Potential impact of

Short Sea Shipping in the Southern California Region

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1. Introduction:

Regional Freight Transportation Challenges

Asia-Pacific trade, especially containerized cargo, continues to play an important and growing role in both the Southern California region and the nation's economy. With the continued growth of U.S. trade with Asia, and in particular with China, containerized shipments handled at the port of Los Angeles and Long Beach (here after refer as SPB ports) are expected to double over the next 15 years and perhaps triple over the next 20 years (Global Gateways Development Program Report, 2002). Barring any significant change in the underlying economics, one-half of these containers will continue to be handled by intermodal rail (either at on-dock rail facilities or after being drayed to inland intermodal rail yards) for shipment to eastern destinations across the nation. The remaining containers are trucked to destinations in the relatively large Southern California market, or out of the region to markets in the east, north, or south. In coping with these challenges, ports have engaged in decades-long expansion programs to

accommodate larger cargo volumes and improve terminal productivity. It is increasingly apparent, however, that congestion and other constraints occurring across the region's landside transportation systems, both rail and road, pose the greater challenge to increased port capacity and efficiency.

The increase in rail and truck traffic serving this surge in container volume is already placing significant strain on an overloaded landside transportation system, and nowhere is this stress more evident than at the ports of Los Angeles and Long Beach and the region's coastal transportation corridors. By 2030, heavy-duty truck traffic in the region is expected to grow by 169 percent relative to 2000, (Long Beach Board of Harbor Commissioner study, 2003) with at least a doubling of truck traffic on key routes like the I-710, which links the ports with inland intermodal yards and other logistic centers throughout the Los Angeles metropolitan area.

Even in normal circumstances, efforts to expand surface capacity have proven to be costly and time consuming, and in many cases, fail to noticeably alleviate congestion problems. With the funding available for new capacity being effectively zero, it is unlikely that the highway and railway systems will have the wherewithal to build new capacity sufficient to meet the impending trade explosion facing the region. Moreover, local communities along major commercial corridors are objecting to capacity improvement plans announced by transportation agencies.

Faced with an absence of sufficient political will to develop additional carrying capacity on the region's surface transportation system, along with a forecast of a tripling of international trade coming to the region's ports and highways by 2030, how can the region cope with the inevitable shortfall in surface transportation infrastructure while seeking to sustain regional economic competitiveness?

Short Sea Shipping Initiative

Short Sea Shipping (SSS) is a flourishing mode of freight transport in Asia and Europe. In each of these distinctly different contexts, SSS has been shown to be economical and a viable solution to growing surface freight transportation congestion problems. In the United States, MARAD and USDOT have recently focused on SSS as an integrated and multimodal strategy for reducing congestion and improving reliability on the nation's rail and highway systems. In the past two years, these agencies have initiated a number of pilot SSS projects, mainly associated with the East Coast and Gulf Coast ports.

Drawing on international and domestic experiences with SSS and considering the critical need to provide an efficient and effective regional freight transportation system, this paper will investigate the potential for implementing SSS operations in Southern California, and analyze its ability in this context to positively impact congestion on landside transportation systems. The likely environmental benefits or costs, as the case may be, associated with the initiation of SSS operations will also be discussed. In conducting this analysis the focus will be on the movements of international containers, with the inclusion of domestic containers and trailers as appropriate. Moreover, this

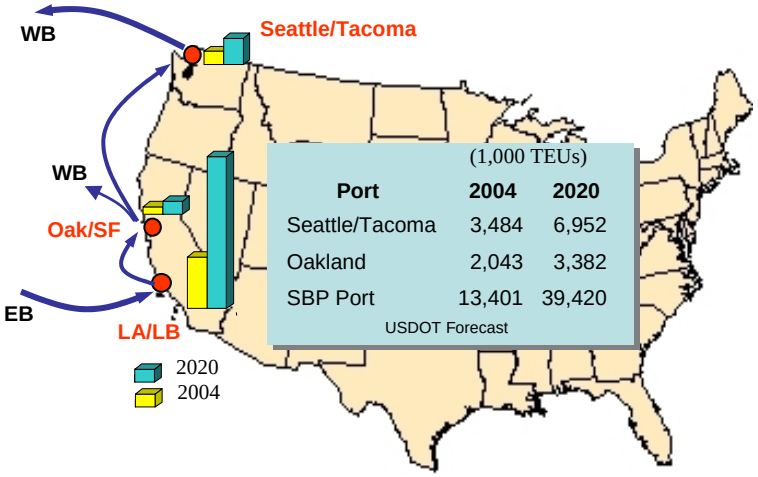
analysis will use maritime ports and operations along the West Coast of the U.S. as a larger context for evaluating the potential for implementing SSS operations in Southern California.

2. Marine Container Movements in the Southern California Region:

Current Structure of West Coast Port System and Shipping Patterns

Most ports on the West Coast, including the San Pedro Bay (SPB) ports of Los Angeles and Long Beach, are publicly owned. This public ownership, however, is almost exclusively local rather than state or federal. Public ports are typically owned by municipalities (cities) or special governmental units established by voters (e.g. harbor or port districts). These public ports are governed by boards comprising elected or appointed officials. This being the case, there is a strong emphasis on local control and accountability.

Figure 1—Major West Coast Ports and Shipping Patterns



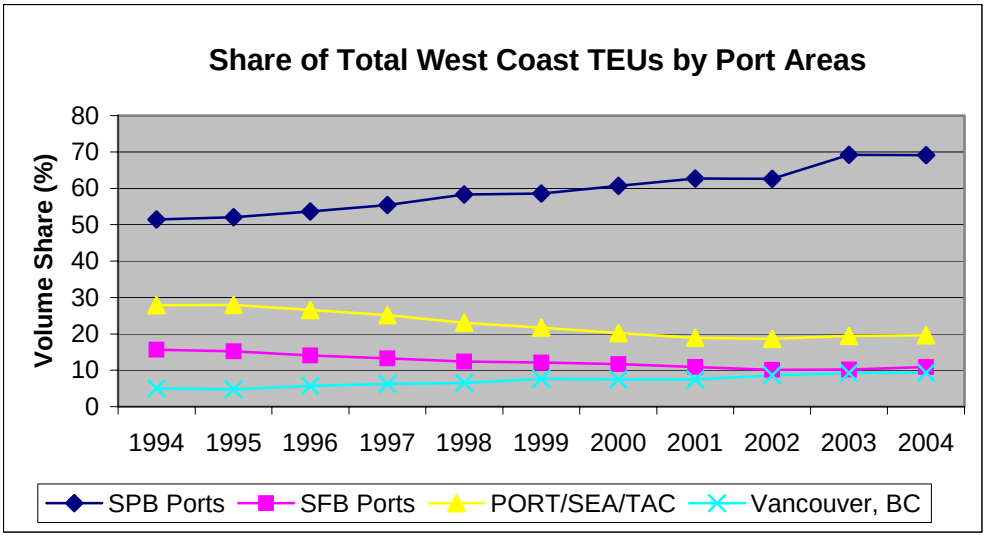
Containerization systems advanced on the West Coast during the mid-80s, subsequent to the innovative development of double-stacked intermodal rail service. With this the Pacific North West (PNW) ports of Seattle and Tacoma; the Northern California ports of Oakland and San Francisco; and the Southern California ports of Los Angles and Long Beach emerged as major container ports serving the three largest urban centers of Puget Sound (PS), San Francisco Bay (SFB) and San Pedro Bay (SPB). Containerized cargo originating in Asia are routing through these major West Coast ports for distribution to inland regions by intermodal rail and short- or long-haul truck.

As general cargo handled at West Coast ports became more and more containerized, its share of total shipments increased from 20.8% in 1972 to 70.5% in 2004 (Pacific Marine Association (PMA) Statistics), while the bulk and break-bulk market gradually declined. This process, together with the West Coast geography that discourages any development of new deep water ports, has brought about a container port system along the West Coast that focuses activities at the three urban centers, or cluster ports of Seattle/Tacoma, Oakland/San Francisco, and Los Angeles/Long Beach. Moreover, with the emphasis of activity being drawn to these cluster ports, the West Coast did not develop a secondary container handling system within the overall system of ports, a situation that differs from that found on the East Coast, and from the container port systems of Asia and Europe.

Industrial development in central and southern China in the 90s brought about a shift in the prevailing patterns of international trade. Both the geographic location and the

export oriented, consumer goods emphasis of manufacturing developments in China have placed the Southern California ports in a better logistic situation relative to the northern ports. At the same time, the development of ever larger Post Panamax vessels, presently capable of carrying 8,000 to 10,000 TEUs (Twenty Equivalent Units), and their deployment primarily on China-U.S. West Coast routes, has made theSPB ports the principal gateway for Asia-U.S. trade.

Figure 2—the Dominant of SPB Ports



Source: PMA Statistics

As shown in Figure 2, the share of West Coast container cargo handled by SPB ports has increased rapidly, from 51 percent in 1994 to 69 percent in 2004.

The fast growth and dominate position of the SPB ports is the result of current shipping patterns as demonstrated in Figure 1. According to a SCAG study in 2003, 52 percent of shipping strings to the West Coast choose to call at the SPB ports first, with the rest split up between the Puget Sound (PS) ports and the San Francisco Bay (SFB) ports.

The remaining shipping strings are mostly direct services to the northern ports from Asia. Only 15% of the West Coast shipping strings make their last call at the SPB ports. Furthermore, a number of the vessels which choose SPB ports for their first port-of-call are mega vessels and the SPB ports, especially the port of Long Beach, are the only ports that can currently accommodate vessels of 8,000+ TEUs, owing to the depths of its water basin and channels. At their first port of call, it is economical and logistically practical for these large vessels to discharge as much local and intermodal cargo as possible, and to pick up export and mostly empty boxes before sailing up north. At the northern ports, the balance of any remaining import containers are offloaded, and loaded export and empty containers are brought aboard for shipment and return to Asia.

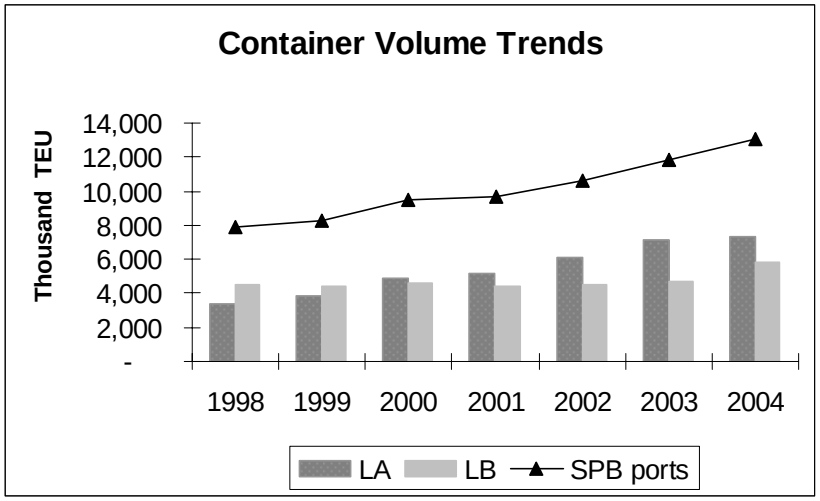
Although some current developments would tend to favor shipping routes to the northern ports or all-water-service to the Gulf or Eastern seaboards, the overall pattern of shipping between Asia and the U.S. will remain essentially constant for the near- and mid-term. Numerous factors contribute to the advantageous position presently enjoyed by the SPB ports, not the least of which is that this port complex is supported with rail capacities that are double that of the other West Coast ports combined (SCAG, 2003). The SPB ports also benefit from the natural water depths of their harbors, an attribute that minimizes dredging and permits the operation of the new larger vessels. Moreover, the large manufacturing and consumer markets represented by the urbanized centers of the Southwest region bring in a significant amount of containers through these ports. These factors generate the load center effect quantified above, and influence the strategic calculations of both carriers and shippers.

Container Volume Growth at SPB Port

According to Inbound Logistics, in 2003 West Coast ports handled 21.2 million TEUs, compared to 16.2 million TEUs by ports on the East Coast. Among the West Coast ports, the ports of Los Angeles and Long Beach alone accounted for more total container units shipped that year – 11.8 TEUs – than the 11.1 TEUs handled by the East Coast's top six container ports combined (NY/NJ, Charleston, Hampton Roads, Savannah, Miami, and Montreal) (O'Reily, 2005).

As shown in Figure 3, container volume handled at the SPB ports increased rapidly at a rate of 157 percent during the period from 1994 to 2004—an increase from about 5 million TEUs in 1995 to more than 13.1 million TEUs in 2004. This volume will likely reach 36 million TEUs in 2020 and 44.7 million TEUs in 2030 (Long Beach Board of Harbor Commissioner study, 2003

Figure 3—Rapid Growth at LA/LB



Source: Ports of LA/LB data

Barring any sudden change in the dynamics of international trade, the continued concentration of West Coast container movements at SPB ports will ensure that port-related traffic pressures continue to build on the landside intermodal and highway distribution systems in Southern California. And it is becoming clear that congestion on the landside transportation systems now represents the greatest competitive challenge to efficient goods movement in Southern California.

3. Potential Short Sea Shipping Services in the US West Coast

The Concepts

Short Sea Shipping (SSS) is the movement of containers or other shipments by sea between ports along the same coast line, providing service between major ports or between a major port and other secondary and tertiary ports. The nature of West Coast SSS services, should they be introduced, would likely be similar to intra-Asia or intra-Europe 'feeder' services. One key difference in the U.S. market, however, is that SSS can only be provided by domestic carriers, as opposed to either international or domestic carriers as in the intra-Asia and intra-Europe markets. In addition, the scheduling of SSS services here would not need to be coordinated precisely with the schedules of deep sea liner services, as is often the case with Asian or European feeder services. With this, SSS along the West Coast could operate independently of ocean carriers and be flexible with the scheduling and frequency of services provided.

The flexibility of SSS operations extends as well to its physical location at a port, where it can be arranged in a number of configurations and facility types. Technically, SSS facilities can be located at any existing port, at a newly developed port, or at areas of a

port redeveloped specifically to handle SSS. In any of these circumstances, SSS facilities could be developed as a separate terminal, or at a designated area within an existing terminal already serving ocean-going vessels. With the current high demand for container terminal space, however, it is most likely that separate SSS facilities would be located at a redeveloped area of an existing port.

Possible Service Arrangements

As mentioned earlier, the structuring of ports along the West Coast differs from the hierarchical ordering of ports, by size and function, found in Asia and Europe. These overseas port systems comprise primary, secondary, and sometimes tertiary ports that are functionally differentiated by cargo volume and geographic service areas. The West Coast container port system consists of three primary port clusters located between 400 to 700 nautical miles from each other and competing across a similar range of market segments. Rather than being differentiated by size, the smaller ports here are differentiated by the market niche that they service.

Given the structure and market service characteristics of West Coast ports, establishing SSS between the major port clusters of Seattle/Tacoma; San Francisco/Oakland; or Los Angeles/Long Beach would not appear to be practical. Each of these port clusters are already called on directly by major ocean carriers with cargo destined for each local urban center as well as with non-local intermodal cargo en route to the mid-West, South East, and Eastern regions of the nation. Moreover, current pendulum services[1] operated by ocean carriers along the West Coast call at each of the major clusters, calling first at

[1] "pendulum" refers to shipping service that calls at a sequence of ports along a coastline

the San Pedro Bay ports, for example, before stopping again in San Francisco Bay or Puget Sound, or both, before returning to Asia. With these existing shipping services provided by ocean carriers, adding movements and smaller vessels to introduce SSS services for inbound cargo between the major clusters would unnecessarily duplicate service and increase costs. For this reason, SSS between major port clusters along the West Coast will be removed from further consideration in this study: notwithstanding that, under certain circumstances, SSS service designed to carry solely domestic cargo between the major ports may eventually prove to be viable.

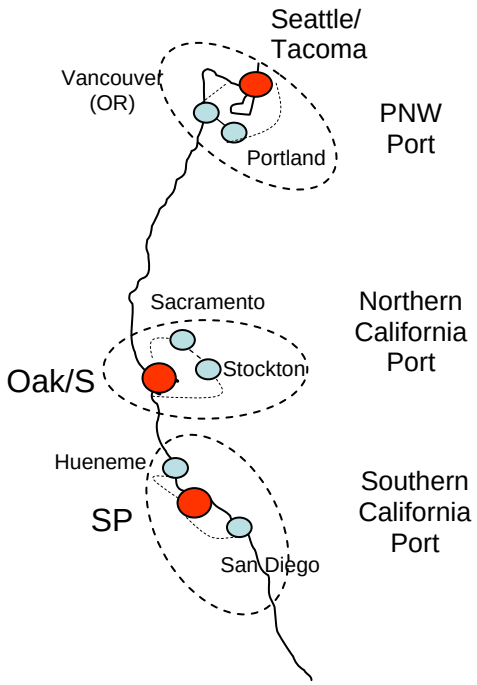
SSS and Regional Port Systems

The concept of SSS may yet prove to be useful, however, as we focus in on the set of ports within each particular port region along the West Coast: the PNW, Northern California, and Southern California port regions. In the PNW region, for example, in addition to the two major ports of Seattle/Tacoma, the port of Portland and the port of Vancouver, Oregon and others located nearby, combine to form a regional port system. Similarly, the Northern California ports of Stockton and Sacramento are secondary to the ports of Oakland/San Francisco. And the ports of San Diego and Hueneme are part of the Southern California port region, joining with the major SPB ports. These major port clusters and their proximate smaller ports can be envisioned as a “regional port system” for each respective region

Within each regional port system, the smaller ports have tended to specialize in handling unique commodities or serving niche markets, such as construction equipment or agricultural products and automobiles. These ports also have the capacity to develop

facilities to handle a larger share of container cargo. In the context of each regional port system, the proximity of these smaller ports to the major ports establishes a combined infrastructure with the potential to serve their respective local and regional markets.

Figure 4—West Coast Regional Port System



Owing to the particular transportation system geography and economic profile of each port region, the relationship between ports within a regional port system offers an opportunity to develop SSS that could be both economical and an environmental benefit the region.

In each regional port system, import cargo (*inbound flow*) destined for local, regional, and national deliveries is typically off-loaded at the major ports. Using SSS, some inbound containers can be shipped to smaller ports and from there be routed to local, regional, and national destinations as well, using alternative surface transportation facilities and routes.

For *outbound flows*, local export cargo and empty containers from various local destinations could be first consolidated at these smaller ports and then transported via SSS to major ports for loading on ocean-going vessels. To the extent that landside infrastructure improvements are made to support these SSS strategies, the catchment areas associated with the smaller ports could be expanded to include local and regional exporters and importers, as well as inland warehouses, intermodal facilities, and logistics and distribution centers.

The key objective of this study is to consider the potential of SSS as an alternative mode of freight transport to move a portion of truck and rail trips associated with international trade volumes away from the SPB ports and off of the impacted urban landside transportation systems. Accordingly, this study looks specifically how SSS services could operate within the Southern California port system. The concepts developed here can then be used subsequently to discuss the potential of SSS in the other port regions of Northern California and the Pacific Northwest.

4. Southern California Port System and Targeted Markets

Southern California Ports

Southern California's port region includes the San Pedro Bay (SPB) ports of Los Angeles and Long Beach, and two smaller commercial ports, the ports of San Diego and Hueneme. The port of San Diego is located 96 nautical miles (NM) south of the SPB ports, and the port of Hueneme is about 60 miles north of the SPB ports.

Although both of these smaller ports service primarily bulk, break-bulk and automobile markets, each does have some capacity to handle containerized cargo. In the past few years, these ports have been pursuing modernization and expansion plans that include greater container capacities. Recently, container traffic handled at the two ports, especially at the port of San Diego, increased dramatically as demonstrated in Table 1.

Table 1—Loaded Container Volume Handled at Southern California Ports

Ports	Total Loaded TEUs	% WC	% Chg from 2002	% loaded:% discharged
Hueneme	16,007	0.1%	26.9	20.6:79.4
San Diego	53,582	0.4%	453.5%	19.:80.7
Long Beach	3,138,821	26.3%	-3.9%	24.4:75.6
Los Angeles	5,118,270	42.9%	20.70%	24.7:75.3
Total	8,326,680	69.8%	10.60%	24.5:75.5

Source: PMA Annual Report, 2004

Nevertheless, even with the presence of these two ports, the SPB ports continue to serve as the primary regional port, not only for the six-county SCAG region but also for Santa Barbara, San Diego, and the border region of northern Mexico.

Potential Market Segments in Southern California

SSS strategies are being considered in Southern California as a way to reduce congestion on landside transportation systems and to positively impact air quality by reducing diesel emissions. To accomplish this, a number of market segments or institutional practices that might benefit from SSS strategies need to be identified and

evaluated. Some immediate candidates in this region would include the pattern of empty ocean-going container movements and shipments to manufacturing zones along the U.S. - Mexico border south of San Diego.

- **Growth of Empty Ocean Going Containers**

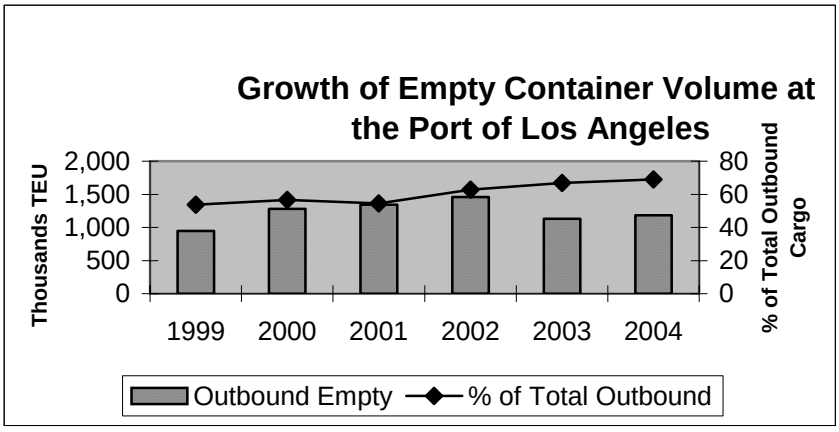
The volume of ocean-going empty containers transiting Southern California has increased faster than the rate of container movements in general. This situation arises from a severe imbalance in import and export trade flows between China and the West Coast, as well as from current business arrangements between carriers and trucking firms regarding the return of empty ocean-going containers.

As shown by these shipping statistics, the share of empty containers in the westbound cargo flow has increased significantly in the past few years. In 2004, almost 70 percent (2.2. million TEU) of westbound containers handled at the port of Los Angeles alone were empty. According to a recent forecast by SCAG, the volume of empty westbound containers will reach 6.4 million TEUs in 2010 and 9.6 million TEUs in 2015, an increased of 77 percent and 167 percent respectively from 3.6 million in 2000.

Without any changes in the balance of trade or the current industry practice requiring empty containers to be returned to the originating marine terminal after being off-loaded at a local importer’s warehouse or logistics center, the number of trucks passing through terminal gates carrying westbound empty containers for return will increase drastically (see Table 2). This trend of increasing empty westbound containers has been confirmed in a recent report by Reuters which documents that China has reached an all time high

in its trade imbalance, with exports exceeding imports by a factor of 5; with the U.S. being China's largest export market.

Figure 5—Growing of Outbound Empty Containers



Source: Port of Los Angeles Statistics

According to the METRANS Empty Container Study (Le, 2003), empty containers are returned to their originating marine terminals from several local points, including regional warehouse districts where trans-loading and value added logistics (VAL) activities occur. These VAL locations are typically situated an average of 15-50 miles from the ports. Intermodal rail yards are closer, located within 5 to 25 miles of the ports.

Two trends occurring in the Southern California logistics market will increase the number of empty containers in the region: (1) the growing amount of trans-loading activity taking advantage of the larger 53-ft domestic containers, and (2) the development of large-scale warehouse and distribution facilities further inland; e.g., in San Bernardino and Imperial counties.

Table 2—Empty Container Trend—SPB Ports West-Bound Moves

	2000	2010	2015	2020
	Mil. TEU	Mil. TEU	Mil. TEU	MIL.TEU
Port Outbound/Westbound	3.60	6.40	9.50	14.50
Via Rail	0.30	0.50	0.73	1.10
On-Dock Intermodal	0.30	0.50	0.73	1.10
Via Truck	**3.30**	**5.86**	**8.80**	**13.40**
Off-Dock Intermodal	0.57	0.92	1.50	2.37
Local from Import Loads	2.10	3.85	5.66	8.50
Local from WB Domestic Loads	0.65	0.11	0.17	0.27
Repo Off-Hires from Depots	0.33	0.60	0.90	1.35
Local Empties from Transloads	0.25	0.40	0.60	1.00

Source: SCAG Empty Container Study, 2001

- ***Increased Demand for Trans-loading***

According to port officials, 20 to 25 percent of all inbound cargo discharged at the ports is reloaded into larger domestic containers at local trans-loading facilities. The trans-loading of shipments in Southern California offers a number of cost and logistic advantages to importers of containers from Asia. By taking advantage of larger capacity domestic containers and trailers, trans-loading provides lower unit costs per cubic foot than intermodal rail using 40-ft international containers. Moreover, the savings per unit increases as the value of the cargo increases. Accordingly, the higher the value of the goods filling available space, the lower unit costs per cubic foot will be. As China increases its export of high-value manufacturing goods, trans-loading will continue to play a significant role in the SPB port area logistics.

Also, the share of intermodal rail handled at the SPB ports is expected to increase, and, there will continue to be a shortage of international container boxes (of 20 ft and 40 ft) in export markets like China (McGowan,2005). These shortages cause it to be more expensive to re-position international containers from destinations further inland, encouraging the trans-loading of shipments as near as possible to the ports. Together these factors create a situation where the trend of trans-loading will continue to increase. In 2003, carriers effectively encouraged more trans-loading by raising their rates higher for shipments to inland destinations than for those to port destinations.

- ***Development of Warehouses and Distribution Centers Further Inland***

Trans-loading usually occurs as close as possible to the ports in order to simplify logistics, to reduce costs, and to utilize near dock intermodal rail yards. With the relatively rapid increase in trans-load activity, however, shipper demands for larger warehouse and distribution facilities have encountered growing space limitations and environmental challenges around the ports. These pressures have caused the development of warehouse and distribution facilities to explode in the San Gabriel Valley, to the extent that limits to growth are being experienced in this area as well. Areas even further inland, such as the Inland Empire, are beginning to see increasing development. A major importer, Target, responding to the need to minimize total logistic costs, has located its 1.7 million sq. ft. West Coast import center at Center Valley, 150 miles from the port of Long Beach. This decision suggests that for larger retail importers like Target, the higher drayage costs associated with bringing containers further inland

are more than offset by lower land and utility costs, local tax incentives, greater labor availability at a lower cost, and the ability to operate 24 hours a day (McGowan, 2005).

Few question that the SPB ports will maintain their dominant role in receiving U.S. bound cargo from China. This, coupled with the regional center of warehouse and distribution facilities moving further inland, guarantees that the number of truck trips between the ports and inland distribution and warehouse facilities will increase significantly. On top of this, there is a growing awareness that the inland shift of logistic facilities is effecting a reconfiguration of the regional supply chain, creating a regional opportunity to re-direct the flow of empty return containers. The potential seems to be forming for an integrated SSS service that would allow for the repositioning of empty containers to be accomplished through the ports of San Diego and Hueneme, relieving congestion pressures that would otherwise build on the region's core commercial corridors.

On top of this, once these new movement patterns of empty container are established, they will attract a new flow of local and regional export cargo seeking to take advantage of these less congested export corridors and services, creating a beneficial spill-over economic development benefit associated with the new SSS system.

- **International Movements to/from Manufacturing Areas in Northern Mexico**

Import cargo destined for the manufacturing zones along the Mexican border currently transiting through the SPB ports represent another potential market for SSS. Based on interviews with a number of representatives with the SPB ports and the port of San

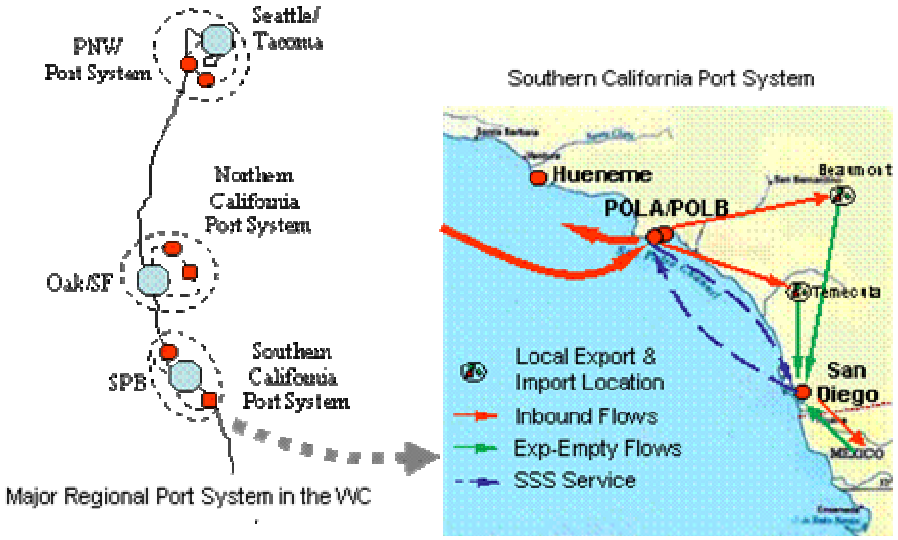
Diego, a substantial amount of unconventional containerized cargo passes through the SPB ports en route to the border manufacturing zones. These shipments include in-process equipment fabrications, construction materials, and manufacturing parts and supplies. One specific example of these shipments would be break-bulk steel. Presently these shipments are brought to Mexico by truck after offloading at the SPB ports. There are more than 5 million tons of these commodities shipped though the SPB ports, of which about 6,000 tons are trucked to Mexico and San Diego area weekly via highway I-5. The recent construction of several electronic factories near Tijuana, Mexico, such as Samsung, ensure a growing number of south bound movement from the SPB port carrying electronic parts and components for the assembly plant in this area.

The logistic convenience or load center advantages of the SPB ports are the principal reason that these shipments currently bypass the port of San Diego. In most cases, these loads arrive at the SPB ports from number of different vessels, as part of a larger shipment. Once offloaded at the SPB ports, trucking is the only practical option available to delivery these shipments to the Mexican border. Given the proximity of the port of San Diego to Mexico and the border manufacturing areas, these shipments presently routed through the SPB ports and trucked back to the border represent another opportunity for SSS strategies. In addition, though no detailed data is available, there are also a number of shipments landed in San Diego that are subsequently trucked up to the Los Angeles metropolitan area that could be involved in this strategy as well.

5. Integrated SSS Alternatives for the Southern California Port System

SSS operations designed to service empty container flows and local exports, and movements to and from the border region are discussed below to demonstrate, at a conceptual level, the implementation of integrated SSS operations in Southern California,

Figure 6—Integrated SSS Operation in Southern California Port System



As logistic centers handling cargo for the SPB ports have moved further inland, an opportunity to re-direct current flows of empty containers, as well as local and regional export containers, through the port of San Diego has emerged. Moreover, the manufacturing areas along the border with Mexico present a complementary SSS opportunity. For a SSS operation serving these market segments, the northbound SSS movement would carry empty containers and local export boxes, the southbound movement would ship import cargo for the border manufacturing zone. As a regional benefit, the collection of empty containers and local export cargo at the port of San

Diego removes truck trips from the most congested commercial corridors in the region by using SSS to move these boxes to the SPB ports for consolidation for shipping to Asia.

Moreover, import cargo destined for the Mexican border manufacturing offloaded at the SPB ports can be shipped via SSS to terminals at the port of San Diego. At the port of San Diego, these boxes can be trucked across the Mexican border to their destinations. The return flow of the empty boxes could be first collected at the port of San Diego, and together with other regional empty and export containers, be shipped via SSS to the SPB ports.

This conceptual integrated SSS system can be extended to include the port of Hueneme as well; however, for simplicity our discussion on the system operation analysis focus here is on the system that contains the port of San Diego.

Operational Analysis

Existing SSS shipping operations have been reviewed to identify which type of operation might be suitable for the Southern California region port system. Barge operations, for example, are suitable for inland waterway systems like those found along the East Coast. The Southern California port region operates mainly along deep sea lanes that experience fairly strong currents, and therefore push-pull barge operations as employed on the East Coast would not be practical.

A survey of the terminal facilities available at the port of San Diego and the SPB ports, and a consideration of the various types of SSS operations, suggests that a coastwise service using Container-Roll on-Roll off (RO-RO) vessel with containers on chassis would be the most suitable for quickly initiating SSS operations. A further investigation of region economics and terminal capacities may show that additional shipping technologies could be used for SSS; however, this paper considers RO-RO because it requires less capital investment in wharf and terminal facilities, is more flexible for modifying future operations, and involves lower labor and handling costs. In addition, both the SPB ports and the port of San Diego already have modern RO-RO facilities as well as management and stevedoring personnel experienced with RO-RO operations.

Table 3—SSS System Characteristic

Characteristics	Service Local Export and International Empty Boxes
Operation	Roll on-Roll off
Equipment	Chassis-Tractor/Trailer
Service Area	Within Regional Port System
Customer Base	Ocean Carriers and Exporter
Infra.Structure Require	Loading/unloading Ramp

A detailed discussion of the terminal capacities and design requirements at each port of the proposed integrated SSS services are not included in this particular study. Rather, this paper focuses on the regional operations associated with the proposed SSS segments.

Overall System Operations—Example of North Bound Movement

Figure 5(a) and (b) depict a conceptual flow of SSS operations between the port of San Diego and the SPB ports serving outbound empty and export cargo, or the northbound movement. Starting from the port of San Diego, these major components are:

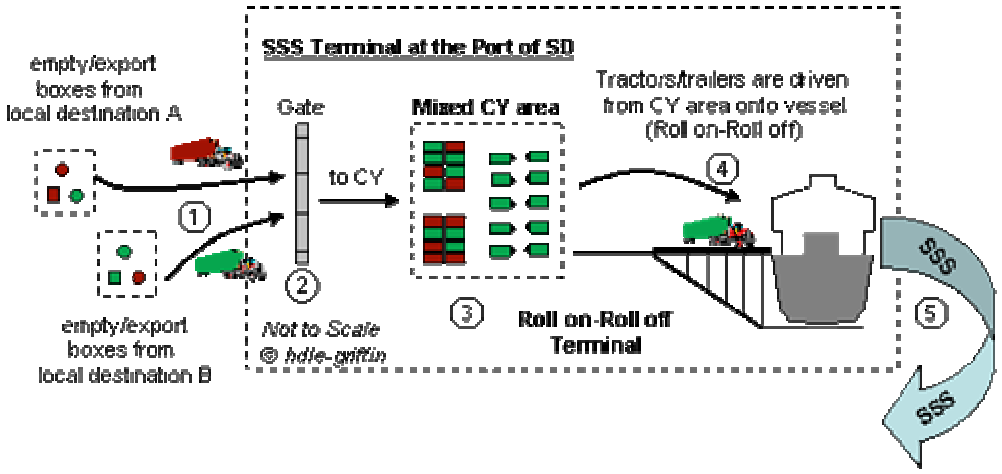
1. Inland move: export and empty boxes are drayed by truck from local destinations to the port of San Diego;
2. Gate Processing: export cargo and empty box return documentation are processed at the gate of SSS terminal at the port of San Diego;
3. Storage: where export cargo and empty containers are received, consolidated, sorted in a mixed container yard (CY). Repairs of empty box also can be provided, if necessary;
4. Loading directly from mixed-CY to RO-RO Ramp onto RO-RO Vessel by terminal tractors: SSS terminal tractors with export and empty boxes move from the storage site to the RO-RO Ramp for loading onto SSS vessel;
5. Sea Transport between the port of San Diego and the SPB ports;
6. RO-RO Ramp at SPB Ports: SSS tractors drive containers off the RO-RO vessel and directly deliver the export and empty return boxes to their respective carrier terminals or to temporary storage at SSS terminal's yard for transfer to their respective terminal at a suitable time;
7. Terminal Gate Processing: local export and empty return boxes are received;
8. Storage: storage at respective carrier's terminal yard;

9. Storage to Apron: empty and export boxes move to apron for loading;

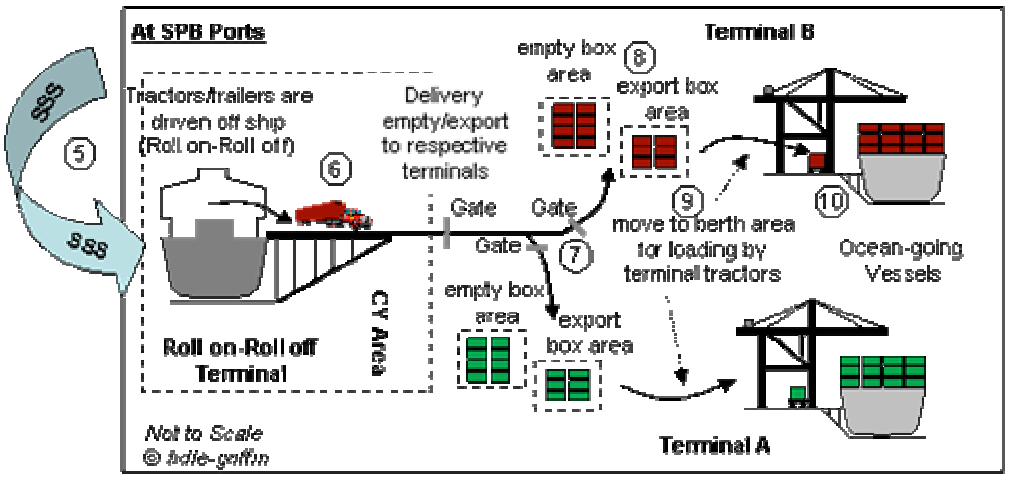
10. Ocean-going Vessel and Berth Activities: empty and export boxes are loaded onto the ocean-going vessel.

Figure 7—Integrated SSS RO-RO Operations Serving Out-Bound Flows

a) At the Port of San Diego



b- At SPB Ports



In the southbound movement, import cargo destined for Northern Mexican border would be shipped by SSS service to the port of San Diego and then delivered by truck across

the U.S.-Mexico border to the manufacturing zones. One difference between the operations involving empty and local export boxes compared with moves across the Mexico border is that the border movements could be made with Mexican drayage contractors for the road segment between the border and the port of San Diego. Current arrangements permit trucks from Mexico to operate in the U.S. within 25 miles of the border, providing a likely cost advantage for this segment.

Elements of Operational Costs

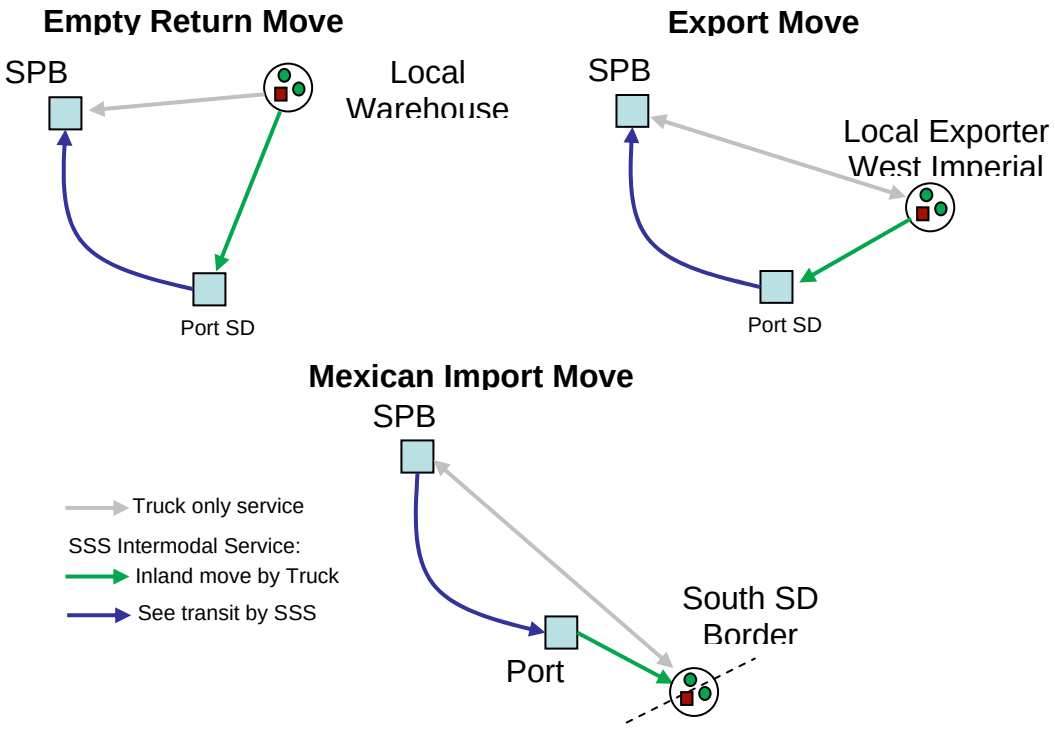
Operational costs for this integrated SSS service would include the land movement by truck from inland destinations to the port of San Diego, the sea movement between the port of San Diego and the SPB ports, and the handling processes for cargo at the two ports. The proposed SSS service would therefore require additional coastal shipping and cargo handling at the ports.

According to our survey, vessel operating costs for shipment distances between the port of San Diego and SPB port were found to be relatively insignificant compared to port related costs. The cost, or handling charge, of one-man driving a container-trailer in to and out of a vessel in RO-RO operations is relatively low, compared to operations using a gantry crane; so, it is reasonable to assume that the true cost of this integrated SSS service will be driven primarily by port charges incurred at the port of San Diego and SPB ports. Port charges are levied for the use of a port facility and are separate from handling charges.

The cost analysis for this exercise involved gathering data from three different sources: (1) interviews with terminal operators at the port of San Diego and SPB ports and with trucking firms serving Southern California cities; (2) commercial tariffs published by the ports and Southern California Drayage rates from 3 local trucking firms; and (3) assumptions draw from other previous studies on SSS in the U.S. Combining of these data sources presents a preliminary estimate of the proposed SSS costs, and how these costs generally compare with trucked operations. All costs associated with port charges are based on the assumption of using a Container-RO-RO vessel which is 800 ft long and has a carrying capacity of 800 container trailers. A seventy-five percent vessel utilization rate is assumed, taking into consideration the cargo imbalance between northbound and southbound movements.

In Table 5, total port charges are calculated for the following specifications: since it takes less than 24 hours to complete loading operations of the proposed RO-RO vessel at the terminal (taken from the TOTE carrier experience), a one day, or 24 hour, dockage charge is used; also, a 12-line gang—6 men for tie up and 6 men for let go (untie)--is used to compose the line charge; there are two tug boats, one for tug-in and one for tug-out, for four hours of operation; furthermore, empty boxes are considered as transshipment cargo at the SPB port, with the 50 percent wharfage charge being applied; and finally, since export cargo is no longer subject to the harbor maintenance tax, this charge is excluded for the export portion of the calculation, and the average $30 per trailer port security charge is also taken into consideration.

Figure 8—SSS Intermodal Service for Different Market Segments



As for the trucking costs, a review of current trucking rates in Southern California shows that for a trip of 100 miles on congested urban commercial corridors stemming out of the SPB harbor area the trucking rate is about $5/mile. For 100 miles of travel on the less congested commercial corridors connecting the Inland Empire area to San Diego, a rate of average $3/mile is applied. These trucking rates are consistent with rates found in a recent toll truckway study conducted by Reason Foundation. Using these trucking rates, total costs for shipping a 40 ft container by SSS intermodal service and by truck-only service between a given inland destination and the SPB ports have been estimated for each of the market segment moves being considered: empty return, export, and Mexico import. The movement of each shipping segment of the proposed SSS

intermodal operation is demonstrated in figure 8, from which, the trucking cost components of the SSS intermodal system are given in Table 4.

Table 4—Trucking Cost Component of SSS Intermodal Operation

Trucking Segment of SSS Alternative	Distance (Miles)	$/Mile	Trucking Cost
Empty Northbound:			
SD - East LA Area	100	$3	$300
Export Northbound:			
SD -West Imperial Velley	60	$3	$180
Import Southbound:			
SD - South SD Border	25	$4	$100

Table 5— Total Unit Cost of SSS Intermodal Service

Shipping Segment	Unit Cost ($ 40 ft Container-Trailer)			
	Truck	Ports	Sea	Total
Empty Northbound:				
SPB - East LA Area	$300	$185	$50	$535
Export Northbound:				
SPB - West Imperial Velley	$180	$650	$50	$880
Import Southbound:				
SPB - South SD Border	$100	$740	$50	$890

As shown in Table 5, the port cost component of the empty container movement using this integrated SSS service is relatively low compared with that of export and import cargo. This is because the wharfage charge for handling an export or import box at the terminal is more than 10 times higher than the wharfage charge for handling an empty container.

To conduct a modal analysis, truck costs (as shown in Table 6) are developed for the three segments between the SPB ports and the inland destinations of east Los Angeles Basin, the west Imperial Valley and south San Diego border. These inland destinations are the locations of major warehouses for import, export and Mexican shipments. In the

total drayage cost table (Table 7) the $80 per 40-ft Pier Pass charge is included to provide the same operation arrangement at anytime as compared with the SSS option.

Table 6—Basic Drayage Cost

Direct Trucking Distance	Distance (Miles)	$/Mile	Trucking Cost
Empty Northbound:			
SPB - East LA Area	100	$5	$500
Export Northbound:			
SPB - West Imperial Velley	100	$5	$500
Import Southbound:			
SPB - South SD Border	140	$4	$560

Table 7—Total Drayage Cost for a 40 ft Container-Trailer

Direct Trucking Distance	Distance	Basic Cost	10% FSC Charge	PierPass Charge	Total Cost
Empty Northbound:					
SPB - East LA Area	100	$500	$50	$80	$630
Export Northbound:					
SPB - West Imperial Velley	100	$500	$50	$80	$630
Import Southbound:					
SPB - South SD Border	140	$560	$56	$80	$696

As shown in Table 7, the total drayage cost for moving a container-trailer (empty or loaded) from the SPB ports to inland destinations includes a basic cost of between $600 to $700, a 10 percent fuel surcharge (FSC) and the PierPass charge. The FSC surcharge amounts to 10 to 16 percent of the total drayage charge. This rate varies according to the daily fuel price, and in Southern California it has reached as high as 25% in the summer of 2005. Also, along with these charges, there is a long list of additional charges applied by trucking companies operating out of the SPB ports, the most common of these are:

- Additional charge of $45 per hour will be applied after the first hour of free waiting time expires;

- Additional charge of $75 per each stop for customs examinations;
- Charge for any damage or lost of equipment;
- Steamship company detention per-diem charge for late return equipment;
- Citation for overweight loads, gross or axles (over 57,000lbs). seems different type

Most of these additional charges are incurred due to the unreliability of road and traffic conditions. Once these additional charges are applied, the cost of drayage for a container out of the SPB ports could increase to as high as $800 or $900. This is more or less a 50 percent increase over basic trucking costs. As landside congestion problems worsen, the economic competitiveness of trucking diminishes as these additional charges mount up. It is also conceivable that congested urban areas will eventually devise a means for collecting a congestion impact fee or impose tolling on congested urban roads for commercial vehicles. As suggested by a Reason Foundation study (Toll Truckway Study, 2005), a possible voluntary tolling rate of up to $1.89 per mile may apply.

As shown in Tables 8, the SSS Intermodal services discussed here are not generally competitive with trucked operations in terms of both cost and transit time, even though the cost of shipping an empty container on the northbound SSS segment could be somewhat competitive. However, as empty container and export shipments are relatively less time sensitive compared to shipments of imported consumer goods, it is likely that the SSS transit time of 24 hours, as opposed to a 7 to 8 hours total delivery

time by truck (including pickup and drop-off time), would not necessarily be a determining factor for these market segments.

Table 8—Modal Comparison

Service Factor	$ per 40 ft Container-Trailler	
	Truck	SSS Intermodal
	Cargo Sensitivity to Total Shipment Time or Cost	
Cost	Low	High
Time	High	Low
	Cost and Transit Time	
Cost		
Empty	$500	$535
Export	$500	$880
Import	$560	$890
Time	7 to 8 hours	24 hours

These estimates of SSS intermodal operational costs are based on published tariff rates: a review of publicly available financial reports and statistics, however, reveals that the tariff revenues actually received by the ports are significantly less than the amounts that would be calculated from the published tariff. Of total port charges, more than 80 percent is attributed to wharfage charges—a charge per container, by type and size, for the use of wharves or wharf area. According to interviews with terminal operators at the SPB ports, revenue sharing arrangements established in confidential lease agreements can significantly reduce actual average annual wharfage charges, based on the number of containers handled over a minimum guarantee. These arrangements provide an incentive for container terminal operators to maximize their operational volumes in order to realize the lowest possible unit costs. In some cases these revenue sharing arrangements allow container terminal operators to achieve an effective average annual wharfage charge that represents up to as much as a 50 percent discount from published rates. This means that total port charges could be managed to at least 40 percent lower

than published tariffs for all port charges. Also, different port administrations have different levels of control over port charges. The port of San Diego, for example, manages itself as an operating port, as compared with the landlord port management of the SPB ports. This means that the port of San Diego can be more flexible in determining port costs, where as in SPB these costs are managed by the terminal operators. Furthermore, the cargo carried by SSS will be mostly empty containers and local exports—traditionally these types of shipments have been able to negotiate for lower shipping charges in order to promote local exports that utilize empty containers and thereby reduce the number of empty containers flowing back to the SPB ports.

While in concept these services appear to be viable, the actual integration of SSS into the existing freight system would face some additional challenges. There are number of current business practices and institutional issue [2] that would work against this integration process. One example would be existing business arrangements between carriers and trucking firms that require the return of empty ocean-going containers directly to the originating carrier's terminal at the SPB ports. This practice helps the carriers, who typically own both the containers and chassis, to manager their equipment, especially for chassis that are in short supply. Insurance and liability issues involved with the remote transfer of an empty box would be another concern for carriers. The business costs associated with these concerns may eventually be greater than the drayage cost savings that could be gained with the re-directing of empty returns to the port of San Diego. Nevertheless, these circumstances may change as the development of warehouses and distribution centers materialize further inland. This re-configuration

[2] see Le (2003) The Logistics of Empty Container in Southern California, METRANS Research Report

of the regional supply chain toward the Inland Empire will increase the logistical importance of the port of San Diego and the port of Hueneme, opening a way for integrated SSS alternatives to play a role in developing a regional port system and improving regional goods movement.

In the near future, landside congestion pressures will likely increase the costs of trucking, at the same time many of the port costs associated with SSS operations can be negotiated or managed down. The combined effect of these anticipated changes in cost will increase the competitiveness of SSS. And with the smaller ports like San Diego and Hueneme enthusiastically seeking to attract new niche markets through aggressive development and marketing plans, conditions appear to be shaping up for the introduction of SSS services in the region.

Congestion and Environmental Implications of the SSS Alternative

Owing to its economies of scale and greater fuel efficiency over truck and rail, recent studies have demonstrated certain congestion and environmental benefits for SSS. For the SSS operations discussed in this study, the volumes involved would support an initial bi-weekly SSS operation capable of re-directing the movement of 2,400 containers a week away from the most congested commercial corridors, such as the I-710. This equates to about 6,400 truck trips (including bobtail and empty box moves as result of current logistic arrangements at the SPB ports), or about 3 percent of the current daily truck traffic on the I-710.

Though not inconsequential, the effectiveness of this SSS strategy in reducing congestion is relatively slight when compared with the shift of 20 percent of daily truck trips to off peak hours that has been achieved with the PierPass policy. Clearly PierPass has been successful in reducing the number of truck trips during peak hours and in relieving rush hour cargo congestion along urban commercial corridors; however, this policy retains the same aggregate number of truck trips, leaving communities along the corridor to contend with the same, or even actually greater, environmental and social impacts associated with these truck trips. Conversely, with the SSS strategy truck trips are removed entirely from congested corridors, along with all of their attendant environmental and social impacts on local communities.

To secure the environmental advantages of SSS on a regional basis, care should be taken to ensure that the diesel emission reductions gained in the urban corridors are not simply shifted to an equal or greater amount of diesel emissions at the ports. Port-related diesel emissions result from vessel operations and the use of diesel yard equipment, and increasingly these port emissions have become a subject of public concern. In response the ports have adopted “green port” policies to avoid any increase of emissions, and it is assumed here that SSS operations would be accomplished in line with these green policies.

5. Conclusions

This paper has demonstrated that SSS strategies are conceptually viable within regional port systems along the West Coast, and that these operations would have a positive effect on urban congestion and regional air quality.

In Southern California the relatively high cost of cargo handling at the region's ports prevents the SSS strategies discussed in this paper from being as competitive as established truck operations. Components comprising the cost of SSS operations have been identified sufficiently in terms of their relative magnitude within the overall system to allow for an initial comparison with trucked operations. This investigation establishes an initial basis for evaluating the competitiveness of SSS concepts, and shows where market and environmental circumstances could be manipulated to enhance the competitiveness of SSS. Over and above calculations of operational costs, SSS would contribute positively to the lessening of congestion in urban commercial corridors. Other policies, such as PierPass, have immediate effects in this regard. Nevertheless, the growth of Asia-U.S. trade, especially trade with China, will continue to expand. With this the traffic congestion and inadequate capacities of the landside transportation systems in Southern California will further degrade the reliability and relative competitiveness of trucked operations. Absent any reasonable alternative, shippers will increasingly seek to circumvent the region and the economic benefits that the region would have otherwise gained from these activities will be lost. To prevent this, while simultaneously contributing positively to lessening congestion and improving air quality, SSS services could be introduced as part of a regional port system. Such a system would strengthen and add sustainability to the region's container handling capacity, create alternative commercial corridors away from the most congested urban centers, and increase the reliability and security of the transportation system.

Principally the findings of this study argue for the recognition of regional port systems within the larger structuring of West Coast ports. In this framework, SSS strategies

demonstrate the potential to compete economically with trucked operations, allowing for less congestion along urban commercial corridors, better regional air quality, and opportunities for new economic activities and efficiencies along alternative corridors. For the introduction of a regional port system to succeed, a number of management practices within the shipping industry, as well as some institutional concerns found in the larger regional context, would need to be modified and resolved. First among these, perhaps, would be the coordination or management of ports within a region. This coordination would allow the ports to function as a system rather than as competing, disjointed entities. Within such a port system, regional infrastructure investments could be prioritized to enable SSS operations, and business and labor contracting provisions could be modified to allow for such innovative operations. More over, the interests and energies of the private sector could be leveraged to realize potential regional advantages.

To prepare for this, some likely next steps should be taken to determine how regional port systems might be formed and administrated, to quantify the economic development benefits that would accrue by this to both the private and public sectors, to determine the level of landside transportation and marine port investments necessary to establish a regional port system and implement SSS operations, and to identify the legislative measures required to authorize a regional port system. Such steps would serve the interests of nearly all stakeholders involved in regional transportation and logistics, and provide the West Coast with a more reliable marine transportation system and one that is closely integrated with landside transportation systems.

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