PREPARED FOR:

PORT FREEPORT
FORT BEND COUNTY, TEXAS
BRAZORIA COUNTY, TEXAS

SH 36A RAIL DEVELOPMENT CORRIDOR

BUSINESS PLAN: FEASIBILITY STUDY

NOVEMBER 2015

PREPARED BY:

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BROWN & GAY ENGINEERS, INC. IN ASSOCIATION WITH AGUIRRE & FIELDS, LP

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Chapter 1. Study Purpose and Scope

If Port Freeport develops into a major container port as expected, the proposed SH 36A Development Corridor will develop into a major trade corridor connecting the rail yards, intermodal centers, and retail distribution centers of central, northern and west Texas. Due to geography it is expected that Port Freeport will need to rely heavily on intermodal connections, so the ability to effectively develop the needed inland rail connectivity is critical to its success.

This report is an update and reflects a number of refinements to the concept study that was originally presented in September 2014. This new report further develops the project plan for implementing a rail connection from Port Freeport along the SH 36A Corridor to serve inland markets of Texas and Middle America. In particular, a representative alignment has been developed for the rail corridor connecting Freeport to Rosenberg to Caldwell, and detailed engineering costs have been developed. Additionally, the demand model that was originally used for Panama Canal forecasting has been upgraded from 2006 to 2014 data, and the internal zone system and networks have been considerably refined.

1.1 Introduction

Given the improvements to the Panama Canal that are expected to come on-line in mid-2016, and the consequential development of Port Freeport into a major container port, the purpose of this feasibility study is to evaluate the potential for developing a Freeport/SH 36A Development Corridor as a rail trade corridor serving the intermodal centers of northern Texas and mid-America. The corridor will also provide a bypass and reliever to the ports of Galveston and Houston, which are being "choked off" by bottlenecks and congestion[1]. The Houston ship channel is not able to be dredged to the 50+ feet depth needed by fully-loaded Post-Panamax containerships. However, if Port Freeport can dredge its channel to the planned 56 feet and provide the required container facilities, it could become a major port of call for such ships.

1.2 Study Objectives

Transportation Economics & Management System, Inc. (TEMS), Brown & Gay Engineers, Inc. (B&G) and Aguirre & Fields (A&F) with assistance from HDR Engineering have been asked to update the earlier Concept Study into a Feasibility Level Analysis Business Plan that will answer the following questions:

- Is there a Business Case for investing in rail along the SH 36A Corridor and developing a trade corridor?
- How will the Port Freeport and the communities along the SH 36A Corridor benefit?
- Can the private sector play a role in developing the corridor, and can the freight railroads become a partner in the process?
- What are the potential sources of public and private funding (revenue, loans, grants, bonds, letters of credit, etc.) that can be obtained to support and develop the project?

[1] *Texas Chicken*, See: http://bill37mccurdy.com/2015/02/20/texas-chicken-game-in-houston-ship-channel/ and http://www.bloomberg.com/bw/articles/2014-02-27/houston-ship-channel-congested-by-u-dot-s-dot-oil-and-gas-boom

1.3 Study Approach

The purpose of the feasibility study is to assess the market opportunities, physical facility needs, financial and economic returns, business arrangements and implementation timeline for developing rail service along the SH 36A Corridor to and from Port Freeport.

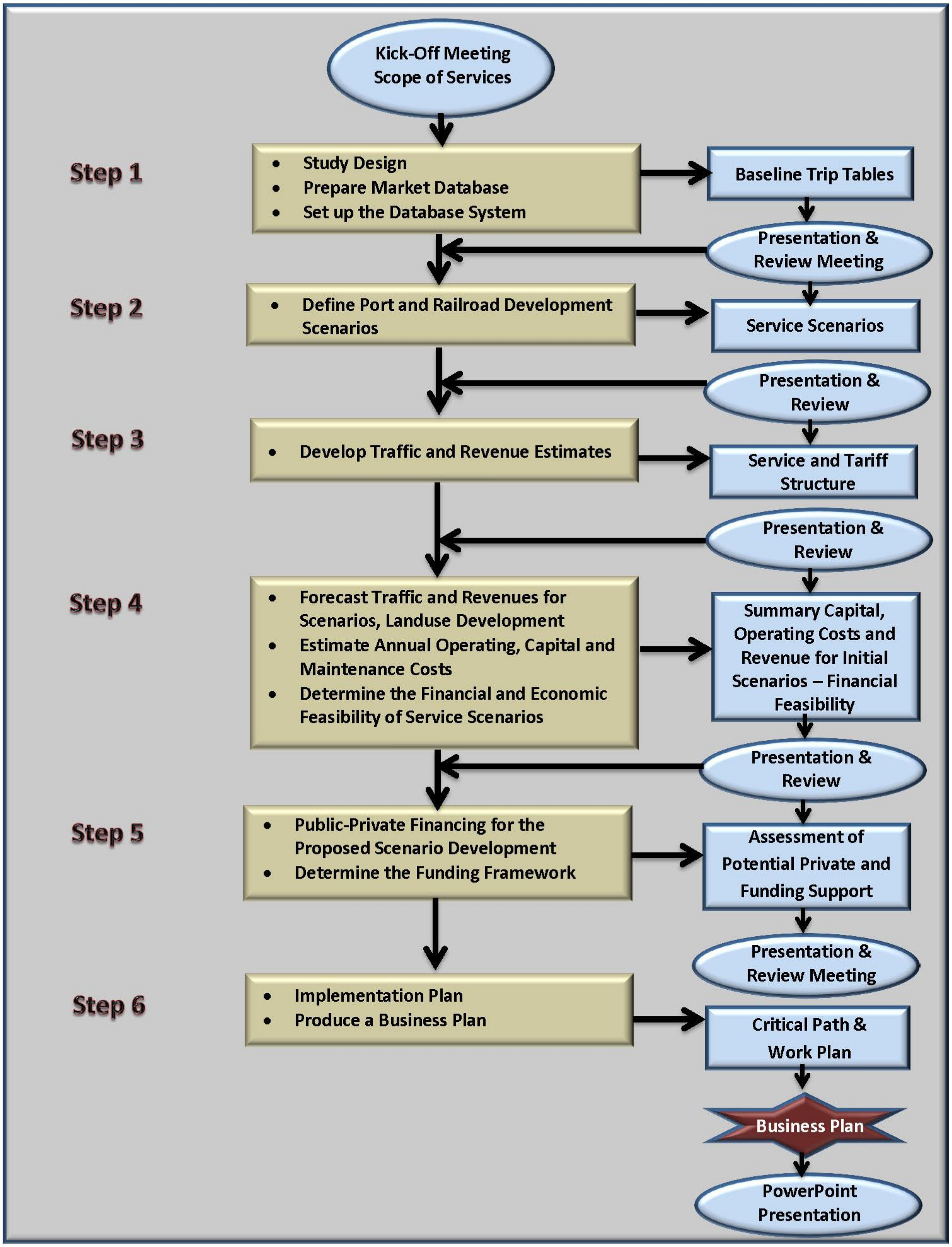
In undertaking this analysis TEMS, in cooperation with B&G and A&F, will use its six step Business Planning process. The process is shown in Exhibit 1-1. As work progresses from Concept to Feasibility to Investment Grade, the fundamental methodologies are similar, but feasibility and investment grade studies develop much more detailed and refined data bases than do the early concept studies. At the current feasibility level of detail, the study databases are much more refined than in the earlier concept study and now reflect an estimated ± 30 percent error range on rail corridor demand and costs. All studies have assumed that Port Freeport will be able to make the necessary investments for developing its own port facilities. A future Investment Grade study database will need to refine the analysis even further to reflect a ± 20 percent error level that is needed to support the issuance of both general and revenue bonds, as agreed with Wall Street.

Step 1 – Overall Market Assessment

In Chapters 2, 3, and 5, TEMS GOODS™ multimodal freight model market database has been upgraded. Originally developed for the Panama Canal, Gulf Coast Port Study, West Coast Port Study, and National Ports Models, the existing 2006 database of socioeconomic data, marine markets, and competitive inland transport networks has been updated to 2014. It now reflects the latest Port statistics, updated inland transportation data, and changes in mode competition due to oil prices, congestion and fuel efficiency. The GOODS™ model allocates traffic to modes using a "Generalized Cost" metric that reflects shipper and carrier behavior in the face of different mode and service options. It provides a mechanism for estimating market share traffic volumes and revenue potential for each element of the traffic movement.

Medium and Long Term forecasts have been prepared using the Texas Comptroller's estimates of economic growth and expected changes in transport infrastructure in the Port Freeport and the other Gulf Ports, to estimate the market shares of the Gulf versus both West and East coast ports. The market analysis has been used to identify truck and rail traffic potential from Port Freeport along the SH 36A corridor for horizon years 2020, 2030, 2040, and 2050.

Exhibit 1-1: Steps for Development of the Business Plan



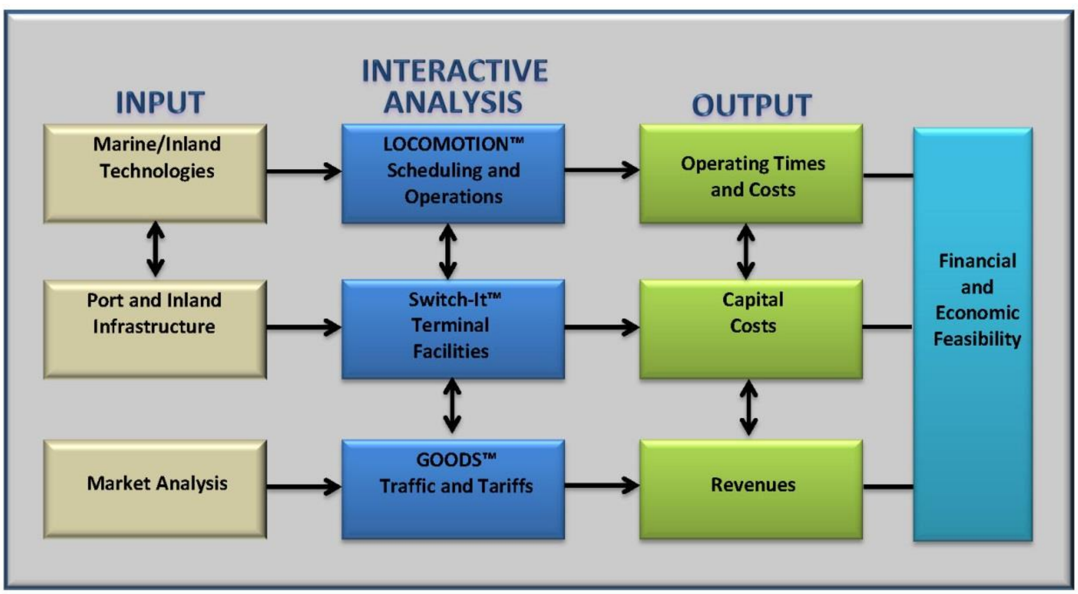
Step 2 – Service Scenario Definition

In Chapter 4, the Feasibility Study will further refine the port, and rail infrastructure and development strategies that were proposed for Port Freeport and the SH 36A corridor in the Concept Study. This reflects not only specific market data on the potential market pairs and service needs, but also reflects the direct input and feedback that has been provided by the project stakeholders. An Interactive Analysis has been completed to assess the relationship between market volumes, and service development options for the Port Freeport and Inland distribution networks. From an evaluation of these options the analysis has identified the rail traffic potential, intermodal interface needs, port to port services, and potential schedules and tariffs.

Port and rail Infrastructure needs to service Port Freeport and the SH 36A Corridor have been identified and their operating and capital costs estimated. This includes the ability to support on-dock, near dock, and conventional rail intermodal services. Furthermore, the timing of rail infrastructure needs has been assessed to ensure that it is timed to relate to changing traffic conditions, which could well occur in the next five to ten years due to the Panama Canal and increasing congestion in the Houston region.

Exhibit 1-2 shows the Interactive Analysis process. It can be seen how data on the marine and inland transport distribution systems and on the market is used to identify the character of the transport operations that can be provided in the Freeport/SH 36A Development Corridor.

Exhibit 1-2: Interactive Analysis Process



The interactive analysis defines the most effective way to develop both water services and inland distribution services, by assessing their performance in both financial and economic terms. In developing the service plan, the analysis also recognizes and considers existing and potential institutional, fiscal, and policy issues that are fundamental to the success of the project.

A key element of the Investment Grade phase of this assessment will be that the study teams work closely with important stakeholders such as the railroads and shippers to ensure they are comfortable with the basic concepts, market forecasts, and Port Freeport service proposals. It is important to achieve "buy-in" from the key project stakeholders, and to identify their needs in meeting the Port Freeport proposals. As required, both line and yard capacity needs will be addressed using the MISS-IT™ and Switch-It™ models. The service plan as finally developed will include contingencies to manage issues affecting its implementation.

Step 3 – Traffic and Revenue Assessment for the Representative Option

For the representative option as identified in Step 2 above, a traffic and revenue yield assessment has been completed in Chapters 5 and 6 to optimize the tariff systems and estimate cash flows available for servicing bonds. By providing an analysis of tariffs in relation to the supply and demand conditions, a final set of forecast traffic volumes and revenues can be derived. These tariffs when applied to the market, will optimize revenues and provide the key input to the financial model used to assess the potential of Port Freeport, and SH 36A Corridor.

Step 4 – Facilities Analysis

In the fourth step, the market analysis, service plan and tariff structures developed in Steps 1 through 3 will be used to define the specific infrastructure, land uses, and development proposals for the Freeport/SH 36A Development Corridor. The service scenario definition in Chapter 5 identifies these critical inputs:

- Rail infrastructure,
- Port infrastructure,
- Inland port potential,
- Terminal facilities, parking and access,
- Bulk and car load rail yard traffic,
- Maintenance facilities,
- Interface access systems for truck and rail traffic,

A financial and economic evaluation in Chapter 6 will assess financial return and economic benefits including net present value, internal rate of return, payback period, debt coverage and financial risk. As the process develops, specific recommendations for Port Freeport and the SH 36A Corridor will be examined to maximize the economic success of the project.

A preliminary Implementation Plan has been developed, defining the milestones and components for implementing the Freeport/SH 36A Development Corridor.

Step 5 – Financing and Funding Plan

In Step 5 a potential financing framework and funding plan will be defined to include potential public-private partnerships, franchise potentials and others. This will be presented in Chapter 6. The role of funding sources in terms of both the public and private sector will be assessed and a variety of creative financing and funding programs will be considered. Specific consideration will be given to the appropriate institutional structures for the operation and the needs of stakeholders. As required, specific cost sharing arrangements will be developed between federal, state, ports, shippers and the freight railroads and cost allocation procedures proposed. A preliminary Risk Analysis identifies key factors and issues associated with the different strategic options.

Step 6 – Business Plan

In Step 6, a preliminary Business Plan brings together the various sub-plans and agreements that were developed in the original Concept study, and then updated in Steps 1 through 5. This sets out a development plan and investment program to support the development of a rail corridor and operation to support the updated Port Freeport infrastructure, and a full multimodal "Inland Port" facility to facilitate traffic movement by rail, truck and water out of and into the Port Freeport hinterland. This development will require full financial and economic justification and an understanding of the contribution the rail facility can make to the Texas economy in terms of jobs, income and transfer payments like tax base expansion and additional rents and fees. The preliminary Business Plan will include:

- Market Analysis
- Operating and Service Plans
- Land use Requirements
- Preliminary Financial Plan
- Preliminary Funding Plan
- Preliminary Implementation plan

The Business Plan identifies capital needs, operating costs and potential revenues. It guides and supports the key stakeholders throughout the implementation and financing activities of the rail project.

Chapter 2. The Need for a Deep Water Port in Texas

With its planned 56' main channel depth, Port Freeport will be able to accept any container ship using the expanded Panama Canal. Thus, Freeport will be able to fully exploit the market opportunity afforded by enlargement of both the Panama and Suez Canals.

2.1 Impact of Panama Canal Expansion on Vessel Sizes and Costs

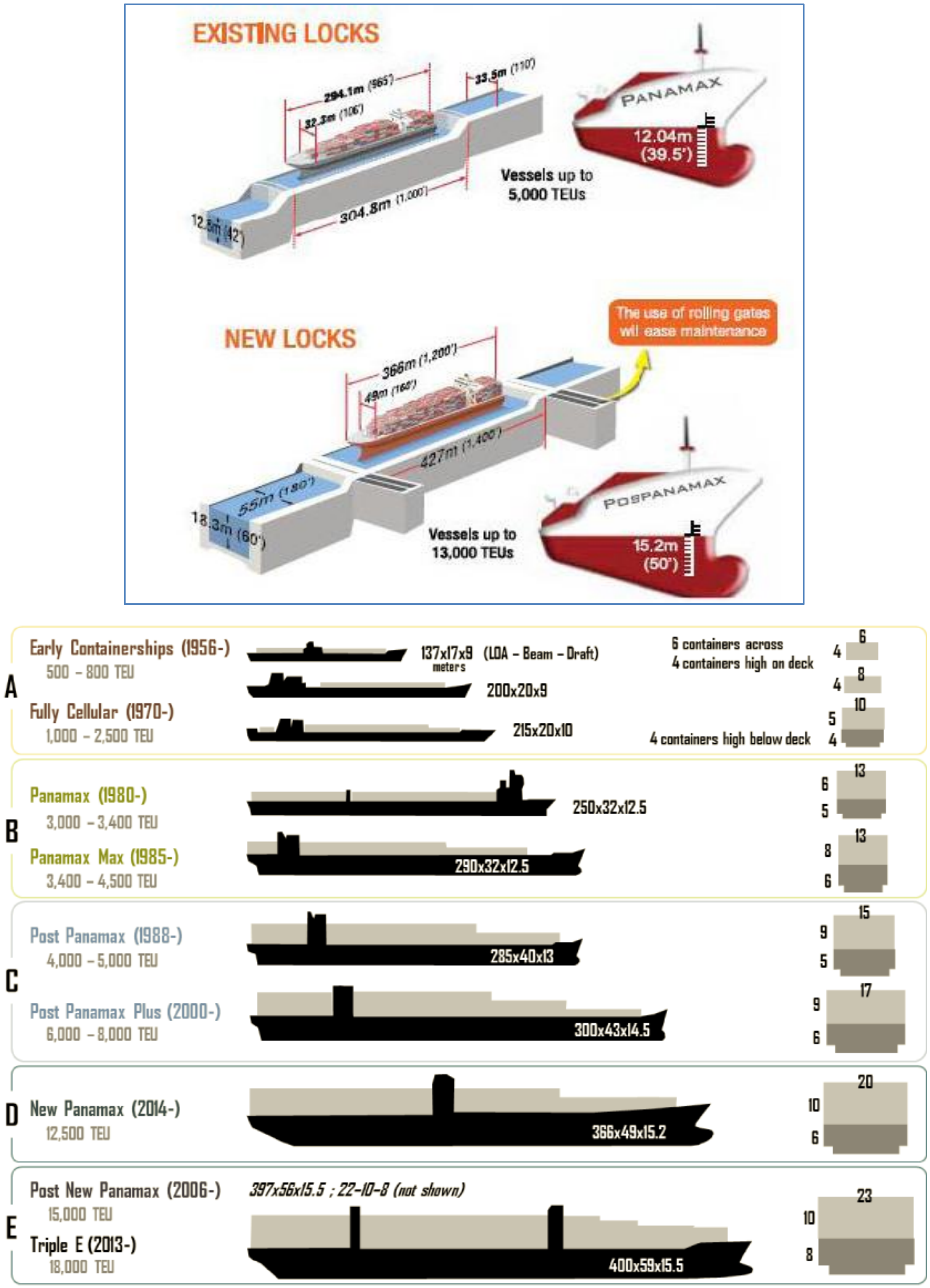
The shipping industry is moving towards larger container ships in both Pacific and Atlantic lanes. As shown in Exhibit 2-1 the new Panama Canal locks could potentially permit more than a doubling of containership vessel size in terms of TEU capacity. To accommodate larger vessels, ports need at least 50 feet of water. On the Gulf coast only Freeport and Corpus Christi will have this water depth.

Previous studies[2,3] have found costs in the range of approximately $0.04 per TEU-mile for a 2,000 TEU ship and $0.02/per TEU-mile for a 6,000 TEU ship. Larger ships cost even less. By comparison, a double stack rail move costs $0.12 per TEU-mile (plus terminal handling) and truck $0.95 per TEU-mile (one typical trailer load equals two TEU) for a one-way loaded movement.[4] Though the precise numbers will vary, the magnitudes of cost differentials for larger ships, ***by cutting line-haul costs approximately in half***, explains the rapid growth of Post-Panamax container ships in the world fleet. ***A mile of sea costs between six and thirty times less than a mile of rail or truck,*** respectively.[5] This is why it is cheaper to bring goods by water through the Panama or Suez Canals even overcoming the longer distance of the ocean routes. As shown in Exhibit 2-1:

- The type "C" ship can carry 4,000 to 8,000 TEU comparable to the size of ships that have been used at West Coast ports. It needs a channel depth of 14.5 meters or 48' fully loaded, which exceeds the depth of the Houston Ship Channel, but could be comfortably accommodated by Freeport's proposed 56' main channel.[6] The type "D" ship is largest that will be able to transit the expanded Panama Canal locks. Such a ship could carry 12,500 TEU and will not be needed at first. As volume builds however, the steamship lines will want to introduce these types of vessels into the schedule rotations.
- The type "E" ship is largest container ship in the world.[7] It is too wide to fit through the Panama Canal locks, but can come through the Suez Canal. [8] However, it does not need much more depth than the type "D" ship. It could carry 18,000 TEU and needs a depth of 15.5 meters or 51' fully loaded. The proposed 56' main channel at Freeport could accommodate this, given appropriate birth space.

[2] Texas Gulf Ports Study, Figure 4.3. See: http://www.utexas.edu/research/ctr/pdf_reports/1833_3.pdf
[3] Vessel cost functions that were measured by TEMS and the RAND Corporation for the Great Lakes and St. Lawrence Seaway independently confirmed vessel operating costs in the same range. See: http://www.marad.dot.gov/documents/NCNV_Report-Part_1.pdf
[4] Rail costs were modeled as $125 lift costs per TEU for loading and unloading, or $62.50 at each end, plus 12¢ per mile for the rail line-haul. These values were derived from published truck and rail operating costs, in particular rail Intermodal costs developed using the U.S. Surface Transportation Board's Uniform Rail Costing System (URCS) methodology, as summarized and used in the previous TEMS/RAND GLSLS study, and from the U.S. Federal Railroad Administration's Intermodal Transportation and Inventory Cost model. See: http://trb.org/news/blurb_detail.asp?id=4801
[5] This finding is from the Texas Gulf Ports Study, page 47: http://www.utexas.edu/research/ctr/pdf_reports/1833_3.pdf, but it was independently corroborated by the other sources cited in this analysis.
[6] See: http://www.usace.army.mil/Portals/2/docs/civilworks/CWRB/freeport2/freeport2_slides.pdf
[7] See http://en.wikipedia.org/wiki/CMA_CGM_Marco_Polo , http://www.bbc.com/news/magazine-21432226 and http://en.wikipedia.org/wiki/M%C3%A6rsk_E-class_container_ship
[8] See also: http://www.joc.com/port-news/panama-canal-news/production-shifts-mega-ships-challenge-panama-canal_20131108.html

Exhibit 2-1: Panama Canal Ship Capacity vs. Dimensions[9,10]



9 https://ftp.dot.state.tx.us/pub/txdot-info/panama/final_report.pdf
10 Ashar and Rodrigue, 2012. All dimensions are in meters. LOA: Length overall. http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/containerships.html

However, the main competition for Texas ports today relies on neither the Panama nor Suez Canals. Instead, most Asian traffic to the U.S. today comes via direct vessel service across the Pacific Ocean into a West Coast port, then by rail to mid-America or the East Coast. Railroads have (up until now) been able to arbitrage the water cost differential all the way across the Pacific Ocean, due to big ships on the West coast versus small ships on the Gulf and East Coasts.

The reality is that, in spite of all the marketing "hype" about West Coast ports being "Big Ship Ready"[11,12] recent attempts to introduce larger ships have been linked to severe port congestion at both New York and Los Angeles.[13] This shows that higher port costs can easily offset line haul savings, unless ports are fully geared to accommodate the needs of large ships. It should be noted that the Port of Freeport itself might have issues with the size of ships depending on how it lays out the container berths and ship turning basins. Nonetheless, it is clear that ocean carriers favor larger ships, even in spite of the challenges they pose at ports -- and that ocean carriers will continue to pressure ports to improve their facilities and operations.[14] Therefore, the ports who are best able to handle large ships are the ones who will be favored by the ocean carriers. Ports who cannot handle large ships will be bypassed.

KFW-IPEX Bank[15,16] agrees, saying that once East Coast port improvements (e.g. dredging) are completed, large Post-Panamax ships will become the standard in trans-Atlantic lanes as well as trans-Pacific. Smaller ships although still serviceable have become economically obsolescent, and many will likely end up being scrapped.[17,18]

As a result, the clear trend has been towards larger ships as soon as ports are able to complete dredging projects that are prerequisites to handling them. Along with dredging, dockside improvements such as larger and faster container cranes, improved train loading and better container stack management, are all needed to be able to effectively load and discharge more containers per vessel call. In addition, rail and highway bottlenecks must be addressed to ensure that trains and trucks have the capacity to haul containers off the dock as quickly as the cranes can unload them.

[11] See: http://www.polb.com/about/bigshipready.asp

[12] See: http://www.presstelegram.com/technology/20120609/giant-container-ship-arrives-in-port-of-long-beach-from-china

[13] See: *Mega-Ships dealing Worst Congestion Hand to LA-LB, NY*-NJ, http://www.joc.com/port-news/us-ports/port-new-york-and-new-jersey/mega-ships-dealing-worst-congestion-hand-la-lb-ny-nj_20150701.html and *Growing Shipping Alliances Are Straining Major U.S. Gateway Ports*, http://www.wsj.com/articles/growing-shipping-alliances-are-straining-major-u-s-gateway-ports-1430733531

[14] From 2007 to 2015, the average vessel size at San Pedro Bay increased by 34%. Mercator has projected that by 2020, average vessel size in the Asia-California lanes will increase to over 9,100 TEUs and most services will be operated with ships exceeding 10,000 TEU capacity. See: http://portoftacoma.com/sites/default/files/PugetSoundGateway_FinalReport.pdf

[15] *Panama Canal expansion reinforces cascade effect,* June 4, 2014. See https://www.kfw-ipex-bank.de/pdf/Analyses-and-views/Market-analyses/2014-06-04-Blitz-Licht-Analyse-Panamakanalausbau.pdf KFW-IPEX Bank is a German government-owned development bank, based in Frankfurt. Its name originally comes from *Kreditanstalt für Wiederaufbau*, meaning Reconstruction Credit Institute. It was formed in 1948 after World War II as part of the Marshall Plan. http://en.wikipedia.org/wiki/KfW

[16] See: http://www.joc.com/maritime-news/container-lines/%E2%80%9Cmassive%E2%80%9D-surplus-midsize-container-ships-coming-drewry_20140428.html

[17] Unfortunately, the 5,000 TEU Panamax ship is about the largest that the 45' Houston Ship Channel can take fully loaded. This poses a serious quandary for the shipping lines – not being deep enough to allow direct vessel calls using the types of container ships that the major shipping lines will find most economical to operate -- there is a chance that Houston may lose some of its direct Asian vessel services and be relegated once again to the role of a feeder port. Once as expected large ships are also fully deployed in the European trade lanes, Houston's European traffic would similarly be at risk. See: http://www.porttechnology.org/news/panama_canal_container_trades_past_present_future_issued_by_dynamar_bv_#.U9eu6lJ0y71

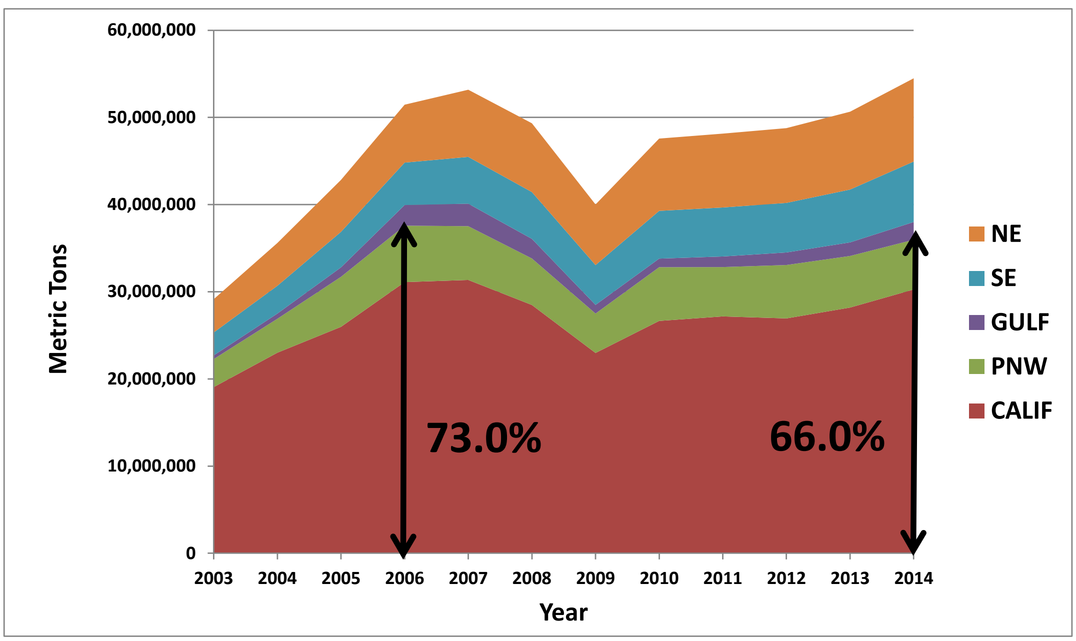
[18] Existing Panamax-sized ships will likely become obsolescent as shipping lines continue migrating towards larger vessels, including in trans-Atlantic lanes that are not directly related to Panama Canal. Many of those smaller ships will likely end up being scrapped because they will no longer be able to economically compete against the larger ships.

It should be noted that the long haul lanes that transit the Suez or Panama canals[19] offer even better economics for big ships than the trans-Pacific lanes, which are relatively short by comparison. As a result, vessel sizes will likely continue to grow as the Texas market continues to develop over the next 20-30 years. Long term planning for Port Freeport should anticipate type C/D Ships via Panama or even larger ships arriving via the Suez Canal within 20-30 years as the Texas market continues to develop. Rising tolls on both Panama and Suez Canals may further accelerate the trend towards larger ships, so Freeport should be prepared to accept larger vessels in the long term.

2.2 Demand Forecasting Assumptions

In anticipation of Panama Canal expansion, a significant share of traffic has already shifted from the West Coast to East and Gulf Coast ports. Since China is the United States' largest single Asian trading partner, Exhibit 2-2 shows the history of imported Chinese containerized tonnage[20] since 2003 as according to U.S. Census data. Exhibit 2-3 shows the same data in terms of dollar value. As shown in these exhibits, West Coast (California + Pacific Northwest) share of China tonnage declined from 73.0% in 2003 to 66.0% in 2014; in value terms from 79.8% in 2003 to 72.1% in 2014.

Exhibit 2-2: China Imports: Metric Tons by Port Zone



[19] In the future, a serious disadvantage of vessels in the 7,000-8,000 TEU range is that they would waste a significant share of the Panama Canal's added capacity -- such vessels are too large for existing locks, but won't nearly utilize the full capacity of the expanded locks that can handle vessels up to approximately 12,500 TEU. The expectation is that the relatively short trans-Atlantic and trans-Pacific lanes will likely be served by type "C/D" ships whereas the long-haul lanes that transit the Panama and Suez Canals are the ones that are most likely to operate with the largest vessel sizes.

[20] In general, ports are more interested in tonnage than in value, since tonnage more closely correlates to TEU counts. The Census bureau does not directly report TEU counts by origin country and port.

Exhibit 2-3: China Imports: Value by Port Zone

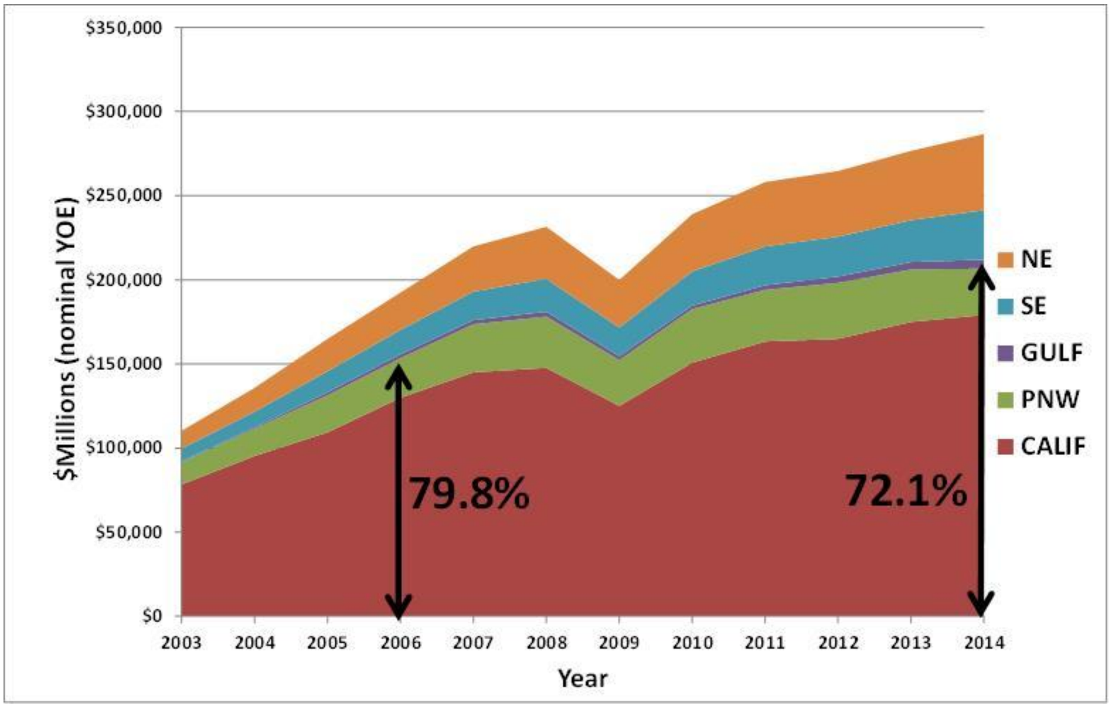


Exhibit 2-2 shows that containerized tonnage of Chinese traffic on the West Coast actually *declined by 4%* from 37.6 million metric tons in 2006 to 36.0 million in 2014; while U.S. total tonnage[21] *increased by 6%* from 51.5 million to 54.5 million metric tons. While the West Coast lost tonnage, East Coast tonnage from China *increased* by 43% from 11.5 to 16.5 million tons from 2006 to 2014. It can be seen that the East Coast captured *all* the Chinese traffic growth, much of which has been directed through the Suez Canal.

A key factor driving this shift is the level of West Coast port congestion, which has triggered a desire of shippers to diversify their port and rail routing options:

- Port congestion and a West Coast strike in 2002[22] demonstrated supply chain vulnerabilities associated with over reliance on only a single port, and encouraged shippers to begin to look for new options.
- A second labor slowdown[23,24] in 2014-2015 again resulted in severe west coast port congestion. This forced additional diversion to East Coast ports. Both Panama and Suez Canals[25] have benefited: Panama through higher utilization of existing vessels, and Suez by attracting US East Coast vessel strings, using large ships to offset the longer sailing distance from Asia.

[21] This excludes a less than 1% share that is headed to Alaska, Hawaii, and other U.S. territories that are non-contiguous to the lower 48-states.
[22] *Giant distribution complex will have widespread impact*, May 2005, http://www.bizjournals.com/houston/stories/2005/05/16/story1.html
[23] See. http://www.railwayage.com/index.php/intermodal/strike-threat-spurs-retail-import-surge.html?channel=48&utm_source=WhatCounts+Publicaster+Edition&utm_medium=email&utm_campaign=RGN+6.9.14&utm_content=Full+Article
[24] Some of the slowdown has also been blamed on deployment by ocean carriers of larger ships in the Trans-Pacific lanes *West Coast Ports expect to be "Back to Normal" by end of May*, http://www.joc.com/port-news/us-ports/port-los-angeles/west-coast-ports-expect-be-back-%E2%80%98normal%E2%80%99-end-may_20150511.html
[25] *Suez and Panama Expansions Hope to Provide Smoother Passage for the Shipping Industry*, http://www.oceanair.net/index.php/blog-list-view/item/111-suez-and-panama-expansions-hope-to-provide-smoother-passage-for-the-shipping-industry/111-suez-and-panama-expansions-hope-to-provide-smoother-passage-for-the-shipping-industry

Industry observers believe that *"not all the shift is temporary. Many problems with West Coast ports are chronic; with a labor pool poised to strike and bottlenecked connections to roads and rail."* [26] Another added: *"That's how capitalism works when unions have more power over the labor market than businesses because of pro-union labor laws (in California) which unfairly restrict labor competition."* [27]

Another critical issue in the forecasting is the role of Panama and Suez Canal tolls. Both canals are committed to increasing their capacity and the size of ships they can handle. While the average size of ships using the Suez Canal has grown from 6,911 TEUs to 7,756 TEUs over the past year[28] the size of Panama ships remains constrained by the lock sizes. However, the size of vessels passing through the Suez Canal is continuing to grow and it's also likely that much larger vessels will also operate through the Panama Canal once the expansion project is completed. Recent toll increases[29] by the Panama Canal have resulted in some loss of some East Coast share[30] as for example Maersk withdrew its vessels from Panama in favor of running large ships through the Suez Canal. As a result, Panama now holds only a 48% share of U.S. East Coast container traffic as compared to Suez's 52%. It should also be noted that in spite of the diversion of some ships to Suez, loaded container volumes through the Panama Canal are actually still growing[31] as a result of increased cargo diversion from the west to east coast ports, and as ocean carriers strive to completely fill the ships they are already operating through the Panama Canal.

For the future, the Panama Canal has committed to offering a competitive toll structure on containers[32] that it plans to introduce after the new locks open: *"We are taking more risk under the new toll structure to lure more liners to come over and maybe re-network around the Panama Canal."* The new structure will rewards frequent container customers with premium prices once they reach a particular volume of 20-foot-equivalent units on ships transiting the canal. Clearly, large ships are changing the distribution of traffic by offering lower and lower costs as ships sizes continue to go up.

A more aggressive stance by the Panama Canal will be good for Texas ports, since East Coast ports have disproportionately benefited from the expanded use of the Suez Canal. None of the new Asia-Suez vessel

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[26] *LA port traffic jam may finally be ending, but shipping route changes could be permanent*, http://fortune.com/2015/05/05/shipping-traffic-east-coast/

[27] Chinese Imports Bypassing West Coast Ports, http://www.wsj.com/articles/chinese-imports-bypassing-west-coast-ports-1437065725 ; Imports plunged at West Coast ports amid labor dispute, http://www.latimes.com/business/la-fi-west-coast-port-decline-20150317-story.html

[28] According to Drewry, in June 2014 the average size of vessel from Asia for East Coast of North America ports passing through the Panama Canal was just 4,630 TEU, as compared to 7,510 TEU via the Suez. Even though a few vessels transiting the Suez are much larger, this current average 7,510 TEU vessel size for the Suez Canal is consistent with what KFW-IPEX Bank has projected is most likely to be expected on the East and Gulf Coasts after expansion of the Panama Canal, see: http://www.tradewindsnews.com/weekly/342068/Suez-overtakes-Panama-Canal-on-key-container-route

[29] According to http://www.bloomberg.com/news/2013-03-11/maersk-line-to-dump-panama-canal-for-suez-as-ships-get-bigger.html *Fees for ships to go through the Panama Canal have tripled in the past five years to $450,000 per passage for a vessel carrying 4,500 containers, Skou said. In February, the Suez Canal Authority announced canal toll increases that would be effective from May, according to the Asian Shipowners' Forum.* This is $100 per TEU each direction. According to http://www.joc.com/port-news/panama-canal-news/suez-canal-lure-more-traffic-panama-canal_20131111.html *The Suez Canal Authority currently charges about $1 million for a combined northbound and southbound transit by ships of between 8,000 TEUs and 9,000 TEUs.* This is $62.50 per TEU each direction. At the current time the Suez Canal tolls are substantially cheaper than Panama Canal tolls on a TEU basis, which along with the economics of larger ships, has helped in the short term to accelerate the trend away from use of the Panama Canal toward the Suez Canal for traffic from Asia to the east coast of North America.

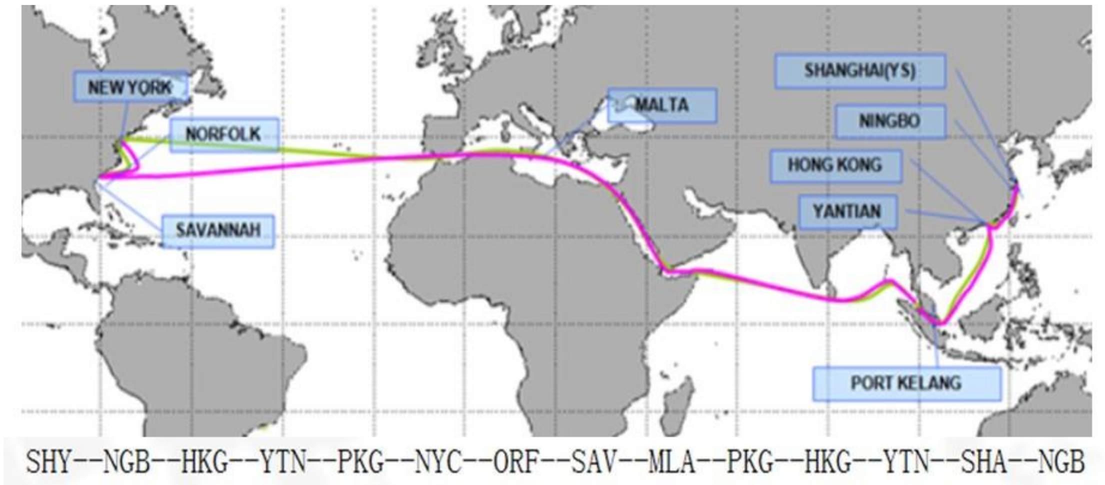
[30] See http://www.joc.com/port-news/panama-canal-news/suez-canal-lure-more-traffic-panama-canal_20131111.html However, Drewry says the damage caused by the overdue opening of the Panama Canal's new locks is not irreparable. "*Everything currently being lost through Suez could easily be switched back to the Panama Canal depending on the level of its new tariffs*" Drewry explained.

[31] See *Panama Canal Aims to Keep Volume Gains Fueled by West Coast Congestion*, http://www.joc.com/port-news/panama-canal-news/panama-canal-aims-keep-volume-gains-fueled-west-coast-congestion_20150223.html

[32] See *Panama Canal Proposes New Tolls, Carrier Loyalty Program,* http://www.joc.com/maritime-news/panama-canal-proposes-new-tolls-carrier-loyalty-program_20150106.html

rotations go to the Gulf of Mexico, since none of the Gulf ports are able to handle ships of the size that carriers are operating via the Suez Canal. Therefore it is impossible for the Suez rotations to go into the Gulf. The rotation shown in Exhibit 2-3 is typical of the kind of new vessel services that have been recently instituted.

Exhibit 2-3: CMA-CGM America Service AAE1: it turns back east at Savannah



The influence of the Suez rotations can be seen in terms of Asian containers bound for Texas that are currently being dropped at New York and Savannah, then using rail to move into Texas from the east coast. But in spite of this, Gulf port container volumes (particularly at Houston) have continued to grow steadily since 2010 as the economy has recovered and driven by the ongoing West to East coast traffic shift. When the Panama Canal expansion opens in 2016, then Gulf ports will likely have an opportunity to recapture some of this East Coast Asian traffic.

Clearly, the trend is to longer water movements in larger ships. Whether container movements come to the U.S. East and Gulf Coasts via the Panama or Suez Canals, the future level of cost will be lower and highly competitive. The Panama Canal expanded locks won't open until 2016 but competitive forces are already compelling ocean carriers to quickly move to larger ships. In the meantime, ports on the Gulf and East Coast have all been advancing their plans to get ready.[33]

[33] However, port readiness on both the East and Gulf coasts will clearly constrain the rate at which traffic can be shifted. See: http://www.logisticsmgmt.com/images/site/LM1205_TopPorts.pdf, http://www.colliers.com/-/media/Files/MarketResearch/UnitedStates/2012-NA-Highlights-Reports/2012%20Q2/Colliers_PortReport_2012q2_final?campaign=Colliers_Port_Analysis_NA_Aug-2012

Chapter 3. Market Assessment

This section assesses the existing markets and Texas transportation system identifying strengths on which to build, potential weaknesses or bottlenecks, markets opportunities and competitive threats that may impact Port Freeport's ability to grow and develop.

3.1 The Current Market in Texas

Expansion of the Panama Canal offers a key opportunity for Texas ports, but also a challenge to handle the larger ships that will be transiting the canal in the near future. This has been perceived as benefiting mostly the US East Coast and not the Gulf, except for heavy bulk shipments like coal, grain, oil and LNG, which could all move more cost effectively from the Gulf in larger ships.[34,35] However, this view belies the fact that Houston, since the Los Angeles port strike of 2002[36] has been able to successfully attract container vessel calls from Asia through the Panama Canal. Feeder service from Panama started by 2004[37] but by 2006 Houston already attracted direct CMA CGM[38] vessel service. As shown in Exhibit 3-1, COSCO added a second direct vessel service in 2012.[39] In contrast, other Gulf coast ports including Corpus Christi, New Orleans[40], Mobile and Tampa[41] are all still dependent on feeder services from Caribbean Hubs. So Houston is as of now the only Gulf port that has been able to attract direct vessel calls from Asia. In fact as shown in Exhibit 3-2, the level of trade with China has grown to the point that China is now Houston's single largest import trading partner for containerized goods.

Houston's success in Asian trade over the past 10 years has been *in spite* of current vessel size limitations of the Panama Canal. When the new locks open in 2016[42], larger vessels will be able to lower shipping costs even more. This is projected to increase East Coast share of trade relative to West Coast ports; but there is no reason to believe that Gulf ports cannot share in this growth if they can accept the larger ships. Nonetheless, although Houston has been able to gain some market share, because it is currently limited to Panamax ships, its competitive position in Asian trade is marginal relative to using rail from the West Coast. The West Coast has the advantage of being able to use larger ships on the trans-Pacific lanes which gives it a natural cost advantage. Houston's shippers today use the port mainly as a back-up to protect against disruptions on the West Coast, not for significant cost savings, since the rail vs. water economic tradeoff today is very close.

[34] *Preparing Texas Land and Sea for the Panama Canal*, Panama Canal Stakeholder Working Group, November 2012, https://ftp.dot.state.tx.us/pub/txdot-info/panama/final_report.pdf
[35] *Panama Canal Expansion Study*, USDOT MARAD, November 2013, http://www.marad.dot.gov/documents/Panama_Canal_Phase_I_Report_-_20Nov2013.pdf
[36] *Shifting U.S-China Maritime Logistical Patterns: The Potential Impacts on U.S. Gulf Coast Ports*, M. Bomba, 2004, http://onlinepubs.trb.org/onlinepubs/archive/Conferences/MTS/4C%20BombaPaper.pdf
[37] *Port of Houston teams up with Panama to draw a piece of Asia's massive trade away from West Coast,* http://www.freerepublic.com/focus/news/1273495/posts
[38] *Port of Houston Authority Tests Operations At Bayport,* http://www.irconnect.com/noc/press/pages/news_printer.html?d=110133
[39] *Port of Houston lands Asia Water Service*, http://www.yourhoustonnews.com/pasadena/news/port-of-houston-lands-asia-water-service/article_c0018894-5a04-5e51-8488-85c30db23f85.html
[40] See: http://www.logisticsmgmt.com/article/ocean_shipping_cma_cgm_csav_expand_service_at_port_of_new_orleans
[41] See: http://tampabayfreight.com/wp-content/uploads/2008-4_PanamaCanalExpansion1.pdf
[42] *Deal signed to end row over Panama Canal expansion,* March 2014, http://www.bbc.com/news/world-latin-america-26587046

Exhibit 3-1: Houston All-Water Asia Container Services Volumes (Loaded TEUs)

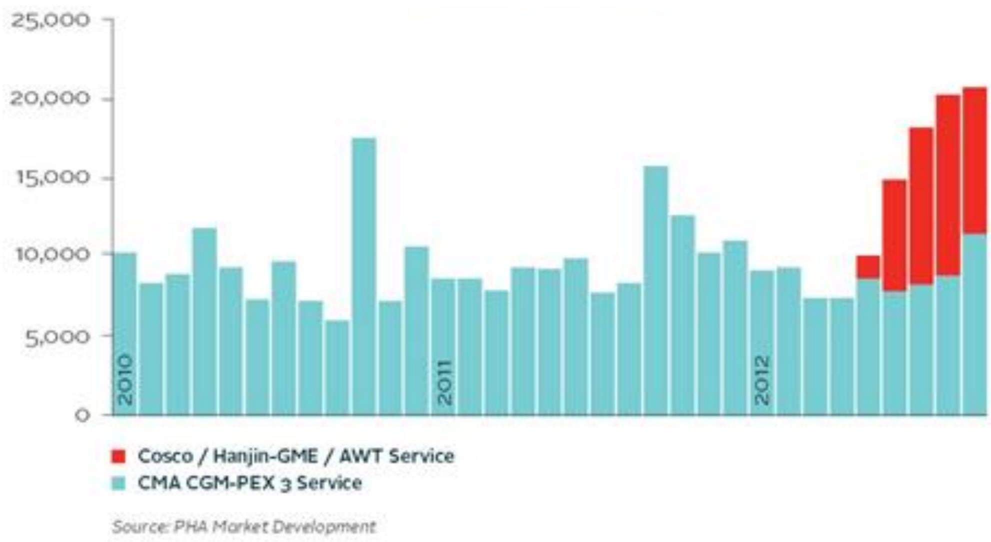
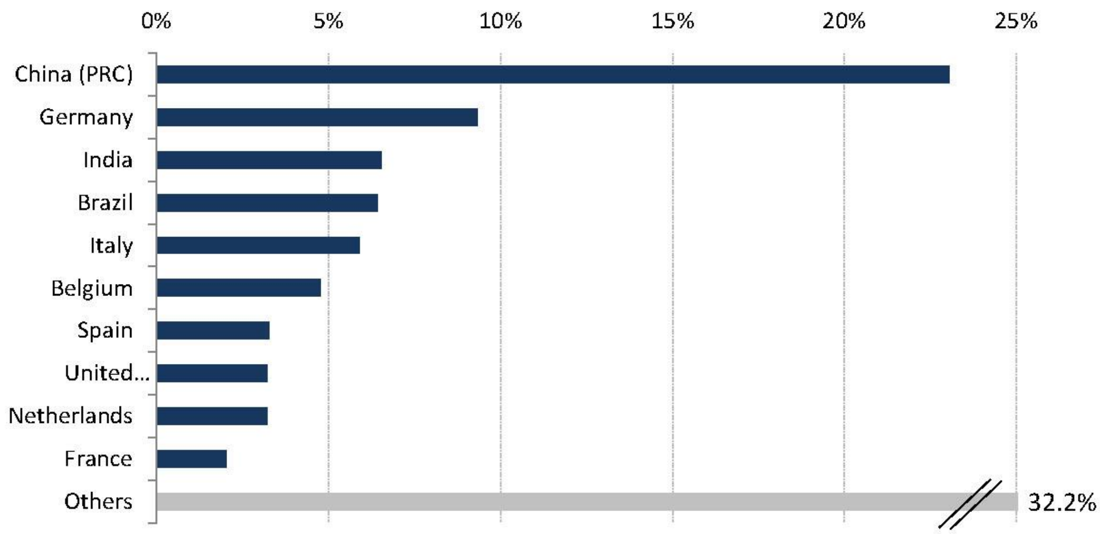


Exhibit 3-2: Houston Container Trade Partners: Imports (Percent of 2013 TEU Total)[43]

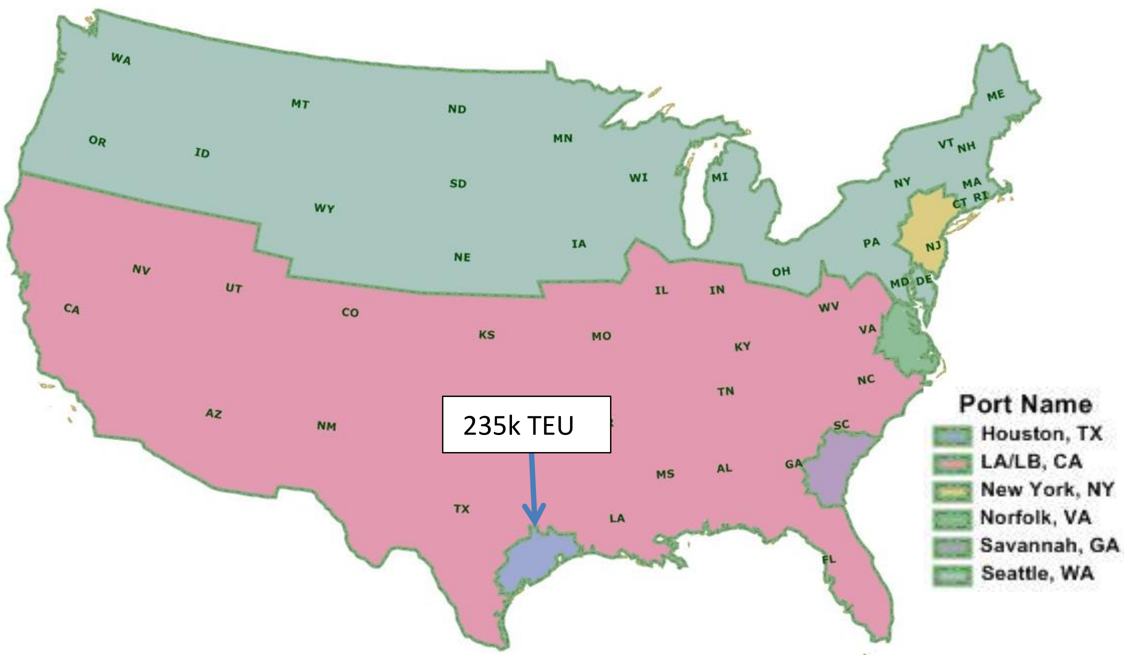


Source: PHA Market Development, Journal of Commerce/ PIERS data
Notes: Values include all Houston Ship Channel Terminals. Totals are estimated, not exact. See details below.

[43] See: http://www.portofhouston.com/static/gen/business-development/Origination/3-Container_Volume_by_Country_Stats2013.pdf

As Exhibit 3-3 shows, West Coast ports dominate the whole country today; this effectively limits Houston's service area to the immediate port hinterlands (truck market only, very little penetration even to Dallas, Fort Worth or interior points) *but the same thing can also be said of most of the East Coast ports,* which are also effectively limited to their local port hinterlands. Although Houston today has up to a 75% share of its truck hinterland container market[44], it has only about a 15% share of all Asian imports[45] coming into Texas; 80% of Asian imports still come into Texas via the West Coast and 5% via East Coast.

Exhibit 3-3: Current Small Ship Houston Port Hinterland[46] from Asia



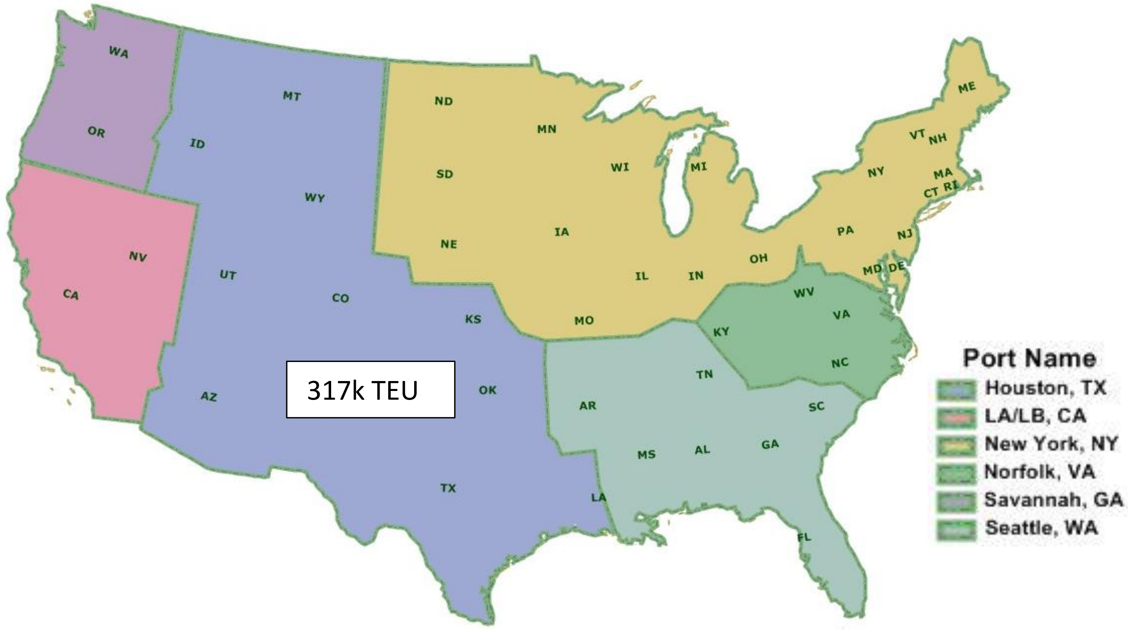
By comparison, Houston's position in European trade today is quite strong (Exhibit 3-4.) Houston attracts direct vessel services from Europe, which also connect to Suez routes that add containers from India and Southeast Asia. For European traffic, Houston competes with East Coast ports, primarily Charleston, SC and Savannah, GA. As a result, Houston has an 80-90% share of European and Suez (e.g. India) containers within a large port service area extending north and west from Houston across the whole Great Plains, east of the Rocky Mountains.

[44] This is an unusually high market share for water given the relatively tight spread that exists between rail and all-water rates at Houston. However, it might not be unexpected since a number of the major importers, like Wal-Mart, opened distribution centers in Houston for the express purpose of diversifying their supply chain options. This creates a strong "bias" towards water use since the distribution centers were located near the port for the specific purpose of being able to use water, rather than relying on rail shipping from the West Coast.

[45] This 15% consists primarily of Houston-area imports from China and Korea where direct container services operate. However, Texas is not connected to all Asian origins by a direct vessel service. For example, Houston's has no direct vessel connection to Japan, so Houston's share of Japanese imports to Texas is only about 2% -- almost all container imports from Japan arrive via West Coast ports.

[46] Large Ships (2¢/TEU mile) to West Coast, Small Ships (4¢/TEU mile) to Houston and East Coast due to Panama Canal and Port constraints, Rail Intermodal (12¢/TEU mile). This costing framework is consistent with the Texas Gulf Ports Study, Figure 4.3. See Exhibit 1-3 in this report. Web link: http://www.utexas.edu/research/ctr/pdf_reports/1833_3.pdf

Exhibit 3-4: Current Small Ship Houston Port Hinterland[47] from Europe and Suez

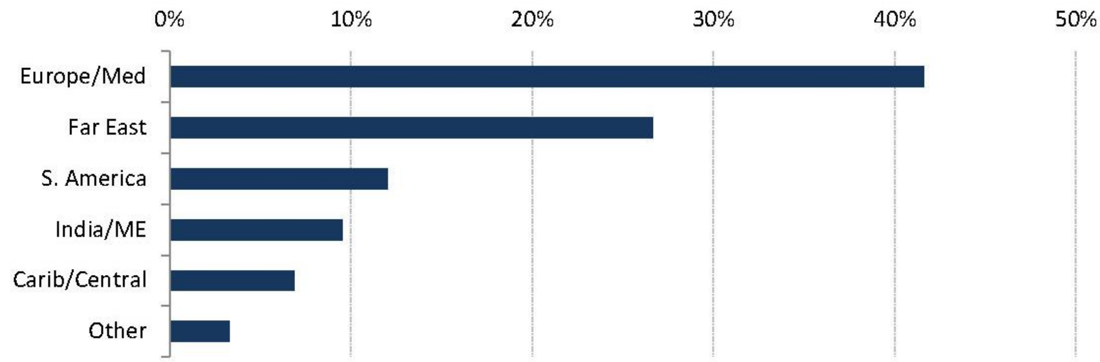


Comparing Exhibits 3-3 and 3-4, it can be seen that the Houston port hinterland area for European goods is geographically much larger than it is for Asian goods. In large part, this reflects the fact that for European (and Suez) trade today, East Coast ports are limited to smaller ships by their channel depths; European traffic to the West Coast is limited to small ships because of current Panama Canal limitations. As a result, all three coasts: East, West and Gulf are limited to small ships in European trade today. This competitive parity allows the Houston port to remain competitive over a much larger area for European than for Asian goods, where it is disadvantaged by the West Coast's sole ability to take big ships.

It is important to note that the result of the TEMS GOODS™ trade and traffic model[48] port Hinterland area modeling validates closely the Port of Houston's current trade statistics shown in Exhibit 3-5. Today, because the European hinterlands are large while Asian[49] hinterlands are very small, the Houston port actually handles more European import containers than it does Asian. (The total market size shows 317k / 235k or 35% more European containers than Asian, are available to the Port of Houston in Exhibits 3-3 and 3-4.) TEU's handled at Houston in 2013 was 274k / 176k for Europe vs. Asia – 57% more European import containers than Asian. Exhibit 3-6 shows that Houston's 72% share of Asian containers within the immediate environs of the port (primarily the Baytown area) is still lower than Houston's 78% market share for European containers – because of the economics of big ships at the West Coast ports. West Coast ports dominate the flow of containers to Dallas/Ft. Worth and even compete with the Port of Houston for the Houston market.

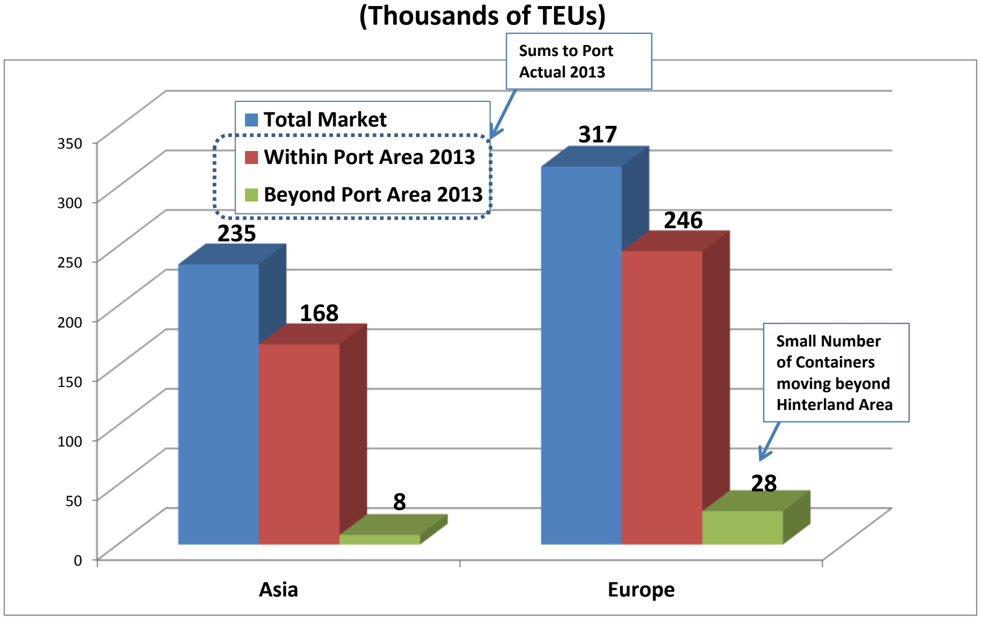
[47] Small Ships (2¢/TEU mile) to West Coast due to Panama Canal and Port constraints, Small Ships (4¢/TEU mile) to Houston and East Coast due to Port constraints, Rail Intermodal (12¢/TEU mile).
[48] Please see Chapter 6 and Appendix 2 for a more detailed description of this model.
[49] China is the ports largest single trade partner but all European countries exceed all Asian countries.

Exhibit 3-5: Houston Container Trading Lanes: Imports (Percent of 2013 TEU Total)[50]



Source: PHA Market Development, Journal of Commerce/ PIERS data
Notes: Values include all Houston Ship Channel Terminals. Totals are estimated, not exact. See details below.

Exhibit 3-6: Houston Port Actuals vs. Hinterland Validation: Europe vs Asia (Thousands of TEUs)



50 As compared to Exhibit 3-2, this graph shows Imports by *Trading Lane* rather than by *Country*. Although China remains the largest single import trading partner, collectively imports from all European countries are currently larger than Asian trade at Houston. See: http://www.portofhouston.com/static/gen/business-development/Origination/2-Container_Volume_by_Trade_Lanes_stats_2013.pdf

A third market as shown in Exhibit 3-5 that is very important to Houston is the Caribbean and South American trade. Due to volume and port limitations, as well as the relatively short lengths of haul, very small ships are mostly used in these trade lanes.[51] Feeder vessels also connect to Caribbean hub ports[52] where they can pick up containers from European or Asian origins –anywhere in the world. "Catch all" services from Caribbean hubs provide basic connectivity to other Gulf ports that don't have enough volume to support dedicated vessel services. But since Houston has been able to attract direct vessel calls from Europe and Asia, most traffic comes directly into Houston without needing to transfer at a Caribbean hub. Even so, some residual European and Asian volumes occasionally do arrive into Houston on feeder vessels.[53]

Both Houston and Freeport[54] have a strong position today in the Caribbean and South American markets, but since small feeder vessels are used in these lanes, New Orleans and other smaller Gulf ports have been able to compete strongly as well.[55,56] In competition with Houston, New Orleans also has a very strong position in Caribbean and South American trade – which naturally flows on a north/south axis -- because its on-dock rail connections with CN at Napoleon Avenue[57,58,59] provide fast and efficient connections to Memphis, Chicago and Canada. At the same time, this CN rail connection doesn't help New Orleans very much[60] for east/west European or Asian traffic, since the East and West coast ports are much more competitive than New Orleans for this traffic at Memphis and Chicago. This prevents New Orleans gaining much share in the European or Asian markets, in spite of its excellent rail connectivity. This is not likely to change because of New Orleans 45' channel depth limitation and the small size of the local New Orleans hinterland container markets, both of which are problematical for the deployment of large ships and will make it difficult for New Orleans to reduce its costs.

[51] As a result, shipping rates to South America, but especially in the Caribbean region, tend to be very high compared to the major trade lanes. This reflects high costs for the small ships used, low volumes and resulting port inefficiencies. See for example, Harding et al. (page 21) at http://www.cepal.org/publicaciones/xml/2/12812/Lcl1899i.pdf

[52] Two good references on Caribbean Hubs are: Frankel http://www.eclac.cl/transporte/perfil/iame_papers/proceedings/frankel.doc and Pinnock et. al. http://www.faq-logistique.com/EMS-Livre-Corridors-Transport-19-Maritime-Highway-Carribean-Seas-Panama-Canal.htm

[53] It should be noted that in the PIERS 2014 dataset, sometimes the origin country of traffic is misreported if it comes through a hub or intermediate port. For example it appears that some of the Asian traffic that is being dropped off at a Caribbean hub is being reported as Caribbean traffic. In PIERS report the traffic this way, then those traffic flows are still captured in our demand model but would show up as an "East Coast of South America" volume rather than as Asian traffic.

[54] In 2013, Great White Fleet moved 21,894 TEUs through Port Freeport, making it the port's top container cargo tenant. Its second-largest tenant, Dole Ocean Cargo Express, moved 21,312 TEUs. Most of their ships are coming from Central America, specifically Guatemala and Costa Rica. See: http://www.joc.com/port-news/us-ports/port-freeport-texas/port-freeport-ties-crane-investment-rising-demand_20140520.html

[55] Some other ports like Corpus Christi, Mobile and Tampa also participate in these trades although they serve mostly local port markets. These same feeder vessels also serve the major Caribbean Hubs where they are able to pick up some Asian and European traffic, which accounts for the relatively small share of Asian and European traffic that is captured by the New Orleans, Corpus Christi, Mobile and Tampa ports.

[56] See: http://www.joc.com/port-news/us-ports/port-gulfport-ms/chiquita-leave-gulfport-new-orleans_20140515.html

[57] See: http://portno.com/napoleon-avenue-intermodal-terminal

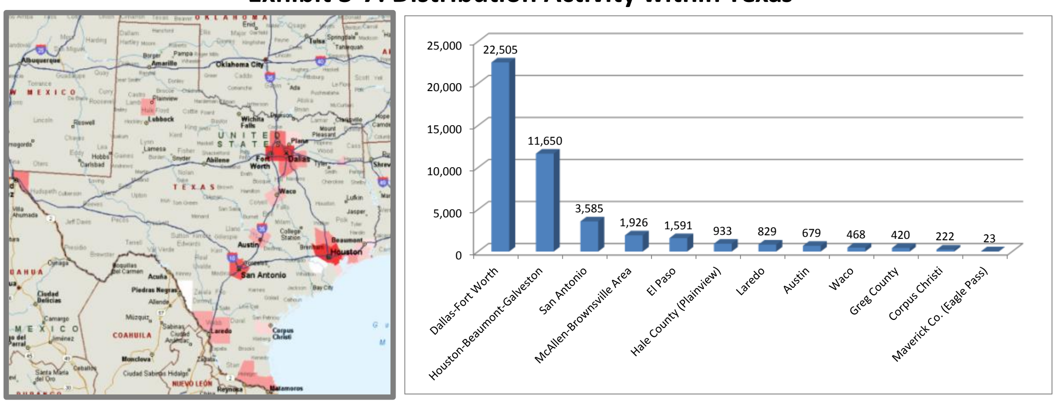
[58] See: http://www.louisianaweekly.com/port-enlarges-its-container-capacity-to-meet-panama-canals-growth/

[59] *Plans for the port's Napoleon Avenue terminal have been Scaled Down* at: http://www.nola.com/business/index.ssf/2009/09/plans_for_the_ports_napoleon_a.html

[60] Development of the New Orleans port is hampered by its small hinterland population: New Orleans population of 1,227,096 http://en.wikipedia.org/wiki/New_Orleans_metropolitan_area (devastated by Hurricane Katrina in 2005 and actually reduced since then) as compared to Houston's rapidly growing 6,313,158 and Dallas/Fort Worth's 6,526,548. (http://en.wikipedia.org/wiki/Greater_Houston and http://en.wikipedia.org/wiki/Dallas%E2%80%93Fort_Worth_metroplex) This tends to drive container ships to Houston rather than New Orleans. New Orleans has difficulty attaining enough "critical mass" to develop into a major container port. Although it aspires to a greater role and plans to aggressively compete for Asian imports (http://portno.com/CMS/Resources/brochure_panama.pdf) economics will likely continue to limit its ability to attract Asian and European direct vessel calls, so it will continue to be confined to a niche role in the Caribbean trade.

In contrast to New Orleans' weak hinterland container market, the Texas market is very large and growing rapidly. This is why Houston and not New Orleans has emerged as the primary Gulf coast container port. Exhibit 3-7 shows that Dallas and Fort Worth have emerged as important logistics hubs. The Dallas/Fort Worth logistics hub is the third largest in the US, ranked only after Los Angeles/Long Beach and the combined markets of New York/New Jersey. It is even larger than Illinois' market since Chicago serves as more of a transshipment point than as a value-added logistics hub. Even though Houston and Dallas/Fort Worth are similarly sized by population, Dallas/Fort Worth has almost twice Houston's warehousing employment.

Exhibit 3-7: Distribution Activity within Texas[61]



While Houston has the greater concentration of heavy industry, Dallas/Fort Worth is Texas' main logistics center.[62] Collectively, the "Texas Triangle" (Houston, Dallas/Fort Worth and San Antonio) account for 84% of all distribution employment in Texas. Clearly, development of effective linkages from Freeport to Dallas/Fort Worth as well as to San Antonio will be essential to expand the port market area. This supports the high container volumes that will be needed to bring large ships to Port Freeport.

Exhibit 3-8 shows the distribution of Houston port-related container traffic in Texas today. Houston itself absorbs about two-thirds of the containers that come into the port, while the balance is distributed to other cities within Texas and to other states, mostly by truck. The largest single destination for containers beyond Houston (besides the port area itself) is Dallas, but most of these today are European, South American and Caribbean containers. The reported 30 (FEU) containers per train (twice as week) on UP's rail service squares nicely with the Asian container data in Exhibit 3-8, which suggests Dallas is receiving an average of 64 import containers (128 TEU) per week from Asia via Houston.[63]

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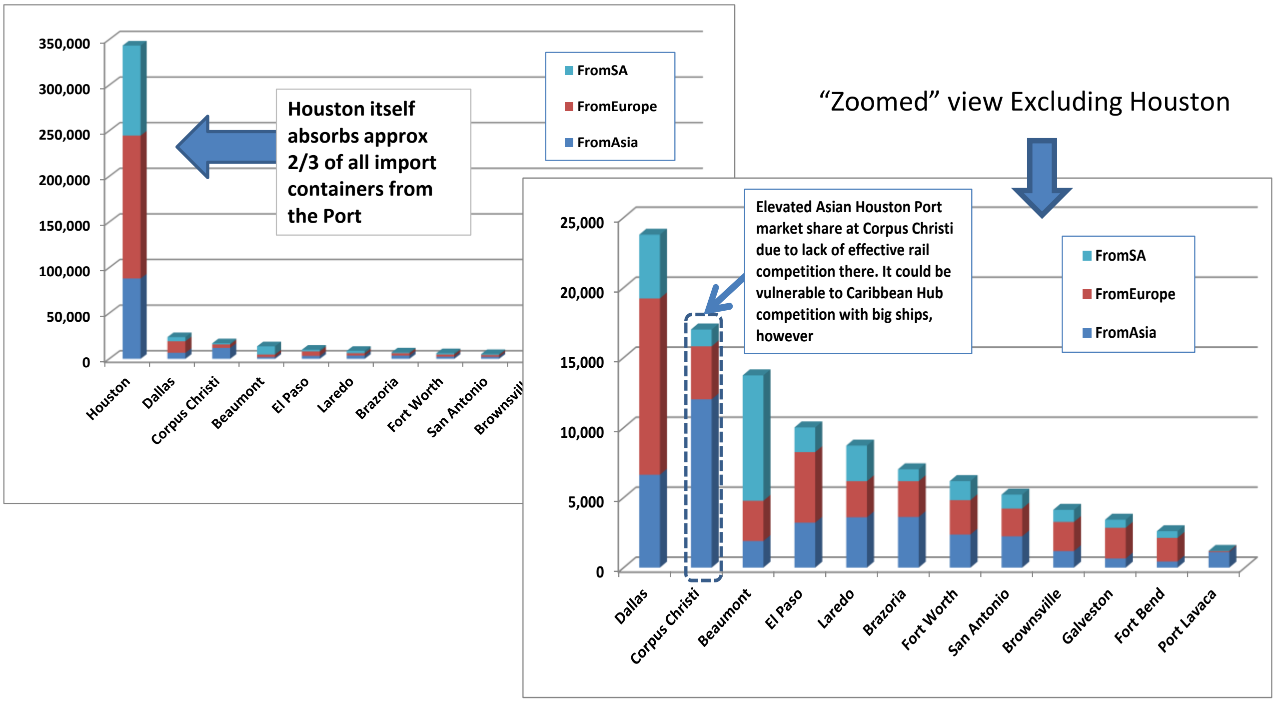
[61] Data downloaded from U.S. Census Bureau in June 2014 from http://www.census.gov/econ/cbp/download/. NAICS 493 (Warehousing and Storage Employment) totals were cross checked by comparing to www.tracer2.com/admin/uploadedPublications/2047_TLMR-Feb12.pdf This exhibit shows that:

- Dallas/Fort Worth area is the main logistics hub of Texas having twice the warehousing employment of Houston.
- After Houston itself, the next most important area to reach in Texas is San Antonio.
- Next is the Brownsville/Laredo area which could be a candidate for a COB connection, but either KCS or UP could provide rail options for reaching these markets.
- Fifth is El Paso, but since for Asian traffic west coast ports are likely to dominate this market (see Exhibit 2-10) this is outside the Houston port service area. As a result, it should not be a high priority for developing a Houston inland port. UP's new Santa Teresa facility could be used for any European containers that are headed to El Paso.

[62] See: http://dallaslogisticshub.com/?p=592

[63] This is based on the Panama Canal model's 2006 USITM database that was used in the original Concept study. Asian containers are only the blue shaded area at the bottom of the bar, about 6,500 TEU total for the year.

Exhibit 3-8: Current Distribution of Houston Port Containers within Texas[64]



Currently, containers to and from Europe, India, South America and the Caribbean are routinely trucked from Houston to Dallas/Fort Worth as well as to San Antonio. The distance from Houston to Dallas/Fort Worth is approximately 250 miles and to San Antonio is 200 miles. This is far enough to make trucking expensive, but too short for conventional intermodal service which needs a minimum of 500-600 miles length of haul to be profitable (primarily, to offset high terminal and drayage costs at both ends of the move.)[65] However, with on-dock rail and sufficient volumes, an intermodal connection can work.

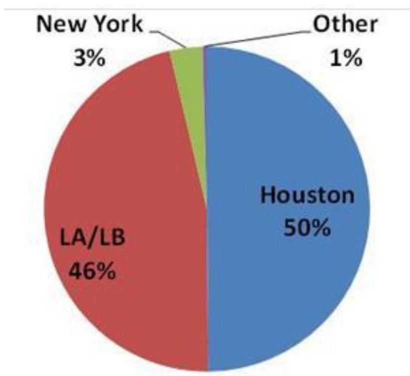
Union Pacific is already operating a twice a week "Texas Shuttle" from Barbour's Cut to its South Dallas intermodal ramp at Wilmer, TX.[66] The train times are coordinated with the arrival times of the two weekly vessels that arrive from Asia (CMA CGM and COSCO). The Panama Canal Authority has promoted this link to Dallas as a major growth opportunity for the Houston port[67]. In October 2013 this service was reportedly handling about 30 containers per train.[68] UP's goal is to increase that to 100 containers per train, but this may

[64] Currently Corpus Christi does not have intermodal service by any railroad; UP has a ramp at Brownsville, and both UP and KCS have ramps at Laredo. This comparison provides some important insights into the competitive structure of shipping and rail intermodal services in south Texas. While there are rail ramps in Houston, there are none in Corpus Christi. As such, the only way to get a container from Houston to Corpus Christi is to truck it. Due to the lack of direct rail competition at Corpus Christi, it is cost effective for ocean carriers to bring containers into Houston on a vessel service and then truck to Corpus Christi. Corpus Christi is also close enough to Houston (220 miles) so trucking can compete with direct water service using feeder vessels from a Caribbean hub. As a result, trucking from Houston to Corpus Christi is cost competitive both with rail from Houston-area ramps as well as with vessel service from the Caribbean hubs. However, farther south (at Brownsville, 350 miles from Houston) trucking costs are higher, and there is also a Union Pacific rail ramp at Brownsville. Houston's reduced market share into Laredo and Brownsville reflects the impact of direct rail competition as well as use of feeder vessels from Caribbean hubs. See http://www.corpuschristi-mpo.org/04_studies/04_studies_fr/ccmffis_fr_021010.pdf
[65] See: http://www.supplychainbrain.com/content/blogs/think-tank/blog/article/intermodal-thrives-while-long-haul-trucking-dives/
[66] See: http://www.uprr.com/customers/intermodal/txshuttle.shtml and http://www.uprr.com/customers/intermodal/attachments/texas_shuttle.pdf
[67] See: http://dallaschamberblog.org/2012/10/25/interview-with-alberto-aleman-zubieta-chief-executive-officer-panama-canal-authority/
[68] See: http://www.cargonewsasia.com/secured/print_view.aspx?article=31971&issue=2013-10-21

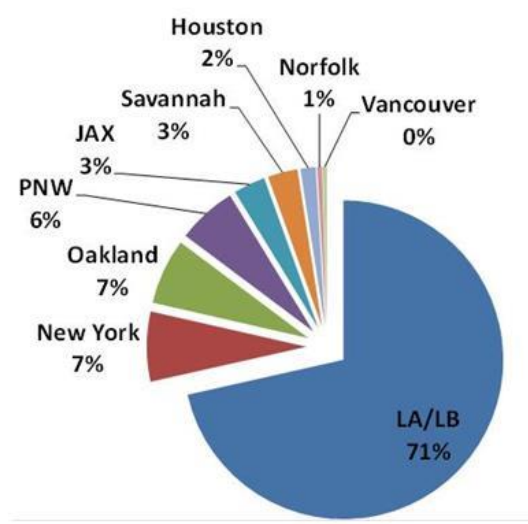
be difficult since it appears that the rail service has already captured most of the available Asian traffic. Additional containers may be available at Houston, but capturing significant volumes will be difficult since this traffic is higher valued (thus worth trucking) and the infrequent rail service isn't timed well to connect with ships from Europe, India, South America and the Caribbean. Unfortunately, Panamax-sized ships can't deliver Asian containers to Houston at a low enough cost (in competition with West Coast ports) to significantly penetrate the Dallas/Fort Worth market. Given the 45' depth of the Houston Ship Channel which prevents using larger ships, this seems unlikely to change so long as the rail service stays at Barbour's Cut.

New 2014 PIERS data has confirmed the results of the earlier Concept study. Exhibit 3-9 compares the Port shares of Chinese containers at Houston and Dallas/Fort Worth based on the new PIERS data.

Exhibit 3-9: 2014 Port Market Share of Asian Containers at Houston and Dallas-Fort Worth, TX



HOUSTON



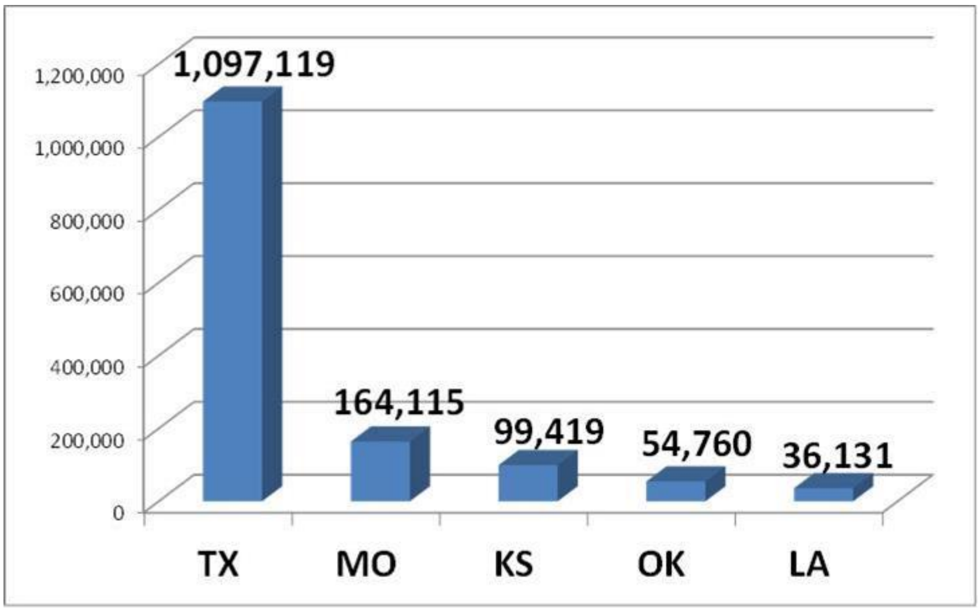
DALLAS-FORT WORTH

The 2014 traffic distribution in Exhibit 3-9 results from the economics of *small* ships at Houston, and shows that within Houston in 2014, the local port holds more than 50% market share vs. the West Coast. However, the situation is completely different at Dallas-Fort Worth (DFW) where Houston has only a 2% share of the market. It can be seen that the Ports of Los Angeles/Long Beach dominate the Asian container market at DFW holding a 76% share of Chinese containers. At DFW, New York, Jacksonville and Savannah ports hold a higher share of the market than Houston does. The strength of East Coast ports is due to the ocean carriers' development of Suez Canal routings[69]. Most likely this reflects containers that moved from Asia via the Suez Canal, were dropped at eastern ports and used rail to get to DFW and even back to Houston. This shows the extremes to which shippers will go to avoid West Coast port congestion. However it is clear that development of the Suez Canal routings has not yet benefitted Gulf of Mexico ports due to their inability to handle large ships.

[69] None of the new East Coast US Suez Canal vessel routes have been seen to enter the Gulf of Mexico.

Exhibit 3-10 shows the PIERS 2014 distribution of Asian containers within Freeport's likely "big ship" hinterland area. It shows that Freeport's strongest market will be heavily focused on the State of Texas, primarily Dallas-Fort Worth. This chart is based on the reported actual destinations of the containers. This does not imply that Missouri, Kansas or Oklahoma are not receiving imported goods; only that imported goods bound for these states often move first through a Texas distribution center first. That's why Texas would be shown as the destination for these import containers.

Exhibit 3-10: 2014 PIERS, Direct Imports of Asian TEUs by State



This shows the very significant role played by the DFW-area distribution centers in distributing goods across a broad geographic area that includes several neighboring states. DFW serves as a national distribution node that consolidates large volumes of traffic into a focused geographic hub. Therefore, if Port Freeport can successfully gain share at DFW, it will not only capture a substantial share of the Texas market that is served by trucking out of DFW, but also that of neighboring states as well.

3.2 Texas Market Growth

Container traffic will be a key beneficiary of Texas ports growth in the future, provided the ports can develop modern facilities that can handle large ships that will be forthcoming after expansion of the Panama Canal. GDP has been shown to be a key driver of container traffic, and GDP is growing rapidly in Texas and in the whole south-central region of the USA. As shown in Exhibit 3-11, Imports are closely related to GDP nominal, which is used to forecast imports in the future. Exhibit 3-11 shows the historical US GDP nominal as compared to US container traffic, and develops a regression relationship between them. The regression coefficient of 1.15 means that container traffic grows 15% faster than GDP and the R^2 coefficient shows that the predictive model is very strong.

It is important to note that the Texas GDP growth rate is significantly higher than US growth Rate. As shown in Exhibit 3-12, Texas has sustained a 6-7% growth every year for the past 20 years, with the exception of a couple of years as a result of the recent economic downtown. The Grain Belt region has sustained 6%, and Midwest region 4% growth per year. However, this high rate of growth has since resumed after the downturn, increasing pressure on the need for significant infrastructure development in Texas. The earlier Concept Study simply assumed a continuation of these historical trends, giving an overall this gave a 5.6% average growth rate for the whole of the Texas port hinterland area.

Exhibit 3-11: Historical Relationship between GDP and Container Traffic

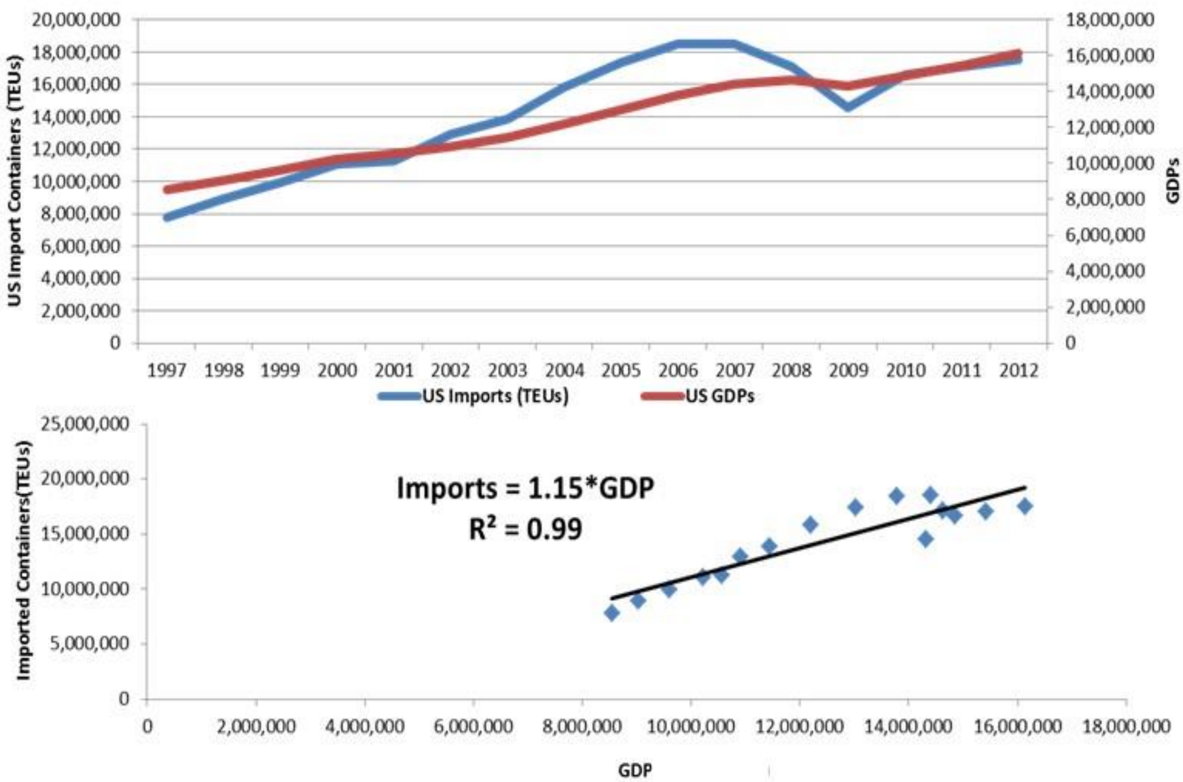
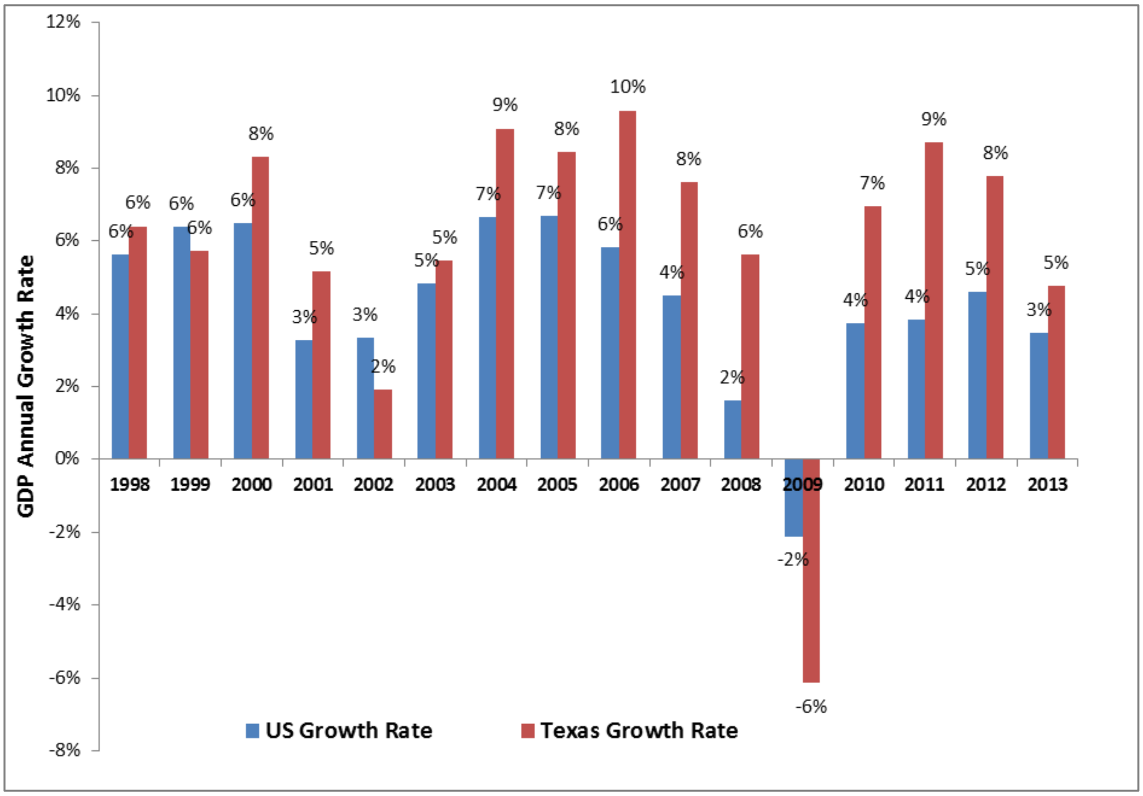


Exhibit 3-12: Texas Historical GDP Growth[70]

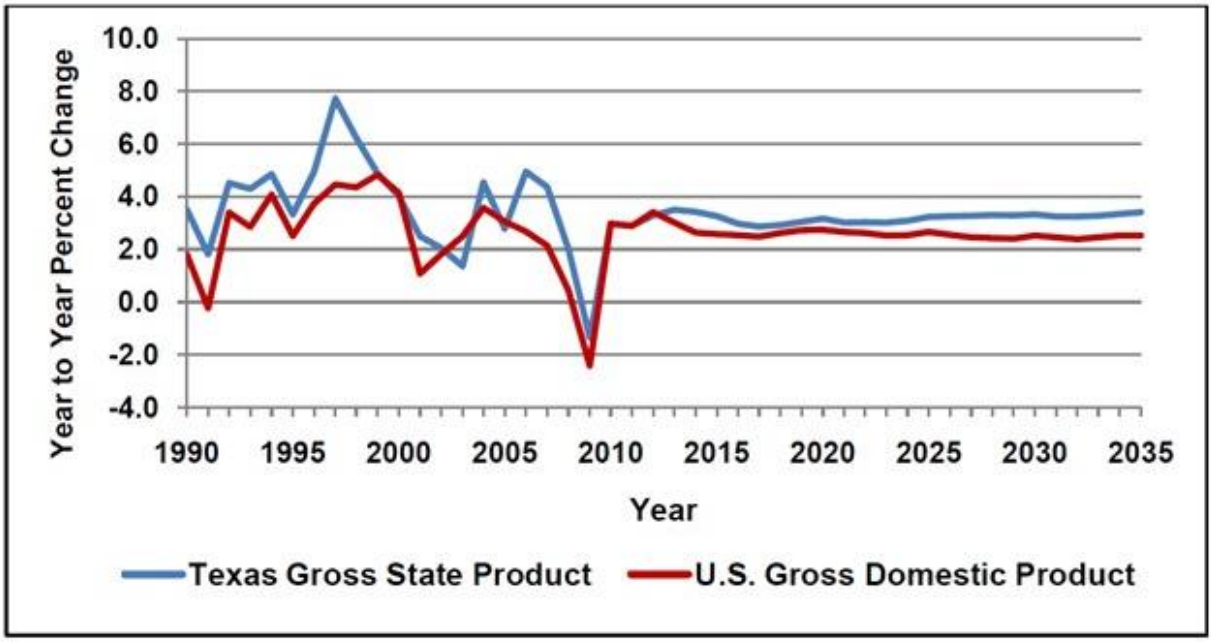


For this feasibility level assessment, a more refined and specific GDP forecast was obtained from the Texas Comptroller of Public Accounts. As shown in Exhibit 3-13, this forecast was used in the most recent Texas State Transportation Plan[71] and predicted that the U.S. and Texas economies will rebound from the current recession (in terms of GSP and GDP), and grow at 2.6 percent and 3.37 percent, respectively, on average, per year between 2010 and 2035 . Faced with this level of growth, an efficient and well-maintained transportation system will clearly be vital to the state‘s ability to remain economically competitive at home and abroad.

[70] Source: Bureau of Economic Analysis, 2014

[71] *Texas Statewide Long-Range Transportation Plan 2035* at:
http://ftp.dot.state.tx.us/pub/txdot-info/tpp/rural_2035/report/slrtp_final_ch2.pdf

Exhibit 3-13: Texas Controller's Comparative Annual Economic Forecast (Real Growth Rates) 1990 to 2035



The Texas Comptroller GDP Forecast is in real or inflation-adjusted dollars. So, adding a 2% annual inflation gets us right back into the 5+% growth range shown in Exhibit 3-12. It should be noted that the Texas Controller's forecast is a conservative one, since it assumes a slight decline in the historical growth rates of both population and GDP. However, for the moment, neither of these trends show any sign of abating. Overall, based on the Texas Controller's forecast, the average assumed growth rate will be 5.4% (nominal or YOE dollars) within the Texas market area. This growth rate is only slightly lower than the 5.6% that was assumed in the concept study. This is considered a conservative assumption since it is slightly less than the historical growth rate.

Chapter 4. Service Scenario Definition

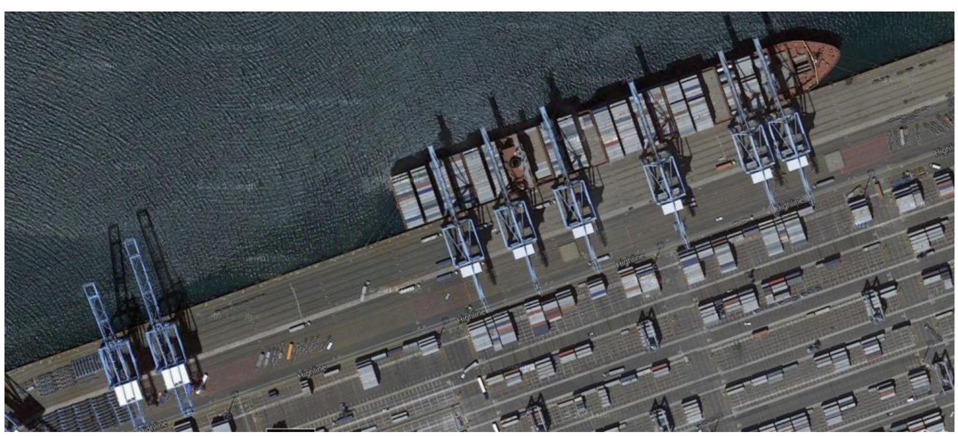
Given the high growth rate of the Texas markets, this section identifies the market opportunities, required services and related infrastructure needs for the Port Freeport to fully realize its potential. Specific strategies for linking Freeport to its potential markets will be identified. From this, the need for specific supporting infrastructure will be developed.

4.1 Assumed Facilities at Port Freeport

It is clear that the need for inland transportation improvements depends on the development of Port Freeport. A critical step for Port Freeport is the dredging of its channel to 56 feet, and developing appropriate berths for large container ships. Some assumptions must be made about the character and capabilities of Port Freeport. To begin with, it will be essential for Port Freeport to have enough berths, cranes, dockside space and loading tracks to accommodate forecasted demand. Although Freeport, TX with its deepened channel could in theory handle any container ship in the world, this is not expected to be a regular occurrence. Ships in the 5,000-8,000 TEU range are more likely in the short term. Larger ships will however, probably be used for expanding capacity in the future as demand continues to grow. Port Freeport therefore, should be designed for 12,500 TEU ships although these are not likely in the short term.

For an acceptable loading and unloading rate (competitive to what other ports offer) a 7,000-8,000 TEU ship will need a ***minimum*** of 4 Post-Panamax cranes.[72] Larger ships will need more cranes. In the future to handle a 12,500 TEU ship, Freeport should be able to assign six to seven cranes to each ship to be able to unload and reload the ship within an acceptable time frame. Exhibit 4-1 is a Google satellite image showing six cranes working on a ship in the Los Angeles harbor.

Exhibit 4-1: Six Cranes Working a Ship at Los Angeles Port



[72] The reference *Intermodal Transportation and Containerization* at https://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c6en.html suggests that each crane can handle roughly 30 movements (loading or unloading) per hour. This reference suggests that 5 to 6 cranes can service a 5,000 TEU containership. However, this many cranes are not commonly used in practice. The Port of Long Beach claims to run 16 hours a day on two shifts, five cranes to a ship: http://articles.latimes.com/2011/may/14/business/la-fi-cranes-20110514 But the very large 16,000 TEU CMA/CGM containership is seen to have only four cranes working on it: http://www.dailymail.co.uk/news/article-2245394/Worlds-largest-container-ship-396m-long-arrives-Britain-maiden-carrying-thousands-Christmas-presents.html A minimum of 4 cranes should be assigned to each ship although a fifth crane could be added if available. However, only two cranes are currently coming to Freeport: http://www.houstonnewcomerguides.com/news/freeport-tx-%E2%80%93-post-panamax-cranes-heading-to-port-freeport-tx so Freeport is going to need to order more cranes if it wants to develop into a major container port.

Currently, the Barbours Cut terminal in Houston has nine small (50' gauge) cranes[73] but four large (100' gauge) Post-Panamax cranes have been ordered to expand its capacity.[74] Houston's Bayport terminal already has nine Post-Panamax ZPMC cranes with twin-pick capabilities.[75,76] As such, either Barbours Cut or Bayport are already positioned to offer competitive turn-around times for big ships, although neither facility has the channel depth needed to take a fully loaded Post-Panamax ship.

By comparison, Freeport currently has only two Post-Panamax cranes.[77] While this is probably adequate for the needs of the Great White Fleet and its small vessels, Freeport does not yet have enough cranes to be able to load and unload a large ship in a time frame that is competitive to other ports. In the short term, this will likely be a negative factor in terms of the port's ability to attract vessel calls beyond the current Chiquita banana business.

As a result, Freeport needs ***at least*** four cranes and 1000 feet of dock to be able to work one 5,000-8,000 TEU ship at a time and should expand to this capability as soon as possible. As business starts to develop, because of the challenges associated with scheduling multiple vessel calls, Port Freeport will need at least eight cranes[78] to be able to work two ships simultaneously (one loading, the other unloading.) Over time this will be need to be further expanded to 12-18 cranes to either work more ships or larger 12,500 TEU ships as volumes continue to grow. In terms of the projected volume forecasted, the Freeport Master plan needs to provide this level of capacity improvement over time.

Cranes can typically make about 30 moves per hour, and most containers are in fact 40' units, so if each crane handles 2 TEUs per lift:

- 1,000 TEU / 2 TEU per 40' container / 30 moves per hour = 16.7 hours for 1,000 TEU per crane.

For complete unloading, a 12,500 TEU Post-Panamax ship would need 35-52 hours, then another 35-52 hours for reloading, depending whether the ship arrives fully loaded and how many cranes are assigned:

- 12,500 TEU * 16.7 hours / 1,000 TEU / 4 cranes = 52 hours
- 12,500 TEU * 16.7 hours / 1,000 TEU / 6 cranes = 35 hours

The more typical case would be an 8,000 TEU ship with 4 cranes assigned to work it. This ship would need 33 hours for complete unloading and another 33 hours for reloading.

- 8,000 TEU * 16.7 hours / 1,000 TEU / 4 cranes = 33 hours

[73] See: http://www.portofhouston.com/container-terminals/barbours-cut/barbours-cut-specifications/
[74] See: http://www.joc.com/port-news/us-ports/port-houston/port-houston-orders-cranes-barbours-cut_20130424.html, http://www.mccarthy.com/quasi/qs-content/uploads/2013/11/18/McCarthy-Texas-October-2013pdf.pdf
[75] See: http://www.portsamerica.com/portofbayport-texas.html
[76] See: http://www.porttechnology.org/images/uploads/technical_papers/PT34-18.pdf
[77] See: http://www.joc.com/port-news/us-ports/port-freeport-texas/port-freeport-ties-crane-investment-rising-demand_20140520.html
[78] By comparison, the Long Beach has 15 container cranes: 9 cranes reach 24 containers across, and 6 cranes reach 20 containers across. http://www.polb.com/economics/cargotenant/containerized/pierj.asp There are 16 Post-Panamax cranes at Savannah, GA: http://www.joc.com/port-news/us-ports/port-savannah/new-super-post-panamax-cranes-operational-port-savannah_20131024.html The Velasco Terminal at Freeport, TX will only have two cranes which is not enough to unload a large ship in a competitive time. http://www.yourhoustonnews.com/pearland/news/new-port-freeport-cranes-on-the-way/article_8762a3ee-9100-584a-ac48-56d254875b17.html

As a result, it can be seen that each ship will need about 1½ days in port to unload, and then another 1½ days to reload assuming all cranes are working on a 24 hours + 7 day a week basis. If Freeport can attract two vessel calls per week, then four cranes could (in theory) suffice provided the vessel schedules can be coordinated.[79] If the ships only partially load or unload (assuming they take Houston containers to Barbours Cut) then the dwell time at Freeport will be reduced, lessening pressure on dock space and crane capacity at Freeport. If Freeport has just four cranes for each 8,000 TEU ship and if the port handles two ships per week, then the throughput of the Port would be:

- 8,000 TEU * 2 ships/week * 52 weeks/per year = 832,000 TEU per direction[80], or 1.6 million TEU for the port annually (both loaded and empty containers) This design capacity would represent a 4½ times increase over today's Asian trade resulting from the expanded port hinterland area, encompassing the added large cities of San Antonio, Dallas and Fort Worth as well as areas to the north. This volume can be seen as roughly comparable to the Port of Houston's current total throughput and is consistent with the result of Chapter 3. [81]
- If, however, European vessel calls were also added to port according to the analysis of Chapter 3, this would generate roughly 0.3 million TEU's per direction, or 0.6 million TEUs for the port annually (both import and exports, assuming these remain in balance) requiring one additional vessel call per week. Port Freeport would not have enough capacity to handle this third vessel call without another set of 4 cranes, so 8 cranes would be needed to support volumes above 1 million TEUS's annually.
- If ships only partially load/unload at Port Freeport (assuming they take ⅓ to ½ of their containers on to Barbours Cut to finish unloading) then four cranes might be sufficient for 3 vessel calls – if schedules can be tightly coordinated. This requires further analysis in the next phase of work.

If each ship carries 4,000 containers (8,000 TEU) for the purpose of developing the rail operating plan, if half the containers are forwarded by rail, then 4,000 TEU or 2,000 containers will come off each ship. Each double stack train can haul 250 40' containers at a time[82] so each ship generates 8 trains in and out of the port, twice a week: 3-4 trains each to Dallas and Fort Worth, and 1-2 trains to San Antonio per ship. This would be 16 trains in a week, an average of 2-3 trains per day each way, to start. A single track rail link to Rosenberg would be sufficient for handling this volume of train traffic.

[79] However, it would be more efficient to have eight cranes and four vessel calls per week so that one vessel is loading and the other is simultaneously unloading. This will create a smooth flow of containers both on and off the dock, which would promote the most effective utilization of the port and inland distribution infrastructure. At this level of utilization, the cranes, docks, and inland port facilities can be kept running on a practically continuous basis. To the extent it possible to smooth demand and even out the traffic flows, this will result in the most effective utilization of both port and inland distribution facilities.

[80] This is consistent with forecast range of 0.6 to 0.9 million Asian import TEU's per year, from Chapter 2 which is a three to fivefold increase over Houston's current traffic levels.

[81] By comparison, the Port of Houston handled approximately 2 million TEU's in 2013, roughly 350,000 TEU's are estimated to have come from Asia: 175,765 import loads; 90,360 export loads; 85,405 export empties (estimated)

[82] The largest double stack trains carry up to 400 containers at a time (800 TEU) but a train size of 250 containers (500 TEU) is more typical. (see https://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c6en.html)

4.2 Import Container Transloading at Freeport

Ancillary services, such as distribution warehousing and trans-loading capabilities, are needed near the port, since some shippers will want to transload import containers, particularly for destinations beyond Texas, into larger domestic boxes.[83,84]

Transloading benefits ocean carriers by keeping containers close to the port, as well as shippers by allowing them to move goods inland utilizing more efficient domestic containers.[85] For example: at Los Angeles, after goods are reloaded into a 53' domestic box, some shipments reappear in downtown Los Angeles as "domestic" loads. Unfortunately, this means that these containers do not take advantage of the Alameda Corridor investment, nor do they pay the Alameda Corridor toll. Rather, trucks travel on city streets adding to congestion in downtown Los Angeles. [86] However, since the existing rail ramps are all so far away, long distance drayage from Port Freeport is not going to be economical for avoiding the anticipated tolls or port fees. (UP facilities are at Settegast and Englewood yards near the center of Houston; BNSF has an intermodal yard at Pearland, and KCS has intermodal yards at Rosenberg[87] and Port Arthur.[88])

However to accommodate this need, the Port needs either to offer transloading services itself, or else to allow transloaded goods to reenter the Port for riding the rail shuttle trains.[89] Further study is needed to determine the volumes that are actually likely to be transloaded, as well as the most effective way to accommodate transloads.

4.3 Export Container Transloading at Freeport

A related issue is how exports are to be handled. Houston is unusual for a United States port, since it actually exports more containers than it imports. As shown in Exhibit 4-2, containerized exports are mostly industrial commodities rather than consumer goods. As a result, maintaining connectivity to industrial shippers (for export) may be as important as connectivity to distribution centers (for imports). The ability to transload exports (such as resins, plastics, chemicals and minerals) into ocean containers will be a critical adjunct to development of Port Freeport.

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[83] Because a 53' US standard truck trailer holds up to 60% more freight than a 40' ocean container, drayage of ocean containers is significantly less productive than conventional trucking. See: http://exportlogisticsguide.com/apl-introduces-53-foot-ocean-containers/

[84] If goods are intended to move inland for any significant distance, it is often beneficial to transload goods into domestic trailers or containers. These transloads are typically done close to the port. See: http://www.idstransportation.com/news/transloading-benefits-driving-growth

[85] It easy to find a backhaul for a domestic container in Chicago, but ocean containers are not wanted for domestic loads so most of them end up being sent back to the ports empty.

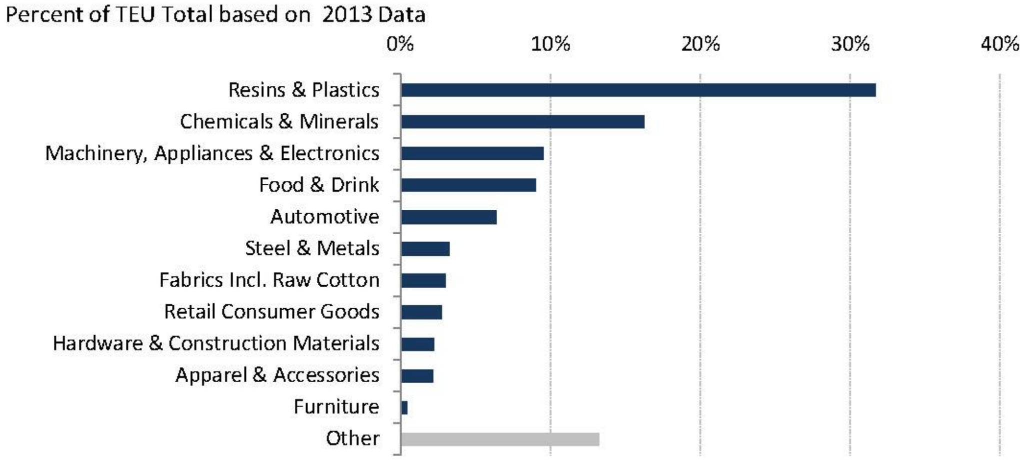
[86] See: http://www.idstransportation.com/news/transloading-benefits-driving-growth , http://digital.americanshipper.com/i/104911/13 and http://www.inboundlogistics.com/cms/article/getting-involved-in-transloading/

[87] Currently the Kendleton, TX facility (just southwest of Rosenberg) is used primarily for Mexico-bound traffic although presumably northbound traffic could use it as needed, See: http://www.centerpointenergy.com/staticfiles/CNP/Common/SiteAssets/doc/Rosenberg%20-%207-10%20Rosenberg%20Intermodal%20Center%20gaining%20speed.pdf

[88] Currently the Port Arthur facility is used primarily for traffic to Atlanta and the northeastern U.S., See: http://www.thefreelibrary.com/Kansas+City+Southern+and+Norfolk+Southern+Open+Joint+Intermodal...-a020504362

[89] An open port policy would allow Brazoria and Fort Bend Counties to share the economic growth potential that will result from development of Port Freeport, by developing their own value-added logistics industry. If would allow Freeport logistics to compete with Dallas, Fort Worth and San Antonio on a level playing field. It would also help build volume on the rail shuttle services since goods could ride the trains whether they are transloaded into domestic containers, or come directly off the docks.

Exhibit 4-2: Houston Export Commodities[90]



Source: PHA Market Development, Journal of Commerce/ PIERS data
Notes: Values include all Houston Ship Channel Terminals. Totals are estimated, not exact. Commodity categories based on custom PHA Market Development definitions.

While the opportunity to backhaul ocean containers may seem like an obvious benefit to steamship lines, it adds cost if the goods are not available in exactly the same place where containers were made empty. Then, the need for repositioning empty containers usually involves a complex triangulation of movements. It takes time and adds cost compared to the economics of returning empty containers directly to the ship. Since backhaul rates are typically low, this may not be an effective use of the container asset from the shipping line's perspective, especially during the peak season.[91]

An alternative – which avoids costs associated with repositioning empty containers – is an innovative approach that *brings loads to the empty containers, rather than trying to take empty containers to the loads.* For example, unit trains of agricultural products are today being brought into Yermo, CA and into Tacoma, WA in covered hoppers where they are transloaded ***near the port*** into ocean containers.[92] Port Freeport should anticipate the need for bringing industrial commodities into the port on railcars, trucks and barges, and should provide facilities for efficiently transloading these exports into empty containers. Empty container availability is a key issue for the development of export business -- since ocean carriers try to balance the utilization of their ships, the more imports arrive at Freeport, the greater the likely market opportunities will be for containerized exports as well.

[90] Source: http://www.portofhouston.com/static/gen/business-development/Origination/4-Container_Volume_by_Commodity_Stats_2013.pdf

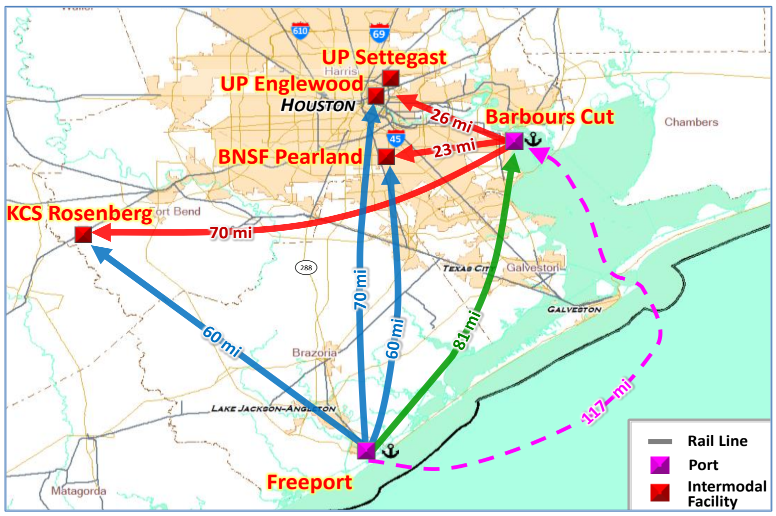
[91] See: http://www.tc.gc.ca/pol/EN/Report/Containers2006/C7.htm This describes the situation in Canada where front-haul business generates 80% of the steamship line revenues leaving backhaul traffic to generate only 20%. The fronthaul versus backhaul rate is heavily influenced by container utilization. At times when plenty of containers are available, backhaul rates falls, but in the peak season, the incentive is to get empty containers back to Asia as quickly as possible for reloading. Because of this, backhaul rates tend to be extremely volatile. Nonetheless, many backhaul commodities (such as grain) can be stored and shipped off peak when plenty of container capacity is available. According to an example in: http://infratrans.gov.ab.ca/INFTRA_Content/docType56/Production/UseofContainersinCanadaFinalReport_0.pdf page viii a steamship line needs at least $800 per box to make the backhaul "interesting" as compared to the front haul rate of $3,000-$3,800 per box, so the backhaul rate even during the peak season was cited as just 27% of the front haul rate. The assumed 40% of front haul factor would be sufficient to cover some added surface transportation cost while still making a contribution towards fixed costs, especially during the off peak season when the opportunity cost of container utilization does not exceed the actual cost of leasing or owning the equipment.

[92] See: http://www.uprr.com/newsinfo/releases/service/2011/0328_yermo.shtml , http://www.uprr.com/customers/ag-prod/attachments/plant_to_port.pdf and http://www.tacomatransload.com/transload/transloading.htm

4.4 Linking Back to the Houston Ship Channel Area

A challenge to shifting Asian and European big ship calls to Freeport will be how to maintain connectivity to the existing industrial base in the Houston Ship Channel. As shown in Exhibit 4-3, the distance from Freeport to Barbours Cut is 81 miles by truck or 117 miles by water. Currently the analysis assumes that this linkage will be maintained by trucking. But because of the distance and high traffic volumes involved, it is logical to develop an intermodal connection from Freeport back to the Barbour's Cut area. This requires further discussion between the Texas Ports and steamship lines to determine the best approach. Perhaps some type of collaboration, as Pacific Northwest ports are now doing, might make it easier to develop the link.[93]

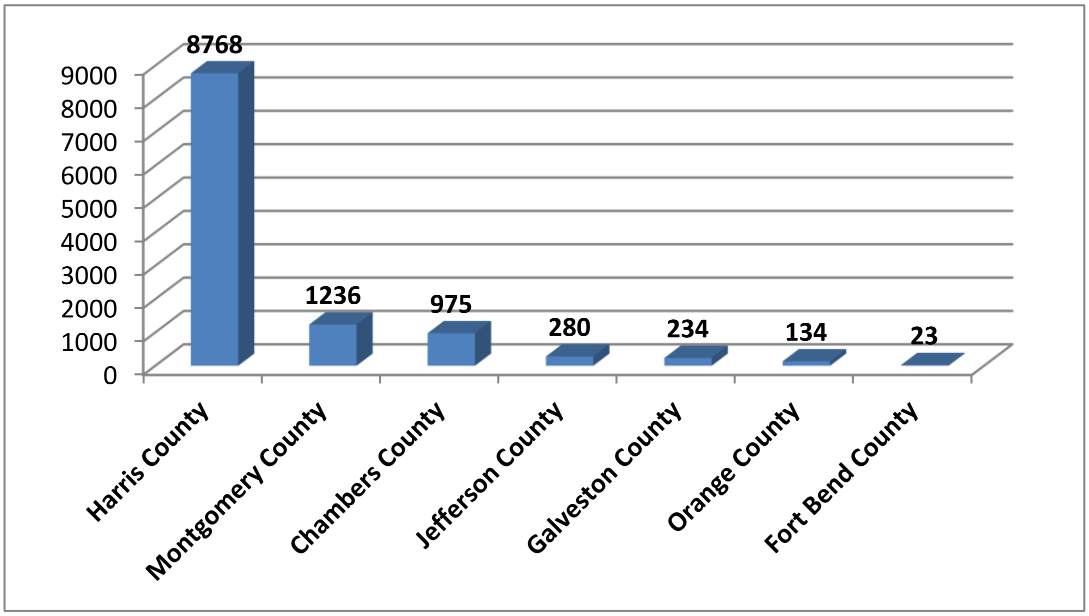
Exhibit 4-3: Distances from Freeport and Barbours Cut to Houston-Area Rail Ramps[94]



Warehousing employment data[95] (Exhibit 4-4) makes it clear that distribution activity in Houston[96] today is heavily concentrated in Harris County. Within Harris County there are several distinct pockets of logistics employment. While some logistics centers are located along the ring roads along the north and west of the city, the University of Texas[97] identifies many of the large distribution centers as being located in the immediate vicinity of the Port, south and east of the city center. Wal-Mart's national distribution center, for example, is located in Baytown, TX right across the Fred Hartman Bridge[98] just 5 miles away from Barbour's Cut marine terminal. In 2005, Wal-Mart signed a 30-year lease on its 4-million square feet facility[99] so it is committed to stay there for another 20 years at least.

[93] *Ports of Seattle, Tacoma Agree to Alliance* at http://www.wsj.com/articles/ports-of-seattle-tacoma-agree-to-alliance-1433542075; *Seattle, Tacoma Ports Vote to Form Alliance* http://www.wsj.com/articles/seattle-tacoma-ports-vote-to-form-alliance-1438714867; https://www.nwseaportalliance.com
[94] This exhibit also shows the distances to existing UP, BNSF and KCS intermodal ramps. However, not much port traffic uses these ramps today since Barbour's Cut is mostly a truck port today, and will likely remain so in the future due to its channel depth limitation.
[95] Data downloaded from U.S. Census Bureau in June 2014 from http://www.census.gov/econ/cbp/download/. NAICS 493 (Warehousing and Storage Employment) totals were cross checked by comparing to www.tracer2.com/admin/uploadedPublications/2047_TLMR-Feb12.pdf
[96] According to http://www.bayareahoustonmag.com/trucks-road-sign-positive-economic-times/ over 70% of the goods imported through the Port of Houston container terminals are consumed by the 7 million people located within a single day's drive.
[97] See: library.ctr.utexas.edu/digitized/products/0-5068-P3.ppt and http://www.utexas.edu/research/ctr/pdf_reports/0_5068_1.pdf
[98] See: http://en.wikipedia.org/wiki/Fred_Hartman_Bridge
[99] See: http://www.chron.com/business/article/Giant-Wal-Mart-center-to-be-a-draw-to-Baytown-1502276.php

Exhibit 4-4: Distribution Activity by County within the Houston Area



Local Houston market connectivity can affordably be established by trucking. For reaching Wal-Mart's Baytown warehouse, for example:

- The highway distance from Freeport to Baytown is 82 miles; from Barbours Cut to Baytown the distance is only 7 miles. This is an increase of 75 miles. Based on a one-way trucking cost of $0.95 per TEU-mile[100] this would add $71 to the cost of each TEU delivered from Freeport to Wal-Mart's warehouse in Baytown.
- Based on a distance of 11,647 miles[101] from Shanghai to Houston a savings of 2¢ per TEU-mile in vessel line haul operating cost would save $233 per TEU.
- As a result, trucking is economically justified, given the length of ocean haul from China and the use of the bigger ship, since the ocean line haul savings exceeds the added drayage cost from Freeport.

This suggests that Houston Ship Channel shippers could save $233- $71 = $162 per TEU on Asian containers by trucking from Freeport to take advantage of the ocean transportation costs savings, compared to using a small ship to reach Barbour's Cut directly. Even taking into account the need for returning empty containers and "bob tailing" typically associated with drayage which could increase trucking costs, Houston-area shippers would still likely be better off with big ships at Freeport than with small ships at Houston.

For connectivity back to the Houston Ship Channel area, this study conservatively assumes (because it's more expensive than other intermodal connectivity options) that ships will be completely unloaded at Freeport, and containers trucked back to the Houston Ship Channel area. A more cost-effective solution would be to develop

[100] Source: Texas Gulf Ports Study, Figure 4.3. See: http://www.utexas.edu/research/ctr/pdf_reports/1833_3.pdf
[101] Based on 10,121 NM or 11,647 statute miles from Shanghai to Houston via the Panama Canal, http://www.sea-distances.org/and http://e-ships.net/dist.htm

an intermodal connection to Houston that does not rely on trucking. If a large ship could directly serve Houston as a second port-of-call, then Houston Ship Channel shippers would have the "best of both worlds." By doing this, both Freeport and Houston ports would be able to enjoy the benefits of cost-effective vessel service using big ships in spite of Houston's 45' channel depth limitation.

For example, it might be possible to have Port Freeport "top off" a large ship and then take the partially unloaded ship into Houston as a second port of call. This is how Savannah works today. New York takes most of the loaded containers off the big ship, so it can then access Savannah. Alternatively, as is done at Rotterdam today, containers could be unloaded from ships at Freeport and Houston's containers forwarded via a Container-on-Barge (COB) shuttle.[102]

In the Investment Grade study, this requires further discussions with the Ports of Houston and Freeport, as well as the steamship lines to find out which intermodal connectivity options they will prefer. However, it is clear that an alliance between the Houston and Freeport ports would enhance the market position of both ports and the whole State of Texas. It is recommended that this be explored by the project stakeholders to further clarify how the ports of Houston and Freeport, can work together. The recent agreement of the Pacific Northwest ports to work together to develop terminals for big ships might serve as a model for framing a similar cooperative relationship between the Ports of Houston and Freeport.[103]

4.5 Intermodal Rail Loading Facilities and a Freeport Terminal Railroad

To develop into a competitive ocean port, Freeport will need efficient rail links to key inland markets, and competitive access by more than one railroad. North Carolina's *Maritime Strategy*[104] explains why competitive rail service is important for developing a world-class container port:

> *CSX and Norfolk Southern agree that the shipping lines desire access to two railroads. When a shipping line has the option for two railroads at a given port, it can offer a competitive advantage in attracting vessel calls and shipper demand. . . . NC Ports and in-state shippers contend that the lack of dual rail service contributes to high quotes for rail transport to the state's port facilities. Dual rail service would introduce rail freight competition by offering service of two railroads to each port location. . . . NCSPA also cites lack of dual rail service as a challenge in trying to attract new container vessel calls to Wilmington. This is particularly problematic because NC Ports are the only port facilities among the regional peer ports that do not benefit from dual freight rail service into the port facility. Because shippers and shipping lines often have agreements with specific railroads, waterborne cargo may be directed to a specific railroad and the actual advantage of dual rail service may be less than perceived. Still, the railroads agree that it would benefit both companies to have access into each port.*

[102] It is even possible that a whole network of connecting water services might be developed linking Freeport to neighboring ports such as Corpus Christi, Brownsville, and Beaumont as well as to the Houston ship channel area. This COB service could utilize either open water sailing or the GIWW. It would be similar in length to the Norfolk-Richmond COB service sponsored by the Virginia Ports Authority, see http://hamptonroads.com/2009/12/container-barge-service-norfolk-richmond-still-business and http://blog.portofvirginia.com/my-blog/2012/10/richmond-barge-service-adds-third-sailing-tuesday-thursday-and-saturday.html

[103] See: http://www.joc.com/port-news/us-ports/port-seattle/seattle-tacoma-ports-forge-alliance-protect-market-share_20141007.html and http://www.pacmar.com/story/2015/05/01/features/west-coast-ports-join-forces/342.html

[104] See: http://www.ncdot.gov/download/business/committees/logistics/maritime/railroadsexistingplannedinfrastructure.pdf , page 11

At Houston, UP and BNSF both seem to understand the need for competitive port access, since both railroads serve the Barbour's Cut Marine Terminal[105,106] and the railroads have also been cooperative on the need for developing competitive rail access to Bayport[107] in the future. It should be noted that shippers still have competitive choices due to the competitive availability of alternative ports that are served by more than one railroad. It is expected that the railroads would extend the same consideration to Port Freeport that they have already extended to Houston's Bayport.

A recommended first step for Port Freeport would be to establish a neutral terminal switching railroad (similar to the PTRA in Houston) for operating any port-owned rail trackage — either existing track that might be purchased from Union Pacific, or any new track that might by constructed by the Port. As is done at the San Pedro ports, the main responsibility of the terminal railroad would be to make up intermodal trains at Freeport's proposed new on-dock rail terminal as well as to switch dockside industrial tracks. Many of Freeport's existing port facilities will be repurposed under the Master Plan, so much of the existing port's rail infrastructure will likely be made obsolete. If Union Pacific were willing to sell, the Port could purchase all track from the Brazos River south to the end of the line. Then the Port would have the ability to reconfigure the tracks to support whatever new facilities it intends to develop in the future.

This type of rail purchase transaction would be very similar to what was done on the west coast, where the Pacific Harbor Line[108] (PHL) serves the Ports of Los Angeles and Long Beach. PHL operates 75 miles of track mostly owned by the two ports[109] although it also leases some industrial track from Union Pacific.[110] In Los Angeles, PHL serves nine on-dock intermodal terminals and numerous carload customers. It was developed by the ports in conjunction with the Alameda Corridor project to provide a neutral switching carrier for both BNSF and UP, and began operations in 1998:

> *The ports bought all of the physical rail assets from the railroads to level the playing field for shippers. Prior to this, Harbor Belt Line was owned and run by the Southern Pacific, the Santa Fe Railway and the Union Pacific. In the past, a shipper could have problems getting their goods to or from the port depending on where an individual railroad's track ended. With the inception of PHL, shippers now had*

[105] At the present time, the majority of container traffic at Houston is bound for destinations within close proximity to the port. According to: http://www.gcfrd.org/docs/Freight%20Rail%20in%20the%20Houston%20Region%20Study.pdf, p.34: *To date, container traffic at the Port has been mainly the domain of trucks . . . . To support inter-modal transportation, the Port Authority has built 12 miles of main line rail track and has expanded the Barbour's Cut rail facility. Currently, direct trains are operated between Barbour's Cut and Pier 400 at the Port of Los Angeles four times per week. The Port Authority is in preliminary engineering to build a new main line track to the Bayport container terminal and plans an inter-modal facility at Bayport in 2012. . . . Class I railroad companies have expressed some doubt about the Houston region's ability to capture significantly more share of container freight shipped by rail. From their perspective, to make shipping containers by rail more attractive, shippers need to be able to originate and terminate trains at the dock to minimize handling of containers. Yet they believe that the Port's rail facilities will not be sufficient for increased volumes of direct long-distance travel by rail. Barbour's Cut, for example, is designed primarily to move containers by truck.*

[106] According to http://swamplot.com/pasadena-still-waiting-for-its-ships-to-come-in/2010-08-16/ *Yes, the Houston area needs its Port and it has been vital to our economy. However, currently the container traffic is faltering. Also, there are few if any containers going out by rail from Barbours Cut and probably won't be any rail need at Bayport for the foreseeable future. (All those containers you see on trains are moving from Los Angeles, not the Port of Houston.) The Port of Houston still cannot handle the newer container ships as the channel is not deep enough, and that's a battle they haven't started to fight yet.*

[107] Union Pacific agreed in 1995 to allow BNSF access to the Bayport facility, if and when a rail on-dock facility is ever established: http://www.stb.dot.gov/filings/all.nsf/6084f194b67ca1c4852567d9005751dc/3380390608e91b0185256d7800644d19/$FILE/208599.pdf . See (STB Finance Docket 34342, Comments of the Port of Houston Authority) However, Kansas City Southern (KCS) does not serve the port because it is not allowed to serve Houston directly, it only has overhead trackage rights through the Houston terminal.

[108] See: http://en.wikipedia.org/wiki/Pacific_Harbor_Line

[109] See: http://www.presstelegram.com/business/20090310/pacific-harbor-line-serving-ports-named-short-line-railroad-of-the-year

[110] See: http://polb.granicus.com/DocumentViewer.php?file=polb_463f30c2c8b41193485304df2eb3d22f.pdf

a neutral switching railroad that could dispense reliable service at the largest port complex in the western hemisphere which handles 14 million TEU annually. In other words, the PHL leveled the playing field between the ports and the railroads.[111]

This leads to a proposed three step implementation process for developing Freeport's container handling capability:

- The first step is for Port Freeport to establish its own neutral terminal railroad. Then the port will have control over switching its own facilities. The terminal railroad can prepare trains ready for pick up by the Class I line-haul carriers.
- The second step is to develop inland ports at San Antonio, Dallas and Fort Worth (Section 4.6) and an integrated hub at Rosenberg (Section 4.7.) In the short term the needed capacity could be contracted at existing ramps. Over a longer term the development of new capacity will likely be needed. From these hubs, efficient rail connections can be made to anywhere else in North America or the world.[112]
- The third and final step is to establish a competitive rail link, connecting Port Freeport to the outside world[113] as described in Section 4.8.

4.6 The Need for Inland Ports

The development of a network of inland port facilities would complement the capabilities of on-dock rail loading, and also supports the goals for establishing competitive rail services that shippers want. As a rule, inland ports are justified when there is a concentrated volume of sufficient container traffic moving to or towards a particular location, beyond a comfortable truck drayage distance from the ocean port. Inland ports could lower shipping costs at key competitive points as Dallas, Fort Worth and San Antonio that will have enough concentrated traffic volume to justify running direct, dedicated train services. [114]

For example, the Virginia Port Authority has been running an Inland Port at Front Royal[115,116] 220 miles from Norfolk[117] with a dedicated double stack rail service since 1989. In 2013, the port of Charleston, SC opened an

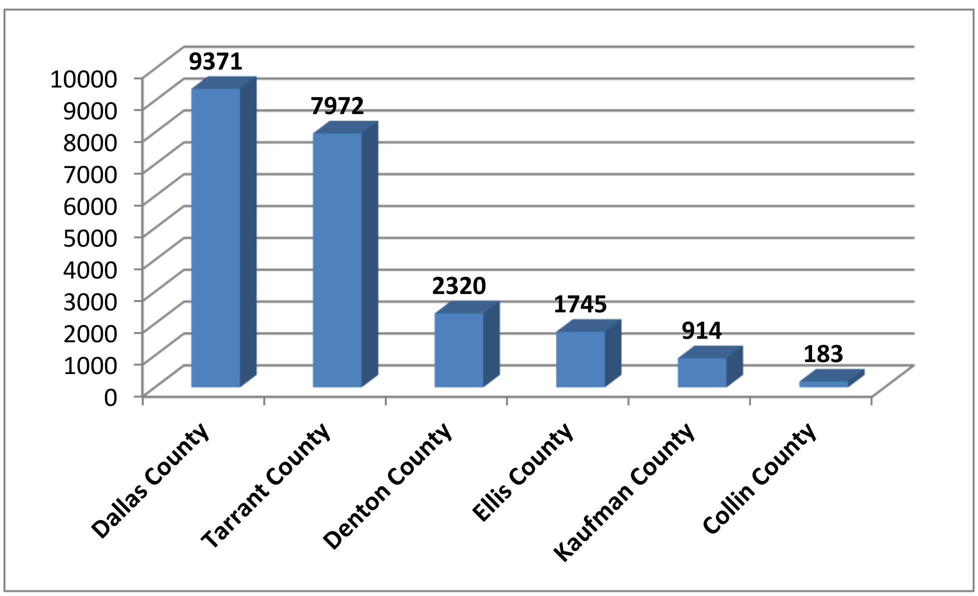
[111] See: http://www.trainweb.org/richard/APTA/APTA_Page_1.html
[112] In the short term it is likely that needed terminal capacity can be obtained by contracting for space at existing terminals. Over the longer term it is likely that new terminal capacity will need to be constructed. Once these contracting arrangements are in place, rail shuttle trains could be started linking Freeport to the inland ports and to the Rosenberg hub.
[113] This rail connection will likely consist of some combination of existing rail lines, along with new greenfield rail alignments for developing an efficient rail bypass around the west side of Houston. It is assumed that costs for developing, operating and maintaining these port, rail and inland terminal facilities will be recovered by the port's own fees and railroad trackage charges. While it is intended that these fees should be sufficient to fully recover the costs of these facilities, more study is needed to confirm the level of fees that will be needed to recover operating and capital costs. This will be done during the Investment Grade Study of the project which will involve extensive stakeholder collaboration. Water costs are modeled as approximately \$400 lift costs per TEU for loading and unloading (\$200 at each end of the water movement) plus line-haul of 2¢ per TEU-mile in large ships, or 4¢ per mile in small ships. This assumed \$200 per TEU fee (\$400 for a 40-foot container) is based on a competitive level of costs at Los Angeles and other ports. Port charges at Los Angeles are \$325-425 per 40 foot container, see http://www.polb.com/civica/filebank/blobdload.asp?BlobID=6866 Rail costs are modeled as \$125 lift costs per TEU for loading and unloading, or \$62.50 at each end of the rail movement, plus 12¢ per TEU-mile for the rail line-haul. These costs are based on double stack trains, and were developed from *"Rail Short Haul Intermodal Corridor Case Studies"*, Table 6.3.3 on page 32. See: https://www.fra.dot.gov/Elib/Document/1649
[114] See the discussion related to Exhibit 2-5, where these locations were identified earlier
[115] See: http://en.wikipedia.org/wiki/Virginia_Port_Authority
[116] See: http://www.freightlocation.org/Downloads/NCFRP23_Virginia_Inland_Port_Excerpt_From_Report.pdf
[117] This is a highway distance via I-64. The rail distance via Roanoke is almost 400 miles.

inland port at Greer, SC,[118] halfway between Greenville and Spartanburg, 215 miles from Charleston. The distances to Dallas/Fort Worth and San Antonio are very similar so a concept similar to Virginia's and South Carolina's would likely work in Texas as well. [119] Inland ports are increasingly becoming standard adjuncts to ports, as more and more ports start to develop these kinds of facilities.

Co-locating inland ports as close as possible to existing rail ramps would also facilitate opportunities for long-distance moves connecting onto the national rail system beyond these points. As a result, the proposed inland ports could serve not only as destinations for Texas-bound traffic, but also as transshipment hubs (like CSX's Northwest Ohio[120] facility) for shipments beyond Texas. Given the distance from Freeport to any existing Houston area intermodal ramp, it will certainly be more efficient to make a direct connection to the national rail network at a Dallas, Fort Worth or San Antonio hub than to rely on truck drayage to any of the existing Houston area rail ramps. This will also support Texas DOT's objectives for avoiding the congested rail and highway networks of downtown Houston.

Exhibit 4-5 shows the distribution of Warehousing and Storage Employment by county within the Dallas/Fort Worth area - showing that distribution activity there is divided almost evenly between the two cities, with three other counties also sharing significant employment. With such a large and geographically dispersed market, it will be difficult for any single facility to effectively serve both Dallas and Fort Worth. Also, BNSF has its main intermodal facility at Alliance, TX north of Fort Worth, whereas UP's is in Wilmer, TX south of Dallas. Thus there is an opportunity to develop an effective inland port facility in ***both*** cities by working cooperatively with ***both*** railroads.

Exhibit 4-5: Distribution Activity within the Dallas/Fort Worth Area



118 See: http://www.port-of-charleston.com/Cargo/ReadytoGrow/sc_inland_port.asp

119 Dallas has an existing inland port Initiative, but Virginia's concept is a little different since the Front Royal facility is operated under the direct control of the Port Authority as a dedicated facility. However, either a dedicated or a shared facility could work with the appropriate institutional arrangements. See: http://www.iipod-texas.org/

120 See: http://www.csx.com/index.cfm/media/press-releases/northwest-ohio-terminal-begins-service/

As a result, three inland port facilities are proposed, at or adjacent to:

- UP's Dallas facility in Wilmer, TX[121] which also could support a KCS connection from Dallas[122] using this Meridian Speedway for eastbound containers;
- BNSF's Fort Worth facility in Alliance, TX
- UP's San Antonio[123] ramp

In addition to this an "Integrated Hub" facility is proposed at Rosenberg, as will be described in Section 4.8 The proposed inland port strategy for Freeport would have the advantages of:

- Promoting dual access by both UP and BNSF into Port Freeport.
- Only a limited number of on-dock sorts would be required at the Freeport ICTF. Freeport would build dedicated sorts only to the highest volume destinations. This would build economies of scale on the shuttle trains.
- Keeping Freeport container traffic out of the congested Houston highways and rail networks.

Exhibit 4-6 shows a tonnage density map of Union Pacific intermodal service, which confirms the importance of the Dallas Fort Worth market in terms of international container flows. Union Pacific's Intermodal tonnage density map reinforces the importance of developing an effective rail link from Freeport to the Dallas/Fort Worth (DFW) logistics hub. It can immediately be seen that the intermodal traffic moving to Dallas is much greater than that moving to Houston. This reflects in part the market share taken by the Houston port, but also to a significant degree the development of the market in the two cities. While Houston's traffic is more industrial, DFW has emerged as the primary distribution hub for consumer products. The relative tonnage density of the rail routes into Dallas and Houston agrees with the employment data, strongly suggesting that as a logistics hub for containerized traffic, DFW plays a much stronger role today than does Houston.

This has also been independently confirmed by trucking data that shows that Dallas is originating a lot more tonnage than it receives. The reported lane imbalance[124] shows that many of Houston's consumer products are passing through Dallas logistics centers and trucked to Houston, rather than being brought to Houston by rail. Developing a rail link from Freeport is essential to maintaining the economic competitiveness of DFW as a rail-based logistics hub. This will enable DFW to maintain its role as a major distribution center while at the same time, the Houston area will also be able develop into a port-based logistics hub. Houston's emergence will likely be accomplished by shifting some of the future job *growth* from California ports. There is no indication that Houston's growth will be accomplished at the expense of DFW's, but rather it would appear that future development of the two logistics areas will be more synergistic than competitive.

[121] See: http://www.dallasnews.com/business/columnists/jim-landers/20110404-southern-dallas-inland-port-panama-canal-link-still-viable.ece
[122] UP is partnered with KCS and NS on developing the Meridian Speedway connection to Atlanta. This is UP's new transcontinental route from Los Angeles to Atlanta, which is now goes through Dallas and Meridian rather than through Houston and New Orleans. BNSF is working with CSX, it has its own Atlanta ramp which it reaches by using trackage rights over CSX from Birmingham.
[123] UP is the only railroad that owns infrastructure in San Antonio, although BNSF has trackage rights. See: http://www.txtransportationmuseum.org/history-rr-burlington-northern-santa-fe.php
[124] Today, there are more than two Dallas-Houston loads for every backhaul. A flow reversal that brings more loads into the Houston market will strongly improve the trucking lane balance. See: http://www.dat.com/blog/post/Dallas-Offers-Mix-of-Head-Haul-and-Back-Haul-Freight

Exhibit 4-6: Union Pacific Intermodal Tonnage Density[125]

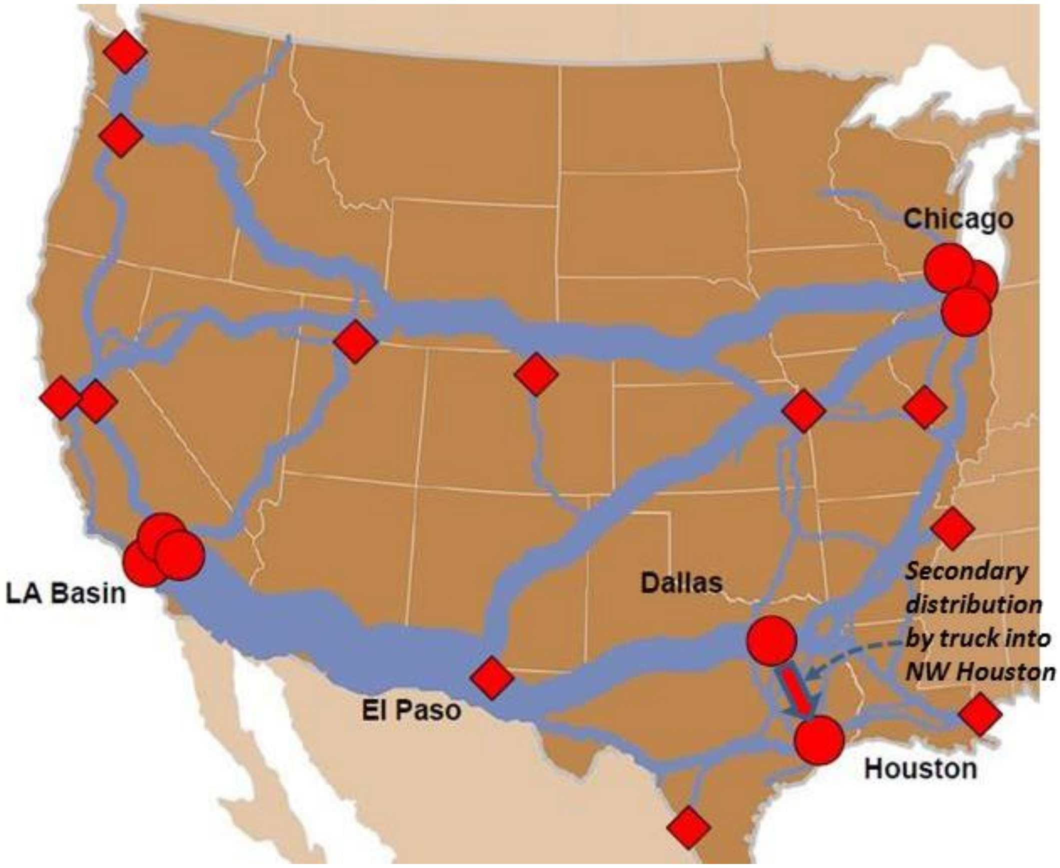
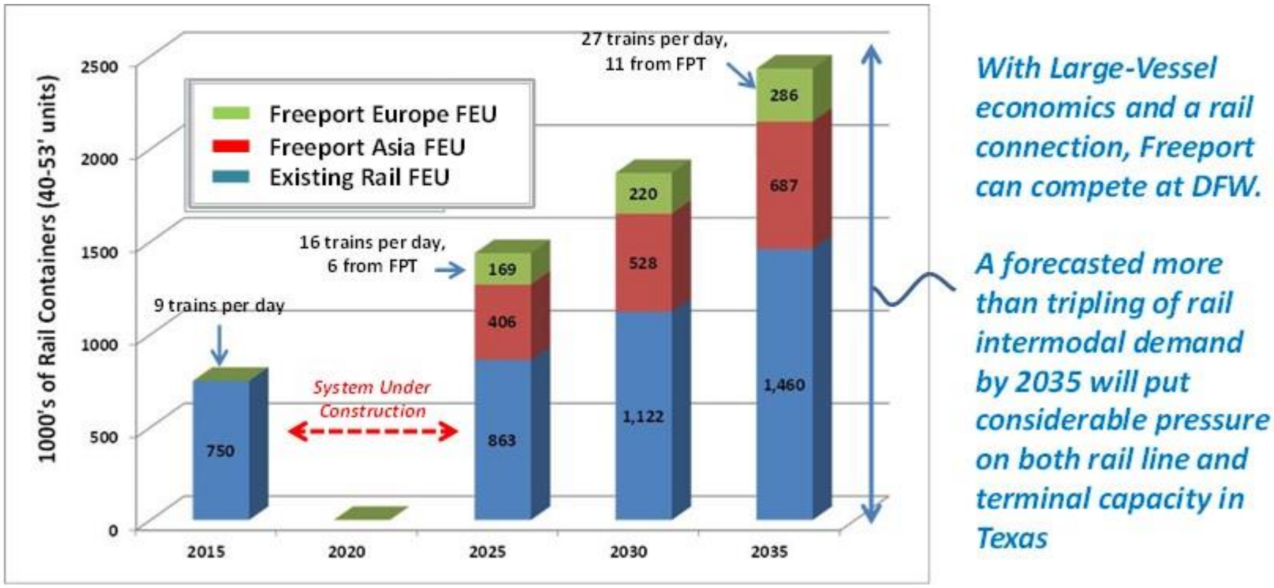


Exhibit 4-7 shows the impact development of Port Freeport is projected to have on the rail container market at Dallas/Fort Worth. As can be seen, California ports are expected to retain a majority share of the total market. Given the high rate of growth in Texas, by 2025 (the first year the proposed new system is fully operational) volumes from California into Texas are expect to fully recover to current levels. After that, the West Coast traffic into Texas is forecasted to continue growing, albeit at a slower rate.

Summarizing, due to the high rate of demographic growth in Texas, it is clear that additional port, rail line and intermodal terminal capacity are needed. As a result, development of Port Freeport will be a key component of any plan to handle this growth, since economical vessel service will be especially attractive to price-sensitive sectors of the container market. However, higher values and more time sensitive imports will likely continue arriving on the West Coast provided the labor situation there can be stabilized. This suggests the future emergence of a differentiated service model for West Coast traffic focusing on faster rail service to high valued container traffic, since bulkier and heavier freight will clearly prefer lower cost all-water Panama Canal routings to the Gulf and East coasts.

[125] *Source: Base map is from UP Presentation to AAPA, November 6, 2013 by G. Bisaillon.*
See: http://aapa.files.cms-plus.com/seminarpresentations/2013seminars/13faceng/bisaillon_g.pdf

Exhibit 4-7: Freeport's impact on Dallas/Fort Worth Container Market



Notes:
1. *Estimate approx. 750,000 containers total IMX market in and out of DFW today.*
2. *Freeport will come online between 2020 and 2025. By 2025 fully operational.*
3. *Freeport would add rail European boxes that are currently trucked which results in an immediate boost in rail traffic*

4.7 Development of Rail Connections to Dallas, Fort Worth and San Antonio

By working with both BNSF and UP, the proposed inland ports strategy supports the goal of competitive rail access, promotes competitive equity and also would link to KCS's Meridian Speedway via UP's Dallas facility.[126] This section discusses infrastructure needs for developing rail connectivity to the three proposed inland ports at UP Dallas (Wilmer), BNSF Fort Worth (Alliance) and UP San Antonio.

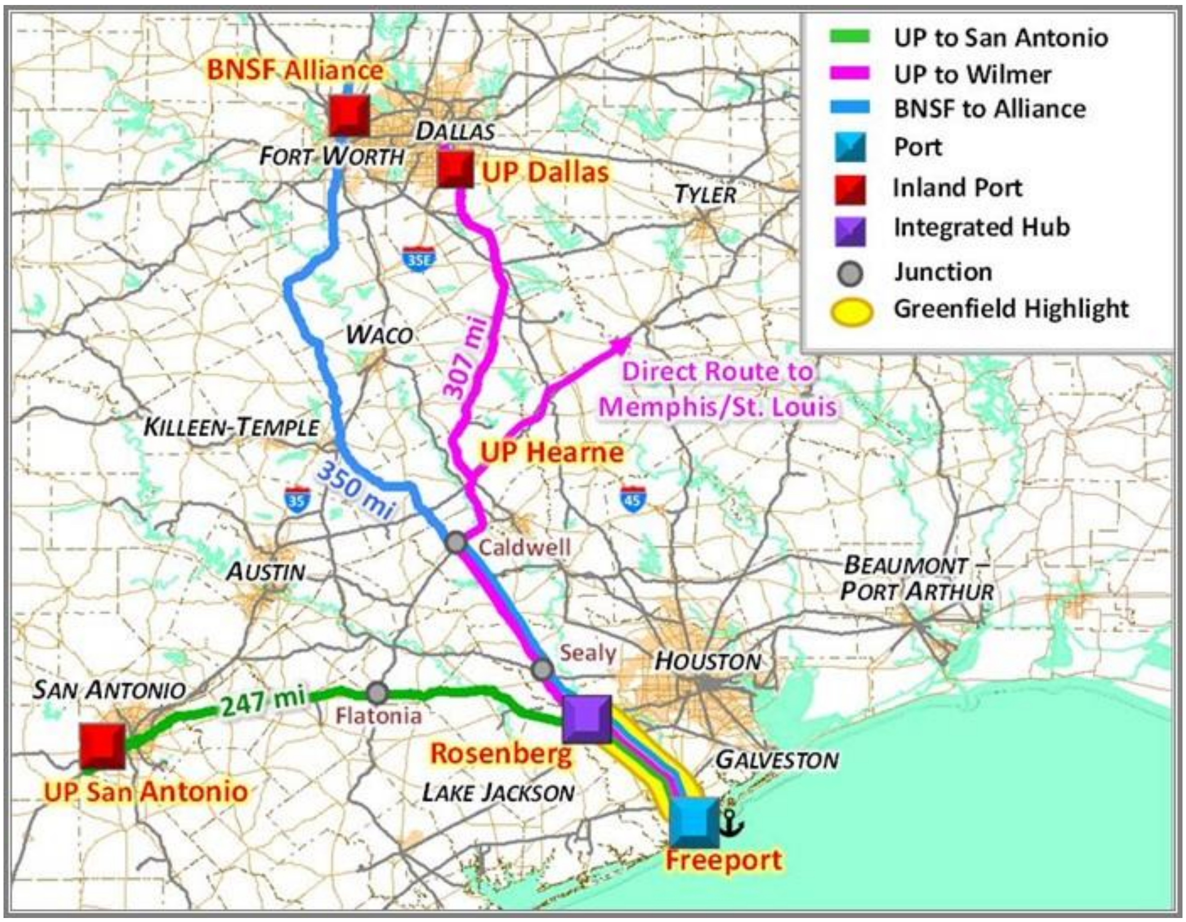
For development of new rail options, Texas DOT has suggested that "bypass" strategies to get traffic around, rather than through Houston would have important public benefits. Implementation of a new port at Freeport can support this objective by providing an alternative gateway for container imports. Freeport is close enough to develop a cooperative and synergistic relationship with Houston's port; but far enough away so traffic bound to Dallas, Fort Worth and San Antonio will neither be delayed by nor contribute to Houston's congestion problems.

[126] Connecting to KCS in Dallas may be more advantageous than connecting with them in Houston, since KCS runs all of its trains east from Rosenberg over UP trackage rights through the heart of downtown Houston. Even if KCS does not serve Freeport directly, in cooperation with Union Pacific, Freeport containers that go up to Dallas on UP could still access the Meridian Speedway using the connecting UP "Blue Streak" intermodal connection towards Atlanta. This may in fact turn out to be a more advantageous strategy since containers given to KCS locally would route east through downtown Houston. If instead UP takes the containers to Dallas, Freeport containers would bypass Houston.

Currently, while BNSF's Galveston Subdivision[127] bypasses Houston, UP's network strongly focuses on Houston since its two main terminals, Englewood and Settegast are located downtown. Also, UP's alternative routes tend to be very circuitous. As a result, UP's tendency today is to take everything through downtown Houston. Therefore, development of an effective UP route to Dallas (Wilmer) will be the most challenging in terms of keeping Freeport containers out of downtown Houston. As shown in Exhibit 4-8, a two-part solution is proposed to develop an effective Houston rail bypass for Freeport rail traffic:

- A direct link from Freeport to Rosenberg (greenfield alignment) would shorten the rail distance by 35 miles by eliminating the "dog leg" via Alvin for BNSF traffic.
- By staying on the BNSF's Galveston Subdivision to Caldwell, UP's direct route to Dallas would be only 307 miles long, as compared to 321 miles via UP's existing route through downtown Houston.[128] As a result, this Houston bypass would become UP's shortest and most effective route for moving trains north from Freeport to Dallas.

Exhibit 4-8: "Proposed" New Routes Linking Freeport to Inland Ports and Integrated Hub



[127] The Galveston Subdivision acts as a western bypass of the city of Houston. It skirts the west edge of the city rather than going through downtown Houston. BNSF trains headed to the Pearland intermodal facility follow the Galveston Subdivision to Alvin, then turn left and head north on the Mykawa Subdivision. BNSF trains are actually able to enter Houston from the south rather than trying to navigate the downtown Houston rail network.

[128] UP's most likely route would head through the heart of downtown Houston, following BNSF's Mykawa Subdivision to UP's own Palestine and Navasota Subdivisions. North of Hearne the route would follow UP's Ennis Sbdivision to Wilmer. This route is 321 miles long.

Developing a new Houston rail bypass for Port Freeport traffic (Exhibit 4-8) would require:

- Development of a new greenfield rail link from Freeport connecting to both the BNSF Galveston Subdivision and the UP Glidden Subdivision north and west of Rosenberg.[129,130]
- Capacity improvements and development of a UP/BNSF joint rail facility north from Rosenberg to Caldwell over the BNSF Galveston Subdivision.
- A new northeast quadrant connection at Caldwell would link the BNSF Galveston Subdivision to UP's Giddings Subdivision. This would connect directly to both to UP's proposed new freight yard at Hearne, TX and to the Wilmer, TX intermodal facility south of Dallas.
- Exhibit 4-8 shows the three proposed Inland Ports; and also includes a proposed Integrated Hub at Rosenberg which is also proposed to be developed in conjunction with the rail corridor. This will be further described in the next section of this report.

Detailed engineering and environmental studies will be needed for developing rail improvements north of Freeport. For gaining regulatory approvals, a full Environmental Impact Statement will likely be required including "No Build" and possible route alternatives. The proposed Environmental study would result in a full assessment of environmental benefits (e.g. Houston congestion, safety, energy savings, emissions reduction) as well as costs (e.g. farmland and property takings, wetlands impacts) and would identify appropriate mitigations for any negative impacts.

4.8 The Case for an Integrated Hub at Rosenberg

Because of Texas's high growth rate, there is a need for all kinds of additional transportation capacity to be added in Texas. This includes highway, rail and intermodal terminal capacity. An integrated intermodal hub in Rosenberg is proposed to be developed in conjunction with the proposed Freeport-Rosenberg-Caldwell rail corridor. This intermodal facility would anchor the development of a significant logistics base along the west side of the Houston ring roads. The ocean port improvements at Freeport, development of inland ports and Rosenberg integrated hub are all essential parts of a synergistic strategy for maximizing the economic potential associated with development of the SH36A corridor

The railroads have tended to follow an emerging "Logistics Park" model in development of new intermodal facilities. Typically new ramps have been built 20-30 miles out from the main city center in a suburban location: well connected to urban ring roads, with plenty of land for growth and for supporting development of nearby distribution centers. In addition to the brand new BNSF/UP Texas ramps at Alliance, Wilmer, San Antonio and El Paso (which all fit this model) additional recent examples of new logistics centers are: BNSF Elwood, IL (2002); UP Global III Aurora (2003); BNSF Memphis, TN (2010); UP Global IV Joliet (2010), BNSF Edgerton, KS (2013); and CSXT Winter Haven FL (2014).

[129] Rosenberg is a major rail junction where all three railroads (UP, BNSF and KCS) cross. The proposed connection point would not be in downtown Rosenberg, but in the open countryside about 6 miles west of Rosenberg where the proposed Fort Bend rail bypass would have connected to the BNSF Galveston Subdivision.

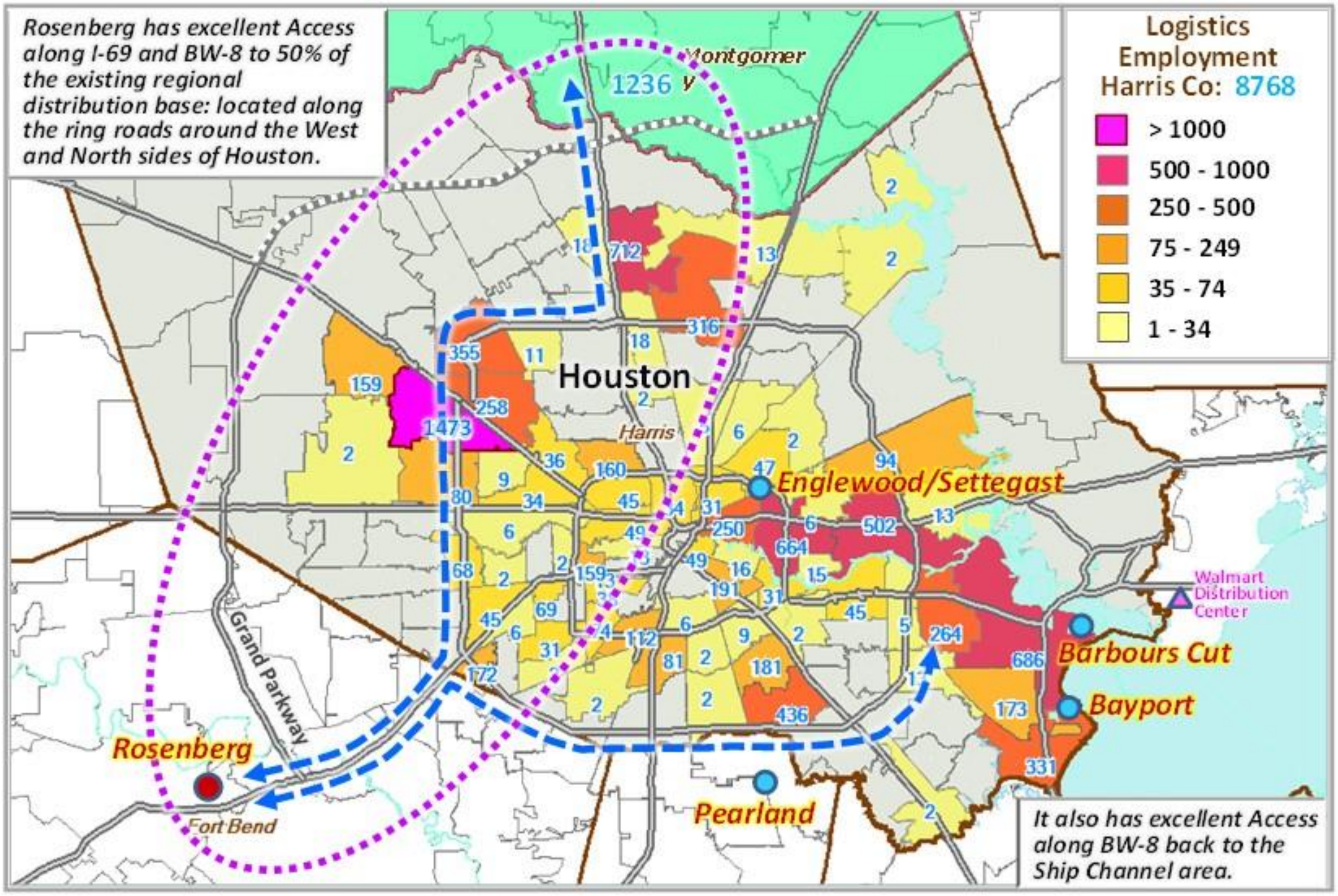
[130] For KCS, Rosenberg is the eastern end of the line from Victoria that was recently rebuilt to support NAFTA trade. KCS has an intermodal ramp at Kendleton, TX just south of Rosenberg. UP purchased 2,000 acres of land comprising a triangle beginning at the intersection of U.S. 90A and State Highway 36 in west Rosenberg. UP may use this for a new intermodal facility. http://www.instantnewsfortbend.com/2007/07/23/30112

In fact, Houston is the ***only*** major Texas market which has ***not*** received a major new intermodal rail facility investment in the past 25 years. As shown in Exhibit 4-9, ***both*** of Houston's existing downtown UP ramps are landlocked and will be very difficult to expand. Both ramps are located in the congested downtown Houston terminal, so it is hard to see how either ramp can be cost effectively expanded to deal with the forecasted increase of Houston's local container market over the next 20 years. Additionally, operations there add to congestion in both the downtown Houston rail and highway networks.

Exhibit 4-9: UP's Two Downtown Rail Ramps are Landlocked and Difficult to Expand

Exhibit 4-10 shows the distribution of logistics employment within Houston. As can be seen, a Rosenberg hub would provide convenient access to major logistics zones on the north and west sides of the city without needing to bring either trains or trucks into the congested center city area. This existing traffic base creates a great opportunity for the development of Rosenberg Integrated Hub.

Exhibit 4-10: Rosenberg Provides Access to Significant Existing North and West Logistics Zones



By comparison to the congested downtown rail ramps, an integrated hub at Rosenberg could offer:

- **Convenient Access to Existing Logistics Areas**
  - Easy access to existing logistics areas along ring roads – developing centers in Fort Bend County, as well as north and west of Houston, and even back to the Ship Channel area using the Sam Houston Tollway.
  - Future planned SH 36A Highway development would enhance access Port Freeport to Rosenberg to DFW supporting flow reversal, which would result in a better fronthaul / backhaul lane balance for the trucking companies.

- **Room to Grow**
  - Plenty of developable land in close proximity to major markets.
  - Rosenberg Integrated Hub would reduce rail and highway congestion in downtown Houston. It both would reduce train count in the rail terminal and keep drayage trucks off congested urban highways

- **Rail Integration both West and East**
    - Three Class I Railroads: UP, BNSF and KCS offer convenient access to West Coast Ports and Mexico via existing rail lines, for supporting both international and domestic freight movements, further supporting the attractiveness of Rosenberg as a developing logistics center
    - New Freeport Rail Corridor (under development) will add a congestion free rail link avoiding Houston providing a "Short Cut" to eastern gateways of Memphis, St. Louis, Kansas City, Chicago and Canada and a direct, environmentally friendly link to the Freeport Ocean port.

- **Port Integration**
    - Although development of Port Freeport is separate from the Rosenberg Integrated Hub and each project has Independent Utility, the coordinated development of both projects together would be economically synergistic and mutually supportive.
    - Integrating Port Freeport container traffic into the UP rail network at Rosenberg could help support the volume requirements for running full trains from Rosenberg to Los Angeles, El Paso, San Antonio, Chicago, St Louis, Memphis and other potential destinations. Connections to the national rail network could be made at Rosenberg rather than at Dallas enabling a shorter route to the north and east.

All these factors build a compelling business case for pursuing development of an integrated Hub at Rosenberg. The economic benefits to Fort Bend County could also be significant. For example, when CSX developed its 318 acre Winter Park rail facility, it was surrounded by 930 acres reserved for development of up to 7.9 million square feet of warehouse distribution centers. It was projected that at full build-out, the Winter Haven ILC will create 8,500 annual jobs with a total annual payroll of $282.2 million. All indications are that a similar impact would be likely if Fort Bend County were to seriously pursue the development of the Rosenberg Hub and all the jobs that would go with it.

Chapter 5. Engineering Assessment of the Corridor

In this task, data regarding corridor development and cost development have been assembled. This task has been accomplished by Brown & Gay Engineers, Inc. (BGE), and Transportation Economics & Management Systems, Inc. (TEMS). BGE and TEMS coordinated the cross-street cost estimate with Aguirre & Fields (AF) and coordinated the overall cost estimate with HDR, Inc. (HDR).

The rail corridor improvements from Freeport to Rosenberg and on to Caldwell, as described in Chapter 4, have been assessed by Brown & Gay Engineers to develop a feasibility-level cost estimate. This includes a new greenfield rail corridor connecting Port Freeport to Rosenberg, and capacity improvements to the BNSF Galveston Subdivision from Rosenberg to Caldwell. From Caldwell, UP trains could connect to the Giddings Subdivision and continue to Hearne, while BNSF trains would continue along the Galveston Subdivision to Temple. This provides dual railroad access to the Port of Freeport and an effective Houston area bypass route for both the BNSF and UP railroads that is shorter than UP's existing route through the city.

5.1 Background and Assumptions

Geometric Criteria: The geometric criteria was based on the American Railway Engineering and Maintenance-of-Way Association's (AREMA) Manual for Railway Engineering, Chapter 5, Part 3. The maximum design speed of the railroad was calculated by the following formula:

$$\boldsymbol{V_{max}} = \sqrt{\frac{\boldsymbol{E_a + E_u}}{\boldsymbol{0.0007D}}}$$

where:

Vmax = Maximum allowable posted timetable operating speed (mph)

Ea = Actual elevation of the outside rail (inches)

Eu = Qualified cant deficiency of the vehicle type (inches) and

D = Degree of curvature (degrees).

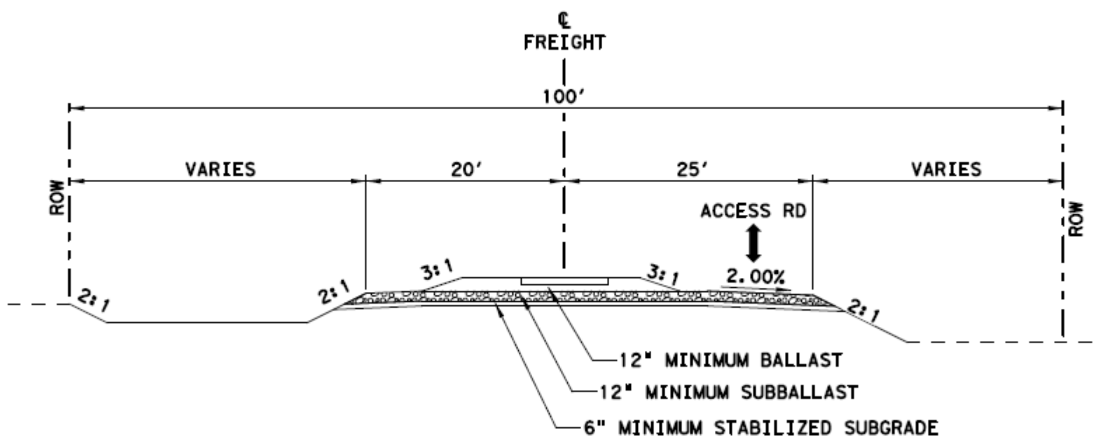
In the most critical case, the actual elevation of the outside rail and the qualified cant deficiency were assumed to be 1 inch and 2 ½ inches, respectively, which provides a maximum rail speed of 40 mph and a critical design radius of 4,300 feet.

ROW Requirement: The width of railroad ROW is significant to the discussion of the greenfield segment because ROW width influences land acquisition costs, railroad construction costs, and the extent of potential community and environmental impacts which might arise from the construction of the railroad.

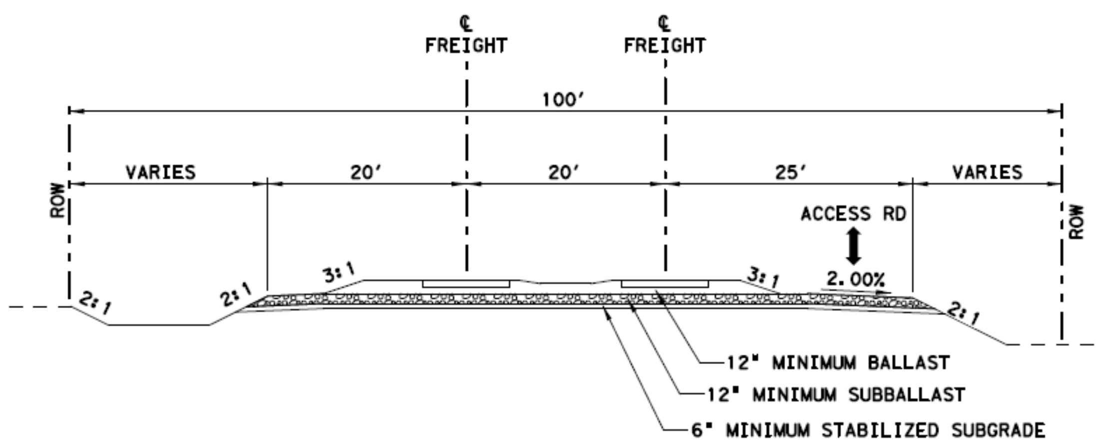
Railroads are placing more emphasis on building access roads in their ROW, and wider spacing between tracks, to enhance safety and productivity of maintenance-of-way (MOW) employees while working on a track that is adjacent to one or more tracks on which trains are operating. The wider track spacing and availability of access roads increases the amount of area in which Maintenance-of-Way (MOW) employees can stand clear of a train moving on an adjacent track. The availability of such 'stand clear' space also reduces train delays associated with MOW work being performed on a track that is adjacent to one or more active tracks.

With the above in mind, a typical section was created, within a proposed 100-foot ROW, illustrating designs supporting single-track freight rail operations with designs for double-track freight rail when sidings are necessary. See Exhibit 5-1 for the proposed railroad typical section.

Exhibit 5-1: Proposed Railroad Typical Section



TYPICAL FREIGHT RAIL SECTION



FREIGHT RAIL WITH SIDING

Physical Constraints: In this process, major physical constraints were identified within the greenfield segment from Port Freeport to Rosenberg, such as towns, historic locations, environmental concerns, wildlife areas, parks, churches and schools.

Initial corridors were developed that had minimal or no impacts on the major constraints. These initial corridors were analyzed and refined based on the following guidelines.

- Number of constraints which can be avoided;
- Impacts upon constraints;
- Cost of acquiring land to create the railroad ROW;
- Cost of constructing the railroad and
- Cost of constructing railroad – roadway grade separations.

5.2 Corridor Development

For the purposes of this study a representative corridor was developed. This representative corridor is not the result of an alternative analysis. It is a corridor which avoids major environmental constraints while maintaining the operational characteristics of a feasible alternative. This representative corridor was then used for the cost estimating and operational analyses necessary for this feasibility study.

Port Freeport to Brazoria: The proposed rail corridor begins in Port Freeport, at a proposed new Freeport Intermodal Container Transfer Yard (ICTF). During the June 24, 2015 steering committee meeting, it was decided that the proposed ICTF site would be located north of the Brazos River, where the Port has ample land and would also eliminate the construction of a new rail bridge across the Brazos River. See Exhibit 5-2 for the proposed Port Freeport ICTF site. With this concept, container berths could be located anywhere within the port.

Exhibit 5-2: Proposed Port Freeport ICTF Site North of Brazos River

A dedicated drayage road would be necessary to transport containers from the yard to the new ICTF site. This project assumed that the existing SH 36 bridge, a very lightly-used 4-lane bridge over the Brazos River, would have adequate capacity to serve as the drayage road. See Exhibit 5-3 for the existing SH 36 Bridge.

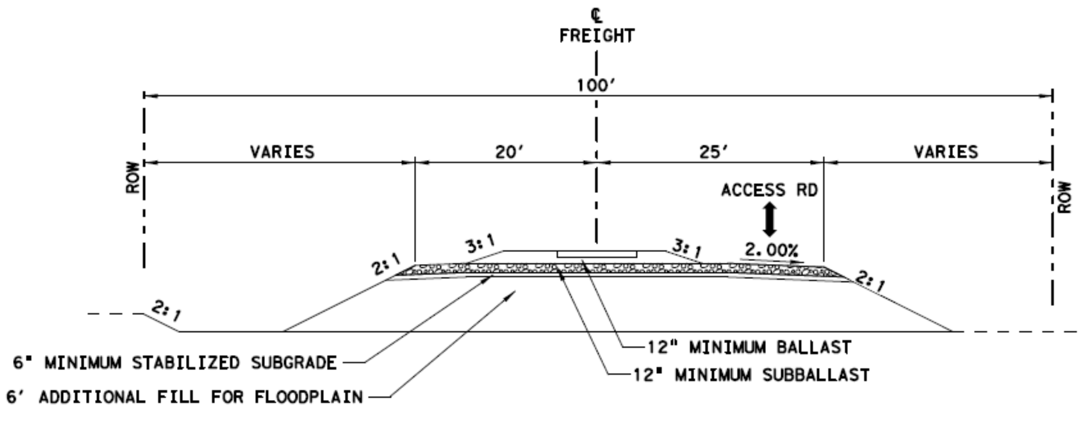
The development of the port infrastructure, ICTF terminal and drayage road are assumed to be the responsibility of Port Freeport and are not included in the current Engineering cost estimate.

Exhibit 5-3: SH 36 Bridge over the Brazos River

The area north of Port Freeport is heavily urbanized with the development of Lake Jackson and Clute. To avoid these areas as well as the Brazoria Reservoir, the representative corridor traverses northwest in the direction on Brazoria. Several alternatives were analyzed in this area to ensure the rail would not impact the historic Austin 300 Plantation and would have minimal impacts through the 100-year floodplain.

The floodplain was a design concern because of the added cost required to elevate the rail across the floodplain. The profile of new proposed rail line was designed to be above the 100-year floodplain by adding fill under the typical rail section. See Exhibit 5-4 for the typical section of the rail through the floodplain.

Exhibit 5-4: Proposed Railroad Typical Section within Floodplain



Brazoria to Rosenberg: Once in Brazoria, the representative corridor would connect with the UP Angleton Subdivision to allow freight rail the option use the UP Angleton Subdivision to continue to Houston as well as head northwest from south Texas towards Rosenberg.

The representative corridor then traverses northwest in the direction of Needville running along the west side of SH 36 and West Columbia. This design also avoids all major constraints and has minimal impacts through the 100-year floodplain and endangered species habitat.

From Needville, the representative corridor traverses north towards the west side of Rosenberg and follows the same alignment as the proposed Fort Bend Bypass freight rail line, a study completed by the Gulf Coast Freight Rail District. In doing this, the impact to this urbanized area outside of Needville and Rosenberg remains minimal.

At Rosenberg, the representative corridor joins the existing BNSF Galveston Subdivision ROW several miles west of Rosenberg. This location allows for rail connections with the UP Glidden Subdivision and the KCS Rosenberg Subdivision.

This proposed alignment also runs parallel to property owned by UP, which allows UP to have direct access to the rail from a potential rail yard or ramp. This concept provides maximum integration with the existing rail system and provides the maximum benefit not only to the rail clients, but also to the public in terms of goods movement. See Exhibit 5-5 for the Rosenberg area.

Exhibit 5-5: Rosenberg

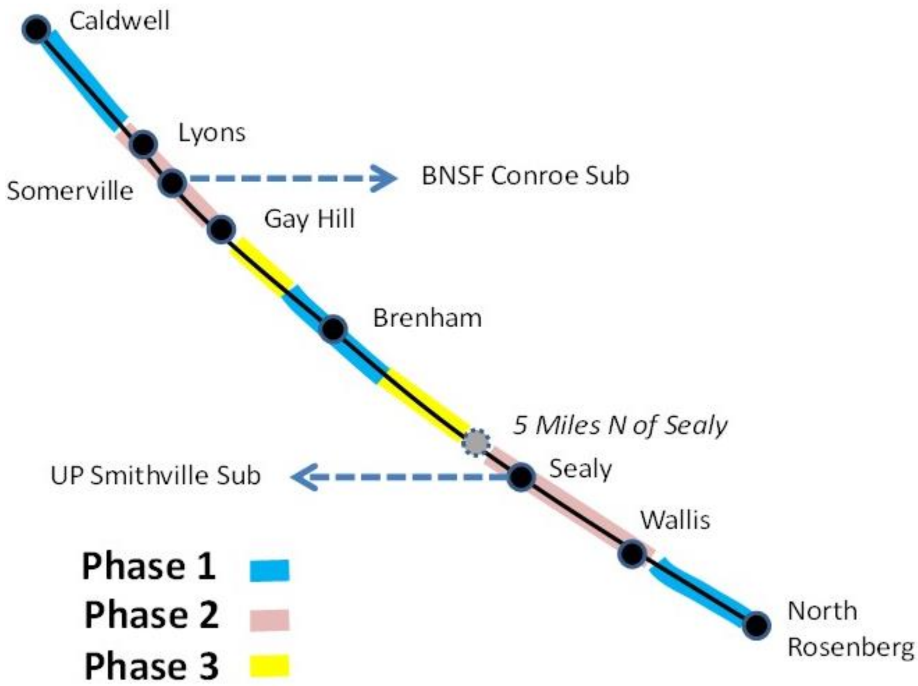
Rosenberg to Caldwell: From Rosenberg, the representative corridor parallels the existing BNSF Galveston Subdivision within existing BNSF ROW into Caldwell. It is proposed that this corridor will be upgraded to handle the additional traffic volumes coming out of Port Freeport and serve as a Houston bypass route. This rail line could be used by both the BNSF and UP from Rosenberg to Caldwell. Once in Caldwell, UP trains could diverge to Hearne while BNSF trains could continue towards Temple.

A three phase upgrading plan has been proposed that would result in eventual full double-tracking of the rail line from Rosenberg to Caldwell. The current capital cost estimate is based only on Phase 1 and is intended to provide enough capacity to accommodate trains from Port Freeport. The additional Phases 2 and 3 would be constructed in the future as traffic volumes grow. Exhibit 5-6 illustrates the proposed three phases described below:

- **Phase 1**: 31 miles of double-track at both ends and in the middle of the line. 10 miles of track would be added at both ends of the corridor to buffer connections to other rail lines. Additionally, 10 miles of track would be added centered on the Brenham area.
- **Phase 2**: 20 additional miles of double -track would be added to buffer the connections to other rail lines that join in the middle of the corridor. Complete double-track from Caldwell to Somerville which eases BNSF access to Conroe Sub, and from Rosenberg to Sealy, which eases UP access to Smithville Sub.

- **Phase 3**: Fill in all remaining gaps. Completion of this phase would result in 100% double-track freight rail from Rosenberg to Caldwell.

Exhibit 5-6: Three-Phase Plan for Improving the BNSF Galveston Subdivision



5.3 Cost Development

Cost estimates were developed for three segments of independent utility that make up the proposed project, which are listed below.

- **Port Freeport to Brazoria:** This provides a connection from the UP Angleton Subdivision to the proposed Freeport ICTF location.
- **Brazoria to Rosenberg:** This segment provides a short-cut to Rosenberg that is 35 miles shorter than the existing rail route. It connects to the BNSF Galveston Subdivision north of Rosenberg.
- **Rosenberg to Caldwell:** Provides a Houston bypass that connects to the UP Giddings Subdivision to Hearne

Railroad construction costs can be broken down into eight main categories – land acquisition, grading, utilities, rail crossings, railroad infrastructure, fences and signs and signals. The following illustrates the assumptions and decisions made in this process to finalize a unit cost in connection with each category.

Due to the preliminary nature of the study, the cost analysis was done by applying unit costs to estimated units required for the construction. This methodology includes assigning unit costs to rail construction components (linear-foot of rail, tons of stone, etc.), roadway grade separation overpass construction cost per overpass, etc. This unit cost approach allows for a comparative analysis and is a similar approach to past railroad feasibility studies. At this stage, the cost can be broken down into three categories: land acquisition, railroad construction and roadway grade separation overpass construction. The methodology involved in calculating a unit cost of each category is detailed below.

Land Acquisition Cost: Land use greatly influences land value; for example, land in a highly developed area is commonly priced higher than land in a rural, open area. The following information was needed to develop a unit cost of land acquisition:

1. Total number of parcels impacted;
2. Total acreage of parcels impacted and
3. Total appraised land value of parcels impacted.

Using the Fort Bend County and Brazoria County parcel mapping information, the total acreage of land impacted was determined. Next, using the formula below, the impacted land value was calculated per parcel and the sum of these values became the total land acquisition amount.

$$Land\_Acquisition = \sum Parcel\_Land\_Cost_x \frac{Acre\_Impacted_x}{Acre\_Parcel_x}$$

Parcel costs were further developed using Fort Bend County and Brazoria County Appraisal Districts' total land value estimates as well as other land acquisition data from similar area projects, such as the Grand Parkway Segment E. Both county district values did not account for the differences in actual market values, additional acquisition fees including title transfers, condemnation requirements, hearings, relocation fees and other miscellaneous costs that would be incurred were land actually acquired. Exhibit 5-7 illustrates the finalized unit cost per acre for the construction of the new proposed rail line. It is important to note that the following unit costs are solely for the purposes of overall cost estimation. The acquisition costs of individual parcels will be subject to market appraisals at the appropriate time.

Exhibit 5-7: Land Acquisition

36A RAIL LAND ACQUISITION UNIT COST CALCULATIONS		
	FORT BEND COUNTY	BRAZORIA COUNTY
ROW NEEDED	279 ACRES	485 ACRES
TOTAL NUMBER OF PARCELS	197	392
TOTAL ACREAGE OF PARCELS	8,083 ACRES	22,310 ACRES
TOTAL APPRAISED LAND VALUE	$277,858,020	$322,282,350
UNIT COST PER ACRE	**$34,374**	**$14,446**
TOTAL LAND ACQUISITION COST	**$9,600,000**	**$7,100,000**

Grading: Grading costs include excavation, fill soil stabilization, stormwater management, seeding and sub-ballast. These were all calculated based on a unit cost methodology given the parameters of the proposed new rail line.

Utilities: Since this representative corridor traverses through southeast Texas, a number of existing pipelines are in the vicinity and needed to be analyzed. Avoiding all of the pipeline crossings is not feasible. Due to the preliminary nature of the study, the cost analysis was based upon five different approaches to avoid pipelines and associated a unit cost for each approach. It was assumed that 20% of the pipelines would be avoided, 25% would be protected with a concrete slab, 25% would be encased, 25% would be relocated, and the final 5% would require a rail bridge over the pipeline easement. Actual construction costs for each of the approaches were analyzed and a unit cost for each approach was developed.

Other nominal costs for utilities located at each cross-street crossing were also added into the overall utility cost. The unit cost for relocating electrical, fiber optic, water, sanitary and natural gas was applied per intersection through the limits of the representative corridor.

Rail Crossings: As part of this study, cross-streets were analyzed to determine whether they should be reconstructed to at-grade intersections or grade-separated overpasses.

Because the representative corridor ROW is still conceptual, assumptions were made as to the type of railroad grade-separations proposed. Conceptual typical bridge sections based on possible crossings of the route were developed. Criteria used in developing typical sections and retaining wall lengths were found in the following reference materials: TxDOT's Roadway Design Manual (RDM); TxDOT's LRFD Bridge Design Manual; the 2012 AASHTO LRFD Bridge Design Specifications and the BNSF Railway – Union Pacific Railroad Guidelines for Railroad Grade Separation Projects. To produce planning level cost estimates, TxDOT's unit bid prices for retaining walls and TxDOT's average unit costs of bridges structures were utilized.

A total of five cross-streets were found to warrant a roadway overpass – US 59, SH 35, Spur 10, US 90A and SH 36. For the US 59 overpass, a proposed design speed of 70 mph was assumed, and roadway grade of 3%. For the SH 35, Spur 10, US 90A, and SH 36 overpasses, a proposed design speed also at 70 mph was assumed, and a maximum grade of 4%.

Using a bridge structure depth of nine feet, an estimated cost of $80 per square foot was assumed for all bridges. A maximum retaining wall height of 25 feet, an estimated cost of $45 per square foot was assumed for all retaining walls.

The remaining cross-streets were assumed to be at-grade crossings. Pre-cast concrete crossing panels were estimated to cost $1,000 per linear foot and that the crossings will extend one foot past the width of the existing roadway on either side. Other than dirt road crossings, all roads would get crossing arms estimated to cost $250,000 per crossing.

In both roadway overpasses and at-grade crossings, it was assumed that the roadway would have to be reconstructed a certain distance from the railroad. The county and private roads were reconstructed for 50 feet on either side, FM roads were reconstructed for 100 feet and major roadways were reconstructed for 1,000 feet. The full break down of all the rail crossing calculations are shown in Appendix 1.

Railroad Infrastructure: Railroad infrastructure costs are all inclusive of everything to build the rail from the sub-ballast up. This includes, but is not limited to the, ballast, rail, track and turnouts.

Fences and Signs: A single unit cost was developed for fences and signs based on other proposed rail projects. This unit cost was applied along the parameters of the proposed new rail line.

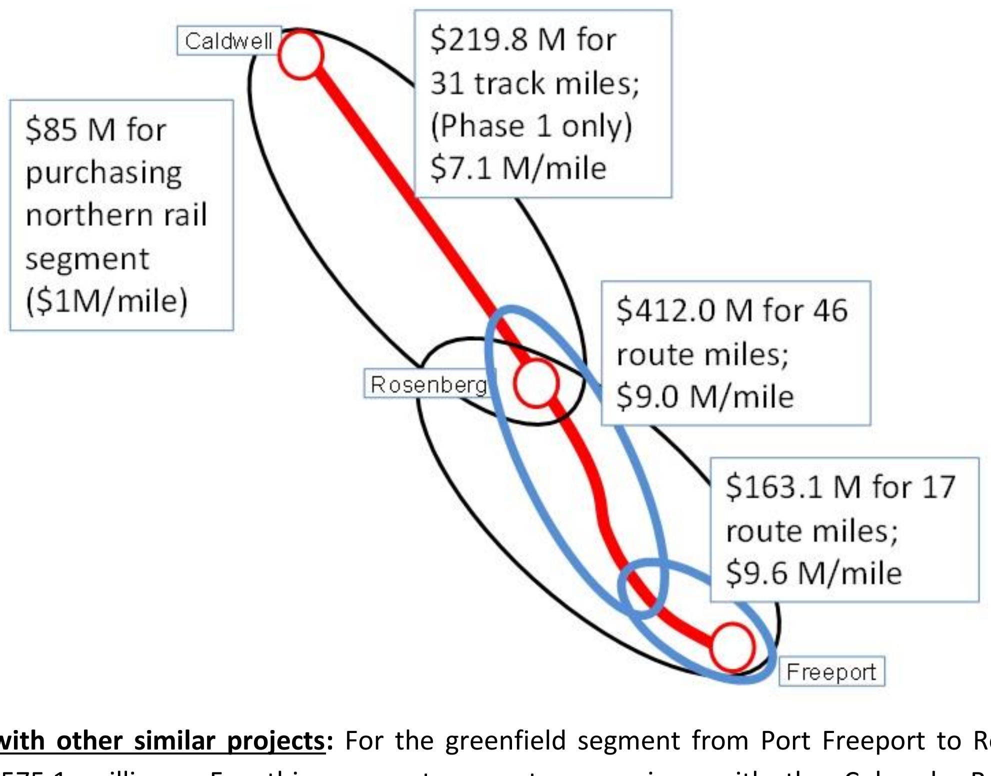
Signals: Signals along the main line and at all rail diamond interchanges and turnouts were included in the cost of this feasibility study. This was also calculated based on a unit cost methodology along the proposed new rail line.

Final Railroad Construction Cost: A railroad construction cost was developed for the three segments specified earlier in this section and are summarized in Exhibit 589. A detailed cost breakdown of each segment can be found in Appendix 1.

In addition, a placeholder cost of $1 million per mile has been assumed as a cost for purchasing the BNSF rail line from Rosenberg to Caldwell. The $1 Million a mile estimate recognizes that the existing rail asset has value and ensures that the current feasibility study provides a placeholder for compensating BNSF in the future.

However, it should be noted that the terms of access to this rail corridor, are as of yet, not negotiated and unfunded. The actual amounts will be determined in future phases of work. With the assumed $85 million placeholder, the overall project cost is $879.9 million. This has been used to in cash flow analysis in Chapter 7, although it is treated separately from the Engineering costs here.

Exhibit 5-8: Projected Costs for Freeport to Caldwell



Comparison with other similar projects: For the greenfield segment from Port Freeport to Rosenberg, the costs total $575.1 million. For this segment, a cost comparison with the Colorado Rail Relocation Implementation Study (R2C2) was developed. This is an important benchmark since both the BNSF and UP railroads heavily participated in this 2008 study and in development of the costs. For the purpose of this comparison, the 2008 R2C2 unit costs were adjusted for inflation to 2015 dollars. The results are shown in

Exhibit 5-9 and illustrates the current project costs per mile. These comparisons will be further developed in subsequent sections of this chapter.

Exhibit 5-9: R2C2 Benchmark Comparison

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: PORT FREEPORT TO ROSENBERG (63 MILES)				R2C2 ALIGNMENT B (180 MILES)		
	COST CATEGORY	TOTAL COST	PRICE PER MILE (2015 $$)	TOTAL COST (2008 $$)	PRICE PER MILE (2008 $$)	PRICE PER MILE (2015 $$)
1	RIGHT OF WAY	$ 16,600,000	$ 260,000	$ 12,000,000	$ 70,000	$ 76,000
2	GRADING	$ 120,290,000	$ 1,910,000	$ 317,000,000	$ 1,760,000	$ 1,910,000
3	UTILITIES/GRADE SEPARATIONS	$ 91,700,000	$ 1,460,000	$ 60,000,000	$ 330,000	$ 358,000
4	RAIL CROSSINGS/DRAINAGE STRUCTURES	$ 25,480,000	$ 400,000	$ 31,000,000	$ 170,000	$ 184,000
5	TRACKWORK	$ 79,500,000	$ 1,260,000	$ 232,000,000	$ 1,290,000	$ 1,400,000
6	FENCES AND SIGNS	$ 5,063,000	$ 80,000	$ 10,000,000	$ 60,000	$ 65,000
7	SIGNAL AND COMMUNICATIONS	$ 28,500,000	$ 450,000	$ 123,000,000	$ 680,000	$ 738,000
8	AT-GRADE CROSSINGS	$ 12,600,000	$ 200,000	$ 7,000,000	$ 40,000	$ 43,000
9	OTHER COST ITEMS	$ 195,300,000	$ 3,100,000	$ 396,000,000	$ 2,200,000	$ 2,387,000
	TOTAL:	**$ 575,033,000**	**$ 9,120,000**	**$ 1,188,000,000**	**$ 6,600,000**	**$ 7,162,000.00**

Overall, the proposed railroad construction cost fell right in line with the R2C2 construction cost, with the exception of utilities. Given the area for the R2C2 railroad does not have as many pipelines, the cost for this project traversing the southeast Texas region is higher.

Chapter 6. Traffic and Revenue Assessment

Based on the target market area, preliminary market assessment and infrastructure strategies proposed in previous Chapters a quantitative assessment of the market and forecast traffic potential will be developed. This will form the basis of the financial and economic assessment to be conducted for the proposed rail improvements.

6.1 Key Assumptions

After the expansion of the Panama Canal, Port Freeport will be able to attract a substantial volume of Asian/Panama Canal and European/Suez Canal traffic. This is due to the global shipping industry's move towards larger ships. As a result, because of its deep shipping channel as well as its close proximity to the major Houston and DFW markets, Port Freeport has an opportunity for developing world-class facilities. This includes:

1. Docks, cranes, gates, storage yards, and on-dock rail facilities. Port Freeport will be responsible for developing these facilities.
2. Dedicated intermodal yards at inland points, particularly Dallas, Fort Worth and San Antonio, which are presumed to operate under the direct control of the Port, in a coordinated manner for supporting the needs of the Port. Port Freeport will be responsible for developing these facilities either as new infrastructure, or by contracting with the freight railroads to provide ramp capacity.
3. An integrated Hub at Rosenberg for effective distribution into the west and north sides of Houston.
4. An efficient inland rail connection for linking Freeport to Dallas, Fort Worth, San Antonio and Rosenberg that will also support the goal of avoiding the congested downtown Houston rail network.

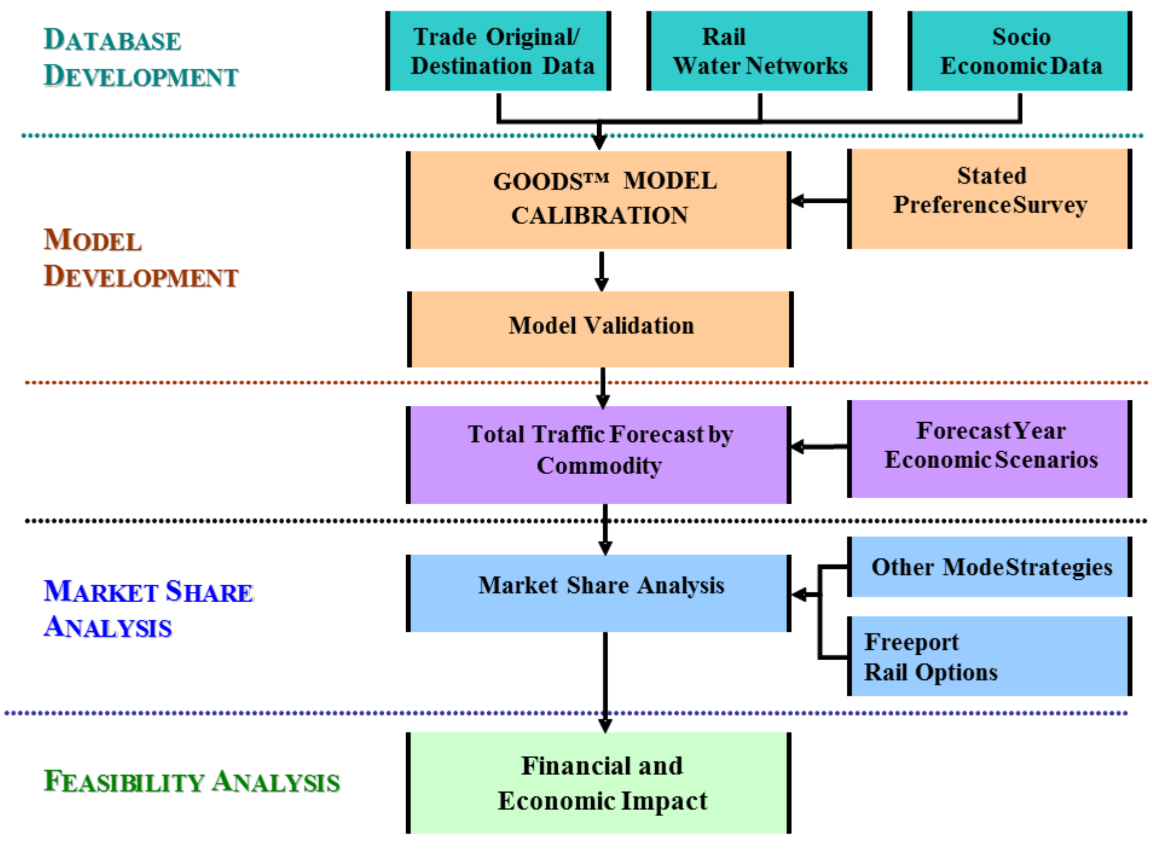
The traffic and revenue forecasts developed here assume that inland ports have been set up in Dallas, Fort Worth and San Antonio which also provide rail connectivity to the national intermodal rail network. Based on this, the focus of this chapter will be on developing a specific traffic and revenue assessment for the proposed intermodal rail system. This study has developed a feasibility-level assessment based on models that TEMS developed for previous USDOT MARAD, Army Corps and Panama Canal studies. These will be sufficient for a feasibility-level assessment of market potential, but a more detailed investment grade study will need to be completed to develop a more accurate estimate.

6.2 The GOODS™ Modeling Framework

TEMS GOODS™ modeling framework is designed to support the analysis of freight traffic flows at the national, regional and urban levels. The level of specificity of the model results depends on the level of aggregation of the traffic flow data, zone systems and networks. A major focus of this study has been to update the traffic data and make the zone systems and networks more specific so that the model could effectively be refined from the national to the regional levels.

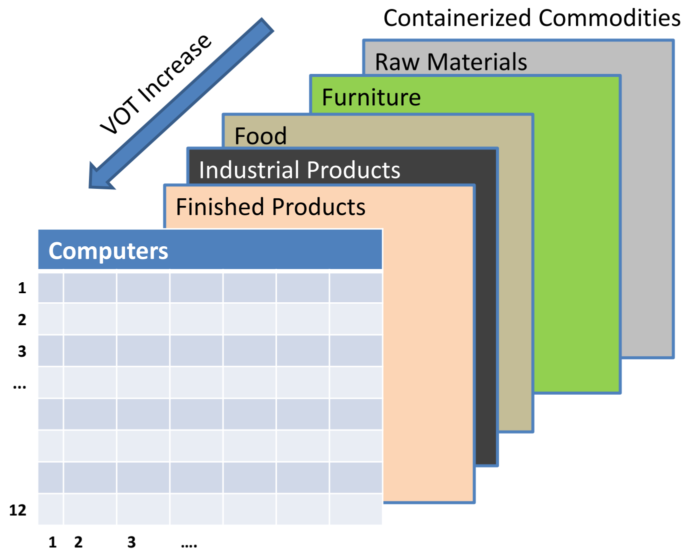
The GOODS™ model uses data on current traffic flows, regional economic growth potentials, and specific industrial development proposals to develop total freight traffic flows and forecasts. The evaluation processes of the GOODS™ model includes both financial and economic analyses that identify the commercial potential of new transportation infrastructure, as well as the economic benefits to users and surrounding communities, as shown in Exhibit 6-1.

Exhibit 6-1: GOODS™ Model Structure



As in the previous Concept study, the traffic database in this study has been disaggregated into six commodity groups based on differentiated Value of Time characteristics. Shippers of these six types of goods behave differently in making route choice tradeoffs. For example, computers are the highest value commodity and also the most likely to stay on its current West Coast port routing. Raw Materials tend to be heavier and less time sensitive, so they are more likely to flow over more cost effective but slower routes, such as the Panama Canal. To clarify, these breakdowns are only for containerized commodities -- bulk goods and Ro/Ro traffic are treated by completely separate models which have not been used in this study. The current study focuses only on containerized traffic. See Exhibit 6-2.

Exhibit 6-2: Containerized Commodity Disaggregation



In line with Discrete Choice Theory[131], Generalized Costs are used in GOODS™ to estimate the impact of changes in the transportation system.

$$GC_{ijmp} = TT_{ijm} + \frac{TC_{ijmp}}{VOT_{mp}} + Other\ Factors$$

Where:

TT_{ijm} = Travel Time (in minutes) between zones i and j for mode m

TC_{ijmp} = Travel Cost between zones i and j for mode m and commodity p

VOT_{mp} = Value of Time for mode m and commodity p

GOODS™ also includes a Total Demand model that forecasts the growth in traffic in future years, reflecting the impacts both of changing demographics as well as transportation supply and demand conditions.

$$T_{ijp} = e^{\beta 0p}(SE_{ijp})^{\beta 1p} e^{\beta 2p\, U_{ijp}}$$

Where:

T_{ijp} = Number of trips between zones i and j for commodity p

SE_{ijp} = Socioeconomic variables for zones i and j for trip commodity p

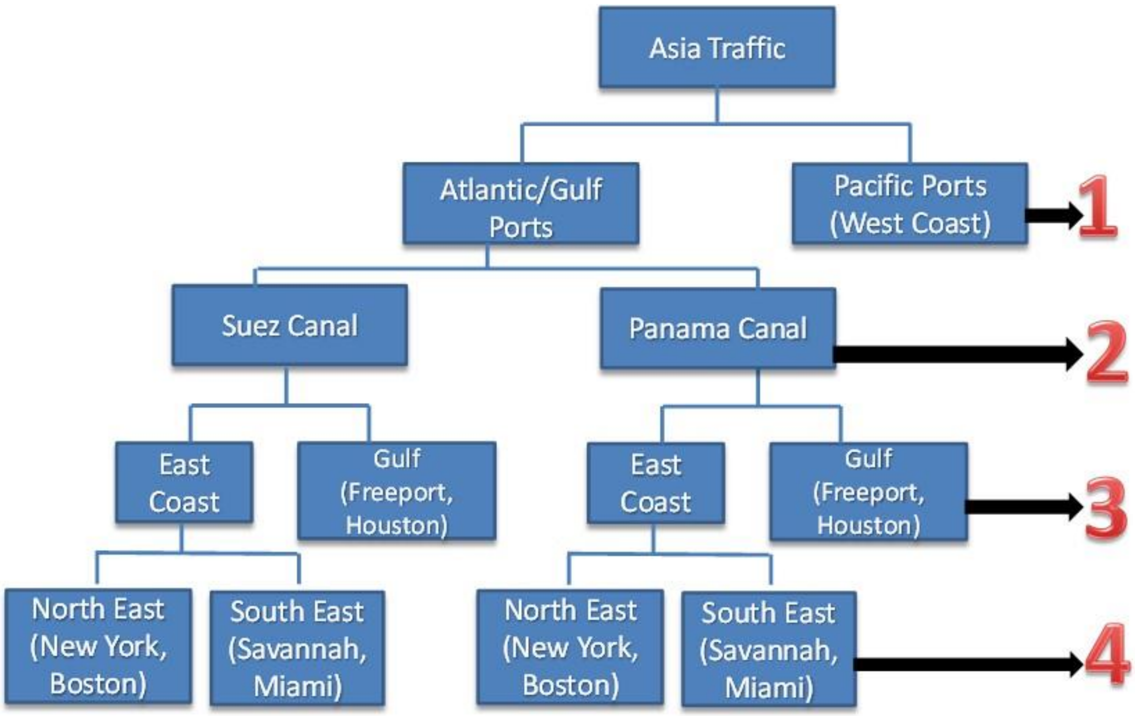
U_{ijp}= Total utility of the transportation system zones i to j for commodity p

$\beta_{0p}, \beta_{1p}, \beta_{2p}$ = Coefficients for commodity p

[131] M. Ben-Akira and S. Lerman: Discrete Choice Analysis: Theory and Applications to Travel Demand, MIT Press, 1985

The GOODS™ decision-choice framework utilizes a hierarchical structure which is intended to model the process by which shippers and carriers actually make routing decisions. Exhibit 6-3 shows the structure of the model that was used in this study for routing Asian traffic. Similar models were used for European and South American traffic.

Exhibit 6-3: Asia Decision Choice Model



US Zones and Inland Network Update

To model decision choices, the equations are individually calibrated at each layer of the model based on the transportation network and observed (actual) modal split behavior associated with each of the six commodity groups. Each market uses a hierarchical structure appropriate to the decisions being made. For example the Europe model treats the Suez and Panama Canals differently, and the South American models both include New Orleans as well as Houston as a competitive choice.

In addition to a network of vessel strings and services, the TEMS database also includes a comprehensive network of rail lines and services upon which the rail intermodal analysis is based. These schedules were compiled and updated from the published timetables of rail carrier schedules, based on the railroad carriers' web sites. The internal US rail distribution network was expanded massively as compared to the earlier 2006 model that was used in the earlier Concept study. For example, the network from the former concept study had 11 zones, 117 links and 97 nodes. The new network however, has 131 zones, 1,155 links and 431 nodes which reflects almost an order of magnitude more precision. This adds enough detail into the model so it can make regional as well as national traffic forecasts. See Exhibits 6-4 and 6-5.

Exhibit 6-4: Concept vs. Feasibility Study, Zone Systems

CONCEPT STUDY:

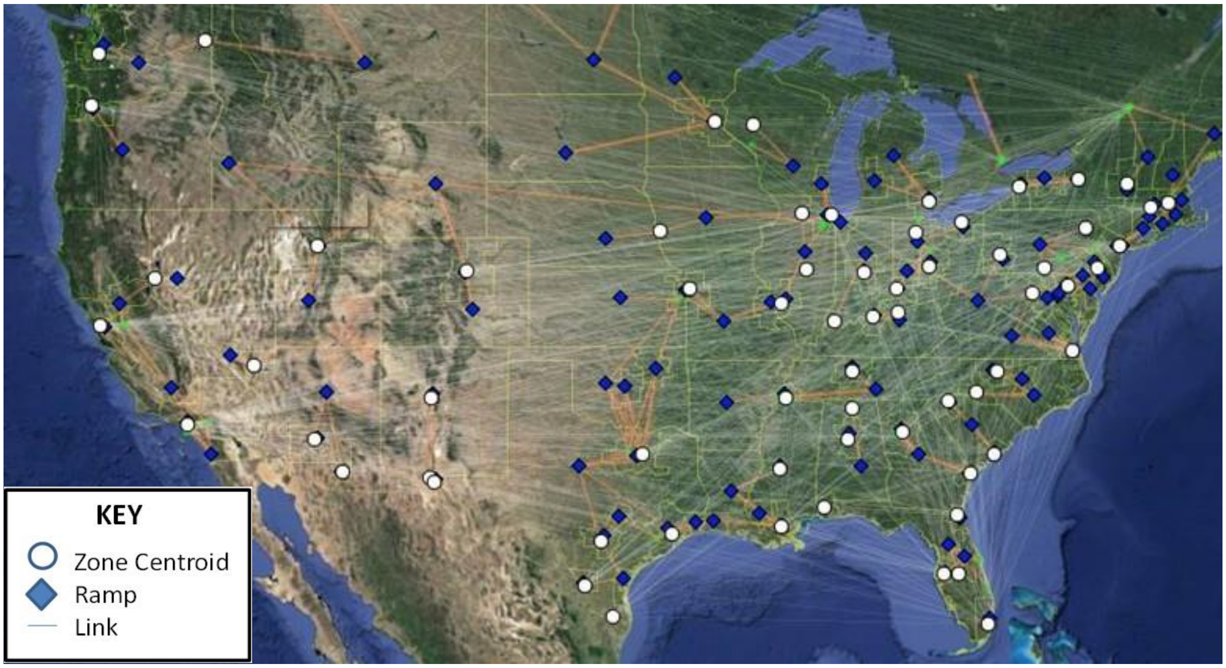
11 US ZONES

FEASIBILITY STUDY:

131 US ZONES

(FAF-3)

Exhibit 6-5: Feasibility Study Rail Network



International and OD Traffic Data Update

TEMS converted the Panama Canal Demand Model from 2006 US Inland Trade Monitor (USITM) to 2014 PIERS data. USITM is no longer produced. IHS (Global Insight) who had produced USITM, acquired the Journal of Commerce group in December 2014 -- so IHS now owns and produces PIERS.

- USITM was based on US Census data and the inland distribution from ports was developed based on statistical attribution.
    - Census publishes Origin Country + US Port, or Origin County + Destination State. Census does not publish Origin Country + US Port + Destination State all together, which is what we need.
    - The level of publication of Census data is limited by law to protect confidentiality.
- By comparison, PIERS directly collects all needed data by direct survey. PIERS includes Origin Country + Origin Port + US Port + Destination City + Destination State

However, TEMS cross checked PIERS versus the US Census data versus PIERS for consistency. While PIERS data is authoritative and is been extracted from the same data files that are supplied to the Census, some shippers have chosen to “opt out” and suppress certain data from being sent to PIERS. As a result, some inland city/state destination reporting is missing. TEMS matched PIERS data back to Census and post processed the records that were missing destination data, to bring the result closer to the US Census totals and reconcile the two data sets. The result of this post-processing are summarized in Exhibit 6-6 and show that the dataset used in GOODS™ effectively reconciles the differences between PIERS and CENSUS data.

Exhibit 6-6: Three Way Comparison – PIERS, Census, Corrected PIERS Metric Tonnage

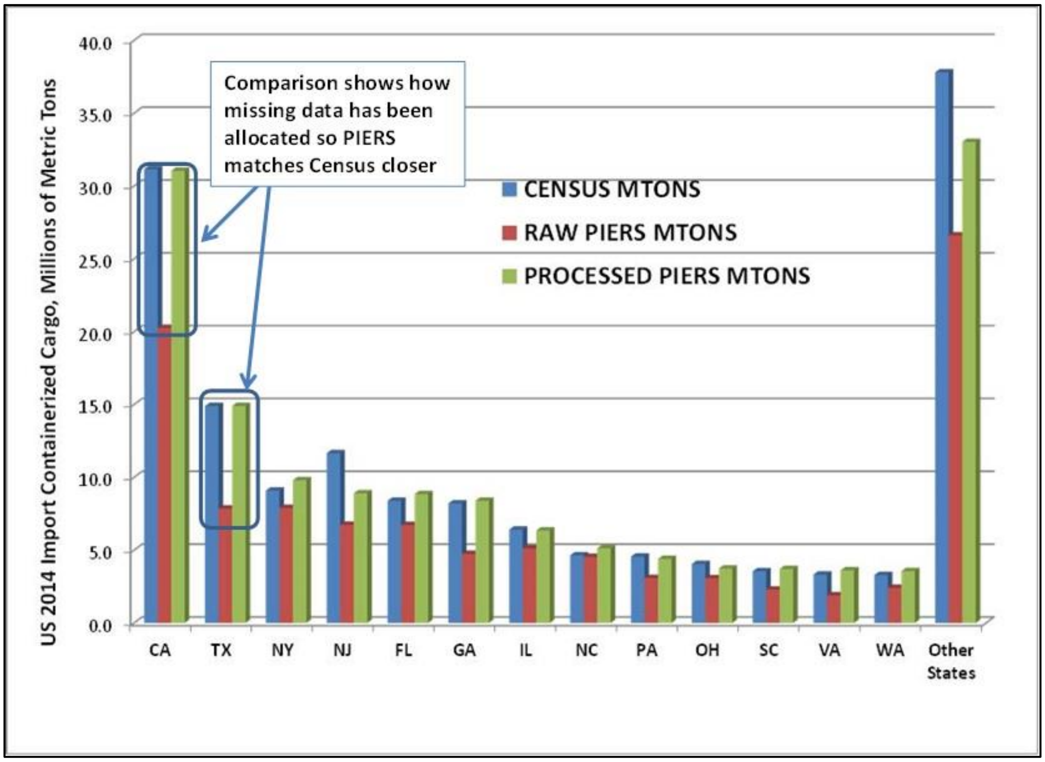
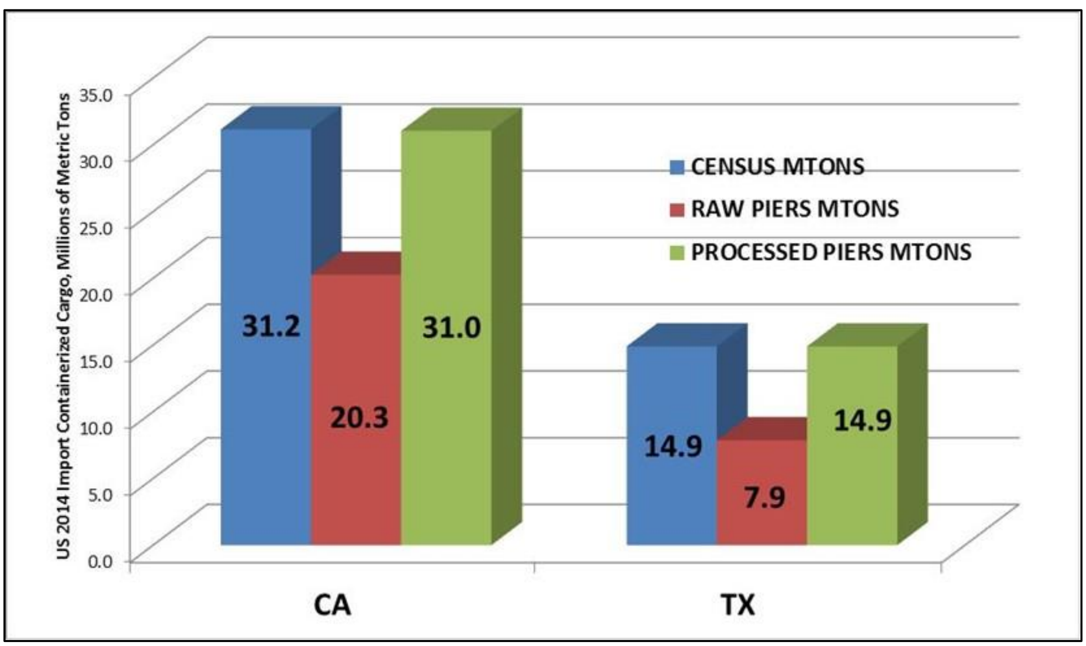


Exhibit 6-7 shows a zoomed view of Exhibit 6-6 that shows only the two highest states in terms of terminating containerized tonnage: California and Texas. The result shows that the Texas market is #2 ranked only behind California. If New York and New Jersey were combined then Texas would rank #3. Illinois is much smaller than might be expected. This is due to Chicago's main role as a rail transfer point rather than as an intermodal logistics center.

Exhibit 6-7: California vs Texas Comparison – PIERS, Census, Corrected PIERS Metric Tonnage



Marine Network Update

The marine network update reflects the ocean carrier changes since 2006. Significant changes that have occurred since then include: bigger ships; longer port loading and unloading times; and slow sailing. These changes have resulted in longer transit times but lower overall shipping costs. There are structural changes in the vessel service network that are expected to be permanent.

Additionally, a number of transitional issues have affected the vessel schedules and operating patterns. These include: Suez vs. Panama Canal development; readiness of individual ports; and wide and unpredictable fuel cost fluctuations that have occurred since 2006, but which have affected the evolution and development of the ocean container network. There are transient changes in the vessel service network that are expected to be temporary and likely to further adjust in the future.

Summarizing the impact of these changes on Asian Container schedules, as compared to 2006:

- **Pacific Ocean Direct**
  - Via California: Some schedules were slightly faster, most slower; Average 9% longer time
  - Via Pacific Northwest: None faster; Average 33% longer time
- **Panama Canal Services**
  - To the Gulf: Same time as before, no change
  - To the Southeast: Some slightly faster, most slower; Average 11% longer time
  - To the Northeast: None faster; Average 14% longer time
- **Suez Canal Services:**
  - To the Gulf: All direct services discontinued, transfer via Hub Port
  - To the Southeast: Some slightly faster, some slower; Average same as before, no change
  - To the Northeast: Most faster, some slower; Average 4% faster time

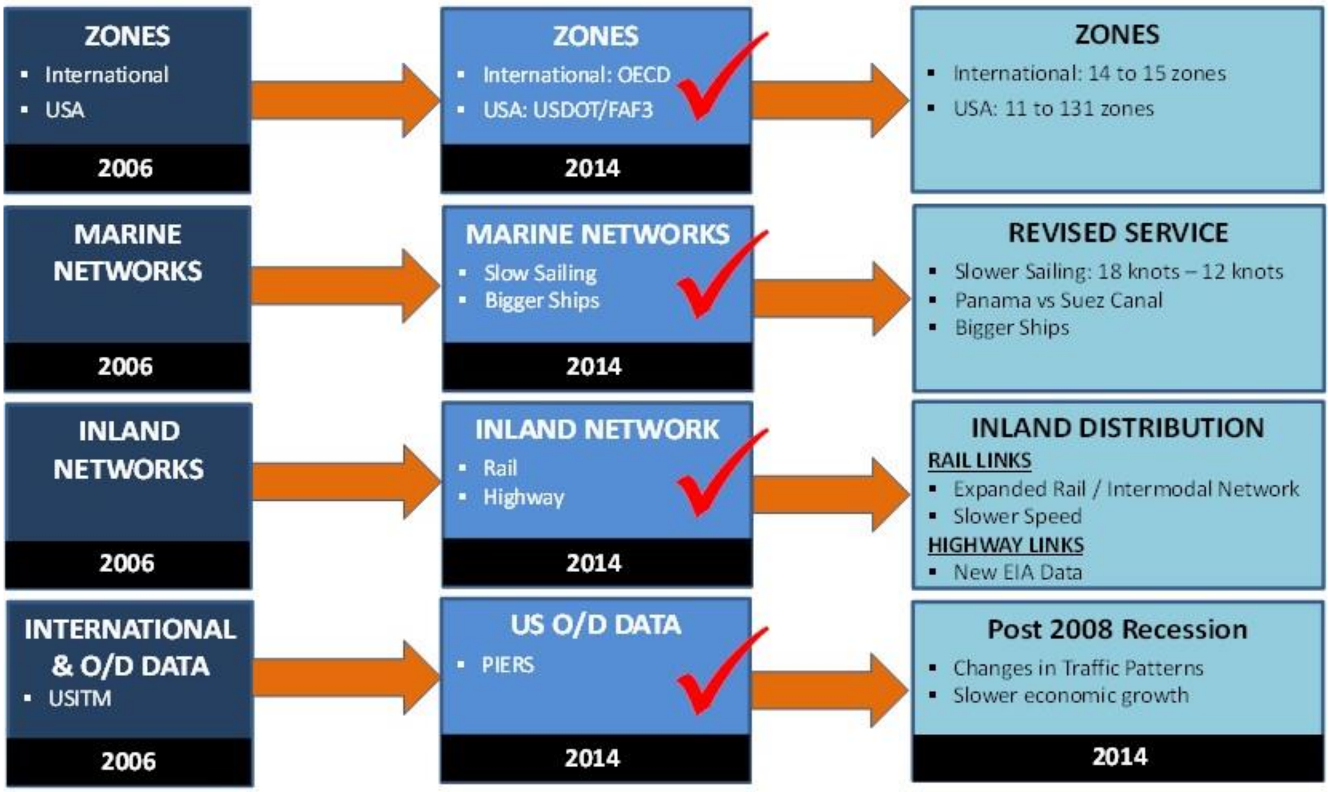
In summary, slow sailing has resulted in an overall decrease of speed, hurting Pacific Northwest ports the most; but the Gulf coast services via the Panama Canal have hardly been affected. It is apparent that the Ocean carriers have made an effort to make the Suez Routing to the US East Coast competitive, since this is the only lane in which vessel schedules have reduced. However, the Gulf Coast has not been a player in Suez shipping. It has lost direct vessel service via the Suez, while large Suez vessel routes are mostly dropping their Texas cargoes in New York and Savannah. However, this Texas cargo will likely return to the Gulf Coast once Freeport can take large ships via the Panama Canal.

Reducing maritime costs while slowing speed will only reinforce the predicted shift of lower valued commodities away from the West Coast and towards the Gulf and East Coasts, once the Panama Canal expansion opens next year. This will make all-water shipping more attractive to low value commodities like Furniture and less attractive to high valued commodities like Computers. Instead of competing head-to-head for the same traffic, shipping options are being differentiated to better match the needs of specific market segments. This will tend to reinforce the commodity based route choice where high value commodities favor the west coast, and lower valued commodities tend to take all-water routes to the Gulf and East Coast ports.

Summary of Model Improvements

Exhibit 6-8 summarizes all the key improvements that were made to the Panama Canal model for updating it to a current 2014 traffic data set. The exhibit shows the four key areas of improvement were in implementing a much finer and more detailed zone system; reflecting recent updates and changes to the marine networks, refining the inland rail network to support the expanded US zone system; and updating the former 2006 USITM data to use PIERS 2014.

Exhibit 6-8: California vs Texas Comparison – PIERS, Census, Corrected PIERS Metric Tonnage



6.3 The Freeport "Full-Build" Case

This considers what is likely to happen if Port Freeport is fully developed as a coastal container terminal. Developing the port will require inland rail and highway transportation infrastructure to efficiently distribute the containers that would be coming into and out of the port. The resulting expanded port service areas are shown in Exhibits 6-9 and 6-10.

- This analysis assumes that cost effective intermodal links will be developed in conjunction with the port wherever traffic volumes warrant: most particularly, rail links and inland ports serving the key market areas of Dallas, Fort Worth, and San Antonio.

- Additionally, intermodal linkages to maintain connectivity between Freeport and the traditional Houston Ship Channel area (e.g. Barbour's Cut) should be considered along with links to Texas coastal ports (Corpus Christi, Brownsville, and Beaumont.)

Because of the ability to handle large ships at Freeport, Exhibits 6-9 and 6-10 show that Houston and Freeport by working together can successfully push back against both east and west coast port competition. What emerges is a large core hinterland area in the heart of the North American continent where Freeport will have a clear ***cost advantage*** and should be able to capture significant market share. Beyond this core lies an expanded service area (dashed outline) where Freeport will have ***close cost parity*** with other ports and should therefore be able to capture some market share. Particularly in the expanded cost parity zone it is currently difficult to predict the level of market penetration that Freeport will be able to achieve, but the value of supply chain diversification is a solid marketing argument that Freeport most likely would be able to sell[132] too many shippers and consignees within this expanded area. The potential impact of this on Freeport volumes should be assessed in a future more detailed study.

The hinterland analysis shows that with a deeper channel, Port Freeport has a huge potential to attract Asian container volumes. As shown in Exhibit 6-9, the Asian hinterland market potential in 2014 is between 1.5 and 2.7 million annual TEU's[133], of which it reasonable on a cost competitive basis to conclude that Freeport is actually likely to capture something like a 40% market share. This results in a forecast range of 0.6 to 1.1 million Asian import TEU's per year.

It is also assumed that Freeport would be able to capture in the neighborhood of 0.4 million TEU's per year from the European market once larger ships are deployed in those lanes. As a result Freeport would be handling approximately 1.1 million loaded import TEUS's per year. Because of the rapid demographic growth in the State of Texas, these volumes will grow rapidly over time and support the economics of even larger ships.

[132] For example, Kansas City and St Louis today are almost solely dependent on West Coast ports for their Asian imports, so that places those key gateways in the unfortunate position of vulnerability to supply chain disruptions. With large vessel service, however a routing to Kansas City or St. Louis via Freeport would be cost competitive even though it may take a day or two longer than coming via a West Coast port. This however, may be an acceptable tradeoff for shippers who would be asked to route a certain percentage of their traffic via Freeport in order to maintain a competitive shipping alternative. See: http://www.inboundlogistics.com/cms/article/panama-canal-more-questions-than-answers/ Many shippers would likely accept this argument.

[133] By comparison to Exhibit 5-7, the Asian container market potential is seen to dwarf the European container traffic, which has been historically the main focus of the Houston port.

Exhibit 6-9: "Full Build" 2014 Large Ship Freeport Hinterland from Asia[134]

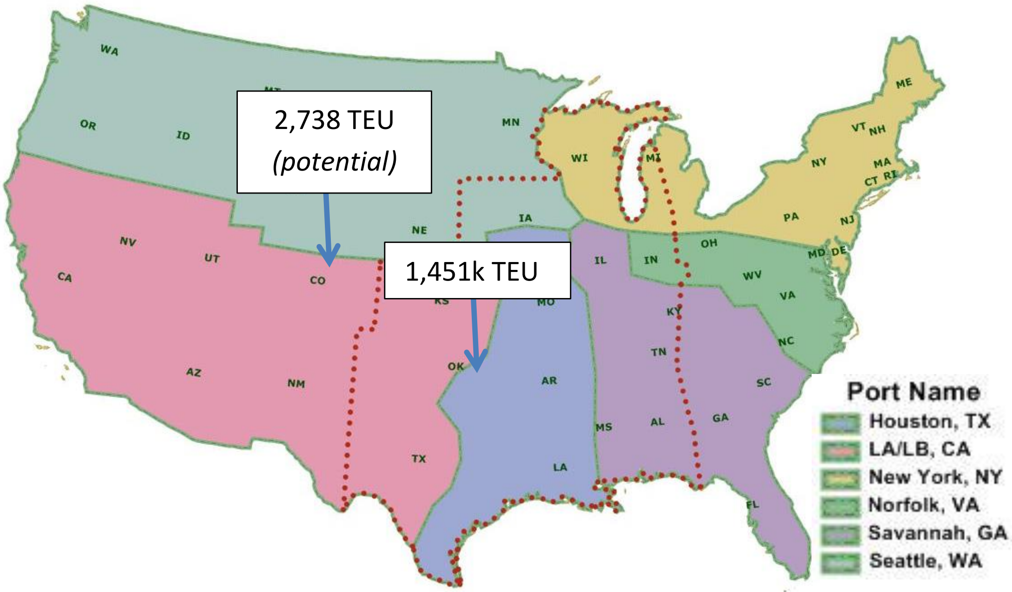
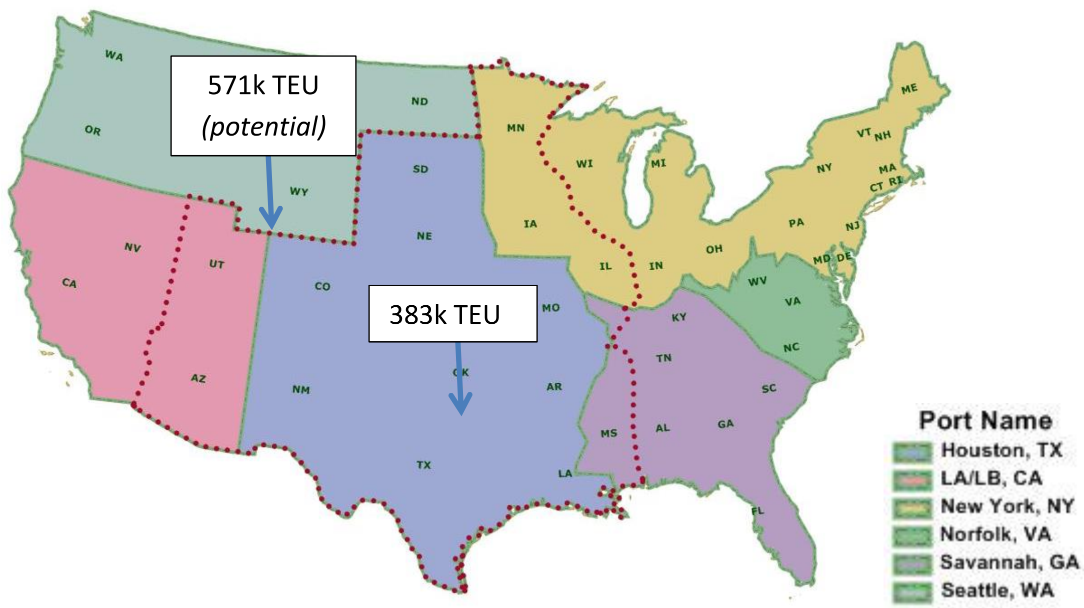


Exhibit 6-10: "Full Build" 2014 Large Ship Freeport Hinterland from Europe and Suez[135]



[134] Large Ships (2¢/TEU mile) to West Coast, Large Ships (2¢/TEU mile) to Freeport, Large Ships (2¢/TEU mile) to East Coast, Rail Intermodal (12¢/TEU mile). "Core" Houston area shows cost advantage. "Buffer" area (dashed line) shows expanded region of approximate cost parity.

[135] Same assumptions as before: Large Ships (2¢/TEU mile) to West Coast, Large Ships (2¢/TEU mile) to Freeport, Large Ships (2¢/TEU mile) to East Coast, Rail Intermodal (12¢/TEU mile). "Core" Houston area shows cost advantage. "Buffer" area (dashed line) shows expanded region of approximate cost parity. Note that Freeport has an even stronger position in Asian Suez traffic than it does in Asian traffic that is routed via the Panama Canal. Assuming the use of Panama therefore results in a more conservative forecast for Freeport potential traffic volumes.

For Asian traffic via the Panama Canal (Exhibit 6-9) the port service area will expand to include San Antonio, Dallas and Fort Worth (but not El Paso) -- and also north to include large areas of Oklahoma, Arkansas and Missouri. Based on the economics of large ships via the Panama Canal, Port Freeport will have cost dominance for distribution into this area. Beyond this into the expanded "potential" market area where Freeport will have cost parity with other ports, it is possible that Freeport could capture some market share as far north as Chicago and as far east as Atlanta.

For European and Asian Suez Canal traffic (Exhibit 6-10) the port service area is even larger, and shifted slightly towards the west. Although the market area for European goods covers the whole State of Texas as well several neighboring states the overall size of the European market today is much smaller compared to the amount of traffic that is potentially available from Asia and these goods tend to be higher valued. To the extent that more traffic develops from Asia via the Suez Canal, this will only improve Texas ports market position.

Exhibit 6-11 summarizes the results of the GOODS™ model forecasts for the base year 2014 and forecast year 2035. The model projects that if the full system including Panama Canal expansion were open today, Port Freeport and Houston would carry a volume slightly exceeding 1.1 million TEU. By 2035 this would grow to 3.2 million TEUs.'

Exhibit 6-11: 2014 and 2035 Freeport Forecast Summary

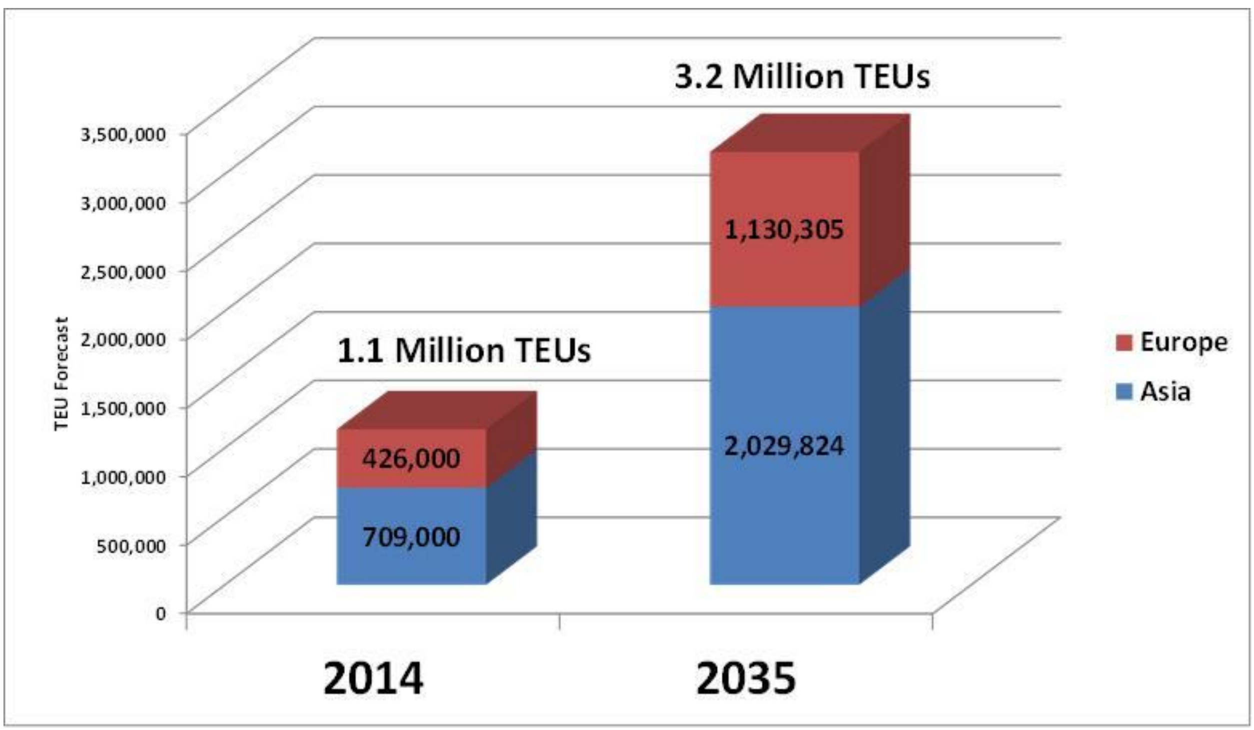


Exhibit 6-12 gives a detailed breakdown of the base year 2014 estimate. Between one quarter and one third of the TEUs would continue on to Houston and the balance would be unloaded at Freeport. They would be forwarded either to Rosenberg, San Antonio, Dallas or Fort Worth. An approximate 50/50 traffic split between UP Dallas and BNSF Fort Worth hubs is assumed. Projected container volumes would be sufficient to operate 1 train per day to San Antonio; 2 trains to Alliance (Fort Worth), and 2 trains to Wilmer (Dallas) each day. In addition one round trip short-haul move from Freeport to Rosenberg might be able to operate, although trucking may also be a very strong contender for this traffic as well.

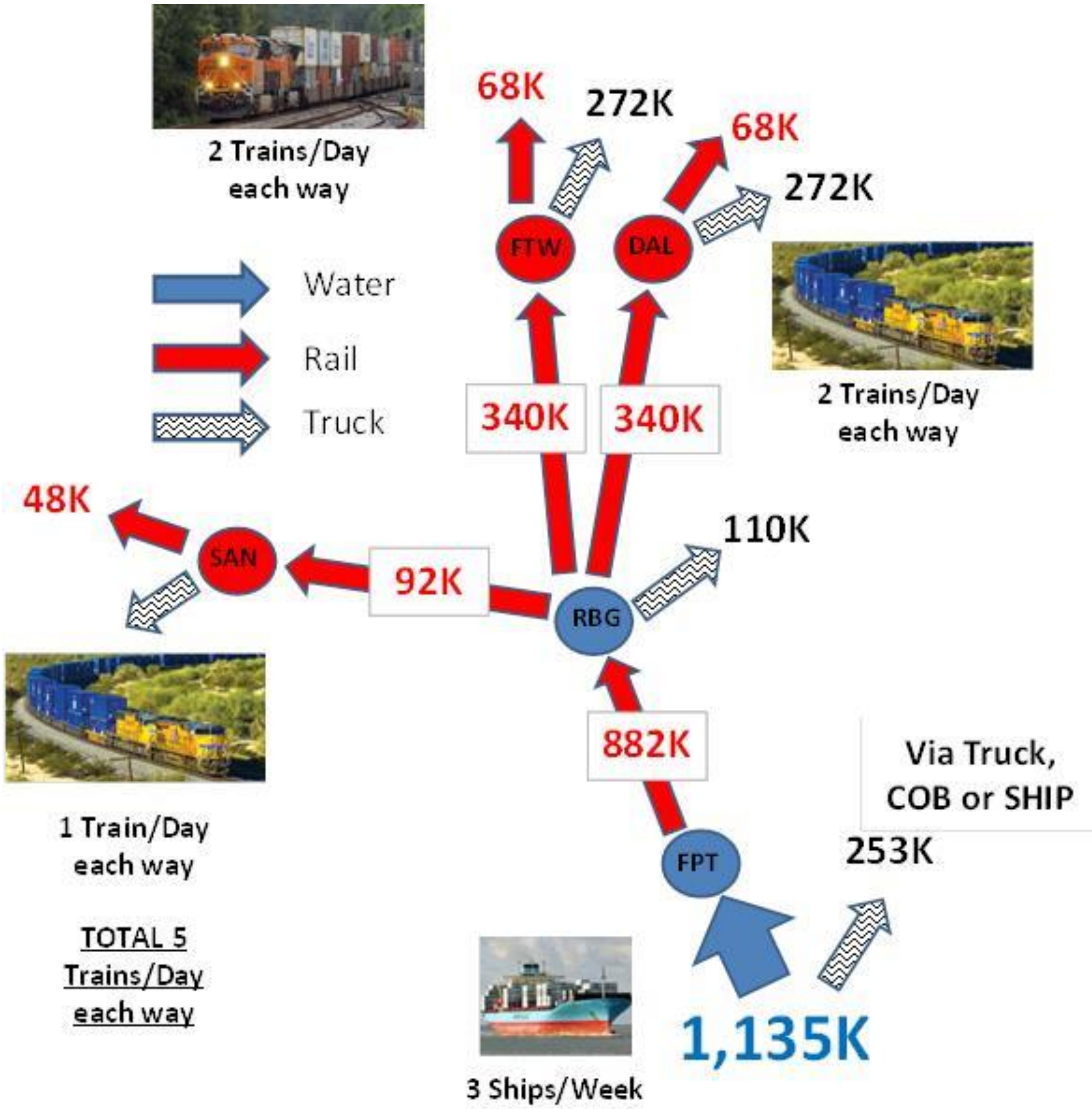
Dallas/Fort Worth logistics centers serve an extended market area even beyond Texas extending all the way to Kansas, Missouri and the Mississippi River. Ocean containers are brought by rail into these logistics centers and repacked for final delivery by truck. PIERS data shows a great deal of market concentration at the Houston and DFW hubs and not many ocean containers moving far beyond the metropolitan areas. As a result it is expected that the majority of containers would move out of the three inland ports by truck.

Please note that the Freeport will serve largely as a transshipment port and that half to two-thirds of the boxes arriving at Freeport will be forwarded by the rail system. This is not an unreasonable number by comparison to other existing ports:

- In 2006, California State GDP was $1.87 Billion so California residents are estimated to actually consume 2.24 Million TEU.[136] During that same time period, the port of Los Angeles/Long Beach imported 8.10 million TEUS, so local consumption can account at most for 28% of the port's throughput. The Alameda Corridor itself captures fewer than half the Port's containers, but many containers go out the gate by truck for transloading. Many transloaded goods reappear at the downtown Los Angeles rail ramps as domestic loads. Including these volumes (that are in fact transloaded but not locally produced), it is not unreasonable to suggest that as much as 72% of the Los Angeles/Long Beach port traffic ultimately moves beyond California, mostly by rail.
- The situation is even more pronounced in the Pacific Northwest and Canadian ports that are gateways for major population centers in the Midwest and eastern Canada, but don't have large local populations that generate cargo the way Los Angeles-Long Beach or Oakland do. It has been estimated that at least 50 to 70 percent of their inbound cargo moves on to eastern destinations.[137]
- Speed and reliability are the advantages Prince Rupert builds on to keep its existing customers and attract new services, said Shaun Stevenson, vice president of marketing and business development. Prince Rupert is located 500 miles north of Vancouver. Virtually all of its inbound cargo leaves the port by rail, so the efficient transfer of intermodal containers from vessels to trains at the port's on-dock rail yard is crucial to its success.

[136] The regression relationship between 1997-2007 US national Imports and GDPs is Imports (millions)=1.200386*GDP (billions).
[137] See: http://www.joc.com/port-news/pnw-ports-building-reliability_20120518.html

Exhibit 6-12: 2015 Freeport Forecast Detail



As such, the projected high rail share of traffic at Freeport is in-line with West Coast port experience. The rail share at Los Angeles only *appears* to be lower because of the high share of ocean containers that are being transloaded to domestic boxes.

Asian and European service will provide enough "base volume" at Freeport to support development of dedicated rail connections to Dallas, Fort Worth and San Antonio. While Caribbean or South American services do not provide enough traffic to support a dedicated rail service, they could ride as incremental volume. For example, Chiquita's Great White Fleet already brings about 60,000 containers a year into

Freeport from the Caribbean and South America.[138,139] As a time sensitive and perishable cargo, bananas and other fruits are currently trucked from Freeport – no bananas moved by rail in 2014 in the United States.[140] Refrigerated containers can and do move by double-stack trains using self-contained diesel power units[141] but Chiquita's refrigerated ocean containers need external electric power supply. The CN however has announced that they are adding on board power generation on board some stack trains that would enable Chiquita's containers to be carried.[142] Chiquita has in the past expressed interest in shipping bananas by rail[143] so possibly they may be interested in utilizing the proposed rail intermodal services out of Freeport as well.

While it is expected that Houston will hold onto most of its current Caribbean and South American traffic, Freeport's proposed on-dock intermodal connections would be directly competitive to New Orleans in the Caribbean and South American trades. This is not a major component of the forecasted traffic base, so it can be further assessed in a future study.

6.4 Carload Traffic Forecasts

In addition to intermodal container traffic, Freeport also has a base of existing carload traffic. Most of this is related to petrochemical industrial customers in the Freeport area. The previous Concept Study roughly estimated this traffic potential, as well as the volumes likely carried on the Angleton Subdivision. While this carload traffic may potentially utilize the proposed new rail system in whole or in part, at present none of it is included in the financial projections for the new rail system. This is because the current estimates for carload traffic are too approximate, and the railroads have not yet told the study team that they are interested in routing any of the carload traffic over the proposed new rail lines. The following sections however, will recap the logic of the earlier Concept study that did develop an estimate for the carload traffic potential.

Although we do not have exact figures on the number of carloads at Freeport, Exhibits 6-13 and 6-14 allow a rough estimation of this level of traffic based on the Gross Tonnage and train count reported for the Angleton Subdivision and the branch line to Freeport.

[138] See: http://www.joc.com/port-news/us-ports/port-freeport-texas/port-freeport-expands-meet-petrochemicals-demand_20140609.html
[139] See: http://www.louisianaweekly.com/n-o-awaits-boost-in-economy-from-chaquitas-relocating/ and http://apicscharlotte.org/Resources/Documents/Chiquita%20Presentation_Charlotte%20APICS%20PDM_%2010-15-13.pdf
[140] See: http://www.csx.com/index.cfm/working-at-csx/retirees/regional-organizations/rabo/alumni-news/bananas-once-the-railroadse28099-golden-cargo-by-frank-dewey/
[141] See: http://www.truckinginfo.com/channel/fleet-management/news/story/2010/09/cr-england-introduces-double-stack-refrigerated-container-on-flatcar-service.aspx and http://www.nfiindustries.com/services/nfi-intermodal/refrigerated-container-specs
[142] CN will acquire 32 electrical generators to move 40-foot international marine refrigerator rail cars, or "reefers," to and from CN-served ports on CN intermodal trains. The power packs provide economies of scale by connecting up to 17 international marine reefers at a time, CN officials said in a press release. See: http://www.progressiverailroading.com/canadian_national/article/CN-to-expand-cold-supply-chain-capacity--44636
[143] See: http://cs.trains.com/trn/f/111/t/158289.aspx?sort=DESC

Exhibit 6-13: 2007 Gross Tonnage of Texas Rail Lines[144]

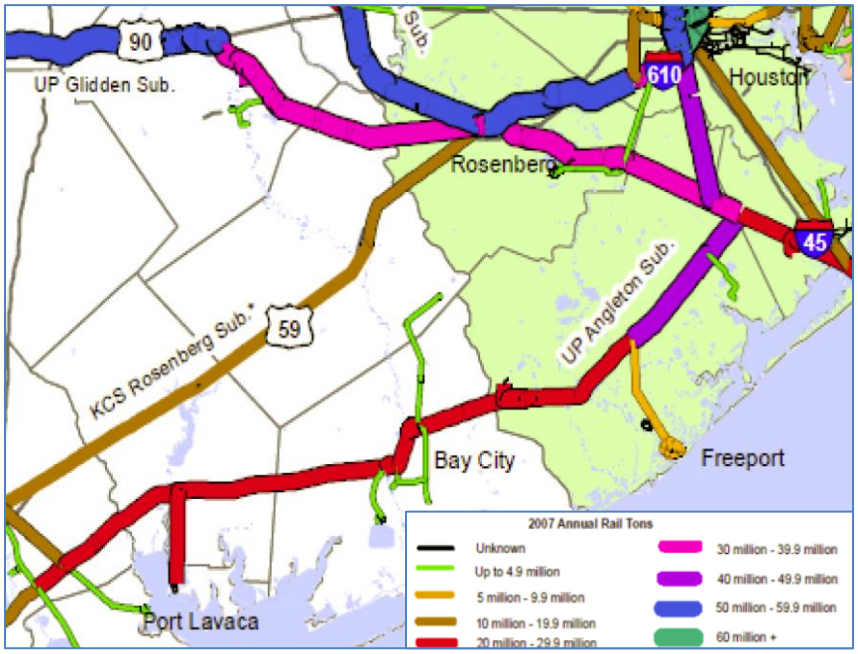
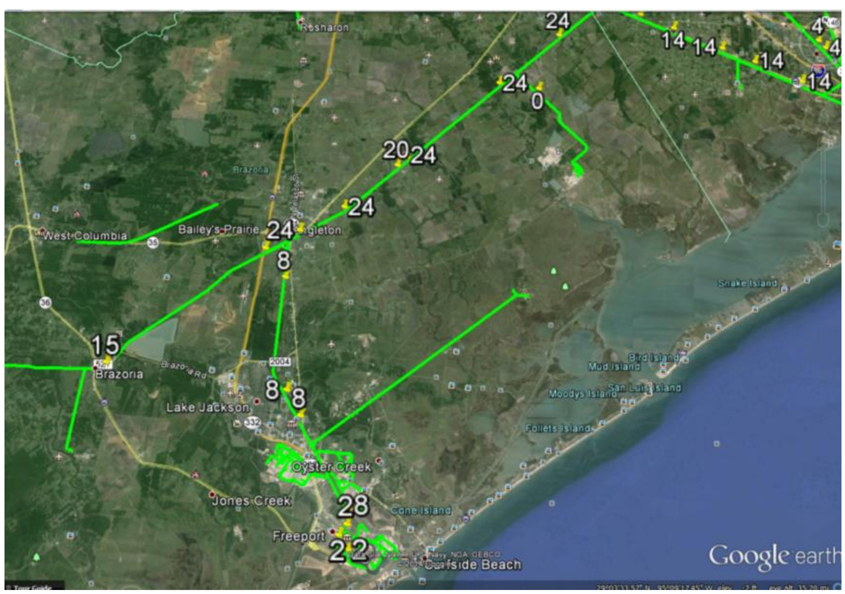


Exhibit 6-14: Train Counts from TEMS RailScape™ FRA Grade Crossing Visualization



[144] Source: Figure 3-3 on page 3-4 of the Texas State Rail Plan, based on 2007 data. See: ftp://ftp.dot.state.tx.us/pub/txdot-info/rail/plan/ch3.pdf

In Exhibit 6-13, the Freeport branch is seen to carry traffic in the 5-10 million gross ton range. But since the rail line segment north of Angleton carries 40-50 million tons, and the segment south of Angleton carries 20-30 million tons, the loading of the Freeport branch that feeds into it must be close to the high end of the range, e.g. 10 million tons. Since most railcars carry 100 tons and weigh 30 tons empty, assuming 100% empty return factor and 10% locomotive tonnage, the loaded carloads at Freeport can be converted from gross tonnage as follows:

10,000,000 Gross Tons / (100 + 30 + 30) tons per car / 1.1 loco-tons factor = 56,800 loaded cars

This would be matched with an equal number of empty railcars moving in the opposite direction. If there are 312 operating days per year, this would be an average of:

56,800 cars per direction * 2 directions / 312 days per year = 364 cars per day

The FRA grade crossing database (Exhibit 6-14) shows 8 trains daily to and from Freeport; this is 4 trains in each direction. This would be an average of:

364 cars per day / 8 trains = 46 loaded and empty cars per train

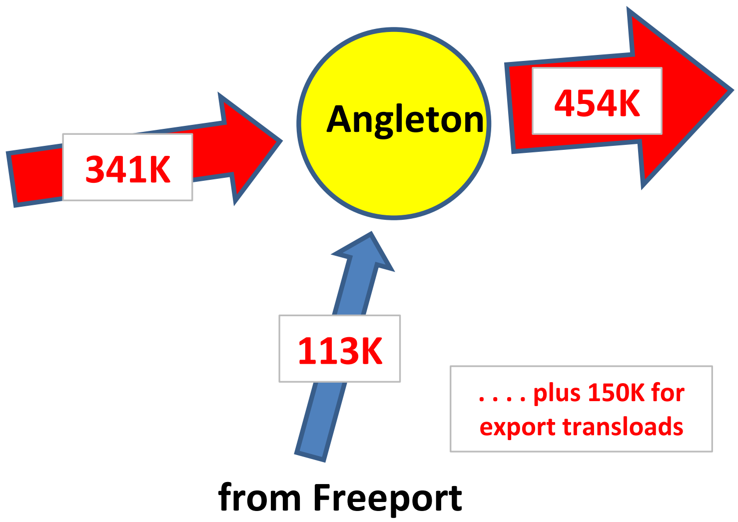
This is reasonable considering that a number of these trains are local freights operating out of the Angleton freight yard, which directly serve Freeport industrial customers. As a result, the revenues associated with this carload traffic could carry much of the infrastructure cost burden of the proposed Freeport Terminal Railroad.

In terms of what carload traffic might potentially contribute to the cost of a greenfield north of Angleton or Brazoria, it would appear that the rail line continuing past Angleton south towards Corpus Christi carries about three times the traffic of the Freeport branch: about 364 * 3 = 1,092 cars per day, or 341,000 cars per year south of Angleton. North of Angleton the volume would be the combined total of 364 * 4 = 1,456 cars per day or 454,000 cars per year. This is the best that can be estimated using publicly available data and needs to be confirmed by a future more detailed study.

The proposed export container transload activity will likely increase the level of carload traffic coming into Freeport. It is difficult to forecast the exact potential for added carload rail traffic due to a number of variables. For example, since Freeport would be expected to handle a large share of Asian traffic (largely import containers from China) the first challenge is in forecasting how many exports China will buy. At present China is not buying much from the United States, even raw materials – ships are departing from Houston to China 80% empty. However, to get a rough order of magnitude estimate of the traffic volume potential, if we assume that 50% of 1 million annual TEU's were to be reloaded for export, that would be 500,000 TEUs to be filled with plastics, resins and other raw materials for exports. At an average of 15 tons per TEU this would correspond to 7.5 million tons of export freight. At 100 tons (net) per railcar this would generate an inbound traffic of 75,000 loaded railcars, generating another 75,000 empty return trips, which would more than double the current rail carload traffic base at Freeport. Assuming 312 working days per year this would be the equivalent of approximately 240 railcars (or two trains in and out of Freeport) per day over and above current traffic levels. By 2035 expected growth in railcar traffic may necessitate three or four daily trains, both in and out of Freeport.

The resulting Freeport carload estimate is summarized in Exhibit 6-15: as 113K annual cars from Freeport (loads + empties) plus 341K coming into Angleton from south Texas. As a result it is estimated that 454K cars are moving on the Angleton Subdivision north of Angleton. An as-yet unknown share of these cars may also be able to use the proposed new Freeport rail line to bypass downtown Houston. This could also help contribute to the financial case for improving the rail system.

Exhibit 6-15: Existing Freeport Carload Traffic Estimate



6.5 West Coast Ports: Competitive Response

To refine Freeport's container demand forecasts in future feasibility or investment-grade studies, it will be necessary to consider a range of a potential competitive responses at the West Coast Ports. To do this, it is important to note that shipping lines (and not ports) establish vessel services, and together with shippers they (and not ports) determine the most advantageous container routings.

Because of the economics of double stack rail coupled with the large-ship advantage of the West Coast ports, West Coast ports have until now actually held the cost advantage for shipping from Asia to most of the United States -- except for the immediate port hinterlands of Gulf and East coast ports. Together with the railroads, West Coast ports have pursued a "Cost Leadership" business model based on the economics of large ships, high volumes generating economies of scale[145] and heavy, slow double stack trains that maximize railroads' line haul efficiency. Railroads have in fact been competing with Panama Canal ships rather than with trucks for the West Coast container business.

[145] See: http://www.maersk.com/Innovation/WorkingWithInnovation/Documents/Slow%20Steaming%20-%20the%20full%20story.pdf

Even so, it is not clear why as shown in Exhibit 6-16, stack trains need to take 5 days to get from Los Angeles to Houston (1,632 miles average 14-mph[146]) when Amtrak does the same run in 37 hours (average 44-mph).[147] This narrow service differential actually *increases the railroads' competitive vulnerability* since, transit times via the Panama Canal are almost as fast as rail schedules via West Coast ports. This gives shippers very little reason to pay a higher price for using rail as compared to direct water service. As a result, shippers are more likely to select the lower cost alternative, which will be the all-water service. Since rail transit times are insufficiently differentiated against water, this puts a substantial share of West Coast rail traffic at risk even for high valued, service sensitive commodities.

Exhibit 6-16: Los Angeles to Houston Published Rail Schedule[148]

Intermodal Schedules

Search Criteria

Origin Metro: Los Angeles
Origin Ramp: Los Angeles (ICTF,CA)
Service Level: Standard
Equipment Type: Container
Destination Metro: Houston
Destination Ramp: Houston (Englewood,TX)
International/Domestic: International

Get Schedule | Reset

Export to Excel

International/Domestic	International	Standard Schedule						
Equipment Type	Container	Effective 01/01/2000						
Los Angeles (ICTF, CA)	C/O Day	Sun (7/13)	Mon (7/14)	Tue (7/15)	Wed (7/16)	Thu (7/17)	Fri (7/18)	Sat (7/19)
	C/O Time	0700-0		0700-0	0700-0	0700-0	0700-0	0700-0
Houston (Englewood, TX)	Avail Day	Thu (7/17)		Sat (7/19)	Sun (7/20)	Mon (7/21)	Tue (7/22)	Wed (7/23)
	Avail Time	0600-4		0600-4	0600-4	0600-4	0600-4	0600-4
	C/O - Avail:	93:00		93:00	93:00	93:00	93:00	93:00
	90th Percentile Hrs:			120:58	121:45	107:46	118:01	130:01

Notes and Information

- 90th Percentile Hrs represents the hours from cutoff to availability in which 90% of the units arrived by during the past 60 days. At terminals utilizing the Gate Reservation System. cutoff is based on the associated gate reservation.
- Holiday schedules and times may vary.
- Scheduled Available Time also referred to as Van Grounding Time.
- View Union Pacific's Highest Elevation Map for Intermodal Customers.
- Ramp Service Matrix

Given this reality, West Coast Ports and railroads have two choices if they want to maintain share against all-water competition: either improve their services or drop prices. Dropping prices may be risky for the railroads, since water, not rail will have the low cost advantage. Therefore the water carriers will likely win any straight-out price war. Water carriers also have the advantage of having a simpler logistics chain with fewer handlings than the railroads, thus all-water service is perceived by shippers as more reliable, even though it may take longer.

[146] 5 days based on published 90% reliability. This rail speed is about the same as the 12-knots that Maersk ships sail when slow-steaming, so rail loses its speed advantage over ocean shipping

[147] See: http://www.amtrak.com/ccurl/866/419/Sunset-Limited-Schedule-060914.pdf

[148] Exhibit source: MARAD 2013 *Panama Canal Expansion Study,* See http://www.marad.dot.gov/documents/Panama_Canal_Phase_I_Report_-_20Nov2013.pdf Figure 15 on page 57. The 5-day transit time from Los Angeles to Houston was re-confirmed by a current schedule inquiry to the Union Pacific website on July 17, 2013 at http://c02.my.uprr.com/pic/jas/intermodalSchedulePage.jas although it should be noted that Union Pacific does offer faster 79-hour schedules on domestic traffic.

Improving service may be a better option for the railroads and for the West Coast ports as well. Perhaps the West Coast ports and railroads will choose to move away from their current cost leadership strategy and instead pursue a service differentiation strategy, improving services to more securely hold onto higher valued goods (e.g., electronics) that offer the most natural advantage to the west coast ports. However it will be difficult for the railroads to implement this strategy on their own. A coordinated strategy will likely also need to have a port and vessel component as well, so the overall service offering via the West Coast becomes a clearly differentiated, albeit higher cost transportation product that is of distinctly higher quality than what the main steamship lines offer via their all-water, slow-steaming routes.

Matson Navigation, for example, already offers a "guaranteed expedited service"[149,150] from China to Long Beach with a money-back guarantee. Using the motto, "Smaller, Faster, Better," Matson's new U.S.-flag service is shaving two to five days off standard Transpacific shipping times at comparable rates to international carriers by using small 2,000-3,000 TEU ships. Matson explains: [151]

> *Most of the bigger vessels – up to 9,000 TEUs – sailing the Pacific have to stop at additional Asian ports to fill the ships before sailing to the West Coast. Matson's 2,600 TEU ships do not. In addition, unloading larger ships requires three or four days in port, which can be hampered further by congestion at large multi-user terminals. In contrast, Matson sails direct from Ningbo and Shanghai to Long Beach, arriving every Sunday at Matson's dedicated facility, with cargo availability the next day. For added convenience, Matson drays all local cargo to an off dock container yard four miles from the harbor, allowing large retailers 24/7 cargo availability and the ability to avoid the congestion of bigger ships.*

However, it is not clear that service differentiation based on Matson's strategy is going to be adopted as an industrywide practice, since vessel sizes at West Coast ports have continued to grow, and the trend has only accelerated in recent years.[152] Ocean carriers expect ports to improve their facilities and operations so they can load and unload cargo quicker. By putting more pressure on ports to perform, ocean carriers can achieve their service goals without sacrificing the economics of large vessel service.

Modeling developed for the current study has assumed that competition from West Coast ports will remain very strong. Even if Freeport is able to take a 30-40% share of its hinterland market, West Coast port traffic will continue to grow. Even though West Coast container volumes may dip temporarily as some traffic diverts to East and Gulf coast ports, those volumes are forecasted to rapidly recover. Given the magnitude of traffic growth that the West Coast ports will be called upon to handle in the future, West Coast ports will need to more than double the amount of traffic they are handling, which in an environment of more competitive rates may be difficult to do.

[149] See: http://www.matson.com/china/ges.html
[150] See: http://www.hawaiibusiness.com/Hawaii-Business/February-2011/Matson-sails-fast-boats-to-China/
[151] See: custommedia.bnpmedia.com/Custom/Home/Files/PDFs/Matson_adv.pdf
[152] See: http://www.wsj.com/articles/growing-shipping-alliances-are-straining-major-u-s-gateway-ports-1430733531

Also, the suggestion that West Coast ports will be able to mount a competitive response neglects the simple fact that the same shipping lines serve both West Coast ports and Panama Canal routes. While shipping lines do compete against one other, they have no need to price competitively against their own routes. Rather it is more likely that the shipping lines will simply allow traffic to flow over the most naturally cost effective routes. If anything, the shipping lines will likely have a bias towards the Panama Canal routes that give them a greater length of haul, and thus more profitability.

6.6 East Coast Ports: Competitive Response

The main issue is that the East Coast ports are only partially ready for the largest ships. Only Norfolk and Miami are ready now; Charleston is going to 52 feet; New York is raising the Bayonne Bridge (2017); Savannah with only 47' recognizes its fate is tied to New York's. However, as shown in Exhibit 5-15 a key competitive consideration particularly In the Dallas/Fort Worth market is the "Meridian Speedway." The KCS rail corridor has been developed as a high quality, high capacity rail line directly linking Atlanta, GA to Dallas/Fort Worth, bypassing the congested rail gateways of Memphis and New Orleans. In 2005 Norfolk Southern Railway (NS) invested over $300 million[153] to acquire a joint interest from Kansas City Southern (KCS) in this rail line. Union Pacific also partners with KCS and NS, using the Meridian Speedway for its transcontinental Los Angeles-Dallas-Shreveport-Atlanta "Blue Streak" intermodal service[154]. The Meridian Speedway provides a direct rail link between Texas and the east. In combination with the development of Suez Canal vessel services, the East Coast ports have recently started using the Speedway to be able to bring Asian goods into the DFW market. Thus the competitive threat posed to Gulf Coast ports by this route is more than hypothetical.

Exhibit 5-15: The KCS/NS "Meridian Speedway" Rail Line

[153] See http://en.wikipedia.org/wiki/Meridian_Speedway Map Source: Norfolk Southern web site. See: http://www.nscorp.com/content/nscorp/en/ship-with-norfolk-southern/shipping-options/corridors/meridian-speedway.html

[154] See: https://www.uprr.com/newsinfo/releases/service/2007/0430_uprr_ns.shtml?print and http://www.prnewswire.com/news-releases/union-pacific-and-norfolk-southern-to-offer-fastest-service-between-southern-california-and-southeast-58895457.html , http://www.progressiverailroading.com/intermodal/article/Norfolk-Southern-and-Union-Pacific-Streaking-to-the-West--13220 , http://www.progressiverailroading.com/intermodal/article/BlueStreak-picks-up-speed-for-Norfolk-Southern-Union-Pacific--13262 , http://www.knichellogistics.com/intermodal/expedited/ and http://de.freightgate.com/shippingnews/shippingnews.tet?db_id=5746&action=viewOnly

For Port Freeport, the Meridian Speedway poses both an opportunity and a competitive threat:

- ***Opportunity:*** By exploiting Savannah's vulnerabilities[155] in Asian traffic via the Panama Canal, the Meridian Speedway could potentially allow Texas ports to compete with East Coast ports as far east as Atlanta. For example, a container routing from Asia to Atlanta via Freeport would be faster than coming through Savannah (as a second port of call) and less expensive than from a west coast port.
- ***Threat:*** By directly connecting the Ports of New York, Norfolk and Savannah to Union Pacific's Blue Streak intermodal service, European and Asian traffic via the Suez Canal could use the Meridian Speedway to penetrate as far west as El Paso against West Coast port competition. According to the 2014 PIERS data this has already started to happen. This threat however, would likely be neutralized if large ships could directly serve Texas markets via Freeport.

Either way, it is clear the Meridian Speedway is likely to play an increased role. The outcome depends on whether Texas chooses to develop Port Freeport to its full potential.

[155] Particularly the fact that Savannah is only dredging its channel to 47' will prevent fully loaded ships from calling there. The MARAD November 2013 *Panama Canal Expansion Study* says on page 49 that Post-Panamax ships could only call on Savannah at periods "when tides are favorable." As a practical matter, this will lock in the current vessel rotation pattern where ships sail first to New York, then call at Savannah on their return trips to Asia (mostly empty) from New York adding at least a week additional sailing time. By comparison, Freeport will have a deep channel for large ships and be the first U.S. port of call. This makes Savannah more vulnerable to competition.

Chapter 7. Implementation, Financing and Funding Plan

This section will lay out a preliminary implementation plan and assumed capital costs for development of infrastructure, a terminal railroad for Port Freeport, and rail connections to the interior of the U.S.

7.1 Implementation Plan

Conceptually it is assumed that port and rail improvements will be developed in three stages:

1) ***Develop the Ocean Port Itself:*** From the perspective of the ocean shipping lines, Port Freeport needs to offer competitive rail access by at least two railroads if it wants to be a credible market player. The first step is to develop the necessary terminal capacity at the Port itself.

2) ***Develop Inland Ports:*** The second step is to develop Inland Ports in Dallas, Fort Worth and San Antonio as well as the Integrated Hub in Rosenberg. This should be done concurrently with development of rail facilities at Freeport. Although initially the needed capacity might be contracted at existing terminals, since the Texas economy is growing so quickly, it is clear over the longer term that there will be a need for expanding intermodal terminal capacity in Texas. This offers Freeport a clear opportunity to build Inland Ports.

3) ***Develop Rail Connections for Linking Freeport to the Inland Hubs:*** The third step is to develop the rail corridor as proposed by constructing a new shorter alignment from Freeport to Rosenberg, then improving the existing BNSF rail line up to Caldwell, TX where UP trains would diverge towards Hearne and Dallas onto their own lines. An important step has already been taken for realizing this goal through establishment of the Brazoria–Fort Bend Rail District,[156] who under Chapter 172 of the Texas Transportation Code[157] has the authority to issue revenue bonds for financing the project, to exercise eminent domain as needed for acquiring needed rights of way, and to own, operate and maintain the project. This authority is by law not limited to the jurisdictional areas of the two counties so the existing authority is in fact capable of carrying out the entire rail project as envisioned.

One obvious limitation of this three-stage implementation strategy is the inability to provide any service at all until the project is completely built-out. This increases the financial and market risk of the project. Development of an interim plan could to enable some service to begin sooner. This would help reduce the financial risks associated with the project, and would enable DFW-area shippers to start diversifying their supply chain options, as Houston-area shippers have already been able to do. However, the development of an interim plan depends on developing institutional arrangements, such as with Union Pacific Railroad and/or the Port of Houston, which are not currently in place. This is beyond the scope of the current study but could be developed as discussions are further progressed.

[156] See http://agendalink.co.fort-bend.tx.us:8085/docs/2015/CCTR/20150728_2711/18655_Amended%20Creation%20of%20Brazoria-Fort%20Bend%20Rail%20District.Final.FBC.pdf and http://www.statutes.legis.state.tx.us/Docs/CN/htm/CN.10.htm
[157] See: http://www.statutes.legis.state.tx.us/Docs/TN/htm/TN.172.htm

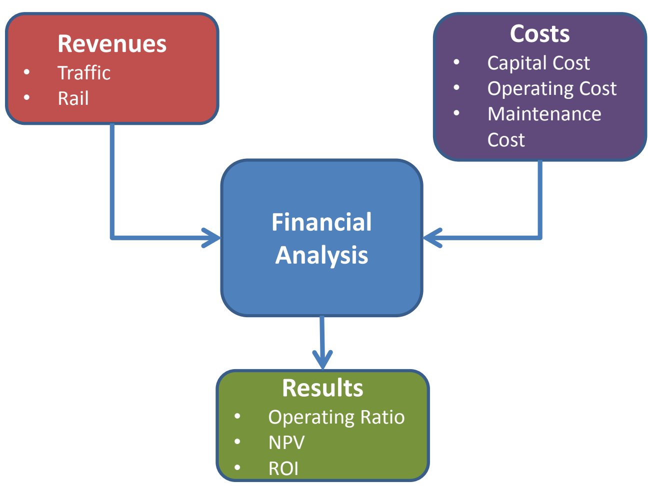
7.2 Institutional Framework

Different institutional models could be used to facilitate the development of the rail corridor, but the current analysis assumes that a Public Private Partnership following the example of the Alameda Corridor[158] will be used to develop a high quality, publicly owned rail line for providing common access for all railroads into Port Freeport. The Alameda Corridor[159] model has been followed in every respect in development of this study. Alternative institutional arrangements are possible but beyond the scope of this study. They could be developed as implementation planning is progressed.

One of the key advantages of following the Alameda Corridor model is that it would enable the use of cost effective revenue bond financing – or even lower cost RRIF financing – to reduce the interest cost burden associated with financing the project. It is assumed that debts would be serviced by tolls collected from the railroads on a TEU-basis by a public authority, who would be responsible for owning and maintaining the corridor. Operationally, the Alameda Corridor is managed by a joint UP/BNSF dispatching center in San Bernardino.[160] However, BNSF and UP have together also created a joint regional center for the Houston area as well, located in Spring, TX,[161] which controls the whole Houston area rail network. To guarantee equitable and neutral dispatching, it would seem logical that the proposed Freeport corridor up to Caldwell could be managed out of this existing Spring dispatching center as well.

The Alameda Corridor pioneered a new Public/Private approach for finance, ownership, administration and rail corridor operations that could be used as a model for Freeport. As shown in Exhibit 7-1, it is assumed that a Freeport Rail Authority would be separate and distinct from Port Freeport.

Exhibit 7-1: Structure of the Financial and Economic Assessment



[158] See: https://www.aar.org/keyissues/Documents/Background-Papers/Public%20Private%20Partnerships.pdf
[159] See: http://www.acta.org/
[160] See: http://www.acta.org/agendas/Operating_Committee/Special_Rail_Operation_Comm_9-5-07_Agenda.pdf
[161] See: http://www.grainnet.com/articles/BNSF__UP_Sign_Historic_Dispatching_Agreement-3073.html

7.3 Freight Railroad Benefits for Using the New Corridor

The Toll Authority would derive revenues from tolls collected from the freight railroads as usage fees, plus other contractual commitments such as to annual track maintenance. It is assumed that the financial structure would be modeled after ACTA's and that the toll structures would be similar. [162,163] For the Alameda Corridor the railroads have agreed to pay:

- A fixed charge per TEU for every ocean container using rail that originates from Los Angeles/Long Beach -- whether that container uses the Alameda Corridor or not. Since the railroads agreed to this "Take or Pay" fee for all ocean containers, this maximizes the railroads incentive to actually use the corridor. Under law and also by contract, the railroads are required to pay this fee for every ocean container, even those that are trucked to the downtown rail ramps. This is possible to audit since the Port Authority maintains records of all containers that originated at the Port.[164]
- A much reduced charge per TEU for loaded containers that are not port related, for empty containers and for railcars, which lowered fees are intended to encourage the railroads to use the corridor for discretionary traffic. Fees on these discretionary units generate some small incremental revenues for ACTA since the fees are intended to encourage the railroads to use the Alameda Corridor rather than their own lines (which pass at grade through congested areas of the city) but which both BNSF and UP railroads continue to maintain for local traffic.

At Freeport, the proposed new rail line could provide a direct route for Union Pacific carload traffic to go straight to the new classification yard which UP plans to develop at Hearne. However, to encourage Union Pacific to voluntarily use the bypass rather than taking trains through downtown Houston, fees for carload and non-port-related containers must be kept low. Even for port-related container traffic it is desirable to keep the level of toll as low as possible, and in any case to be able to demonstrate an economic advantage to the freight railroads for using the route. The advantages to the railroads from using the new route are:

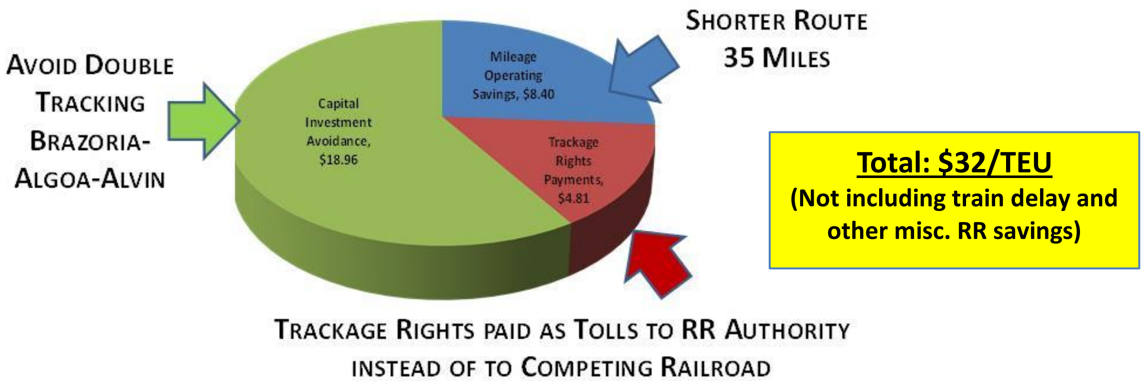
1. The segment from Freeport to Brazoria would be needed in any case, since provides access to a proposed ICTF site that is currently not rail accessible.
2. The greenfield segment from Brazoria to Rosenberg is 35 miles shorter than the circuitous existing rail route via Algoa. *This produces an operating cost savings for the railroads.*
3. The existing rail line from Brazoria to Algoa to Rosenberg will not need capacity improvements since trains will use the new greenfield instead. Capacity improvements would be provided by the Freeport Railroad Authority on the Rosenberg to Caldwell segment. *This produces a capital cost savings for the railroads.*

[162] See: http://www.uprr.com/customers/intermodal/alameda/alamedafaq.shtml, http://www.uprr.com/customers/intermodal/alameda/alameda_supp.shtml, http://www.uprr.com/customers/intermodal/alameda/circ20b.shtml
[163] See: http://www.acta.org/projects/projects_completed_alameda_factsheet.asp, http://www.railway-technology.com/projects/alameda/, www.ops.fhwa.dot.gov/freight/freight_analysis/financing/Appendix/Presentations/Martin.ppt
[164] Shippers can avoid this charge, however, by transloading the goods to a domestic container and reconsigning the goods as domestic freight.

4. BNSF and UP would also avoid trackage rights fees, since neither railroad can currently get from Brazoria into Houston without running over the tracks of the other railroad. *This produces an operating cost savings for the railroads.*

Therefore, a preliminary view has been taken from a freight railroad perspective to identify the level of potential benefits, as shown in Exhibit 7-2. Based on the Brazoria to Rosenberg segment alone, this suggests a railroad capital and operating cost savings on the order of $32 per TEU round trip.

Exhibit 7-2: Prospective Freight Railroad Benefits of New Corridor

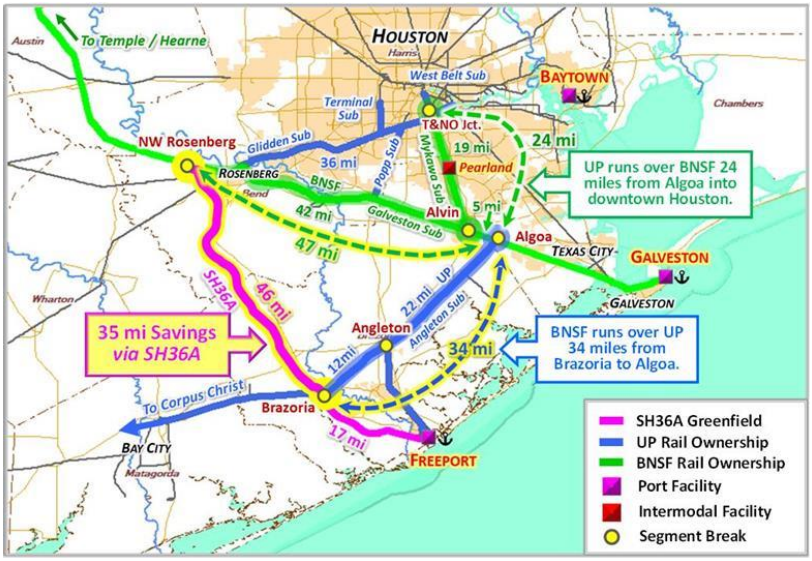


In terms of benefits to the railroads, the proposed new greenfield route would be 35 miles shorter than the existing rail route through Algoa, as shown in Exhibit 7-3. A line-haul cost of 12¢ per TEU-mile[165] has been developed from STB data. The railroads would save 12¢ per TEU-mile in ***both directions*** (loaded and empty) by using the new, shorter greenfield route. Applying this to the assumed 35-mile shorter greenfield route in both directions results in a direct railroad cost savings of $8.40 per loaded TEU. The railroads should be willing to pay at least this level of fees for using the new shorter rail route since it would be less expensive than using their own but longer tracks.

Unlike Los Angeles/Long Beach where each railroad has its own line to the Port, ***neither*** railroad has its own line to South Texas, since as shown in Exhibit 7-3 each railroad must rely on trackage rights over the other. In terms of avoided trackage rights payments, this has been estimated to contribute $4.81 per TEU.[166] This shared ownership and use structure also complicates the railroads' investment decisions[167] since the benefits of the investment may not be equitably shared between the carriers. This lowers the owing railroad's effective ROI and discourages investing at an optimal level in the corridor.

[165] Rail costs are modeled as $125 lift costs per TEU for loading and unloading, or $62.50 at each end of the rail movement, plus 12¢ per TEU-mile for the rail line-haul. These costs are based on double stack trains, and were developed from *"Rail Short Haul Intermodal Corridor Case Studies",* Table 6.3.3 on page 32. See: https://www.fra.dot.gov/Elib/Document/1649 It should be noted that the rail line haul cost of 12¢ per TEU-mile includes a 40% markup (the ratio of direct to long term variable cost) which includes an allowance for amortizing the capital cost of the railroads' infrastructure. Underlying cost development was based on STB URCS http://www.stb.dot.gov/stb/industry/urcs.html and the railroads' annual R-1 reports http://www.stb.dot.gov/stb/industry/econ_reports.html.
[166] See Page 140 of the SP/UP Merger Decision at *https://www.uprr.com/aboutup/history/decision.pdf* reported trackage rights fees at 3 mills per Gross Ton mile (in 1996) = $.003 per GTM with 130 ton is 39¢ per Loaded car mile. Inflated by 28.5% increase over 11 ½ years using AAR's Rail Cost inflation index https://www.aar.org/StatisticsAndPublications/Rail-Cost-Indexes/Documents/RCAF%20History%202014Q3.pdf yields a current equivalent rate of 50¢ per Loaded car mile and 12¢ per Loaded car mile.
[167] Angleton Subdivision study, *http://d2dtl5nnlpfr0r.cloudfront.net/swutc.tamu.edu/publications/technicalreports/473700-00011-1.pdf*

Exhibit 7-3: New Rail Line Would Offer a Shorter Route (35 Miles) with Less Trackage Rights



Finally, it is noted that the significant volume of trains added by Port Freeport would likely necessitate adding track to the existing rail corridor from Brazoria to Alvin and up to Rosenberg. Since this existing rail route is so much longer than the proposed greenfield connection, up to 81 miles of double track may eventually need to be added for adding capacity to the existing rail route over time. Even if track could be added to the 81 mile existing corridor for a lower unit cost, it is not clear that the total cost would end up less expensive than developing a much shorter 46-mile direct greenfield. It should be noted that a neither a detailed capacity assessment nor engineering estimate have been developed for assessing this issue in detail. However, for comparative purposed only by assuming phased development of double track along this segment (over a 20 year time frame) the avoided investment is conservatively[168] worth the equivalent of $18.96 per TEU.

In summary, the freight railroad savings were assessed at $32 per loaded TEU between Brazoria and Rosenberg, which is less than the TEU toll of $28.41 (current ACTA fee, on a round trip basis assuming 100% empty return) that was assumed in this analysis for the whole Freeport to Caldwell corridor. This freight railroad alternatives analysis should be further refined in the next phase of work with the support of the freight railroads.

7.4 Capital Costs for Constructing the Line

A capital cost of $879.9 million for the project was based on the feasibility-level engineering costs described in Chapter 5, including the placeholder allowance of $85 million for purchasing the Rosenberg to Caldwell segment. Construction cash flows are assumed as $293.3 million per year over a three year construction period.

[168] Based in part on STB's 10.65% railroad cost of capital in 2014, which is known to be less than the hurdle rate that railroads use for funding discretionary capital investments. See: http://www.railwayage.com/index.php/regulatory/stb-sets-2014-rail-cost-of-capital-at-1065.html

7.5 Operating and Maintenance Costs

Once the rail line has been built the Rail Authority will need to maintain it and periodically replace components (cyclic maintenance). In addition the Rail Authority will itself have some administrative overhead including management, legal and financial fees for collecting revenues, servicing the debt, and maintaining the required financial reporting.

Administrative fees have been tentatively estimated at 4.2% of revenue based on the overhead rate of the Alameda Corridor Transportation Authority. This will be subject to refinement once more is known about the actual financing approach that will be utilized for this project.

Once the new rail line is built, it will have to be maintained. Exhibit 7-4 shows the relationship between track maintenance cost and total tonnage that was calibrated from a 2004 Zeta-Tech study. It shows a strong relationship between tonnage, FRA track class (4 through 6, corresponding to a 79-mph, 90-mph and 110-mph track speed) and track maintenance cost.

Exhibit 7-4: Zeta-Tech Track Maintenance Costs (in $2002)

TOTAL	LOW		MIDDLE		HIGH	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
Class 3[1]	$17,880	$0.917	$21,683	$1.231	$25,487	$1.548
Class 4	$26,294	$1.348	$31,887	$1.810	$37,481	$2.277
Class 5	$28,072	$1.509	$33,937	$2.020	$39,801	$2.530
Class 6	$31,714	$1.837	$38,446	$2.440	$45,178	$3.035

OPER	LOW		MIDDLE		HIGH	
	Intercept	Slope	Intercept	Slope	Intercept	Slope
Class 3	$6,558	$0.579	$8,216	$0.726	$9,873	$0.872
Class 4	$9,644	$0.852	$12,082	$1.067	$14,519	$1.283
Class 5	$11,283	$0.997	$14,135	$1.249	$16,987	$1.501
Class 6	$14,640	$1.293	$18,371	$1.623	$22,101	$1.953

In Exhibit 7-4, Zeta-Tech gives Total and Operating cost components; the difference is in Capital cost. For example, the mid-line Cost functions (in $2002) for Class 4 track is broken down as follows:

- $12,082 + $1,067 * MGT = ***Operating*** Cost per Mile Class IV track
- $19,805 + $ 743 * MGT = ***Capital*** Cost per Mile Class IV track
- $31,887 + $1,810 * MGT = ***Total*** Cost per Mile Class IV track

Capital costs for periodic infrastructure renewal, are not incurred all at once but rather are subject to a ramp-up as specified by Zeta-Tech in Exhibit 7-5:

Exhibit 7-5: Zeta-Tech Track Capital Cost Ramp-Up Factors

Year	% of Capital Maintenance	Year	% of Capital Maintenance
0	0%	11	50%
1	0%	12	50%
2	0%	13	50%
3	0%	14	50%
4	20%	15	75%
5	20%	16	75%
6	20%	17	75%
7	35%	18	75%
8	35%	19	75%
9	35%	20	100%
10	50%		

Inflated to $2014 (an approximate 52% increase, a higher rate of inflation than CPI, reflecting the energy-intensity of construction materials) these cost functions become:

- $18,365 + $1,621 * MGT = Operating Cost per Mile Class IV track
- $29,784 + $1,112 * MGT = Capital Cost per Mile Class IV track
- $48,149 + $2,733 * MGT = Total Cost per Mile Class IV track

It is estimated that Port Freeport will generate approximately 15 Million Gross Tons (MGT) annually of intermodal traffic[169] on the proposed new rail line at first so:

- Operating maintenance of the proposed new rail line would cost $45,000 per mile eventually rising to over $125,000 per mile (in current dollars) as volumes grow to 65 MGT by 2045.
- Capital maintenance would eventually reach $100,000 per mile per year (in current dollars) but as a result of both ramp-up factors and traffic growth would take 30 years to reach this level.

7.6 Financial Analysis

The analysis assumes the proposed 148 Miles Freeport to Caldwell rail corridor, costing $879.9 million in operation by 2025.

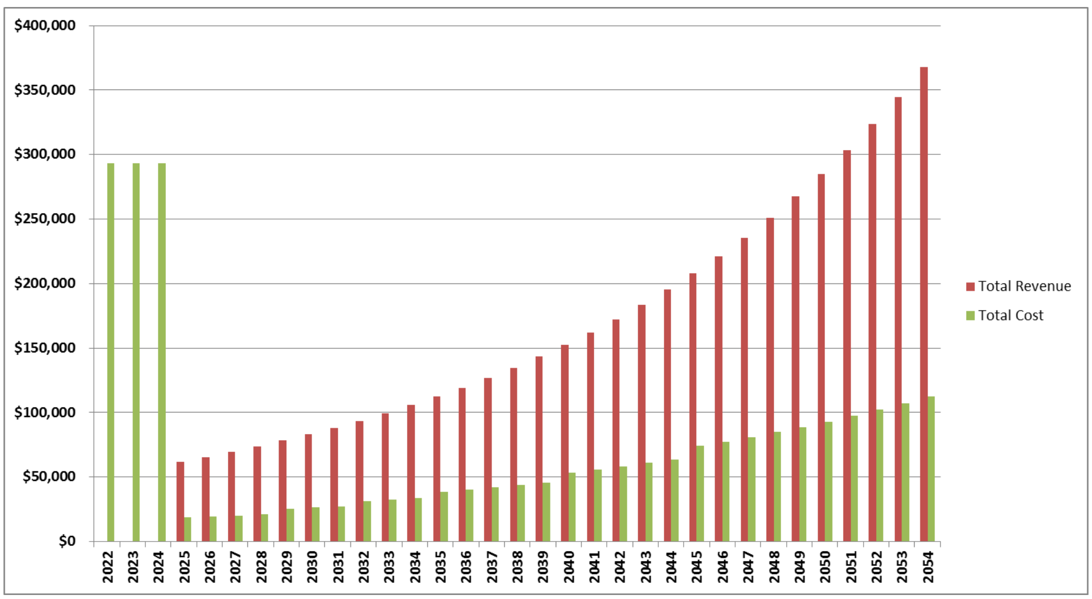
A key assumption for any financial analysis is the interest rate. According to the Bond Buyer website[170] the weighted average 2014 rate for Revenue Bonds is 4.4%.[171] This was assumed along with 1.4% annual inflation so that effectively a 3% real discounting rate is used. The forecasted TEU container rail volumes were used along with the assumed $28.41 per loaded TEU revenue yield (assuming 100% empty return, and 40¢ per car mile for carload traffic north of Rosenberg) to develop a very preliminary, conceptual analysis from the point of view of the Freeport Railroad Authority. Since inflation was

[169] A 500 TEU double stack train will weigh on average (loaded + empty) around 9,000 tons. 9,000 tons/train* 16 trains/week * 52 week/year * 2 directions = 14.976 MGT (practically 15 MGT) for 832,000 TEU - an average of 18 tons per TEU including the weight of container and train.
[170] See: The Bond Buyer website, at: http://www.bondbuyer.com/apps/custom/msa_search.php?product=bbi_history&col1=1&start_date=01%2F01%2F2014&end_date=08%2F01%2F2014&submit=GO&csv=1
[171] If a RRIF loan could be obtained, this financing will likely be even less expensive than Revenue Bonds.

assumed along with a nominal interest rate, the analysis reflects year of expenditure dollars. It yields a strongly positive Net Present Value for the Freeport Rail Authority, as shown in Exhibit 7-6. The detailed financial worksheets will be found in Appendix 3.

Exhibit 7-6: Projected Cash Flows for the Freeport Rail Authority

Container Revenues	$1,633,683
Car Revenues	$405,251
Total Revenue	**$2,038,934**
GF Capital Cost	$807,769
Track Mtce Cost Oper	$389,014
Track Mtce Cost Cap	$189,503
Admin Cost	$85,635
Total Cost	**$1,471,922**
NET	**$567,012**
IRR	***7.79%***



It can be seen that due to the length of the route and forecasted tonnage, operating and capital maintenance is a significant component of the corridor's cost structure, which must be recovered through usage fees.

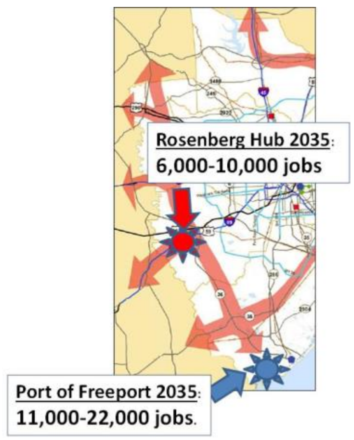
At a competitive tolling level and existing carload traffic north of Rosenberg to Caldwell; 4.4% interest and 1.4% inflation the NPV is $567 million positive: this suggests that an infrastructure authority could fully service its Bonds from fees without needing subsidy or grant assistance. These results support the potential for a RRIF loan or use of Revenue Bonds as a low-cost financing vehicle for developing needed infrastructure improvements. More study however, is needed to positively confirm both costs and revenues, to confirm the financial feasibility of the project.

This gives a Return on Investment of 7.79 percent. This shows that there is a good case for a public investment.

7.7 Economic Impacts

An analysis of potential job creation, income and tax impacts associated with logistics opportunities within the SH 36A corridor has been undertaken. As shown in Exhibit 7-7, two major opportunities for the corridor have been identified resulting in significant job creation potential. These are development of Port Freeport for ocean shipping, as well as a new rail multimodal facility in the Rosenberg area.

Exhibit 7-7: Projected Logistics Opportunities in the SH 36A Corridor



The overall magnitude of the potential economic impacts is estimated at between 17-32 thousand full time jobs by 2035. The vast majority of employment impact will be in warehousing, logistics, trucking and industrial jobs, while port and railroad operations themselves are so efficient that they have only a relatively minor impact on overall employment levels.

- In Rosenberg, 6,500 industrial, warehousing and trucking jobs[172] would be created by development of a new rail intermodal ramp.
- At Freeport 7,100 jobs would be created, as follows: 200 at Port Freeport, 750 on the railroad and 650 jobs for transloading bulk exports[173] at the Port. In addition, 5,500 distribution warehousing jobs would be created for transloading long-distance containers[174] bound for out of state destinations into larger domestic boxes.

[172] See: http://www.thefutureneedsus.com/images/uploads/cc-book_1.pdf This is also consistent with the level of economic impacts that were estimated by CSX for their recently-opened Winter Haven, Florida intermodal facility (8,500 annual jobs with a total annual payroll of $282.2 million; over a 10 year period, more than $10 billion in economic development and $900 million in state and federal tax revenue.) See: http://www.flgov.com/2012/11/08/governor-scott-breaks-ground-on-winter-haven-intermodal-rail-terminal/

[173] See: http://www.midwestshippers.com/news_detail.php?article=844

[174] This 2/7 factor is based on the observed transloading rate at Los Angeles/Long Beach where it has been estimated that 50% of the containers move directly off the dock, while 20% go out the gate for transloading to domestic containers and subsequently reappear as domestic loads at the downtown intermodal ramps. This factor is applied only to the share of long-distance containers that would be moving ***beyond*** Dallas, Fort Worth or San Antonio not to local containers that terminate in those cities, or in Houston.

Because of the influence of the port, it is reasonable to assume that the SH 36A corridor will additionally be able to capture a share (25%) of the forecasted ***growth*** of container logistics that is currently focused on Dallas, Fort Worth and San Antonio. Since the total volume of freight will be increasing dramatically, it will be necessary to substantially expand existing distribution capacity. While the vast majority of growth would likely be focused in the existing distribution areas, since the containers will be passing through the corridor (at both Freeport and Rosenberg) it is likely that the SH 36A corridor may be able to capture some of the related value-added distribution activity. Rosenberg, for example could be a good place from which to distribute into Houston's rapidly growing western and northern suburbs. This would certainly be more effective than trucking goods into northwest Houston from Dallas/Fort Worth, as is the case today.

If Rosenberg and Freeport could together capture 25% of the overall forecasted growth of Texas logistics, as shown in Exhibit 7-8, this would result an additional 10-11 thousand jobs in the SH 36A corridor resulting in a total impact of around 25,000 jobs which we take as the base line estimate for likely impact to the corridor. Translating these jobs into likely income and tax revenues the result, as shown in Exhibit 7-9 shows the likelihood of substantial economic impacts in the SH 36A corridor.

Exhibit 7-8: Sources of Jobs Increase by 2035 in the SH 36A Corridor

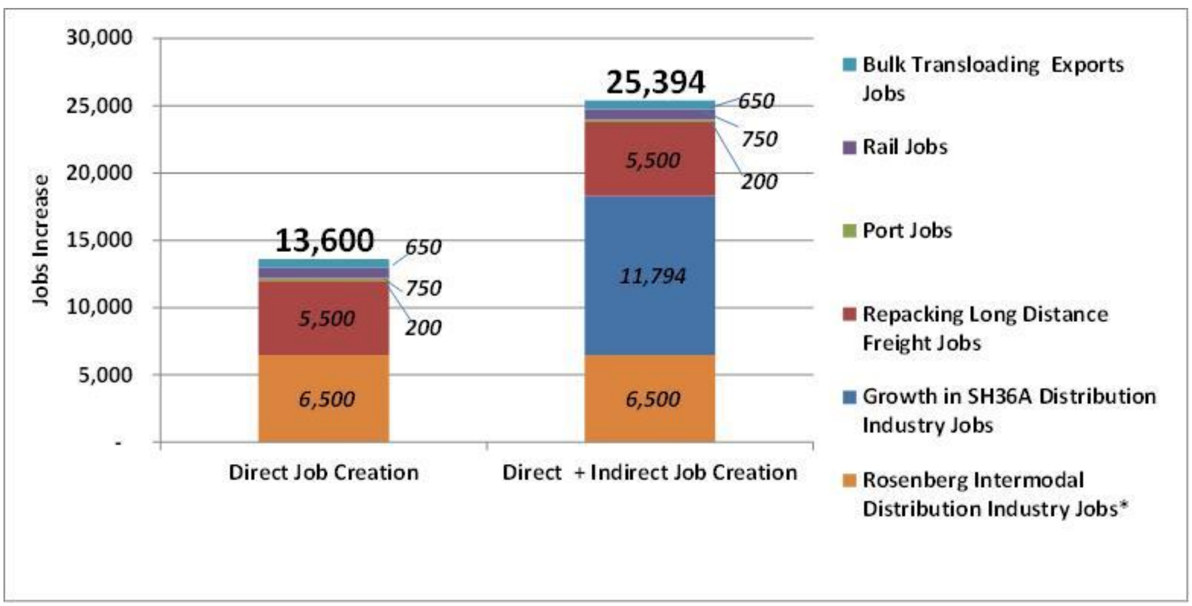
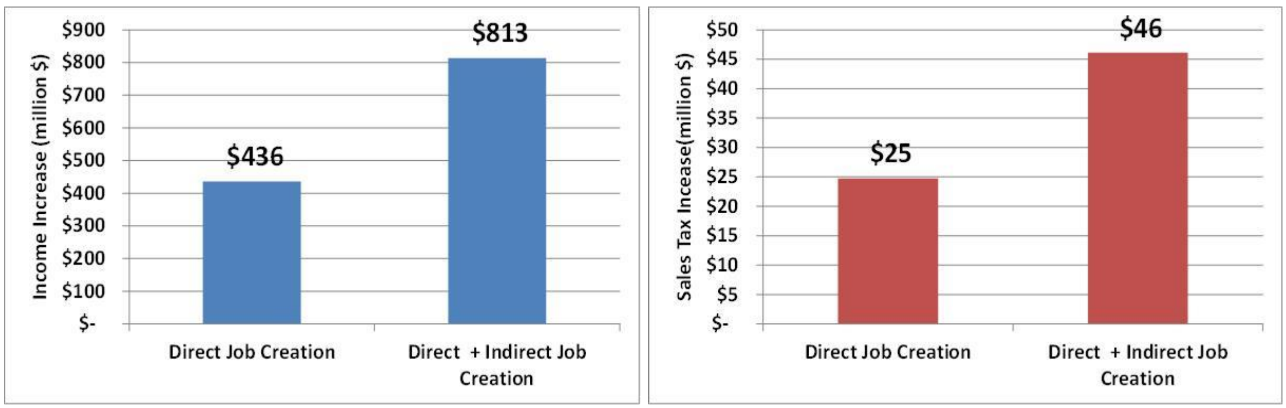


Exhibit 7-9: SH 36A Economic Impacts by 2035

Total Income Increase ($ millions per year) | **Total State Sales Tax Increase** ($ millions per year)



It should be noted, however, that the two initiatives (Port Freeport and Rosenberg rail ramps) are not independent, but rather will tend to strongly reinforce one another. That is, if both developments were undertaken together, it is apparent that the Rosenberg distribution industry would also likely induce a strong demand for trucking containers up SH 36A from Port Freeport. In this case the local job creation impact would be further amplified boosting employment impact closer to the 30,000 range that was cited in Exhibit 7-7.

It is estimated that the increase in Income due to Direct and Indirect jobs in the SH 36A corridor will be $813 million in 2035, and this will expand the sales tax base by over $46 million per year in 2035. This creates a very good case for the counties of the corridor to both support the development of Port Freeport, as well as the rail and highway infrastructure of the SH 36A Corridor.

The economic benefits to the Houston region could be further amplified by the development of a cooperative alliance between the ports of Houston and Freeport. Large ships could be "topped off" at Freeport so they could bring the balance of their cargoes directly into the Houston port. In this way, Houston Ship Channel shippers could gain the benefit of large-ship economics without having to suffer the cost penalties associated with either trucking containers from Freeport, or with transfer of their containers at a Caribbean Hub. Without the ability to take large ships in south Texas, there will not be much market growth. [175,176] But, if large ships can directly call on Houston as a second port of call after Freeport then the market growth in Houston will likely match what has been projected for Freeport, e.g. the addition of yet another 11,000 to 22,000 jobs in Houston (over and above the status quo) due to the overall greater economic competitiveness of the south Texas market area.

[175] *Panama Canal Expansion Study* pg. 120, USDOT MARAD, November 2013, http://www.marad.dot.gov/documents/Panama_Canal_Phase_I_Report_-_20Nov2013.pdf

[176] Port Authority gets green light for major dredging projects, See: http://www.houstonchronicle.com/news/transportation/article/Port-Authority-gets-green-light-for-major-5484906.php

A well-known economic theory (known as Metcalfe's law[177]) states that the value of a network is proportional to the square of the number of connected users of the system (n^2). In other areas of economic endeavor it is similarly understood that non-linear effects are common. The consolidation and integration of market areas is well understood to enhance economic prosperity because it enhances the opportunities for trade. Similarly a unified economic area will be more economically competitive than a fragmented one. As such, there is a great deal of synergy between the development of the two ports of Freeport and Houston and the proposed Rosenberg integrated hub. This needs further study to assess the likely degree of synergy that may exist between the projects (ports and rail ramp) and to determine the probable level of interaction between them.

[177] See https://en.wikipedia.org/wiki/Metcalfe%27s_law

Chapter 8. Summary and Conclusion

Based on the finding and results of this analysis, the following conclusions and next steps are recommended for pursuing further development of freight logistics in the SH 36A corridor.

The Panama Canal expansion will open in 2016. The opportunity for Port Freeport to develop as the major container port on the gulf needs to be realized within the next 5 years, and this needs to include dredging the port to handle 48-50' draft container ships as currently proposed, and building facilities for berthing large container ships. Without this investment other competitive ports will establish Market Share, and this will tend to lock in distribution patterns of major retailers and industrial consumers, and make it harder to shift traffic after that.

This places some urgency on the task of completing the planning for both development of Port Freeport, as well as associated infrastructure, including both the rail link between Freeport and Rosenberg and the proposed SH 36A highway. As a result, this study assumes a 2025 implementation date. This reflects the urgency of capitalizing on the current market opportunity for Texas ports to gain control of their own hinterlands -- including the major cities of Houston, Dallas, Fort Worth and San Antonio -- rather than ceding control of these areas to LA/LB, Miami/Savannah or foreign Caribbean Hubs. Moving promptly is necessary to send a clear signal to the marketplace of Freeport's intention, in conjunction with Houston, to fully develop its Port.

The detailed market analysis conducted in this study suggests that there is a major opportunity for Texas ports to reestablish control of their own market hinterlands. The Texas market is the third largest in the Unites States only after California and the combined markets of New York/New Jersey. There is enough container volume available in Texas to full big ships, which can offer competitive marine rates that will undercut the current price advantages of West Coast ports.

However, while the West Coast (Los Angeles, Long Beach) shares of the Dallas/Fort Worth markets may fall, in absolute terms the growth of container volumes is likely to continue because of the very high growth rates now being experienced in Texas. This will require the development of new infrastructure in any case, so this creates an opportunity to provide Texas residents and businesses with direct access to economical and efficient ocean transportation. Establishing Freeport as a first port of call for large ships would also support the role of Houston as a second port of call. Otherwise Houston would continue with "small ship" costs which will become, over time, less and less competitive with the West Coast ports and will likely relegate Houston's role to that of a satellite port dependent on Caribbean Hubs. It is clear that the ocean shipping lines are committed to a large ship strategy for container traffic so any port who is unable to handle large ships will end up being bypassed. This will saddle Houston shippers with the cost of a double lift with a small feeder ship used only on the final leg into Houston. But as a second port of call, large ships could serve the Houston Ship Channel directly ensuring its continued economic competitiveness for the foreseeable future. The Houston market itself is forecasted to more than triple by 2035 at current rates of growth. This will require a massive expansion of port facilities on the south Texas coast, which will significantly raise employments levels at both Freeport and Houston.

For the SH36A corridor, with development of Port Freeport and an integrated hub at Rosenberg, logistics activity will increase significantly and result in the likely addition of 25,000-30,000 jobs in the corridor. Furthermore the development of a greenfield rail alignment will allow freight railroads to bypass Houston, avoiding the congestion and delays associated with existing rail routes, and reducing truck traffic in the congested urban core as well. Even though the economics associated with the rail project are very strong, the public benefits associated with the development of this project are considerable. In recognition of these benefits, the freight railroads will likely expect some level of public participation in development and financial support of the project.

This study has focused primarily on the development of a rail link in conjunction with development of the SH 36A highway, although rail and highway could be developed on separate alignments, it is also possible that the two projects could be developed together. A key decision of the Texas DOT in cooperation with the SH 36A coalition will be whether to separate the rail and highway projects or to advance them together.

Key goals for development of the rail project are:

- Port Freeport should dredge and develop the Container Port facilities for large ships.
- Work with the railroads to provide rail access to Port Freeport by two or more railroads.
- Development of the rail system should proceed concurrently with Port Freeport development.
- Seek 100% Cost Recovery From Tolls, to minimize Capital Grants
    - Base tolls on railroad operating savings and alternative capital cost avoidance
    - Rail bypass should be more economical than going through downtown Houston
    - Keep tolls lower than Alameda Corridor charges so they remain attractive to the shippers and freight railroads

While this study has not been able to fully develop all the alternatives, at the current time it appears feasible that all the project goals could be achievable within the scope of subsequent planning efforts.

8.1 Next Steps

For further development of the system, the following next steps are recommended:

- Rail development is dependent on Port development, so Port Freeport will need to take the lead in developing its own plans for developing a world-class container port, as well as coordinating all aspects of its own port development with the Port of Houston and the steamship lines.
    - Advance Freeport port infrastructure and proposed port terminal railroad planning from institutional, engineering, environmental, economic and operational perspectives.
    - Assess the feasibility of developing supporting container transload and coastal COB container distribution services in conjunction with Port Freeport and Port Houston.
    - Develop strategies for Inland Ports whether by sharing existing rail ramps with the freight railroads, or by developing new dedicated capacity.
- Fully fund the Brazoria – Fort Bend Rail District so it can aggressively pursue the next stages of project development for the rail system.
    - A critical need for developing financing for both the Port and Rail projects is to refine Port Freeport and Port Houston freight forecasts to the investment grade level. These forecasts drive everything else including the need for both Port and Rail investments.
    - Environmental and Engineering (NEPA) studies of new rail alignment options are needed, including discussions with Texas DOT, freight railroads and ultimately the public regarding the utility of such routes. However, under Texas law, the Brazoria–Fort Bend Rail District already has sufficient legal authority to finance, build and operate the rail corridor, including the right to exercise eminent domain. It is not clear that any additional Federal authorities are needed to build the project. If the need for applying for Federal authorities can be bypassed it is likely that the project delivery can be accelerated by several years.
    - The District will need to coordinate its plans with:
        - The three counties of SH 36A Coalition.
        - Ports of Houston and Freeport
        - Freight Railroads
    - Assess the potential for developing an Integrated hub in the vicinity of Rosenberg and assess the role that SH 36A highway development could play in supporting development of logistics facilities along the corridor.
    - Refine and further develop the financial and economic impact analysis for evaluating both port and rail intermodal facilities on the need for developing the SH 36A corridor.

APPENDICES

APPENDIX 1: Engineering Detailed Cost Breakdowns

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: PORT FREEPORT TO ROSENBERG (63 MILES)			
	COST CATEGORY	TOTAL COST	PRICE PER MILE
1	RIGHT OF WAY	$ 16,600,000	$ 260,000.00
2	GRADING	$ 120,290,000	$ 1,910,000.00
3	UTILITIES/GRADE SEPARATIONS	$ 91,700,000	$ 1,460,000.00
4	RAIL CROSSINGS/DRAINAGE STRUCTURES	$ 25,480,000	$ 400,000.00
5	TRACKWORK	$ 79,500,000	$ 1,260,000.00
6	FENCES AND SIGNS	$ 5,063,000	$ 80,000.00
7	SIGNAL AND COMMUNICATIONS	$ 28,500,000	$ 450,000.00
8	AT-GRADE CROSSINGS	$ 12,600,000	$ 200,000.00
9	OTHER COST ITEMS	$ 195,300,000	$ 3,100,000.00
	TOTAL:	**$ 575,033,000**	**$ 9,120,000**

All Costs in 2015 Dollars

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: ROSENBERG TO CALDWELL (31 MILES)			
	COST CATEGORY	TOTAL COST	PRICE PER MILE
1	RIGHT OF WAY	-	-
2	GRADING	$ 38,800,000	$ 1,270,000.00
3	UTILITIES/GRADE SEPARATIONS	$ 40,300,000	$ 1,320,000.00
4	RAIL CROSSINGS/DRAINAGE STRUCTURES	$ 9,400,000	$ 310,000.00
5	TRACKWORK	$ 32,200,000	$ 1,060,000.00
6	FENCES AND SIGNS	$ 1,240,000	$ 40,000.00
7	SIGNAL AND COMMUNICATIONS	$ 13,600,000	$ 450,000.00
8	AT-GRADE CROSSINGS	$ 8,400,000	$ 280,000.00
9	OTHER COST ITEMS	$ 75,900,000	$ 2,490,000.00
	TOTAL:	**$ 219,840,000**	**$ 7,220,000**

All Costs in 2015 Dollars

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: BRAZORIA TO ROSENBERG (46 MILES)			
	COST CATEGORY	TOTAL COST	PRICE PER MILE
1	RIGHT OF WAY	$ 13,600,000	$ 300,000.00
2	GRADING	$ 70,980,000	$ 1,540,000.00
3	UTILITIES/GRADE SEPARATIONS	$ 74,300,000	$ 1,620,000.00
4	RAIL CROSSINGS/DRAINAGE STRUCTURES	$ 16,640,000	$ 360,000.00
5	TRACKWORK	$ 59,500,000	$ 1,290,000.00
6	FENCES AND SIGNS	$ 3,646,000	$ 80,000.00
7	SIGNAL AND COMMUNICATIONS	$ 20,800,000	$ 450,000.00
8	AT-GRADE CROSSINGS	$ 10,300,000	$ 220,000.00
9	OTHER COST ITEMS	$ 142,200,000	$ 3,090,000.00
	TOTAL:	**$ 411,966,000**	**$ 8,950,000**

All Costs in 2015 Dollars

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: PORT FREEPORT TO BRAZORIA (17 MILES)			
	COST CATEGORY	TOTAL COST	PRICE PER MILE
1	RIGHT OF WAY	$ 3,000,000	$ 180,000.00
2	GRADING	$ 49,310,000	$ 2,900,000.00
3	UTILITIES/GRADE SEPARATIONS	$ 17,400,000	$ 1,020,000.00
4	RAIL CROSSINGS/DRAINAGE STRUCTURES	$ 8,840,000	$ 520,000.00
5	TRACKWORK	$ 20,000,000	$ 1,180,000.00
6	FENCES AND SIGNS	$ 1,417,000	$ 80,000.00
7	SIGNAL AND COMMUNICATIONS	$ 7,700,000	$ 450,000.00
8	AT-GRADE CROSSINGS	$ 2,300,000	$ 140,000.00
9	OTHER COST ITEMS	$ 53,100,000	$ 3,120,000.00
	TOTAL:	**$ 163,067,000**	**$ 9,590,000**

All Costs in 2015 Dollars

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: PORT FREEPORT TO ROSENBERG					
ITEM	**DESCRIPTION OF WORK**	**ESTIMATED QUANTITY**	**UNIT**	**UNIT COST**	**TOTAL COST**
1	**RIGHT OF WAY**				
	LAND ACQUISITION COST - 100 FT ROW - FORT BEND	279	AC	$ 34,374	$ 9,600,000
	LAND ACQUISITION COST - 100 FT ROW - BRAZORIA	485	AC	$ 14,446	$ 7,000,000
2	**GRADING**				
	CLEARING & GRUBBING	764	AC	$ 15,000	$ 11,500,000
	EXCAVATION	674,764	CY	$ 10	$ 6,700,000
	FILL	408,705	CY	$ 12	$ 4,900,000
	FILL - ADDITIONAL FOR FLOODPLAIN - SINGLE TRACK	734,712	CY	$ 12	$ 8,800,000
	SOIL STABILIZATION	1,804,000	SY	$ 7	$ 12,600,000
	STORMWATER MANAGEMENT	63	MI	$ 30,000	$ 1,890,000
	SEEDING & MULCHING	391	AC	$ 2,000	$ 800,000
	SUB-BALLAST - SINGLE TRACK	592,416	TNS	$ 65	$ 38,500,000
	SUB-BALLAST - WITH SIDING	226,512	TNS	$ 65	$ 14,700,000
	SUB-BALLAST - ADDITIONAL FOR FLOODPLAIN - SINGLE TRACK	306,363	TNS	$ 65	$ 19,900,000
3	**UTILITIES/GRADE SEPARATIONS**				
	UTILITIES - PROTECT	41	EA	$ 150,000	$ 6,200,000
	UTILITIES - ENCASE WITH HOT TAP	41	EA	$ 100,000	$ 4,100,000
	UTILITIES - RELOCATE	41	EA	$ 250,000	$ 10,300,000
	UTILITIES - RAIL BRIDGE	8	EA	$ 1,600,000	$ 12,800,000
	UTILITIES - POWER, FIBER, WATER, SANITARY AND GAS	62	EA	$ 26,368	$ 1,600,000
	ROADWAY OVERPASSES *	1	LS	$ 56,700,000	$ 56,700,000
4	**RAIL CROSSINGS/DRAINAGE STRUCTURES**				
	BRIDGES OVER DRAINAGE WAYS - DUAL CELL BOX	100,000	SF	$ 225	$ 22,500,000
	DRAINAGE STRUCTURES - 5' X 5' MBC	5,717	LN FT	$ 450	$ 2,600,000
	DRAINAGE STRUCTURES - MBC HEADWALL	54	EA	$ 7,000	$ 380,000
	INFORMATIONAL PURPOSES ONLY - LIFT BRIDGE - BRAZOS RIVER **	1	EA	$ 36,800,000	$ 36,800,000
5	**TRACKWORK**				
	TRACK	396,000	TRK FT	$ 175	$ 69,300,000
	NO. 15 TURNOUTS	12	EA	$ 200,000	$ 2,400,000
	NO. 20 CROSSOVER - BNSF	1	EA	$ 605,000	$ 600,000
	DIAMOND - BRAZORIA	1	EA	$ 2,040,000	$ 2,000,000
	DIAMOND CROSSING - UP & KCS	2	EA	$ 2,580,000	$ 5,200,000
6	**FENCES AND SIGNS**				
	FENCES	332,640	LN FT	$ 15	$ 5,000,000
	SIGNAGE	63	MI	$ 1,000	$ 63,000
7	**SIGNAL AND COMMUNICATIONS**				
	SIGNAL MAIN LINE	63	MI	$ 310,000	$ 19,700,000
	SIGNALS - AT RAIL INTERSECTIONS/CROSSOVERS	4	LS	$ 3,000,000	$ 8,800,000
8	**AT-GRADE CROSSINGS**				
	AT GRADE CROSSINGS - ROADWAY, PANELS AND ARMS *	1	LS	$ 12,600,000	$ 12,600,000
9	**OTHER COST ITEMS**				
	MOBILIZATION/DEMOBILIZATION (5%)	1	LS	$ 17,200,000	$ 17,200,000
	NON-MAJOR PAY ITEMS (10%)	1	LS	$ 34,500,000	$ 34,500,000
	CONTINGENCIES (20%)	1	LS	$ 69,000,000	$ 69,000,000
	PRELIMINARY ENGINEERING - 3%	1	LS	$ 14,000,000	$ 14,000,000
	FINAL ENGINEERING - 5%	1	LS	$ 23,300,000	$ 23,300,000
	ENVIRONMENTAL MITIGATION - 3%	1	LS	$ 14,000,000	$ 14,000,000
	CONSTRUCTION ENGR & INSP - 5%	1	LS	$ 23,300,000	$ 23,300,000
				36A TOTAL RAILROAD CONSTRUCTION COST:	**$ 575,033,000**

*** SEE TABLE "36A RAIL CROSSINGS_NEW" FOR MORE DETAILED INFORMATION**

**** FOR INFORMATIONAL PURPOSES ONLY; THIS VALUE IS NOT PART OF THE TOTAL COST**

SOURCE: BROWN & GAY ENGINEERS, INC.

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: PORT FREEPORT TO BRAZORIA					
ITEM	DESCRIPTION OF WORK	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1	RIGHT OF WAY				
	LAND ACQUISITION COST - 100 FT ROW - BRAZORIA	206	AC	$ 14,446	$ 3,000,000
2	GRADING				
	CLEARING & GRUBBING	206	AC	$ 15,000	$ 3,100,000
	EXCAVATION	182,079	CY	$ 10	$ 1,800,000
	FILL	110,285	CY	$ 12	$ 1,300,000
	FILL - ADDITIONAL FOR FLOODPLAIN - SINGLE TRACK	650,109	CY	$ 12	$ 7,800,000
	SOIL STABILIZATION	472,267	CY	$ 7	$ 3,300,000
	STORMWATER MANAGEMENT	17	MI	$ 30,000	$ 510,000
	SEEDING & MULCHING	108	AC	$ 2,000	$ 200,000
	SUB-BALLAST - SINGLE TRACK	174,240	TNS	$ 65	$ 11,300,000
	SUB-BALLAST - WITH SIDING	37,752	TNS	$ 65	$ 2,400,000
	SUB-BALLAST - ADDITIONAL FOR FLOODPLAIN - SINGLE TRACK	271,085	TNS	$ 65	$ 17,600,000
3	UTILITIES/GRADE SEPARATIONS				
	UTILITIES - PROTECT	21	EA	$ 150,000	$ 3,200,000
	UTILITIES - ENCASE WITH HOT TAP	21	EA	$ 100,000	$ 2,100,000
	UTILITIES - RELOCATE	21	EA	$ 250,000	$ 5,300,000
	UTILITIES - RAIL BRIDGE	4	EA	$ 1,600,000	$ 6,400,000
	UTILITIES - POWER, FIBER, WATER, SANITARY AND GAS	16	EA	$ 26,368	$ 400,000
4	RAIL CROSSINGS/DRAINAGE STRUCTURES				
	BRIDGES OVER DRAINAGE WAYS - DUAL CELL BOX	27,500	SF	$ 225	$ 6,200,000
	DRAINAGE STRUCTURES - 5' X 5' MBC	5,059	LN FT	$ 450	$ 2,300,000
	DRAINAGE STRUCTURES - MBC HEADWALL	48	EA	$ 7,000	$ 340,000
5	TRACKWORK				
	TRACK	100,320	TRK FT	$ 175	$ 17,600,000
	NO. 15 TURNOUTS	2	EA	$ 200,000	$ 400,000
	DIAMOND CROSSING - BRAZORIA - COMPLETE	1	EA	$ 2,040,000	$ 2,000,000
6	FENCES AND SIGNS				
	FENCES	89,760	LN FT	$ 15	$ 1,400,000
	SIGNAGE	17	MI	$ 1,000	$ 17,000
7	SIGNAL AND COMMUNICATIONS				
	SIGNAL MAIN LINE	17	MI	$ 450,000	$ 7,700,000
8	AT-GRADE CROSSINGS				
	AT GRADE CROSSINGS - ROADWAY, PANELS AND ARMS *	1	LS	$ 2,300,000	$ 2,300,000
9	OTHER COST ITEMS				
	MOBILIZATION/DEMOBILIZATION (5%)	1	LS	$ 4,600,000	$ 4,600,000
	NON-MAJOR PAY ITEMS (10%)	1	LS	$ 9,300,000	$ 9,300,000
	CONTINGENCIES (20%)	1	LS	$ 19,000,000	$ 19,000,000
	PRELIMINARY ENGINEERING - 3%	1	LS	$ 3,800,000	$ 3,800,000
	FINAL ENGINEERING - 5%	1	LS	$ 6,300,000	$ 6,300,000
	ENVIRONMENTAL MITIGATION - 3%	1	LS	$ 3,800,000	$ 3,800,000
	CONSTRUCTION ENGR & INSP - 5%	1	LS	$ 6,300,000	$ 6,300,000
				36A TOTAL RAILROAD CONSTRUCTION COST:	$ 163,067,000

* SEE TABLE "36A RAIL CROSSINGS_END @ BRAZ" FOR MORE DETAILED INFORMATION

SOURCE: BROWN & GAY ENGINEERS, INC.

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: BRAZORIA TO ROSENBERG					
ITEM	DESCRIPTION OF WORK	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1	**RIGHT OF WAY**				
	LAND ACQUISITION COST - 100 FT ROW - FORT BEND	279	AC	$ 34,374	$ 9,600,000
	LAND ACQUISITION COST - 100 FT ROW - BRAZORIA	279	AC	$ 14,446	$ 4,000,000
2	**GRADING**				
	CLEARING & GRUBBING	558	AC	$ 15,000	$ 8,400,000
	EXCAVATION	492,685	CY	$ 10	$ 4,900,000
	FILL	298,420	CY	$ 12	$ 3,600,000
	FILL - ADDITIONAL FOR FLOODPLAIN - SINGLE TRACK	84,603	CY	$ 12	$ 1,000,000
	SOIL STABILIZATION	1,331,733	SY	$ 7	$ 9,300,000
	STORMWATER MANAGEMENT	46	MI	$ 30,000	$ 1,380,000
	SEEDING & MULCHING	282	AC	$ 2,000	$ 600,000
	SUB-BALLAST - SINGLE TRACK	418,176	TNS	$ 65	$ 27,200,000
	SUB-BALLAST - WITH SIDING	188,760	TNS	$ 65	$ 12,300,000
	SUB-BALLAST - ADDITIONAL FOR FLOODPLAIN - SINGLE TRACK	35,278	TNS	$ 65	$ 2,300,000
3	**UTILITIES/GRADE SEPARATIONS**				
	UTILITIES - PROTECT	20	EA	$ 150,000	$ 3,000,000
	UTILITIES - ENCASE WITH HOT TAP	20	EA	$ 100,000	$ 2,000,000
	UTILITIES - RELOCATE	20	EA	$ 250,000	$ 5,000,000
	UTILITIES - RAIL BRIDGE	4	EA	$ 1,600,000	$ 6,400,000
	UTILITIES - POWER, FIBER, WATER, SANITARY AND GAS	46	EA	$ 26,368	$ 1,200,000
	ROADWAY OVERPASSES *	1	LS	$ 56,700,000	$ 56,700,000
4	**RAIL CROSSINGS/DRAINAGE STRUCTURES**				
	BRIDGES OVER DRAINAGE WAYS - DUAL CELL BOX	72,500	SF	$ 225	$ 16,300,000
	DRAINAGE STRUCTURES - 5' X 5' MBC	658	LN FT	$ 450	$ 300,000
	DRAINAGE STRUCTURES - MBC HEADWALL	6	EA	$ 7,000	$ 40,000
	INFORMATIONAL PURPOSES ONLY - LIFT BRIDGE - BRAZOS RIVER **	1	EA	$ 36,800,000	$ 36,800,000
5	**TRACKWORK**				
	TRACK	295,680	TRK FT	$ 175	$ 51,700,000
	NO. 15 TURNOUTS	10	EA	$ 200,000	$ 2,000,000
	NO. 20 CROSSOVER - BNSF	1	EA	$ 605,000	$ 600,000
	DIAMOND CROSSING - UP & KCS - COMPLETE	2	EA	$ 2,580,000	$ 5,200,000
6	**FENCES AND SIGNS**				
	FENCES	242,880	LN FT	$ 15	$ 3,600,000
	SIGNAGE	46	MI	$ 1,000	$ 46,000
7	**SIGNAL AND COMMUNICATIONS**				
	SIGNAL MAIN LINE	46	MI	$ 260,000	$ 12,000,000
	SIGNALS - AT RAIL INTERSECTIONS/CROSSOVERS	4	LS	$ 2,200,000	$ 8,800,000
8	**AT-GRADE CROSSINGS**				
	AT GRADE CROSSINGS - ROADWAY, PANELS AND ARMS *	1	LS	$ 10,300,000	$ 10,300,000
9	**OTHER COST ITEMS**				
	MOBILIZATION/DEMOBILIZATION (5%)	1	LS	$ 12,600,000	$ 12,600,000
	NON-MAJOR PAY ITEMS (10%)	1	LS	$ 25,200,000	$ 25,200,000
	CONTINGENCIES (20%)	1	LS	$ 50,000,000	$ 50,000,000
	PRELIMINARY ENGINEERING - 3%	1	LS	$ 10,200,000	$ 10,200,000
	FINAL ENGINEERING - 5%	1	LS	$ 17,000,000	$ 17,000,000
	ENVIRONMENTAL MITIGATION - 3%	1	LS	$ 10,200,000	$ 10,200,000
	CONSTRUCTION ENGR & INSP - 5%	1	LS	$ 17,000,000	$ 17,000,000
				36A TOTAL RAILROAD CONSTRUCTION COST:	**$ 411,966,000**

*** SEE TABLE "36A RAIL CROSSINGS_END @ BRAZ" FOR MORE DETAILED INFORMATION**

SOURCE: BROWN & GAY ENGINEERS, INC.

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: ROSENBERG TO CALDWELL					
ITEM	DESCRIPTION OF WORK	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1	RIGHT OF WAY				
2	GRADING				
	CLEARING & GRUBBING	185	AC	$ 15,000	$ 2,800,000
	EXCAVATION	163,383	CY	$ 10	$ 1,600,000
	FILL	197,922	CY	$ 12	$ 2,400,000
	FILL - ADDITIONAL FOR FLOODPLAIN - SINGLE TRACK	122,667	CY	$ 12	$ 1,500,000
	SOIL STABILIZATION	447,462	SY	$ 7	$ 3,100,000
	STORMWATER MANAGEMENT	31	MI	$ 30,000	$ 900,000
	SEEDING & MULCHING	92	AC	$ 2,000	$ 200,000
	SUB-BALLAST - SINGLE TRACK	354,390	TNS	$ 65	$ 23,000,000
	SUB-BALLAST - ADDITIONAL FOR FLOODPLAIN - SINGLE TRACK	51,150	TNS	$ 65	$ 3,300,000
3	UTILITIES/GRADE SEPARATIONS				
	UTILITIES - PROTECT	11	EA	$ 150,000	$ 1,700,000
	UTILITIES - ENCASE WITH HOT TAP	11	EA	$ 100,000	$ 1,100,000
	UTILITIES - RELOCATE	11	EA	$ 250,000	$ 2,800,000
	UTILITIES - RAIL BRIDGE	2	EA	$ 1,600,000	$ 3,600,000
	UTILITIES - POWER, FIBER, WATER, SANITARY AND GAS	42	EA	$ 26,368	$ 1,100,000
	ROADWAY OVERPASSES *	3	EA	$ 10,000,000	$ 30,000,000
4	RAIL CROSSINGS/DRAINAGE STRUCTURES				
	BRIDGES OVER DRAINAGE WAYS - DUAL CELL BOX	39,500	SF	$ 225	$ 8,900,000
	DRAINAGE STRUCTURES - 5' X 5' MBC	955	LN FT	$ 450	$ 400,000
	DRAINAGE STRUCTURES - MBC HEADWALL	9	EA	$ 7,000	$ 100,000
5	TRACKWORK				
	TRACK	161,086	TRK FT	$ 175	$ 28,200,000
	NO. 15 TURNOUTS	1	EA	$ 200,000	$ 200,000
	NO. 20 CROSSOVER - BNSF, BLUEBELL & INDUSTRIAL	3	EA	$ 605,000	$ 1,800,000
	DIAMOND CROSSING - BREHNAM BLUE BELL LINE - WB CONNECTION	1	EA	$ 2,040,000	$ 2,000,000
6	FENCES AND SIGNS				
	FENCES	80,543	LN FT	$ 15	$ 1,210,000
	SIGNAGE	31	MI	$ 1,000	$ 30,000
7	SIGNAL AND COMMUNICATIONS				
	SIGNAL MAIN LINE	31	MI	$ 150,000	$ 4,600,000
	SIGNALS - AT RAIL INTERSECTIONS/CROSSOVERS	3	LS	$ 3,000,000	$ 9,000,000
8	AT-GRADE CROSSINGS				
	AT GRADE CROSSINGS - ROADWAY, PANELS AND ARMS *	42	EA	$ 200,000	$ 8,400,000
9	OTHER COST ITEMS				
	MOBILIZATION/DEMOBILIZATION (5%)	1	LS	$ 6,700,000	$ 6,700,000
	NON-MAJOR PAY ITEMS (10%)	1	LS	$ 13,400,000	$ 13,400,000
	CONTINGENCIES (20%)	1	LS	$ 27,000,000	$ 27,000,000
	PRELIMINARY ENGINEERING - 3%	1	LS	$ 5,400,000	$ 5,400,000
	FINAL ENGINEERING - 5%	1	LS	$ 9,000,000	$ 9,000,000
	ENVIRONMENTAL MITIGATION - 3%	1	LS	$ 5,400,000	$ 5,400,000
	CONSTRUCTION ENGR & INSP - 5%	1	LS	$ 9,000,000	$ 9,000,000
				36A TOTAL RAILROAD CONSTRUCTION COST:	$219,840,000

* SEE TABLE "36A RAIL CROSSINGS_EXISTING" FOR MORE DETAILED INFORMATION

SOURCE: BROWN & GAY ENGINEERS, INC.

36A RAIL CROSSINGS - PORT FREEPORT TO ROSENBERG

FULL NAME	CROSSING TYPE	PAVEMENT TYPE	CROSSING LENGTH (FT)	EXISTING LANES	RETWALL AREA (SF)	FILL VOLUME (CY)	BRIDGE WIDTH (FT)	ROADWAY COST	BRIDGE COST	RETAINING WALL AND FILL COST	RAIL CROSSING PANELS	RAIL CROSSING ARMS	TOTAL COST
LEVEE RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 242A	AT GRADE	ASPHALT	15.00	1.00				$8,300.00			$17,000.00	$250,000.00	$275,300.00
SEA DOCK TERMINAL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 2611	AT GRADE	ASPHALT	24.00	2.00				$26,700.00			$26,000.00	$250,000.00	$302,700.00
CR 310	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 521	AT GRADE	ASPHALT	42.00	2.00				$23,300.00			$44,000.00	$250,000.00	$317,300.00
CR 797	AT GRADE	ASPHALT	20.00	2.00				$11,100.00			$22,000.00	$250,000.00	$283,100.00
CR 746	AT GRADE	DIRT	11.00	1.00				$6,100.00			$13,000.00		$19,100.00
CR 244	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 654B	AT GRADE	DIRT	12.00	1.00				$6,700.00			$14,000.00		$20,700.00
CR 851A	AT GRADE	ASPHALT	22.00	2.00				$12,200.00			$24,000.00	$250,000.00	$286,200.00
CR 347	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 348	AT GRADE	ASPHALT	22.00	2.00				$12,200.00			$24,000.00	$250,000.00	$286,200.00
CR 353	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 352	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 356	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 522	AT GRADE	ASPHALT	24.00	2.00				$26,700.00			$26,000.00	$250,000.00	$302,700.00
CR 823	AT GRADE	ASPHALT	22.00	2.00				$12,200.00			$24,000.00	$250,000.00	$286,200.00
SH 35	ROADWAY BRIDGE	CONCRETE	N/A	4.00	38149.92	105972.00	84.00	$1,493,300.00	$7,896,000.00	$2,776,500.00	N/A		$12,165,800.00
CR 376	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 1301	AT GRADE	ASPHALT	42.00	2.00				$46,700.00			$44,000.00	$250,000.00	$340,700.00
CR 450	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 5	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 772	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 522	AT GRADE	DIRT	24.00	2.00				$13,300.00			$26,000.00		$39,300.00
CR 522	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 522	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
VRLLA RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
JC WICKS	AT GRADE	DIRT	12.00	1.00				$6,700.00			$14,000.00		$20,700.00
FM 442	AT GRADE	ASPHALT	44.00	2.00				$48,900.00			$46,000.00	$250,000.00	$344,900.00
HURTA RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
HUBENAK RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 1236	AT GRADE	ASPHALT	34.00	2.00				$37,800.00			$36,000.00	$250,000.00	$323,800.00
ALTIMORE RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 360	AT GRADE	ASPHALT	24.00	2.00				$26,700.00			$26,000.00	$250,000.00	$302,700.00
BAKER RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FOERSTER SCHOOL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
WILLIAMS SCHOOL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FENSKE LN	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
GERKEN RD	ROADWAY BRIDGE	ASPHALT	N/A	2.00	38149.92	59344.32	84.00	$1,493,300.00	$7,896,000.00	$2,310,200.00	N/A		$11,699,500.00
BAND RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
MARIAN LN	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
COTTONWOOD SCHOOL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
KLOSTERHOFF RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
US 59	ROADWAY BRIDGE	CONCRETE	N/A	4.00	43163.60	126293.50	120.00	$2,133,300.00	$11,280,000.00	$3,205,300.00	N/A		$16,618,600.00
US 59 FRONTAGE ROADS	AT GRADE	ASPHALT	72.00	4.00				$40,000.00			$74,000.00	$250,000.00	$364,000.00
RANDON SCHOOL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
US 90A	ROADWAY BRIDGE	ASPHALT	N/A	2.00	38149.92	29672.16	42.00	$746,700.00	$3,948,000.00	$2,013,500.00	N/A		$6,708,200.00
ROBINOWITZ RD N	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
SH 36		ASPHALT	N/A	2.00	49594.90	38573.81	42.00	$970,700.00	$5,132,400.00	$3,402,800.00	N/A		$9,505,900.00
BRAZOS RIVER	LIFT BRIDGE								$36,800,000.00		N/A		$36,800,000.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
							TOTALS	$7,724,700.00	$72,952,400.00	$13,708,300.00	$1,534,000.00		$106,169,400.00

36A RAIL CROSSINGS - PORT FREEPORT TO BRAZORIA

FULL NAME	CROSSING TYPE	PAVEMENT TYPE	CROSSING LENGTH (FT)	EXISTING LANES	RETWALL AREA (SF)	FILL VOLUME (CY)	BRIDGE WIDTH (FT)	ROADWAY COST	BRIDGE COST	RETAINING WALL AND FILL COST	RAIL CROSSING PANELS	RAIL CROSSING ARMS	TOTAL COST
LEVEE RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 242A	AT GRADE	ASPHALT	15.00	1.00				$8,300.00			$17,000.00	$250,000.00	$275,300.00
SEA DOCK TERMINAL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 2611	AT GRADE	ASPHALT	24.00	2.00				$26,700.00			$26,000.00	$250,000.00	$302,700.00
CR 310	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 521	AT GRADE	ASPHALT	42.00	2.00				$23,300.00			$44,000.00	$250,000.00	$317,300.00
CR 797	AT GRADE	ASPHALT	20.00	2.00				$11,100.00			$22,000.00	$250,000.00	$283,100.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
							TOTALS	$184,000.00	$0.00	$0.00	$340,000.00		$2,274,000.00

36A RAIL CROSSINGS - BRAZORIA TO ROSENBERG

FULL NAME	CROSSING TYPE	PAVEMENT TYPE	CROSSING LENGTH (FT)	EXISTING LANES	RETWALL AREA (SF)	FILL VOLUME (CY)	BRIDGE WIDTH (FT)	ROADWAY COST	BRIDGE COST	RETAINING WALL AND FILL COST	RAIL CROSSING PANELS	RAIL CROSSING ARMS	TOTAL COST
CR 746	AT GRADE	DIRT	11.00	1.00				$6,100.00			$13,000.00		$19,100.00
CR 244	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 654B	AT GRADE	DIRT	12.00	1.00				$6,700.00			$14,000.00		$20,700.00
CR 851A	AT GRADE	ASPHALT	22.00	2.00				$12,200.00			$24,000.00	$250,000.00	$286,200.00
CR 347	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 348	AT GRADE	ASPHALT	22.00	2.00				$12,200.00			$24,000.00	$250,000.00	$286,200.00
CR 353	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 352	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 356	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 522	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 823	AT GRADE	ASPHALT	22.00	2.00				$12,200.00			$24,000.00	$250,000.00	$286,200.00
SH 35	ROADWAY BRIDGE	CONCRETE	N/A	4.00	38149.92	105972.00	84.00	$1,493,300.00	$7,896,000.00	$2,776,500.00	N/A		$12,165,800.00
CR 376	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 1301	AT GRADE	ASPHALT	42.00	2.00				$23,300.00			$44,000.00	$250,000.00	$317,300.00
CR 450	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 5	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 772	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 522	AT GRADE	DIRT	24.00	2.00				$13,300.00			$26,000.00		$39,300.00
CR 522	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
CR 522	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
VRLLA RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
JC WICKS	AT GRADE	DIRT	12.00	1.00				$6,700.00			$14,000.00		$20,700.00
FM 442	AT GRADE	ASPHALT	44.00	2.00				$24,400.00			$46,000.00	$250,000.00	$320,400.00
HURTA RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
HUBENAK RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 1236	AT GRADE	ASPHALT	34.00	2.00				$18,900.00			$36,000.00	$250,000.00	$304,900.00
ALTIMORE RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FM 360	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
BAKER RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FOERSTER SCHOOL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
WILLIAMS SCHOOL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
FENSKE LN	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
GERKEN RD	ROADWAY BRIDGE	ASPHALT	N/A	2.00	38149.92	59344.32	84.00	$1,493,300.00	$7,896,000.00	$2,310,200.00	N/A		$11,699,500.00
BAND RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
MARIAN LN	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
COTTONWOOD SCHOOL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
KLOSTERHOFF RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
US 59	ROADWAY BRIDGE	CONCRETE	N/A	4.00	43163.60	126293.50	120.00	$2,133,300.00	$11,280,000.00	$3,205,300.00	N/A		$16,618,600.00
US 59 FRONTAGE ROADS	AT GRADE	ASPHALT	72.00	4.00				$40,000.00			$74,000.00	$250,000.00	$364,000.00
RANDON SCHOOL RD	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
US 90A	ROADWAY BRIDGE	ASPHALT	N/A	2.00	38149.92	29672.16	42.00	$746,700.00	$3,948,000.00	$2,013,500.00	N/A		$6,708,200.00
ROBINOWITZ RD N	AT GRADE	ASPHALT	24.00	2.00				$13,300.00			$26,000.00	$250,000.00	$289,300.00
SH 36		ASPHALT	N/A	2.00	49594.90	38573.81	42.00	$970,700.00	$5,132,400.00	$3,402,800.00	N/A		$9,505,900.00
BRAZOS RIVER	LIFT BRIDGE								$36,800,000.00		N/A		$36,800,000.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
	AT GRADE	DIRT	15.00	1.00				$8,300.00			$17,000.00		$25,300.00
							TOTALS	$7,438,800.00	$72,952,400.00	$13,708,300.00	$1,177,000.00	$8,500,000.00	$103,776,500.00

36A RAIL CROSSINGS - ROSENBERG TO CALDWELL						
FULL NAME	ADDITIONAL NAMES	CROSSING TYPE	DISTANCE (FT)	DISTANCE (MI)	RAILROAD BRIDGE LENGTH (FT)	TOTAL CULVERT LENGTH (FT)
ROSENBERG TO WALLIS						
2906 TEXAS 36 ROSENBERG		AT-GRADE				
UNKNOWN RD		AT-GRADE	1,497.66	0.28		
UNKNOWN RD		AT-GRADE	1,673.31	0.32		
UNKNOWN RD		AT-GRADE	3,747.10	0.71		
RR BRIDGE (UNKNOWN)		RAILROAD BRIDGE	3,799.10	0.72	55	
UNKNOWN RD		AT-GRADE	1,742.20	0.33		
CREEK (NAME)		CULVERT	1,175.20	0.22		45
UNKNOWN RD		AT-GRADE	4,243.00	0.80		
CREEK (NAME)		RAILROAD BRIDGE	5,116.60	0.97	70	
CREEK (NAME)		RAILROAD BRIDGE	3,621.80	0.69	100	
LONG LN		AT-GRADE	6,403.40	1.21		
MISSOURI ST		AT-GRADE	3,694.70	0.70		
CREEK (NAME)		RAILROAD BRIDGE	2,142.20	0.41	55	
SIMONTON RD	1489	AT-GRADE	117.80	0.02		
UNKNOWN RD		AT-GRADE	1,779.80	0.34		
CREEK (NAME)		RAILROAD BRIDGE	549.70	0.10	55	
UNKNOWN RD		AT-GRADE	1,892.60	0.36		
REINECKER RD		AT-GRADE	5,118.70	0.97		
HATTON RD		AT-GRADE	3,559.00	0.67		
UNKNOWN RD		AT-GRADE	888.50	0.17		
UNKNOWN RD		AT-GRADE	854.00	0.16		
BRENHAM (CENTER)						
CR 36	NEW WEHDEM RD	AT-GRADE				
ALL JERSEY RD		AT-GRADE	5,753.80	1.09		
PLEASANT HILL SCHOOL RD		AT-GRADE	4,604.40	0.87		
CR 109		AT-GRADE	5,780.50	1.09		
KUHN LN		AT-GRADE	1,996.50	0.38		
SALEM RD		AT-GRADE	1,264.40	0.24		
INDUSTRIAL BLVD		AT-GRADE	4,538.90	0.86		
US-290		ROADWAY OVERPASS	1,024.60	0.19		
S. JASKSON ST		AT-GRADE	4,218.40	0.80		
CR 389	COLLEGE AVE	AT-GRADE	596.20	0.11		
W. 3RD ST		AT-GRADE	541.50	0.10		
W. 2ND ST		AT-GRADE	534.30	0.10		
W. 1ST ST		AT-GRADE	537.10	0.10		
RR TRACK CROSSING		AT-GRADE	138.22	0.03		
PEABODY ST		AT-GRADE	257.61	0.05		
US-290	W. ALAMO ST	AT-GRADE	337.60	0.06		
W. MAIN ST		AT-GRADE	231.50	0.04		
MARTIN LUTHER KING JR PKWY		RAILROAD BRIDGE	1,133.80	0.21	65	
W BLUE BELL RD		AT-GRADE	2,288.40	0.43		
LITTLE SANDY CREEK		RAILROAD BRIDGE	3,044.30	0.58	60	
LITTLE SANDY CREEK		RAILROAD BRIDGE	1,742.70	0.33	135	
SH 36	TREADWAY PARK	ROADWAY OVERPASS	587.40	0.11		
BENTON DR	STRANGMEIER RD	AT-GRADE	191.10	0.04		
CR 30	N. BERLIN RD	ROADWAY OVERPASS	4,286.10	0.81		
BIG SANDY CREEK		RAILROAD BRIDGE	2,853.70	0.54	80	
CR 56A	PLEDGER RD	AT-GRADE	4,648.80	0.88		
LYONS TO CALDWELL						
ONE MILE SE OF CR 470(1)						
UNKNOWN RD		AT-GRADE	1,875.00	0.36		
CR 470 (1)		AT-GRADE	3,405.00	0.64		
POTENTIAL CULVERT		CULVERT	885.00	0.17		70
CR 470 (2)		AT-GRADE	1,780.00	0.34		
DAVIDSON CREEK		RAILROAD BRIDGE	2,326.80	0.44	320	
CR 119		AT-GRADE	7,257.60	1.37		
UNKNOWN RD		AT-GRADE	4,413.30	0.84		
CR 123		AT-GRADE	2,476.70	0.47		
CR 120		AT-GRADE	4,051.70	0.77		
DAVIDSON CREEK		RAILROAD BRIDGE	13,474.50	2.55	350	
SH 36	TREADWAY PARK	RAILROAD BRIDGE	9,292.70	1.76	105	
OLD SUMMERVILLE RD	FREEMAN ST	AT-GRADE	2,118.40	0.40		
RR TRACK CROSSING		RAILROAD BRIDGE	981.31	0.19	130	

36A RAIL CONCEPTUAL LEVEL RAILROAD CONSTRUCTION COST: PORT FREEPORT TO ROSENBERG (63 MILES)				R2C2 ALIGNMENT B (180 MILES)		
COST CATEGORY		TOTAL COST	PRICE PER MILE (2015 $$)	TOTAL COST (2008 $$)	PRICE PER MILE (2008 $$)	PRICE PER MILE (2015 $$)
1	RIGHT OF WAY	$ 16,600,000	$ 260,000	$ 12,000,000	$ 70,000	$ 76,000
2	GRADING	$ 120,290,000	$ 1,910,000	$ 317,000,000	$ 1,760,000	$ 1,910,000
3	UTILITIES/GRADE SEPARATIONS	$ 91,700,000	$ 1,460,000	$ 60,000,000	$ 330,000	$ 358,000
4	RAIL CROSSINGS/DRAINAGE STRUCTURES	$ 25,480,000	$ 400,000	$ 31,000,000	$ 170,000	$ 184,000
5	TRACKWORK	$ 79,500,000	$ 1,260,000	$ 232,000,000	$ 1,290,000	$ 1,400,000
6	FENCES AND SIGNS	$ 5,063,000	$ 80,000	$ 10,000,000	$ 60,000	$ 65,000
7	SIGNAL AND COMMUNICATIONS	$ 28,500,000	$ 450,000	$ 123,000,000	$ 680,000	$ 738,000
8	AT-GRADE CROSSINGS	$ 12,600,000	$ 200,000	$ 7,000,000	$ 40,000	$ 43,000
9	OTHER COST ITEMS	$ 195,300,000	$ 3,100,000	$ 396,000,000	$ 2,200,000	$ 2,387,000
	TOTAL:	**$ 575,033,000**	**$ 9,120,000**	**$ 1,188,000,000**	**$ 6,600,000**	**$ 7,162,000.00**

2008 to 2015 Adjustment for R2C2 Costs	8.51%

APPENDIX 2: GOODS™ Model

1 Introduction

The GOODS™ ports container model is a flexible multimodal demand forecasting tool that has been developed to provide an assessment of international shipping, port competition and inland distribution for North America Trade and Transportation. It provides an evaluation of the impact of alternative socioeconomic futures, and different transport service options on trade volumes and revenues on different transport links and facilities.

The model is designed to be "transparent" and allow the sensitivity of a set of results to be tested for stability. This includes adjustments to not just economic, trade, and transportation options, but to detailed model assumptions such as specific competitive elasticities, values of time and route/modal biases.

Exhibit 1-1 shows the general structure of the National Ports Model. It can be seen that by using World Trade Data and North American Regional Freight traffic distribution data, a base and forecast year matrix can be developed of traffic commodity flows on a country-to-North American regional market basis (see Exhibit 2-2). This origin-destination matrix provides the basis for calibrating the National Ports Model and evaluating the impact of different shipping, port, and inland transport options.

Shipping route, port, and inland mode market share models are developed using data that describes the transportation time and costs for each combination of possible shipping route, port, and inland mode. Forecasts of traffic are generated on a route, port, and mode basis for different port development and charging strategies. Revenue yield maximizing analysis can be used to identify the levels of port charging possible, the stability for different cargos or commodities of price options, and the impact of different discount or price variation options by commodity and time and type of use.

Exhibit 1-3 shows the general form of the Ports route choice, and competition model as structured to evaluate West Coast Port competition. It can be seen that Northwest Coast ports are separated from California ports; Vancouver from U.S. ports; Portland from Seattle/Tacoma; and Seattle from Tacoma. The structure reflects the competitive differences between ports-the greatest differences existing at the top of the hierarchy, the least difference at the bottom. In practice, some variation from this structure may be used if it is found, for example, that Vancouver is more like the Northwest U.S. ports than the California ports. Vancouver may be different because it is Canadian and works with different regulatory rules and customs policies. Since such variances exist in practice, they are identified in the model calibration process and the model structure adjusted accordingly.

Exhibit 1-1: North American Ports Model

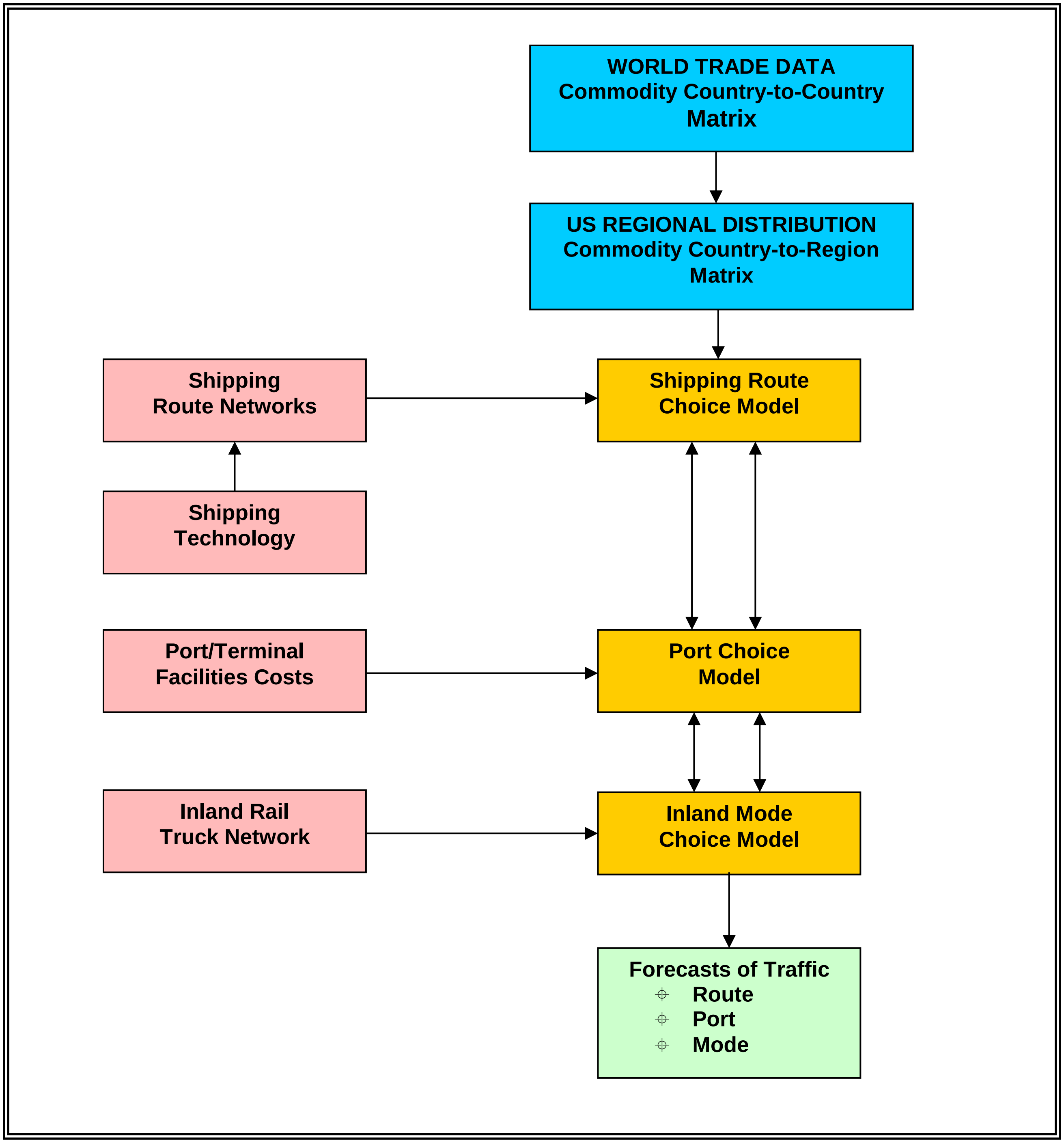


Exhibit 1-2: US Inland Zone System for North American Ports Model

US INLAND ZONE SYSTEM

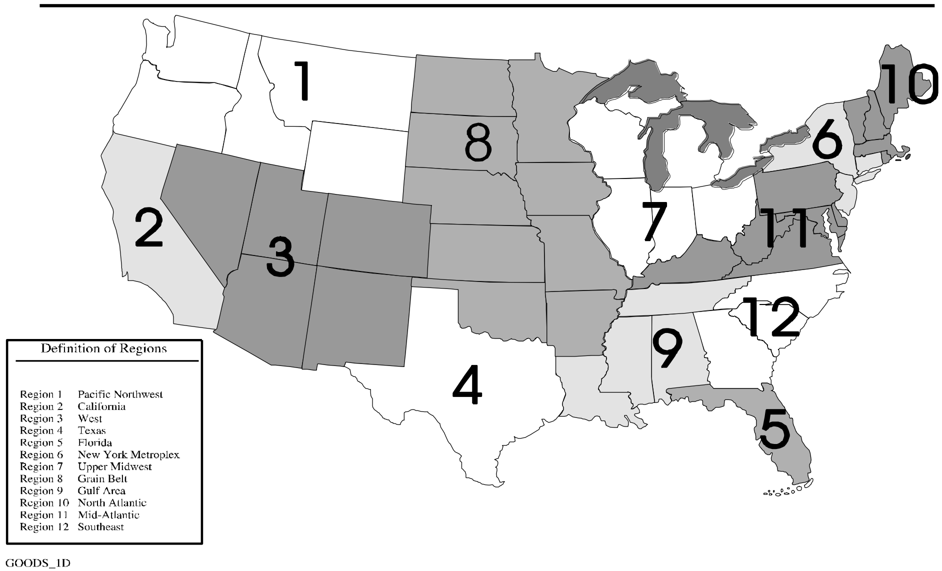
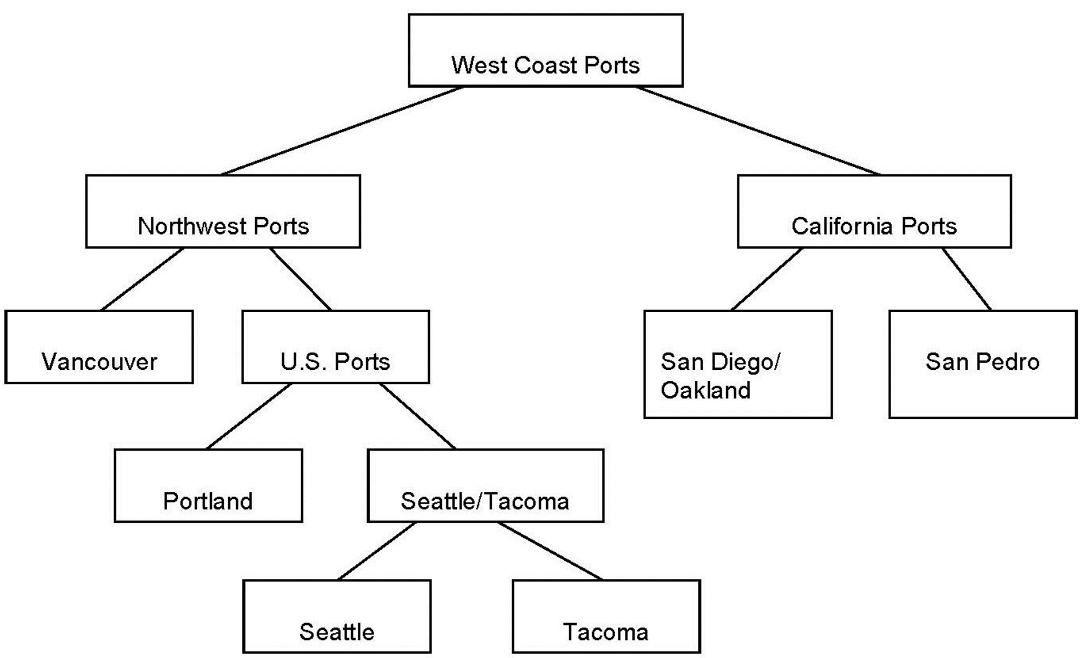


Exhibit 1-3: West Cost Competition Structure



2 Description of the GOODS™ Model system

The *GOODS*™ Model is structured on two principal models: Total Demand Model, and the Hierarchical Modal Split Model. For this study, these two models were calibrated separately for four types of commodity, i.e., *Food, Raw Material, Semi Finished,* and *Finished*. For each market segment, the models were calibrated on origin-destination container freight data, network characteristics and base year socioeconomic data.

The models are calibrated on the base year data. In applying the models for forecasting, an incremental approach known as the "pivot point" method is used. By applying model growth rates to the base data observations, the "pivot point" method is able to preserve the unique container freight flows present in the base data that are not captured by the model variables. Details on how this method is implemented are described below.

2.1 Total Demand Model

The Total Demand Model, shown in Equation 1, provides a mechanism for assessing overall growth in the container freight market. This form of model has been shown to be very successful in reflecting the way in which container traffic relates to both the difficulty or cost of travel and the landuse patterns of a region - See Equation 1.

Equation 1:

$$C_{ijp} = e^{\beta 0p} e^{\beta 1p\, Uijp} (SE_{ip})^{\beta 2p} (SE_{jp})^{\beta 3p}$$

Where,

C_{ijp} = Number of containers of commodity type p from zone *i* to *j*,

SE_{ip} = Socioeconomic variable for zone *i* for commodity type *p*,

SE_{jp} = Socioeconomic variable for zone *j* for commodity type *p*,

U_{ijp} = Total utility of the transportation system for zones *i* to *j* for type *p*,

$\beta_{0p}, \beta_{1p}, \beta_{2p}, \beta_{3p}$ = Coefficients for commodity type *p.*

As shown in Equation 1, the total number of containers moving between any two zones for all modes of shipping, segmented by commodity type, is a function of the socioeconomic characteristics of the zones and the total utility of the transportation system that exists between the two zones. For this study, commodity type includes *Food, Raw Material, Semi Finished,* and *Finished*, and socioeconomic characteristics consist of population, manufacturing employment, and forestry, fisheries and mining employment. The utility function provides a logical and intuitively sound method of assigning a value to the shipping opportunities provided by the overall transportation system.

In the Total Demand Model, the utility function provides a measure of the quality of the transportation system to shippers in terms of the times, costs, reliability and level of service provided by all modes for a given freight type. The Total Demand Model equation may be interpreted as meaning that shipping between zones will increase as socioeconomic factors such as population and employment rise or as the utility (or quality) of the transportation system is improved by providing new facilities and services that reduce shipping times and costs. The Total Demand Model can therefore be used to evaluate the effect of changes in both socioeconomic and shipping characteristics on the total demand for shipping.

Socioeconomic Variables

The socioeconomic variables in the Total Demand Model show the impact of economic growth on container freight. The *GOODS*™ Model System uses three variables (population, manufacturing employment, and forestry fisheries, and mining employment) to represent the socioeconomic characteristics of a zone. The socio economic variables were chosen to best represent the shippers who generate the freight flow and recipients who “consume” the commodity. Exhibit 2-1 shows the variables that were used.

Exhibit 2-1: Socioeconomic variables

Container Freight Type	Generator	Attractor
Food	Manufacturing Employment	Population
Raw Material	Forestry, Fisheries, and Mining Employment	Manufacturing Employment
Semi-Finished	Manufacturing Employment	Manufacturing Employment
Finished	Manufacturing Employment	Manufacturing Employment

Shipping Utility

The value of shippers put on a wide range of transportation factors is considered in defining the utility of shipping.

Estimates of shipping utility for a transportation network are generated as a function of generalized cost (GC), as shown in Equation 2:

Equation 2:

$$U_{ijp} = f(GC_{ijp})$$

Where: GC_{ijp}=Generalized Cost of shipping between zones *i* and *j* for commodity type *p*

Because the generalized cost variable is used to estimate the impact of improvements in the transportation system on the overall level of trip making, it needs to incorporate all the key modal attributes that affect an individual's decision to make shipments. The generalized cost of shipping includes all aspects of shipping time (access, egress, in-vehicle times), shipping cost (fares, tolls, parking charges), schedule convenience (frequency of service, convenience of arrival/departure times) and reliability.

The generalized cost of shipping is typically defined in shipping time (*i.*e., minutes) rather than dollars. Costs are converted to time by applying appropriate conversion factors, as shown in Equation 3. The generalized cost (GC) of shipping between zones i and j for mode m and trip purpose p is calculated as follows:

Equation 3:

$$GC_{ijmp} = ST_{ijm} + \frac{SC_{ijmp}}{VOT_{mp}} + \frac{VOF_{mp}OH}{VOT_{mp}F_{ijm}} + \frac{VOR_{mp}\exp(-OTP_{ijm})}{VOT_{mp}}$$

Where:

ST_{ijm}	=	Shipping Time between zones *i* and *j* for mode *m*
SC_{ijmp}	=	Shipping Cost between zones *i* and *j* for mode *m* and commodity type *p*
VOT_{mp}	=	Value of Time for mode *m* and commodity type *p*
VOF_{mp}	=	Value of Frequency for mode *m* and commodity type *p*
VOR_{mp}	=	Value of Reliability for mode *m* and commodity type *p*
F_{ijm}	=	Frequency in departures per week between zones *i* and *j* for mode *m*
OTP_{ijm}	=	On-time performance for shipping between zones *i* and *j* for mode *m*
OH	=	Operating hours per week

The first term in generalized cost function is the shipping time. The second term converts the cost of shipping into time units. The third term in the generalized cost function converts the frequency attribute into time units. Operating hours divided by frequency is a measure of the headway or time between departures. Tradeoffs are made in the stated preference surveys resulting in the value of frequencies on this measure. Although there may appear to some double counting because the station wait time in the first term of the generalized cost function is included in this headway measure, it is not the headway time itself that is being added to the generalized cost. The third term represents the impact of perceived frequency valuations on generalized cost.

The fourth term of the generalized cost function is a measure of the value placed on reliability of the mode. The negative exponential form of the reliability term implies that improvements from low levels of reliability have slightly higher impacts than similar improvements from higher levels of reliability.

CALIBRATION OF THE TOTAL DEMAND MODEL

In order to ensure that the total demand model uses appropriate local or regional constraints needs to be calibrated using base year data. To calibrate the Total Demand Model, the coefficients are estimated using linear regression techniques. Equation 1, the equation for the Total Demand Model, is transformed by taking the natural logarithm of both sides, as shown in Equation 4:

Equation 4:

$$\log(C_{ijp}) = \beta_{0p} + \beta_{1p}(U_{ijp}) + \beta_{2p}\log(SE_{ip}) + \beta_{3p}\log(SE_{jp})$$

Equation 4 provides the linear specification of the model necessary for regression analysis.

The segmentation of the database by commodity type resulted in four sets of models. The results of the calibration for the Total Demand Models are displayed in Exhibit 2-2.

In evaluating the validity of a statistical calibration, there are two key statistical measures: *t*-statistics and R^2. The *t*-statistics are a measure of the significance of the model's coefficients; values of 1.95 and above are considered "good" and imply that the variable has significant explanatory power in estimating the level of trips. The R^2 is a statistical measure of the "goodness of fit" of the model to the data; any data point that deviates from the model will reduce this measure. It has a range from 0 to a perfect 1, with 0.4 and above considered "good" for large data sets.

Based on these two measures, the total demand calibrations are good. The *t*-statistics are very high, aided by the large size of the data set. The R^2 values imply very good fits of the equations to the data.

For forecasting purposes, the total demand equation needs one modification. Because of increases in the standard of living, the amount of consumption of freight will rise and consequently the volume of commodity flow will also rise. The static model in Exhibit 2-2 does not account for this effect. Thus the following time series model was calibrated:

$$\log (C_t) = 13.258 + 0.682 \log(GDP_t) \quad R^2=0.60$$

$$(11) \qquad (5)$$

where:

C_t= Total container traffic in year t

GDP_t = Gross domestic product (in billions) in year t

(t statistics in parenthesis)

This equation implies that a 1% increase in GDP will result in a 0.682% increase in the total freight traffic. The total demand model was refined with this equation for forecasting.

Exhibit 2-2: Total Demand Model Coefficients [1]

Food $R^2=0.74$

$$\log(C_{ij}) = -5.867 + 0.741\, U_{ij} + 0.623 \log(M_O) + 0.461 \log(P_D)$$

(-9) (14) (16) (12)

where $U_{ij} = \log[\exp(-3.969 + 0.248\, U_{Batch}) + \exp(0.00057\, GC_{Truck})]$

Raw-Material $R^2=0.60$

$$\log(C_{ij}) = -3.862 + 0.462\, U_{ij} + 0.462 \log(FM_O) + 0.560 \log(M_D)$$

(-4) (11) (7) (10)

where $U_{ij} = \log[\exp(-2.406 + 1.741\, U_{Batch}) + \exp(0.000922\, GC_{Truck})]$

Semi-Finished $R^2=0.55$

$$\log(C_{ij}) = 4.138 + 1.215\, U_{ij} + 0.239 \log(M_O) + 0.201 \log(M_D)$$

(6) (21) (4) (4)

where $U_{ij} = \log[\exp(-3.5217 + 0.844\, U_{Batch}) + \exp(0.00078\, GC_{Truck})]$

Finished $R^2=0.83$

$$\log(C_{ij}) = -10.413 + 0.291\, U_{ij} + 0.671 \log(M_O) + 0.696 \log(P_D)$$

(-20) (9) (25) (26)

where $U_{ij} = \log[\exp(-3.910 + 0.940\, U_{Batch}) + \exp(0.001312\, GC_{Truck})]$

where:

M= Manufacturing Employment,

P= Population,

FM= Forestry, Fisheries and Mining Employment,

U_{ij} = Combined utility of all modes,

C_{ij} =Number of Containers moving from zone i to zone j,

U_{ij} =Combined utility of all modes from zone i to zone j,

O =Origin Zone,

D = Destination Zone.

[1] *t-statistics are given in parentheses.*

INCREMENTAL FORM OF THE TOTAL DEMAND MODEL

The calibrated Total Demand Models could be used to estimate the total container freight market for any zone pair using the population, Manufacturing Employment , forestry , fishery, and mining employment and the total utility of all the modes. However, there would be significant differences between estimated and observed levels of trip making for many zone pairs despite the good fit of the models to the data. To preserve the unique container freight shipping patterns contained in the base data, the incremental approach or "pivot point" method is used for forecasting. In the incremental approach, the base container freight data is used as a pivot point, and forecasts are made by applying trends to the base data. The total demand equation as described in Equation 1 can be rewritten into the following incremental form that can be used for forecasting (Equation 5):

Equation 5:

Where:

$$\frac{C_{ijp}^{\ f}}{C_{ijp}^{\ b}} = \exp(\beta_{1p}\,(U_{ijp}^{\ f} - U_{ijp}^{\ b}))\left(\frac{SE_{ip}^{\ f}}{SE_{ip}^{\ b}}\right)^{\beta_{2p}}\left(\frac{SE_{jp}^{\ f}}{SE_{jp}^{\ b}}\right)^{\beta_{3p}}$$

C^f_{ijp} = Number of Containers of commodity type *p* shipped from zone *i* to *j* in forecast year *f*

C^f_{ijp} = Number of Containers of commodity type *p* shipped from zone *i* to *j* in base year *b*

SE^f_{ip} = Socioeconomic variables for zone *i* for commodity type *p* in forecast year *f*

SE^b_{ip} = Socioeconomic variables for zone *i* for commodity type *p* in base year *b*

SE^f_{jp} = Socioeconomic variables for zone *j* for commodity type *p* in forecast year *f*

SE^b_{jp} = Socioeconomic variables for zone *j* for commodity type *p* in base year *b*

U^f_{ijp} = Total utility of the transportation system for zones *i* to *j* for commodity type *p* in forecast year *f*

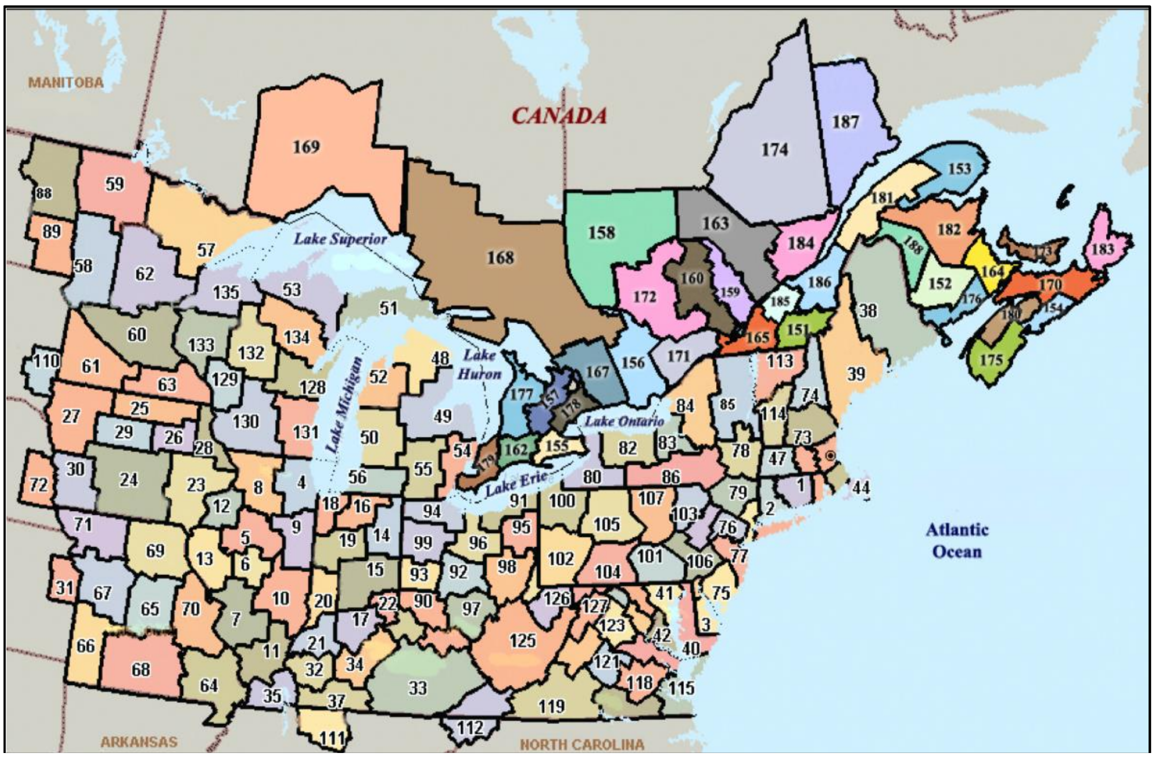
U^b_{ijp} = Total utility of the transportation system for zones *i* to *j* for commodity type *p* in base year *b*

In the incremental form, the constant term disappears and only the elasticities are important.

2.2 Hierarchical Route Choice Model

The role of the Hierarchical Route Split Model is to estimate the relative shares of marine routes and ports, given the total market for any given origin destination pair of trading partner country and North American market. The North American market can be disaggregated to a regional, state/province, or NAICS area. Exhibit 2-3 shows the GOODS™ model zone system used to evaluate Trade and Transportation for the Great Lakes and St. Lawrence Seaway System. In addition to East Coast Ports from Halifax to Norfolk, west coast Ports from Vancouver to San Pedro, as well as possible new ports such as Prince Rupert (Canada) and Lazaro Cardenas (Mexico)

Exhibit 2-3: Great Lakes and St. Lawrence Seaway Zone Map



The general form of the Port and Route Split Model used to estimate market shares is:

$$P_{ijmp} = \frac{e^{U_{ijmp}}}{e^{U_{ijmp}} + e^{U_{ijmp}}}$$

where

$P_{ijmp} =$ Percentage of trips between i and j by mode m for product p

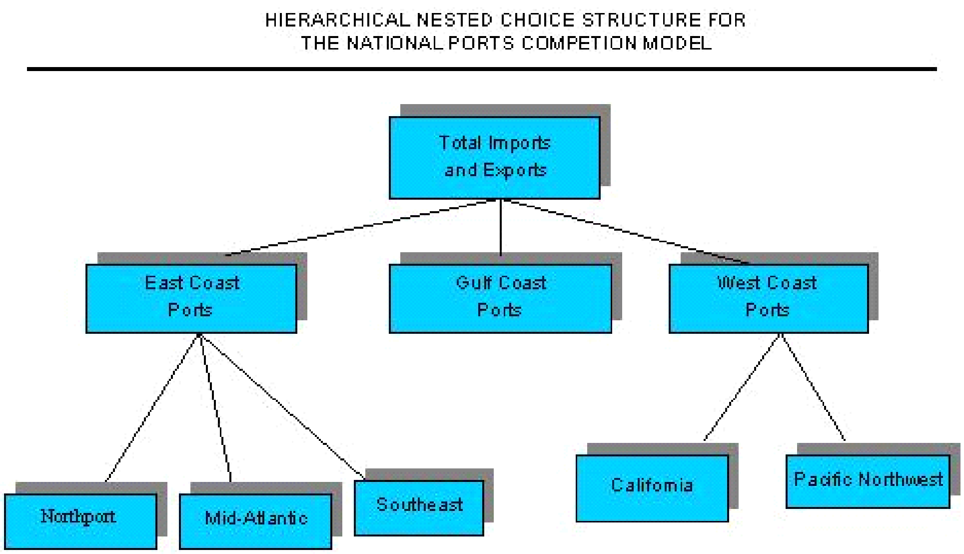
$U_{ijdp,} U_{ijmp,} U_{ijrp}$ = Utilities for movement between zones i and j for product p for the different ports d, modes m, and routes r

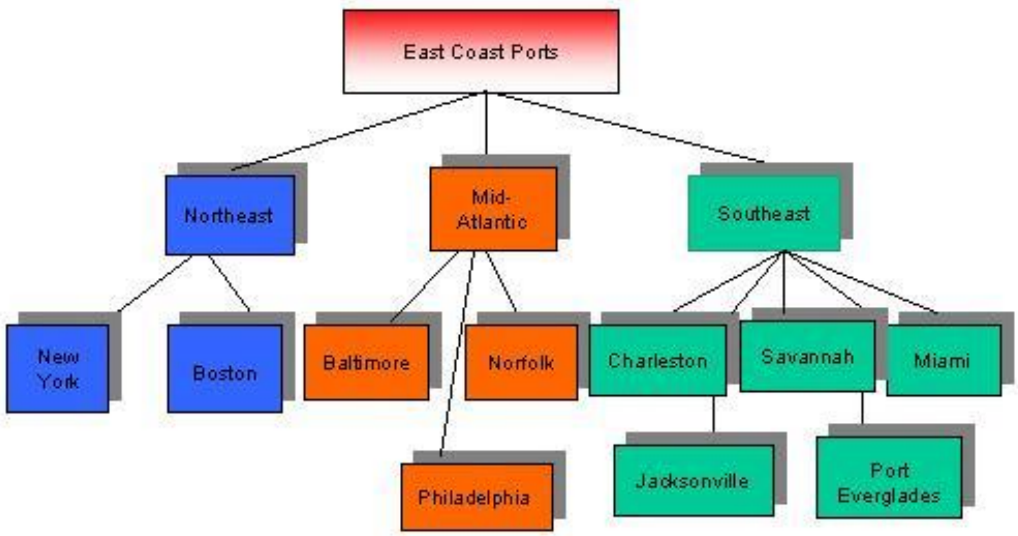
A variety of forms of the modal split function can be used the modal split analysis ranging form multinomial to hierarchical, with different structural orderings. For a short-term elasticity analysis of existing industry conditions, both stated preference and *revealed behavior* models can be calibrated and tested. However, only stated preference models can be used to evaluate the long-term changes associated with a new transportation option (e.g., intermodal corridors or new vessels/ships), as only stated preference models can effectively evaluate the *new system* attributes of the new transportation option.

2.2.1 Competitive Port Analysis

In carrying out a National Ports competitive analysis an approval is needed that considers the competition not only within the East Coast ports, but also between East Coast ports and those of the West Coast and the Gulf (Exhibit 2-4 and 2-5).

Exhibits 2-4 and 2-5: Competitive Structures for Port Analysis

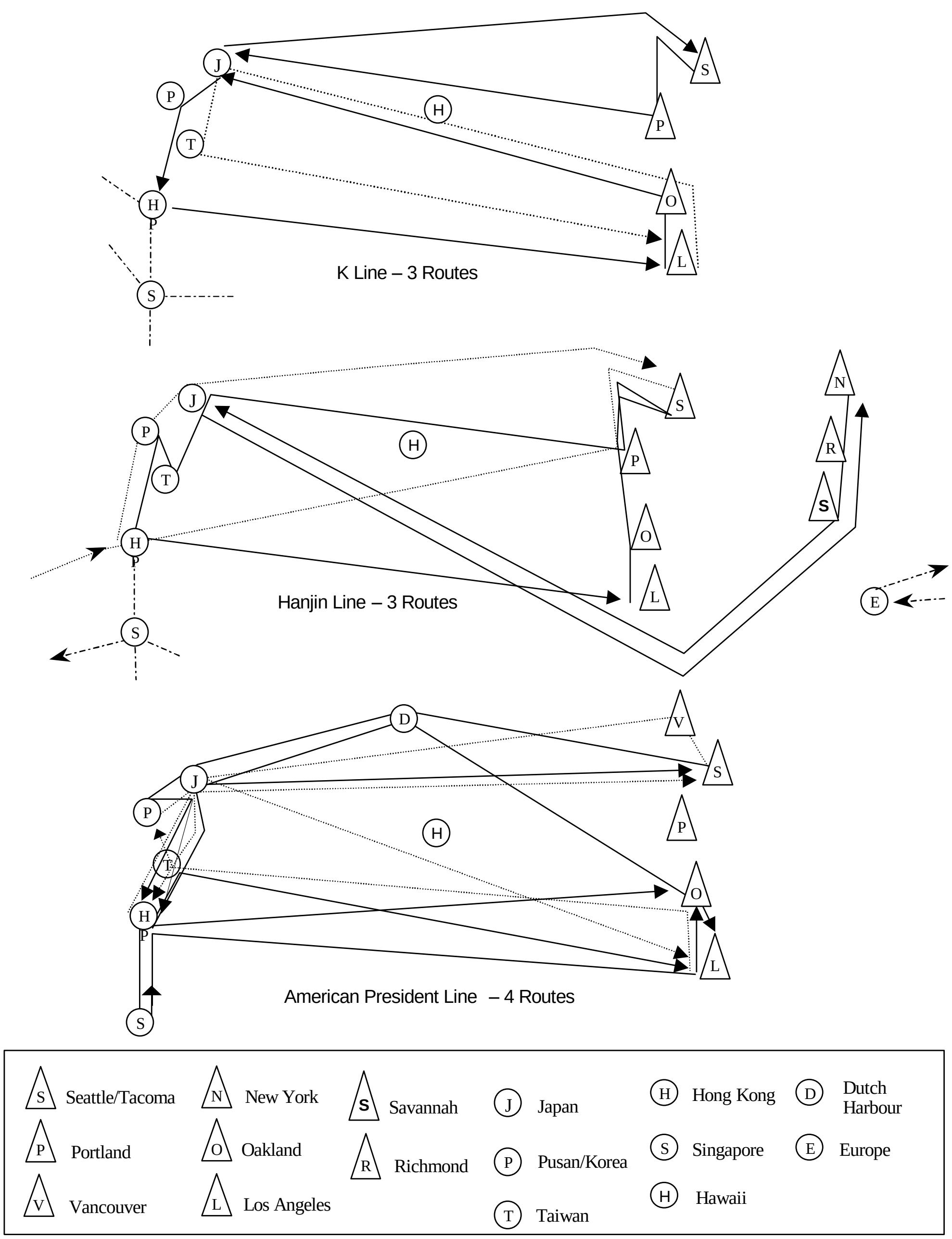




2.2.2 Marine Networks

A key feature of the GOODS™ model analysis of route and port potentials is an understanding of both marine and inland distribution routes. Exhibit 2-6 shows an example of marine links in terms of those used for the West Coast Port competition model. The network shows the various transpacific shipping lines for Asia to US container traffic. These lines are defined in terms of both time and cost and incorporated in a generalized cost function as shown in Equation 3.

Exhibit 2-6: Trans-Pacific Container Routes, USA to Asia



2.2.3 Network Capacity

At various locations along the marine links at port facilities and inland routes capacity problems exist today or will exist in the future. To evaluate these problems TEMS has developed an interactive analysis that allows the travel time along a link to be adjusted or for in extreme cases no new additional traffic to be added to the route. Increased time on links and physical caps on traffic result in increased diversion as traffic seeks new routes. An ordering of diversion routes is generated using the level of generalized cost and available capacity for alternative routes and modes.

For each link in the network, a new travel time T_i is calculated based on the formula:

$$T_i = \frac{D}{S}\left[1 + \left(\frac{V_i}{LC}\right)^r\right]$$

where D = distance of the link

S = free-flow speed

V_i = total assigned volume in current iteration i

L = number of lanes

C = capacity per lane

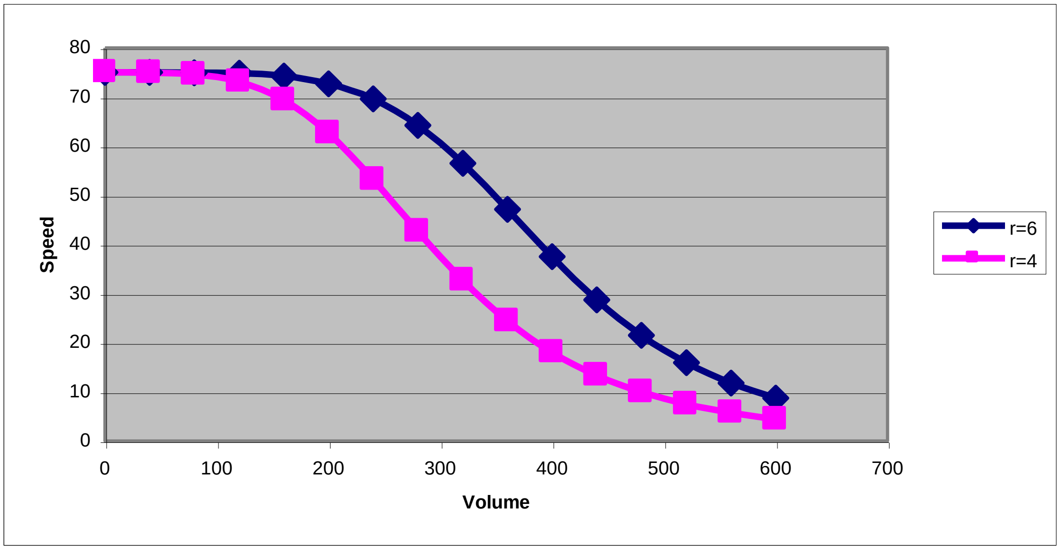
r = delay rate parameter

The networks are reinitialized with the new time for the next iteration.

More iterations will result in a solution that is closer to equilibrium but will increase the running time. The flexibility incorporated into the iteration parameters allow the user to perform the capacity restrained assignment in either a pure interactive manner, an incremental assignment or a volume averaging process.

The capacity restrained assignment is performed independently for each time period.

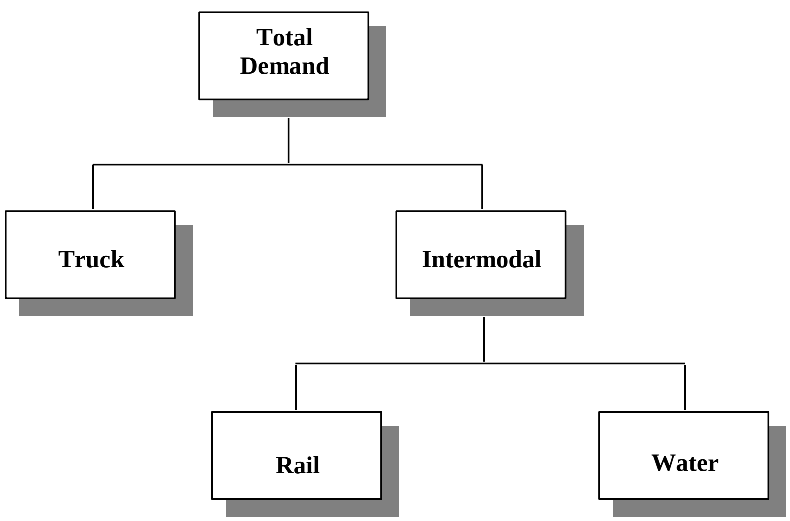
The following graph illustrates the delay function on travel speed using two delay rate parameters (4 and 6).



2.3 Hierarchical Modal Split Model

The role of the Hierarchical Modal Split Model is to estimate relative inland distribution modal shares, given the level of participation by a given route in the total market. The relative modal shares are derived by comparing the relative levels of service offered by each of the shipping modes, and making a choice based on the behavioral values derived from the shipper stated preference survey. The *GOODS*™ Hierarchical Modal Split Model uses a nested logit structure. As shown in Exhibit 2-7, two levels of binary choice are calibrated.

Exhibit 2-7: Hierarchical Structure of the Modal Split Model



The main feature of the Hierarchical Modal Split Model structure is the increasing commonality of shipping characteristics as the structure descends. The first level of the hierarchy separates truck shipping – with its spontaneous frequency and highly personalized characteristics – from the intermodal modes. The second level of the hierarchy separates rail from the water mode.

2.3.1 Incremental Form of the Hierarchical Modal Split Model

To assess modal split behavior, the logsum utility function, which is derived from travel utility theory, has been adopted. As the modal split hierarchy ascends, the log sum utility values are derived by combining the generalized costs of shipping. Advantages of the logsum utility approach are 1) the introduction of a new mode will increase the overall utility of shipping, and 2) a new mode can readily be incorporated into the Hierarchical Modal Split Model, even if it were not included in the base-year calibration.

As only two choices exist at each level of the modal split hierarchical structure, a Binary Logit Model is used, as shown in Equation 6:

Equation 6:
$$P_{ijmp} = \frac{\exp(U_{ijmp}/\rho)}{\exp(U_{ijmp}/\rho) + \exp(U_{ijnp}/\rho)}$$

Where:

P_{ijmp} = Percentage of containers of type *p* from zone *i* to zone *j* by mode *m*

U_{ijmp}, U_{ijnp} = Utility functions of modes *m* and *n* between zones *i* and *j* for container purpose *p*

ρ is called the nesting coefficient

In Equation 6, the utility of shipping between zones *i* and *j* by mode *m* for trip purpose *p* is a function of the generalized cost of shipping. Where mode *m* is a composite mode (e.g., the surface modes in the third level of the Modal Split Model hierarchy, which consist of the rail and bus modes), the utility of shipping, as described below, is derived from the utility of the two or more modes it represents.

2.3.2 Utility of Composite Modes

Where modes are combined, as in the upper levels of the modal split hierarchy, it is essential to be able to measure the "inclusive value" of the composite mode, e.g., how the combined utility for rail and water compares with the utility for truck alone. The combined utility is more than the utility of either of the modes alone, but it is not simply equal to the sum of the utilities of the two modes. A realistic approach to solving this problem, which is consistent with utility theory and the logit model, is to use the logsum function. As the name logsum suggests, the utility of a composite mode is defined as the natural logarithm of the sum of the utilities of the component modes. In combining the utility of separate modes, the logsum function provides a reasonable proportional increase in utility that is less than the combined utilities of the two modes, but reflects the value of having two or more modes available to the traveler. For example, suppose:

Utility of Rail or $U_{rail} = \alpha + \beta_0 GC_{rail}$

Utility of Water or $U_{water} = \beta_1 GC_{water}$

Then:

Inclusive Utility of Surface Modes, or $U_{intermodal} = \log(e^{Urail} + e^{Uwater})$

Improvements to either rail or water would result in improvements to the inclusive utility of the combined intermodal modes.

2.3.3 Calibration of the Hierarchical Modal Split Model

Working from the bottom of the hierarchy up to the top, the first analysis is that of the rail mode versus the water mode. As shown in Exhibit 2-8, the model was effectively calibrated for the four trip purposes with reasonable parameters and R^2 and *t* values. All the coefficients have the correct signs such that demand increases or decreases in the correct direction as shipping times or costs are increased or decreased, and all the coefficients appear to be reasonable in terms of the size of their impact.

Exhibit 2-8: Rail versus Water Modal Split Model Coefficients (1)

Food	$\log(P_{Rail}/P_{Water}) = -0.0000711\ (GC_{Rail} - GC_{Water})$ (-30)	R^2=0.52
Raw-Material	$\log(P_{Rail}/P_{Water}) = -0.0000982\ (GC_{Rail} - GC_{Water})$ (-29)	R^2=0.59
Semi-Finished	$\log(P_{Rail}/P_{Water}) = -0.000104\ (GC_{Rail} - GC_{Water})$ (-47)	R^2=0.70
Finished	$\log(P_{Rail}/P_{Water}) = -0.000143\ (GC_{Rail} - GC_{Water})$ (-47)	R^2=0.80

(1) t-statistics are given in parentheses

For the second level of the hierarchy, the analysis is of the Intermodal modes (i.e., rail and water) versus truck. Accordingly, the utility of the Intermodal modes is obtained by deriving the logsum of the utilities of rail and water. As shown in Exhibit 2-9, the model calibrations for both trip purposes are all statistically significant, with good R^2 and *t* values and reasonable parameters.

The analysis for the top level of the hierarchy is of truck versus the intermodal modes. The utility of the intermodal modes is obtained by deriving the logsum of the utilities of the rail, and water modes. As shown in Exhibit 2-9, model calibrations for all commodity types are all statistically significant, with good R^2 and *t* values and reasonable parameters in most cases. The constant terms show that there is a bias towards the truck mode.

2.3.4 Incremental Form of the Modal Split Model

Using the same reasoning as previously described, the modal split models are applied incrementally to the base data rather than imposing model estimated modal shares. Different regions of the GLSLS may have certain biases toward one form of shipping over another and these differences cannot be captured if a simple regression approach is used. In GOODS™ a "pivot point" method is used that allows different sub-regional biases to be retained. To apply the modal split models incrementally, the following reformulation of the hierarchical modal split models is used (Equation 7):

Equation 7:

$$\frac{\left(\frac{P_A^f}{P_B^f}\right)}{\left(\frac{P_A^b}{P_B^b}\right)} = e^{\beta(GC_A^f - GC_B^b) + \gamma(GC_B^f - GC_B^b)}$$

For hierarchical modal split models that involve composite utilities instead of generalized costs, composite utilities would be used in the above formula in place of generalized costs. Once again, the constant term is not used and drivers for modal shifts are changed in generalized cost from base conditions.

Exhibit 2-9: Intermodal versus Truck Modal Split Model Coefficients (1)

Food $\log(P_{Intermodal}/P_{Truck}) = -3.968 + 0.2480\ U_{Intermodal} + 0.00057\ GC_{Truck}$
$R^2=0.70$

(-50) (3) (27)

Where $U_{Intermodal} = \log[\exp(-0.0000711\ GC_{Rail}) + \exp(-0.0000711\ GC_{Water})]$

Raw-Material $\log(P_{Intermodal}/P_{Truck}) = -2.406 + 1.7417\ U_{Intermodal} + 0.00092\ GC_{Truck}$
$R^2=0.63$

(-15) (14) (26)

Where $U_{Intermodal} = \log[\exp(-0.0000982\ GC_{Rail}) + \exp(-0.0000982\ GC_{Water})]$

Semi-Finished $\log(P_{Intermodal}/P_{Truck}) = -3.5217 + 0.8439\ U_{Intermodal} + 0.00078\ GC_{Truck}$
$R^2=0.65$

(-27) (8) (31)

Where $U_{Intermodal} = \log[\exp(-0.000104\ GC_{Rail}) + \exp(-0.000104\ GC_{Water})]$

Finished $\log(P_{Intermodal}/P_{Truck}) = -3.9104 + 0.9408\ U_{Intermodal} + 0.00131 GC_{Truck}$
$R^2=0.56$

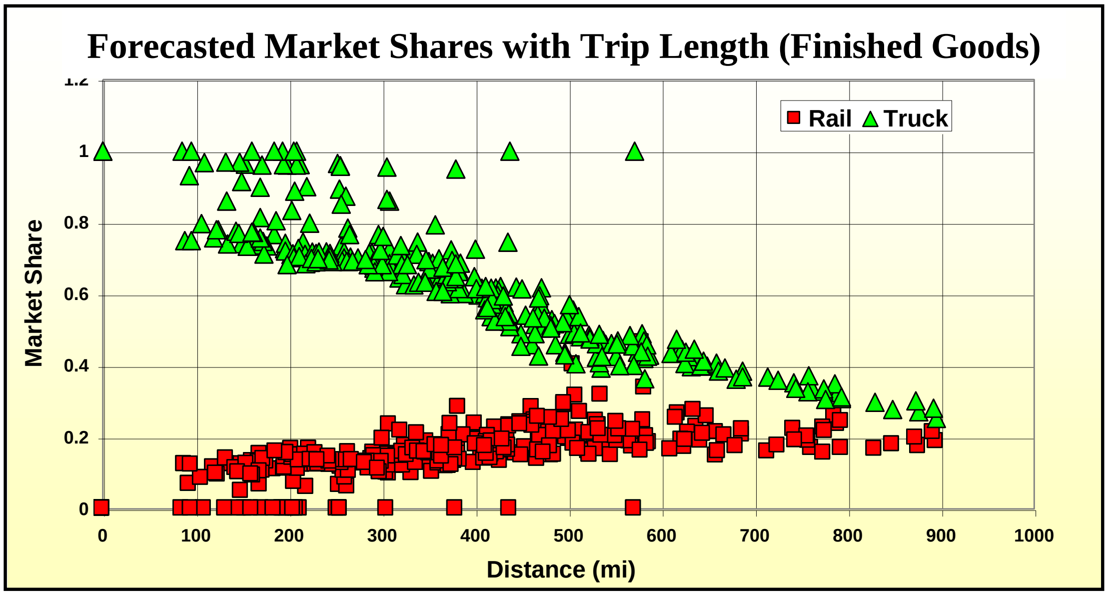
(-17) (5) (17)

Where $U_{Intermodal} = \log[\exp(-0.000143\ GC_{Rail}) + \exp(-0.000143\ GC_{Water})]$

(1) *t-statistics are given in parentheses.*

Exhibit 2-10 shows the typical distribution of rail truck modal split by distance.

Exhibit 2-10: Market Share for Finished Goods by Mode



2.4 Conclusion

The TEMS North American Ports Model has the ability to:

- Organize and upgrade databases to ensure the most effective use of available data
- Assess the role of individual variables such as port charges in the totality of decision-making by carriers and shippers
- Evaluate the impact of local specific port characteristics on the model structure through the use of the market research data
- Identify the role of carrier and shipper biases as well as the key variables that affect traffic decisions
- Allow the comparison of elasticities derived in the study with those previously generated in the different international trade and traffic studies completed in North America and Europe.

TEMS' use of these techniques in a wide range of studies in North America and Europe has enabled the development of realistic and practical demand and supply analyses for a range of port and carrier investment studies and implementation programs. These include West Coast Ports Model, Alameda Corridor, Great Lakes and St. Lawrence Seaway Study, Ohio Inland Port Development Analysis, Windsor-Detroit Jobs Tunnel Study and H_2O East Business Plan.

APPENDIX 3: Financial Cash Flow Projection

All Revenues and Costs in Thousands $

	NPV	*TOTAL SUM*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Calendar Year			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Rate per TEU			$31.31	$31.75	$32.20	$32.65	$33.10	$33.57	$34.04	$34.51	$35.00	$35.49	$35.98	$36.49	$37.00	$37.52
Rate per RailCar			$37.48	$38.00	$38.53	$39.07	$39.62	$40.17	$40.74	$41.31	$41.88	$42.47	$43.06	$43.67	$44.28	$44.90
Loaded TEUs (Thousands)			1132	1196	1263	1335	1410	1489	1573	1661	1755	1853	1958	2068	2184	2307
Railcars (Thousands)			442	451	460	469	478	488	498	507	518	528	539	549	560	572
Container Revenues	$1,633,683	*$4,194,062*	$0	$0	$0	$43,569	$46,665	$49,980	$53,531	$57,335	$61,408	$65,771	$70,444	$75,449	$80,810	$86,551
Car Revenues	$405,251	*$934,517*	$0	$0	$0	$18,318	$18,946	$19,596	$20,268	$20,962	$21,681	$22,424	$23,193	$23,988	$24,810	$25,661
Total Revenue	**$2,038,934**	**$5,128,579**	**$0**	**$0**	**$0**	**$61,888**	**$65,611**	**$69,576**	**$73,799**	**$78,297**	**$83,089**	**$88,195**	**$93,637**	**$99,437**	**$105,620**	**$112,212**
GF Capital Cost	$807,769	*$879,873*	$293,291	$293,291	$293,291	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Track Mtce Cost Oper	$389,014	*$921,545*	$0	$0	$0	$16,066	$16,666	$17,294	$17,952	$18,641	$19,364	$20,123	$20,919	$21,755	$22,633	$23,556
Track Mtce Cost Cap	$189,503	*$538,766*	$0	$0	$0	$0	$0	$0	$0	$3,321	$3,431	$3,546	$6,416	$6,636	$6,867	$10,155
Admin Cost	$85,635	*$215,400*	$0	$0	$0	$2,599	$2,756	$2,922	$3,100	$3,288	$3,490	$3,704	$3,933	$4,176	$4,436	$4,713
Total Cost	**$1,471,922**	**$2,555,584**	**$293,291**	**$293,291**	**$293,291**	**$18,666**	**$19,422**	**$20,216**	**$21,051**	**$25,251**	**$26,285**	**$27,374**	**$31,268**	**$32,568**	**$33,936**	**$38,424**
NET	**$567,012**	**$2,572,995**	**($293,291)**	**($293,291)**	**($293,291)**	**$43,222**	**$46,190**	**$49,360**	**$52,748**	**$53,046**	**$56,804**	**$60,822**	**$62,369**	**$66,869**	**$71,683**	**$73,788**
IRR	***7.79%***															

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
$38.04	$38.58	$39.12	$39.66	$40.22	$40.78	$41.35	$41.93	$42.52	$43.11	$43.72	$44.33	$44.95	$45.58	$46.22	$46.86	$47.52	$48.19	$48.86
$45.53	$46.17	$46.81	$47.47	$48.13	$48.81	$49.49	$50.18	$50.88	$51.60	$52.32	$53.05	$53.79	$54.55	$55.31	$56.08	$56.87	$57.67	$58.47
2437	2574	2719	2872	3033	3204	3384	3574	3776	3988	4212	4449	4700	4964	5243	5538	5850	6179	6527
583	595	606	619	631	644	656	670	683	697	711	725	739	754	769	785	800	816	833
$92,700	$99,287	$106,341	$113,896	$121,988	$130,656	$139,938	$149,881	$160,530	$171,935	$184,151	$197,235	$211,248	$226,257	$242,332	$259,549	$277,990	$297,741	$318,895
$26,540	$27,450	$28,391	$29,364	$30,371	$31,412	$32,489	$33,603	$34,755	$35,946	$37,178	$38,453	$39,771	$41,134	$42,544	$44,003	$45,511	$47,071	$48,685
$119,241	**$126,737**	**$134,732**	**$143,261**	**$152,359**	**$162,068**	**$172,427**	**$183,483**	**$195,284**	**$207,881**	**$221,329**	**$235,687**	**$251,019**	**$267,391**	**$284,876**	**$303,552**	**$323,501**	**$344,812**	**$367,579**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$24,525	$25,545	$26,617	$27,746	$28,933	$30,184	$31,501	$32,890	$34,353	$35,896	$37,524	$39,242	$41,055	$42,970	$44,992	$47,130	$49,389	$51,777	$54,304
$10,517	$10,896	$11,294	$11,711	$18,223	$18,914	$19,639	$20,401	$21,203	$29,395	$30,578	$31,824	$33,137	$34,520	$35,978	$37,516	$39,138	$40,850	$42,658
$5,008	$5,323	$5,659	$6,017	$6,399	$6,807	$7,242	$7,706	$8,202	$8,731	$9,296	$9,899	$10,543	$11,230	$11,965	$12,749	$13,587	$14,482	$15,438
$40,050	**$41,764**	**$43,570**	**$45,473**	**$53,556**	**$55,904**	**$58,382**	**$60,997**	**$63,758**	**$74,022**	**$77,398**	**$80,965**	**$84,735**	**$88,720**	**$92,935**	**$97,395**	**$102,114**	**$107,110**	**$112,400**
$79,190	**$84,973**	**$91,162**	**$97,787**	**$98,803**	**$106,163**	**$114,045**	**$122,486**	**$131,527**	**$133,859**	**$143,931**	**$154,722**	**$166,284**	**$178,670**	**$191,941**	**$206,157**	**$221,387**	**$237,702**	**$255,179**