

Strategic Initiatives for Inland Movement of Containerized Imports at San Pedro Bay

Robert C. Leachman
Institute of Transportation Studies
University of California at Berkeley
January 12, 2017

Executive Summary

In 2015, the Ports of Los Angeles and Long Beach (the “SPB Ports”) handled more containers of imported cargo than any other port complex in the United States. Over three-quarters of the contents of those containers were destined to points far beyond the LA Basin and the Ports’ economic hinterland, yet these shipments resulted in significant intra-regional truck and rail shipments with significant negative environmental impacts. Mitigating those impacts is the focus of this paper and proposal.

In the recent past a significant trend has emerged, and is accelerating, that will increase the amount of highway-borne movement of imports within the Basin. Fewer international containers are being shipped “intact” to US inland points by rail while an increasing percentage are drayed to points within the Basin for de-vanning, sorting or inventorying, and finally re-loading the imported goods into domestic containers or trailers. This paper explores the forces driving the trend away from the intact shipment of international containers by rail (known as inland point intermodal or “IPI” service), identifies public-private initiatives that should be taken to mitigate its effects, and quantifies the associated air quality and congestion benefits for the LA Basin.

Of the 7.8 million TEUs (twenty-foot equivalent units) of waterborne, containerized imports through the SPB Ports in 2015:

- Less than one quarter of these imports (about 21.3%) were actually consumed in the broad local region defined to include Southern California, all of Arizona and New Mexico, and the southern portion of Nevada.
- 36.5% moved to other regions intact in marine containers using IPI service versus 47% in 2001,
- 42.2%, up from 32% in 2001, was de-vanned from marine containers in Southern California and re-shipped to other regions in domestic containers and trailers.

The intense logistics activity associated with re-allocation, re-sale and re-shipment of imports to other regions generates considerable truck traffic and associated emissions in LA Basin. It is estimated that in 2015 import supply chains generated 8.5 million dray trips, 3.9 million lifts at marine and rail terminals, and more than 700 million kilograms of CO₂ emissions within the Basin, not counting dray trips and emissions associated with transportation between regional distribution centers and retail outlets located within the broad local region nor side trips to/from chassis supply terminals or terminals for dray tractors. Supply chains involving re-shipment of imports using domestic vehicles were responsible for about 80% of the aforementioned dray trips, 52% of the lifts and 76% of the CO₂ emissions.

Four potential initiatives are discussed in this paper to significantly reduce these impacts:

- Full eastbound domestic intermodal service from the Intermodal Container Transfer Facility (ICTF),
- Short-haul intermodal service between the SPB Ports and the Inland Empire,
- Infill relocation of national distribution centers and import warehouses to closer proximity to the Ports,
- “Dray-off” from marine terminals of marine containers moving in store-door service.

The potential benefits of the first three initiatives are:

- Reduction of truck trips by more than 50% in terms of distance driven: 0.8 million, 2.9 million, and 4.6 million trips per year, respectively. The number of 8,000-foot double-stack trains per day added to the Alameda Corridor would be 4.0, 14.4, and 12.3, respectively.
- Reduction of CO₂ emissions: 13 million, 308 million, and 257 million kilograms per year, respectively.

The fourth potential initiative (Dray-off) does not reduce truck trips but reduces emissions at the marine terminals by enabling increased use of top-picker container-handling equipment in lieu of rubber-tired gantry cranes. The estimated potential reduction in CO₂ emissions from the Dray-off initiative is 51 million kilograms per year.

It is important to note that the reported potential benefits from the Infill initiative are not additive to benefits afforded by the first two initiatives. The Infill initiative subsumes the initiative for Full eastbound domestic intermodal service at ICTF. Moreover, the Infill initiative obviates some of the reductions attributed to the Short-Haul Intermodal initiative because under Infill a significant portion of Inland Empire facilities are relocated closer to the Ports, thereby eliminating the need for transportation to the Inland Empire. The benefits of the Dray-off initiative are additive to benefits derived from pursuing any combination of Infill and Short-Haul Intermodal.

Considering the extraordinary scale of the potential reductions in truck traffic and emissions, these initiatives could generate substantial public benefits. However, given the current structure of the logistics industry, such initiatives at full potential cannot be profitably undertaken by private enterprise acting alone. Public-private partnerships likely would be required, involving some level of public investment or subsidy, coupled with changes in contractual terms between supply-chain participants, and leadership in bringing the relevant stakeholders together to strike a deal.

OVERVIEW OF THE INITIATIVES

The ICTF has surplus capacity that could be utilized to provide full eastbound domestic container service. At present, domestic container loads generated at cross-docks and import warehouses located in close proximity to the ICTF are largely driven to the downtown rail intermodal terminals. Availability of full domestic container service at the ICTF would provide an opportunity to shorten the round-trip drays of these domestic containers. Unfortunately, there are very few receivers of westbound domestic container shipments in the general vicinity of the ICTF, necessitating re-positioning empty domestic containers from either City of Industry, East Los Angeles or Los Angeles Transportation Center rail terminals to the ICTF, thereby generating extra

lifts of the containers by diesel-powered rubber-tired gantry (RTG) cranes. This traffic imbalance discourages the Union Pacific Railroad from developing the ICTF as a domestic container facility. Public assistance for investments in hybrid RTGs or all-electric rail-mounted cranes (RMCs) to replace the diesel-powered RTGs could help to make the development of full eastbound domestic container service from ICTF economically viable for Union Pacific as well as provide significant environmental benefits.

Most import warehouses operated by large, nationwide retailers and most national distribution centers operated by large original equipment manufacturers (OEMs) distributing imported goods to retailers nationwide are located in the Inland Empire of the Los Angeles Basin, roughly extending from Chino to San Bernardino. Regional distribution centers for certain smaller retailers also are located in the Inland Empire. International containers loaded with imports are drayed from the SPB ports to these warehouses, then drayed back to the ports after unloading. A Short-Haul Intermodal service hauling these containers in double-stack trains between the SPB ports and a suitable rail terminal in the Inland Empire would substantially shorten a large number of dray trips. Short-Haul Intermodal is typically not a viable business for the railroads, in that there is insufficient transportation (in terms of distance) sold to overcome the terminal costs. Moreover, existing terminals at City of Industry and San Bernardino do not have surplus capacity to accommodate such a service. Public assistance for investment in a new terminal in the Inland Empire equipped with hybrid RTGs or electric RMCs, support trackage at the Ports for assembling and disassembling such trains, coupled with contractual innovations to ensure the railroad enjoys subsequent long-haul transport of re-shipped imports could make Short-Haul Intermodal a viable business proposition for the railroad as well as provide a dramatic reduction in truck traffic and emissions.

While there is a significant number of warehouses located in the general vicinity of the ICTF, most of these warehouses were not designed to handle large-scale import volumes. They are generally too small to serve as national distribution centers for large OEMs or as import warehouses or e-commerce fulfillment centers for large nationwide retailers. Razing the small warehouses, performing environmental remediation and securing necessary permits to replace them with much larger facilities is generally not a viable business strategy for commercial real estate developers, compared to the alternative of developing new, large facilities on open ground much further away from the SPB ports.

The Infill initiative is envisioned as a broad partnership involving public agencies, commercial real estate developers, railroads, and major nationwide OEMs or retailers who would become tenants of large, new warehousing facilities. Public assistance would be provided to fund the razing of obsolete, small warehouses, perform environmental remediation, close streets and provide permits as may be required to provide open ground for the construction of large-scale warehousing facilities. One or more commercial real estate companies would commit to build the facilities. A number of major nationwide OEMs or retailers would commit to leasing or purchasing the new facilities. One or both railroads would commit to provide full eastbound domestic container service from the ICTF and/or a repurposed Southern California Intermodal Gateway (SCIG), perhaps re-titled Southern California Multi-modal Gateway. Public assistance also may

be required to equip the rail terminals with hybrid RTGs or all-electric RMCs. Logistics activity now taking place in the Inland Empire would be shifted back closer to the ports, sharply reducing dray transportation and associated emissions.

At present, dray transportation of import containers outbound from marine terminals is typically controlled by the cargo receivers, who dispatch their draymen to retrieve import containers from the terminals. Although under the terms of “store-door” service the steamship line provides for dray movement of the import container from marine terminal to destination, the common practice is for receivers to use their own draymen and apply for a refund of their dray costs. Once a receiver’s drayman shows up at a marine terminal, diesel-powered RTGs sift through stacked containers to find the desired box. This generates significant emissions. The Dray-off initiative envisions provision of an alternative service, priced at a discount to store-door service, whereby the marine terminal controls and dispatches the outbound drays. In lieu of multiple RTG lifts, a top-picker would be used to retrieve the nearest, topmost import box, whereupon the outbound dray of the box would be dispatched. This scheme would reduce required lifting activity and emissions at the terminal.

These initiatives are developed more fully towards the end of this paper (please refer to pages 38 – 55).

BACKGROUND

Containerization and intermodal transportation dramatically lowered the costs of international shipping, enabling American companies to tap low-cost Asian manufacturing. The resulting improvement in international supply chain efficiency and reliability facilitated the outsourcing of American manufacturing that began in the early 1980s and accelerated through the 1990s. From 1980 to 2006 the total waterborne, containerized imports from Asia to North America via West Coast ports grew rapidly. Figure 1 displays the total containerized imports through major US and Canadian West Coast ports during the period 1999 – 2015.¹ Volume doubled from about 6 million twenty-foot equivalent units (TEUs) in 1999 to almost 12 million TEUs in 2006 before a deep recession arrested import growth. While imported container volumes declined for several years following 2006, by 2015 imports via West Coast ports surpassed the 2006 peak. In 2015, there were about 15 million TEUs of containerized imports from the Far East, of which 51% passed through the San Pedro Bay ports, 33% passed through East Coast or Gulf Coast ports, and 16% passed through the other West Coast ports.

Figure 2 displays the shares (TEU basis) by port of total containerized imports through major US and Canadian West Coast ports during the period 2001 – 2015.² The San Pedro Bay Ports (Los Angeles and Long Beach) enjoy a dominant share of imports, although their share eroded from about 73% of total containerized imports via West Coast ports in 2001 to about 66% at present.

¹ Includes only inbound loaded international containers. Ports included: Long Beach, Los Angeles, San Francisco, Oakland, Portland, Tacoma, Seattle, greater Vancouver metro area, and Prince Rupert. *Source:* Port websites.

² Includes inbound loaded international containers only. *Source:* Port websites.



Figure 1: Total Containerized Imports through US and Canadian West Coast Ports 1994-2015 (TEUs)

Sources: Port web sites.

Oakland’s share remained flat during this period at about 7%. The US Pacific Northwest ports’ share declined from a peak in 2005 of 15% to about 11% at present, while Western Canada ports have surged from only about a 7% share in 2001 to almost 17% at present largely at the expense of US West Coast ports. Enabled by provisions of the North American Free Trade Agreement (NAFTA) allowing imports to disembark from vessels at Western Canada ports and proceed intact in marine containers by rail into the USA in bond, without paying any Canadian import duties, the Canadian ports and railroads have successfully marketed their economic and transit time advantages largely at the expense of the US West Coast ports. Container vessels embarking from Asian origins can reach Prince Rupert or Vancouver about two days faster than they can reach the SBP Ports. Thus the Western Canada ports have picked up share of imports moving in the steamship lines’ inland-point intermodal (IPI) service.³

³ Under IPI service, shipments move intact in marine containers from Asian origins to inland USA destinations using a combination of modes: initial dray by truck from Asian origin to Asian port, vessel from Asian port to North American port, double-stack train from North American port to inland rail terminal, and then final dray by truck from rail terminal to destination. Railroads and dray companies serve as subcontractors to the steamship lines.

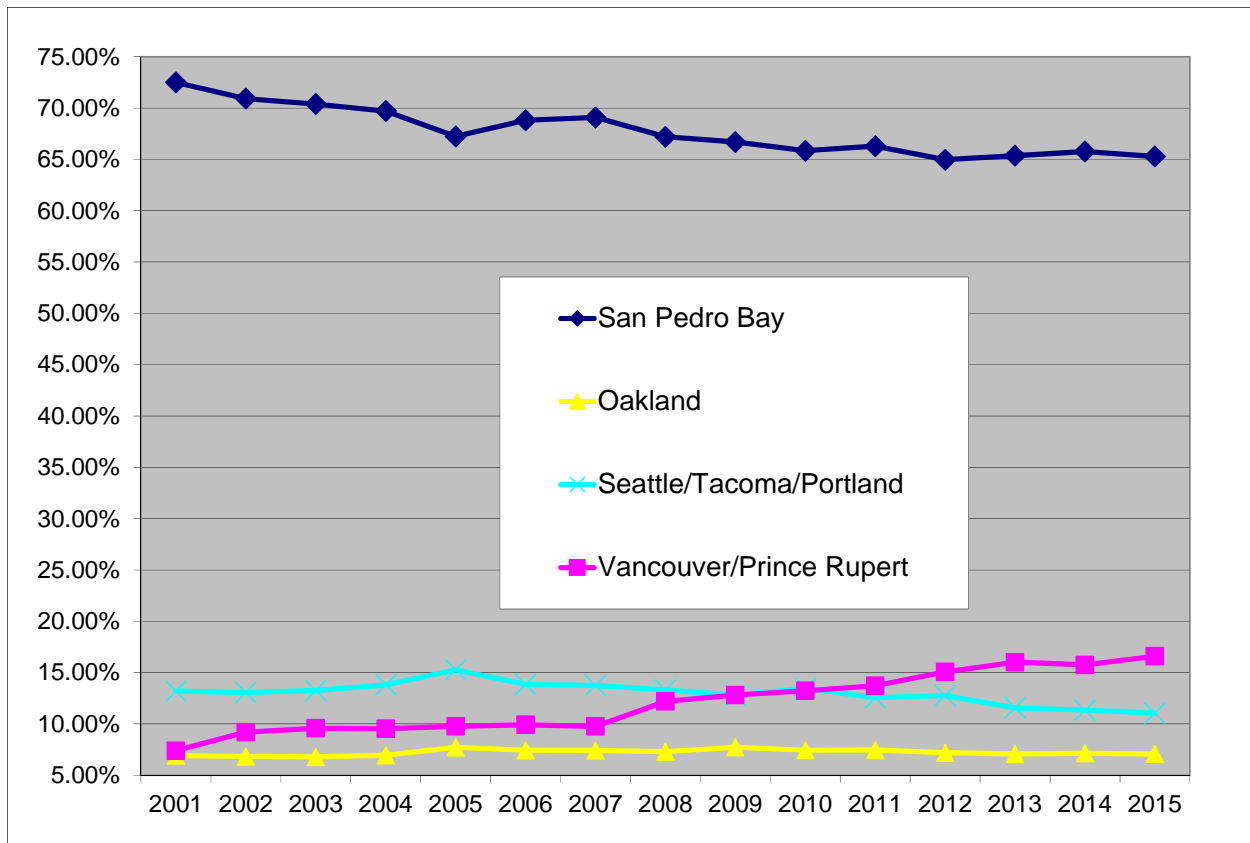


Figure 2: Port Shares of Total Containerized Imports Via US and Canadian West Coast Ports

Sources: Port web sites.

DECLINE IN MOVEMENT OF MARINE CONTAINERS ON RAIL

The investments made by the SPB ports, the railroads and marine terminal operators facilitated rapid growth in the movement of international shipments by rail through the SPB Ports for over two decades. However, changes in the nature of retailing in the US, along with increases in the size of domestic containers and the commercial incentives to use the large domestic containers provided by railroads, have shifted the growth vector in international containerized transportation from intact to trans-loaded shipments. This trend has enormous implications for the SPB Ports and the transportation infrastructure in the LA Basin.

The cubic capacity of domestic intermodal containers paced the increase in size of highway trailers, growing from 45 feet to 48 feet to 53 feet in length. Combined with aggressive pricing spurred by modal competition, low-cost domestic container service would drive a major shift away from intact international container shipments. By the mid-2000s, virtually the entire domestic container fleet in the Continental USA consisted of 53-foot containers. Their cubic capacity is about 4,000 cubic feet, compared to about 2,700 cubic feet for a “high-cube” 40-foot marine container that is nine feet, six inches tall, and compared to about 2,400 cubic feet for an ISO 40-foot marine container that is eight feet, six inches tall. For “cube” freight, i.e., freight that reaches

space limits before reaching highway weight limits, the contents of three marine containers fit in two domestic containers. Some importers report that, considering the edge losses associated with packing irregular cartons into containers or trailers, they find that the contents of five marine containers will fit in three domestic containers or trailers.

Demand for larger domestic containers was driven by an evolution in the mix of importers and an associated increase in the sophistication of supply chain management. The 1980s and 1990s saw the rise of nation-wide “big-box” retailers such as K Mart, Wal-Mart, Target and Home Depot. The big-box firms have steadily taken more and more market share from small and regional retailers. These large, nation-wide retailers enjoy economies of scale and scope that enable a new and more efficient kind of supply chain to be embraced, a supply chain in which goods do not move intact in marine containers from Asian factories to stores or regional distribution centers (RDCs), but instead are de-vanned, sorted and re-allocated to RDCs in the hinterlands of the ports of entry. This re-allocation happens subsequent to the long lead time to book vessel passage and move goods from an interior point in Asia to a USA port of entry, with only the shorter lead times remaining to move the goods from port of entry to the RDCs across the USA. Much more accurate projections of sales in various regions are available over these shorter horizons than for the long horizon facing the importer before vessel passage was booked. Re-allocation of goods by RDC destination after arriving at port of entry enables a much better match-up of supply and demand to be made.⁴

The average time until sale of goods is thereby reduced, and consequently, the average pipeline inventory is reduced, and the required safety stocks at RDCs are sharply reduced. Thus this sort of supply chain is especially attractive for goods with high inventory costs or rapid price erosion.⁵ Better yet, if the imported goods at the time of arrival at port of entry are not yet in demand at any RDC, they can be stored in an import warehouse in the hinterland of the port of entry and shipped later once demand materializes, in lieu of immediate, speculative shipment to what could turn out to be the wrong RDC (wrong in the sense that, if the items had been shipped to a different RDC, they could have been sold much earlier, perhaps at higher prices.)

Considering the cubic capacity advantage of domestic over international containers, the transportation cost savings associated with the reduced number of inland container shipments afforded by domestic containers partially offsets the extra handling costs associated with de-vanning marine containers, sorting and re-allocating the goods, and reloading them in domestic containers. This savings extends the portfolio of goods for which supply chains that re-allocate goods after arrival at port of entry and re-ship them in domestic containers and trailers are superior to supply chains involving intact shipment in marine containers to inland distribution centers. The economies large nationwide retailers derive from such supply chains are not

⁴ Wal-Mart was the first champion of widespread application of *cross-docking* in its supply chains, whereby a fleet of inbound containers or trailers from multiple origins is brought to a dock where their contents are unloaded, sorted and re-allocated to a fleet of outbound containers or trailers heading to multiple destinations. This technique enables better management of pipeline inventories by fine-tuning the alignment of supplies with demands. The technique is now intensely practiced by all of the nation-wide “big-box” retailers. A similar strategy is practiced by original equipment manufacturers (OEMs) bringing imported goods into the USA and re-selling them to US retailers, whereby the imports may be inventoried for some time pending sale and domestic re-shipment.

⁵ Inventory costs are high when the declared value of the goods is high, when the retail price erodes very quickly (such as for fashion goods or electronics), and/or when sales are difficult to forecast (such as new toys).

available to a retailer operating retail outlets in only one region (because there are not multiple RDCs in multiple regions with offsetting sales fluctuations whose inventories can be re-balanced by re-allocation of imports), nor are they available for small retailers (because the need to re-load from marine containers into domestic containers of a different size requires sufficient, sustained import volumes so that the result is not half-empty containers or trailers shipped domestically).

DISTRIBUTION OF FAR EAST - USA IMPORTS BY COMMODITY AND VALUE

The factors driving the distribution of importers of Far East-manufactured goods are the same ones driving the shift from IPI/intact container shipments to trans-loaded shipments:

1. High value goods, such as electronics, imported by large scale OEMs continue to grow in volume and in share of imports.
2. Large-scale e-commerce firms such as Amazon also are rapidly growing their shares of imports.
3. Large-scale retailers continue to take market share from small and regional retailers who were the primary users of IPI/intact shipments.
4. The supply chain characteristics of the large-scale OEM, e-commerce and retailing importers drive toward trans-loading rather than IPI/intact shipments.

To comprehend the relative volumes in trans-loading supply chains vs. direct-shipment supply chains, we will review the distribution of Far East – USA imported goods by commodity and inventory value, the volumes of such imports by importer type. After that, we will elaborate the characteristics of the supply chains practiced by the various types of importers.

Port Import-Export Reporting Services – Trade Intelligencer (PIERS-TI) and Global Trade Atlas (GTA)⁶ summaries of US Customs transactions on waterborne, containerized imports from Asia to the United States for calendar 2015 were secured by the author. Table 1 classifies these imports by commodity. Customs utilizes 99 commodity types in order to assess duties. Shown in the table are the top twelve commodity types (top twelve in terms of volume). These twelve account for almost three fourths of total imports. As may be seen, by a wide margin, the largest import commodity (in terms of cube or TEUs) is furniture and bedding; the next largest, with less than half the volume, is electronics.

There are three important take-aways from Table 1. First, the lion’s share of containerized imports from the Far East to the USA is accounted for by retail-ready goods or goods that are very close to retail-ready goods. Even the auto parts category in Table 1 consists much more of spare parts flowing to the dealer network and to auto parts retailers than of components for use in vehicle assembly. The other 86 commodity types not shown in the table are largely retail-ready goods as well. Second, while there are a few weight-freight commodities such as steel goods, imports from the Far East are largely cube freight, not weight freight. Inland transportation economies are afforded by trans-loading to domestic vehicles. And third, there is a wide variation in the average

⁶ PIERS-TI and GTA are commercial data service products of IHS Markit.

declared value of these commodities. As will be discussed, the least costly supply chain for furniture and bedding, at about \$15,000 declared value per TEU of container space, is very different from the least costly supply chain for electronics, with declared values averaging almost \$65,000 per TEU.

Table 1. Distribution of Far East – USA Containerized Imports

Commodity (Two-digit US Customs HS code)	Percent of Total Volume	Average Declared Value (\$ per TEU)
Furniture, bedding, lamps	16.2%	\$15,338
Machinery	9.0	59,092
Electronics, electrical appliances	7.8	64,743
Toys, games, sporting goods	6.9	24,192
Auto parts, motorcycles	6.7	36,078
Plastic goods	6.1	26,673
Apparel	5.6	66,815
Rubber goods	4.2	21,834
Steel goods	4.2	29,489
Footwear	3.6	32,092
Wooden goods	2.5	13,495
Leather goods (e.g., handbags)	2.5	30,469
All others (86 types)	24.9	33,214

Source: PIERS-TI data for March, July and October, 2015 for imports to USA from 17 Far East nations. PIERS-TI reports volumes in terms of twenty-foot equivalent units (TEUs).

Table 2 lists the top ten importers of waterborne, containerized imports from Asia to the USA in 2015 (by volume). As may be seen, the top importers include familiar “big-box” nation-wide retailers. General broad-category stores such as Wal-Mart, Target and Family Dollar are represented, as are home improvement and furnishing chains such as Home Depot, Ikea, and Lowe’s. Large original equipment manufacturers selling to these and other retailers also appear in the top ten, such as Samsung, LG, Philips Electronics and Nike.

Table 2: Import Volumes by Importer

Importer	2015 Volume in TEUs
Wal-Mart	796,000
Target	537,000
Home Depot	353,000
Lowe’s	262,000
Samsung	159,000
Family Dollar/Dollar Tree	153,000
LG	142,000
Ikea	136,000
Philips Electronics	130,000
Nike	106,000

Source: Journal of Commerce. Figures rounded to nearest thousand.

Figure 3 aggregates all 99 commodity types of Far East – USA waterborne, containerized imports in 2015 as a cumulative distribution over declared value. Note the curve rises steeply at low declared values and much more slowly at high declared values, i.e., there are considerable low-value imports and much less high-value imports. Imports are classified as inexpensive, moderate-value and expensive, for reasons that will become clear below. Up to about \$15,000 in declared value per TEU accounts for about 20% of imports (“inexpensive imports”); from \$15,000 per TEU to about \$40,000 per TEU accounts for about 50% of total imports (“moderate-value imports”); and above \$40,000 in declared value per TEU accounts for about 30% of total imports (“expensive imports”). Generally, expensive imports are not sourced directly from Asian factories by USA retailers as they refuse to buy such expensive items in Asia. Instead, the retailers insist that the original equipment manufacturers (OEMs) bring such goods to the USA, whereby retailers can procure such items from the OEMs much closer to the time they can sell them and avoid risky inventory investment.

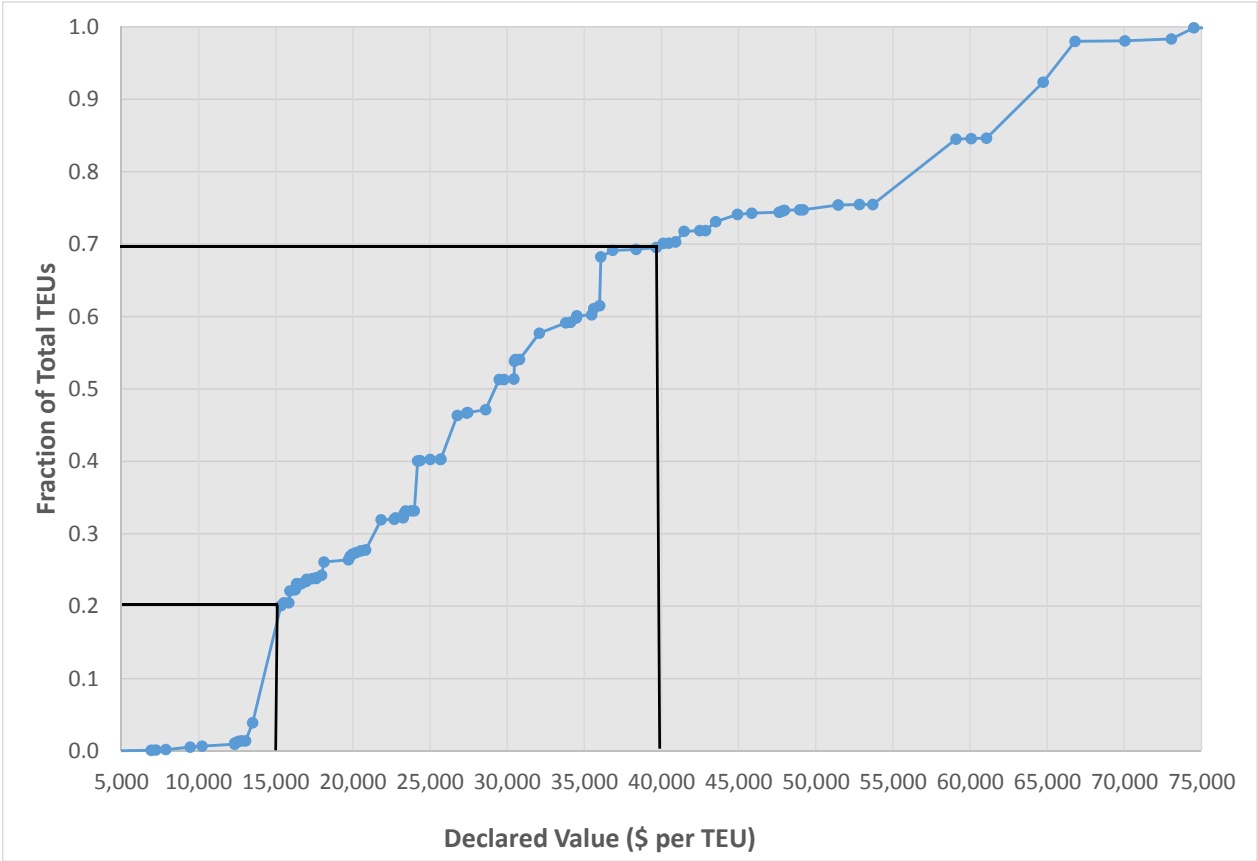


Figure 3: Value Distribution of 2015 Asia-USA Waterborne Containerized Imports

Source: PIERS-TI data for March, July and October, 2015.

Comparing to the value distribution for Far East imports to the USA in 2005, the inexpensive category has declined from 25 to 20%, the moderate-value category has held steady at 50%, and the expensive category has increased from 25 to 30% of total imports. That is, imports in the

expensive category have grown the fastest, and those in the inexpensive category have grown the least.

OVERVIEW OF ASIA – USA SUPPLY CHAINS

There are three types of supply chains that dominate Asia-US logistics: Push, Push-Pull-All-at-San-Pedro-Bay, and Push-Pull-3, 4 or 5-Corners. The Push-Pull supply chains featuring trans-loading are growing in application while Push supply chain associated with IPI is diminishing in use.

A typical large US retailer operates Regional Distribution Centers (RDCs) that restock its retail outlets or its retail customers. A large, nation-wide retailer operates on the order of 20-40 RDCs across the Continental United States. Typically such RDCs are located within an overnight drive of the stores they serve with in-house or dedicated-contract-service trucking used to replenish stores from the RDCs. Most of the retail goods inventory is held at the RDCs or further upstream in the supply chain where the impacts of store-level fluctuations in sales can be pooled. Whether sourced directly from Asian factories or from the import warehouse of an OEM, imports flow from factories in Asia to the RDCs. Broadly speaking, a fundamental decision in designing the supply chain for flows of containerized imports from Asia to RDCs in the Continental United States concerns whether to make intact container shipments directly from Asian supplier factories to RDCs, or, alternatively, to re-allocate and re-bundle factory shipments in the hinterland of the port of entry before re-shipment to RDCs. The former strategy is termed a *Push Supply Chain*, while the latter is termed a *Push-Pull Supply Chain*, explained in more detail as follows.

Push Supply Chains: The name “push” reflects the fact that imports are forwarded to RDCs before replenishment of RDC inventories is required. Importers purchase transportation of marine containers from Asian factories to their regional distribution centers (RDCs). Allocation of container-sized quantities to RDCs is decided by the importer before booking vessel passage. Landside movement to RDCs distant from ports of entry is typically made using IPI service. Landside movement is made via dray of the marine container direct from port terminal to a local RDC or by over-the-road trucking to RDCs in regions not as distant as the regions for which IPI service is utilized.

Push-Pull Supply Chains: The name “Push-Pull” reflects the fact that imports are “pushed” as far as the ports of entry to North America, but “pulled” from facilities near the ports to the RDCs only if and when required to replenish RDC inventories. A set of one up to five ports for handling all imports to the Continental USA is selected by the importer. In the hinterland of each selected port the importer maintains an import warehouse for storing goods that are imported much in advance of demands at its RDCs and for which it desires to delay making the decision to allocate goods to regions until regional demand forecasts become more reliable. Nearby each selected port the importer also contracts a trans-loader/de-consolidator (third-party logistics firm) to unload the contents of marine boxes, sort the imported goods by destination, and re-load the goods into domestic rail containers and highway trailers. Under Push-Pull, the decision is made before booking vessel passage as to how to allocate marine containers to the selected ports of entry (if

there is more than one), but the decision as to how to allocate port volumes to RDCs is deferred. Just before vessel arrival, the retailers makes an allocation of the marine boxes to the trans-loader/de-consolidator in the hinterland of the port, the import warehouse in the hinterland of the port, and the local RDC. Most containers are routed via the trans-loader/de-consolidator; a smaller fraction is routed directly to the import warehouse. In the case of high-volume importers, a small fraction of import containers may be routed directly to the local RDC. Drays of the marine boxes from the port terminal to these three destinations are made accordingly. For boxes routed to the trans-loader/de-consolidator, the retailer makes decisions just before the time of vessel arrival about how to allocate the contents of each marine box into domestic rail containers and highway trailers destined to various inland RDCs, the local RDC and the import warehouse. The trans-loader/de-consolidator processes the contents of the marine boxes and dispatches domestic rail containers and highway trailers accordingly. The domestic rail containers loaded by the trans-loader/de-consolidator are drayed to a nearby rail terminal, moved by train to a ramp in the general area of the destination RDC, then re-loaded onto chassis for final dray movement to the RDC. The highway trailers loaded by the trans-loader/de-consolidator are drayed to the local RDC, drayed to the import warehouse, or trucked to RDCs in regions not as distant as the regions for which domestic rail service is utilized. For boxes routed to the import warehouse, the goods in those boxes are unloaded and placed in storage. At some future times decisions will be made to allocate those goods to RDCs. For goods allocated to the local RDC, there is local dray movement. For goods allocated to distant regions, domestic rail containers are brought to the import warehouse, loaded and drayed to a nearby rail intermodal ramp. The domestic containers are moved by domestic double stack train to a rail terminal in the same area as the destination RDC, then re-loaded onto chassis for final dray movement to the RDC. For goods allocated to other regions for which rail intermodal service is not available or is not economical, the goods are loaded into highway trailers for truck movement to the RDCs in those regions.

For “cube freight” (i.e., imports that reach space capacities of containers before reaching weight limits), the contents of three marine containers fit in two domestic containers or trailers.⁷ As noted above, the lion’s share of imports from Asia is cube freight. For trans-loading to be cost-effective, the import volumes need to be at a scale of at least ten TEUs per week per RDC (i.e., five marine containers per RDC per week) or perhaps more. Importers operating at a scale smaller than this are generally restricted to Push supply chains.

A special case of Push-Pull supply chains concerns the case where goods from Asia are imported by the original equipment manufacturer (OEM) and brought to the OEM’s national distribution center (NDC), typically located in the hinterland of a single port of entry. The imported goods are sold by the OEM to nationwide retailers and re-shipped from the NDC to the retailers’ RDCs in domestic containers and trailers, typically at the retailers’ expense. Figures 4 and 5 depict these strategies in terms of the stages of transit and inventory and the types of transportation vehicles employed (marine container, line-haul domestic container or trailer, and in-house or dedicated-service domestic trailer). Figures 6, 7 and 8 interpret the alternative supply chain strategies geographically. Figure 6 depicts a Push supply chain for a nation-wide retailer operating RDCs spread across the Continental USA. Typically, all or nearly all ports of entry are used,

⁷ Some importers report that they find the contents of five marine containers fit into three domestic containers. Others say the ratio is three to two.

thereby minimizing land transportation costs. A line roughly passing through Pittsburgh and Atlanta divides RDCs served by West Coast ports from those served by East Coast ports. Texas RDCs might be served by the Port of Houston, a Mexican port of entry or the San Pedro Bay Ports (Southern California). This supply chain strategy minimizes transportation and handling costs, but experiences relatively high inventory costs because goods must be “pushed” on RDCs from Asian factories before it is known at which RDC they would sell the earliest. Figure 7 depicts the other extreme, a Push-Pull supply chain in which all imports are passed through a cross dock or national distribution center located in the hinterland of the Ports of Los Angeles – Long Beach. This supply chain permits inventory to be managed as tightly as possible, in exchange for increased transportation and handling expenses. Figure 8 depicts a “Four Corners” Push-Pull supply chain, in which RDCs are allocated to cross-docks and import warehouses in the hinterlands of the Ports of Seattle-Tacoma, Los Angeles – Long Beach, Savannah and New York – New Jersey. This is a compromise strategy in the sense that both transportation and inventory expenses are intermediate to the Push strategy and the Push-Pull-All-at-San-Pedro-Bay strategy.

Variants of the Four-Corners Strategy include Three-Corners Strategy (in which only one West Coast or only one East Coast port is utilized) and the Five-Corners Strategy (in which Houston is added as a port of entry to the Four-Corners Strategy).

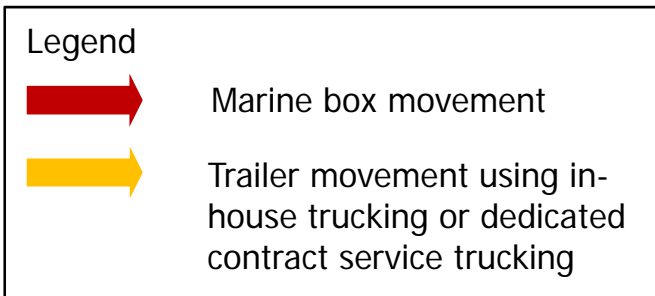
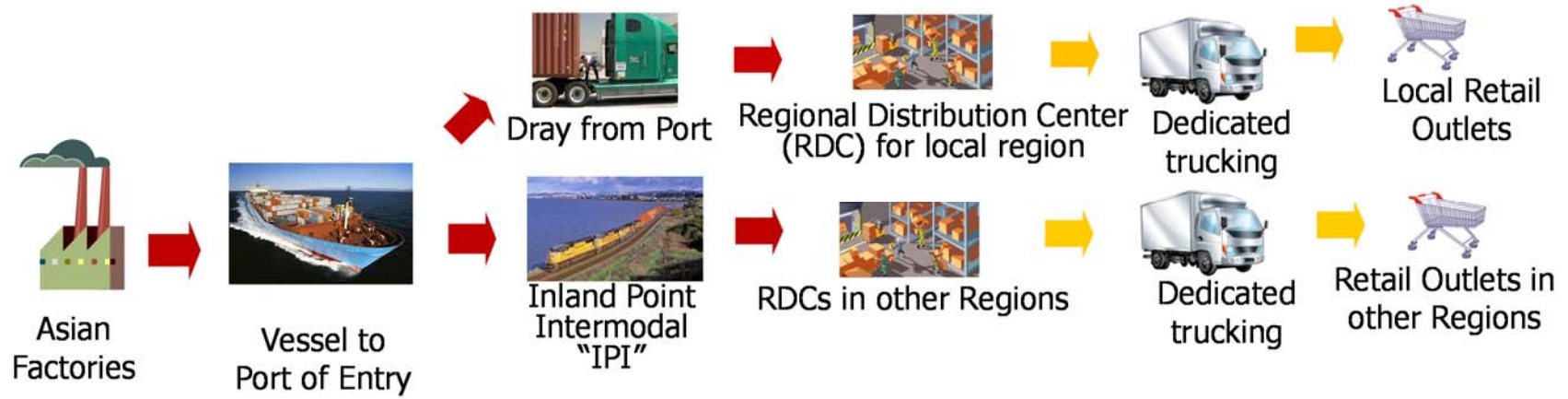


Figure 4: Push Supply Chain

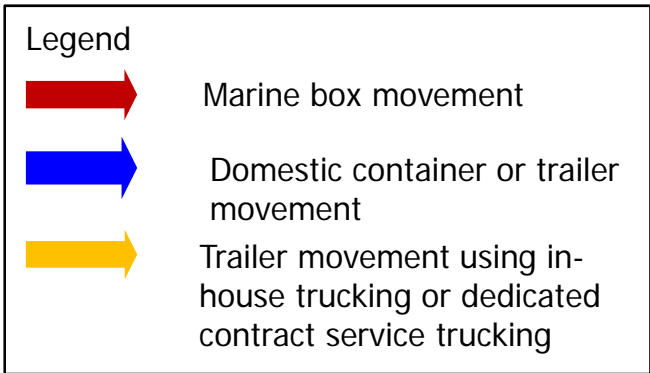
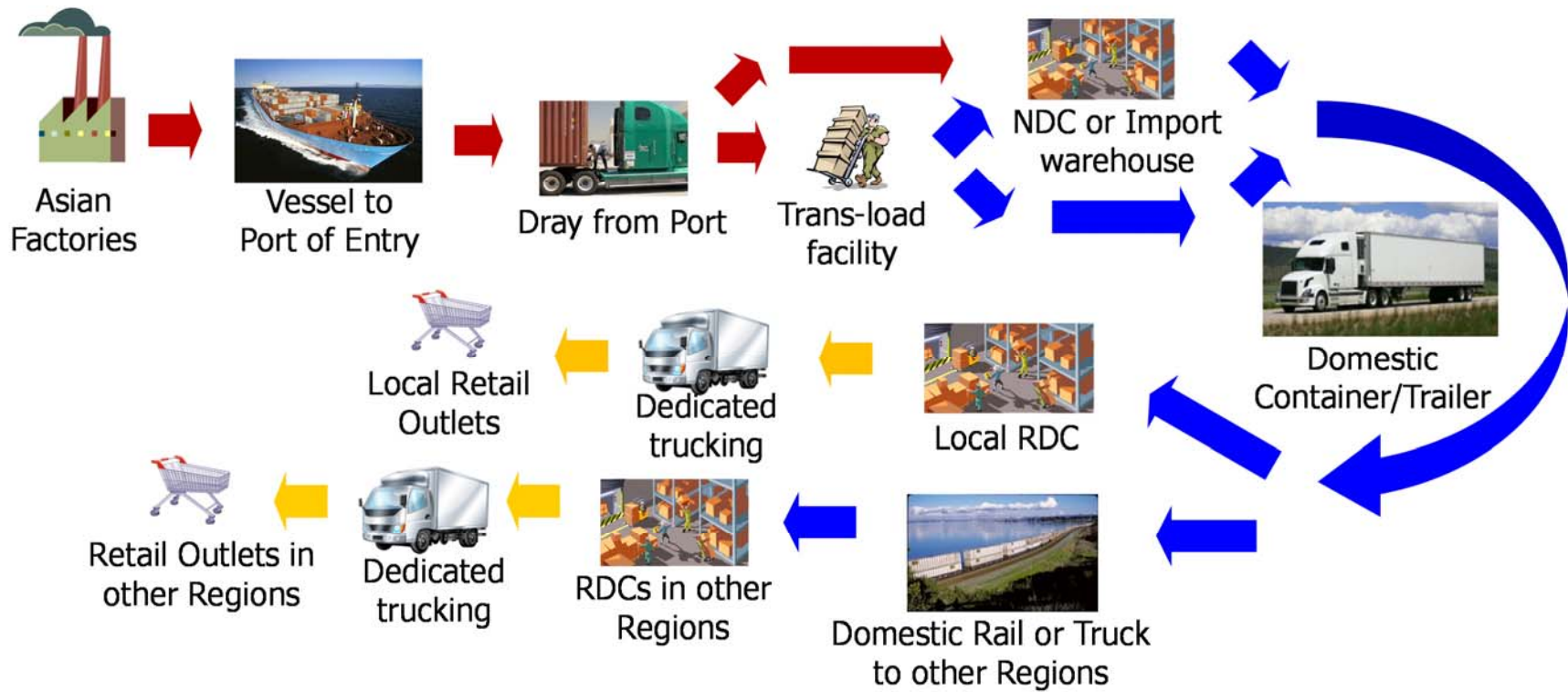


Figure 5: Push-Pull Supply Chain

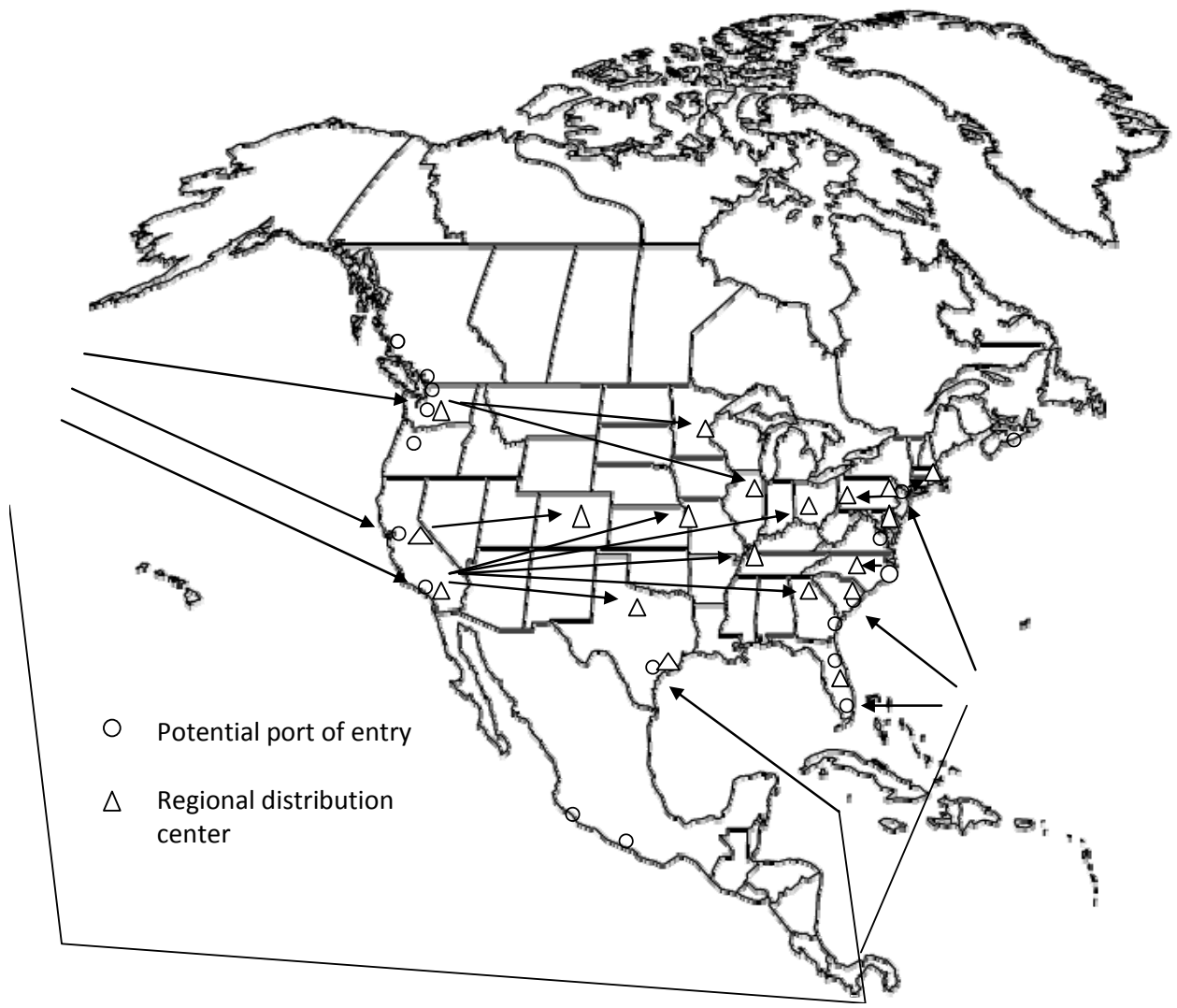


Figure 6: Push Supply-Chain Strategy

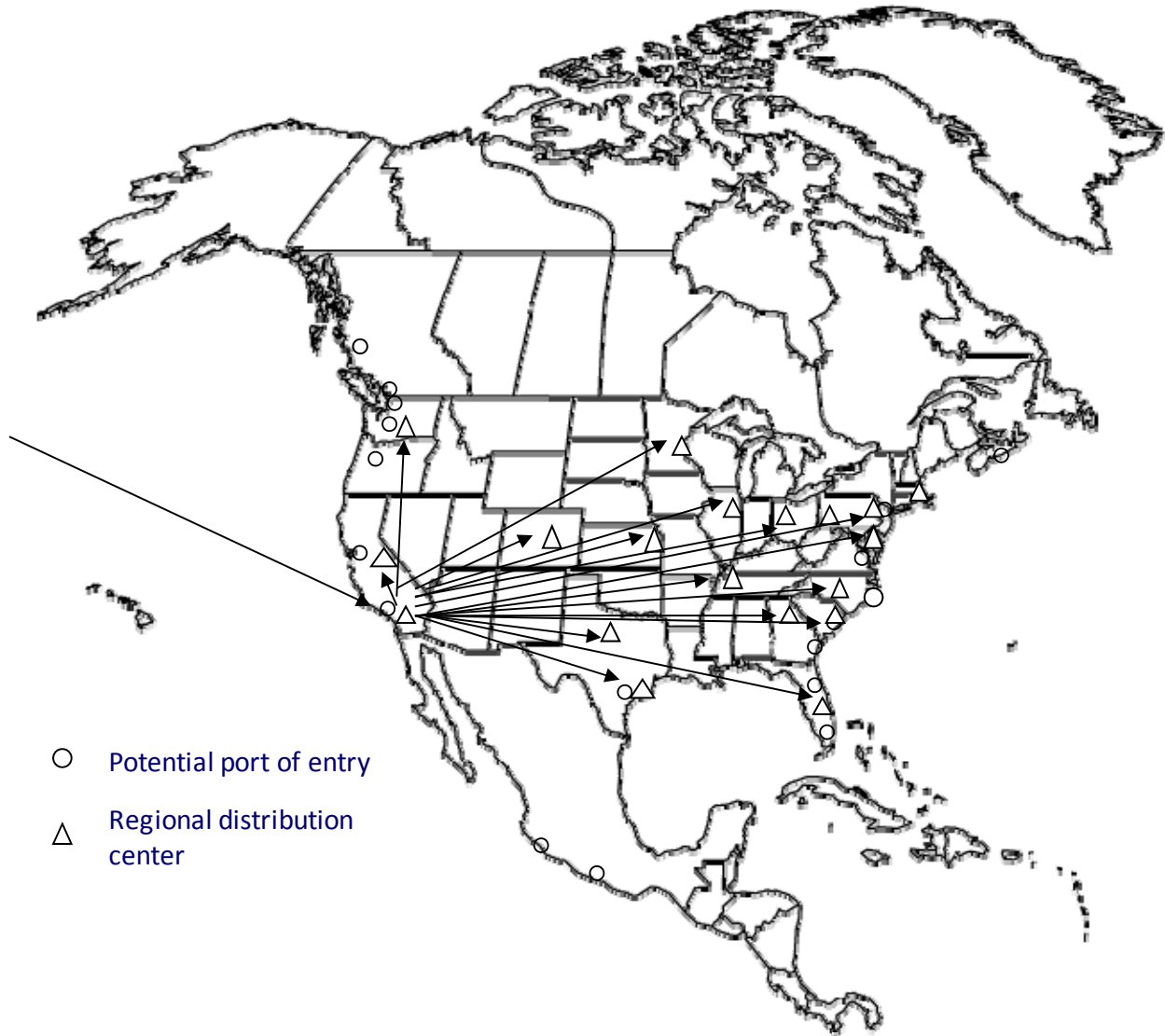


Figure 7: Push-Pull-All-at-San-Pedro-Bay Supply Chain Strategy

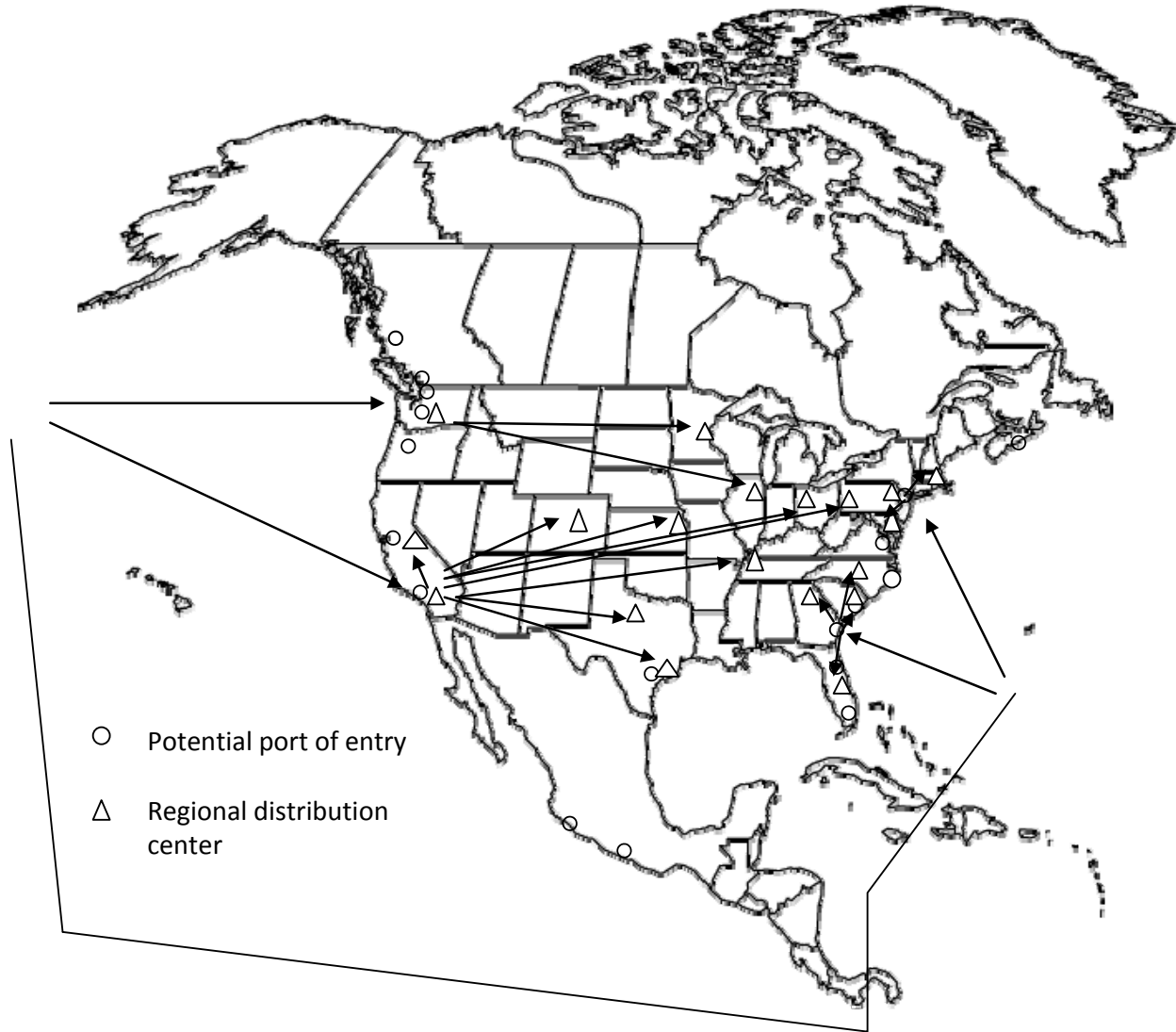


Figure 8: Four-Corners Push-Pull Supply Chain Strategy

SUPPLY-CHAIN STRATEGIES FOR VARIOUS IMPORTERS

The most effective supply chain for a given importer depends on (1) whether the importer possesses the scale and scope to effectively practice trans-loading, and (2) the opportunity for reducing inventory expense and risk associated with the goods being imported. Small-scale and regional importers typically cannot benefit from trans-loading; only large-scale importers distributing goods nation-wide can. For goods imported in sufficiently high volumes and distributed nation-wide, the Push-Pull supply chains achieve lower inventory costs and higher

average retail prices than Push supply chains, but in exchange for increased handling and transportation expenses.

The general distribution of optimal supply-chain strategies calculated by the author in his research is summarized in Table 3. Push-Pull using Three, Four or Five Corners is the best strategy for large, nationwide retailers importing broad portfolios of goods with a moderate average declared value. Such strategies are used by large importers such as Wal-Mart, Target, Home Depot and Sears/K-Mart. This segment accounted for approximately 30% of total imports in 2015. A Push-Pull 1 Corner supply chain is the best strategy for OEMs importing expensive goods re-sold to retailers throughout the Continental USA, and the lowest-cost supply chain of this type is realized if the Corner is located at San Pedro Bay. We refer to such a supply chain serving this segment as Push-Pull-All-at-San-Pedro-Bay. This segment accounted for approximately 15% of total imports in 2015 and includes commodities such as electronics, fashion, auto parts, and shoes.

Table 3: Optimal Supply Chains for Various Types of Importers

Push	Push-Pull 3, 4 or 5 Corners	Push-Pull All at San Pedro Bay
Nation-wide Importers of One-Time-Sale Goods (5%)	Large Nation-wide Importers of Moderate-value Goods (30%)	Original Equipment Manufacturers of Expensive Goods with Nation-wide Sales (15%)
Small and Regional Importers (50%)		

The Push supply chain strategy is used to some extent by large nation-wide retailers for those goods marketed in one-time sales events, such as patio furniture at Memorial Day or back-to-college refrigerators in late August. In addition, the Push supply chain strategy must be practiced by all small and regional importers, as they do not possess the scale or scope to practice Push-Pull strategies. The segment for which a Push supply chain is most suitable accounted for approximately 55% of total imports in 2015.

INCREASED USE OF PUSH-PULL SUPPLY CHAINS

During the period 2005-2015, the use of Push-Pull supply chains grew while the use of Push supply chains declined. Nation-wide, it is estimated that in 2006 total Push imports to Continental USA from Asia were 64% and total Push-Pull imports were 36%, whereas in 2015 the split was 55% Push and 45% Push-Pull. That is, the share of Push-Pull climbed nine points over a decade. The effect of this change is most pronounced in Southern California, because the San Pedro Bay ports are utilized in both Push-Pull-All-at-San-Pedro-Bay supply chains and Push-Pull- 3, 4, or 5-Corner supply chains. It is estimated that total import volume in 2006 at San Pedro Bay was 53%

Push and 47% Push-Pull, whereas in 2015 it was 43% Push and 57% Push-Pull. That is, the Push-Pull share at San Pedro Bay rose by 10 points over a decade. At the present time, more imports leave the Los Angeles Basin for inland USA points in domestic containers and trailers than leave the Basin in marine containers.

Figure 9 displays trends in volumes handled at rail intermodal terminals in the Los Angeles Basin since the 2006 import peak. Volumes are expressed in “lifts,” i.e., containers or trailers placed in rail cars or removed from rail cars, normalized as a percentage of 2006 peak-volumes. Displayed are trends in lifts at three groups of terminals. “Inland Empire Ramps” include the BNSF San Bernardino intermodal terminal and the UP City of Industry intermodal terminal. They serve the OEM national distribution centers as well as import warehouses and e-commerce fulfillment centers for large retailers located in the Inland Empire and are exclusively for domestic containers and trailers. “Port Area Ramps” include the ICTF and a number of on-dock and near-dock terminals at the ports. This group of terminals handles very few domestic containers; and almost all of their business is in marine containers. “Downtown” ramps include BNSF’s Hobart and Commerce terminals and UP’s East Los Angeles and Los Angeles Transportation Center terminals; this group includes a mixture of marine containers and domestic containers and trailers. As may be seen, in 2015, the port area terminals and the downtown terminals were still about 5% below the peak volumes they experienced in 2006. In contrast, the Inland Empire terminals, serving exclusively domestic containers and trailers, were 15% above the 2006 peak. These trends demonstrate the shift from Push to Push-Pull supply chains and the consequent increase in truck traffic in the Basin.

There are several reasons for this change in supply-chain mix. First, large nation-wide importers have been learning to manage their supply chains better and re-engineering them accordingly. They are realizing the “Power of Postponement” afforded by waiting to commit destinations for imports until after regional and local store demands materialize. By routing goods to where they can be sold first, cash flow is accelerated, and high selling prices are maintained.

Second, the product portfolios of certain importers include both “weight freight” imports and “cube freight” imports sourced from different factories in Asia, perhaps from different countries. For example, a home improvement retailer imports marine containers loaded with hardware (heavy) and other marine containers loaded with furniture or bedding (light). The marine boxes of these imports may be routed to the same cross-dock, where the contents can be blended into domestic container loads that weight-out exactly when the cubic capacity is reached, thereby significantly reducing inland transportation requirements. The low-value loads of furniture and bedding, which otherwise might have been shipped directly to inland RDCs in IPI service, are trans-loaded to domestic containers drayed from cross-docks to domestic rail terminals.

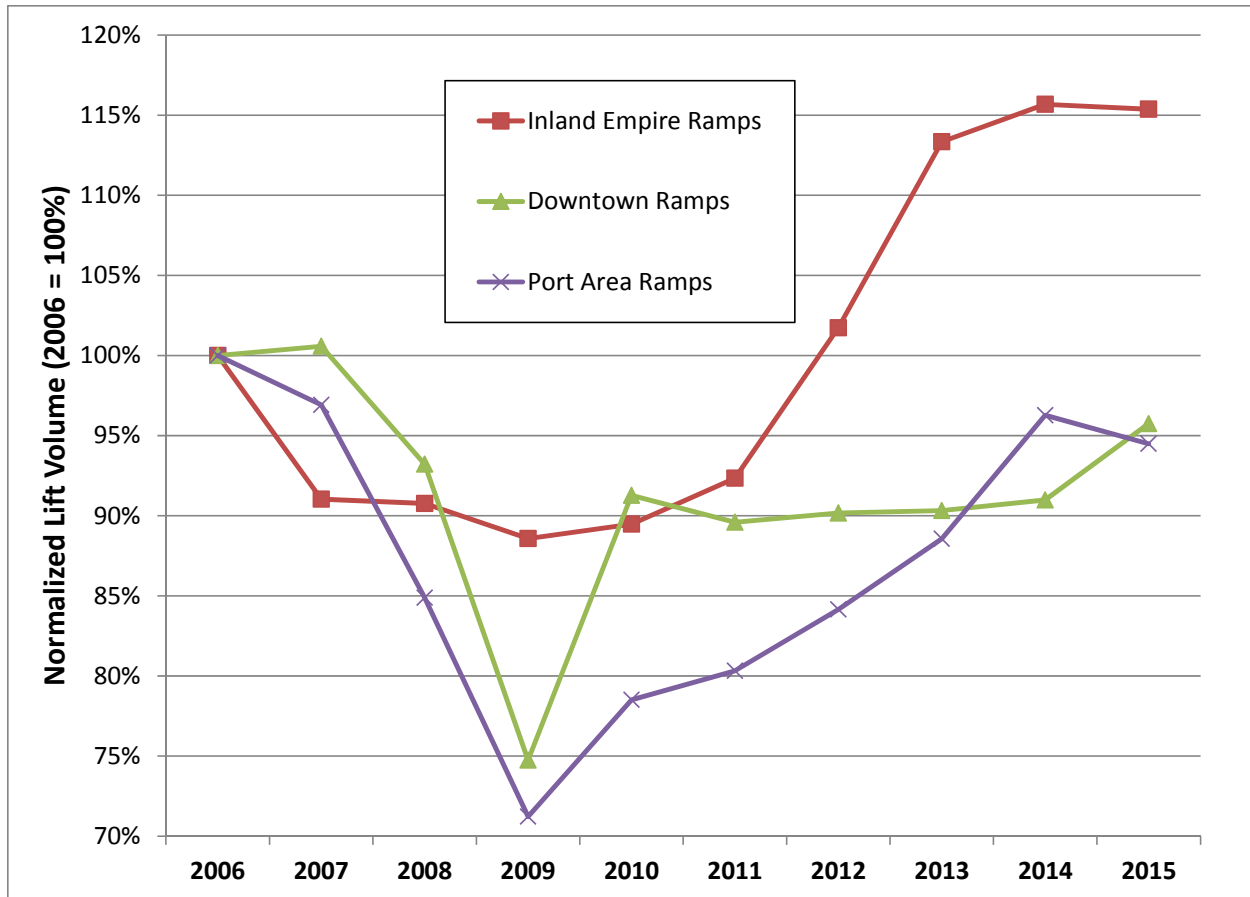


Figure 9: Evolution of Lift Volumes at Los Angeles Basin Intermodal Terminals

Source: Private communications from BNSF and UP.

Third, the cost advantages of large, nation-wide retailers enable them to undercut small and regional retailers and drive them out of the market. From calculations made using the model, the large nation-wide importers practicing Push-Pull supply chain strategies enjoy a 18-20% cost advantage (in terms of total transportation and inventory costs for imports from Asia) over small and regional importers unable to effectively adopt such strategies. This explains the increasing dominance of retailing by the large nation-wide retailers and the steady decline of small and regional retailers. The 2008-2009 recession was particularly hard on many small and regional retailers. For example, in California, the Mervyn's and Gottschalk's chains closed down. Their market shares were taken by the likes of Wal-Mart, Target and Sears/K-Mart, and thus their import volumes moved from Push supply chains to Push-Pull supply chains.

Finally, the steamship lines enjoyed long-term (e.g., 10-year) contracts from the railroads for IPI service to haul marine boxes inland at attractive rates. These legacy contracts started to expire in 2007; the last of them expired in the spring of 2011. They have been replaced by shorter contract terms at much (typically 25-35%) higher rates. Thus rail rates on marine boxes have risen more

than have rail rates on domestic boxes. This serves to offset the extra handling costs associated with cross docking, thereby making Push-Pull more attractive and Push less attractive than otherwise.⁸

EXAMPLE OF DRAY VOLUMES GENERATED BY A PUSH-PULL SUPPLY CHAIN

While most people imagine that an international shipment might generate one or two drays in the LA Basin, the reality is startlingly different: Counting all the necessary trips with loaded and empty containers and trailers, the number of drays can vary from 0 to 6.

The sophistication and complexity of contemporary supply chains as practiced by large, nation-wide importers is illustrated by the hypothetical example in Figure 10. Actual volumes in the various channels illustrated in the figure vary by time of year and from day to day, so this example is simply representative but nonetheless realistic.

Consider the case of a 10,000-TEU vessel arriving at the Port of Los Angeles. “Big-Box Stores, Inc.” accounts for 10% of total Asia – USA waterborne, containerized imports; accordingly, 500 out of the 5,000 forty-foot boxes on this vessel contain imports that will ultimately be sold in Big-Box Stores’ retail outlets. However, only 400 of the 500 boxes are imported with bills of lading showing Big-Box as the importer; the other 100 boxes contain expensive goods imported by OEMs, and Big-Box will purchase these goods from the OEMs sometime after clearing customs.

Tracing the 400 boxes for which Big-Box is the importer, 140 of these boxes contain inexpensive imports or one-time-sale imports that are passed through a Push supply chain. Thirty of these are drayed from the port terminal to the RDC serving the Southern California region (the “local RDC”). The other 110 are loaded into rail double-stack well cars for inland movement under IPI service.

The 260 boxes containing moderate-value goods are passed through a Push-Pull supply chain. The entire contents of five of these boxes are in current demand in Southern California, so they are drayed directly to the local RDC. Another 130 boxes contain goods not in demand in any region yet, so they are drayed to the import warehouse operated by (or on behalf of) Big-Box stores in the Inland Empire region of the Los Angeles Basin. The other 125 boxes contain goods that are being routed to multiple destinations, so they are drayed to a cross-dock. The 125 marine boxes routed to the cross-dock generate domestic-box loads as follows: 27 trailer loads to the local RDC, 11 trailer loads trucked to the Northern California RDC, and 48 domestic container loads drayed to domestic rail intermodal ramps in downtown Los Angeles or the Inland Empire.

The contents of the 130 marine boxes routed to the import warehouse are unloaded and stored. But later they will become in demand at various RDCs. When they do, the breakout of the corresponding outbound volume from the import warehouse is as follows: 28 trailer loads will be

⁸ The rise in IPI rates also promoted a shift in imports from IPI via West Coast ports to “all-water” service via the Panama Canal to East and Gulf Coast ports of entry.

drayed to the local RDC; 11 trailer loads will be trucked to the Northern California RDC; and 48 domestic container loads will be drayed to the domestic container rail terminals.

Finally, we turn to the 100 boxes of expensive goods imported by OEMs. They are drayed to the OEM’s national distribution center, pending sale to Big-Box Stores. As they are sold, they generate truck trips as follows: 8 trailer loads drayed to the local RDC, 3 trailer loads trucked to the Northern California RDC, and 54 domestic container loads drayed to the domestic container rail intermodal terminals.

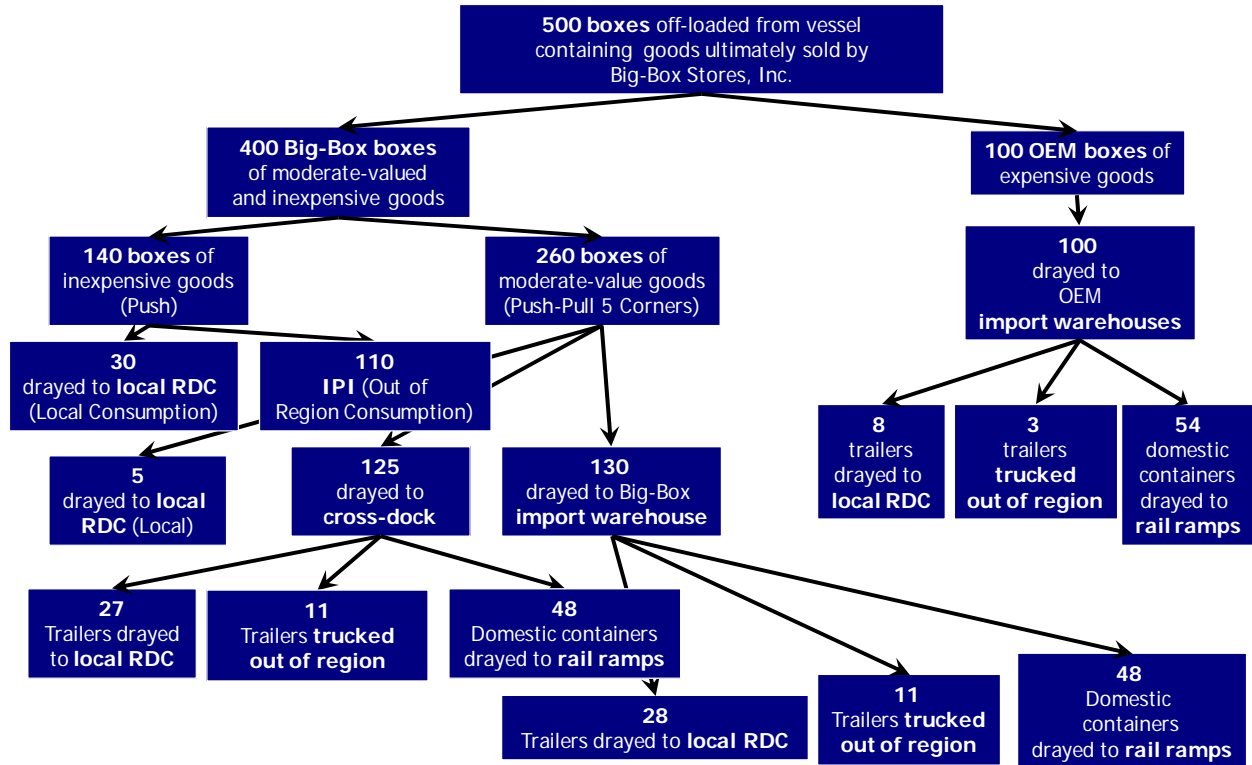


Figure 10: A Big-Box Stores Example

Re-capping this example, for the 500 marine boxes arriving at the port terminal, 110 went IPI (loaded in rail cars), 35 were drayed to the local RDC, 230 were drayed to import warehouses or national distribution centers, and 125 were drayed to a cross-dock facility. From the import warehouses, national distribution centers and the cross-dock, truck trips were generated as follows: 63 trailer loads to Big-Box’s local RDC, 22 trailer loads trucked to Northern California, and 150 domestic containers drayed to domestic rail intermodal ramps.

Even if all 110 IPI boxes were loaded at an on-dock rail terminal (and thus there are no truck trips outside the port terminal for these boxes), the other 390 boxes generated 1,350 truck trips in

the Los Angeles Basin (675 loaded container movements plus 675 return movements of empty boxes or chasses), not counting distribution from the local RDC to retail outlets.

The Alameda Corridor project was very effective in providing efficient and completely grade-separated access to the San Pedro Bay ports for IPI service. It reduced railroad impacts on the urban area, and it was dramatically more cost effective than the traffic and sound mitigation measures that would have been required had the railroads serving the ports not been consolidated into a single corridor. But the train volumes in the Alameda Corridor never reached projections used in planning or environmental assessment of the project. While total imports at the San Pedro Bay ports reached or surpassed projections (up until 2006, anyway), the IPI volumes did not. And this is precisely because a larger and larger share of imports moved into the hands of nation-wide retailers and OEMs practicing the managed supply chains as described above.

At present, rail terminal capacity for domestic containers near the San Pedro Bay Ports is negligible. Most cross-docks handling inbound marine containers are located near the ports, and so the outbound domestic containers are drayed on the freeways from domestic rail terminals located near downtown Los Angeles and then drayed back. Moreover, the OEM warehouses are mostly located in the Inland Empire, so that marine containers containing goods imported by the OEMs are drayed on LA Basin freeways from the ports to the Inland Empire, and then the subsequent domestic container shipments to the OEM's retail customers are drayed to rail intermodal terminals bracketing the Inland Empire in City of Industry or San Bernardino.

In terms of truck traffic and emissions, the hardship from Push-Pull supply chains on the Los Angeles Basin cities located between the San Pedro Bay ports and the Inland Empire domestic-box rail intermodal terminals is severe. But it should be noted that the trans-loading to domestic boxes significantly reduces the required transportation further inland. Considering the lengths of marine and domestic double-stack well cars, and considering the cubic capacity of marine and domestic containers, total train length to move a given import volume inland is reduced by 17% (i.e., 17% less trains are needed to move the cargo inland), the weight of the trains hauling the imports is reduced by 1.3 tons per TEU, and dray trips at the destination end of the rail trip are reduced by 40% (because two domestic containers do the work of three marine containers).

THE STRUCTURE OF SAN PEDRO BAY IMPORTS

For the purposes of transportation and emissions analysis it is useful to stratify San Pedro Bay containerized imports by supply chain channel. In this section, the overall San Pedro Bay import volume is broken out by channel and mode. This is accomplished by first determining a stratification of import volumes by supply chain type, then breaking out supply chain volumes by distribution channels and transportation modes.

As discussed in the previous section, there are three basic types of supply chains for Far East – Continental USA imports:

- Push supply chains
- Push-Pull 3[4][5] Corners supply chains

- Push-Pull 1 Corner supply chains

As noted above, the author estimates that Push supply chains account for about 55% of total Far East – USA imports, Push-Pull 3[4][5] Corner supply chains account for about 30%, and Push-Pull 1 Corner supply chains account for the remaining 15%. In the following analysis we shall adopt these shares as a starting assumption. As developed below, there are certain known local volumes concerning San Pedro Bay imports, and these local volumes serve as boundary conditions to be satisfied for San Pedro Bay imports and thereby facilitate the estimation of import volumes at San Pedro Bay moving in each type of supply chain.

We divide the Continental USA into twenty-two retailing regions, as shown in Table 4.⁹ The last column of the table provides data on purchasing power (population multiplied by income per capita, both extracted in September, 2016 from the US Census web site). Note that the Southern California region, including all of Arizona and New Mexico plus the southern portion of Nevada, accounts for just 10.8% of total Continental USA purchasing power. Moreover, for the months of March, July and October, 2015, the share for San Pedro Bay of total waterborne containerized imports from Far East countries to the United States was 50.7%.¹⁰ Assuming this figure applies to the entire year, and considering that imports from the Far East to USA are nearly all retail goods, this suggests that *about* $10.8/50.7 = 21.3\%$ of San Pedro Bay imports were ultimately consumed in the local region, whereas 78.7% were shipped landside to other regions.

Next, the Alameda Corridor Transportation Authority reports that in 2015, there were 2,843,549 TEUs in eastbound inland point intermodal (IPI) service from San Pedro Bay, including 2,530,775 loaded TEUs moving through the Corridor and 312,774 loaded TEUs drayed from the ports to downtown Los Angeles rail terminals (Hobart on BNSF and East Los Angeles and LATC on UP).¹¹ This compares against 7,784,725 total loaded TEUs discharged at San Pedro Bay in 2015,¹² making for a ratio of $2,843,549/7,784,725 = 0.365$. Thus, in 2015, *the total San Pedro Bay percentage of imports moving in IPI service was about 36.5%*. Comparing against the 78.7% figure derived above for total shipping of imports to other regions, this means *about 42.2% of San Pedro Bay containerized imports were ultimately shipped to other regions in domestic containers and trailers*.

While most Push-Pull 1 Corner supply chains for Far East – USA imports utilize San Pedro Bay as the single port of entry, there are some counterexamples, such as Recreational Equipment Inc. distributing its imported sportswear imports from Puget Sound, or Limited Brands, Inc. distributing its imported fashion items from Columbus, OH. It is assumed herein that 80% of Push-Pull 1 Corner supply chains utilize a national distribution center located in Southern California.

⁹ Leachman (2008) uses twenty-one regions to stratify Far East – Continental USA imports. One more region is incorporated here, an Intermountain region, reflecting purchasing power growth in Utah and Colorado.

¹⁰ Source: PEIRS-TI extracts. PEIRS-TI is a commercial data product of IHS Markit.

¹¹ Source: Private communication to the author from ACTA.

¹² Source: Port of Long Beach and Port of Los Angeles web sites.

Table 4. Purchasing Power in Retailing Regions of the Continental USA

Region	Assumed Location of RDC	Assumed Geographical Extent (expressed percentages of states apply to total purchasing power in those states)	Fraction of Cont. USA Purchasing Power
Southern California	Ontario, CA	60.1% of CA, all of AZ and NM, 67% of NV	0.108
Northern California	Lathrop, CA	39.9% of CA, 33% of NV	0.054
PNW	Kent, WA	WA, OR, 50% of ID, 50% of MT	0.041
Intermountain	Salt Lake City, UT	UT, WY, CO, 50% of ID, 50% of MT	0.033
Houston	Baytown, TX	50% of TX, all of LA and MS	0.059
Dallas	Midlothian, TX	50% of TX, all of OK	0.051
Kansas City	Lenexa, KS	KS, NE, MO, IA	0.041
Minneapolis	Rosemount, MN	MN, SD, ND, 50% of WI	0.033
Memphis	Millington, TN	KY, TN, AR	0.037
Chicago	Joliet, IL	50% of WI, all of IL, IN and MI	0.099
Atlanta	Duluth, GA	50% of GA, 50% of FL, all of AL	0.056
Columbus	Springfield, OH	50% of OH	0.017
Cleveland	Chagrin Falls, OH	50% of OH, 25% of NY	0.035
Pittsburgh	Beaver Falls, PA	50% of PA, all of WV	0.025
Savannah	Garden City, GA	50% of GA, 50% of FL	0.044
Charleston	Summerfield, SC	50% of SC	0.007
Charlotte	Salisbury, SC	50% of SC and all of NC	0.035
Norfolk	Suffolk, VA	VA	0.030
Baltimore	Frederick, MD	MD, DE, DC	0.030
Harrisburg	Allentown, PA	50% of PA	0.020
New Jersey	East Brunswick, NJ	NJ, CT, 75% of NY	0.103
Boston	Milford, MA	MA, VT, NH, ME	0.042

Source: Purchasing power figures from the US Census web site.

In typical Push-Pull 4 Corners supply chains, regions assigned to San Pedro Bay for inventory replenishment include Southern California, Northern California, Houston, Dallas, Kansas City, and Memphis. The Chicago, Columbus, Cleveland and Pittsburgh regions comprise the “Neutral East,” i.e., regions which might be assigned to either the Puget Sound corner or to the San Pedro Bay corner, because rail rates from the two ports to Neutral East regions are competitive. Considering the purchasing power of the regions involved, we expect that, at a minimum, the San Pedro Bay corner handles 37.9% of USA imports moving in such supply chains, and up to 55.5% if the entire Neutral East is assigned to San Pedro Bay. For Push-Pull 3 Corners supply chains, the range would move up; for Push-Pull 5 Corners supply chains, the range would move down.

We have the following boundary conditions matching data on actual San Pedro Bay import flows for calendar 2015:

- 50.7% of total Far East – USA waterborne containerized imports move through San Pedro Bay;
- 10.8% of total Far East – USA waterborne containerized imports are consumed in the “Sou Cal” local region, assumed to have been entirely imported via San Pedro Bay;
- 36.5% of Far East – USA waterborne containerized imports via San Pedro Bay moved in IPI service.

Taken with the assumptions of shares for supply chain type expressed above, it turns out that these boundary conditions make the amounts of imports moving through San Pedro Bay in each supply chain type determinate (see equations in Appendix 1). The results are:

- 48.2% of San Pedro Bay imports move in Push supply chains
- 28.1% of San Pedro Bay imports move in Push-Pull 3[4][5] Corners supply chains
- 23.7% of San Pedro Bay imports move in Push-Pull 1 Corner supply chains

For the assumed nationwide shares and the local boundary conditions, the fraction of total USA Push supply chain imports moving through San Pedro Bay is 44.5%. Moreover, for the assumed shares and the boundary conditions, the fraction of total USA Push-Pull 3[4][5] Corners supply chain imports moving through San Pedro Bay implied by the boundary conditions is 47.5%. These results are consistent with the 37.9% - 55.5% range – depending on the extent to which Neutral East regions are assigned to the San Pedro Bay corner – as discussed above.

These figures result in precise satisfaction of the boundary conditions, i.e. 21.3% of total imports are consumed locally, 36.5% of imports move eastward in IPI service, and 42.2% of total imports move out of region in domestic containers or trailers.

Stratification of Import Volumes by Supply Chain Channels

The key facilities utilized in import supply chains are located as follows:

- *Regional Distribution Centers (RDCs)* – These facilities are used by retailers to distribute imports to their retail outlets within the local region. It is assumed that the RDCs serving

the Southern California region for all large, nation-wide retailers utilizing Push-Pull 3[4][5] Corners supply chains are located in the Inland Empire (Chino – San Bernardino) or adjacent areas. For small or regional importers practicing Push supply chains, it is assumed that only 30% of such importers have RDCs located in the Inland Empire, and the rest are located elsewhere in the region.

- *National Distribution Centers (NDCs)* – These are used by OEMs located in Southern California to distribute goods nation-wide to their retailing customers. Generally, the retailing customers pay for the outbound freight from the OEM's NDC to the retailer's RDC. We assume 85% of Southern California NDCs are located in the Inland Empire or adjacent areas, while 15% are located in the general vicinity of the ICTF (i.e., the communities surrounding the San Pedro Bay ports).
- *Cross-docks* – These are used by large, nation-wide retailers utilizing Push-Pull 3[4][5] Corners supply chains to re-allocate multiple type of goods from multiple origins arriving in marine containers into mixed shipments in domestic containers or trailers. It is assumed that 90% of such facilities processing imports via San Pedro Bay are located in the general vicinity of the ICTF and 10% are located closer to the downtown rail terminals (Hobart on BNSF and East Los Angeles and LATC on UP).
- *Import Warehouses* – These facilities also are used by large, nation-wide retailers utilizing Push-Pull 3[4][5] Corners supply chains. Imported goods arriving well in advance of retail demand are temporarily stored in import warehouses, then re-dispatched as shipments in domestic containers or trailers closer to the time retail demands will materialize. It is assumed that 100% of such facilities warehousing imports in such supply chains moving via San Pedro Bay are in the Inland Empire or adjacent areas.

While there is considerable warehousing near the San Pedro Bay ports, these are smaller, older facilities, generally on the order of 80,000 – 120,000 square feet. They are too small to be useful as import warehouses or regional distribution centers for large nation-wide retailers, which are typically on the order of 1 million square feet. They also are too small to be useful as national distribution centers for most OEM importers; their facilities are typically on the order of 250,000 – 800,000 square feet. A few OEMs have found suitable buildings to serve as their NDC in the general vicinity of the ICTF, but the lion's share occupy facilities in the Inland Empire or adjacent areas. To the author's knowledge, all major Big-Box retailers have located their Southern California import warehouses and RDCs in the Inland Empire or adjacent areas.

Cross-dock facilities used for processing imports of the large, nation-wide retailers are ideally located close to the ports; locating them further out may engender back-tracking of certain outbound shipments. For example, if the cross-dock were located in the Inland Empire, goods allocated to the Northern California RDC will have further to travel than if the cross-dock were located close to the ports. Cross-docks generally are sized around 80,000 – 100,000 square feet; the old warehouses in the general vicinity of the San Pedro Bay ports are suitable for conversion to cross-docks, provided enough truck doors can be cut into the sides and provided there is enough parking space. For these reasons, virtually all cross-docks utilized by the large,

nation-wide retailers are located close to the ports, i.e., in the general vicinity of the ICTF, or in a broadly-defined corridor stretching from the ICTF up to the downtown rail terminals.

Imports to be processed at the cross-docks are drayed from marine terminals. Outbound shipments from cross-docks to regions east of the Rockies are generally loaded into domestic containers drayed up to the downtown rail intermodal terminals. Shipments from the cross-docks to the Northern California RDCs are loaded into domestic trailers for truck movement. Shipments from the cross-docks to Southern California RDCs or import warehouses also are loaded into trailers for dray movement to the Inland Empire or adjacent areas. We assume that for every 6 TEUs of imports, two domestic container or trailer outbound loads are generated. The same ratio applies to inbound and outbound shipments at NDCs and import warehouses.

At the other end of the supply chain spectrum, the small and regional retailers serving the Southern California region do not require large facilities; many of the facilities in the Inland Empire warehouse parks are too large for their purposes. For this reason, it is assumed only 30% of such importers have RDCs located in the Inland Empire; the rest are located elsewhere in the region.

We now proceed to delineate import flows through these facilities. We consider all movements from departure from the ports to arrival at local RDC or departure from the Southern California region:

- 36.5% of import boxes get on a train (IPI service). In 2015, 73.0% were loaded into well cars at on-dock terminals, 16.0% were loaded at ICTF, and 11.0% at the downtown rail terminals.¹³ All of this volume is moving in Push supply chains. Over time, the fraction downtown is diminishing, although it will probably never completely go away, as some Push supply chain importers on occasion pay for premium train service not available at on-dock terminals or the ICTF.
- We assume the Northern California region and the PNW region are not served by the San Pedro Bay ports for imports moving in Push supply chains. Thus the remaining San Pedro Bay import volume moving in Push supply chains is for consumption in the Southern California region and therefore moves to the RDCs serving the region. Considering that total Push supply chain volume through San Pedro Bay comprises 48.2% of total Far East imports through San Pedro Bay, this is $(0.482) \cdot (0.108 / 0.445) = 11.7\%$ of the San Pedro Bay imports. As discussed above, we assume 30% of this volume is drayed to RDCs located in the Inland Empire and the rest drayed to RDCs located elsewhere. Thus 3.5% of San Pedro Bay imports are drays to RDCs located in the Inland Empire for Push supply chain importers and 8.2% are drays to RDCs located elsewhere.
- 23.7% of import boxes are drayed from the ports to OEM NDCs. Considering the current locations for such facilities, this breaks down into 20.1% drayed to NDCs in the Inland Empire and 3.6% drayed to NDCs in the general vicinity of the ICTF.

¹³ Source: The figure for downtown rail terminals is a private communication from ACTA. The split between on-dock and ICTF is the author's estimate based on lift data.

- From NDCs, truck shipments to the retailing customers' RDCs serving the Northern California region are generated. Considering that the Northern California region comprises 5.4% of the purchasing power in the Continental USA, we conclude that 5.4% of the outbound volume from NDCs in the Inland Empire or the general vicinity of the ICTF are trailer shipments to RDCs serving the Northern California region.
- From NDCs, shipments to the retailing customers' RDCs serving the PNW region are generated. We assume 100% of these shipments move in domestic rail containers. Considering that the PNW region comprises 4.1% of the purchasing power in the Continental USA, we conclude that 4.1% of the outbound volume from NDCs in the Inland Empire or the general vicinity of the ICTF are domestic container shipments drayed to downtown rail terminals (East Los Angeles or LATC).
- From NDCs, shipments to the retailing customers' RDCs serving the Intermountain region are generated. We assume 100% of these shipments move in domestic rail containers. Considering that the Intermountain region comprises 3.3% of the purchasing power in the Continental USA, we conclude that 3.3% of the outbound volume from NDCs in the Inland Empire or the general vicinity of the ICTF are domestic container shipments drayed to downtown rail terminals (East Los Angeles or LATC).
- From NDCs, truck shipments to the retailing customers' RDCs serving the Southern California region are generated. For the purposes of this analysis, we assume 100% of these RDCs serving Southern California are in the Inland Empire. Considering that the Southern California region comprises 10.8% of the purchasing power in the Continental USA, we conclude that 10.8% of the outbound volume from NDCs in the Inland Empire is trailer movements within the Inland Empire. For the NDCs in the general vicinity of the ICTF, 10.8% of the outbound volume is trailer movements to the Inland Empire.
- The remaining outbound volume from NDCs is destined to regions east of the Rockies. We assume 100% of this volume is handled in domestic rail containers. For NDCs in the Inland Empire, we assume the domestic containers move via the rail terminals serving the Inland Empire (City of Industry on UP and San Bernardino on BNSF). For NDCs located in the general vicinity of the ICTF, we assume the domestic containers move via the downtown rail terminals (Hobart on BNSF and East Los Angeles and LATC on UP). We conclude that 76.4% of the outbound volume from NDCs in the Inland Empire are domestic container drays to the Inland Empire rail terminals. Similarly, we conclude 76.4% of the outbound volume from NDCs in the general vicinity of the ICTF are domestic container drays to the downtown rail terminals.
- For the nation-wide Big-Box retailing importers utilizing Push-Pull 3[4][5] Corners supply chains, the split of their imports routed to cross-docks vs. import warehouses varies by time of year. For most, the split favors the import warehouses in the spring and early summer but shifts to favor the cross-docks in late summer and the fall. A small portion of their import volumes is drayed directly from the ports to their RDCs serving the Southern California region. A portion of the imports routed via the cross-dock are drayed from the cross-dock to the import warehouse before allocation and re-shipment to

an RDC; again, this fraction diminishes towards the end of the year. For the purposes of this analysis, it is assumed the yearly average split is 35% to the import warehouse, 63% to the cross-dock, and 2% direct from port to the RDC serving the Southern California region. It is further assumed that 12% of the import volume is first routed to the cross-dock and then drayed from the cross-dock to the import warehouse for temporary storage before allocation to RDCs served by the San Pedro Bay Corner. (This 12% is included in the 63% routed to the cross-dock.)

- We assume none of the PNW region is assigned to the San Pedro Bay corner for Push-Pull 3[4][5] Corners supply chains.
- From import warehouses, truck shipments to the RDCs serving the Northern California region are generated. Considering that the Northern California region comprises 5.4% of the purchasing power in the Continental USA, and considering that 47.5% of total Continental USA imports in Push-Pull 3[4][5] Corners supply chains move through San Pedro Bay, then assuming the Northern California region is 100% assigned to the San Pedro Bay corner, we may conclude that 11.4% of the outbound volume from import warehouses in the Inland Empire are trailer shipments to RDCs serving the Northern California region.
- From import warehouses, shipments to replenish the RDCs serving the Intermountain region are generated. We assume 100% of these shipments are made in domestic rail containers. Considering that the Intermountain region comprises 3.3% of the purchasing power in the Continental USA, and considering that 47.5% of total Continental USA imports in Push-Pull 3[4][5] Corners supply chains move through San Pedro Bay, then assuming the Intermountain region is 100% assigned to the San Pedro Bay corner, we may conclude that 7.0% of the outbound volume from import warehouses in the Inland Empire are domestic-box rail shipments to RDCs serving the Intermountain region.
- Considering that the Southern California region comprises 10.8% of the purchasing power in the Continental USA, and considering that 47.5% of total Continental USA imports in Push-Pull 3[4][5] Corners supply chains move through San Pedro Bay, then assuming the Southern California region is 100% assigned to the San Pedro Bay corner, we may conclude that 22.7% of the outbound volume from import warehouses in the Inland Empire are trailer shipments to RDCs serving the Southern California region, i.e., truck trips within the Inland Empire.
- The remaining outbound volume from import warehouses is destined to regions east of the Rockies assigned to the San Pedro Bay corner. We assume 100% of this volume moves in domestic intermodal containers via the rail terminals serving the Inland Empire (City of Industry on UP and San Bernardino on BNSF). This is 59.0% of the outbound volume from the import warehouses.
- From cross-docks, on average, $0.12/0.63 = 19.0\%$ of outbound volume are trailer shipments to the import warehouses located in the Inland Empire or adjacent areas. Considering shipments direct from the ports to RDCs and shipments from import warehouses to RDCs serving the Southern California region $0.108/0.475 - 0.02 - (0.35 +$

$0.12 \times 0.227 = 10.1\%$ of San Pedro Bay imports in Push-Pull 3[4][5] Corners supply chains move from cross-docks as trailer shipments to the RDCs serving the Southern California region, also located in the Inland Empire or adjacent areas. This corresponds to $0.101/0.63 = 16.0\%$ of outbound shipments from cross-docks.

- As derived above, 11.4% of the volume in Push-Pull 3[4][5] Corners supply chains should end up as trailer shipments to RDCs serving the Northern California region. Considering the import volume in these supply chains not routed to import warehouses, this is $0.114 \times (0.63 - 0.12 + 0.02) / 0.63 = 9.6\%$ of the volume departing the cross-docks.
- As derived above, 7.0% of the volume in Push-Pull 3[4][5] Corners supply chains should end up as domestic-container rail shipments to RDCs serving the Intermountain region. Considering the import volume in these supply chains not routed to import warehouses, this is $0.07 \times (0.63 - 0.12 + 0.02) / 0.63 = 5.8\%$ of the volume departing the cross-docks.
- The remaining volume departing the cross-docks is destined to regions east of the Rockies. It is assumed 100% of this volume moves in domestic rail containers via the downtown rail terminals (Hobart on BNSF and East Los Angeles and LATC on UP). Therefore, $1.00 - 0.19 - 0.16 - 0.096 - 0.058 = 49.6\%$ of the volume departing the cross-docks is comprised of domestic container drays to the downtown rail terminals destined east of the Rockies.

Figure 11 provides a pie chart summarizing San Pedro Bay import flows by mode and general destination. As may be seen, 21.3% of imports are consumed in the Southern California region; 36.5% leave the region in IPI service; 4.8% are trucked to Northern California; and 37.4% move out of region in domestic rail service.

The flow factors by channel developed in this section are depicted in Figure 12 below. The 2015 import volume at San Pedro Bay, 7,784,725 TEUs, is applied to the percentages to indicate the number of dray trips per year by channel. While not all import volume at San Pedro Bay is from the Far East, the lion's share is, so the volume figures are representative. Red boxes indicate dray movements of marine boxes ("FEU" stands for forty-foot equivalent unit); light blue boxes indicate dray movements of 53-foot domestic containers; dark blue boxes indicate over-the-road trucking of 53-foot trailers; and yellow boxes indicate dray movements of 53-foot trailers, typically performed by dedicated contract service vendors or in-house trucking staff of the importer. All percentages appearing in the figure are of total Far East imports entering the USA via San Pedro Bay. Summarizing the flows in the figure, in 2015 imports at San Pedro Bay resulted in about 2.9 million FEUs of dray trips hauling loaded marine boxes within the Los Angeles Basin, 1.3 million dray trips of 53-foot domestic containers and trailers hauling trans-loaded or re-shipped imports within the Los Angeles Basin, and about 100,000 long-haul truck trips with 53-foot trailers hauling trans-loaded or re-shipped imports from the Los Angeles Basin to Northern California.

It is interesting to compare the predicted domestic intermodal flows to actual 2015 lifts reported at Southern California intermodal terminals. These lift volumes were as follows:¹⁴

BNSF Hobart/Commerce: 1,149,085

UP East Los Angeles: 448,574

UP LATC: 230,052

BNSF San Bernardino: 604,633

UP City of Industry: 272,289

The subtotal for downtown rail terminals above is 1,827,711 lifts. From this we need to subtract marine-box traffic. According to ACTA, the TEUs of marine boxes handled at downtown rail terminals in 2015 amounted to 446,553.¹⁵ Applying the average TEUs/lift for all marine box traffic in the Alameda Corridor in 2015, the estimated lifts of marine boxes at downtown rail terminals was 278,080. Therefore:

- Subtotal, domestic intermodal lifts at downtown rail terminals: 1,549,631
- Subtotal, intermodal lifts at Inland Empire rail terminals: 876,922

If we assume domestic traffic was perfectly balanced westbound and eastbound, then domestic intermodal units should amount to half the number of lifts:

- Estimated 2015 eastbound domestic intermodal units, downtown rail terminals: 774,816
- Estimated 2015 eastbound domestic intermodal units, Inland Empire terminals: 438,461
- Total eastbound domestic intermodal units from Southern California: 1,213,277

In Figure 12, the eastbound trans-loaded or re-shipped import volume from Inland Empire ramps is 642,000 and from downtown ramps is 353,000, for a total of 995,000. This comparison suggests that (1) about 82% of total eastbound domestic intermodal units from Southern California in 2015 were shipments of imports, and (2) at present, there are destinations served or intermodal services provided (e.g., premium-service trains) from downtown rail terminals that are not available from Inland Empire rail terminals, and so a significant number of trans-loaded imports are being drayed from Inland Empire distribution centers or import warehouses to downtown rail terminals in order to reach such destinations or utilize premium intermodal services.

¹⁴ Source: Private communications from UP and BNSF.

¹⁵ Source: Private communication from ACTA.

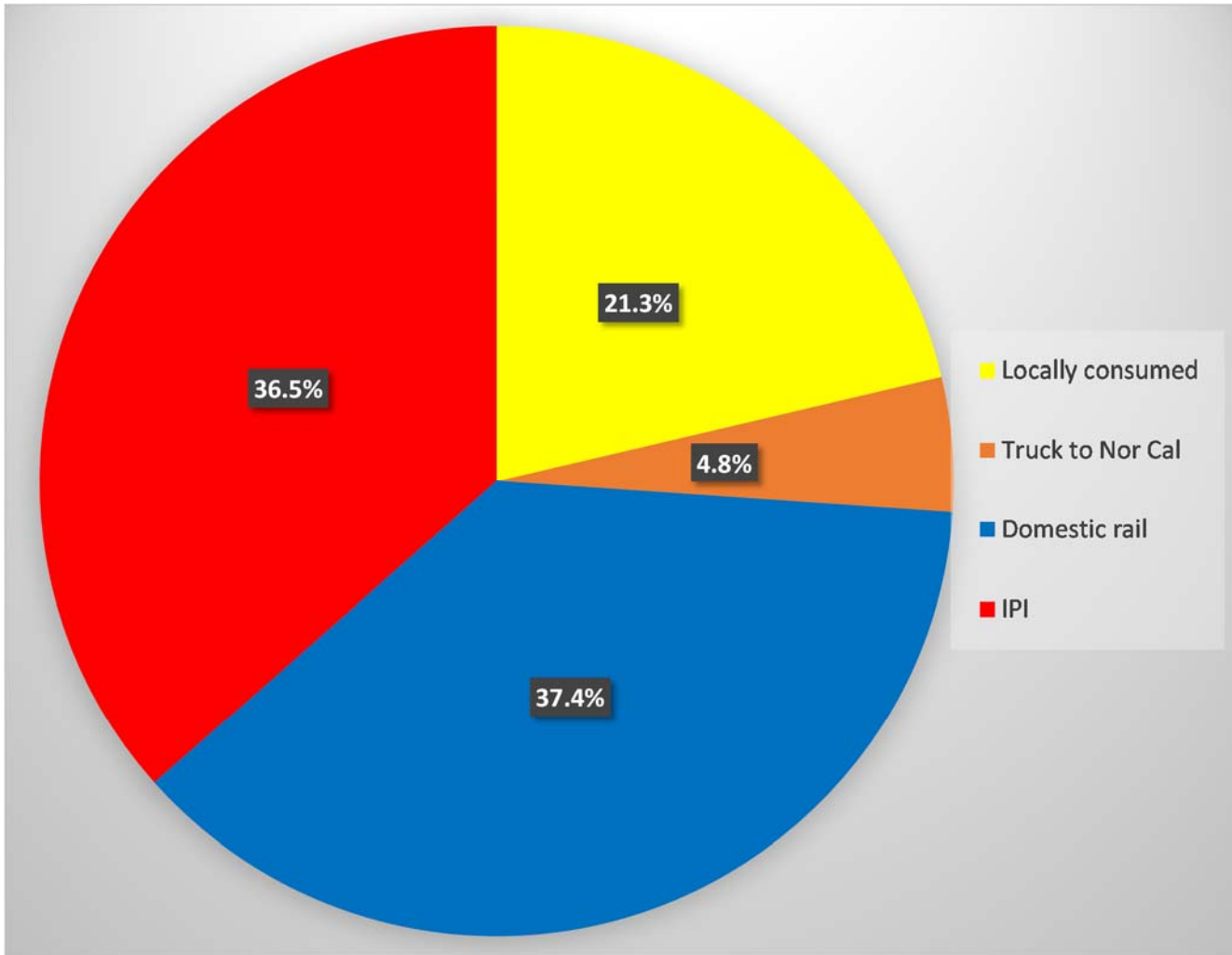
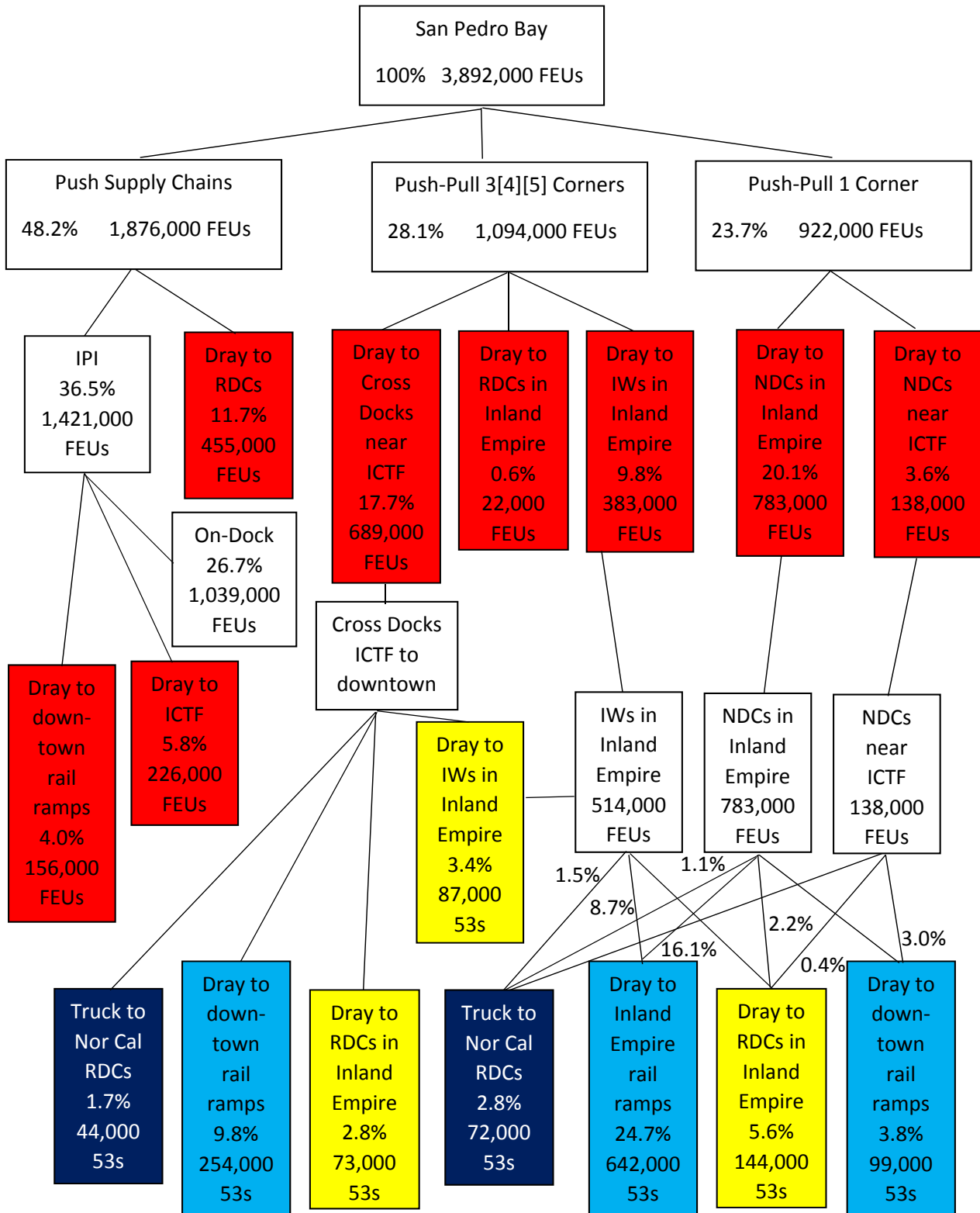


Figure 11. Distribution of San Pedro Bay Imports

Figure 12. Import Flows at San Pedro Bay



COST SAVINGS AND ENVIRONMENTAL BENEFITS TO DATE

As shown in Table 8 below, in 2015, the on-dock rail terminals at the San Pedro Bay ports made 2,203,294 lifts of containers on or off railroad well cars, while the ICTF made 482,882 lifts. About 95% of the ICTF lifts were for marine containers. Had the Alameda Corridor, the ICTF and the on-dock rail terminals not been built, the containers experiencing these lifts all would have been drayed between the Ports and the rail terminals near downtown Los Angeles.

Table 5 provides estimates of emissions for various container transport and handling activities. As may be seen in the table, it is estimated that an average dray of a marine box between the Ports and the downtown rail terminals emits 52,743 grams of CO₂; an average dray between the Ports and the ICTF emits 17,062 grams; a marine-box double-stack train from an on-dock terminal to downtown (20 miles) emits 7,449 grams per marine container; and a marine-box double-stack train from the ICTF to downtown (15 miles) emits about 5,587 grams per marine container.

Table 5: Assumed Emissions Inventory (grams)

Activity	CO₂	HC	CO	NOx	PM2.5
Top-picker lift	7114.06	2.92	12.11	64.93	1.53
Diesel RTG lift	13871.51	3.64	22.95	106.46	2.68
Hybrid RTG lift	3963.29	1.04	6.56	30.42	0.77
Marine-box double-stack train, per container-mile	372.43	0.28	0.97	5.40	0.14
Empty marine-box train, per container-mile	266.24	0.199	0.69	3.859	0.102
Domestic-box double-stack train, per container-mile	497.76	0.37	1.29	7.21	0.19
Empty domestic-box train, per container-mile	320.23	0.240	0.83	4.641	0.123
Dray ports to downtown rail	52743.43	13.11	72.79	311.33	18.27
Dray ports to ICTF	17062.20	5.57	29.01	95.82	6.22
Dray ports to nearby cross-dock or warehouse	18105.36	5.62	29.81	104.42	6.51
Dray ports to Inland Empire (IE)	143983.72	34.21	193.44	855.72	49.52

warehouse or rail terminal					
Dray IE warehouse to IE rail terminal or warehouse	15458.67	5.080	26.75	87.3	5.65
Dray IE warehouse to downtown	80231.61	19.21	108.36	476.19	27.64
Dray cross-dock to downtown rail terminal	26054.3	6.710	37.35	153.46	9.06
Dray cross-dock to ICTF	5056.51	1.89	8.93	28.87	1.93
Dray cross-dock to warehouse in ICTF area	4994.43	1.57	8.33	28.62	1.79
Dray ICTF area warehouse to IE warehouse	89591.97	21.45	121	531.74	30.87

Notes: A top-picker crane can lift a container off a chassis or off the top of a pile of containers. A rubber-tired gantry (RTG) crane can retrieve a container buried beneath other containers. Typically, lifts at port terminals of rail-borne marine boxes are made by top-pickers, while lifts of dray-borne marine boxes are made by RTGs. Lifts at off-dock rail terminals are typically made by RTGs. A marine-box double-stack train assumed to consist of 290 forty-foot containers in 29 well cars drawn by 4 Tier 3 locomotives. A domestic-box double-stack train assumed to consist of 222 fifty-three-foot containers in 37 well cars drawn by 4 Tier 2 locomotives.

Source: *Port of Los Angeles Inventory of Air Emissions – 2011*, published by the Port of Los Angeles. Total emissions for various dray movements from author’s calculations.

Table 6 calculates emissions savings using these figures. As may be seen, *the investments in the Alameda Corridor, the ICTF and the on-dock terminals served to reduce 2015 emissions of CO₂ from import and export container movements by about 143 million kilograms.* The last row of the table shows potential additional savings in emissions if the marine containers using ICTF and downtown rail terminals were shifted to on-dock rail terminals at the Ports.

Alternatively, if the rail service to and from the Ports had not been consolidated into the Corridor and if grade separations providing an equivalent level of mitigation of vehicular delays had been made to all the railroad routes to the Ports proposed for use by the railroads, the additional public investment in grade separations would have been at least \$5 billion.

Table 6: Estimated 2015 Emissions Savings (kilograms) Afforded by the Alameda Corridor, the Intermodal Container Transfer Facility, and On-Dock Rail Terminals at the San Pedro Bay Ports

	CO ₂	HC	CO	NO _x	PM _{2.5}
Actual	143.4 million	26,100	181,200	741,100	44,200
Additional Potential	10.6 million	1,800	15,100	46,200	2,800

Notes: Savings calculated as follows: Actual 2015 lift volumes of marine boxes at the various rail terminals are considered. For lifts at on-dock terminals, a dray from the port to the downtown rail terminals plus a diesel RTG lift at downtown is replaced by movement via marine-box double stack train from port terminal to downtown. For lifts at the ICTF, a dray from the port to the downtown rail terminals replaced by a dray from the port terminal to the ICTF, a diesel RTG lift at the ICTF, and movement via marine-box double stack train from the ICTF to downtown. The “additional potential” savings is calculated assuming all ICTF and downtown terminal marine-box lifts are shifted to on-dock terminals.

PROPOSED INITIATIVES FOR FURTHER IMPROVEMENTS IN HANDLING SAN PEDRO BAY IMPORTS

As the San Pedro Bay ports continue development of on-dock rail capacity, there will be a continuing reduction in drays of IPI traffic between the ports and the ICTF or downtown rail terminals. The last row of Table 6 shows the potential, at 2015 import levels, for additional reductions in emissions from these development efforts, i.e., about 11 million kilograms of CO₂ per year.

Considering IPI’s declining share of imports at San Pedro Bay, there will be surplus capacity at the ICTF and in the Alameda Corridor for the foreseeable future. One strategy for pursuing further reductions in emissions is to make use of this capacity by developing a full program of outbound domestic stack-train service from the ICTF. The primary customers for this service are the large, nationwide retailers cross-docking their imports in the general vicinity of the ICTF. At present, domestic-box intermodal loads generated at these cross-docks must be drayed up to the downtown rail terminals. Were comparable domestic-box intermodal service available at ICTF, these drays could be replaced by much shorter drays to the ICTF and rail movement of the domestic boxes through the Alameda Corridor. Offsetting this savings is the cost of re-positioning empty domestic boxes from downtown rail terminals to the ICTF, required because there are very few westbound domestic loads destined to receivers in the general area of the ports.

An estimate of the emissions reductions afforded by full domestic-rail service from the ICTF is summarized in Table 7. As may be seen, for the lift equipment presently in use at rail terminals, the potential reduction in CO₂ emissions is about 600,000 kilograms per year, but there would be increases in HC, CO and NO_x emissions. This is due to the need for two extra lifts of empty domestic boxes plus extra rail movement of empty domestic boxes from downtown rail terminals

to the ICTF to accommodate the traffic. If diesel RTGs currently in use at the rail terminals were replaced by hybrid RTGs, then CO₂ savings rises to 6.7 million kilograms per year and adverse trends in the emissions of all other factors except HC would be reversed. If diesel RTGs were replaced by rail-mounted cranes (RMCs) affording all-electric operation (i.e., zero emissions), then CO₂ savings rises to above 9 million kilograms per year and the adverse trends in the emissions of all other factors would be reversed. About 612,000 domestic-box dray trips per year between the downtown rail terminals and the general vicinity of the ICTF would be replaced by a like number of shorter dray round trips between the ICTF and cross-docks in the vicinity of the ICTF. An additional 3.8 8,000-foot domestic double-stack trains per day in each direction per day would be added to the Alameda Corridor.

Table 7: Potential Emissions Savings (kilograms) Afforded by Full Domestic-Box Rail Service at ICTF

	CO ₂	HC	CO	NO _x	PM _{2.5}
Savings	0.6 million	-2,100	-6,400	-43,000	1,300
Savings with hybrid RTGs at rail terminals	6.7 million	-501	3,700	3,000	2,500
Savings with electric RMCs at rail terminals	9.1 million	100	7,700	22,000	3,000
Savings if cross-docks near downtown re-locate near ICTF	4.1 million	-1,600	-2,900	-26,000	2,500
Savings with re-location and electric RMCs at rail terminals	13.3 million	800	12,300	45,000	4,300
Savings including other lifts at ICTF	48.2 million	9,200	59,000	252,000	16,300
Savings including other lifts at both ICTF and East LA	52.2 million	10,100	65,000	275,000	17,700

Note: Savings calculated as follows: An estimated 11.8% of 2015 San Pedro Bay imports moved from the ports to cross-docks in the general vicinity of the ICTF or to OEM distribution centers in the general vicinity of the ICTF where the imports were trans-loaded to domestic containers drayed to downtown rail terminals. An additional 1.0% of 2015 San Pedro Bay imports moved from the ports to cross-docks closer to downtown rail terminals where the imports were trans-loaded to domestic containers drayed to the downtown rail terminals. It is assumed that three inbound FEUs (forty-foot equivalent unit marine containers) generated two outbound domestic container moves from the cross-docks or OEM distribution centers. A round-trip dray of a domestic box from a cross-dock to

downtown rail terminal is replaced by an RTG lift of an empty domestic box at a downtown rail terminal, rail movement of the empty domestic box from downtown to ICTF, RTG lift of the empty domestic box at ICTF, round-trip dray of the box from ICTF to cross-dock located in the general vicinity of the ICTF, and rail movement of the box in a domestic double-stack train from ICTF to downtown.

Cross-docks typically operate in leased buildings. If cross-docks currently located closer to the downtown rail terminals were motivated by the new ICTF service to terminate leases and re-locate closer to the ICTF (and thereby reduce total dray distance from ports to cross-docks to RDCs or import warehouses located in the Inland Empire), the number of dray trips reduced and the emissions savings would rise substantially. In addition to the savings above, about 138,000 marine-box dray trips between the ports and cross-docks near downtown rail terminals would be replaced by a like number of shorter marine-box dray trips between the ports and cross-docks located in the general vicinity of the ICTF. About 32,000 domestic-box dray trips made between cross-docks near the downtown rail terminals and import warehouses or RDCs located in the Inland Empire would be replaced by longer domestic-box dray trips between cross-docks located near the ICTF and import warehouses or RDCs located in the Inland Empire, and about 4,000 truck trips from downtown cross-docks to Northern California RDCs would be extended to originate at cross-docks in the general vicinity of the ICTF. But because of the reduced number of drays required for domestic boxes in lieu of the same imports hauled in marine boxes, and because of the reduced circuitry to reach Inland Empire warehouses, total truck-miles and consequent emissions would decline substantially. CO₂ emission reductions would rise by 3.5 million kilograms per year. If lifts at rail terminals were performed with electric RTGs, CO₂ reductions would rise to 13.3 million kilograms per year. Additional trains in the Alameda Corridor would rise to 4.0 8,000-foot double-stack trains in each direction per day.

The alternatives incorporating emissions reductions from use of hybrid RTGs or all-electric RMCs involve the introduction of such equipment at both ICTF and East Los Angeles rail intermodal terminals. Introduction of such equipment might involve simply a supplement to existing diesel-powered RTGs in order to handle the proposed additional intermodal traffic, or it could involve complete replacement of the existing RTG equipment. If marine-box lifts performed at the ICTF also were performed by electric RMCs, the emissions reductions climb dramatically, reaching 48.2 million kilograms of CO₂ per year. If an additional 50,000 domestic-box lifts of non-cross-dock traffic at East Los Angeles also are performed using electric RMCs, the emissions savings climbs to about 52.2 million kilograms of CO₂ per year.

It must be remembered that the railroad bears the cost of operating intermodal terminals but does not operate the drays for intermodal service nor does it bear the dray costs. A scheme that increases rail costs while reducing dray costs decreases margin for the railroad, even if it reduces overall supply chain costs. In this case, extending domestic container service to the ICTF increases railroad-borne costs (it adds two more lifts plus train operating costs to re-position empty domestic boxes to the ICTF) in exchange for 15 more miles of line haul of trans-loaded imports. This is unlikely to be a value proposition to the railroad without public subsidy.

Hybrid RTGs and electric RMCs offer a lower operating cost than diesel RTGs, but in exchange for significantly higher investment cost. Public assistance in such investments could provide operating savings to the railroad while at the same time reducing emissions.

Before discussing further proposals, it is helpful to understand the concerns of the various stakeholders in import supply chains. There are multiple participants in import supply chains, all with different incentives arising from the business contracts and governmental regulations that enable the chains. These incentives are not always aligned, in the sense that each participant's efforts to optimize its scope of the chain might not be best for the overall chain.

- **The large nationwide retailers:** For most of their product portfolios, they wish to practice supply chains utilizing cross-docking and import warehouses, re-shipping in domestic containers and trailers from cross-dock or import warehouses located in the hinterlands of ports of entry. This sort of supply chain enables them to manage inventories as tightly as possible, minimizing the time from purchase of goods in Asia until sale in a store and thereby minimizing price erosion and working capital outlay. The large retailers refuse to import expensive items, requiring the OEMs to import such items and purchasing the items much closer to the time of sale. (In effect, the same sort of supply chain applies to expensive goods; it's just that part of the chain is administered by the OEM and part is administered by the retailer.) Only one-time-sales-event goods (e.g., patio furniture, back-to-school personal refrigerators, Halloween costumes) and inexpensive goods (under \$15,000 in declared value per TEU) are shipped intact in marine containers all the way to RDCs (because it is impossible to achieve any inventory economies for the one-time-sale goods and the inventory economies are insufficient to justify the additional handling expenses for cross-docking). The large retailers do not want their goods cross-docked inside the ports (because longshore labor is much more expensive than labor outside the port). They would like their cross-dock and import warehouse facilities to be situated close to the ports and to domestic rail terminals (to minimize dray expenses), but not be located where property is very expensive or regulation is excessive or local government is unwelcoming to logistics.

The internet sales ("e-commerce") of large retailers are growing much faster than are in-store sales. Goods imported from Asia and sold on the web present a different supply-chain challenge. As internet sales grow, the large nation-wide retailers are implementing very-large distribution centers known as "e-commerce fulfillment centers," located in the hinterland of ports of entry. Replacing shipments to RDCs and thence to stores, some e-commerce sales to customers generate shipments from the fulfillment centers direct to customers via package express carriers such as UPS. For inexpensive goods sold in e-commerce instead of stores, this represents yet another reduction of IPI volume, replacing it by trans-loaded volume and associated drayage.

For their import warehouses and e-commerce fulfillment centers, the big-box retailers desire warehouses on the order of 1,000,000 square feet in size.

- **The large nationwide OEMs:** Similar to the retailers, the OEMs would like their national distribution centers to be located close to the ports (to minimize inbound dray costs), but not be located where property is very expensive or regulation is excessive or local government is unwelcoming to logistics. Normally, outbound transportation is paid for and arranged by their retailing customers, who may arrange for full-domestic-container or full-trailer shipments, or may order smaller quantities and arrange for cross-docking of pickups from multiple OEMs into full outbound domestic containers and trailer shipments to their RDCs. The large OEMs desire warehouses serving as their nationwide distribution centers to be 500,000 – 1,000,000 square feet in size.
- **The ocean carriers:** The steamship lines struggle to compete in a business with few barriers to entry. Capacity outstrips demand, keeping prices low. Lines survive by moving to larger and larger vessels, pushing cross-ocean costs down. This trend works to the advantage of the San Pedro Bay ports, because the lines are desirous of making fewer ports of call with the very-large vessels. Lines not able to make the investments in larger vessels must retreat to niche markets or go out of business.

The lines solicit IPI business in preference over trans-load business, because the lines can make a margin over the inland haul if done as IPI in lieu of solely a margin on the ocean haul and port-area dray if the imports are trans-loaded. However, after the initial 10-year contracts with the railroads expired and the railroads successfully drove up their contract prices for IPI service, the lines have generally reduced their IPI networks to serve a smaller number of high-volume inland points.

Perhaps as a response to competitive pressures, the lines have been generous in allowances of free time until large importers are required to pick up their container loads at US port terminals before per diem charges ensue, as well as allowing importers to arrange their own dray services to come and pick up their import containers in lieu of the steamship line arranging the dray. Thus the marine terminals serving the ocean carriers have lost the ability to schedule the departure of drays from their terminals and instead must cope with large and variable container inventories.

- **The commercial real estate developers:** Typically, import warehouses and national distribution centers are constructed by commercial real estate companies. They may build-to-suit for certain large customers, or search for customers to which to lease facilities they build at risk. The real estate company wants minimum delay from decision to go forward with a development until a lease or bill of sale is signed (because its capital is expended and at risk until then). They do not want to be troubled with long delays to get governmental approvals for a project, nor with environmental clean-up costs, let alone with local governments unwelcoming to logistics or local governments insisting the developer pay

for road network improvements in order to gain project approval. The developer thus prefers a “greenfield” or “desert patch” project away from urban areas in order to maximize its return and cash flow.

The railroads: The railroads’ role in intermodal transportation has been reduced to the wholesale trainload aspect, with no responsibility for the origin or destination drays or retail pricing. They prefer a few very large terminals to achieve economies of scale to better utilize cranes, chassis and terminal crews as well as reduce risks of underutilized investment. Over time, the number of intermodal terminals operated by the railroads has been reduced, to the point that at present the two railroads operate four intermodal terminals in Northern California and six in Southern California. See Table 8.

Because the railroads outsourced the retailing and pricing of the overall service, their profitability for various services depends on the outcomes of negotiations with their retailing partners. For the first decade of IPI service, the railroad margins were rather thin on IPI traffic as they sought to develop the traffic. As contracts with steamship lines expired, the railroads exploited their market power and raised the rates substantially. Meanwhile, they negotiated flat prices with their retail partners for all shipments in domestic containers independent of the commodity shipped and independent of end customer. Shipments of very truck-competitive domestic products, such as wine, are priced the same as re-shipments of imports from OEM distribution centers and from retailer cross-docks, yet the latter are much less susceptible to truck competition. As a result, the railroads’ margins on IPI trains are generally higher than their margins on double-stack domestic container re-shipments of imports. The railroads have promoted investment in IPI infrastructure near the ports but have not promoted investment in domestic container terminal infrastructure near the ports. Because of their capital intensity and their lack of control over marketing and pricing, the railroads are risk-averse and are therefore change-followers rather than change-leaders. For example, they are loath to locate a new intermodal terminal until there are existing traffic levels and/or shipper commitments to fill the terminal.

- **The ports:** The ports are basically landlords; their tenants are the marine-terminal-operator subsidiaries of the steamship lines, or independent terminal operators providing terminal services for multiple lines. The ports sign long-term contracts to lease waterfront to the terminal operators, typically structured so that payments are made to the ports per unit container volume, but with volume incentives in the form of reduced unit payments as volume climbs. The ports seek success and contentment of their tenants. They seek labor stability, good relations with the community, and good services from the various suppliers to their tenants, including the railroads and draymen. Given that their ocean carrier clients prefer IPI service, the ports generally promote investment in same.

Table 8: Rail Intermodal Terminals in California

Terminal	2015 Lifts	Railroad	Notes
Oakland (near dock)	158,568	UP	Marine containers, domestic containers and trailers
Oakland International Gateway (near dock)	98,471	BNSF	Marine containers only
North Bay (Richmond)	51,629	BNSF	Operated by UPS, for UPS domestic containers and trailers
Stockton	368,474	BNSF	Predominantly domestic containers and trailers
Lathrop	258,052	UP	Domestic containers and trailers only
Subtotal, Northern California	935,194		
Ports of LA-LB On dock and near-dock	2,203,294	BNSF & UP	Operated by marine terminal companies, marine containers only
Intermodal Container Transfer Facility (Carson)	482,882	UP	Predominantly marine containers
Hobart/Commerce	1,149,085	BNSF	Mostly domestic containers and trailers
East Los Angeles	448,574	UP	Predominantly domestic containers and trailers
Los Angeles Transportation Center	230,052	UP	Predominantly domestic containers and trailers
City of Industry	272,289	UP	Domestic containers and trailers only
San Bernardino	604,633	BNSF	Domestic containers and trailers only
Subtotal, Southern California	5,390,809		

Sources: Private communications from BNSF and UP.

- Third-party logistics companies (3PLs):** Most cross-docks are not owned and operated by large retail importers or large OEM importers. Instead, the retailers and OEMs contract annually with 3PLs to perform their cross-docking work. Virtually any warehouse or large covered dock can be adapted for cross-docking work, provided enough doors can be cut into the warehouse to simultaneously accommodate a large number of inbound and

outbound vehicles. Typically, large retailers and OEMs put their cross-docking work up for bid annually. The lion's share of cross-docks handling inbound marine containers are located in fairly close proximity to the San Pedro Bay ports, in the adjacent communities such as Long Beach, Carson, Wilmington, Compton, Lynwood and Torrance. With little barriers to entry and little facility expense, cross-docking is generally a commodity and margins are thin. In a few instances, mostly automated cross-dock facilities have been developed using networks of conveyors and scanners to route cartons from inbound vehicles to outbound vehicles. However, software interfaces with clients take on the order of six months to implement, so longer-term contracts between importer and 3PL are required. This inhibits more widespread adoption of automation.

- **Large nationwide retail importers:** The large nationwide retailers typically own and operate their own import warehouses, and large OEM importers with customers nationwide typically own and operate their own national distribution center. But moderate- and smaller-scale retailers and OEMs typically rely on 3PLs to operate warehouses for them. Again, 3PL services tend to be contracted for a relatively short term such as one or several years, and then put up for bid again. Given their short contractual horizons and limited responsibilities, 3PLs are typically not in a position to lead or promote longer-term strategic change, and typically they are reluctant to make long-term facility investments.
- **Operators of import warehouses, cross-docks and national distribution centers:** The operators of such facilities could be nationwide retailers, OEMs, or 3PLs. The operators or their customers are basically managing inventory systems. Some marine boxes arriving at port terminals contain goods that are urgently needed, while the goods in other boxes may be quite the opposite. To manage inventory well, they wish to dispatch drays to claim the urgently-needed boxes as soon as possible, while delaying the pick-up of boxes containing goods not yet in demand. To an alarming extent, they have been successful in moving the push-pull boundary out of their facilities and back into the marine terminals. The irony of this is arresting: The most expensive property on earth (created by filling in the ocean at San Pedro Bay), manned by the most expensive labor on earth (the longshoremen), utilizing awkward rubber-tired gantry cranes to sort huge indivisible chunks of inventory (marine containers) on behalf of the American retailers, yet under terms of service from the ocean carriers whereby storage is partially or completely free.
- **The dray operators:** Dray companies typically have no assets. Their drivers are independent contractors who own or lease their own dray tractor. They work for a dray company because the company has agents and relationships that find them business. The draymen wish to work five-day-a-week jobs. They wish to be able to complete trips in a reasonable amount of time rather than get stuck in traffic or stuck in congested terminals. Dray companies and dray operators do not have much market power. Their margins are thin.

- **The marine terminal operators.** The terminal operators must cope with very-expensive longshore labor, restrictive work rules, and very limited space. They have little or no control over when consignees will pick up boxes; typically they only find out when the consignee's drayman shows up at their gate and informs them of the box they have come to pick up.¹⁶ They have no control over the terms for free time and for per diem charges placed on boxes not picked up, as those terms are set by their parent or client steamship line.
- **The local governments.** The city governments for the small cities surrounding the San Pedro Bay ports are generally unwelcoming to logistics activity. They view warehouse development as something offering a low density of employment and relatively low-paying jobs, and as a generator of traffic and pollution. Their plans for development in their communities include things like shopping malls, sports stadiums, and software companies (in order to secure good tax revenues and well-paying jobs).

Possible Solution Sets

The situation in Southern California is an example of what can happen in multi-participant supply chains: Given of the typical contractual terms among the participants, with each participant acting to optimize its profits, the result is not the most efficient overall supply chain. To move towards a more efficient supply chain requires changes in the contractual terms between the participants. In particular, public-private partnerships could be key enablers of such changes. We discuss three possible initiatives in this regard: Short-Haul Intermodal, Infill, and Dray-Off.

There is considerable warehouse development in the communities surrounding the San Pedro Bay ports. But this is largely older development, not intended to accommodate the needs of today's large-scale importers. Instead it was primarily built to support inbound logistics for the large defense contractors, whose businesses were booming in the Los Angeles Basin during the 1960s and 1970s Cold War period. The large defense firms were basically systems integrators, outsourcing fabrication of components to many small specialized machine shop firms located in the Basin. The warehouses located near the ports are mostly in the size range of 50,000 – 120,000 square feet. They were very suitable for the storage of machined components pending integration into missiles, fighter planes and other defense systems. But military-aerospace production in Southern California is much smaller now, and so the warehouse space has been repurposed for handling imported goods. Some were converted to cross-docks; others are operated by 3PLs as import warehouses for small- or medium-sized importers and OEMs. Unfortunately, these relatively small warehouses are of little or no use to large nationwide retailers and OEMs. As

¹⁶ Some terminals have implemented a reservation system with two-hour windows for pick-up of import containers, providing terminal management with a near-term, rough idea of when boxes will be demanded.

described above, the large importers need facilities that are an order-of-magnitude larger. Many of these facilities are now vacant or under-utilized.

The commercial real estate companies are reluctant to knock down the older, small warehouses and merge lots to build larger facilities. It is difficult to secure permits from local governments generally unwelcoming to logistics development. It is much more cost effective to secure space for the development of new large-scale facilities much further away from the ports. While distant locations increase transportation expenses for the importers, at least they are feasible in a timely manner, and the lower property taxes and possibly less expensive labor can partially offset the increased transportation costs.

Thus, as imports grew through the 1980s and 1990s, the Inland Empire became the preferred locale for commercial development of warehouses supporting import logistics. Property suitable for warehousing in the Inland Empire is largely built out now, so more recent development of modern large-scale distribution facilities is moving further out, to places like Perris, Apple Valley and the Tejon Ranch. At the same time, the vacancy rate of the smaller warehouses located close to the ports continues to grow. See Figure 13. As may be seen, there is a huge surplus of facilities smaller than 250,000 square feet, while no facilities were available to meet lease requests for facilities larger than 750,000 square feet. For the latter demand, new facilities were required.

This is an alarming trend. But it's predictable, as all participants are acting to optimize their aspect of the supply chain.

Short-Haul Intermodal

The huge flow of imports from the San Pedro Bay ports to downtown rail terminals and to warehouses in the Inland Empire has given rise to several proposals for constructing expensive infrastructure to cope with the burgeoning goods movement demand. These proposals include double-decking freeways with dedicated truck lanes, building all-new truck corridors, and even magnetically-levitated trains hauling the import containers.

A much less costly proposal that has been advanced envisions conventional double-stack trains making a short run from a near-dock rail terminal or on-dock terminals in the ports area to a rail terminal or terminals located in the Inland Empire. While this proposal is much less capital-intensive than others cited above, it is not economically viable without public assistance. In marine terminals at the San Pedro Bay ports, assuming marine boxes are staged by vessel unloading crews close to the on-dock rail tracks, a lift of a marine box into a well car using a one-man top-picker costs about \$100. Another lift out at the Inland Empire terminal to put the box on a chassis would be required, probably using a more expensive RTG crane. A dray from the Inland Empire rail terminal to a local consignee would cost \$150 - \$200. These costs should be compared to a direct dray from the marine terminal to the consignee, which costs in the range \$300 - \$400 (plus \$140 for PierPass if the box is picked up during the day shift on a weekday, free if picked up on second

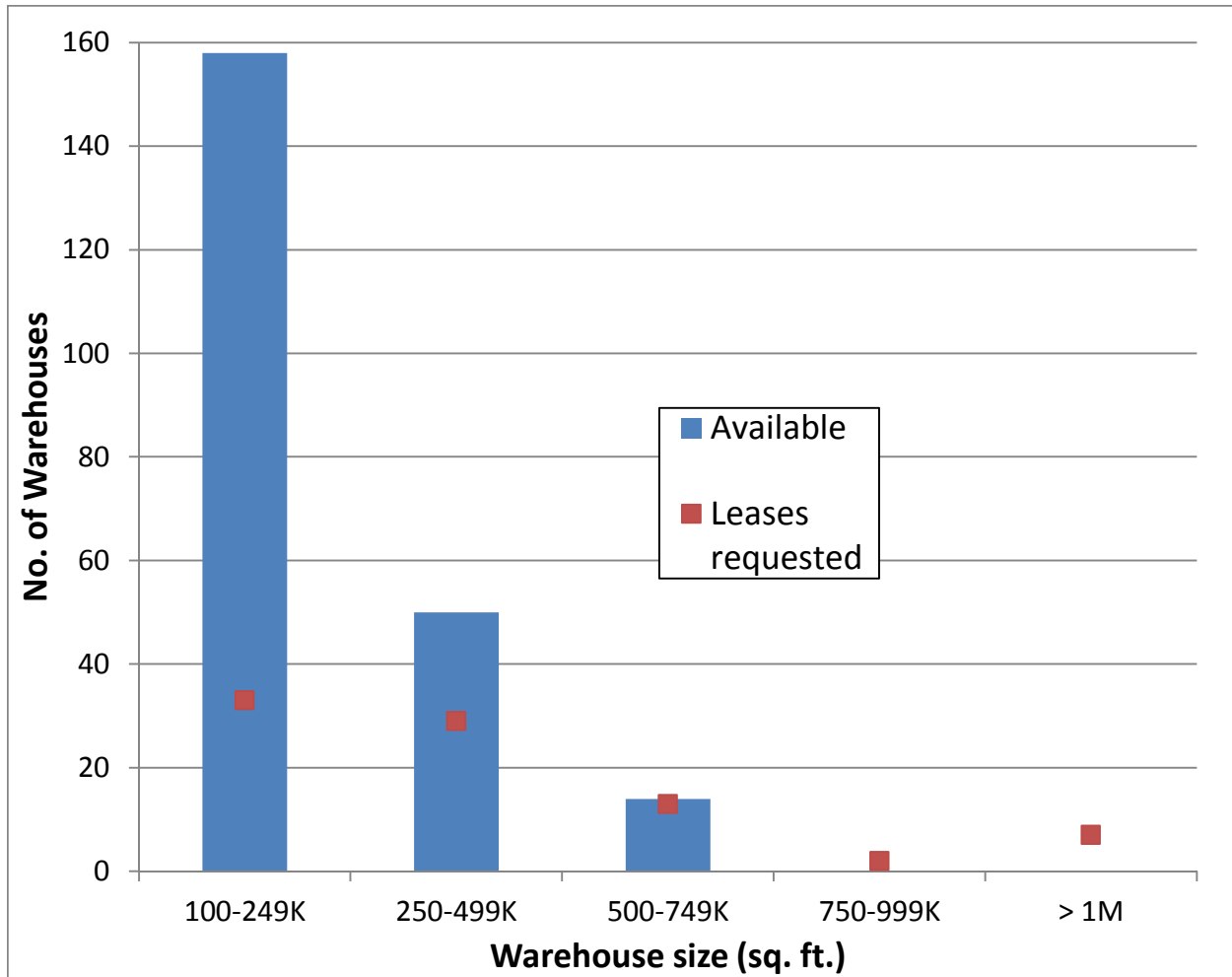


Figure 13: Supply vs. Demand for Warehouse Facilities in Greater Los Angeles, as of Sept. 2013

Source: Jones Lang LaSalle “Big Box Outlook Fall 2013” <http://www.us.jll.com/united-states/en-us/research/industrial-and-logistics>

shift or on Saturday).¹⁸ Required rail operations would include switching to assemble a train from well cars loaded at various on-dock and near-dock terminals, line haul to the Inland Empire terminal, line haul to bring the empty boxes back to the ports, and switching to distribute the empties to the port terminals.

While short-haul intermodal has not been a commercially attractive business for the Western railroads under traditional market conditions, there is a unique opportunity to make it viable and attractive in Southern California, whereby the short-haul movement of international containers is coupled with re-shipping the imported goods long-haul in domestic rail containers.

¹⁸ These figures are from private communications with marine terminal and dray companies.

Previous studies have indicated a subsidy on the order of \$150 per container would be required.²⁰ As dray costs rise and as the PierPass fee rises, the economics of short-haul intermodal become more favorable, but it seems likely that some level of public subsidy still would be required to develop an intermodal terminal in the Inland Empire, plus an on-going subsidy for the operations. Public subsidy of short-haul intermodal could well be in the public interest, considering the reductions in freeway traffic and emissions. The primary customers for such a service would be the large nationwide OEMs operating national distribution centers in the Inland Empire. Another group of potential customers is comprised of retailers operating import warehouses and/or RDCs in the Inland Empire. While a portion of the large nationwide retailers' volumes moving to the import warehouses must be cross-docked and re-loaded in domestic trailers for movement to the import warehouses, another portion moves intact in marine boxes from the ports to the Inland Empire import warehouses. Imports by smaller, regional retailers also move intact in marine containers from the ports to Inland Empire RDCs.

Estimates of the potential for emissions reductions from short-haul rail intermodal are provided in Table 9. As may be seen, the potential emissions reductions from short-haul intermodal are impressive, about 180% of the current contribution of the Alameda Corridor for a short-haul service for only marine boxes, and more than twice the current Alameda Corridor contribution if in addition the Inland Empire rail terminal equipped with electric RMCs. About 2.6 million drays per year between the ports and the Inland Empire would be replaced by rail movement to the Inland Empire and much shorter dray trips in the Inland Empire, adding about 12.6 8,000-foot marine-box double-stack trains each way per day to the Alameda Corridor.

An option for the short-haul intermodal initiative is to also offer domestic-container rail transportation for imports moving from cross-docks located in the general vicinity of the ICTF to Inland Empire warehouses. This option has the potential to replace about 290,000 dray trips per year between the general vicinity of the ICTF and Inland Empire warehouses with much shorter dray trips between cross-docks and the ICTF and between an Inland Empire rail terminal and Inland Empire warehouses. This option provides only minor additional reductions in CO₂ emissions, but the potential port area – Inland Empire dray trips that could be replaced by rail movement plus much shorter dray trips would rise to more than 2.9 million per year. The total double-stack trains required to accommodate the combined market potential would rise to about 14.4 8,000 foot double stack trains per day in each direction.

The main impediments to the short-haul intermodal initiative would be (1) securing adequate rail intermodal terminal capacity in the Inland Empire, (2) provision of adequate staging trackage in the ports complex and/or adjacent to the ICTF to assemble/disassemble trains of well cars moving from/to multiple port terminals, and (3) negotiation of an agreement with a railroad to provide the service with a politically-feasible public subsidy.

²⁰ Mongelluzzo, Bill, "Shippers await short-haul rail option to San Pedro Bay ports," *Journal of Commerce*, April 27, 2016.

Table 9: Potential Emissions Savings (kilograms) Afforded by Short-Haul Intermodal Service

	CO ₂	HC	CO	NO _x	PM _{2.5}
Savings – marine boxes only	256.6 million	17,600	233,000	871,000	86,000
Savings – marine boxes only, with hybrid RTGs at rail terminals	282.8 million	24,500	276,000	1,072,000	91,000
Savings – marine boxes only, with electric RMCs at rail terminals	293.3 million	27,200	293,000	1,153,000	93,000
Savings – marine boxes plus domestic boxes	263.2 million	13,800	226,000	812,000	89,000
Savings – marine boxes plus domestic boxes, with electric RMCs at rail terminals	308.0 million	25,500	300,000	1,156,000	97,000

Note: Savings calculated as follows: An estimated 23.7% of 2015 San Pedro Bay imports were made by large, nationwide OEMs or e-Commerce firms; it is assumed 85% of them operate distribution facilities located in the Inland Empire. In addition, an estimated 10.4% of 2015 San Pedro Bay imports were moved intact in marine containers by large, nationwide retailers from port terminals to their import warehouses or regional distribution centers (RDCs), assumed to be 100% located in the Inland Empire. In addition, an estimated 11.7% of 2015 San Pedro Bay imports for consumption in the local region made by small and regional importers; it is assumed 30% of them operate distribution centers in the Inland Empire. Two RTG lifts at the port terminals (an average of one to clear a box in the way and one to retrieve the desired box) and a round trip dray from the port terminals to the Inland Empire are replaced by a top-picker lift at the port terminal, movement via marine-box double-stack train from port terminal to an Inland Empire rail intermodal terminal, RTG lift of loaded box at the Inland Empire rail terminal, round trip dray from Inland Empire rail intermodal terminal to Inland Empire warehouse, RTG lift of empty box at the Inland Empire rail terminal, and movement via empty marine-box double-stack train from Inland Empire to port terminal. Not included in this estimation are emissions associated with rail switching to assemble/disassemble trains of well cars originating/terminating at multiple port terminals. For the option including domestic boxes, an estimated 5.8% of 2015 San Pedro Bay imports are cross-docked in the general vicinity of the ICTF and then drayed in domestic trailers to import warehouses or regional distribution centers in the Inland Empire operated by large, nationwide retailers. For such imports, a round trip dray of a domestic trailer from cross-dock to Inland Empire warehouse is replaced by an RTG lift of empty domestic container at Inland Empire rail terminal, double-stack rail movement of empty domestic container from Inland Empire rail terminal to ICTF, two RTG lifts at ICTF (one of empty box and one of loaded box), round trip dray of domestic container from ICTF to cross-dock, double-stack rail

movement of loaded domestic container from ICTF to Inland Empire rail terminal, and an RTG lift of loaded domestic container at an Inland Empire rail terminal.

Infill

The standard paradigm for transportation planning is to take origin-destination travel demand as a given, and then plan infrastructure and/or traffic control systems to accommodate this demand. In contrast to the standard paradigm for transportation planning, we could consider re-engineering the import supply chains in ways that reduce the need for dray transportation. A more informed perspective, cognizant of the larger supply chains, makes one realize that the current locations for distribution centers – intermediate points in the supply chains – perhaps could be changed and need not be taken as a given. In terms of total supply chain cost, it might be cheaper to relocate those facilities than to build transportation infrastructure to serve them. Put another way, an outside-the-box approach to reducing the trucking impacts in the Los Angeles Basin involves *reducing the need for freight transportation instead of building infrastructure to accommodate it.*

While the Inland Empire is a sensible location for regional distribution centers, enabling ease of distribution to San Diego, Las Vegas and Phoenix, it is less sensible as the site for the national distribution centers and import warehouses making heavy use of rail intermodal. Were such facilities located closer to the ports, with intermodal loads entrained in the vicinity of the ports, a dramatic reduction in dray transportation could be realized.

If there was only one party controlling all aspects (both public and private) of the supply chains, a very different and much better solution could be engineered, as follows.

- The old warehouses near the ports that are vacant or underutilized would be knocked down. Perhaps in some instances, low-volume streets running between them would be closed. Environmental clean-up of the sites would be done as required. Lots would be merged to realize suitable lots for development of large start-of-the-art distribution facilities.
- The commercial real estate companies would develop modern, large distribution facilities on these new sites.
- The large big-box retailers and OEMs would site their import warehouses, e-commerce fulfillment centers, and national distribution centers in these new facilities, close to the ports instead of at sites far away from the ports. Cross-docks located near downtown rail terminals would be abandoned in favor of sites closer to the ports, freeing up central warehouse space for local distribution activity.
- Union Pacific's underutilized Intermodal Container Transfer Facility (ICTF), currently handling marine containers and only a very small volume of domestic containers, would be re-purposed to handle a large volume of domestic containers, and UP would offer frequent domestic stack train service from the ICTF to major points east of the Rockies.
- Instead of an exclusively-marine-box facility, BNSF's proposed SCIG (Southern California Intermodal Gateway) rail terminal would be repurposed to handle a large volume of domestic containers, and BNSF would offer frequent domestic stack train service from SCIG to major points east of the Rockies.

If all the supply-chain stakeholders were brought to the table, an agreement might be achievable whereby all parties could be made better off, and supply chains could be rationalized as suggested above. We call this initiative *Negotiated Infill with Domestic Rail*. The terms of such a deal might include the following items:

- The government of at least one and preferably several of the small cities near the ports must support logistics development in its municipality. An insightful leadership would recognize that a community located right next to a port is the logical site for logistics activities related to international trade, and this is an aspect to be leveraged, not discouraged. For example, software companies specializing in automation of warehouses and cross-docks could be encouraged to locate in the city. An insightful leadership would recognize that if no development occurs, the drays to and from the ports will not go away, they will simply pass through their community on the freeway network, generating more noise and more pollution than if the drays ended their trips in their community. If instead of passing by on the freeways, the drays from the ports used city streets to make trips to warehouses or cross-docks located in their municipality and then subsequent trips on city streets from those facilities to the nearby rail terminals, it would result in a reduction in noise and emissions in their community as well as in the Basin as a whole. Moreover, the new facilities and expanded rail terminals would generate blue-collar jobs for their community, and such jobs would be preferable to jobs at new software companies because such companies likely would bring in educated workers from elsewhere rather than hire the underemployed current citizens in the community.
- Local governmental agencies and the state government would recognize that a proposal to eliminate the need for freight transportation could be far more environmentally beneficial and far less costly than proposals to expand freeways with truck lanes and proposals to develop subsidized conventional or advanced-technology trains to haul containers from the ports area to the Inland Empire warehouse district. Bureaucratic and legal barriers would be eased so that monies earmarked for transportation infrastructure could be reallocated to raze obsolete small warehouses near the ports and perform environmental remediation as required. The commercial real estate owners or developers would be invited to agree to build on these cleared sites modern, large distribution facilities attractive to the large retailers and OEMs.
- Given the commitment of commercial developers to build new facilities, large nationwide retailers and OEMs would agree to buy or lease the new facilities, perhaps with the proviso that one or both of the railroads would implement significant domestic stack train service from nearby rail terminals. Moreover, large nation-wide retailers utilizing cross-docks near the downtown rail terminals would agree to shift such activity to cross-docks in the general vicinity of the ICTF.

- Given a commitment of large retailers and OEMs to shift their distribution activity to facilities in the general vicinity of the ICTF, the Union Pacific would agree to re-purpose and expand the ICTF²¹ to offer attractive domestic stack train service.
- Given the commitment of large retailers and OEMs to facilities in the general vicinity of the ICTF, the Port of Los Angeles and BNSF would agree to revise the SCIG²² proposal to feature significant and attractive domestic stack train service. The proposal would note that, because of the repurposing, the revised SCIG would engender a much larger reduction in Los Angeles Basin truck traffic than the previously proposed facility.

If a large-scale public-private-partnership deal as envisioned above could be reached, the potential reduction in truck traffic in the Los Angeles Basin is significant. Estimates of the potential emissions reductions for such an initiative are provided in Table 10. As may be seen the potential reductions in emissions amounts to about 238 million kilograms per year, or about 70% more than the current contribution of the Alameda Corridor. The potential rises to 257 million if rail terminals are equipped with electric cranes. If implemented to its maximum potential, the Negotiated Infill with Domestic Rail initiative would replace almost 4.6 million dray trips per year with shorter dray trips, mostly replacing trips between the ports or the general area of the ICTF and the Inland Empire with shorter trips within the general area of the ICTF and the ports. However, about 248,000 existing dray trips within the Inland Empire (between retailer import warehouses or OEM national distribution centers and retailer regional distribution centers) would be replaced by trips between the general vicinity of the ICTF and the Inland Empire, making for a potential net number of reduced dray trips of about 4.3 million per year. At maximum potential, about 12.3 8,000-foot domestic double-stack trains per day in each direction would be added to the Alameda Corridor. This is much less than the number of additional trains associated with short-haul intermodal because of the efficiencies associated with transportation in the 33% larger domestic boxes.

The reader is cautioned that the potential savings for Short-Haul Intermodal and for Infill are not additive because shifting distribution activity from the Inland Empire to the general vicinity of the ICTF, as envisioned under Infill, reduces the potential traffic for Short-Haul Intermodal. Moreover, the Infill alternative includes full domestic intermodal service at the ICTF, whereas the benefits of ICTF domestic intermodal service and short-haul intermodal service are additive.

Were either the Short-Haul Intermodal initiative or the Negotiated Infill with Domestic Rail proposal fully implemented, or if some combination were implemented, the Alameda Corridor finally could become fully utilized and fulfill its promise. In fact, it could exceed its originally-envisioned promise because of the increased environmental efficiency afforded by shipping in domestic containers in lieu of marine containers. Truck traffic on the 110, 710 and 60

²¹ Efforts to seek environmental approval to expand the ICTF were initiated but then tabled when marine container volumes did not meet expectations.

²² A recent ruling denied environmental approval for SCIG. As of this writing, BNSF and the Port of Los Angeles are re-assessing whether to go forward with further efforts to gain approval.

Table 10: Potential Emissions Savings (kilograms per year) Afforded by the Negotiated Infill with Domestic Rail Initiative

	CO ₂	HC	CO	NO _x	PM _{2.5}
Savings	238.4 million	30,700	248,000	988,000	83,600
Savings if rail terminals equipped with hybrid RTGs	251.7 million	34,200	270,000	1,089,000	86,300
Savings if rail terminals equipped with electric RMCs	256.7 million	35,500	278,500	1,128,000	87,200

See Appendix 2 below for calculated savings methodology.

freeways could be dramatically reduced. Considering that imports trans-loaded to domestic containers and trailers already exceed imports moving inland intact in marine containers from San Pedro Bay, and are likely to account for an increasingly larger share of imports in the future, these initiatives would seem to be promising directions for public policy.

Dray-Off

Steamship lines offer three basic kinds of rates for containerized imports through California ports: IPI (discussed above), Store-Door (SD), and Container Yard (CY). For an SD rate, the line quotes a rate including vessel passage plus a dray to a customer dock in the hinterland of the port of entry. For a CY rate, the customer must pick up the box at the port terminal and separately arrange for a dray from the port terminal to destination.

In the early years, the steamship lines subcontracted dray companies to make SD deliveries on their behalf. But a number of large import customers became dissatisfied with this service, and requested that the customer’s in-house dray staff or customer-subcontracted dray companies be allowed to perform the dray from port terminal, whereby the line refund the dray portion of the SD rate. Over time, this became the dominant practice for SD import traffic. In effect, the SD import volume morphed into CY volume.

This transition is significant from an emissions point of view because the port terminals lost control of drays of imports. Before the transition, import boxes could be dispatched by the terminal based on nearest-box dispatched first. The box on top of the front stack could be dispatched first. A top-picker crane is sufficient for loading the box on a chassis under such a protocol. After the transition, for a given import box, at the time a vessel is unloaded, the terminal management does not know how long a given box will reside in the terminal. In the tight confines of port terminals, the import boxes must be stacked. Once the customer-contracted drayman arrives to pick up a desired box, typically there are one or more boxes on top of, or in front of, the desired box. These other boxes must be lifted out of the way in order to retrieve the desired box. This requires use of

a rubber-tired gantry (RTG) crane. An RTG crane requires a larger crew and generates more emissions per lift than a top-picker. And more lifts are required.

At present, the average number of lifts to retrieve a desired box at a port terminal for an SD or CY dray is about 2.0. However, if the terminal becomes very congested, this figure can grow to 2.5 or more. As more and more lifting work is required to retrieve boxes, the terminal can fall further and further behind, leading to a terminal “melt-down” crisis.

To protect themselves from melt-down, as well as in an effort to control terminal costs, some San Pedro Bay marine terminals have implemented a practice known as *dray-off*. Under dray-off, import boxes awaiting customer dray are placed on chassis by a top-picker. A terminal-contracted dray company immediately drays the boxes to an off-terminal lot, leaving the boxes resting on chassis at this lot. Customer-contracted draymen coming to pick up their box are directed to the off-terminal lot to claim their box.

The practice is popular with some customers because their draymen can pick up boxes with much less terminal delay than experienced at port terminals. Moreover, the PierPass fee can be avoided if boxes are drayed to the off-site lot during off-peak periods.

Generally, three working days of storage at port terminals free of charge are allowed for import containers, after which demurrage charges are assessed for all time in excess of the free time.²³ Thus the transition in SD service from dray performed by the steamship line to dray performed by the importer has provided the importers with up to three free days of storage for imports moving under SD rates. This free time can be used by importers for inventory management purposes, i.e., boxes whose contents are urgently needed are picked up first while boxes whose contents are not in near-term demand can be left at the port terminals to use up the free storage time.

The transition in SD service results in a significant increase in emissions for imports, and arguably results in more investment in the expensive marine terminals than otherwise required (because of the increased population of import boxes on the terminal).

Given the potential cost savings to terminals and the potential for emissions reduction, it is suggested that importers ought to be given an economic incentive to change their import policy. We envision a new SD rate, lower than the current SD rate, in which the importer is required to accept a terminal-controlled dray in lieu of the importer-controlled dray as at present. Instead of draying to an off-terminal lot, the terminal-contracted draymen would dray directly to consignee dock. Terminal-contracted drays would be loaded by a top-picker, in the order most convenient for terminal operation. (A variant of this initiative works as follows: Customers participating in the new lower-rate service agree to pool their draymen with the draymen of other participating customers. Loads are assigned to the pooled draymen at the convenience of the terminal, independent of which customer employs the draymen.) The estimated potential for emission savings per year from such a dray-off program at the San Pedro Bay ports is provided in Table 11 below.

²³ Reportedly, some large importers are granted additional free time under terms of their confidential contracts with the lines.

Table 11: Potential Emissions Savings (kilograms) Afforded by the Dray-Off Initiative

	CO2	HC	CO	NOx	PM2.5
Savings	51.0 million	11,000	83,000	366,000	9,000

Note: Savings calculated as follows: An estimated 63.5% of San Pedro Bay imports are not moving in Inland Point Intermodal service and require a dray from marine terminals. An average of two RTG lifts per FEU (forty-foot equivalent unit) for this traffic are replaced by one top-picker lift.

As may be seen, if all non-IPI imports were shifted from customer-controlled dray to terminal-controlled dray, about 51 million kilograms of CO2 emissions per year could be avoided. The reader is cautioned that these savings are not additive to the savings from the Short-Haul Intermodal initiative, because that initiative also shifts imports from RTG lifts to top-picker lifts at the port terminals.

The reader may wonder, if dray-off would save port terminals money and reduces emissions, why is it not more prevalent? It should be recognized that steamship lines must compete for the business of larger importers, and so the lines are reluctant to provide less attractive terms of business to such customers. Requiring customers to participate in a dray pool or accept terminal-controlled drays might be seen as an affront to important customers. Raising SD rates also would be seen as an affront. Moreover, at a time when all lines are losing money, it is probably difficult for the lines to consider a new dray service offered at a discounted price. Public intervention may be required to enforce a price difference between a new dray-off service and the currently-allowed random customer pick-up service.

In summary, given current contractual relationships, it is difficult for the private enterprise system to achieve further reductions in emissions. But there are several very promising avenues for public-private partnerships that could make dramatic reductions in emissions and truck traffic associated with imports through San Pedro Bay, including short-haul intermodal, infill and dray-off.

Acknowledgments

Preparation of this white paper and the analysis supporting it was supported in part by Caltrans and the Intermodal Transportation Institute of the University of Denver. My erstwhile student Ajay Bawa provided considerable assistance in applying the emissions formulas developed by the Port of Los Angeles to tally emissions from import supply chain activity within the LA Basin. Dr. Payman Jula wrote queries against the PIERS-TI and Global Trade Atlas databases to identify 2015 Far East – USA import volumes by commodity and importer nationwide as well as through the SPB Ports. While the direct support for this paper is much appreciated, it should be recognized that the insights and analysis summarized in this paper are the culmination of 13 years of research conducted by the author. Key consulting reports and academic publications from this research are provided in the Bibliography below. The initial and primary sponsor of this research was the Southern California Association of Governments. The

research also benefited from consulting assignments or research sponsorship received from the Ports of Long Beach, Tacoma and Seattle; SSA Marine, Inc.; Union Pacific Railroad; and Target Stores, Inc. The author is grateful for this support, as well as for the time spent by many logistics managers to explain their operations and analysis of same. However, the conclusions and recommendations of this report are solely the views of the author and do not necessarily reflect the views of any sponsor or collaborator.

Bibliography

Leachman, Robert C., *San Pedro Bay Ports Access Study, Phase 2: Railroad Access, Volume II – Railroad Operations Analysis*, prepared for Southern California Association of Governments, 1984.

Leachman, Robert C., *Final Report – Port and Modal Elasticity Study*, prepared for the Southern California Association of Governments by Leachman & Associates LLC, 2005. Available on-line at <http://www.scag.ca.gov/goodsmove/pdf/FinalElasticityReport0905.pdf>.

Leachman, Robert C., “Port and Modal Allocation of Waterborne Containerized Imports from Asia to the United States,” *Transportation Research Part E*, **44** (2), p. 313 – 331 (March, 2008).

Leachman, R. C., “Final Report – Port and Modal Elasticity Study, Phase II. Consulting report prepared for the Southern California Association of Governments” 2010. Available on-line at <http://www.scag.ca.gov/goodsmove/elasticitystudyphase2.htm>.

Jula, Payman and Robert C. Leachman, “A Supply Chain Optimization Model for the Allocation of Containerized Imports from Asia to the United States,” *Transportation Research Part E*, **47** (5), 609-622 (September, 2011).

Jula, Payman and Robert C. Leachman, “Long- and Short-run Supply Chain Optimization Models for the Allocation and Congestion Management of Waterborne, Containerized Imports from Asia to the United States,” *Transportation Research Part E*, **47** (5), 593 – 608 (September, 2011).

Leachman, Robert C. and Payman Jula, “Congestion Analysis of Waterborne, Containerized Imports from Asia to the United States,” *Transportation Research Part E* **47** (6), 992 – 1004 (November, 2011).

Mongelluzzo, Bill, “Shippers await short-haul rail option to San Pedro Bay ports,” *Journal of Commerce*, April 27, 2016.

Appendix 1. Analysis of Boundary Conditions to Deduce Import Flows at San Pedro Bay

In the text it is asserted that, given the total share of Far East – USA imports at San Pedro Bay, given the IPI fraction at San Pedro Bay, given the fraction of total Far East – USA imports

consumed in the local region, given the shares of total Far East – USA imports moving in Push-Pull 3[4][5] Corners supply chains and in Push-Pull 1 Corner supply chains, and given the fraction of Push-Pull 1 Corner importers whose national distribution center is located in Southern California, then the fraction of imports in Push-Pull 3[4][5] Corners supply chains moving through San Pedro Bay, the fraction of imports in Push supply chains moving through San Pedro Bay, and the overall fraction of Far East – USA imports moving in Push supply chains may be deduced. This appendix develops the equations proving this assertion.

Notation

SPB – fraction of total Far East – USA imports moving through San Pedro Bay

L – fraction of total Far East – USA imports consumed in the Southern California region

IPI – fraction of San Pedro Bay imports from the Far East moving in inland point intermodal service

SR – fraction of total Far East – USA imports moving in Push supply chains. Such chains are utilized by small and regional retailers for all of their imports as well as by large, nation-wide retailers for their “one-off” goods that are not re-stocked.

SM – fraction of total Far East – USA imports moving in Push-Pull 1 Corner supply chains. Such chains are utilized by large, nation-wide original equipment manufacturers.

SB – fraction of total Far East – USA imports moving in Push-Pull 3[4][5] Corners supply chains. Such chains are utilized by large, nation-wide “Big-Box” retailers.

XR – fraction of total Far East – USA imports moving in Push supply chains that pass through San Pedro Bay.

XM – fraction of total Far East – USA imports moving in Push-Pull 1 Corner supply chains that pass through San Pedro Bay.

XB – fraction of total Far East – USA imports moving in Push-Pull 3[4][5] Corners supply chains that pass through San Pedro Bay.

Initial Conditions

Suppose we are given SPB , L , IPI , SM , SB , and XM . We now proceed to solve for SM , XB and XR .

Derivation

The shares of the three supply chain types account for all Far East – USA imports:

$$(1) \quad SM + SB + SR = 1; \text{ therefore, } SR = SM + SB.$$

Considering the Push supply chain, we have:

$$(2) \quad XR SR = SR * L + IPI * SPB .$$

Considering San Pedro Bay's share of overall Far East – USA imports, we have:

$$(3) x_{RSR} + x_{MSM} + x_{BSB} = SPB .$$

Equations (1) and (3) imply

$$x_R = [1/(1 - s_M - s_B)] * IPI * SPB + L .$$

Substituting this result into equation (3), we have:

$$x_{MSM} + x_{BSB} = SPB - x_{RSR} = SPB - x_R(1 - s_M - s_B) = SPB - IPI * SPB - (1 - s_M - s_B) * L .$$

Solving for x_B , we have:

$$x_B = (1/s_B)[(SPB - IPI * SPB - L) - (x_M - L) * s_M] + L .$$

Numerical Results

For $SPB = 0.507$, $L = 0.108$, $IPI = 0.3653$, $s_M = 0.15$, $s_B = 0.3$, and $x_M = 0.8$, we obtain $s_R = 0.55$, $x_B = 0.475$ and $x_R = 0.445$. The shares of imports by supply chain type at San Pedro Bay become $x_{RSR}/SPB = 48.2\%$ for Push supply chains, $x_{BSB}/SPB = 28.1\%$ for Push-Pull 3[4][5] Corners supply chains, and $x_{MSM}/SPB = 23.7\%$ for Push-Pull 1 Corner supply chains, as reported in the text.

Appendix 2. Footnotes to Table 10

Savings were calculated as follows: It is assumed that no regional distribution centers would move from the Inland Empire to the infill area, i.e., only relocation of national distribution centers, e-commerce fulfillment centers and import warehouses is considered. It is assumed that three inbound FEUs (forty-foot equivalent units) generated two outbound domestic container moves from OEM distribution centers or retailer import warehouses. An estimated 23.7% of 2015 San Pedro Bay imports were made by nationwide OEMs or e-commerce firms; it is assumed that 85% of such firms operate national distribution centers located in the Inland Empire. For such importers, it is assumed that 83.8% of their imports are re-shipped from the distribution centers to retailing customers using domestic rail containers, 10.8% are trucked to regional distribution centers located in the Inland Empire, and 5.4% are trucked to regional distribution centers located in Northern California. A round trip dray of the marine box from the port terminals to the Inland Empire is replaced by a round trip dray from the port terminals to a distribution center located in the general vicinity of the ICTF. Considering outbound shipments from the distribution center, a round trip dray of a domestic container from Inland Empire rail terminal to Inland Empire warehouse is replaced by an RTG lift of empty domestic container at Inland Empire rail terminal, movement in empty-container double-stack train from Inland Empire rail terminal to ICTF, RTG lift of empty container at ICTF, round trip dray of domestic container from ICTF to nearby warehouse, and movement in loaded double-stack train from ICTF to the Inland Empire. A round trip dray of a domestic trailer from OEM warehouse in the Inland Empire to retailer RDC in the Inland Empire is replaced by a round trip dray of domestic trailer from OEM warehouse in the general vicinity of the ICTF to retailer RDC in the Inland Empire. A one-way domestic trailer movement from Inland Empire warehouse to downtown en route to Northern California is replaced by a one-way trailer movement from a warehouse in the general vicinity of the ICTF to downtown. In addition, an estimated 9.8% of 2015 San Pedro Bay imports were moved by nationwide retailers intact in marine containers to their import warehouses, also assumed to

be located in the Inland Empire. Of this amount, it is assumed 65.9% were re-shipped in rail domestic containers; 22.7% were drayed in domestic trailers to the local RDC in the Inland Empire, and 11.4% were trucked to Northern California distribution centers. A round trip dray of the marine box from port terminals to Inland Empire warehouses is replaced by a round trip dray from port terminals to a warehouse in the general vicinity of the ICTF. Considering outbound shipments from the import warehouse, a round trip dray of a domestic container from Inland Empire rail terminal to Inland Empire warehouse is replaced by an RTG lift of empty domestic container at Inland Empire rail terminal, movement in empty-container double-stack train from Inland Empire rail terminal to ICTF, RTG lift of empty container at ICTF, round trip dray of domestic container from ICTF to nearby warehouse, and movement in loaded double-stack train from ICTF to the Inland Empire. A round trip dray of a domestic trailer from import warehouse in the Inland Empire to the retailer's RDC in the Inland Empire is replaced by a round trip dray of domestic trailer from import warehouse in the general vicinity of the ICTF to retailer RDC in the Inland Empire. A one-way domestic trailer movement from Inland Empire warehouse to downtown en route to Northern California is replaced by a one-way trailer movement from a warehouse in the general vicinity of the ICTF to downtown. In addition, an estimated 8.8% of San Pedro Bay imports were made on behalf of large nationwide retailers and moved to cross-docks in the general vicinity of the ICTF where the imports were trans-loaded to domestic rail containers drayed to downtown rail terminals. Another estimated 3.0% of San Pedro Bay imports were made on behalf of large nationwide OEMs operating national distribution centers in the general vicinity of the ICTF that were re-shipped from the distribution centers in domestic rail containers drayed to downtown rail terminals. A round-trip dray of a domestic box from downtown rail terminals to cross-docks in the general vicinity of the ICTF is replaced by an RTG lift of an empty domestic container at a downtown rail terminal, movement of empty box in double-stack train from downtown to ICTF, RTG lift of empty domestic box at ICTF, round trip dray of domestic container from ICTF to cross-dock in the general vicinity of the ICTF, and movement of loaded domestic box in double-stack train from ICTF to downtown. In addition, an estimated 3.0% of San Pedro Bay imports were made by large, nationwide retailers, drayed in marine boxes to cross-docks in the general vicinity of the ICTF, and then drayed in domestic trailers from cross-docks to import warehouses located in the Inland Empire. Of this amount, from the import warehouse, an estimated 65.9% was re-shipped in domestic rail containers drayed to an Inland Empire rail terminal, 22.7% were drayed in domestic trailers to the local RDC in the Inland Empire, and 11.4% were trucked up to Northern California RDCs. A round trip dray of a domestic container from Inland Empire rail terminal to Inland Empire warehouse is replaced by an RTG lift of empty domestic container at Inland Empire rail terminal, movement in empty-container double-stack train from Inland Empire rail terminal to ICTF, RTG lift of empty container at ICTF, round trip dray of domestic container from ICTF to nearby warehouse, and movement in loaded double-stack train from ICTF to the Inland Empire. A round trip dray of a domestic trailer from import warehouse in the Inland Empire to the retailer's RDC in the Inland Empire is replaced by a round trip dray of domestic trailer from import warehouse in the general vicinity of the ICTF to retailer RDC in the Inland Empire. A one-way domestic trailer movement from Inland Empire warehouse to downtown en route to Northern California is replaced by a one-way trailer movement from a warehouse in the general vicinity of the ICTF to downtown. Another estimated 1.0% of San Pedro Bay imports were made on behalf of large nationwide retailers and moved to cross-docks in the general vicinity of the downtown rail terminals where the imports were trans-loaded to domestic rail containers and trailers. Outbound from the downtown cross-docks in domestic containers and trailers, 55.4% are drays to downtown rail terminals, 19.0% are drays to an import warehouse in the Inland Empire, 16.0% are drays to an RDC in the Inland Empire, and 9.6% are truck movements to Northern California RDCs. These would be replaced by corresponding moves from a cross-dock located in the general vicinity of the ICTF. The drays to downtown rail terminals would be replaced by a round trip dry from the ICTF or SCIG to a cross-dock in the general vicinity of the ICTF, an RTG lift of an empty domestic container at both a downtown rail terminal and at the ICTF or SCIG, and round trip rail movement of a domestic container between the downtown rail terminals and the ICTF or SCIG.