basis for comparing both the emissions associated with transport and the rail capacity available to move the cargo. Chicago is a major rail hub as described in Part 1.

4. The emissions reductions measures envisioned in the San Pedro Bay Clean Air Action Plan would not be included in emissions calculations because, as yet, there is not enough quantitative basis for such an analysis. Moreover, those emission reduction measures would likely affect only a small fraction of the total route since they are limited to San Pedro Bay.

Partly because of these assumptions, partly because of the extensive geographical scope of this analysis, and partly because of the screening nature of this analysis, the numbers used in this document cannot be compared with numbers generated by other studies, including the impact analyses that support environmental documentation for specific projects. Those studies employ more detailed and rigorous methodologies than were used in the present, concept-level analysis. The numbers in this analysis are useful for evaluating the advantages and disadvantages of the options analyzed herein, but should not be used in any evaluation of specific projects or other study reports.

5. **Other Factors**

An important factor in the screening analysis is the consideration of the impacts of the various options. Use of different options may have different environmental and economic implications, including air emissions, traffic congestion, ecological impacts, land use, energy consumption, and the creation or loss of jobs and revenues.
5.1 Economics

Each of the various options has economic implications. The goods movement industry is a major generator of jobs; as described in Part 1, Section 5, cargo through the POLB alone supports, directly or indirectly, over 300,000 jobs and $65 billion in sales, wages, and tax revenues in Southern California, including 40,000 jobs in port industries (e.g., terminals, maritime support, warehouses, trucking). Accordingly, choosing one option over another can have major implications for Southern California’s employment and economic vitality.

5.2 Air Emissions

A complete analysis of the environmental impacts of each option is beyond the scope of this document, as it would require an advanced design effort for each. However, a screening-level evaluation is possible in the area of the amount of air emissions generated in handling a given amount of cargo by different options. Accordingly, this study conducted a semi-quantitative analysis of air emissions that might be expected from several of the options. The air pollutants considered in this study are the typical criteria pollutants of concern or in the case of NOx and hydrocarbons, their precursors. The study did not consider greenhouse gases.

The three primary equipment modes that result in the production of emissions -- container vessels, trains, and trucks -- were included in the analysis. For the purpose of comparing the emissions of the various options, this analysis calculated the amount of emissions that would be generated by handling one million TEUs of cargo in the options where such a comparison is appropriate. For example, the option to divert discretionary cargo outside Southern California by shipping to a port of entry in the U.S. other than Long Beach and then rail this cargo to the railroad hub in Chicago was analyzed. The routes analyzed in this report are shown and identified by city designation in Figure 7 which shows major shipping routes to and from the U.S.. Appendix A provides more details as to what is compared in these optional routes. For these examples, truck emissions are not included since they are negligible in a global emissions calculation. The resulting mileage for the ship and rail components for each route applied to the emissions per mile provides a relative comparison with respect to global emissions derived from these route options. The options where truck transport is a significant component, the truck emissions per mile are calculated.

The comparisons of the modes do not assume emissions reductions measures that might be imposed by local entities; thus, for example, the measures that are expected to be implemented through the San Pedro Bay Clean Air Action Plan are not included in the analysis. For the purpose of emission comparisons shown in Figure 8, the emissions for truck engines with average age reported in 2005 and on road diesel fuel characteristics in 2005 (500 ppm sulfur) were calculated. Figure 8 compares ship, rail and truck emissions per TEU-mile calculated as described in Appendix A which is under their most efficient operating conditions (fully loaded, full speed).
As can be seen in Figure 8, trains are, overall, the most efficient mode of transport from an emissions point of view for most criteria pollutants, followed by ships. Only for SO2 are trucks more efficient than ships. These differences have environmental implications for the various options. For some options, the implications manifest themselves on a global, rather than local, scale, and for others the implications are most obvious at the local level.
Figure 8. Comparison of Emissions of Pollutants Produced by Conveying Containerized Cargo by Vessel, Train, and Truck (M&N Data, 2006)
The comparisons shown are for a point in time and emission factors and fuel characteristics are constantly changing as discussed below.

5.3 **Time Dependency of Air Emission Rates**

One limitation of this analysis is that emission rates for various modes of transportation are changing with time at varying rates and with varying degrees of certainty. For some sources, such as trucks, the regulation is mature and established therefore it is possible to project future emission reductions as fleets turn over at a predictable rate to newer lower emitting engines. For sources such as ships, the future is much less certain so it is not possible at this point to make an accurate projection of the timing and magnitude of ocean going vessel emission reductions. There are existing regulations in place for locomotive engines but the reductions required by the regulations are relatively modest and the timing of locomotive turn-over to the higher tiered engines (Tier 0, 1 & 2) is uncertain. There are also regulatory proposals in place that will impact these emission rates such as proposed revisions to Marpol Annex Vland new rail and marine vessel standards proposed by USEPA. The variation of truck emission rates is demonstrated by Figure 9. As the fleet turns over, from older to younger trucks, the dramatic differences between older truck emission rates and the most modern truck emission rates (07’) trucks results in greatly reduced truck emissions.

**Figure 9. Heavy Duty Diesel Truck, Model Year vs. Emission Rate**

As an extreme example, the same calculations shown in Figure 8 were run with only model year 2007 trucks, in which case truck movement of containers goes from the highest emitting to the lowest emitting mode as shown in Figure 10. However, it is unknown how much the other modes will reduce emissions in a similar time frame as it takes for the truck fleet to turn over to 2007 and younger.
Figure 10. Comparison of Emissions of Pollutants Produced when Using only 2007 Model Year Heavy Duty Trucks

Ocean Going Vessels
- Fully Loaded 4,000 TEU Container Ship, 40,000Kw m/6, 9,000Kw aux engines
- 0.03 and 0.13 load factors respectively. Sailing at 24 knts
- Burning RFO of 2.7% sulfur in slow speed diesel m/v
- Burning MDO of 1.6% sulfur in medium speed aux engines

Line Haul Rail
- 4,000ft train, 50% double stack, 100% car utilization resulting in 216 TEU per train
- Two 1,250 hp diesel line haul locomotives per train. Chasing at 60 mph in notch position 7
- Assumed 200 ppm sulfur content
- Emission Factors taken from EPA RSD "Locomotive Emission Standards" (EPA April 1999)

Heavy Duty Trucks
- 1.7 TEU per truck. 80 heavy duty diesel truck traveling on highway at 60 mph.
- Only 2007 Model Year (2001)
- 15 ppm sulfur fuel
- Emission factors developed using EPA Mobile 6.2 emissions model.
It is important to reiterate, the air quality analyses contained in this study are not comparable to the much more rigorous and detailed project-specific analyses typically produced in port environmental documents. The assumptions concerning activity levels, equipment types, and emissions factors used for this study are necessarily different because of the very different levels of detail in the project descriptions and the fuel and engine characteristics at the time. In addition, the analytical methodologies used here are less rigorous than those approved for use in CEQA and NEPA documents. Accordingly, any comparison of the numbers in this study, which are presented only for relative comparisons among the options in this study, with numbers presented in port environmental documents would be inappropriate. Nevertheless, the analyses in this study with a given set of data circumstances permit a concept-level comparison of options with respect to one of the key environmental factors associated with port projects. Other environmental consequences of the various options are also noted as appropriate.
CHAPTER II  EVALUATION OF OPTIONS

1  OPTION 1 – USE OF OTHER NORTH AMERICAN PORTS

1.1  Introduction

Diversion of cargo from Long Beach to other North American ports is theoretically possible so long as the other ports have the capacity to receive that cargo. In fact, a recent analysis (Journal of Commerce, 2007a) noted that the trend is already underway, to some degree, as shippers elect to bring cargo through ports that have less congestion and lower prices than the San Pedro Bay ports. In this option, therefore, other ports in North America would constitute an alternative to container terminal development at the POLB.

About 25 of the North American ports in Figure 1, including Long Beach, are considered to have deep water and container-capable facilities, based on research by the American Association of Port Authorities (AAPA). The ports in the AAPA ranking (Table 1-1) were reviewed as a cross-section of potential alternatives to the POLB. Of the 24 ports other than Long Beach, eight are West Coast, 11 are East Coast, three are Gulf Coast, and two are in “Other” locations (islands) (Table 1-2 and Figure 1). The review did not address every river and/or coastal port in North America, only the larger container ports that have a realistic potential to accommodate a portion of Long Beach’s cargo.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Port (State)</th>
<th>Country</th>
<th>TEUs</th>
<th>Rank</th>
<th>Port (State)</th>
<th>Country</th>
<th>TEUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Los Angeles (CA)</td>
<td>United States</td>
<td>7,484,624</td>
<td>14</td>
<td>Honolulu (HI)</td>
<td>United States</td>
<td>1,077,468</td>
</tr>
<tr>
<td>2</td>
<td>Long Beach (CA)</td>
<td>United States</td>
<td>6,709,818</td>
<td>15</td>
<td>Miami (FL)</td>
<td>United States</td>
<td>1,054,462</td>
</tr>
<tr>
<td>3</td>
<td>New York / New Jersey</td>
<td>United States</td>
<td>4,792,922</td>
<td>16</td>
<td>Manzanillo (COL)</td>
<td>Mexico</td>
<td>873,976</td>
</tr>
<tr>
<td>4</td>
<td>Oakland (CA)</td>
<td>United States</td>
<td>2,272,525</td>
<td>17</td>
<td>Port Everglades (FL)</td>
<td>United States</td>
<td>797,238</td>
</tr>
<tr>
<td>5</td>
<td>Seattle (WA)</td>
<td>United States</td>
<td>2,087,929</td>
<td>18</td>
<td>Jacksonville (FL)</td>
<td>United States</td>
<td>777,318</td>
</tr>
<tr>
<td>6</td>
<td>Tacoma (WA)</td>
<td>United States</td>
<td>2,066,447</td>
<td>19</td>
<td>Veracruz (VER)</td>
<td>Mexico</td>
<td>620,858</td>
</tr>
<tr>
<td>7</td>
<td>Charleston (SC)</td>
<td>United States</td>
<td>1,986,586</td>
<td>20</td>
<td>Baltimore (MD)</td>
<td>United States</td>
<td>602,486</td>
</tr>
<tr>
<td>8</td>
<td>Hampton Roads (VA)</td>
<td>United States</td>
<td>1,981,955</td>
<td>21</td>
<td>Halifax (NS)</td>
<td>Canada</td>
<td>550,462</td>
</tr>
<tr>
<td>9</td>
<td>Savannah (GA)</td>
<td>United States</td>
<td>1,901,520</td>
<td>22</td>
<td>Anchorage (AK)</td>
<td>United States</td>
<td>516,367</td>
</tr>
<tr>
<td>10</td>
<td>Vancouver (BC)</td>
<td>Canada</td>
<td>1,767,379</td>
<td>23</td>
<td>Fraser River (BC)</td>
<td>Canada</td>
<td>372,844</td>
</tr>
<tr>
<td>11</td>
<td>San Juan (PR)</td>
<td>United States</td>
<td>1,727,389</td>
<td>24</td>
<td>Altamira (TAM)</td>
<td>Mexico</td>
<td>323,366</td>
</tr>
<tr>
<td>12</td>
<td>Houston (TX)</td>
<td>United States</td>
<td>1,582,081</td>
<td>25</td>
<td>Wilmington (DE)</td>
<td>United States</td>
<td>250,507</td>
</tr>
<tr>
<td>13</td>
<td>Montreal (QU)</td>
<td>Canada</td>
<td>1,254,560</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1-1. North American Container Traffic 2005, Port Ranking by TEUs (AAPA)

Four basic conditions must be met in order for a port to be a reasonable option for diverting containerized cargo from the POLB. These conditions were not employed as screening criteria.

Evaluation of Options 18
for this analysis, but they are indicative of the practical limitations on diverting substantial amounts of cargo from the POLB.

1. The port must have current (or currently planned for) container handling capacity greater than the forecasted TEU volume for that port (thus excess capacity would be available for the TEUs from the POLB);

2. Authorized channel depths at the port must be sufficient for the vessels currently on the major liner services (minimum of -45 feet MLLW);

3. In order to handle discretionary cargo the port must be supported by adequate rail and highway infrastructure connecting the port to points east.

4. The port should be compatible with modern liner service operations (for example, carriers could experience difficulty adding another port-of-call to a service in order to handle the TEUs that could not be accommodated at the POLB).

<table>
<thead>
<tr>
<th>West Coast</th>
<th>East Coast</th>
<th>Gulf</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchorage, AK</td>
<td>Halifax, NS</td>
<td>Houston, TX</td>
<td>Honolulu, HI</td>
</tr>
<tr>
<td>Vancouver, BC</td>
<td>Montreal, QU</td>
<td>Altamira, TAM</td>
<td>San Juan, PR</td>
</tr>
<tr>
<td>Fraser River, BC</td>
<td>New York/New Jersey</td>
<td>Veracruz, VER</td>
<td></td>
</tr>
<tr>
<td>Seattle, WA</td>
<td>Wilmington, DE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tacoma, WA</td>
<td>Baltimore, MD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>Hampton Roads, VA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>Charleston, SC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Beach, CA</td>
<td>Savannah, GA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manzanillo, COL</td>
<td>Jacksonville, FL</td>
<td>Port Everglades, FL</td>
<td>Miami, FL</td>
</tr>
</tbody>
</table>

Table 1-2. Top 25 North American Container Ports (by location)

The 24 ports in Table 1 (all but Long Beach) were reviewed for their potential feasibility as alternatives to Long Beach. Since the ports are grouped geographically, some conditions can apply to groups of ports. For example, the use of the Panama Canal is an issue that tends to separate East/Gulf Coast ports from West Coast ports. Therefore, this review first considered overall issues such as West Coast port capacity versus forecasted cargo volumes.

Second, as mentioned above, factors related to amount of equipment required and length of trip for the goods can affect the amount of air pollutants generated by an option. In order to allow an emissions-based comparison of West Coast and East/Gulf Coast ports to the POLB, this analysis provides an estimate of the emissions associated with sending 1 million TEUs of containerized cargo through each of the geographical groups of ports to Chicago.

Finally, for West Coast ports the analysis considers a number of port-specific issues such as water depths, expansion plans, and infrastructure capacity. These issues are not presented as screening criteria but rather as illustrations of opportunities and constraints at those ports.
1.2 Description of Option 1

In this scenario the POLB would elect not to improve or expand its container terminals or to build new terminals in order to handle future volumes of discretionary cargo. This means the expansions assumed by the JWD study summarized above in Chapter I would not occur. Instead, much of the additional approximately 11 million TEUs per year projected for POLB by the year 2020, and the even greater volume in 2030, would be handled at other ports. Discretionary cargo currently coming to Long Beach would gradually be diverted to other ports, so that although the total volume of cargo coming to Long Beach would increase from the current amount of around 7 million TEUs, a greater proportion of cargo would be local rather than overland.

Under this scenario, other ports would need to have, or be able to create, sufficient capacity, both terminal and transportation, to handle the excess Long Beach cargo in addition to their own forecasted increased cargo volumes. No one port would need to handle the entire increase; this analysis assumes the cargo would be diverted to several ports. Any combination of North American ports capable of absorbing substantial additional cargo through the year 2020 would constitute a reasonable option to handling discretionary cargo at Long Beach. In this option, even while cargo was being diverted away from Long Beach, the amount of cargo continuing to come to Long Beach would be increasing and the type of cargo would be shifting from rail delivery out of Long Beach to truck delivery in Southern California since much of the increase would be in local cargo.

1.3 Analysis

1.3.1 West Coast Ports Outside Southern California

West Coast Capacity

As at Long Beach, future increases in the capacity of other West Coast terminals will be achieved by a combination of productivity increases and expansion. Just as container handling productivity is expected to increase over time at POLB’s terminals even without capital projects (Chapter I, Section 2), it is reasonable to assume that productivity will increase at other West Coast ports, as well. As Table 1-3 shows, the current productivity is approximately 3,317 TEUs/acre/year averaged at West Coast ports outside San Pedro Bay and 4,710 TEUs/acre/year within San Pedro Bay. The future productivity increase at these ports is illustrated in Table 1-3 as the milestone steps of 6,500 TEUs (the current maximum density of any West Coast terminal), 8,000 TEUs (the maximum this study judges could be achieved without major capital improvement projects; see Chapter I, Section 2), and 10,800 TEUs per gross terminal acre (the approximate maximum throughput assumed at the San Pedro Bay ports in the JWD study). These figures may be optimistic for the other West Coast ports, since most have, on average, smaller and less optimally configured terminals than do Los Angeles and Long Beach, as well as limited intermodal capability, but they do represent the theoretical upper limit of what those ports could achieve with their planned expansions.

The theoretical maximum productivity of 10,800 TEUs is assumed to occur by approximately 2020, consistent with the JWD study of the San Pedro Bay ports. At that point the maximum estimated capacity of the West Coast ports in their current configurations would be 58 million TEUs per year (Figure 1-1, Table 1-3). This figure is lower than the figure of 79 million presented in Chapter I (Figure 3) because it does not include planned (although currently unpermitted) expansions at the various West Coast ports. Even 58 million TEUs should not be regarded as a realistic maximum, however, as many facilities in the ports are not sufficiently
modern to support the highest current density nor the intermodal traffic that would accompany the increased volume.

<table>
<thead>
<tr>
<th>Port</th>
<th>2005 Throughput (TEUs)</th>
<th>2005 Container Terminal Acres</th>
<th>2005 Throughput Density, TEUs per Acre</th>
<th>Current Capacity</th>
<th>Maximum Practical Capacity Without Construction</th>
<th>Maximum Capacity With Densification And Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prince Rupert</td>
<td>0</td>
<td>58</td>
<td>NA</td>
<td>377,000</td>
<td>464,000</td>
<td>626,400</td>
</tr>
<tr>
<td>Vancouver</td>
<td>1,767,300</td>
<td>358</td>
<td>4,937</td>
<td>2,327,000</td>
<td>2,864,000</td>
<td>3,866,400</td>
</tr>
<tr>
<td>Seattle</td>
<td>2,088,000</td>
<td>535</td>
<td>3,903</td>
<td>3,477,500</td>
<td>4,280,000</td>
<td>5,778,000</td>
</tr>
<tr>
<td>Tacoma</td>
<td>2,066,000</td>
<td>555</td>
<td>3,723</td>
<td>3,607,500</td>
<td>4,440,000</td>
<td>5,994,000</td>
</tr>
<tr>
<td>Portland</td>
<td>111,000</td>
<td>150</td>
<td>740</td>
<td>975,000</td>
<td>1,200,000</td>
<td>1,620,000</td>
</tr>
<tr>
<td>Oakland</td>
<td>2,273,000</td>
<td>693</td>
<td>3,280</td>
<td>4,504,500</td>
<td>5,544,000</td>
<td>7,484,400</td>
</tr>
<tr>
<td>Oakland Railport + JIT</td>
<td></td>
<td></td>
<td></td>
<td>1,657,260</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles</td>
<td>7,484,000</td>
<td>1,686</td>
<td>4,439</td>
<td>10,959,000</td>
<td>13,488,000</td>
<td>18,208,800</td>
</tr>
<tr>
<td>Long Beach</td>
<td>6,709,000</td>
<td>1,347</td>
<td>4,981</td>
<td>8,755,500</td>
<td>10,776,000</td>
<td>14,547,600</td>
</tr>
<tr>
<td>LA-JP ICTF</td>
<td>1,164,000</td>
<td></td>
<td></td>
<td>4,144,000</td>
<td>4,144,000</td>
<td>5,172,800</td>
</tr>
<tr>
<td>Total West Coast</td>
<td>23,662,300</td>
<td>5,382</td>
<td>4,397</td>
<td>34,983,000</td>
<td>43,056,000</td>
<td>58,125,600</td>
</tr>
<tr>
<td>Manzanillo*</td>
<td>873,976</td>
<td>100</td>
<td>8,740</td>
<td>650,000</td>
<td>800,000</td>
<td>1,080,000</td>
</tr>
<tr>
<td>Lazaro Cardenas*</td>
<td>132,479</td>
<td>37</td>
<td>3,581</td>
<td>240,500</td>
<td>296,000</td>
<td>399,600</td>
</tr>
</tbody>
</table>

| * Mexican Ports do not currently serve U.S. hinterland markets. They are located to serve Central and Southern Mexican markets and have their own forecasted growth. Their capacity/ability to serve U.S. markets is speculative. |

Table 1-3. West Coast Ports 2005 Cargo Data and Capacity Forecasts

In fact, the situation with regards to intermodal capacity is even more severe than for terminal capacity. This study calculated intermodal capacities from the actual amount of existing in- and near-port rail loading infrastructure. Even at the rate of 40% of the cargo being intermodal (the current figure is approximately 50% for the San Pedro Bay ports [Parsons, 2006] and is as high as 73% for other West Coast ports [e.g., Tacoma: Journal of Commerce, 2007a]), the West Coast is likely to run out of capacity by around 2020. Furthermore, higher mode splits cannot be supported by the existing intermodal infrastructure (Table 1-3, Figure 1-2). Accordingly, it is not reasonable to assume any significant amount of San Pedro Bay discretionary (intermodal) cargo can be diverted to other West Coast ports without substantial improvements in rail facilities.

If the West Coast ports are to meet the demand described in Chapter I, their productivity and overall capacity must increase dramatically. Table 1-3 and Figures 1-1, 1-2 and 1-3 show that West Coast volumes exceeding 58 million TEUs and approximately 24 million TEUs of intermodal cargo could not possibly be accommodated even if all existing terminals in all ports were to achieve productivities of 10,800 TEUs per acre per year. Figure 1-3 provides a graphic of the demand vs. capacity situation the West Coast will find itself in. The only practical outlet for the increased demand over the capacity is to divert more cargo through other routes (Panama Canal if expanded and Suez Canal) to East Coast/Gulf Coast ports (see Section 1.3.2).
**Figure 1-1. West Coast Ports Cargo Forecast vs. Capacity at Various Densities (includes existing facilities, but not unpermitted future facilities)**

**Figure 1-2. West Coast Ports Intermodal Cargo Forecast at Various Percentages of Total**
West Coast Port Descriptions

The above analysis does not mean all West Coast ports will run out of capacity at the same time, or that they all have the same relative shortfall between capacity and demand. It is worth considering each of the ports in order to evaluate the factors that affect the ability of each to accommodate increased cargo volumes in the future.

**Anchorage, AK**

The Port of Anchorage is the 22nd largest container handling port in North America (Table 1-1), handling about 500,000 TEUs in 2005. None of the containerized cargo coming to Anchorage is from foreign ports: it is all trans-shipped from other West Coast ports and it is all destined for consumption in Alaska. Anchorage’s key constraint is that there is no land-based transportation system that offers a practical solution for getting consumer goods from Anchorage to markets in the rest of the U.S. Accordingly, diverting discretionary cargo to Anchorage is not a viable alternative.

**Vancouver, BC**

Vancouver’s terminals serve both Canadian and U.S. markets, and in 2005 handled 1.8 million TEUs (Table 2-3). Vancouver has three privately operated container terminals that have limited expansion potential. The terminals are nearing their capacity with current technology and there are limited opportunities to construct new terminals due to a shortage of land adjacent to deep water. This study suggests that Vancouver’s terminals might be able to double their capacity, to 3.9 million TEUs, by implementing the aggressive productivity increases described in Chapter 1, and a recent industry analysis reported that Vancouver has active plans to achieve that capacity (Journal of Commerce 2007a).
**Prince Rupert, BC**

The Prince Rupert Port Authority is converting an existing break-bulk terminal to serve container ships and trains. It will be a small-capacity container terminal with practically no local market: it is intended to serve Canadian and Mid-West U.S. markets by rail. Phase 1 will open in the fall of 2007 with a capacity of about 377,000 TEUs. If it is successful, there are plans for future expansion that could boost capacity to about 1,500,000 TEUs, and productivity enhancements could boost capacity even higher.

**Seattle, WA**

In 2005, the Port of Seattle was the 5th largest container port in North America (Table 1-1). The port’s current forecast is for the volume of containers to double by the year 2025, to 4 million TEUs per year.

The Port of Seattle has four container terminals equipped with about 26 modern container handling cranes. Additionally, the Port’s vessel channel and berth depths are 50 feet, which can accommodate the most modern container vessels in the international fleet. All four of Seattle’s cargo terminals are privately operated, which somewhat constrains full optimization, at least in the near term, as explained for Oakland, below. Seattle’s rail connections to the rest of the country are severely limited in their capacity to handle intermodal cargo (see Part 1, Section 3.3) and the prospect of additional intermodal lift capacity appears to be poor; both factors would limit that port’s ability to handle increased discretionary cargo. The interstate highway system, however, is adequate to support long-distance trucking.

The Port of Seattle, being totally surrounded by private property and urban development, does not currently have significant expansion capability, and there are no new terminal projects being planned. The port will have to optimize the available land within its jurisdiction and increase productivity substantially from the current average of 3,900 TEUs/ac/year (Table 1-3) in order to meet its forecasted demand. If that effort achieves the productivities described in Table 1-3, however, Seattle could generate as much as 1.8 million TEUs of excess terminal capacity to accommodate diversion of cargo from Long Beach. The ability of the Pacific Northwest’s rail connections to the east to accommodate substantially more intermodal traffic is problematic without a major investment in intermodal facilities and transcontinental rail lines.

**Tacoma, WA**

The Port of Tacoma is the 6th largest container port in North America (Table 1-1), handling 2.1 million TEUs in 2005. Tacoma’s rail infrastructure is the same as Seattle’s, and is thus constrained, as described in Part 1, Section 3.3, but it shares the same highway network with Seattle. In 2006 approximately three-quarters of Tacoma’s container cargo arrived and departed by rail (Journal of Commerce, 2007c), indicating that much of it was discretionary.

The Port of Tacoma is completing expansion and improvement projects in accordance with its master plan (Vision 2020). The port expects its annual container throughput to nearly double, to about 3.5 million TEUs, in about 20 years. In 2005, the Port of Tacoma opened three new container terminals and established a 51-foot water depth, and is thus capable of handling modern container ships. Such improvements make the port capable of meeting its forecasted demand through 2020, and if it achieves the highest productivity increases considered in Table 1-3 Tacoma could have as much as 2.4 million TEUs of excess capacity for diverted cargo. However, the very high proportion of intermodal cargo makes Tacoma’s future growth dependent on adequate rail connections, so that handling diverted discretionary cargo would require major investment in rail facilities.
**Portland, OR**

The Port of Portland is not on the list of major North American container ports (Table 1-1) but is being considered in this study for its potential. It has had difficulty attracting significant volumes of containerized cargo (in 2005 it handled approximately 200,000 TEUs) because it is on the Columbia River, which has until recently had a water depth limitation of 40 feet, too shallow for most modern container vessels. However, a current deepening project will yield a channel depth of 43 feet, and with the terminal modernization projects currently being evaluated it is possible that greater amounts of containerized cargo may ultimately be routed through Portland. Even with the deepening project, however, Portland will not be able to handle the largest vessels – the so-called post-Panamax vessels (see Part 1) -- in the current fleet, which require 45 feet or more of water.

**Oakland, CA**

The Port of Oakland, which is the 4th largest North American container port (Table 1-1), is located approximately 500 miles north of Long Beach. Container vessels calling at the Port of Oakland are in similar liner services as other ports along the West Coast, and transported 2.3 million TEUs of cargo in 2005 (Table 1-3).

The Port of Oakland has the appropriate infrastructure to accommodate additional container throughput. The port has almost a dozen container terminals, about three dozen modern container cranes, and 50 feet of water depth. In addition, Oakland is linked to the rest of the nation by good interstate highways. Only its rail connections are weak (see Part 1, Section 3.3). An analysis of its physical situation and future plans, however, shows that the Port of Oakland has limited expansion capability remaining:

1. Most of the port’s terminals serve single liner services (such terminals are less flexible in accepting additional cargo and third-party business in order to protect the quality of service of the proprietary liner service, and those under long leases need not modify their operations to achieve the high cargo densities needed to increase overall port throughput). Accordingly, Oakland’s terminals are operating at lower productivities than terminals at most other ports and can be expected to continue to do so. The figure for maximum capacity presented in Table 1-3 is, therefore, very optimistic.

2. The Port of Oakland’s master plan (Vision 2000) illustrates that most landside projects are now complete. That means that not only is no significant expansion of the marine terminals contemplated, but also that the intermodal facilities will not be expanded.

3. The port is surrounded by residential areas, a visitor-serving district, and significant railroad infrastructure – very little port-controlled land is left for future expansion.

The distance between Oakland and Long Beach falls within the traditional cost break-even zone for truck versus rail (350 to 550 miles). Accordingly, it is very possible some portion of any cargo diverted to Oakland would be sent back to the Los Angeles area. That would result in additional trucks on the road bringing the cargo to Southern California, which would increase not only traffic congestion but also emissions compared to the emissions associated with local delivery from the San Pedro Bay ports.

In recent years, the port was able to meet demand because, through the Vision 2000 Plan, most of the former Navy Base was converted to 270 acres of new container terminals (the balance was converted to public access and additional rail facilities). This development, combined with increased future productivity, will probably allow the Port of Oakland to meet its future cargo
demand, assuming the rail infrastructure is improved. Note that a forecast for Oakland was not available at time of writing, so it is not possible to evaluate Oakland's potential to handle more cargo in the long term.

**Manzanillo**

The Port of Manzanillo is the 16th largest container port in North America (Table 1-1), handling approximately 870,000 TEUs in 2005 (Table 1-3). The Port of Manzanillo, like most ports in Mexico, is in part privatized. The port does have container berths with container handling equipment, but at present the facilities can not be considered modern. Manzanillo and Long Beach are called on by similar liner services.

The Port of Manzanillo does not have robust transportation connections to destinations in the U.S. Neither the highway nor the rail infrastructure between Manzanillo and the U.S. could presently accommodate substantial cargo destined for the United States; in fact, at present little if any cargo arriving at Manzanillo is destined for the United States. However, it is probable that, with planned improvements to the rail system, there will be some intermodal traffic between Manzanillo and the U.S. Security is a great concern, so much that some shippers would not be willing to utilize facilities that handle their cargo in Mexico (as an example, it was very evident during the West Coast labor lockout of 2004 that shippers preferred to have vessels wait in San Pedro Bay rather than divert to Mexico). Manzanillo is already operating at a very high level of productivity (Table 1-3), so it is unlikely that there will be significant additional capacity available to handle U.S. cargo.

**Lazaro Cardenas**

Lazaro Cardenas, located south of Manzanillo, does not appear in Tables 1-1 and 1-2 because it only recently became operational for containers (130,000 TEUs in 2005) and is thus not among the top 25 ports. However, the port authority plans to start construction of new container terminals with an ultimate capacity of up to 2,000,000 TEUs per year (note that on the basis of its current size, the present study estimates the maximum capacity of Lazaro Cardenas to be approximately 400,000 TEUs [Table 1-3]). In contrast to Manzanillo, Lazaro Cardenas will have modern container handling facilities and adequate intermodal lift capacity for its size. Like Manzanillo, however, rail and road connections to the United States are weak and would need substantial improvements in order to handle U.S.-bound cargo. The security concerns described for Manzanillo apply to Lazaro Cardenas, as well. Both Lazaro Cardenas and Manzanillo primarily serve the Mexican market; only a small portion of their capacity is available for U.S. cargo.

**Punta Colonet**

Punta Colonet is not on the list of ports in Table 1-1 because it has not yet been built. Nevertheless, Punta Colonet is being considered here because it has been mentioned in a number of projections of the future port industry as a possible alternative to shipping containers through the crowded Southern California ports. The Mexican and Baja California governments have announced that they will invite tenders to design, build, and operate a new container port at Punta Colonet in Baja California. The site is about 50 miles south of Ensenada (250 miles south of Long Beach) and is currently completely undeveloped. The project, if one materializes, would require a very large investment in new infrastructure including a power plant, a water desalination plant, a sewer treatment plant, breakwaters, landfill for port terminals, a new city to house workers, and approximately 125 miles of new railroad to connect to main lines in the U.S. The cost of the new port alone has been estimated at $US5 billion, an equal investment would be required for the rail line, and additional costs would be associated with the supporting city. If constructed, this port would serve U.S. markets in the mid-west and south. Estimates of
its potential capacity range between 4 and 7 million TEU's per year, but until the port is actually designed and financing has been secured, the port’s capacity and its very feasibility are highly speculative, and it cannot be considered in estimates of near-term or mid-term capacity.

1.3.2 East Coast and Gulf Coast Ports

East Coast and Gulf Coast ports can be considered together as a potential alternative to the POLB for container cargo because they differ from the West Coast ports in the same way, namely the constraints of getting imported cargo from its primary origins – China and the countries of Southeast Asia – to markets in the East and Midwest. As shown in Figure 6, the possible routes are: across the Pacific to West Coast ports and then overland by train (the landbridge route that most of the Midwest and much of the East Coast cargo currently takes); across the Pacific and through the Panama Canal; or westbound through the Suez Canal and across the Atlantic to landbridge routes.

Capacity

As Table 1-2 shows, half of the continent’s major container ports are on the East and Gulf coasts. Although cargo volumes with the historic trading partners of those ports (Europe, Africa and the Middle East, and South America) are not expected to grow much, if at all, trade with Asia is growing and will continue to do so, although probably not as fast as the West Coast’s trade with Asia. Many of the East Coast and Gulf Coast ports have the modern facilities and deep water to accommodate the projected growth in trade with Asia and the increased vessel sizes. Because their cargo volumes have not grown nearly as fast as those of the West Coast ports, however, they have not embarked on major expansion and modernization programs the way the West Coast ports have done. Nevertheless, it is likely that there is excess capacity in the East Coast/Gulf Coast ports that could absorb discretionary cargo from POLB. This analysis reviews current and forecasted capacity at those ports and the factors that go into the forecast.

![Figure 1-4. Projected Capacity of East Coast and Gulf Coast Ports at Various](image)
Productivities (Moffatt & Nichol Data)

East Coast ports typically operate at lower productivities than West Coast ports – in 2005 the average throughput was approximately 3,700 TEUs per acre versus 4,500 on the West Coast -- largely because container dwell times are longer, many of the terminals are not well suited to handle containers, and the broader mix of markets served by East Coast ports reduces the efficiency of container storage operations. These inherent inefficiencies mean that it is unlikely those ports could ever achieve the future levels of productivity assumed for West Coast ports (See Section 1.3.1). Instead, it is assumed that East Coast ports could achieve 5,500 TEUs/ac/year simply by intensifying their existing operations, 6,500 TEUs/ac/year if they undertake the types of operational changes described in Chapter I, and 8,000 TEUs/ac/year if they undertake capital projects to reconfigure and expand their terminals.

Several East Coast container terminal projects are either currently under construction or within the planning horizon that will increase their terminal cargo capacity. Examples of development projects include:

- The Virginia Port Authority development of a new container terminal at Craney Island. The planned facility will consist of 8 berths and 600 acres.
- APM new 4-berth 200-acre terminal in Portsmouth Virginia is scheduled to start operations in August 2007.
- South Carolina State Port Authority is developing a container terminal at the decommissioned Charleston Navy Base. The planned terminal will consist of 3 berths and 200 acres. Completion of Phase 1 is scheduled for 2013.
- At Dames Point, Jacksonville, Florida a new 203 acre 2-berth facility is under construction and is expected to open in 2008.

At those levels of throughput the East Coast/Gulf Coast ports could handle approximately 53 million TEUs per year (Figure 1-5, although it is not known when (and if) that maximum capacity would ever be realized, as few of the planned expansion projects have gotten underway. Nevertheless, as Figure 1-5 indicates, it is likely that East Coast and Gulf Coast ports could, by implementing the extensive changes envisioned for West Coast ports, provide enough capacity to handle a considerable volume of diverted cargo at least until 2030.
Panama and Suez Canal Routes
As mentioned above, Asian cargo diverted to the East and Gulf coast ports would have to travel through either the Panama or Suez canal. The Panama Canal offers an alternative vessel routing in the short term (currently, approximately 70% of the container trade that utilizes the Panama Canal is bound to or from the U.S.), and some carriers are already offering more all-water services based on the Canal (Journal of Commerce 2007b). As Part 1 explained, however, the Panama Canal’s container capacity is not limited. The Panama Canal Authority (ACP) has proposed a “Third Locks” project that will add capacity, but this is not proposed to be in place until 2014. In the interim, the ACP has indicated their capacity will improve due to operational improvements, shifting of non-container daily transit slots to container slots and the trend to more containers per vessel. Accordingly, the Panama Canal can accommodate some portion of diverted Asian cargo but this amount is difficult to predict exactly. Nevertheless, any future lack of capacity would have a direct effect on vessel routing options for the U.S.: cargoes manufactured in the Far East and destined for the East Coast that cannot use the Panama Canal would either have to use the landbridge route (via West Coast ports) or the Suez route (via East or Gulf Coast ports). If the landbridge route becomes unavailable due to the inability or unwillingness of West Coast ports to handle discretionary cargo then the Suez route will be the only option. As Part 1 explained, that route would involve considerable increases in the number of ships and travel time.

Accordingly, although it is likely the East Coast and Gulf Coast ports will have the capacity to accept considerable quantities of POLB discretionary cargo in the future (approximately 7 million TEUs in 2030), there would be substantial costs and environmental impacts involved. The need for more vessels on the all-water routes would increase the costs of transporting each container; although at this writing there are no unequivocal data to indicate how much the
increase might be, which is dependent on the Port of Call. Higher costs would be a disincentive for shippers to route cargo through East Coast and Gulf Coast ports, although rising rail rates (Journal of Commerce, 2007c) could eventually reduce or even eliminate the cost differential between the landbridge and all-water routes. The longer travel time (China to New York takes 7 days longer by water than by landbridge; Journal of Commerce, 2007a) will be an added disincentive for time-sensitive cargos.

1.4 Comparative Emissions Analysis

A comparative, screening-level analysis was performed of the additional trips and corresponding emissions if 1 million TEUs of discretionary cargo were diverted to other ports in the U.S. As explained in Chapter I, this analysis was not performed using the methodologies and assumptions that are used in the POLB’s port-wide emissions inventory or in the environmental analyses performed for specific projects; instead, it is an analysis specific to this study intended solely to support comparisons of the various scenarios considered in this study.

In 2004, 94% of TEUs to San Pedro Bay ports (Long Beach and Los Angeles) were from Asia, and 58% of those were from China. Accordingly, Shanghai was selected as the origin of TEUs, as it is a representative port of China. Representative major, deepwater, container handling ports were selected as U.S. destinations for this analysis: three West Coast ports, two East Coast ports, and one Gulf Coast port. Chicago was chosen as the final destination because it is the centroid of consumption in the U.S. and is actually a major distribution point for cargo. In these scenarios, cargo was assumed to originate in Shanghai and travel to Chicago by three basic routes: trans-Pacific to West Coast then by rail to Chicago; trans-Pacific and through the Panama Canal to Houston, Charleston, or New York then by rail to Chicago; trans-Indian Ocean, through the Suez Canal, and across the Atlantic to New York then by rail to Chicago. (see Figure 7).

Table 1-4 shows the percentages of emission changes compared to the Long Beach case. All East/Gulf Coast options would generate substantially more emissions - for example, from 40% more of NOx for Charleston to 64% more for New York - of all pollutant types than the LB/LA route. All West Coast options other than Long Beach will produce less pollutants than the Long Beach case. Diverting cargo to other West Coast ports would result in less overall emissions of the pollutants than continuing to send the cargo through Long Beach, and thus from a pollution point of view could be considered a net benefit.

<table>
<thead>
<tr>
<th>Shanghai to Chicago via:</th>
<th>Percent changes compared to Long Beach case</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOx</td>
</tr>
<tr>
<td>LB/LA, CA</td>
<td>0.00%</td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>-2%</td>
</tr>
<tr>
<td>Seattle/Tacoma, WA</td>
<td>-7%</td>
</tr>
<tr>
<td>New York, NY through Panama</td>
<td>43%</td>
</tr>
<tr>
<td>Houston, TX through Panama</td>
<td>43%</td>
</tr>
<tr>
<td>Charleston, SC through Panama</td>
<td>40%</td>
</tr>
<tr>
<td>New York, NY through Suez</td>
<td>64%</td>
</tr>
</tbody>
</table>

Table 1-4. Emissions of the Various Scenarios as a Percentage of the Long Beach Case
Sending the cargo to either the East Coast or the Gulf Coast would result in considerably more pollution, so even though pollution would be removed from Long Beach, the consequence would still be detrimental on a global basis. As previously mentioned, this difference is primarily due to the longer journey, and thus the greater number of ships that would need to be employed.

**Special Oakland Circumstances**

A diversion of cargo to the Port of Oakland also poses a special circumstance for emissions since the concept could be to divert a vessel with both discretionary and non-discretionary cargo on board. In this case the non-discretionary containerized cargo would be trucked back to Southern California consumers, and truck emissions become a more important component in the overall emissions especially for the local environment.

In this case the generic 1,000,000 TEUs would be diverted to Oakland with a reasonable modal split of 400,000 TEUs continuing on to Chicago via rail and 600,000 TEUs trucked back to Long Beach. A special circumstance analysis was done to compare the emissions for this routing using a local consumption of 600,000 TEUs in Southern California along with the 400,000 TEUs railed to Chicago for both the Long Beach and Oakland port of entry scenarios. The emissions factors by mode of transportation used and calculation methods were the same as the previous global analysis except truck emissions were included with the results shown in Table 1-5.

<table>
<thead>
<tr>
<th>Million TEU-Miles</th>
<th>Pollutant Percentage Change Compared to Long Beach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port of Entry</td>
<td>Ship</td>
</tr>
<tr>
<td>Long Beach</td>
<td>6541</td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>6187</td>
</tr>
</tbody>
</table>

**Table 1-5. Special Emissions Comparison for Vessel Diversion to Oakland**

You can see from the table, any vessel diversion to Oakland, representing the farthest practical location from which the domestic or non-discretionary Long Beach cargo would return via truck, will have increased overall emissions. Table 1-5 uses the emissions factors for trucks based on the 2005 truck fleet distribution and fuel data. If all 2007 model year trucks and fuel data is used, Table 1-6 shows the resulting comparisons with Oakland.

<table>
<thead>
<tr>
<th>Million TEU-Miles</th>
<th>Pollutant Percentage Change Compared to Long Beach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port of Entry</td>
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<td>6541</td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>6187</td>
</tr>
</tbody>
</table>

**Table 1-6. Special Emissions Comparison for Oakland Diversion with 2007 Model Year and Fueled Trucks**

You’ll see from Table 1-6 that if all trucks are cleaned to 2007 standards, the diversion of a vessel to Oakland with back haul non-discretionary cargo to Long Beach will result in less overall pollutants primarily due to the lesser ship miles involved. However, if you only look at
local truck emissions, Oakland diversion would create more truck emissions in Southern California due to the longer truck travel distance within the region.

1.5 Conclusions

1.5.1 West Coast Ports
This analysis has shown that there is no single port on the West Coast that could accommodate Long Beach’s forecasted increases in container cargo over the next 15 to 25 years; all West Coast ports will struggle just to meet their own forecasted demands. By 2020 most of the ports will be operating at maximum capacity – the forecast of approximately 56 million TEUs would be balanced by a capacity of 56 million TEUs only under the most optimistic scenario of very large productivity increases at every terminal in every port (Table 1-3, Figure 1-1). Even in combination, therefore, the West Coast ports outside San Pedro Bay will not have enough excess capacity to absorb more than a fraction of Long Beach’s projected increases in container throughout.

As Part 1 showed, goods movement through the POLB has substantial economic benefits to the Southern California economy in terms of jobs, wages and salaries, and tax revenues; those benefits would not be realized in Southern California were cargo to be diverted to other ports. Diversion to other ports could be significantly more expensive for shippers because of delays caused by infrastructure constraints, increased costs of terminal and rail services (see Part 1), and, in the case of the Mexican ports, by the longer sailing time from Asian origins.

Screening-level emissions calculations suggest that diverting discretionary cargo to other West Coast ports (other than Mexico, for which emissions calculations were not performed) would not increase overall emissions significantly, and could actually reduce SOx and diesel particulate matter emissions slightly. It is important to note that diversion would not eliminate those emissions, nor the increased traffic congestion, but rather impose them on port communities outside Southern California such as Oakland, Seattle, and Vancouver, all of which are already facing air quality problems.

1.5.2 East Coast and Gulf Coast Ports
In the case of East and Gulf Coast ports as an alternative to Long Beach, there is the potential of enough future capacity to handle a considerable portion of Long Beach’s forecasted cargo increases. Diverting cargo to East/Gulf Coast ports would have the same negative impact on jobs and economic vitality in Southern California as would diversion to other West Coast ports. The greatly increased cost of routing vessels directly from Asia to the East Coast would translate into increased costs of goods for consumers throughout the nation. Increased shipping costs could provide a significant disincentive to routing Asian cargo via the Suez Canal, as would longer travel times (Journal of Commerce 2007a). Accordingly, shippers will probably continue to route cargo through the West Coast until the disincentive of rising costs and increased transit times caused by congestion, delays, and limited capacity on the West Coast makes the Suez route preferable.

Because this option would result in large increases in equipment needs and because each unit of cargo would travel farther by ship, more pollutants, including greenhouse gases, would be produced per container: in the case of the Suez route, emissions would be more than twice those of the Long Beach case. As in the West Coast case, those emissions and the traffic congestion associated with increased cargo volumes would be imposed on other port communities such as Houston, Savannah, Baltimore, and Montreal.
2 OPTION 2 – EXPANSION OF SOUTHERN CALIFORNIA TERMINALS OUTSIDE POLB

2.1 Introduction

Another potential alternative to expanding terminal facilities in the POLB is to divert cargo to other Southern California ports, namely Port Hueneme, San Diego, or Los Angeles. This option recognizes the long-established drivers to send cargo to Southern California rather than other North American ports: a large population center, competitive transportation rates, a high-capacity rail system, and a large warehousing industry among others (see Part 1 Section 3). This study reviewed the potential expansion of terminals at those other ports. As with Option 1, the sites were reviewed for their container handling capacity, channel and water depth at berth, and transportation infrastructure.

Because of the proximity of the ports analyzed in this option to the POLB, this study assumed that the overall emissions would be very similar among the ports, and a comparative emissions analysis was not conducted.

2.2 Description of Option 2

For this option it was assumed that the same mix of containerized cargo – local and intermodal – currently handled at Long Beach would be diverted to the alternative facility. Since the California Coastal Act prohibits the creation of a new port somewhere else in Southern California (or anywhere else in California), that option was not considered in this study.

2.2.1 Port Hueneme

Port Hueneme, located approximately 35 miles north of Long Beach, is ranked 50th among North American container handling ports, but the port’s primary cargoes are automobiles and chilled/frozen commodities; the approximately 30,000 TEUs that Port Hueneme handled in 2005 were primarily carried by smaller, specialized non-container vessels whose cargo included some containers. The port is controlled by the Oxnard Harbor District. Planned improvements by the District do not include development of any container handling facilities.

Port Hueneme

Port of San Diego

2.2.2 San Diego

The Port of San Diego, located approximately 90 miles south of Long Beach, is ranked 37th in size among North American container-handling ports. The port is controlled by the San Diego
Unified Port District. The port’s primary cargoes are automobiles, bulk, breakbulk, and chilled/frozen commodities, and it is a home port for various cruise lines. The Port has two separate cargo terminals at different locations in the harbor district. The 125-acre National City Marine Terminal (NCMT) mostly handles automobiles and chilled/frozen commodities, and the 96-acre Tenth Avenue Marine Terminal (TAMT) handles a variety of cargoes including bulk, breakbulk, and containers. In 2005 approximately 100,000 TEUs were handled at the TAMT, all by one chilled/frozen commodities account. Planned improvements by the port authority do not include development of any container handling facilities.

Port of Los Angeles

2.2.3 Port of Los Angeles
The Port of Los Angeles (POLA) is located immediately adjacent to the POLB. The POLA is ranked as the largest U.S. container handling port, handling 7.5 million TEUs in 2005, and is landlord to some of the largest container terminals in the world. While the POLA and POLB make up one of the most productive port complexes in the world, they are controlled by two separate and distinct governmental agencies, namely the cities of Los Angeles and Long Beach, respectively. The POLA has its own planned approach to accommodating its share of the container cargo market. This diversion option assumes that cargo diverted from Long Beach would be handled by existing or new terminals at POLA.
2.3 Analysis

2.3.1 Port Hueneme

While Port Hueneme is certainly within the Pacific Rim’s vessel deployment area, any liner services calling Hueneme would not be the same as those deployed to Long Beach. Port Hueneme cannot handle deep-draft vessels as the harbor is only 35 feet deep, considerably shallower than the minimum 45 feet required for typical container vessels today.

The cargo terminals at Port Hueneme share the vessel channel and basin with commercial fishing and the U.S. Navy. The port’s expansion capability is severely restricted by a public-accessible shoreline, residential areas, and military installations; only by negotiating with the surrounding military installations was the port able to achieve a temporary expansion of its automobile terminal a few years ago. There is insufficient expansion room to accommodate a container terminal capable of handling a significant number of containers. The existing terminal equipment and infrastructure are not compatible with modern container terminal operations, nor are the existing wharf and pavement capable of sustaining the loads produced by a container handling operation. Accordingly, any significant increase in container handling capabilities would require a substantial redevelopment effort.

Finally, the transportation infrastructure that serves Port Hueneme has limited capacity. The local government has restrictions on the commercial use of the public thoroughfare that connects the port and the nearest transportation highway (U.S. 101). The Port has limited rail infrastructure with no container handling (intermodal) capability. Assuming a way could be found to accommodate the truck traffic without conflicting with local traffic restrictions, containers destined for the Long Beach-Los Angeles area would add the same amount of traffic congestion to the regional transportation system as cargo delivered directly to Long Beach. However, relatively little of that cargo would travel on the highway segments close to the San Pedro Bay ports that are currently heavily impacted by port-related truck traffic.

2.3.2 San Diego

While both of the Port’s cargo-handling terminals are within the Pacific Rim’s vessel routes, neither has the capability to accommodate a modern container terminal. The NCMT and TAMT have 35 and 42 feet of water at berth, respectively, which are not sufficient to handle modern container vessels requiring 45 feet or more. The terminals do not have modern container-handling facilities or any on-dock rail facilities. Both terminals are located adjacent to modern highway transportation infrastructure (Interstate 5).

Containers at the TAMT are handled by vessel gear (cranes on-board the vessel) – the port facilities do not include functional container cranes. The TAMT has been developed for automobiles and the shallow-draft vessels that carry them, and was recently expanded to accommodate growth in the automobile market. It is surrounded by a public access area, rail yard, and the port’s own convention center/hotel, leaving no room for further expansion.

Despite the proximity of I-5, the port’s transportation infrastructure is constrained by a restricted entry gate, and already experiences traffic congestion on a daily basis, which backs up trucks and vehicles onto public right-of-way. Contributing to this congestion is the location of a nearby at-grade rail crossing serving the adjacent private railyard.

San Diego has two rail lines connecting it to the east, both owned by BNSF. A low-capacity route winds through the mountains and deserts east of San Diego, crossing several old trestles; it is not suited for container trains. The other route, which is heavily utilized by commuter trains,
heads north along the coast before joining BNSF’s main line just east of Los Angeles.

2.3.3 Los Angeles
POLA’s channel and berth depths are currently capable of handling the largest modern containerships, and POLA has similar liner services as POLB. Like Long Beach, Los Angeles has undertaken massive programs to modernize container terminals, deploy automated technologies, and optimize land configuration and operations.

The major transportation corridors serving the POLA are the same as those serving the POLB. Both ports are configured to handle intermodal cargo. POLA’s master plan reflects the need for optimization and development to meet demand. Additionally, the results of joint research efforts, such as the previously mentioned “San Pedro Bay Ports Long-Term Cargo Forecast”, substantiate the need for POLA to develop its container handling capability further.

2.4 Comparative Emissions
As mentioned above, a quantitative emissions analysis was not performed for this option because the proximity of the alternative ports to Long Beach made such a comparison meaningless (all of the options would produce very similar quantities of emissions). Instead, the emissions of each alternative relative to Long Beach are discussed in general terms.

On a regional basis, the emissions associated with bringing cargo to Hueneme would probably be fairly similar to the emissions associated with Long Beach, but, as with the traffic, the emissions would be displaced away from San Pedro Bay and imposed instead on communities in Ventura and northern Los Angeles counties. For San Diego, however, the emissions would be slightly greater than the emissions associated with Long Beach because of the increased distance the trucks and ships would have to go. As with the traffic, those emissions would be displaced away from San Pedro Bay, albeit to a region that is experiencing increasing air quality problems of its own. Diverting cargo from Long Beach to Los Angeles would have no benefit in terms of overall emissions, and would have only minor, localized benefits for some Long Beach neighborhoods by displacing emissions to San Pedro and Wilmington neighborhoods.

2.5 Conclusions
Port Hueneme does not have the expansion potential, existing infrastructure capacity, water depth, or transportation infrastructure to accommodate either a dedicated container terminal or a significant increase in container throughput at existing terminals. If a way were found to bring containers to Hueneme, the traffic and emissions associated with moving the cargo by rail and truck would be displaced approximately 35 miles northwest from the San Pedro Bay communities but would still affect the greater Los Angeles area and the South Coast Air Basin.

The Port of San Diego does not have the terminal space, water depth, or eastbound rail capacity to support containerized cargo throughput demand beyond what it is currently accommodating. If capacity for containers could be generated, cargo destined for the Long Beach-Los Angeles area from San Diego would exacerbate local traffic and air quality in the San Diego area and add to congestion of the transportation system between the two regions. Relatively little of that cargo, however, would travel on the highway segments close to the San Pedro Bay ports, and so traffic in the Long Beach area would be alleviated by this option. Diversion to San Diego would also displace emissions away from the Long Beach area.

Theoretically, the POLA could be an alternative for POLB container operations. Practically, however, the POLA can not be an alternative because both ports have forecasted growth that
will exceed capacity within the planning horizon (Part I). Accordingly, both ports anticipate needing container terminal development beyond currently planned optimization and capacity maximization in order to accommodate future cargo forecasts. Furthermore, given the proximity of the two ports, diverting cargo to POLA would not eliminate the environmental impacts of that cargo on port-area communities and natural resources.
3 OPTION 3 – OFF-SITE BACKLANDS FACILITY

3.1 Introduction
Several options were considered that could reduce port-related land requirements, air pollution, and traffic congestion in the port. One such, the Off-site Backlands Facility, addresses the potential for developing a container handling facility that would perform the functions of a conventional marine terminal’s backlands at some distance from the vessel loading facilities. This alternative could potentially optimize the Port’s waterfront and postpone the need to expand existing terminals or construct new ones in the harbor district. A screening-level emissions analysis was not performed for this alternative because the only difference in emissions would be the additional truck trips and container handling that the off-site scenario would entail (see below).

3.2 Description of Option 3
This scenario (Figure 3-1) examines the potential for using underdeveloped land outside the Port as a container storage and handling facility in lieu of redeveloping and expanding an existing container terminal or building a new terminal in the harbor district. The off-site facility could provide backlands for more than one waterfront terminal or it could be part of a single facility that includes a marine terminal for loading and unloading vessels. Either configuration would require the development of a container storage yard on the off-site backlands, including heavy-duty pavement, utilities, lighting, a gate complex, maintenance and administration buildings, and other facilities necessary for storing and processing containers.

Figure 3-1. Conceptual Configuration of an Off-Site Container Yard
Since the facility would not include any berthing facilities, containers would need to be drayed between waterfront facilities and the off-site container facility. The waterfront facilities would provide minimal storage and sorting functions – instead, the functions normally provided by a container terminal’s container yard (see Part 1, Section 4) would be conducted in the off-site facility. For the sake of this analysis, the average draying distance was assumed to be approximately three miles, placing the facility in the general vicinity of Carson, Wilmington, or west Long Beach. Import containers for local delivery would be drayed or otherwise transported from the wharf directly to the off-site facility and then sorted for release to the shippers. From there, conventional on-road trucks would pick the local import containers up, just as in a conventional marine terminal, exit through the gate complex, and deliver them to local destinations. Export containers would arrive at the off-site terminal via on-road trucks, be processed through the gate and sorted by yard equipment, stored until the vessel arrived, then drayed to the marine terminal for loading onto the vessel.

3.3 Analysis
The assumptions and calculations used to determine the size of the facilities required for the off-site option are presented in Appendix B. That analysis concluded that each 1,000,000 TEUs would require approximately 21 acres of marine terminal (wharf, cranes, and gate complex) coupled with an off-site container facility of approximately 110 acres, so the total size of the facility would depend upon the target throughput volume. Each 1 million TEUs of activity would involve approximately 540,000 trips per year to move containers between the two facilities; those are trips that would not happen with a conventional marine terminal in which the container yard is adjacent to the wharf.

3.4 Comparative Emissions
Compared to the operation of a conventional marine terminal, this option would be expected to generate additional traffic and emissions associated with draying containers between the terminal and the off-site facility. Although a quantitative analysis was not performed for this option, it is clear that the amount of emissions would depend on the technology used in the draying operation (alternative-fueled or electric trucks, or a non-truck-based method, would obviously be much cleaner than conventional diesel trucks). Very clean draying technology could in theory result in an overall reduction in emissions compared to a terminal in the harbor district using conventional draying equipment. In addition, the facility would be located three miles closer to the ultimate destination of the cargo, and thus the truck and train trips employing conventional technology between the offsite facility and the cargo’s destination would be a little shorter than with the in-harbor terminal scenario, which would also result in lower emissions compared to a conventional marine terminal. The facility’s construction would produce more emissions than the construction of a conventional terminal because of the need to duplicate facilities such as gate systems, administration and maintenance facilities, and terminal operation equipment, but that would be a temporary, short-term increase.

3.5 Conclusions
3.5.1 Advantages and Opportunities
The off-site backlands alternative offers several theoretical advantages over other options.
- Harbor fills for new and expanded terminals would be postponed or eliminated, thus reducing impacts on marine resources compared to the expansion or creation of conventional marine terminals.
• The opportunity to use ultra-low-emissions technology in the draying operation could bring air quality benefits to the region.

• Jobs and revenues associated with maritime commerce would remain in the Long Beach/Los Angeles area rather than being lost to other areas as would be the case with Options 1 and 5, and, to some extent, Option 2.

3.5.2 Disadvantages and Constraints
There are several constraints to this alternative.

• Suitable land would be difficult to obtain: there is unlikely to be any large tract of land outside the Port that is sufficiently removed from residential areas to be acceptable to the public.

• Unless a non-truck-based draying technology could be used, this alternative would involve two vehicles for each local container: the dray to/from the waterfront and the truck trip to/from the cargo’s destination or origin. That means roads in the immediate vicinity of the facility would experience more congestion than with a conventional terminal, since they would have to accommodate both the drayage vehicles and the on-road trucks.

• Existing labor agreements may not be able to accommodate the economical operation of a remote facility. For example, the use of longshore labor to transport containers between the terminal and the backland yard would likely be so expensive as to render this alternative uncompetitive with existing conventional terminals and thus unacceptable to potential terminal operators.
4  OPTION 4 – INCREASED USE OF NEAR-DOCK INTERMODAL RAILYARDS

4.1 Introduction
Transportation by rail over long distances is cheaper than trucking, reduces highway congestion, and, as shown in Figure 7, produces less air pollution per container. Accordingly, the shipping industry has embraced intermodalism to the extent that, currently, approximately 40% of the containers that come through the POLB are transported in and out of the Los Angeles area on rail cars specially designed to carry cargo containers. These containers are loaded and unloaded at intermodal railyards. To support this trend, the San Pedro Bay ports have constructed intermodal railyards inside their terminals (on-dock railyards) and have cooperated with the railroads in providing additional intermodal facilities in the port area (near-dock railyards).

4.2 Description of Option 4
This option consists of the construction and operation of a new near-dock railyard in the vicinity of the POLB. It is being considered because it could potentially eliminate the need for on-dock railyards in new and reconfigured terminals, thus reducing the land requirements of those terminals. In addition, near-dock railyards are theoretically more productive than on-dock railyards because, unlike on-dock yards, they may handle the cargo from more than one terminal and thus can use labor, facilities, and equipment at maximum efficiency.

An on–dock intermodal yard (Figure 4-1) is located within the container terminal it serves, and containers exiting the terminal on rail cars do not go outside the terminal on trucks. Most of the container terminals in the San Pedro Bay ports have on-dock facilities, and typically each of those railyards only handles cargo coming through the terminal in which it is located.

Figure 4-1. Conceptual Configuration of On-Dock Rail Facilities
Near-dock intermodal yards (Figure 4-2) are located in or near the port but outside any of the container terminals. They can be anywhere from less than a mile to several miles from the marine terminals they serve. Any container terminal could ship some or all of its intermodal containers through near-dock railyards. An example of a near-dock railyard is the Union Pacific (UP) Intermodal Container Transfer Facility (ICTF) located in Carson. This facility is on average about five miles from each of the container terminals that it serves. Since the intermodal rail yard is outside the terminals, on-road trucks, rather than yard hostlers, must dray the containers from the marine terminal to the near-dock rail yard (at present there is no other technology to replace trucks).

![Figure 4-2 Conceptual Layout of Near-Dock Intermodal Rail Facilities](image)

A near-dock intermodal rail yard requires considerable acreage: for example, the ICTF is situated on over 233 acres of land. To develop this option, sufficient existing acreage must be found for the yard, or acreage could be created by filling part of the harbor. Once land is found or created, the near-dock rail yard would be developed with tracks, heavy duty pavement, utilities, yard lighting, a gate, and other facilities required for processing containers and servicing rail cars and engines. For the sake of this analysis the rail yard was assumed to be at an inland location an average of five miles from port container terminals, but it could be developed on created land within the Harbor District.

As a note, so-called “off-dock” railyards are located a considerable distance from the port and require the use of on-road trucks to haul containers between the marine terminals and the railyard. In the Los Angeles area the major off-dock yards are Hobart (BNSF) and East Los Angeles (UP) just east of downtown Los Angeles, approximately 25 miles from the ports. Additional off-dock railyards are not considered a viable alternative to on-dock or near-dock railyards because of the obviously greater traffic and air quality impacts they entail.

### 4.3 Analysis

The near-dock railyard considered in this scenario would need to be proposed and implemented by some entity other than the POLB, since the project would take place outside the Harbor District.
District. This requirement would complicate the approval process, but it is not a “fatal flaw”: the ports have already undertaken two large rail-related projects outside their jurisdictions (the ICTF and the Alameda Corridor) by participating in joint powers authorities.

This analysis of the concept is based on a comparison of an on-dock intermodal rail facility in a marine terminal with a near-dock facility that serves several container terminals (Table 4-1). In both configurations, 60% of the container throughput is delivered by truck (locally). However, the 40% non-local container traffic destined to be moved by rail is handled differently in the two configurations. For the on-dock configuration, the intermodal rail cargo departs directly from the terminal by train, but in the near-dock configuration the same cargo would travel to the intermodal yard by truck (or possibly, in the future, by a non-truck-based technology) before departing on rail.

<table>
<thead>
<tr>
<th>On-Dock Intermodal Rail</th>
<th>Near-Dock Intermodal Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Located within the container terminal for dedicated use by the terminal operator</td>
<td>Located within 3 to 7 miles from container terminals, used by multiple users and operated by the railroad companies</td>
</tr>
<tr>
<td>As integral part of the container terminal allows the sharing of container handling equipment, container storage areas, administration and maintenance facilities, and security system</td>
<td>Requires dedicated container handling equipment, container storage areas, administration and maintenance facilities, gate facility, and security system</td>
</tr>
<tr>
<td>Takes significant container storage area away from the terminal</td>
<td>Can be located on a site away from the container terminals where land is cheaper</td>
</tr>
<tr>
<td>Short drayage distance from container yard to rail yard (avg = 0.5 miles), drayage performed by yard tractors</td>
<td>Long drayage (5 miles) to railyard, drayage performed by on-road trucks (alternative technology not yet feasible).</td>
</tr>
<tr>
<td>No truck traffic between the container terminal and the on-dock facility.</td>
<td>Generates truck traffic between container terminals and the near-dock facility.</td>
</tr>
</tbody>
</table>

Table 4-1 Characteristics of On-Dock and Near-Dock Railyards

4.4 Comparative Emissions

A comparison of emissions associated with the two options would show that the use of a near-dock yard with conventional truck technology would produce more emissions, depending upon the pollutant being considered, than are produced by on-dock yards due to the added distance travelled. Of course, the use of cleaner trucks or other technology for the draying operation, as already being considered in the San Pedro Bay Clean Air Action Plan and for the UP’s ICTF in Carson, would reduce the difference dramatically.

4.5 Conclusions

A near-dock intermodal rail facility has some attractive characteristics, but it also has significant disadvantages and negative impacts relative to on-dock facilities.

4.5.1 Advantages

- A near-dock yard uses space more efficiently than near-dock yards because it services multiple terminals.
• A near-dock yard allows more efficient use of waterfront property and reductions in the size of terminals because it does not take up terminal space with a use unrelated to loading and unloading ships.

4.5.2 Disadvantages and Constraints

• The near-dock yard involves more truck trips, thus increasing road congestion and air emissions compared to on-dock yards.

• In this scenario a near-dock yard would generate greater traffic and public nuisance impacts than on-dock yards because it would be closer to residential areas than on-dock yards; if the near-dock yard were located within the Harbor District that would probably not be the case.

• Locating a suitable site for a near-dock facility outside the Harbor District would be much more challenging than including an on-dock yard in a marine terminal.

From an environmental impact perspective, a near-dock facility is not necessarily preferable to on-dock railyards. Nevertheless, the concept cannot be dismissed because recent studies have established the need for additional near-dock facilities in the San Pedro Bay area to handle overflow from on-dock facilities and to service terminals that do not have on-dock railyards. Specifically, while the Rail Master Plan (Parsons, 2006) commits the two San Pedro Bay ports to maximizing on-dock facilities over the next two decades, it demonstrates that even with full build-out of all possible on-dock facilities, the shortfall in intermodal capacity of over 3 million TEUs per year in 2030 will necessitate construction of at least one, and very possibly two, additional near-dock facilities.
5 OPTION 5 – INLAND PORT

5.1 Introduction
Another option for reducing land requirements and traffic congestion at the port, known as the inland port (IP), would move cargo as rapidly as possible through the marine terminal to an inland location for sorting and distribution. The IP would be a container terminal located some significant distance from Long Beach, for example in the Inland Empire or the high desert area. The IP would provide a facility outside the port where containers could be stored and processed, thus partially eliminating the need for terminal expansion within the Harbor District. The ports of Long Beach and Los Angeles have been exploring the feasibility of this concept for several years. This option differs from Option 3 in that the inland terminal would be much farther away and much larger (because of the need for a railyard) and the containers would be transported to the inland site by train rather than truck.

5.2 Description of Option 5
The IP would consist of three components (Figure 5-1): the marine container terminal at the port, with an intermodal rail yard but minimal container yard; a rail corridor (in this example, approximately 100 miles long); and the inland terminal with a full container yard and gate complex. Such a concept would provide a potential alternative to full container terminal development within the port, particularly the need for new landfill. In theory, an existing container terminal at the Port could be converted to the marine terminal component of an inland port concept by 1) providing the maximum amount of wharf, 2) expanding the existing on-dock yard or building one in the existing container yard area, and 3) eliminating the container yard and possibly the gate complex, potentially freeing land for other uses.

![Figure 5-1 Conceptual Configuration of the Inland Port Concept](image)
This scenario would require the construction of a relatively small (50-100 acre) marine terminal or the conversion of an existing port terminal at the Port with a wharf, shiploading cranes, container handling equipment (mobile cranes, hostlers, etc.; see Part 1 Section 4), a small container yard to support ship loading and unloading operations, an intermodal railyard connected to the Alameda Corridor; and the construction of an inland container terminal facility with a container yard, railyard connected to a main rail line (BNSF or UP), gate complex, administration and maintenance facilities, and fencing and lighting.

IPs could be used in two ways. In the first, the IP would handle a portion of the local cargo and all of the overland discretionary cargo. Containers bound for inland local destinations would be loaded onto shuttle trains that would carry them via the Alameda Corridor and main lines to the IP, where they would be unloaded, sorted, and hauled by truck to distribution center warehouses. The remaining local import containers would be trucked from the marine terminal. Overland cargo would be loaded onto trains at the marine terminal pre-sorted as to ultimate destination; at the IP the blocks of railcars coming from the marine terminal(s) would be shuffled to make up whole trains headed east. This scenario would, of course, require a larger marine terminal because it would need to have a container yard to handle local cargo.

In the second scenario, containerships would unload import containers at the marine terminal (more than one marine terminal could utilize a single IP; the only requirements would be an on-dock railyard and appropriate arrangements with the railroads) and all of the containers would be put on rail cars, completely unsorted, to be hauled via the Alameda Corridor and main rail lines to the IP. At the IP the containers would be unloaded and sorted in the container yard for further handling: either to be put on trucks for local delivery to customers or distribution centers or on trains for transport eastward. Note that because roughly half of import containers coming to Long Beach are for local consumption, a significant proportion of containers handled at the IP would actually have to back-track and return to the metropolitan Los Angeles area by truck. Export containers would be handled in reverse. In the second scenario, very few, if any, truck pickups and deliveries would occur at the marine terminal. Instead, the majority of truck activity would take place at the inland port.

5.3 Analysis

Development of an Inland Port, because it would include elements outside the Harbor District, would involve a number of challenges that options within the Harbor District would not face. Specifically, an inland development of this nature is beyond the jurisdiction of the Long Beach port authority, meaning the POLB could not authorize such a project. It could, however, be accomplished by a joint powers authority supported by the POLB. The IP concept would require substantial additional rail capacity -- at least to/from the main lines out of East Los Angeles and the IP location. This could also require expansion of the existing Alameda Corridor since the Alameda Corridor lacks the capacity to support a substantial shuttle train operation for all cargo growth assigned to an IP operation (ACTA 2003).

Development of an IP would require substantial private investment, as it is not likely that the cost of such a major project, in particular, the rail improvements, could or would be borne by local agencies. Capital purchases, especially of railcars, would be needed to support a shuttle train operation. No such private project was being contemplated at the time of writing, as under current conditions there is no economic incentive, but future conditions could improve the concept’s economic viability.

The IP would need to be reasonably near existing concentrations of distribution centers in order to minimize drayage, making land availability an issue. If the IP were located in a remote, currently undeveloped area there would be induced development and changes in patterns of rail
and truck traffic that would have new impacts on local air quality and communities.

Unless the IP is serviced by both Class I Railroads, it would lose the current competitive environment, since both railroads currently have access to all port terminals. The lack of competition could adversely affect the economic viability of the IP.

### 5.4 Comparative Emissions

A screening-level analysis was not performed to compare the emissions from a conventional terminal with those from an inland port. In the conventional terminal scenario, 40% of the cargo was assumed to travel by train from the marine terminal’s on-dock rail to Chicago and 60% of the cargo via truck from the terminal gate to local destinations within the Los Angeles basin. For the more likely IP scenario, 100% of the cargo was assumed to travel unsorted via train to the IP. From there, 40% of the cargo was placed on railcars bound for Chicago and 60% of the cargo traveled back to the Los Angeles basin via truck. In this IP scenario, the centroid of destinations for local cargo is assumed to be 20 miles from Long Beach while the IP is assumed to be located 100 miles from Long Beach. This results in IP local cargo to travel 100 miles out and 80 miles back or 180 miles vs. the 20 mile trip if leaving from a conventional terminal in Long Beach.

An emissions comparison of priority pollutants from truck activity would show the IP scenario to be greater than the conventional terminal scenario. As noted above, those emissions would be reduced from the port-area communities, but they would be added to existing emissions in areas with very poor air quality and would thus add to the challenges of bringing the Inland Empire’s air quality into attainment with federal and state standards.

### 5.5 Conclusions

The Inland Port concept has enough advantages to prompt ongoing interest and active exploration by the ports and the goods movement industry as a whole. Negative environmental impacts and the implementation challenges, however, are among the concept’s disadvantages.

#### 5.5.1 Advantages and Opportunities

- Cheaper land is available in outlying areas such as San Bernardino and Riverside Counties.
- Some portion of the future demand for additional land at the marine terminals would be reduced by this option.
- Near-port truck emissions and traffic would be reduced by being displaced inland.
- Some of the emissions associated with container handling at the marine terminals would be eliminated.

#### 5.5.2 Disadvantages and Constraints

- Truck traffic would be increased in the Inland Empire, especially in the case of the second scenario, and the average length of truck trips to move goods back into Los Angeles, Ventura, and Orange County communities could increase.
- Port-related air emissions from trucks, container-handling equipment, and locomotives would be shifted to an area with already seriously degraded air quality.
- Costs and emissions associated with double handling containers (once at the marine terminal, again at the IP) prior to distribution would be increased.
- Institutional challenges to implementation, especially with regard to expanding the existing rail network; given that the POLB would have very limited authority, have already proven formidable.
- Port communities would lose goods-movement jobs.
6 OPTION 6 – MARINE TERMINAL AUTOMATION

6.1 Introduction

The functions of a container terminal are: to transfer containerized cargo to and from a ship, to store containers in a storage yard, to deliver containers to and from intermodal railyard facilities, and to provide a controlled gate for truck pickup and/or delivery. The equipment used to load, unload, and transport containers within the marine container terminal varies among terminals, but in San Pedro Bay all of this equipment is operated by people and most of it is diesel-powered. Part 1, Section 4 describes the types of equipment and the operations they perform (loading/unloading, transportation, and stacking/unstacking) in a conventional container terminal. Automation of a container terminal is, then, the automation of these operations and of gate transactions and security processes.

The basic concept of this option is to increase the degree of automation at POLB terminals in order to reduce the amount of terminal space and the impact of terminal operations. It should be noted at the outset, however, that the container terminals at the POLB are already some of the most efficient facilities in the world and employ some degree of automation. The current level of automation that has been accomplished by most terminals operators in Long Beach includes installation of optical character recognition (OCR) equipment at the terminal gates to identify containers; and computers, OCR equipment, and radio antennas on wharf cranes, transporters, and stackers. OCR computers and radio antennas allow terminal operators to utilize terminal operating software to direct equipment operators to perform specific tasks, thus automating the information transfer associated with routine terminal activities and reducing or eliminating errant movements within the terminal.

A few terminals elsewhere in the world have a higher degree of automation than Long Beach terminals but are actually less productive. Technology exists today, and is being used on a limited basis at terminals in Europe, that is more automated. For example, there is equipment in service that does not need to be manned to perform the functions of transporting containers within the terminal, stacking and retrieving stored containers, and loading rail cars. This analysis reviews current automation technology as it relates to container terminals, determines its appropriateness for the POLB, and determines whether applying this technology would increase the efficiency of terminals and reduce the impacts of their operations.

6.2 Description of Option 6

In this option (Figure 6-1), the Port of Long Beach would require the operator of a new terminal to employ a higher degree of automation than is currently the industry standard in San Pedro Bay. Specifically, the operator would employ:

1. Automated ship loading cranes that would be computer-controlled rather than operated by a longshore worker;
2. Computer-controlled, electrically-powered rail-mounted gantry cranes, instead of manually-operated, diesel-powered rubber-tired gantries, to perform stacking operations;
3. Automated lifting vehicles (ALVs) or automated guided vehicles (AGVs) instead of hostlers driven by longshore workers to move containers around in the terminal;
4. Fully automated gate operations.

In an automated terminal, the stacking function is performed by rail-mounted gantry cranes (RMGs) that are typically electrically-powered. Each stack of containers, which can be up to
seven or eight high, is handled by one or more RMGs that straddle the stack on railroad-type rails. Trucks and yard transporters pass under the RMG, which lifts containers from the stack to the vehicle and vice versa. The RMGs also continuously sort through the stacks to retrieve containers that are to be placed on vehicles. The receiving and delivery of containers to and from vehicles is performed by a human operator in a remote location. The operation of the RMG performing the continuous sorting and preparing of the stacks for receiving and delivery is controlled by a computer.

Figure 6-1. Conceptual Configuration of an Automated Marine Container Terminal

In an automated terminal, the transport of containers between wharf and stack and between stack and on-dock railyard can be performed by AGVs and ALVs. AGVs and ALVs transport containers over fixed paths. An AGV receives containers directly from dockside gantry cranes, transports them to storage stacks, and delivers them to the stacking cranes. ALVs are capable of lifting containers from the ground on their own. This automation capability removes the need for cranes to wait for the ALVs to arrive; instead, the ALV receives and delivers to and from the ground at the wharf’s buffer area. Currently, AGVs and ALVs use diesel power, although alternative power systems found feasible in conventional hostlers and mobile cranes could undoubtedly be adapted to automated vehicles.

Automation of gate and security functions includes OCR cameras on portals to read container and chassis numbers. To fully automate gate facilities would require providing an electronic identification tag, such as Radio Frequency Identification (RFID), to all trucks; establishing intelligent identification systems, such as biometrics, for all truck drivers; and requiring all trucks arriving at the terminal do so within a pre-assigned date and time. The RFID tag would be read as the truck passes through the data collection portal, and the information would be matched to
the truck. The computer would verify and match the data to the prearranged appointment and the biometric scan would positively identify the driver by his or her "fingerprint".

6.3 Analysis

Automating container terminals presents opportunities for increasing efficiency and reducing labor costs, but it also imposes capital and operating costs and has a number of technical and institutional challenges, especially in San Pedro Bay. These opportunities and challenges, which are summarized below, will greatly affect the feasibility and benefits of increasing the degree of automation of Long Beach container terminals.

Some of the movements of loading and unloading a ship using gantry cranes can be automated. Semi-automated gantry cranes are currently in operation in some ports in Europe and Asia. However, where crane movement has to be performed within an area where humans are working (such as removing and placing container lashings and twist-locks), automation is not a viable option under current labor rules for safety reasons. In addition, under current labor rules shiploading cranes must be manually operated.

The use of automated container handling equipment (RMGs, AGVs, etc.) has been demonstrated to be feasible at ports elsewhere in the world, and the transfer of containers between wharf cranes and AGVs/ALVs has been fully automated at some ports. Since RMGs operate on a fixed path they are easier to convert to an automated driverless operation, which facilitates operation of an automated yard 24 hours 7 days a week. As a result, higher levels of terminal storage utilization can be achieved, resulting in an increase in throughput capacity.

Union work rules have thus far prevented the implementation of that level of automation in U.S. ports. Such equipment is expensive to install and operate, but it has the advantage of markedly reducing labor costs. Automated stacking equipment can increase the density, and therefore productivity, of the container yard, and can improve safety in some areas of the terminal since there are fewer interactions between machines and people.

It is noteworthy, however, that increased overall productivity is not a given: automated terminals utilizing ALVs and AGVs have been able to achieve only about 23 moves per hour per shiploading crane, which is well below conventional human-operated equipment that achieves 35 to 45 moves per hour per crane, and automated terminals tend not to be nearly as productive as conventional terminals. Another barrier to the implementation of automated container handling technology in the San Pedro Bay ports is that current work rules and labor contracts would have to be substantially altered.

Ports around the world have been instituting automated gate technology. In fact, the San Pedro Bay container terminals, partially in response to security concerns and partially to speed gate operations and reduce labor costs, have already instituted a high degree of automation that includes OCR technology, centralized clerk functions, computer-based pre-screening of paperwork, and internet technology for scheduling and document transfer. The additional measures such as biometric screening of drivers and increased use of electronics are technologically feasible and are likely to be in place at most terminals within a few years.

6.4 Comparative Emissions

A comparison of emissions from this option with those of a conventional terminal is not feasible because there is no clear scenario that could be analyzed. As the discussion above shows, automation does not, in itself, require or promote emissions reductions, since efficiency gains in some areas may be counterbalanced by productivity losses in others. Furthermore, automation
does not imply lower-emission technology except insofar as existing equipment would be replaced by newer equipment.

6.5 Conclusions

The level of automation that might be desirable in POLB container terminals is a balance of required productivity, desired reduction of emissions, and labor practices. The automation of container terminal infrastructure and operations continues to advance at a pace appropriate for the throughput demand. Those terminals in the world that do deploy more automation do not achieve the same levels of productivity as terminals using more human-based technology. At this time, it is unclear whether increasing the degree of automation would substantially reduce the environmental impacts of terminal operations, since efficiencies in some areas might be offset by reduced productivity, which, in turn, would require more terminals. The major barriers to increasing the level of automation at San Pedro Bay ports are existing labor rules and capital costs.

6.5.1 Advantages and Opportunities

- Less labor is required to process trucks at the gate, transport and stack containers, and load and unload vessels.
- Truck queuing and idling time at gates and inside the terminals are reduced, which reduces emissions.
- Highly automated RMG operated storage yards may provide some increase in terminal throughput density and some improvement in safety.
- Electrically powered equipment can reduce on-terminal emissions.
- In some terminal operations, safety may be improved by an increased level of automation.

6.5.2 Disadvantages and Constraints

- Terminal productivity would probably be reduced based on existing automated terminal examples, meaning more terminal space would be needed to handle a given amount of cargo.
- Installing automated systems would require much greater capital investment than current technology.
- Current labor agreements in San Pedro Bay would not permit the fullest degree of automation that is technologically feasible, and thus the greatest degree of the benefits of automation.
REFERENCES


POLB, 2006a. Strategic Plan. Planning Division, Port of Long Beach.

Appendix A  Calculations in Support of Section 1.4, Comparative Emissions Analysis

A comparative, screening-level analysis was performed of the emissions associated with diverting containerized cargo to ports in the U.S. other than the POLB.

Assumptions and Calculations

This study computed the trip miles and corresponding emissions if 1 million TEUs are diverted to other ports in the US. Representative major, deepwater, container handling ports were selected for this analysis: three West Coast ports, two East Coast ports, and one Gulf Coast port (Table A-1).

<table>
<thead>
<tr>
<th>Origin</th>
<th>Port of Entry</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>West Coast</td>
<td>East/Gulf Coast</td>
</tr>
<tr>
<td>Shanghai, China</td>
<td>Los Angeles, CA</td>
<td>New York, NY</td>
</tr>
<tr>
<td></td>
<td>Oakland, CA</td>
<td>Houston, TX</td>
</tr>
<tr>
<td></td>
<td>Seattle/Tacoma, WA</td>
<td>Charleston, SC</td>
</tr>
<tr>
<td>Table A-1 Selected Origin, Port Of Entry and Destination for This Study</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Two transportation components were considered: ship and rail. All ports were assumed to receive ship trips from Shanghai. All land trips used rail to Chicago. The percent change of emissions was computed for each port of entry route, using Long Beach as a base case. The possible emission differences were assumed to be from the following two additional trip miles sources:

1. Ship miles to other US ports;
2. Rail miles to Chicago.

The miles of different transportation modes for different options are shown in the Table A-2.

<table>
<thead>
<tr>
<th>Port of Entry</th>
<th>Miles per mode</th>
<th>Percent changes compared to Long Beach case</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ship</td>
<td>Rail</td>
</tr>
<tr>
<td>Long Beach, CA</td>
<td>6541</td>
<td>2018</td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>6187</td>
<td>2111</td>
</tr>
<tr>
<td>Seattle/Tacoma, WA</td>
<td>5871</td>
<td>2053</td>
</tr>
<tr>
<td>New York, NY through Panama</td>
<td>12279</td>
<td>818</td>
</tr>
<tr>
<td>Houston, TX through Panama</td>
<td>11746</td>
<td>1183</td>
</tr>
<tr>
<td>Charleston, SC through Panama</td>
<td>11808</td>
<td>950</td>
</tr>
<tr>
<td>New York, NY through Suez</td>
<td>14249</td>
<td>818</td>
</tr>
</tbody>
</table>

Table A-2 Travel Miles of Different Transportation Modes for Each Entry Port
**TEU calculation**

The following assumptions concerning the cargo volumes to be diverted were employed:

1. From Shanghai to an entry port: 1,000,000 TEU/year (all by ships)
2. From the entry port to Chicago: 1,000,000 TEU/year (all by rail)

**TEU-mile and emission calculation**

Multiplying the above TEUs by the corresponding trip distances yielded Million TEU-miles for each mode within each alternative route, which will be the same number as shown in the Table A-2. To get emission results, these TEU-miles were multiplied by the emissions per TEU mile for each mode as described in section 5.2 of chapter 1 and as shown below (Table A-3).

<table>
<thead>
<tr>
<th>Transportation mode</th>
<th>Tons per 1,000,000 TEU-mile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOx</td>
</tr>
<tr>
<td>Container Ship</td>
<td>5.21</td>
</tr>
<tr>
<td>Line Haul Rail</td>
<td>7.28</td>
</tr>
</tbody>
</table>

**Table A-3 Tons of Pollutant Emitted per 1,000,000 TEU-Miles, by Mode**

The speed, TEU capacity, and emissions of a typical container ship, truck and train traveling at their full cruising speed were assumed to develop these factors. The assumptions used are as follows:

- **4,800 TEU Container Vessel**: Fully loaded, 40,600 Kw main engines, 9,000 Kw aux engines. 0.83 and 0.13 load factors respectively. Sailing at 24 knts. Burning Residual Fuel Oil in slow speed main diesel engines (2.7% sulfur) and Marine Diesel Oil (1.5% sulfur) in medium speed auxiliary diesel engines. Emission factors taken from EPA best practices guide on preparing Port emission inventories (ICF 2006).


Table A-3 shows that trains emit the least amount of pollutants per unit of cargo moved one mile except in the case of NOx and CO – for those two, trains and ships are comparable although ships are somewhat less polluting. Ships emit far more SO2 than the rail mode, primarily because of the high sulfur content of their fuels.

**Trip Miles and Emission Results**

According to the Table A-2, compared to Long Beach, all east coast ports would involve more ship miles while west coast alternatives would result in fewer ship miles. All east coast alternatives would involve less rail miles, while west coast alternatives have slightly more rail miles than Long Beach case. Multiplying the TEU-miles in the Table A-2 with the emission factors in the Table A-3 will produce emission results for each option as described in Section 1.4 and as shown in the Table A-4 and the Table A-5.
<table>
<thead>
<tr>
<th>Port of Entry</th>
<th>Transportation Mode</th>
<th>Tons of pollutants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nox</td>
</tr>
<tr>
<td>Los Angeles, CA</td>
<td>Ship</td>
<td>34059</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>14694</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>48753</td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>Ship</td>
<td>32214</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>15371</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>47585</td>
</tr>
<tr>
<td>Seattle/Tacoma, WA</td>
<td>Ship</td>
<td>30572</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>14949</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>45521</td>
</tr>
<tr>
<td>New York, NY through Panama</td>
<td>Ship</td>
<td>63936</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>5954</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>69890</td>
</tr>
<tr>
<td>Houston, TX through Panama</td>
<td>Ship</td>
<td>61162</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>8609</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>69770</td>
</tr>
<tr>
<td>Charleston, SC through Panama</td>
<td>Ship</td>
<td>61485</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>6912</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>68398</td>
</tr>
<tr>
<td>New York, NY through Suez</td>
<td>Ship</td>
<td>74194</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>5954</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>80148</td>
</tr>
</tbody>
</table>

Table A-4 Tons of Pollutant for Different Port of Entry Options
<table>
<thead>
<tr>
<th>Port of Entry</th>
<th>Transportation Mode</th>
<th>Nox</th>
<th>CO</th>
<th>HC</th>
<th>PM10</th>
<th>PM2.5</th>
<th>SO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles, CA</td>
<td>Ship</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Oakland, CA</td>
<td>Ship</td>
<td>-5%</td>
<td>-5%</td>
<td>-5%</td>
<td>-5%</td>
<td>-5%</td>
<td>-5%</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>-2%</td>
<td>-1%</td>
<td>-3%</td>
<td>-4%</td>
<td>-4%</td>
<td>-5%</td>
</tr>
<tr>
<td>Seattle/Tacoma, WA</td>
<td>Ship</td>
<td>-10%</td>
<td>-10%</td>
<td>-10%</td>
<td>-10%</td>
<td>-10%</td>
<td>-10%</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>-7%</td>
<td>-5%</td>
<td>-8%</td>
<td>-9%</td>
<td>-9%</td>
<td>-10%</td>
</tr>
<tr>
<td>New York, NY through Pan</td>
<td>Ship</td>
<td>88%</td>
<td>88%</td>
<td>88%</td>
<td>88%</td>
<td>88%</td>
<td>88%</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>-59%</td>
<td>-59%</td>
<td>-59%</td>
<td>-59%</td>
<td>-59%</td>
<td>-59%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>43%</td>
<td>27%</td>
<td>55%</td>
<td>72%</td>
<td>71%</td>
<td>87%</td>
</tr>
<tr>
<td>Houston, TX through Pan</td>
<td>Ship</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>-41%</td>
<td>-41%</td>
<td>-41%</td>
<td>-41%</td>
<td>-41%</td>
<td>-41%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>43%</td>
<td>30%</td>
<td>53%</td>
<td>67%</td>
<td>65%</td>
<td>79%</td>
</tr>
<tr>
<td>Charleston, SC through P</td>
<td>Ship</td>
<td>81%</td>
<td>81%</td>
<td>81%</td>
<td>81%</td>
<td>81%</td>
<td>81%</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>-53%</td>
<td>-53%</td>
<td>-53%</td>
<td>-53%</td>
<td>-53%</td>
<td>-53%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>40%</td>
<td>26%</td>
<td>51%</td>
<td>66%</td>
<td>65%</td>
<td>80%</td>
</tr>
<tr>
<td>New York, NY through Sue</td>
<td>Ship</td>
<td>118%</td>
<td>118%</td>
<td>118%</td>
<td>118%</td>
<td>118%</td>
<td>118%</td>
</tr>
<tr>
<td></td>
<td>Rail</td>
<td>-59%</td>
<td>-59%</td>
<td>-59%</td>
<td>-59%</td>
<td>-59%</td>
<td>-59%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>64%</td>
<td>45%</td>
<td>78%</td>
<td>99%</td>
<td>97%</td>
<td>117%</td>
</tr>
</tbody>
</table>

Table A-5 Percentage Changes of Different Emission Types for Different Port of Entry Options
Appendix B  Calculations In Support of Option 3

Option 3 considers the construction of an off site backlands facility to reduce container terminal area requirements within the Port.

The following documents the area requirement analysis calculations for Option 3.

Basis of Analysis Assumptions

Operations

1. Percentage of 40-foot containers  72.0%
2. Vessel Peaking Factor  90.0%
3. C. Y. Shape Factor  90.0%
4. Seasonal Peaking Factor  85.0%
5. Grounded (RTG & STRAD) Sort Factor  85.0%
6. Empty (TP&SP) Sort Factor  85.0%

Storage Density:
- RTG without top pick using 6w x 1 over 4 resulting in 371 TEU/acre;
- Side Pick for empty containers using 10w x 5h resulting in 600 TEU/acre;

Throughput

1,000,000 TEU/year throughputs / (1+72%) TEU/container = 581,395 lifts/year
Non-storage area factor: 30% (the percentage of the area used for non-storage purpose such as maintenance and administration, gate, security system, power system, and so on.)

Berth Facility

1. Throughput distribution (vessel lifts): Import 52.2%; Export 47.8%;
2. Storage Modes Distribution: Import uses RTG 100%; Export uses RTG 100%;
3. Average Dwell Time: Import 1 day; Export 1 day;

Annual Throughput by Mode (lifts)

1. RTG for import: 581,395 * 52.2% *100% = 303,488 lifts/year
2. RTG for export: 581,395 * 47.8% *100% = 277,907 lifts/year
**Storage Area requirement calculations**

Using formula: Static Capacity Required (TEUs) = Annual Lifts * Storage Conversion Factor * Average Dwell Time / (365 days/year * Vessel Peaking Factor * Seasonal Peaking Factor * Ground Sort Factor), results are:

- RTG for import: 2,199 TEUs;
- RTG for export: 2,014 TEUs;

### Net CY Area Allocation (acres)

Using formula: Net CY Area (acres) = Static Capacity Required (TEU) / (Storage Density (TEU/Acre) * C.Y. Shape Factor)

1. RTG for import: 6.59 acres;
2. RTG for export: 6.03 acres;
3. Total without non-storage area: 12.62 acres;
4. Total with non-storage area: 12.62 * (1+0.3) = 16.40 acres

Berth Area: 1200 feet berth length * 200 feet berth width / (43560 acre/foot²) = 5.51 acres

Total area for berth facility is 16.40 + 5.51 = **21.91 acres**

**Off-Site Backland Facility**

The calculation of Net CY for the backland would be similar to that for the berth facilities, except the following assumptions:

1. Throughput distribution (vessel lifts): Import 52.2%; Export 17.0%; Empty 30.8%;
2. Storage Modes Distribution: Import uses RTG 100%; Export uses RTG 100%; Empty uses Side Pick 100%
3. Average Dwell Time: Import 5 days; Export 9 days; Empty 14 days;
4. No berth area is required;

Total Net CY without non-storage area: 32.93 acres (RTG for import) + 19.31 acres (RTG for exports) + 33.64 acres (Side Pick for empties) = 85.89 acres;

Total area with non-storage area: 85.89 * (1+0.3) = 111.65 acres;

Total area for backland is **111.65 acres**

**Results**

Areas required for Off-Site Backland Alternative:

<table>
<thead>
<tr>
<th>Area (acres)</th>
<th>Berth</th>
<th>Backland</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21.91</td>
<td>111.65</td>
<td>133.56</td>
</tr>
</tbody>
</table>

**Evaluation of Options**

B-2