Cargo on the Move Through California:

Evaluating Container Fee Impacts on Port Choice

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Executive Summary

In many coastal areas, marine freight traffic contributes significantly to overall air pollution levels. This is particularly true in the vicinity of major marine ports in California, where active freight movement, including ocean-going vessels shipping consumer goods in large freight containers, has led to increases in ambient levels of particulate matter (PM), nitrogen oxides (NO_x), and sulfur oxides (SO_x).[1-2] Additionally, elevated levels of these pollutants have been linked to significant local and regional health impacts such as asthma, heart disease and premature death. In the past few years, these health impacts have received significant attention from affected communities, policy makers and the industries involved in transporting consumer goods throughout California.[3-4]

To address these emissions and public health concerns, some regions of the country are considering requiring environmental control technologies and/or clean fuels for ships. Other approaches to fund investments that will address these concerns include the application of port user fees (PUF) per shipping container on ships, where such fees may be used to enhance cargo security, to increase freight mobility by reducing rail congestion, and to mitigate air pollution and environmental damages caused by ship emissions and other freight modes.[5]

There is a concern that ports applying port user fees per shipping container will be put at some economic disadvantage compared to ports without such fees. The fear is that these fees will drive ship traffic away from the PUF ports and towards the non-PUF ports. The key question is: *Given the economic structure of marine shipping on the West Coast, are such diversions likely to occur if fees were assessed at California ports?* This study addresses that question, and concludes that applying PUFs at California ports will not cause significant ship diversion.

[1] McLerrin, D. *Marine Emissions and Central Puget Sound*, presented at the West Coast Marine Ports Conferece, 2004.
[2] See background guidance and regulatory initiatives at U.S. Environmental Protection Agency (EPA). *Diesel Boats and Ships,* http://www.epa.gov/otaq/marine.htm, July 16, 2006.
[3] See California Air Resources Board, *Goods Movement and Ports*, http://www.arb.ca.gov/gmp/gmp.htm; Southern California Association of Governments, *Goods Movement*, http://www.scag.ca.gov/goodsmove/; and the Port of Los Angeles, http://www.portoflosangeles.org/development_goods.htm .
[4] News Sources: *A Trade Boom's Unintended Costs; Neighborhoods such as West Long Beach seek a balance between a thriving port and health concerns*, Los Angeles Times, April 23, 2006; Janet Wilson, Times Staff Writer; *California board approves port smog plan*, Journal of Commerce Online, April 21, 2006 Friday; *Plan to reduce health risks of cargo industry wins air board OK*, Copley News Service, April 20, 2006 Thursday, Gordon Smith.
[5] California State Senate Bill No. 760, Senator Allan Lowenthal, *Ports: congestion relief: security enhancement: environmental mitigation: regulatory fee*, amended 27 May 2005, http://info.sen.ca.gov/.

The following issues were addressed in the analysis undertaken to answer the central question of what effect PUFs might have on diversion at California ports:

(1) Based on the economics of marine freight shipping in California, what is the likely percentage of total waterside freight costs (e.g., fuel costs, port fees, non-fuel related operating costs, and capital costs) that can be attributed to user fees currently being discussed?
(2) Considering user fee effects on voyage costs, and based on observed carrier port calls, would assessing fees on shipping containers in California result in voyage diversion to other ports?

To answer these questions, we evaluated empirical data for over 5,000 port calls to the Ports of Los Angeles and Long Beach (LA/LB) and Oakland. We then applied a voyage cost analysis model to determine the likelihood of ship diversion to other major West Coast ports such as the Ports of Seattle and Tacoma (SEA/TAC).[6]

We conducted our analysis for different classes of voyages. *Our results indicate that current observed behavior shows a strong preference for California ports.* In particular, demand for the Ports of LA/LB is insensitive to an increase in voyage costs due to a PUF, and a California PUF will provide little impetus for diversion. For example, a $30 PUF per twenty-foot equivalent unit (TEU) in LA/LB increases voyage costs to LA/LB by only *1.5-2.5%* on average. These minimal increases (particularly for voyages coming from Asian ports), would induce diversions of *less than 1.5%* for reasons discussed later in the report. Furthermore, where cargo voyages to California cost less than to other U.S. West Coast ports, a PUF would need to be many times greater than $30 before any diversion is likely to occur. Placing these diversion estimates in the context of growth forecasts at the Ports of LA/LB make any diversion impacts from a $30 PUF negligible.

For Oakland, where the majority of ship calls come from LA/LB (about 75%), we also expect to see little diversion. For example, our calculations indicate that a PUF would need to reach a threshold of $43/TEU before any of these voyages from LA/LB consider diversion based on voyage costs alone. For voyages from other ports, a PUF of $30/TEU would increase the Oakland voyage cost by approximately *1.5-2.7%*. We determined that there is a possibility that a percentage of the small fraction of foreign direct shipping into the Port of Oakland could experience some diversion to other ports, such as to SEA/TAC, leading to an overall diversion of ships between 2-4.7%. Therefore, we believe that given projected growth trends, the number of voyage diversions from the Port of Oakland attributable to a $30/TEU PUF will be very low.

For containerized cargo coming to California ports, we believe the above conclusions to be conservative. That is, diversion will likely be less than estimated in this analysis. We identify three primary reasons for this expectation.

[6] This approach is well established in econometric literature for both recreational and commercial transportation choices with regard to a set of destination choices. See for example Brown, G., and R. Mendelsohn, *The Hedonic Travel Cost Method*, Review of Economics and Statistics, 66(3), 1984; Pan, Q. *Freight Data Assembling and Modeling: Methodologies and Practice*, Transportation Planning and Technology, 29(1), 2006; Mangan, J. et al., *Modelling Port/Ferry Choice in RoRo Freight Transportation*, International Journal of Transport Management, 1, 2002; and Stopford, M., Maritime Economics, Routledge, Taylor and Francis Group, 1997.

- First, our analysis of port choice demand considered only the last international leg of what is more often a multi-port circuit according to scheduled container liner service. Therefore, voyage diversions likely are over estimated from this model, and may represent an upper bound. For cases where multi-leg, multi-port voyages include LA/LB and/or Oakland, a PUF of $30 per TEU adds only about 1.0-2.2% to these costs, which would provide an even smaller motivation for diversion.
- Second, similar to another study, we also believe that investments in rail and port infrastructure at the Ports of LA/LB and Oakland will offset the small percent of potential diversions, increasing demand to move cargo through these ports even with a $30 PUF instituted.[7]
- Third, we recognize that containerized cargo growth forecasts are strong for all container ports, especially for West Coast container ports and particularly for California container ports where containerized cargo growth ranges from 7-9% per year.[8] These cargo growth expectations exceed our conservative estimates of voyage diversions, suggesting at most a modest market-share adjustment through future cargo growth rather than any real declines in cargo volumes.

In sum, our analysis shows that a $30/TEU PUF implemented at the Ports of LA/LB will have very little effect on ship diversion from those ports. Voyages to the Ports of LA/LB demonstrate exceptionally strong demand to use California ports for containerized cargo logistics, primarily due to the ancillary benefits of these ports (e.g., landside logistics, access to markets, cargo handling capabilities, etc.). For example, in 2003 some 36% of all U.S. waterborne containerized cargoes shipped went through the ports of LA/LB alone; including Oakland, nearly half of all containerized cargoes were shipped through California ports.

We believe that the Port of Oakland may face a slightly larger percentage of ship diversion (compared to LA/LB) with a $30/TEU PUF because of the proximity and relatively low cost differential between Oakland and SEA/TAC. However, considering that forecast cargo growth rates far exceed the potential voyage diversions estimated in this analysis, the few potential diversions estimated in this study could be rendered unobservable in terms of cargo throughput in California ports.

[7] Leachman, R.C., T. Prince, T.R. Brown, G.R. Fetty (2005) *Final Report: Port and Modal Elasticity Study,* Southern California Association of Governments, Piedmont, CA.

[8] See ARB Goods Movement Analyses, including Alexis, A. et al., Proposed Emission Reduction Plan for Ports and Goods Movement in California: Technical Supplement on Emission Inventory, California Air Resources Board, 2006.

1. Purpose

In many coastal areas, marine freight traffic can contribute significantly to overall emissions inventories. This is particularly true for Southern California, where active marine freight movement has led to significant increases in ambient levels of particulate matter (PM), nitrogen oxides (NO_x), and sulfur oxides (SO_x).[9-10]

To address these emissions and resulting public health impacts, some regions of the country are considering mandating environmental control technologies and/or clean fuels for ships. Other approaches to fund investments that will address these impacts include the application of port user fees (PUF) on ships, where such fees can be used to mitigate environmental damage caused by ship emissions.

There is a concern that ports that apply a PUF per shipping container will be put at some economic disadvantage compared to ports without such fees. The fear is that these fees will drive ship traffic away from the PUF ports and towards the non-PUF ports. The key question is: *Given the economic structure of marine shipping on the West Coast, are such diversions likely to occur if fees were assessed in California ports?* Based on this central question, this project addresses the following:

(1) Based on the economics of marine freight shipping in California, what is the likely percentage of total waterside freight costs that can be attributed to user fees currently being discussed?
(2) Considering user fee effects on voyage costs, and based on observed carrier service behavior, how significant may voyage diversions be to non-fee ports if fees were assessed at California ports?

This work evaluates how port choice may be affected by PUF implementation. The objective, analytical results of the project help inform further development of fee policy options for California and for other ports.

2. Background

Multi-modal cargo logistics include a set of decisions made by distinct groups of individuals. Some studies consider the cargo shipper perspectives to be primary;[11] indeed, shipper perspectives are important since the logistics supply chain motivates multimodal freight movement. Cargo shippers' decisions are fundamentally focused on getting cargo from one location (origin) to another (destination). Factors in these decisions include market characteristics, factory and distribution center locations, costs

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[9] See California Air Resources Board, *Goods Movement and Ports*, http://www.arb.ca.gov/gmp/gmp.htm; Southern California Association of Governments, *Goods Movement*, http://www.scag.ca.gov/goodsmove/; and the Port of Los Angeles, http://www.portoflosangeles.org/development_goods.htm .

[10] News Sources: *A Trade Boom's Unintended Costs; Neighborhoods such as West Long Beach seek a balance between a thriving port and health concerns*, Los Angeles Times, April 23, 2006 Sunday; Janet Wilson, Times Staff Writer; *California board approves port smog plan*, Journal of Commerce Online, April 21, 2006 Friday; *Plan to reduce health risks of cargo industry wins air board OK*, Copley News Service, April 20, 2006 Thursday, Gordon Smith.

[11] Leachman, R.C., T. Prince, T.R. Brown, G.R. Fetty (2005) *Final Report: Port and Modal Elasticity Study,* Southern California Association of Governments, Piedmont, CA.

of freight transportation, costs of inventory, risk management, etc. Shipper choices can involve moving resources (both unprocessed and processed) to locations where labor, factory, or other activities may transform these resources; for example, energy and iron resources are transformed to produce steel, or bulk fabric is transformed to produce apparel. Shippers also seek to transport finished products from factory to market; for example, containerized consumer goods are imported to U.S. markets for retail purchase.

However, other perspectives may determine with greater impact which ports are chosen for waterborne imports. For example, research has shown that geography and demographics determine port choice more than factors like tariffs and fees that are within port control.[12] In other words, transportation carriers (truck, rail, water, and even air freight) may consider market and infrastructure conditions to be exogenous to their route choice connecting origin and destination. Other decision makers influencing port choice include freight forwarders and consolidators, intermediate facilitators among different modal segments; these firms may represent a blending of shipper and carrier perspectives. Lastly, ports and terminals influence port choice by investing to increase productivity within their boundaries, advocating infrastructure improvements to better transport freight beyond their gates, and by providing other services under the tariff schedule that add value to the carrier.

In the broad economic context of commodity transactions, freight transportation is a derived demand arising when the supply of goods is some distance from the demand for these goods.[13] In the current containerized freight environment, shippers do not typically choose the explicit routing of cargoes, relying on published schedules for containerized liner service connecting a network of ports to the landside freight transportation system.

The World Shipping Council offers container cargo rankings of U.S. Ports consistent with these economic principles.[14] The Council notes that in 2003, 83% of total containerized waterborne cargoes moved through the top 10 ten of some 300 U.S. ports and 61% of these cargoes passed through the top 5 ports. Los Angeles and Long Beach together accounted for more than 36% of all U.S. containerized imports and exports in 2003; together with Oakland, California ports handle nearly half of all U.S. waterborne containerized cargoes. Moreover, these ports report recent and forecast growth rates at or above 6% annually.

This suggests that containership voyages are determined by firms who seek to provide reliable and frequent service at least cost among a set of ports in response to shippers' market-driven needs for cargo and landside transportation infrastructure constraints. We rely on this framework to evaluate port choice from observed behavior, using a travel cost framework.

[12] Malchow, M.B. (2001) *An Analysis of Port Selection,* Paper UCB-ITS-DS-2001-3, University of California, Berkeley, CA.
[13] Evans, J.J., P.B. Marlow (1990) Quantitative Methods in Maritime Economics, Fairplay Publications, Ltd., Coulsdon, Surrey, U.K.
[14] See the World Shipping Council's industry information link, Liner Shipping: Facts and Figures, at http://worldshipping.org

3. Methodology

In freight economic analyses, transportation providers for each mode are expected to minimize travel costs.[15] While travel cost is not the only transport choice variable that is optimized, most studies consider cost to be fundamental if not primary.[16] Originally applied to recreation travel because of its power in revealing destination choice through observed travel behavior rather than stated preference, this approach is well established in econometric literature for both recreational and commercial transportation choices with regard to a set of destination choices.[17]

In this work, we assume that the costs of traveling between an origin port and U.S. West Coast ports represent a lower-bound proxy for the voyage freight rate (price). We rely on actual observations of the port-pairs between which individual ships traveled, and estimate their voyage costs using standard maritime economic assumptions about voyage cost elements[18] and representative or current information for these cost elements (e.g., labor, fuel prices, fuel usage). Using the variation in distances among ships and among the port-pairs over a one-year period, we evaluate how the number of trips to California ports (quantities) change as a function of the travel costs (prices or freight rates). If geographic and market factors are more important than voyage costs, then we expect to observe preference for longer voyages (i.e., to West Coast ports in California) despite the fact that voyages are less costly to other West Coast ports (i.e., Seattle and Tacoma). We are suggesting that this preference for more costly voyages into some ports implies an inelastic port choice behavior. Ship operators are willing to accept higher voyage costs into these ports because the cargo shipper is willing to pay at least this much more for the water leg to satisfy market requirements. For example, a 1% increase in costs on the water voyage (e.g., due to a PUF) would result in a reduction of voyages chosen for this port by less 1%.[19]

Given that a profit maximizing company aims to minimize costs for a given service, we developed a cost analysis of voyages for individual ships into the Port of Los Angeles, the Port of Long Beach, and the Port of Oakland. We note that voyage economics into the Port of LA are very similar to the Port of LB and so we group these ports together as the Port of LA/LB.

There are three U.S. ports outside of California that handle containerized traffic on the West Coast: Seattle, Tacoma, and Portland. We explore potential diversion to the Ports of Seattle and Tacoma (SEA/TAC). SEA/TAC was selected due to a combination of factors: (1) SEA/TAC is the U.S. port with the lowest voyage cost from Asian markets; (2) SEA/TAC is a major port complex with potential to compete directly with the LA/LB port complex; and, (3) SEA/TAC accounts for the majority of non-California U.S. West Coast voyages by containerships.

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[15] Pan, Q. *Freight Data Assembling and Modeling: Methodologies and Practice*, Transportation Planning and Technology, 29(1), 2006.
[16] Mangan, J. et al., *Modelling Port/Ferry Choice in RoRo Freight Transportation*, International Journal of Transport Management, 1, 2002.
[17] See for example Brown, G., and R. Mendelsohn, *The Hedonic Travel Cost Method*, Review of Economics and Statistics, 66(3), 1984.
[18] Stopford, M., Maritime Economics, Routledge, Taylor and Francis Group, 1997.
[19] Elasticity of demand is the unit-less ratio of the percent change in quantity demanded for a given percent change in the price; it is generally negative (unless zero) and can be categorized as elastic ($\eta_{Q,P} > -1$), uni-elastic ($\eta_{Q,P} = -1$), inelastic ($\eta_{Q,P} < -1$).

Our cost model includes the following shipping costs: fuel costs for main engines; fuel costs for auxiliary engines; port fees; canal dues (if applicable); non-fuel related operating costs, including personnel cost estimates; and capital costs. We recognize that for cargo diversions, logistics cost minimization would include waterside mode, landside mode, and modal change costs. We do not directly estimate landside mode or modal change costs other than port costs (generally depicted). That is, we consider the waterside cost function to estimate elasticity in voyage port-choice behavior. This may indirectly reflect cargo flow behavior because cargo movement to a given port is a function of both ship size and the number of voyages.

For our analysis, we modeled costs for container ships of three different sizes (small, medium, large). The sizes are estimated from actual ship calls to California (CA) ports and represent the 25^{th}, 50^{th}, and 75^{th} percentiles from 2002 data (the most recent data set for which we have evaluated vessel characteristics). The descriptive information for each case (i.e. ship size and voyage distance) is shown in Tables 1 through 4.

We approached this analysis using a travel cost model framework. This framework defines a null hypothesis that ships bringing cargo to the U.S. West Coast ports would minimize voyage cost to provide seaborne trade services. If the U.S. market and landside logistics network were uniform and homogeneous, ships could minimize cost by delivering cargo to the nearest port. We then evaluate 5225 foreign commerce containership voyages to U.S. West Coast ports for 2002 to observe whether voyages conform or divert from cost-minimizing behavior. We identified two sets of vessels and applied the cost model to these:

(1) <u>SET I. Single-leg Direct Shipping</u>. This involves cases where ship voyages go directly to CA ports from overseas prior ports. In some cases the costs for shipping to CA ports are cheaper and diverting would increase voyage cost. This includes ships from prior ports in the South Pacific, South America, and Mexico. As many as 650 ship calls to the U.S. West Coast, or about 12.5%, fall in this category based on 2002 voyage information that identified the nations where the voyage leg to a CA port originated. (The number may be smaller depending on whether ships were following a multi-port voyage schedule.) This set also includes cases where ship voyages are more costly to CA ports, but nevertheless we observe direct voyages to CA ports (and to alternate diversion ports). For example, these cases include Pacific Rim ports where departing ships are selecting to call on the Port of LA/LB, but are also selecting to call on Northwest ports in separate voyages. The percentage of ships that fall into this category is unknown because multi-leg liner schedules are more common than A-to-B port pair schedules; however an upper bound estimate is approximately 4000 voyages.

(2) <u>SET II. Multi-leg Multi-port Shipping</u>. This set includes cases where ship voyages are more costly to CA ports and the voyage already includes an alternate West Coast port (e.g., Seattle or Tacoma). This set includes a six-leg multi-port route from Hong Kong to Yantian to Xiamen to Kaohsiung to Los Angeles to Tacoma and back to Hong Kong, which represents an example of one posted liner

schedule for weekly container service involving a string of six container ships calling on CA ports. This set also includes other examples of voyages coming from Pacific Rim ports that call on CA ports and continue on to Seattle or Tacoma (or vice versa). At least 525 (10%) of observed foreign voyages that come into the West Coast fall into this category, although we believe that this number is greater because multi-leg liner schedules are common practice.

We note the following caveats to our approach. First, ours is a short run analysis with only one year of observations. Second, we only consider one primary diversion region, from the point of view of voyage cost only. This ignores destination logistics that may, for example, justify diversions involving much longer voyages directly to East Coast ports instead of shorter diversions to SEA/TAC. Third, if the landside conditions change, there is a possibility in the long run that landside cargo logistics advantages, inventory practices, etc., will affect port choice. However, we should note that landside improvements may *decrease* the likelihood of and percent of diversion that we estimate for CA ports in this report. For example, congestion mitigation efforts planned under SB 760[20] are likely to improve CA landside logistics, thereby increasing the preference for CA ports and reducing the diversion impacts estimated here (a point also noted in other reports).[21] In fact, given the planned improvements to infrastructure and air quality mitigation (some funded by the port user fees), we believe the diversion estimates here represent an *upper bound*.

4. Results

This section presents a summary of our results. All tables referenced in this section are included in Appendix I of this report.

4.1 Overview of Results for Set I

4.1.1 Cases Where CA Ports are Currently Less Costly

For SET I, in cases where shipping to CA ports is cheaper than alternative ports, we found that port user fees (PUF) would likely contribute directly to diversions *only if the PUF were greater than the cost differential between CA ports and the diversion port.* Tables 5 through 16 show the results of our analysis for these prior ports, which include Mexico, Panama, Columbia, French Polynesia, New Zealand and Honolulu. Based on our analysis, diversion would be unlikely for ships from these ports until the voyage costs to CA ports exceed those to SEA/TAC. In particular, our results show that:

- Diversion of ships from LA/LB to SEA/TAC is unlikely for ships from Mexico, Panama and Columbia unless the PUF is greater than $220. This is demonstrated in Tables 5, 7 and 9, where $220 represents the cost differential

[20] California State Senate Bill No. 760, Senator Allan Lowenthal, *Ports: congestion relief: security enhancement: environmental mitigation: regulatory fee*, amended 27 May 2005, http://info.sen.ca.gov/cgi-bin/postquery?bill_number=sb_760&sess=CUR&house=B&site=sen.
[21] Leachman, R.C., T. Prince, T.R. Brown, G.R. Fetty (2005) *Final Report: Port and Modal Elasticity Study,* Southern California Association of Governments, Piedmont, CA.

for voyages to LA/LB compared to SEA/TAC for 75th percentile ships. Tables 6, 8, and 10, which compare Oakland and SEA/TAC voyages, show that diversion from Oakland would only occur when a PUF reaches approximately $150.

- Diversion of ships from LA/LB to SEA/TAC and Oakland to SEA/TAC is unlikely for ships from French Polynesia unless the PUF exceeds $150 and $125, respectively (see Tables 11 and 12).
- Diversion of ships from LA/LB to SEA/TAC and Oakland to SEA/TAC is unlikely for ships from New Zealand unless the PUF exceeds $105 and $100, respectively (see Tables 13 and 14).
- Diversion of ships from LA/LB to SEA/TAC and Oakland to SEA/TAC is unlikely for ships from Honolulu unless the PUF exceeds $38 and $63, respectively (see Tables 15 and 16).

In summary, *for all of the prior ports where shipping to CA is less expensive than shipping to SEA/TAC, we found that diversion is unlikely to result from a $10-$30 PUF. In fact, for most of these cases, a PUF reaching $100-$200 would be required before any ship would consider diversion on the basis of voyage cost savings.*

4.1.2 Cases Where CA Ports are Currently More Costly

In cases of SET I where shipping to CA ports is currently more expensive, we found that an added PUF could possibly reduce the fraction of all calls that arrive in CA ports and increase the fraction of calls to non-CA ports. Voyages where costs to SEA/TAC are less expensive than costs to CA primarily originate in the Pacific Rim and Canada. In this section, we separate our findings to consider LA/LB and Oakland ports individually, as the voyage economics and port preferences for these CA ports are highly dissimilar.

Ports of Los Angeles/Long Beach

We show in Tables 17 through 22 results for direct voyages to LA/LB from the prior ports of Hong Kong, Taiwan, Tokyo, South Korea, Shanghai, and Vancouver. Tables 17 through 21 demonstrate that typically a 6-9% cost savings for shipping directly to SEA/TAC currently exists. However, this existing voyage cost differential is not considerable enough to divert most ships to SEA/TAC. In fact, LA/LB ports are *strongly preferred* over SEA/TAC ports, as shown in Table 42 (in one case, *20 times more preferred*). As shown in Tables 22 and 42, for Vancouver a 40% cost increase to LA/LB exists compared to SEA/TAC, yet many Vancouver ships choose to call on LA/LB ports rather than to call on SEA/TAC. This is evidence that the LA/LB ports provide economic advantages in the form of superior market access, landside infrastructure, cargo handling logistics, etc.

Tables 17 through 21 also show that a PUF of $30 would increase the LA/LB-SEA/TAC cost differential by about *1.5-2.5%* for the majority of ports. As shown in Table 22, a larger cost increase is expected for Vancouver, where a $30 PUF would increase the cost differential by about *4.5-6%*. Adding a PUF to voyage costs for LA/LB-bound ships will further increase the existing cost differential and may outweigh the current indirect economic advantages, resulting in diversion. *However, in most cases the*

magnitude of a $30 PUF cost differential is minimal (~2%) compared to existing LA/LB-SEA/TAC differentials (6%-40%).

Port of Oakland

We show in Tables 23 through 28 results for direct voyages to Oakland from the prior ports of Hong Kong, Taiwan, Tokyo, South Korea, Shanghai, and Vancouver. Tables 23 through 27 demonstrate that there is typically a *4-5%* cost savings for shipping directly to SEA/TAC instead of calling on Oakland. As would be expected from our travel cost framework, the comparatively higher-cost voyage to Oakland is less preferred to SEA/TAC for most prior ports (see percentage calls in Table 43). The notable exceptions are voyages from Shanghai, which prefer Oakland over SEA/TAC five-to-one. As shown in Table 28 and 43, for Vancouver a larger cost differential to Oakland exists—30%; as would be expected, the less expensive SEA/TAC ports are preferred.

Tables 23 through 27 also show that a PUF of $30 would increase the Oakland-SEA/TAC cost differential by about *1.5-2.7%* for the majority of ports. As shown in Table 28, a larger cost increase is expected for Vancouver; a $30 PUF would increase the cost differential by about *5.5 to 7.5%*. Considering that SEA/TAC is so strongly preferred with the current cost differential between SEA/TAC and Oakland, we find that increasing the cost differential may result in diversion. *However, in most cases for Oakland voyages, the magnitude of a $30 PUF cost differential is minimal (~2%), which is less than half the existing cost differential between Oakland and SEA/TAC*.

Importantly, we note that the port calculations for SET I rely on data that describe two-port voyages, potentially ignoring multi-port circuits as modeled in our multi-leg SET II below. If these ships were engaged in multi-port routing, then PUF cost impacts would be lower. However, by modeling direct port-pair costs, we conservatively describe voyages that may be particularly sensitive to PUFs.

4.2 Overview of Results for Set II

For SET II (multi-leg journeys), we found that removing the dogleg to the Ports of LA/LB decreases voyage cost considerably. Currently, a *17-26%* cost differential exists for ships choosing to call on CA ports and continuing onto SEA/TAC. Yet, calling on LA/LB ports is still strongly preferred (Table 42). In this section, the SET II findings are discussed for LA/LB and Oakland ports individually, as the voyage economics and port preferences for these CA ports are highly dissimilar.

4.2.1 Ports of LA/LB Multi-leg Direct Cases

China Multi-port Case

As shown in Table 29, an added voyage cost of around 19% exists for port calls to LA/LB for the six-leg China case we explored. According to our analysis, these observed voyages must be justified based on other system logistic benefits (e.g., market access, port productivity, regional logistics for rail and road, etc.). *As shown in Table 29, a PUF of $10 to $30 adds only about 0.3% to 1.4% to these costs, a fraction of the existing cost differential.*

Multi-leg Direct Cases

Tables 30 through 35 show the results of our analysis for multi-leg direct voyages for the prior ports of Hong Kong, Taiwan, Tokyo, South Korea, Shanghai, and Vancouver. Tables 30 through 34 depict a *20-26%* cost savings for shipping directly to SEA/TAC compared to shipping through the LA/LB dogleg for most of the cases we explored, yet shipping through LA/LB is still dominantly preferred. As shown in Table 35, the added voyage cost percentage for ships originating in Vancouver is more than twice that, at nearly 60%.

Tables 30 through 35 also show that a PUF of $30 would increase the LA/LB voyage cost by only 1.3-2.1% for most cases. Vancouver-originating ships, however, would experience a 3-4.4% increase in voyage costs. This demonstrates a smaller cost effect of increased fees on multi-leg voyages than on direct voyages between A-to-B port pairs.

4.2.2 Port of Oakland Multi-leg Direct Cases

Tables 36 through 41 show the results of our analysis for multi-leg direct voyages through Oakland for the prior ports of Hong Kong, Taiwan, Tokyo, South Korea, Shanghai, and Vancouver. Tables 36 through 40 demonstrate a *17-22%* cost savings for shipping directly to SEA/TAC compared to shipping through the Oakland dogleg for most of the cases we explored. As shown in Table 41, the added voyage cost percentage for ships originating in Vancouver is more than twice that, at approximately 54%.

Tables 36 through 40 also show that a PUF of $30 would increase the Oakland voyage cost by about 1.5-2.2% for most cases. Vancouver-originating ships, however, would experience a 3.5-5% increase in voyage costs, as shown in Table 41.

We recognize that the port calculations for some voyages in SET II rely on data that convert simple dog-leg voyages (three-port circuits) into direct port-to-port voyages (two-port voyages); this conservatively amplifies cost penalties for longer voyages to Oakland or LA/LB versus SEA/TAC voyages compared to more common multi-port circuits (e.g., the six-leg voyage circuit evaluated above). If these ships were engaged in multi-port routing, then the cost differential would be lower. However, by modeling multi-leg voyages as though they were direct, we may describe voyages that would be most sensitive to PUFs, as these ships already have alternative ports in their voyage routes. For these voyages, PUF cost impact is approximately 1-5%, a fraction of the current cost differential between LA/LB- or Oakland-SEA/TAC and direct-SEA/TAC voyages.

Using the findings for cost differentials resulting from PUFs, we cannot directly conclude whether a diversion would occur or not. However, by examining the relationship between voyage cost differential and port preferences for our analyzed prior ports, we can derive port choice elasticity and estimate the potential diversion resulting from a $30 PUF. We conduct this analysis in the next section.

4.3 Estimating Diversion

In this section, we calculate expected diversions for the Ports of LA/LB and the Port of Oakland. We do this analysis for an assumed PUF of $30. This analysis was done by fitting a non-linear regression line (shown in Figure 1 and Figure 2) to empirical data describing the percentage of voyages ($TP_{i,w}$) to certain destination ports (w) from

different origin ports (i) on the Y-axis, and the percentage difference in these voyage costs ($CP_{i,w}$) on the X-axis. The regression equation has the form:

$$TP_{i,w} = \frac{1}{1+e^{-(\alpha+\beta\cdot CP_{i,w})}}$$

where $TP_{i,w}$ equals the percentage of voyages that go from origin port i to destination port(s) w or combination thereof, and is given by:

$$TP_{i,w} = \frac{n_{i,w}}{\sum_{w} n_{i,w}}$$

and, where $CP_{i,w}$ equals the percentage cost difference of voyages to destination ports in CA with respect to voyage costs to SEA/TAC and is given by:

$$CP_{i,w} = \frac{(C_{i,w} - C_{i,TS})}{C_{i,w}}$$

Here, $C_{i,w}$ and $C_{i,TS}$ are the voyage costs to CA ports (w) and SEA/TAC (TS).

Working with these curves we can determine the percentage change in ship calls ($TP_{i,w}$) corresponding to a percentage difference in voyage costs between destination port w and an alternative port ($CP_{i,w}$). First, we calculate an expected $TP_{i,w}$ under the existing $CP_{i,w}$ using the equation from our non-linear regression. Next, we determine a new $CP'_{i,w}$ based on the new port cost due to a PUF. We then calculate a new $TP'_{i,w}$ for this new $CP'_{i,w}$. We then let $\Delta TP_{i,w}$ represent the difference in $TP_{i,w}$ between the old and new expected trip percentages ($TP'_{i,w} - TP_{i,w}$), and we apply this $\Delta TP_{i,w}$ to the *actual* $TP_{i,w}$ value from our empirical data to get the expected new $TP'_{i,w}$ value due to the PUF. In essence, we are determining the slope relationship for our non-linear curve at each point, and then applying this relationship to determine the $\Delta TP_{i,w}$ due to a $\Delta CP_{i,w}$. With our $\Delta TP_{i,w}$ (and recognizing that $\Delta TP_{i,w} = TP'_{i,w} - TP_{i,w}$) we can calculate the new percentage of voyages to destination port w ($TP'_{i,w}$) to determine the total diversion due to the port user fee for each i and w.

The results of this analysis are shown in Figures 1 and 2, and Tables 44-45. As one can see from these figures and tables, the regression curve for Oakland ports (Figure 2) has an elastic range, while the regression curve for LA/LB ports (Figure 1) does not.[22] This suggests that a similar increase in voyage costs for Oakland will likely result in a greater diversion of at least those Oakland-bound ships that are not part of a multi-port circuit including LA/LB.

[22] Note that the larger data point (green triangle) for California ports was not included in the foreign port voyage data from which the curves were estimated. This is because voyages carrying foreign commerce among California ports are by definition multi-port voyages. However, we plot California ports onto these graphs to illustrate the very flat local curve slopes that may apply in estimating diversions from these domestic port-pairs.

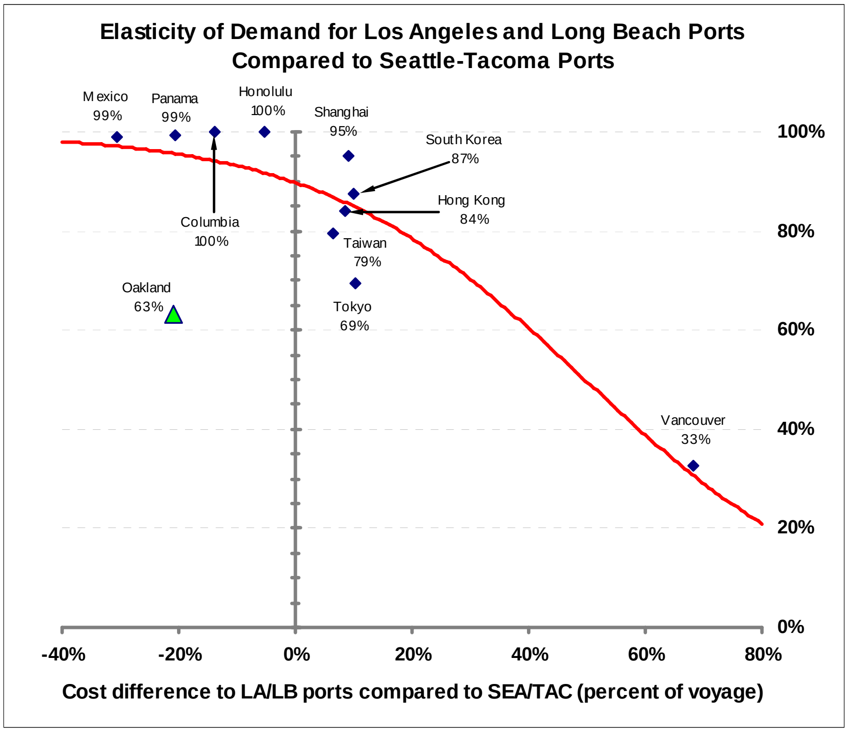

Figure 1. Elasticity of Demand for Los Angeles and Long Beach Ports

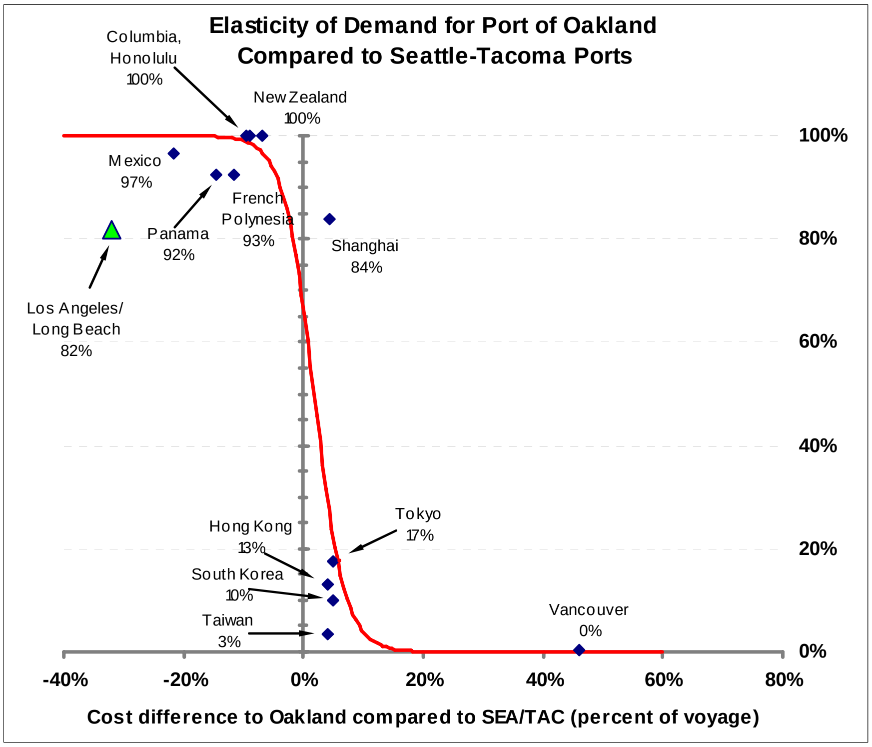

Figure 2. Elasticity of Demand for Oakland Compared to Seattle-Tacoma Ports

As shown in Table 44, a $30 PUF will increase the SEA/TAC-diversion cost differential for LA/LB bound ships by *1.7–9.6%*.[23] The increased cost differential will result in approximately 62 of the 2,129 LA/LB bound ship trips—or *2.9%*—being diverted. However, one could argue that Vancouver and Mexico should be eliminated from this analysis, given their proximity to and highly inelastic demand for SEA/TAC and LA/LB ports, respectively. If Vancouver and Mexico are excluded from the analysis, only 29 of 1,997 LA/LB bound foreign ship trips—or *1.5%*—would likely divert.

If Oakland is considered in the analysis (approximately 7% of voyages to LA/LB originate in Oakland), the expected percentage diversion remains the same, at 2.9% for all voyages and 1.5% excluding Vancouver and Mexico. As shown in Figure 1, the Oakland data point is located where the slope of the line is relatively flat. Intuitively, the expected diversion of ship trips at this point is minimal as well. We used our cost model to verify that diversion of ship trips from Oakland is unlikely. (This analysis is similar to the analysis for Set I presented above.) As shown in Table 47, the existing cost differential for a 50th-percentile vessel to travel to SEA/TAC instead of LA/LB is $95. According to our cost model framework diversion of ship-trips would be unlikely until a PUF exceeded $95.

As shown in Table 45, a $30 PUF will have considerably more impact in diverting Oakland-bound ships for two reasons. First, the cost differential between voyages to Oakland and voyages to SEA/TAC will increase by a slightly higher percentage (1.9-9.9%) due to Oakland's closer proximity to SEA/TAC. Second, demand for Oakland is quite responsive (elastic) to changes in the cost differential to SEA/TAC. The steep slope of the curve in Figure 2 demonstrates the significant elasticity of demand for Oakland. The increased cost differential may result in diversion of approximately 56 of the 206 foreign, direct Oakland-bound voyages—or *27.2%* of current voyages that did not involve multi-leg U.S. port calls. If direct voyages from Vancouver and Mexico are excluded from the analysis, *38%* of foreign, direct Oakland-bound voyages could divert; however, these voyage diversions appear to represent *only about 6%* of Oakland ship traffic.

If one considers the majority of Oakland traffic (nearly three-quarters of which have LA/LB as a prior port), the diversion impact is much less. As shown in Table 45, if LA/LB originating ship-trips are considered in the diversion analysis, only 4.5% - 4.7% of Oakland-bound ship-trips would be expected to divert (depending on whether or not Mexico and Vancouver are included); ***zero*** of the LA/LB originating ship-trips are expected to divert. This result is intuitive, acknowledging the location of the LA/LB point on the elasticity curve graph in Figure 2: the LA/LB point is located where the slope of the line is essentially zero.

These results are consistent with our cost model, which assumes that in order for the LA/LB traffic into Oakland to divert, the PUF in Oakland would have to be greater than the cost differential between LA/LB voyages to Oakland and LA/LB voyages to SEA/TAC. To verify our results, we used our cost model to determine the existing cost differential, the results of which are shown in Table 46. The results indicate that for the

[23] Note that the cost differential percentages given in Table 44 do not represent voyage cost increases; rather, they represent the percentage difference in voyage costs between transiting from a given prior port to LA/LB versus transiting directly to SEA/TAC. Table 45 shows the same differentials for the port of Oakland.

50th percentile vessel, the PUF at Oakland would need to be greater than $166 per TEU to motivate a diversion on a voyage-cost basis. With a $30 PUF, we would not expect diversion of these voyages.

Since 64% of all containership voyages to California involve LA/LB, the diversion effects on CA ports overall will be more similar to those in LA/LB. LA/LB ports receive more than ten times the number of direct, foreign ship calls than Oakland, and Oakland is most often selected within the context of multi-port voyages. Again, we emphasize that by assuming direct port-to-port service, our results likely over-estimate potential diversions. Moreover, growth rates for containerized cargoes (greater than 6% annually) would compensate for even the largest potential diversions after one year. Lastly, this analysis makes no correction for the induced demand for voyages to California ports that can be expected from goods movement infrastructure improvements that are currently planned or proposed.

5. Conclusion

Our results indicate that current observed behavior shows an overall strong preference for California ports. In particular, demand for the Ports of LA/LB is highly insensitive to an increase in voyage costs due to a PUF, and a PUF employed there will provide little impetus for diversion from these ports. For example, a PUF would need to be greater than $220 per twenty-foot equivalent unit (TEU) before we expect to see any diversion of Mexican, Central, and South American ships from the Ports of LA/LB. Furthermore, a $30/TUE in LA/LB increases voyage costs to LA/LB by only *1.5-2.5%* on average These minimal increases (particularly for voyages coming from Asian ports), would induce diversions of *less than 1.5%* for reasons discussed later in the report. Placing these diversion estimates in the context of recent growth forecasts at the Ports of LA/LB make any diversion impacts from a $30 PUF negligible.

For Oakland, where the majority of ship calls come from LA/LB (about 75%), we also expect to see little diversion. For example, our calculations indicate that a PUF would need to reach a threshold of $43/TEU before any of these voyages from LA/LB consider diversion based on voyage costs alone. For voyages from other ports, a PUF of $30/TEU would increase the Oakland voyage cost by about *1.5-2.7%*. We determine that there is a possibility that a percentage of the small fraction of foreign direct shipping into the Port of Oakland could experience some diversion to other ports, such as to SEA/TAC, leading to an overall diversion of ships between 2-4.7%. Even so, we believe that given projected growth trends, the diversion of voyages from the Port of Oakland under a $30/TEU PUF will be very low.

Appendix I: Tables

SET I Ship Characteristics—Single Leg Direct Shipping

Los Angeles/Long Beach Bound Ships

Table 1. Descriptive Information for Los Angeles/Long Beach Bound Ships (Direct Voyages)

Ship/Route/Size	Ship Characteristics				
	Identifier	Dead Weight Tonnage	Capacity (TEU)	Route Distance (nm)	Average Speed (nm/h)
Hong Kong Direct L.A. 25th	HKL25	35445	2381	12726	20
Hong Kong Direct L.A. 50th	HKL50	49444	3351	12726	23
Hong Kong Direct L.A. 75th	HKL75	54415	3966	12726	24
Hong Kong Direct SEA/TAC 25th	HKT25	35445	2381	11524	20
Hong Kong Direct SEA/TAC 50th	HKT50	49444	3351	11524	23
Hong Kong Direct SEA/TAC 75th	HKT75	54415	3966	11524	24
Taiwan Direct L.A. 25th	TWL25	35445	2381	11950	20
Taiwan Direct L.A. 50th	TWL50	49444	3351	11950	23
Taiwan Direct L.A. 75th	TWL75	54415	3966	11950	24
Taiwan Direct SEA/TAC 25th	TWT25	35445	2381	11044	20
Taiwan Direct SEA/TAC 50th	TWT50	49444	3351	11044	23
Taiwan Direct SEA/TAC 75th	TWT75	54415	3966	11044	24
Tokyo Direct L.A. 25th	TOL25	35445	2381	9708	20
Tokyo Direct L.A. 50th	TOL50	49444	3351	9708	23
Tokyo Direct L.A. 75th	TOL75	54415	3966	9708	24
Tokyo Direct SEA/TAC 25th	TOT25	35445	2381	8556	20
Tokyo Direct SEA/TAC 50th	TOT50	49444	3351	8556	23
Tokyo Direct SEA/TAC 75th	TOT75	54415	3966	8556	24
Mexico Direct Los Angeles 25th	MXL25	35445	2381	2412	20
Mexico Direct Los Angeles 50th	MXL50	49444	3351	2412	23
Mexico Direct Los Angeles 75th	MXL75	59980	3966	2412	24
Mexico Direct SEA/TAC 25th	MXT25	35445	2381	4668	20
Mexico Direct SEA/TAC 50th	MXT50	49444	3351	4668	23
Mexico Direct SEA/TAC 75th	MXT75	59980	3966	4668	24
South Korea Direct Los Angeles 25th	SKL25	35445	2381	10460	20
South Korea Direct Los Angeles 50th	SKL50	49444	3351	10460	23
South Korea Direct Los Angeles 75th	SKL75	54415	3966	10460	24
South Korea Direct SEA/TAC 25th	SKT25	35445	2381	9258	20
South Korea Direct SEA/TAC 50th	SKT50	49444	3351	9258	23
South Korea Direct SEA/TAC 75th	SKT75	54415	3966	9258	24
Shanghai Direct Los Angeles 25th	SHL25	35445	2381	11416	20
Shanghai Direct Los Angeles 50th	SHL50	49444	3351	11416	23
Shanghai Direct Los Angeles 75th	SHL75	54415	3966	11416	24
Shanghai Direct SEA/TAC 25th	SHT25	35445	2381	10232	20
Shanghai Direct SEA/TAC 50th	SHT50	49444	3351	10232	23
Shanghai Direct SEA/TAC 75th	SHT75	54415	3966	10232	24
Vancouver Direct Los Angeles 25th	VAL25	35445	2381	2322	20
Vancouver Direct Los Angeles 50th	VAL50	49444	3351	2322	23
Vancouver Direct Los Angeles 75th	VAL75	54415	3966	2322	24

Ship/Route/Size	Ship Characteristics				
	Identifier	Dead Weight Tonnage	Capacity (TEU)	Route Distance (nm)	Average Speed (nm/h)
Vancouver Direct SEA/TAC 25th	VAT25	35445	2381	292	20
Vancouver Direct SEA/TAC 50th	VAT50	49444	3351	292	23
Vancouver Direct SEA/TAC 75th	VAT75	54415	3966	292	24
Panama Direct Los Angeles 25th	PAL25	35445	2381	5898	20
Panama Direct Los Angeles 50th	PAL50	49444	3351	5898	23
Panama Direct Los Angeles 75th	PAL75	54415	3966	5898	24
Panama Direct SEA/TAC 25th	PAT25	35445	2381	8128	20
Panama Direct SEA/TAC 50th	PAT50	49444	3351	8128	23
Panama Direct SEA/TAC 75th	PAT75	54415	3966	8128	24
Columbia Direct Los Angeles 25th	COLA25	35445	2381	11366	20
Columbia Direct Los Angeles 50th	COLA50	49444	3351	11366	23
Columbia Direct Los Angeles 75th	COLA75	54415	3966	11366	24
Columbia Direct SEA/TAC 25th	COTA25	35445	2381	13596	20
Columbia Direct SEA/TAC 50th	COTA50	49444	3351	13596	23
Columbia Direct SEA/TAC 75th	COTA75	54415	3966	13596	24
Honolulu Direct Los Angeles 25th	HOL25	35445	2381	4462	20
Honolulu Direct Los Angeles 50th	HOL50	49444	3351	4462	23
Honolulu Direct Los Angeles 75th	HOL75	54415	3966	4462	24
Honolulu Direct SEA/TAC 25th	HOT25	35445	2381	4850	20
Honolulu Direct SEA/TAC 50th	HOT50	49444	3351	4850	23
Honolulu Direct SEA/TAC 75th	HOT75	54415	3966	4850	24
French Polyn Direct Los Angeles 25th	FPL25	35445	2381	7140	20
French Polyn Direct Los Angeles 50th	FPL50	49444	3351	7140	23
French Polyn Direct Los Angeles 75th	FPL75	54415	3966	7140	24
French Polyn Direct SEA/TAC 25th	FPT25	35445	2381	8636	20
French Polyn Direct SEA/TAC 50th	FPT50	49444	3351	8636	23
French Polyn Direct SEA/TAC 75th	FPT75	54415	3966	8636	24
New Zealand Direct Los Angeles 25th	NZL25	35445	2381	11318	20
New Zealand Direct Los Angeles 50th	NZL50	49444	3351	11318	23
New Zealand Direct Los Angeles 75th	NZL75	54415	3966	11318	24
New Zealand Direct SEA/TAC 25th	NZT25	35445	2381	12406	20
New Zealand Direct SEA/TAC 50th	NZT50	49444	3351	12406	23
New Zealand Direct SEA/TAC 75th	NZT75	54415	3966	12406	24

Oakland Bound Ships

Table 2. Descriptive Information for Oakland Bound Ships (Direct Voyages)

Ship/Route/Size	Ship Characteristics				
	Identifier	Dead Weight Tonnage	Capacity (TEU)	Route Distance (nm)	Average Speed (nm/h)
Hong Kong Direct Oakland 25th	HKL25	38487	2420	12088	21
Hong Kong Direct Oakland 50th	HKL50	50635	3544	12088	23
Hong Kong Direct Oakland 75th	HKL75	59365	4321	12088	24
Hong Kong Direct SEA/TAC 25th	HKT25 O	38487	2420	11524	21
Hong Kong Direct SEA/TAC 50th	HKT50 O	50635	3544	11524	23
Hong Kong Direct SEA/TAC 75th	HKT75 O	59365	4321	11524	24
Taiwan Direct Oakland 25th	TWO25	38487	2420	11614	21
Taiwan Direct Oakland 50th	TWO50	50635	3544	11614	23
Taiwan Direct Oakland 75th	TWO75	59365	4321	11614	24
Taiwan Direct SEA/TAC 25th (Oakland)	TWT25 O	38487	2420	11044	21
Taiwan Direct SEA/TAC 50th (Oakland)	TWT50 O	50635	3544	11044	23
Taiwan Direct SEA/TAC 75th (Oakland)	TWT75 O	59365	4321	11044	24
Tokyo Direct Oakland 25th	TOO25	38487	2420	9118	21
Tokyo Direct Oakland 50th	TOO50	50635	3544	9118	23
Tokyo Direct Oakland 75th	TOO75	59365	4321	9118	24
Tokyo Direct SEA/TAC 25th (Oakland)	TOTA25 (O)	38487	2420	8556	21
Tokyo Direct SEA/TAC 50th (Oakland)	TOTA50 (O)	50635	3544	8556	23
Tokyo Direct SEA/TAC 75th (Oakland)	TOTA75 (O)	59365	4321	8556	24
South Korea Direct Oakland 25th	SKO25	38487	2420	9844	21
South Korea Direct Oakland 50th	SKO50	50635	3544	9844	23
South Korea Direct Oakland 75th	SKO75	59365	4321	9844	24
South Korea Direct SEA/TAC 25th (Oakland)	SKT25 (O)	38487	2420	9258	21
South Korea Direct SEA/TAC 50th (Oakland)	SKT50 (O)	50635	3544	9258	23
South Korea Direct SEA/TAC 75th (Oakland)	SKT75 (O)	59365	4321	9258	24
Shanghai Direct Oakland 25th	SHO25	38487	2420	10796	21
Shanghai Direct Oakland 50th	SHO50	50635	3544	10796	23
Shanghai Direct Oakland 75th	SHO75	59365	4321	10796	24
Shanghai Direct SEA/TAC 25th (Oakland)	SHT25 (O)	38487	2420	10232	21
Shanghai Direct SEA/TAC 50th (Oakland)	SHT50 (O)	50635	3544	10232	23
Shanghai Direct SEA/TAC 75th (Oakland)	SHT75 (O)	59365	4321	10232	24
Vancouver Direct Oakland 25th	VAO25	38487	2420	1632	21
Vancouver Direct Oakland 50th	VAO50	50635	3544	1632	23
Vancouver Direct Oakland 75th	VAO75	59365	4321	1632	24
Vancouver Direct SEA/TAC 25th (Oakland)	VAT25 (O)	38487	2420	292	21
Vancouver Direct SEA/TAC 50th (Oakland)	VAT50 (O)	50635	3544	292	23
Vancouver Direct SEA/TAC 75th (Oakland)	VAT75 (O)	59365	4321	292	24
Panama Direct Oakland 25th	PAO25	38487	2420	6566	21
Panama Direct Oakland 50th	PAO50	50635	3544	6566	23
Panama Direct Oakland 75th	PAO75	59365	4321	6566	24
Panama Direct SEA/TAC 25th (Oakland)	PAT25 (O)	38487	2420	8128	21
Panama Direct SEA/TAC 50th (Oakland)	PAT50 (O)	50635	3544	8128	23

Ship/Route/Size	Identifier	Ship Characteristics			
		Dead Weight Tonnage	Capacity (TEU)	Route Distance (nm)	Average Speed (nm/h)
Panama Direct SEA/TAC 75th (Oakland)	PAT75 (O)	59365	4321	8128	24
Columbia Direct Oakland 25th	COO25	38487	2420	12034	21
Columbia Direct Oakland 50th	COO50	50635	3544	12034	23
Columbia Direct Oakland 75th	COO75	59365	4321	12034	24
Columbia Direct SEA/TAC 25th (Oakland)	COT25 (O)	38487	2420	13596	21
Columbia Direct SEA/TAC 50th (Oakland)	COT50 (O)	50635	3544	13596	23
Columbia Direct SEA/TAC 75th (Oakland)	COT75 (O)	59365	4321	13596	24
Honolulu Direct Oakland 25th	HOO25	38487	2420	4190	21
Honolulu Direct Oakland 50th	HOO50	50635	3544	4190	23
Honolulu Direct Oakland 75th	HOO75	59365	4321	4190	24
Honolulu Direct SEA/TAC 25th (Oakland)	HOT25 (O)	38487	2420	4850	21
Honolulu Direct SEA/TAC 50th (Oakland)	HOT50 (O)	50635	3544	4850	23
Honolulu Direct SEA/TAC 75th (Oakland)	HOT75 (O)	59365	4321	4850	24
French Polyn Direct Oakland 25th	FPO25	38487	2420	7338	21
French Polyn Direct Oakland 50th	FPO50	50635	3544	7338	23
French Polyn Direct Oakland 75th	FPO75	59365	4321	7338	24
French Polyn Direct SEA/TAC 25th (Oakland)	FPT25 (O)	38487	2420	8636	21
French Polyn Direct SEA/TAC 50th (Oakland)	FPT50 (O)	50635	3544	8636	23
French Polyn Direct SEA/TAC 75th (Oakland)	FPT75 (O)	59365	4321	8636	24
New Zealand Direct Oakland 25th	NZO25	38487	2420	11378	21
New Zealand Direct Oakland 50th	NZO50	50635	3544	11378	23
New Zealand Direct Oakland 75th	NZO75	59365	4321	11378	24
New Zealand Direct SEA/TAC 25th (Oakland)	NZT25 (O)	38487	2420	12406	21
New Zealand Direct SEA/TAC 50th (Oakland)	NZT50 (O)	50635	3544	12406	23
New Zealand Direct SEA/TAC 75th (Oakland)	NZT75 (O)	59365	4321	12406	24
Mexico Direct Oakland 25th	MXO25	38487	2420	3088	21
Mexico Direct Oakland 50th	MXO50	50635	3544	3088	23
Mexico Direct Oakland 75th	MXO75	59365	4321	3088	24
Mexico Direct SEA/TAC 25th (Oakland)	MXT25 (O)	38487	2420	4668	21
Mexico Direct SEA/TAC 50th (Oakland)	MXT50 (O)	50635	3544	4668	23
Mexico Direct SEA/TAC 75th (Oakland)	MXT75 (O)	59365	4321	4668	24

SET II Ship Characteristics—Multi-Leg Multi-Port Shipping

Los Angeles/Long Beach Bound Ships

Table 3. Descriptive Information for Los Angeles Bound Ships (Multi-leg Voyages)

Ship/Route/Size	Ship Characteristics				
	Identifier	Dead Weight Tonnage	Capacity (TEU)	Route Distance (nm)	Average Speed (nm/h)
South Korea MP Direct 25th	SK25	35445	2381	11022	20
South Korea MP Direct 50th	SK50	49444	3351	11022	23
South Korea MP Direct 75th	SK75	54415	3966	11022	24
South Korea Direct SEA/TAC 25th	SKT25	35445	2381	9258	20
South Korea Direct SEA/TAC 50th	SKT50	49444	3351	9258	23
South Korea Direct SEA/TAC 75th	SKT75	54415	3966	9258	24
Shanghai MP Direct 25th	SH25	35445	2381	11987	20
Shanghai MP Direct 50th	SH50	49444	3351	11987	23
Shanghai MP Direct 75th	SH75	54415	3966	11987	24
Shanghai Direct SEA/TAC 25th	SHT25	35445	2381	10232	20
Shanghai Direct SEA/TAC 50th	SHT50	49444	3351	10232	23
Shanghai Direct SEA/TAC 75th	SHT75	54415	3966	10232	24
Vancouver MP Direct 25th	VA25	35445	2381	2470	20
Vancouver MP Direct 50th	VA50	49444	3351	2470	23
Vancouver MP Direct 75th	VA75	54415	3966	2470	24
Vancouver Direct SEA/TAC 25th	VAT25	35445	2381	292	20
Vancouver Direct SEA/TAC 50th	VAT50	49444	3351	292	23
Vancouver Direct SEA/TAC 75th	VAT75	54415	3966	292	24

Oakland Bound Ships

Table 4. Descriptive Information for Oakland Bound Ships (Multi-leg Voyages)

Ship/Route/Size	Ship Characteristics				
	Identifier	Dead Weight Tonnage	Capacity (TEU)	Route Distance (nm)	Average Speed (nm/h)
Hong Kong MP Direct Oakland 25th	HKTO25	38487	2420	12624	21
Hong Kong MP Direct Oakland 50th	HKTO50	50635	3544	12624	23
Hong Kong MP Direct Oakland 75th	HKTO75	59365	4321	12624	24
Hong Kong Direct SEA/TAC 25th	HKT25 O	38487	2420	11524	21
Hong Kong Direct SEA/TAC 50th	HKT50 O	50635	3544	11524	23
Hong Kong Direct SEA/TAC 75th	HKT75 O	59365	4321	11524	24
Taiwan Multi-leg Direct Oakland 25th	TWTO25	38487	2420	12147	21
Taiwan Multi-leg Direct Oakland 50th	TWTO50	50635	3544	12147	23
Taiwan Multi-leg Direct Oakland 75th	TWTO75	59365	4321	12147	24
Taiwan Direct SEA/TAC 25th (Oakland)	TWT25 O	38487	2420	11044	21
Taiwan Direct SEA/TAC 50th (Oakland)	TWT50 O	50635	3544	11044	23
Taiwan Direct SEA/TAC 75th (Oakland)	TWT75 O	59365	4321	11044	24

Ship/Route/Size	Ship Characteristics				
	Identifier	Dead Weight Tonnage	Capacity (TEU)	Route Distance (nm)	Average Speed (nm/h)
Tokyo Multi-leg Direct Oakland 25th	TOTO25	38487	2420	9655	21
Tokyo Multi-leg Direct Oakland 50th	TOTO50	50635	3544	9655	23
Tokyo Multi-leg Direct Oakland 75th	TOTO75	59365	4321	9655	24
Tokyo Direct SEA/TAC 25th (Oakland)	TOTA25 (O)	38487	2420	8556	21
Tokyo Direct SEA/TAC 50th (Oakland)	TOTA50 (O)	50635	3544	8556	23
Tokyo Direct SEA/TAC 75th (Oakland)	TOTA75 (O)	59365	4321	8556	24
South Korea Multi-leg Direct Oakland 25th	SKTO25	38487	2420	10369	21
South Korea Multi-leg Direct Oakland 50th	SKTO50	50635	3544	10369	23
South Korea Multi-leg Direct Oakland 75th	SKTO75	59365	4321	10369	24
South Korea Direct SEA/TAC 25th (Oakland)	SKT25 (O)	38487	2420	9258	21
South Korea Direct SEA/TAC 50th (Oakland)	SKT50 (O)	50635	3544	9258	23
South Korea Direct SEA/TAC 75th (Oakland)	SKT75 (O)	59365	4321	9258	24
Shanghai Multi-leg Direct Oakland 25th	SHTO25	38487	2420	11332	21
Shanghai Multi-leg Direct Oakland 50th	SHTO50	50635	3544	11332	23
Shanghai Multi-leg Direct Oakland 75th	SHTO75	59365	4321	11332	24
Shanghai Direct SEA/TAC 25th (Oakland)	SHT25 (O)	38487	2420	10232	21
Shanghai Direct SEA/TAC 50th (Oakland)	SHT50 (O)	50635	3544	10232	23
Shanghai Direct SEA/TAC 75th (Oakland)	SHT75 (O)	59365	4321	10232	24
Vancouver Multi-leg Direct Oakland 25th	VATO25	38487	2420	1780	21
Vancouver Multi-leg Direct Oakland 50th	VATO50	50635	3544	1780	23
Vancouver Multi-leg Direct Oakland 75th	VATO75	59365	4321	1780	24
Vancouver Direct SEA/TAC 25th (Oakland)	VAT25 (O)	38487	2420	292	21
Vancouver Direct SEA/TAC 50th (Oakland)	VAT50 (O)	50635	3544	292	23
Vancouver Direct SEA/TAC 75th (Oakland)	VAT75 (O)	59365	4321	292	24

Port User Fees' Impacts on Voyage Costs

Set I Results

Less Expensive to California Ports

Table 5. PUFs Impact on Voyage Costs; Mexico-LA/LB vs. Mexico to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
MXL25	$/TEU	$677	$687	$697	$707	$737	$797	$974
	% Total		1.5%	3.0%	4.4%	8.9%	17.7%	43.9%
MXL50	$/TEU	$537	$547	$557	$567	$597	$657	$775
	% Total		1.9%	3.7%	5.6%	11.2%	22.3%	44.3%
MXL75	$/TEU	$490	$500	$520	$530	$550	$610	$711
	% Total		2.0%	4.1%	6.1%	12.2%	24.5%	45.0%

Table 6. PUFs Impact on Voyage Costs; Mexico-Oakland vs. Mexico to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
MXO25	$/TEU	$741	$751	$761	$771	$801	$861	$938
	% Total		1.3%	2.7%	4.0%	8.1%	16.2%	26.6%
MXO50	$/TEU	$595	$605	$615	$625	$655	$715	$760
	% Total		1.7%	3.4%	5.0%	10.1%	20.2%	27.7%
MXO75	$/TEU	$538	$548	$558	$568	$598	$658	$691
	% Total		1.9%	3.7%	5.6%	11.1%	22.3%	28.3%

Table 7. PUFs Impact on Voyage Costs; Panama-LA/LB vs. Panama to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
PAL25	$/TEU	$1,136	$1,146	$1,156	$1,166	$1,196	$1,256	$1,429
	% Total		0.9%	1.8%	2.6%	5.3%	10.6%	25.8%
PAL50	$/TEU	$1,361	$1,371	$1,381	$1,391	$1,421	$1,481	$1,140
	% Total		1.1%	2.2%	3.3%	6.6%	13.3%	26.0%
PAL75	$/TEU	$831	$841	$851	$861	$891	$951	$1,049
	% Total		1.2%	2.4%	3.6%	7.2%	14.4%	26.3%

Table 8. PUFs Impact on Voyage Costs; Panama-Oakland vs. Panama to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
PAO25	$/TEU	$1,175	$1,185	$1,195	$1,205	$1,235	$1,295	$1,370
	% Total		0.9%	1.7%	2.6%	5.1%	10.2%	16.6%
PAO50	$/TEU	$958	$968	$978	$988	$1,018	$1,078	$1,121
	% Total		1.0%	2.1%	3.1%	6.3%	12.5%	17.0%
PAO75	$/TEU	$874	$884	$894	$904	$934	$994	$1,024
	% Total		1.1%	2.3%	3.4%	6.9%	13.7%	17.2%

Table 9. PUFs Impact on Voyage Costs; Columbia-LA/LB vs. Columbia to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
COLA25	$/TEU	$1,856	$1,866	$1,876	$1,886	$1,916	$1,976	$2,149
	% Total		0.5%	1.1%	1.6%	3.2%	6.5%	15.8%
COLA50	$/TEU	$1,482	$1,492	$1,502	$1,512	$1,542	$1,602	$1,717
	% Total		0.7%	1.3%	2.0%	4.0%	8.1%	15.9%
COLA75	$/TEU	$1,366	$1,376	$1,386	$1,396	$1,426	$1,486	$1,584
	% Total		0.7%	1.5%	2.2%	4.4%	8.8%	16.0%

Table 10. PUFs Impact on Voyage Costs; Columbia-Oakland vs. Columbia to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
COO25	$/TEU	$1,858	$1,868	$1,878	$1,888	$1,918	$1,978	$2,053
	% Total		0.5%	1.1%	1.6%	3.2%	6.5%	10.5%
COO50	$/TEU	$1,528	$1,538	$1,548	$1,558	$1,588	$1,648	$1,691
	% Total		0.7%	1.3%	2.0%	3.9%	7.9%	10.7%
COO75	$/TEU	$1,400	$1,410	$1,420	$1,430	$1,460	$1,520	$1,551
	% Total		0.7%	1.4%	2.1%	4.3%	8.6%	10.7%

Table 11. PUFs Impact on Voyage Costs; French Polynesia-LA/LB vs. French Polynesia to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
FPL25	$/TEU	$1,299	$1,309	$1,319	$1,329	$1,359	$1,419	$1,496
	% Total		0.8%	1.5%	2.3%	4.6%	9.2%	15.2%
FPL50	$/TEU	$1,036	$1,046	$1,056	$1,066	$1,096	$1,156	$1,194
	% Total		1.0%	1.9%	2.9%	5.8%	11.6%	15.2%
FPL75	$/TEU	$952	$962	$972	$982	$1,012	$1,072	$1,099
	% Total		1.0%	2.1%	3.1%	6.3%	12.6%	15.4%

Table 12. PUFs Impact on Voyage Costs; French Polynesia-Oakland vs. French Polynesia to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
FPO25	$/TEU	$1,272	$1,282	$1,292	$1,302	$1,332	$1,392	$1,434
	% Total		0.8%	1.6%	2.4%	4.7%	9.4%	12.7%
FPO50	$/TEU	$1,038	$1,048	$1,058	$1,068	$1,098	$1,158	$1,174
	% Total		1.0%	1.9%	2.9%	5.8%	11.6%	13.0%
FPO75	$/TEU	$948	$958	$968	$978	$1,008	$1,068	$1,073
	% Total		1.1%	2.1%	3.2%	6.3%	12.7%	13.2%

Table 13. PUFs Impact on Voyage Costs; New Zealand-LA/LB vs. New Zealand to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
NZL25	$/TEU	$1,849	$1,859	$1,869	$1,879	$1,909	$1,969	$1,993
	% Total		0.5%	1.1%	1.6%	3.2%	6.5%	7.7%
NZL50	$/TEU	$1,477	$1,487	$1,497	$1,507	$1,537	$1,597	$1,592
	% Total		0.7%	1.4%	2.0%	4.1%	8.1%	7.8%
NZL75	$/TEU	$1,361	$1,371	$1,381	$1,391	$1,421	$1,481	$1,468
	% Total		0.7%	1.5%	2.2%	4.4%	8.8%	7.8%

Table 14. PUFs Impact on Voyage Costs; New Zealand-Oakland vs. New Zealand to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
NZO25	$/TEU	$1,776	$1,786	$1,796	$1,806	$1,836	$1,896	$1,905
	% Total		0.6%	1.1%	1.7%	3.4%	6.8%	7.2%
NZO50	$/TEU	$1,460	$1,470	$1,480	$1,490	$1,520	$1,580	$1,567
	% Total		0.7%	1.4%	2.1%	4.1%	8.2%	7.3%
NZO75	$/TEU	$1,337	$1,347	$1,357	$1,367	$1,397	$1,457	$1,436
	% Total		0.7%	1.5%	2.2%	4.5%	9.0%	7.4%

Table 15. PUFs Impact on Voyage Costs; Honolulu-LA/LB vs. Honolulu to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
HOL25	$/TEU	$947	$957	$967	$977	$1,007	$1,067	$998
	% Total		1.1%	2.1%	3.2%	6.3%	12.7%	5.4%
HOL50	$/TEU	$754	$764	$774	$784	$814	$874	$795
	% Total		1.3%	2.7%	4.0%	8.0%	15.9%	5.4%
HOL75	$/TEU	$690	$700	$710	$720	$750	$810	$728
	% Total		1.4%	2.9%	4.3%	8.7%	17.4%	5.5%

Table 16. PUFs Impact on Voyage Costs; Honolulu-Oakland vs. Honolulu to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
HOO25	$/TEU	$878	$888	$898	$908	$938	$998	$961
	% Total		1.1%	2.3%	3.4%	6.8%	13.7%	9.4%
HOO50	$/TEU	$710	$720	$730	$740	$770	$830	$779
	% Total		1.4%	2.8%	4.2%	8.5%	16.9%	9.7%
HOO75	$/TEU	$645	$655	$665	$675	$705	$765	$708
	% Total		1.6%	3.1%	4.7%	9.3%	18.6%	9.9%

More Expensive to California Ports

Direct to Los Angeles/Long Beach

Table 17. PUFs Impact on Voyage Costs; Hong Kong-LA/LB vs. Hong Kong to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
HKL25	$/TEU	$2,035	$2,045	$2,055	$2,065	$2,095	$2,155	$1,876
	% Total		0.5%	1.0%	1.5%	2.9%	5.9%	-7.8%
HKL50	$/TEU	$1,625	$1,635	$1,645	$1,655	$1,685	$1,745	$1,499
	% Total		0.6%	1.2%	1.8%	3.7%	7.4%	-7.8%
HKL75	$/TEU	$1,499	$1,509	$1,519	$1,529	$1,559	$1,619	$1,381
	% Total		0.7%	1.3%	2.0%	4.0%	8.0%	-7.8%

Table 18. PUFs Impact on Voyage Costs; Taiwan-LA/LB vs. Taiwan to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
TWL25	$/TEU	$1,933	$1,943	$1,953	$1,963	$1,993	$2,053	$1,813
	% Total		0.5%	1.0%	1.6%	3.1%	6.2%	-6.2%
TWL50	$/TEU	$1,543	$1,553	$1,563	$1,573	$1,603	$1,663	$1,448
	% Total		0.6%	1.3%	1.9%	3.9%	7.8%	-6.2%
TWL75	$/TEU	$1,423	$1,433	$1,443	$1,453	$1,483	$1,543	$1,334
	% Total		0.7%	1.4%	2.1%	4.2%	8.4%	-6.2%

Table 19. PUFs Impact on Voyage Costs; Tokyo-LA/LB vs. Tokyo to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
TOL25	$/TEU	$1,637	$1,647	$1,657	$1,667	$1,697	$1,757	$1,486
	% Total		0.6%	1.2%	1.8%	3.7%	7.3%	-9.3%
TOL50	$/TEU	$1,307	$1,317	$1,327	$1,337	$1,367	$1,427	$1,185
	% Total		0.8%	1.5%	2.3%	4.6%	9.2%	-9.3%
TOL75	$/TEU	$1,204	$1,214	$1,224	$1,234	$1,264	$1,324	$1,091
	% Total		0.8%	1.7%	2.5%	5.0%	10.0%	-9.4%

Table 20. PUFs Impact on Voyage Costs; South Korea-LA/LB vs. South Korea to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
SKL25	$/TEU	$1,736	$1,746	$1,756	$1,766	$1,796	$1,856	$1,578
	% Total		0.6%	1.2%	1.7%	3.5%	6.9%	-9.1%
SKL50	$/TEU	$1,386	$1,396	$1,406	$1,416	$1,446	$1,506	$1,260
	% Total		0.7%	1.4%	2.2%	4.3%	8.7%	-9.1%
SKL75	$/TEU	$1,277	$1,287	$1,297	$1,307	$1,337	$1,397	$1,160
	% Total		0.8%	1.6%	2.3%	4.7%	9.4%	-9.2%

Table 21. PUFs Impact on Voyage Costs; Shanghai-LA/LB vs. Shanghai to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
SHL25	$/TEU	$1,862	$1,872	$1,882	$1,892	$1,922	$1,982	$1,706
	% Total		0.5%	1.1%	1.6%	3.2%	6.4%	-8.4%
SHL50	$/TEU	$1,487	$1,497	$1,507	$1,517	$1,547	$1,607	$1,362
	% Total		0.7%	1.3%	2.0%	4.0%	8.1%	-8.4%
SHL75	$/TEU	$1,371	$1,381	$1,391	$1,401	$1,431	$1,491	$1,255
	% Total		0.7%	1.5%	2.2%	4.4%	8.8%	-8.4%

Table 22. PUFs Impact on Voyage Costs; Vancouver-LA/LB vs. Vancouver to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
VAL25	$/TEU	$665	$675	$685	$695	$725	$785	$408
	% Total		1.5%	3.0%	4.5%	9.0%	18.0%	-40.2%
VAL50	$/TEU	$528	$538	$548	$558	$588	$648	$314
	% Total		1.9%	3.8%	5.7%	11.4%	22.7%	-40.6%
VAL75	$/TEU	$481	$491	$501	$511	$541	$601	$283
	% Total		2.1%	4.2%	6.2%	12.5%	24.9%	-41.3%

Direct to Oakland

Table 23. PUFs Impact on Voyage Costs; Hong Kong-Oakland vs. Hong Kong to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
HKO25	$/TEU	$1,865	$1,875	$1,885	$1,895	$2,272	$2,332	$1,794
	% Total		0.5%	1.1%	1.6%	3.2%	6.4%	-3.8%
HKO50	$/TEU	$1,534	$1,544	$1,554	$1,564	$1,594	$1,654	$1,475
	% Total		0.7%	1.3%	2.0%	3.9%	7.8%	-3.8%
HKO75	$/TEU	$1,405	$1,415	$1,425	$1,435	$1,465	$1,525	$1,351
	% Total		0.7%	1.4%	2.1%	4.3%	8.5%	-3.9%

Table 24. PUFs Impact on Voyage Costs; Taiwan-Oakland vs. Taiwan to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
TWO25	$/TEU	$1,806	$1,816	$1,826	$1,836	$1,866	$1,926	$1,734
	% Total		0.6%	1.1%	1.7%	3.3%	6.6%	-3.9%
TWO50	$/TEU	$1,484	$1,494	$1,504	$1,514	$1,544	$1,604	$1,425
	% Total		0.7%	1.3%	2.0%	4.0%	8.1%	-4.0%
TWO75	$/TEU	$1,360	$1,370	$1,380	$1,390	$1,420	$1,480	$1,305
	% Total		0.7%	1.5%	2.2%	4.4%	8.8%	-4.0%

Table 25. PUFs Impact on Voyage Costs; Tokyo-Oakland vs. Tokyo to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
TOO25	$/TEU	$1,494	$1,504	$1,514	$1,524	$1,554	$1,614	$1,424
	% Total		0.7%	1.3%	2.0%	4.0%	8.0%	-4.7%
TOO50	$/TEU	$1,224	$1,234	$1,244	$1,254	$1,284	$1,344	$1,165
	% Total		0.8%	1.6%	2.5%	4.9%	9.8%	-4.8%
TOO75	$/TEU	$1,119	$1,129	$1,139	$1,149	$1,179	$1,239	$1,065
	% Total		0.9%	1.8%	2.7%	5.4%	10.7%	-4.8%

Table 26. PUFs Impact on Voyage Costs; South Korea-Oakland vs. South Korea to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
SKO25	$/TEU	$1,585	$1,595	$1,605	$1,615	$1,645	$1,705	$1,511
	% Total		0.6%	1.3%	1.9%	3.8%	7.6%	-4.6%
SKO50	$/TEU	$1,300	$1,310	$1,320	$1,330	$1,360	$1,420	$1,239
	% Total		0.8%	1.5%	2.3%	4.6%	9.2%	-4.7%
SKO75	$/TEU	$1,189	$1,199	$1,209	$1,219	$1,249	$1,309	$1,133
	% Total		0.8%	1.7%	2.5%	5.0%	10.1%	-4.7%

Table 27. PUFs Impact on Voyage Costs; Shanghai-Oakland vs. Shanghai to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
SHO25	$/TEU	$1,703	$1,713	$1,723	$1,733	$1,763	$1,823	$1,633
	% Total		0.6%	1.2%	1.8%	3.5%	7.0%	-4.1%
SHO50	$/TEU	$1,399	$1,409	$1,419	$1,429	$1,459	$1,519	$1,340
	% Total		0.7%	1.4%	2.1%	4.3%	8.6%	-4.2%
SHO75	$/TEU	$1,281	$1,291	$1,301	$1,311	$1,341	$1,401	$1,227
	% Total		0.8%	1.6%	2.3%	4.7%	9.4%	-4.2%

Table 28. PUFs Impact on Voyage Costs; Vancouver-Oakland vs. Vancouver to SEA/TAC

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
VAO25	$/TEU	$559	$569	$579	$589	$619	$679	$392
	% Total		1.8%	3.6%	5.4%	10.7%	21.5%	-29.9%
VAO50	$/TEU	$443	$453	$463	$473	$503	$563	$303
	% Total		2.3%	4.5%	6.8%	13.5%	27.1%	-31.5%
VAO75	$/TEU	$398	$408	$418	$428	$458	$518	$269
	% Total		2.5%	5.0%	7.5%	15.1%	30.1%	-32.4%

Port User Fees' Impacts on Voyage Costs

Set II Results

Los Angeles/Long Beach Multi-leg Direct

Table 29. PUFs Impact on Voyage Costs; China Multi-port with LA/LB vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
CM25	$/TEU	$2,880	$2,890	$2,900	$2,910	$2,940	$3,000	$2,312
	% Total		0.3%	0.7%	1.0%	2.1%	4.2%	-19.7%
CM50	$/TEU	$2,321	$2,331	$2,900	$2,910	$2,940	$3,000	$1,872
	% Total		0.4%	0.9%	1.3%	2.6%	5.2%	-19.3%
CM75	$/TEU	$2,142	$2,152	$2,162	$2,172	$2,202	$2,262	$1,734
	% Total		0.5%	0.9%	1.4%	2.8%	5.6%	-19.0%

Table 30. PUFs Impact on Voyage Costs; Hong Kong Multi-leg with LA/LB vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
HK25	$/TEU	$2,393	$2,403	$2,413	$2,423	$2,453	$2,513	$1,876
	% Total		0.4%	0.8%	1.3%	2.5%	5.0%	-21.6%
HK50	$/TEU	$1,901	$1,911	$1,921	$1,931	$1,961	$2,021	$1,499
	% Total		0.5%	1.1%	1.6%	3.2%	6.3%	-21.2%
HK75	$/TEU	$1,744	$1,754	$1,764	$1,774	$1,804	$1,864	$1,381
	% Total		0.6%	1.1%	1.7%	3.4%	6.9%	-20.8%

Table 31. PUFs Impact on Voyage Costs; Taiwan Multi-leg with LA/LB vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
TW25	$/TEU	$2,310	$2,320	$2,330	$2,340	$2,360	$2,430	$1,813
	% Total		0.4%	0.9%	1.3%	2.6%	5.2%	-21.5%
TW50	$/TEU	$1,834	$1,844	$1,854	$1,864	$1,894	$1,954	$1,448
	% Total		0.5%	1.1%	1.6%	3.3%	6.5%	-21.1%
TW75	$/TEU	$1,682	$1,692	$1,702	$1,712	$1,742	$1,802	$1,334
	% Total		0.6%	1.2%	1.8%	3.6%	7.1%	-20.7%

Table 32. PUFs Impact on Voyage Costs; Tokyo Multi-leg with LA/LB vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
TO25	$/TEU	$1,999	$2,009	$2,019	$2,029	$2,059	$2,119	$1,486
	% Total		0.5%	1.0%	1.5%	3.0%	6.0%	-25.7%
TO50	$/TEU	$1,585	$1,595	$1,605	$1,615	$1,645	$1,705	$1,185
	% Total		0.6%	1.3%	1.9%	3.8%	7.6%	-25.2%
TO75	$/TEU	$1,451	$1,461	$1,471	$1,481	$1,511	$1,571	$1,091
	% Total		0.7%	1.4%	2.1%	4.1%	8.3%	-24.8%

Table 33. PUFs Impact on Voyage Costs; South Korea Multi-leg with LA/LB vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
SK25	$/TEU	$2,095	$2,105	$2,115	$2,125	$2,155	$2,215	$1,578
	% Total		0.5%	1.0%	1.4%	2.9%	5.7%	-24.7%
SK50	$/TEU	$1,662	$1,672	$1,682	$1,692	$1,722	$1,782	$1,260
	% Total		0.6%	1.2%	1.8%	3.6%	7.2%	-24.2%
SK75	$/TEU	$1,522	$1,532	$1,542	$1,552	$1,582	$1,642	$1,160
	% Total		0.7%	1.3%	2.0%	3.9%	7.9%	-23.8%

Table 34. PUFs Impact on Voyage Costs; Shanghai Multi-leg with LA/LB vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
SH25	$/TEU	$2,222	$2,232	$2,242	$2,252	$2,282	$2,342	$1,706
	% Total		0.5%	0.9%	1.4%	2.7%	5.4%	-23.2%
SH50	$/TEU	$1,763	$1,773	$1,783	$1,793	$1,823	$1,883	$1,362
	% Total		0.6%	1.1%	1.7%	3.4%	6.8%	-22.7%
SH75	$/TEU	$1,616	$1,626	$1,636	$1,646	$1,676	$1,736	$1,255
	% Total		0.6%	1.2%	1.9%	3.7%	7.4%	-22.4%

Table 35. PUFs Impact on Voyage Costs; Vancouver Multi-leg with LA/LB vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
VA25	$/TEU	$969	$979	$989	$999	$1,029	$1,089	$408
	% Total		1.0%	2.1%	3.1%	6.2%	12.4%	-58.9%
VA50	$/TEU	$760	$770	$780	$790	$820	$880	$314
	% Total		1.3%	2.6%	3.9%	7.9%	15.8%	-58.7%
VA75	$/TEU	$685	$695	$705	$715	$745	$805	$283
	% Total		1.5%	2.9%	4.4%	8.8%	17.5%	-58.8%

Oakland Multi-leg Direct

Table 36. PUFs Impact on Voyage Costs; Hong Kong Multi-leg with Oakland vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
HKOT25	$/TEU	$2,212	$2,222	$2,232	$2,242	$2,272	$2,332	$1,794
	% Total		0.5%	0.9%	1.4%	2.7%	5.4%	-18.9%
HKOT50	$/TEU	$1,797	$1,807	$1,817	$1,827	$1,857	$1,917	$1,475
	% Total		0.6%	1.1%	1.7%	3.3%	6.7%	-17.9%
HKOT75	$/TEU	$1,635	$1,645	$1,655	$1,665	$1,695	$1,755	$1,351
	% Total		0.6%	1.2%	1.8%	3.7%	7.3%	-17.4%

Table 37. PUFs Impact on Voyage Costs; Taiwan Multi-leg with Oakland vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
TWTO25	$/TEU	$2,153	$2,163	$2,173	$2,183	$2,213	$2,273	$1,734
	% Total		0.5%	0.9%	1.4%	2.8%	5.6%	-19.4%
TWTO50	$/TEU	$1,747	$1,757	$1,767	$1,777	$1,807	$1,867	$1,425
	% Total		0.6%	1.1%	1.7%	3.4%	6.9%	-18.4%
TWTO75	$/TEU	$1,589	$1,599	$1,609	$1,619	$1,649	$1,709	$1,305
	% Total		0.6%	1.3%	1.9%	3.8%	7.6%	-17.9%

Table 38. PUFs Impact on Voyage Costs; Tokyo Multi-leg with Oakland vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
TOTO25	$/TEU	$1,842	$1,852	$1,862	$1,872	$1,902	$1,962	$1,424
	% Total		0.5%	1.1%	1.6%	3.3%	6.5%	-22.7%
TOTO50	$/TEU	$1,487	$1,497	$1,507	$1,517	$1,547	$1,607	$1,165
	% Total		0.7%	1.3%	2.0%	4.0%	8.1%	-21.6%
TOTO75	$/TEU	$1,349	$1,359	$1,369	$1,379	$1,409	$1,469	$1,065
	% Total		0.7%	1.5%	2.2%	4.4%	8.9%	-21.1%

Table 39. PUFs Impact on Voyage Costs; South Korea Multi-leg with Oakland vs. without

Ship/Route	Port User Fees							SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
SKTO25	$/TEU	$1,931	$1,941	$1,951	$1,961	$1,991	$2,051	$1,511
	% Total		0.5%	1.0%	1.6%	3.1%	6.2%	-21.7%
SKTO50	$/TEU	$1,561	$1,571	$1,581	$1,591	$1,621	$1,681	$1,239
	% Total		0.6%	1.3%	1.9%	3.8%	7.7%	-20.7%
SKTO75	$/TEU	$1,418	$1,428	$1,438	$1,448	$1,478	$1,538	$1,133
	% Total		0.7%	1.4%	2.1%	4.2%	8.5%	-20.1%

Table 40. PUFs Impact on Voyage Costs; Shanghai Multi-leg with Oakland vs. without

Ship/Route		Port User Fees						SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
SHTO25	$/TEU	$2,051	$2,061	$2,071	$2,081	$2,111	$2,171	$1,633
	% Total		0.5%	1.0%	1.5%	2.9%	5.9%	-20.4%
SHTO50	$/TEU	$1,662	$1,672	$1,682	$1,692	$1,722	$1,782	$1,340
	% Total		0.6%	1.2%	1.8%	3.6%	7.2%	-19.3%
SHTO75	$/TEU	$1,511	$1,521	$1,531	$1,541	$1,571	$1,631	$1,227
	% Total		0.7%	1.3%	2.0%	4.0%	7.9%	-18.8%

Table 41. PUFs Impact on Voyage Costs; Vancouver Multi-leg with Oakland vs. without

Ship/Route		Port User Fees						SEA/TAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
VATO25	$/TEU	$858	$868	$878	$888	$918	$978	$392
	% Total		1.2%	2.3%	3.5%	7.0%	14.0%	-54.4%
VATO50	$/TEU	$665	$675	$685	$695	$725	$785	$303
	% Total		1.5%	3.0%	4.5%	9.0%	18.0%	-54.4%
VATO75	$/TEU	$591	$601	$611	$621	$651	$711	$269
	% Total		1.7%	3.4%	5.1%	10.2%	20.3%	-54.4%

Table 42. Port Preferences: Los Angeles-Long Beach vs. Seattle-Tacoma Ports

Port Preference Relationship	Prior Port Name							
	Shanghai	Taiwan	Hong Kong	Tokyo	South Korea	Vancouver	Columbia	French Polynesia
# LA/LB Calls	118	338	209	493	490	132	29	0
# SEA/TAC Calls	6	88	40	218	71	274	0	2
Percentage LA/LB Calls	73%	79%	82%	60%	85%	29%	94%	0%
Percentage SEA/TAC Calls	4%	20%	16%	27%	12%	61%	0%	100%
Ratio of Calls (LA/LB: SEA/TAC)	19.7	3.8	5.2	2.3	6.9	0.5		

Table 43. Port Preferences: Oakland vs. Seattle-Tacoma Ports

Port Preference Relationship	Prior Port Name									
	Shanghai	Taiwan	Hong Kong	Tokyo	South Korea	Vancouver	Columbia	French Polynesia	New Zealand	Honolulu
# Oakland Calls	31	3	6	46	8	1	1	25	2	13
# SEA/TAC Calls	6	88	40	218	71	274	0	2	0	0
Percentage Oakland Calls	19%	1%	2%	6%	1%	0%	3%	93%	67%	46%
Percentage SEA/TAC Calls	4%	20%	16%	27%	12%	61%	0%	7%	0%	0%
Ratio of Calls (Oakland: SEA/TAC)	5.2	0.03	0.2	0.2	0.1	0.0		12.5		

Results for Diversion Calculations

Table 44. $30 PUF Cost Differential and Diversion Analysis for Foreign, Direct Voyages Los Angeles/Long Beach

	Current cost difference (LA/LB vs. Tacoma)	With PUF cost difference (LA/LB vs. Tacoma)	% Ships to LA/LB before PUF	Predicted current	Predicted PUF	TP Delta	Cost Delta	% after PUF	Current Ships to LA/LB	Post-PUF N ships
Taiwan	6.6%	8.7%	79%	86.8%	85.7%	-1.1%	2.1%	78.27%	338	333.4
Columbia	-13.7%	-12.0%	100%	94.1%	93.7%	-0.4%	1.7%	99.56%	29	28.9
Honolulu	-5.2%	-1.4%	100%	91.6%	90.3%	-1.4%	3.8%	98.65%	1	1.0
Panama	-20.6%	-18.0%	99%	95.6%	95.1%	-0.5%	2.6%	98.71%	128	127.3
Mexico	-30.7%	-26.8%	99%	97.1%	96.6%	-0.5%	3.9%	98.44%	191	190.0
Shanghai	9.2%	11.4%	95%	85.4%	84.2%	-1.2%	2.2%	93.92%	118	116.5
Hong Kong	8.5%	10.5%	84%	85.8%	84.7%	-1.1%	2.0%	82.84%	209	206.3
South Korea	10.1%	12.4%	87%	84.9%	83.6%	-1.4%	2.4%	85.96%	490	482.2
Tokyo	10.2%	12.8%	69%	84.9%	83.3%	-1.5%	2.6%	67.82%	493	482.2
Vancouver	68.2%	77.8%	33%	30.7%	22.6%	-8.1%	9.6%	24.39%	132	99.0
Oakland**	-20.8%	-14.2%	63.0%	95.6%	94.2%	-1.4%	6.6%	61.66%	174	170.2
Total Foreign Voyage									2129	2066.8
Total with Oakland Included									2303	2237.0
No-Vancouver and Mexico									1879	1851.3
Foreign Voyage % Diversion										-2.9%
% Diversion Oakland Included										-2.9%
No Vancouver and Mexico, Foreign Voyage % Diversion										-1.5%
No Vancouver and Mexico, % Diversion Oakland Included										-1.5%

Table 45. $30 PUF Cost Differential and Diversion Analysis for Foreign, Direct Voyages to Oakland

	Oakland Current cost percentage difference	New Cost percentage difference Oakland	% ships to Oakland before PUF	Predicted current	Predicted PUF	TP Delta	Cost Delta	TP % after PUF	Current ships to Oakland	Post-PUF N ships
Taiwan	4.2%	6.3%	3%	28.0%	14.5%	-13.4%	2.1%	0.00%	3	-
Columbia	-9.6%	-7.9%	100%	98.9%	97.8%	-1.1%	1.8%	98.89%	1	1
Honolulu	-8.8%	-5.0%	100%	98.5%	93.4%	-5.1%	3.9%	94.94%	13	12
New Zealand	-6.8%	-4.9%	100%	96.7%	93.3%	-3.4%	1.9%	96.56%	2	2
Panama	-14.5%	-11.9%	92%	99.8%	99.5%	-0.3%	2.7%	92.00%	12	12
Mexico	-21.7%	-17.7%	97%	100.0%	100.0%	0.0%	3.9%	96.63%	58	58
French Polynesia	-11.5%	-9.0%	93%	99.5%	98.5%	-0.9%	2.6%	91.68%	25	25
Shanghai	4.4%	6.6%	84%	26.3%	12.9%	-13.4%	2.2%	70.40%	31	26
Hong Kong	4.0%	6.0%	13%	29.5%	15.8%	-13.6%	2.0%	0.00%	6	-
South Korea	4.9%	7.4%	10%	22.4%	10.0%	-12.3%	2.4%	0.00%	8	-
Tokyo	5.0%	7.6%	17%	21.7%	9.2%	-12.5%	2.6%	4.88%	46	13
Vancouver	46.1%	56.0%	0%	0.0%	0.0%	0.0%	9.9%	0.36%	1	1
Los Angeles/ Long Beach**	-32.1%	-26%	82%	100.0%	100.0%	0.0%	5.8%	82.00%	1040	1,040
Total Foreign Voyage									206	150
Total with LA/LB Included									1246	1,190
Total No Vancouver and Mexico									147	91
Foreign Voyage % Diversion										-27.2%
% Diversion LA/LB Included										-4.50%
Foreign Voyage % Diversion No Vancouver and Mexico										-38.0%
No Vancouver and Mexico % Diversion, LA/LB Included										-4.73%

Table 46. PUF Impact on Voyage Costs; LA/LB-Oakland vs. LA/LB-SEA/TAC

Ship/Route		Port User Fees						Direct SEATAC Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
LAOAK25	$/TEU	$447	$457	$467	$477	$507	$567	$646
	% Total		2.2%	4.5%	6.7%	13.4%	26.8%	44.3%
LAOAK50	$/TEU	$350	$360	$370	$380	$410	$470	$516
	% Total		2.9%	5.7%	8.6%	17.1%	34.3%	47.4%
LAOAK75	$/TEU	$312	$322	$332	$342	$372	$432	$465
	% Total		3.2%	6.4%	9.6%	19.2%	38.5%	49.0%

Table 47: PUF Impact on Voyage Costs; Oakland-LA/LB vs. Oakland-SEA/TAC

Ship/Route		Port User Fees						Direct Tacoma Diversion
		$0 (Base)	$10	$20	$30	$60	$120	
OAKLA25	$/TEU	$457	$467	$477	$487	$517	$577	$575
	% Total		2.2%	4.4%	6.6%	13.1%	26.3%	18.0%
OAKLA50	$/TEU	$361	$371	$381	$391	$421	$481	$456
	% Total		2.8%	5.5%	8.3%	16.6%	33.3%	26.2%
OAKLA75	$/TEU	$326	$336	$346	$356	$386	$446	$414
	% Total		3.1%	6.1%	9.2%	18.4%	36.8%	26.9%