DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

(PENNSYLVANIA, NEW JERSEY, AND DELAWARE)

UPDATED ECONOMIC ASSESSMENT OF RELEVANT MARKET AND INDUSTRY TRENDS

U.S. Army Corps of Engineers, Philadelphia District

North Atlantic Division

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1 Introduction and Executive Summary

The authorized project consists of a navigation channel extending from deep water in the Delaware Bay to Philadelphia Harbor, Pennsylvania and to Beckett Street Terminal, Camden New Jersey, for a distance of about 102.5 miles. The plan provides for modifying the existing Delaware River Federal Navigation Channel (Delaware River, Philadelphia to the Sea and Delaware River in the Vicinity of Camden) from 40 to 45 feet below Mean Low Water (MLW). Public Law 102-580, Section 101(6) of the Water Resources Development Act of 1992, authorized the recommended -45-foot deepening project for construction and was modified by Section 308 of the Water Resources Development Act of 1999 Public Law 106-53, and further modified by Section 306 of the Water Resources Development Act of 2000, Public Law 1-6-541. A Limited Reevaluation Report (LRR) was completed in February 1998 to obtain approval to initiate construction, and to serve as the decision document for budgetary purposes, and the Project Cooperation Agreement.

The U.S. General Accounting Office (GAO), since renamed the U.S. Government Accountability Office, in a June 2002 report on the Delaware River Main Channel Deepening, recommended that a comprehensive reanalysis be conducted to address uncertainties that GAO identified in the project's economic analysis contained in the Limited Reevaluation Report (LRR). The Assistant Secretary of the Army (Civil Works) (ASA (CW)) and the Corps of Engineers Washington, D.C. Headquarters agreed with GAO on the need for the comprehensive reanalysis as well as a review by an external independent party to ensure that the reanalysis accurately represented expected benefits and costs for the proposed project. The Director of Civil Works approved the report on 18 December 2002 and provided the report to ASA (CW). Subsequently, ASA (CW) transmitted the report to GAO on the same date.

The project benefits include the reduced costs of transportation that will be realized through operational efficiencies (from reduced crude oil lightering and cargo light-loading) and the use of larger, more efficient vessels from the proposed navigation improvements. Reduced transportation costs result in reduced production and distribution costs and thereby increase the net value of the national output of goods and services. The quantification of benefits involved computing and comparing total transportation costs for the existing (-40 feet) and improved (up to -45 feet) channel depths for each pertinent vessel class, by trade route, commodity, and by terminal. Benefits were estimated for liquid bulk (crude oil and petroleum product imports), dry bulk (blast furnace slag and slab steel), and containerized cargo. The Comprehensive Reanalysis Report in December 2002 concluded that the channel deepening of the Delaware River to a -45 foot depth was justified with a benefit-cost ratio of 1.18.

Following the Comprehensive Economic Reanalysis completed in December 2002, the principal lightering company that offloaded crude oil from tankers in the lower Delaware Bay, since purchased by another lightering company, provided comments on the crude oil benefit methodology and results.

In order to address the lightering company comments, a refinement of the crude oil transportation cost savings benefits was accomplished. The supplemental analysis also included a review of the other benefiting commodities and incorporated an addition to project costs to assure compliance with the General Conformity Rule of the Clean Air Act. The Director of Civil

Works approved this report on 12 March 2004. This supplement to the Comprehensive Economic Analysis Report verified justification for the deepening of the Delaware River channel to a depth of -45 feet with a benefit-cost ratio of 1.15. The Comprehensive Economic Analysis Report and the Supplement Reports (the 2002-2004 Corps Re-Analysis) were reviewed and approved by an external independent review team (EIPR), consisting of three members from academia and an expert in navigation from private industry.

In 2009, GAO reviewed the 2002-2004 Corps Re-Analysis, which resulted in GAO's March 2010 Report. The overall conclusion of the GAO March 2010 Report was that the 2002-2004 Corps Re-Analysis corrected errors identified by the earlier 2002 GAO report and was responsive overall to GAO's 2002 recommendations. Noting that the data used in the 2004 Corps Re-Analysis was now 7-8 years old, GAO recommended that "the Corps should conduct and provide an Updated Assessment of relevant market and industry trends that identify the extent to which data and assumptions have changed, and quantify the effects of these changes on each benefit category and on net benefits" (GAO Report, March 2010, page 48).

This 2011 Updated Assessment identifies those conditions that have changed since the 2002-2004 Re-Analysis was completed, and re-evaluates project benefits based on those changes. The 2002-2004 Corps Re-Analysis calculated project benefits related to bulk cargo, liquid bulk cargo, and containerized cargo. Delaware River tonnages for each of these cargo types has been impacted by the recent economic recession, which had severely impacted the local economy and Delaware River shipping at the time GOA was conducting its review (2009-early 2010). Since the 2010 GAO review was completed, the economy has begun to recover and the impacts of the recession have lessened, which is reflective of the cyclical nature of the industries represented by the commodities shipped through the Delaware River project.

This 2011 Updated Assessment focuses on changes in factors that would affect project benefits over the 50-year project life. The 2011 Updated Assessment uses the same spreadsheet based models (revised as appropriate to fully reflect current economic conditions) as were previously used and approved through the EIPR process in the 2002-2004 Re-Analysis to calculate updated benefits. The recent recession has had no impact on the operational constraints that the existing 40-foot controlling depth imposes on vessels operating on the Delaware River.

The 2002-2004 Corps Re-Analysis estimated project benefits for slag and steel (bulk cargo), crude oil and petroleum products (liquid bulk), and containerized cargo from Australia, New Zealand, and the east coast of South America. The most important changes that have occurred since the 2002-2004 Corps Re-Analysis that have had the most substantial effects on project benefits are:

1) the increased efficiency of the lightering fleet, which has tended to reduce benefits for the crude oil category, and
2) the increase in containership size and loads, which tended to increase benefits for the container category.

A summary of the major changes that have occurred since the 2002-2004 Re-Analysis includes:

Slag

- Increased industry use of slag in concrete mixtures; and
- Increased reliance by the domestic cement industry on imported slag.

Steel

- Long-term expectations for steel imports exceed the previous projection

Petroleum Products

- New ownership of the Christina River facility.

Crude Oil

- One refinery has been closed permanently;
- One refinery is undergoing a substantial overhaul; and
- The lightering fleet has been reconfigured with more efficient vessels selected to meet the current demand for lightering services.

Containerized Cargo

- Australia/New Zealand import tonnage decreased and the service has shifted to smaller size vessels;
- Four new containership services call at the Packer Avenue Terminal;
- Larger than previously projected vessels now call at the Packer Avenue Terminal; and
- The Panama Canal Expansion, even prior to its 2014 completion, has affected vessel sizes and deployment.

The base year for the 2011 Updated Assessment is now 2015. The base year for the 2002-2004 Re-Analysis was 2009. The discount rate has decreased from 5.625% in the 2002-2004 Re-Analysis to 4.125% in the 2011 Updated Assessment. Vessels operating costs (VOCs) for fiscal year 2002 were used in the 2002-2004 Re-Analysis. The 2011 Updated Assessment uses 2008 vessel operating costs, which are the most recent vessel operating costs available from the Institute of Water Resources. These VOCs were adjusted for this study to include more current, 2010, fuel price levels. The period of analysis extending from the base year remains 50 years, so is now 2015-2064.

Table 1-1 presents a comparison of benefits calculated for the 2002-2004 Re-Analysis (2002 Dollars) and benefits calculated for the 2011 Updated Assessment (2010 Dollars), which accounts for the changes listed above. With a recent revision in the construction schedule, pre-base year benefits, which were included in the Comprehensive Reanalysis report, are no longer claimed in the current analysis.

The average annual benefits for beneficial use savings at Broadkill Beach, at a 2010 price level and 4 1/8% discount rate, are $591,000. Total average annual benefits for the project are $35,167,000. Overall, the project's current Benefit-Cost Ratio is 1.64, based on the 2011

Updated Assessment average annual benefits estimate and the current average annual project cost of $21,502,000. Net Benefits are equal to $13,665,000.

Table 1-1: Average Annual Benefits by Commodity-Type for the Re-Analysis and the Updated Assessment

Commodity Type	2002-2004 Re-Analysis	2011 Updated Assessment
Crude Oil	$11,778,000	$6,854,000
Petroleum Products	$352,000	--
Containerized Cargo	$6,124,000	$19,868,000
Slag	$1,807,000	$2,014,000
Steel	$3,605,000	$5,840,000
Total Transportation Cost Savings	**$23,665,000**	**$34,576,000**
Broadkill Beach	$583,000	$591,000
Total Average Annual Benefits	**$24,249,000**	**$35,167,000**
Total Average Annual Costs	**$21,025,000**	**$21,502,000**
Total Average Annual Net Benefits	**$3,223,000**	**$13,665,000**
Benefit-Cost Ratio	**1.15**	**1.64**

Construction of the project has begun, but benefits have not started to accrue and all benefits due to deepening remain dependent on the continuance of construction. The current construction schedule, which identifies the projected completion dates for individual project segments, negates the potential for any pre-base year benefits. The Remaining Benefit-Remaining Cost Ratio (RBRCR), which nets out the expended costs from the first year of construction, is 1.85. The average annual remaining costs are $19,017,000, netting out the $31 Million expended as part of the first construction contract and the actual expended (sunk) costs of $4 Million to meet Air Conformity requirements.

The 2011 Updated Assessment benefits estimate indicates that, despite the impacts of a severe recession in the 2008-2009 time frame and changes in the crude oil refining industry, the transportation cost savings resulting from deepening the Delaware River remain very robust.

Reductions in estimated benefits have occurred for crude oil and petroleum products. The reduction in crude oil benefits is due to a substantial increase in the use of lightering by a refinery that had previously avoided lightering. This refinery now uses lightering extensively, which has reduced overall transportation costs for that refinery. In addition the lightering fleet has been reconfigured into a more efficiently sized fleet than was used at the time of the 2002 – 2004 Re-analysis so that all lightering is now conducted at a lower cost.

Petroleum product benefits contained in the 2002-2004 Re-analysis are no longer claimed in the 2011 Updated Assessment due to the new facility owner's projection that continued rapid shoaling of the Christina River channel would not allow the facility to be regularly serviced by vessels with deeper drafts, even if the Delaware River is deepened.

The increase in containerized cargo benefits are based on the confirmation of benefits estimated in the 2002-2004 Re-Analysis and on planned increases in vessel size on the Hamburg Sud service currently calling at Packer Avenue.

Both slag and steel benefits have been confirmed by the 2011 Updated Analysis and have been increased to reflect current conditions and revised projections. The following sections provide discussions concerning the benefit analysis for each commodity.

2 Slag

Ferrous slags are a co-product of iron and steel making that are used in the production of cement and concrete. Ground granulated blast furnace slag can replace a portion of total amount of Portland cement used in mixing concrete. The use of slag cement is a lower cost and environmentally preferable alternative to using 100% Portland cement. The use of slag in concrete production reduces the industrial waste stream by utilizing the byproducts of iron and steel production, which would otherwise be sent to landfills.[1] By comparison with Portland cement, manufacture of ground granulated blast furnace slag requires less than a fifth the energy and produces less than a fifteenth of the carbon dioxide emissions. The manufacture of ground granulated blast furnace slag also does not require the quarrying of virgin materials. In the production of Portland cement, 1.6 tons of clay and limestone are removed from the landscape for every ton of Portland cement produced. However, there is zero depletion of natural resources associated with the manufacture of ground granulated blast furnace slag[2].

The St. Lawrence Cement Company operates a slag processing facility in Camden, New Jersey on the Delaware River. This facility processes imported un-ground slag (mostly from Italy and Japan) into ground granulated blast furnace slag. This facility has been characterized as the most energy efficient for its grinding type and is the largest vertical roller mill in the world (2002).[3]The market area for this facility is roughly bounded by Maine, Virginia, Buffalo, and Pittsburgh. In 2007, the facility was granted a NJDEP permit to increase production at the facility from 785,000 metric tons per year to 1,051,000 metric tons per year.

Specifications for using slag in concrete production have been developed by many state and local transportation departments and port authorities. It is typically a lower cost alternative with less environmental impacts than other competitor substitute materials for Portland cement, such as fly ash. The USGS foresees continued growth in total volume and share for ground granulated blast furnace slag, in part due to more restrictive regulations on alternative materials, such as fly ash (based on mercury content). The USGS attributes the growth of ground granulated blast furnace slag imports in the total share of the U.S. domestic cementitious materials market to a variety of

[1] Concreteproducts.com
[2] Cementitious Slag Makers Association, http://www.ukcsma.co.uk/sustainability.html
[3]Concreteproducts.com

factors, including: the continuing closure of U.S. blast furnaces, the lack of new U.S. blast furnace construction, and depletion of old slag piles[4].

Domestic consumption of ground granulated blast furnace slag is closely correlated to construction activities and cement consumption. USGS data indicates that total apparent consumption[5] of slag, which was the equivalent of 17.4% of the total apparent consumption of cement in 2002, had increased to 21.6% of the total apparent consumption of cement in 2010. This increase shows a trend in the increased use of slag in concrete manufacture relative to Portland cement. The proportion of imported slag used in domestic construction also increased during 2002 to 2010. Imports accounted for 5% of total apparent consumption of slag in 2002, and had increased to 10% of total apparent consumption by 2010.[6]

Slag imports to the Delaware River had been growing rapidly through 2005 (Table 2-1). Import tonnage nearly doubled between 2003 (450,245 tons) and 2005 (895,696 tons). The impacts of the recession then reduced import slag tonnage back to 2003 levels by 2008 (455,170 tons). Slag imports reached its lowest level in 2009, with only 2 vessel calls totaling 137,844 tons. Recovery began in 2010, with vessel calls tripling to 6 and total estimated tonnage nearly tripling to 349,636 tons.

Table 2-1: Delaware River Slag Tonnage and Vessel Calls

	Total		Calls by Vessel Arrival Draft				
Year	Tons	Calls	40 feet	39 feet	38 feet	37 feet	36 feet
2003	450,245	8	--	--	--	--	--
2004	605,749	11	10	1	--	--	--
2005	895,696	14	10	2	--	2	--
2006	546,768	9	7	1	--	--	1
2007	572,418	8	6	2	--	--	--
2008	455,170	7	5	2	--	--	--
2009	137,844	2	1	1	--	--	--
2010	349,636	6	2	3	1	--	--

Sources: WCSC and Maritime Exchange for the Delaware River and Bay

[4] US Geological Survey, Minerals Commodities Summaries, January 2011
[5] Total apparent consumption is defined as domestic shipments + imports – exports + adjustments for industry stock changes + imports for semi-finished products (USGS)
[6] ibid

The trends toward increased use of ground granulated blast furnace slag in concrete mixtures and toward increased reliance on imports indicate that slag would likely grow at a somewhat faster rate than historically observed as the economic recovery continues. However, slag and cement use are dependent on construction activity, which has only just begun to pull out of the recent recession. According to the Bureau of Labor Statistics, construction employment grew by 33,000 in February 2011, following a decline of 22,000 in January that may have reflected severe winter weather.[7] Near and long term projections for Gross Domestic Product and unemployment (Table 2-2) indicate projected increases in economic activity, which presumably would include construction and the associated demand for concrete and ground granulated blast furnace slag. The amount of ground granulated blast furnace slag imported via the Delaware River increased nearly three-fold between 2009 and 2010, which is an indication of how quickly growth in this commodity responds to economic recovery.

Table 2-2: Projected GDP Growth and Unemployment Rates

	2011	2012	2013	Long Term
GDP Growth	3.4% to 3.9 %	3.5% to 4.4%	3.7% to 4.6%	2.5% to 2.8%
Unemployment Rate	8.8% to 9.0%	7.6% to 8.1%	6.8% to 7.2%	5.0% to 6.0%

Note: Data presents the central tendency of a survey of the Federal Reserve Governors and Reserve Bank presidents in January 2011, which excludes the three highest and three lowest projections for each variable in each year

Source: Economic projections of Federal Reserve Governors and Reserve Bank presidents, January 2011
http://www.federalreserve.gov/monetarypolicy/mpr_20110301_part4.htm#chtop1

The 2002-2004 Re-Analysis projection for imported slag at the Delaware River in 2015 (the revised base year) was 1 million tons delivered on 17 vessel calls, based on the proposed facility capacity upgrade to 1,051,000 metric tons per year (which did occur in 2007). The port nearly approached that tonnage and number of calls in 2005 (Table 2-1), at which time the processing facility was operating at more than 100% of (then) current capacity. The 2002-2004 Re-Analysis did not project growth in slag tonnage beyond 1 million tons due to limitations of the processing plant capacity. The following factors support the 2011 Updated Assessment's projection of continued recovery and rapid near term growth in slag tonnage:

- recent and projected increases in economic activity (Table 2-2),
- the trend towards greater use of imported slag in cement mixtures, and
- the 2010 threefold increase in Delaware River slag tonnage over 2009 tonnage.

Ground granulated blast furnace slag does not have a long historic record as an input into concrete production. Therefore, historic growth in domestic cement consumption and historic recovery of domestic cement consumption after economic downturns is used to provide insight into potential future recovery of slag consumption. From 1980 to 2000, which predates the rapid growth in construction during the first decade of the 2000's, total apparent consumption of cement grew at an average annual rate of 2%. The twenty year period from 1980 through 2000

[7] The Unemployment Situation – February 2011, http://www.bls.gov/news.release/pdf/empsit.pdf

included three recessions, although none of those recessions were as strong as the 2007 – 2009 recession. During the Great Depression, total apparent cement consumption fell from 30.2 million tons nationally in 1928 to its lowest level of 10.9 million tons in 1933. During this recent recession total apparent cement consumption fell from 128 million tons to a low of 70 million tons, which is a greater decrease than experienced in previous recessions.

Future slag shipments to the Delaware River can be derived from the projection for total apparent consumption of cement which was based on the observed relationship between cement and slag consumption (Table 2-3). Total apparent consumption of slag has on average (2000 – 2010) been 17.7% of total apparent consumption of cement; however this historical average does not adequately represent the projected increase in the use of slag as a cement replacement based on new regulations and greater inclusion in concrete design specifications. The slag projections for this analysis are based on the 2010 observed ratio of slag consumption to cement consumption, which is 21.6%. In recent years, imports account for 10% of slag consumption, and Delaware River imports historically make up 33% of total national imports.

Table 2-3: Historical Cement and Slag Tonnage

	Total US Apparent Consumption		Slag Imports	
Year	**Cement[(1)]**	**Slag[(1)]**	**US Total[(1)]**	**Delaware River**
2000	110.5	20.2	2.0	--
2001	112.8	19.5	1.6	--
2002	110.0	19.1	1.0	--
2003	114.1	19.7	1.0	450,245
2004	122.0	19.9	1.0	605,749
2005	128.3	21.0	1.7	895,728
2006	127.7	20.2	1.6	546,771
2007	117.0	19.6	1.8	572,418
2008	97.0	18.8	1.3	469,510
2009	72.0	12.5	1.3	137,844
2010	70.0	15.0	1.5	374,610[(2)]

[(1)] Millions of tons; [(2)] Estimated from observed number of vessel calls and historical tons per call

Assuming that total domestic cement consumption continues recovering at a rate similar to recovery typical from a significant recession, projected 2014 total consumption (109 million

tons) would be approximately equivalent to the ten-year average consumption prior to the recession (average from 1996 – 2006 = 111 million tons). Projected 2015 cement consumption would be 122.5 million tons, which is approximately equivalent to actual 2004 consumption (122.0 million tons). Based on the assumption that post-recovery growth would continue at the historic rate of 2% (1980 – 2000 growth rate), total cement consumption would be 137 million tons in 2020 (Table 2-4). Slag imports to the Delaware River are projected to achieve pre-recession (2005) levels in 2016. The projection for slag imports to the Delaware River is capped at the Delaware River facility capacity of 1 million tons. This tonnage is projected to be achieved in 2021, which represents an average annual growth rate of 6.1% from 2010 through 2021.

Table 2-4: Projected Cement and Slag Tonnage

	Total US Apparent Consumption		Slag Imports	
Year	**Cement[(1)]**	**Slag[(1)]**	**US Total[(1)]**	**Delaware River**
2011	77.8	16.8	1.68	558,790
2012	87.2	18.8	1.88	625,845
2013	97.6	21.1	2.11	700,946
2014	109.4	23.6	2.36	785,060
2015	122.5	26.4	2.64	879,267
2016	125.3	27.0	2.70	899,440
2017	128.2	27.7	2.77	920,075
2018	131.1	28.3	2.83	941,184
2019	134.1	28.9	2.89	962,777
2020	137.2	29.6	2.96	984,866
2021	140.3	30.3	3.03	1,007,461

[(1)] Millions of tons

The vessels delivering slag to the Delaware River have consistently been arriving with drafts that require full channel depth, including the use of tidal advantage (Table 2-1). These vessels have also consistently originated at the same countries as observed in 2002 and as projected for the future in the 2002-2004 Re-Analysis. Therefore, because vessel operations and points of origin are consistent with the projections used in the 2002-2004 Re-Analysis, there is no need to change these aspects of the slag benefits computations. The revised slag benefits model resulted in

average annual benefits for imported slag increasing from $1.8 million, estimated for the 2002-2004 Re-Analysis, to $2.0 million estimated for the 2011 Updated Assessment.

3 Steel

Domestic steel production capacity has fallen from 125 million tons in 2000 to 108 million tons in 2010. Total US apparent steel consumption, which averaged 114 million tons annually from 2000 through 2007, fell to 63 million tons in 2009, but partially recovered in 2010 to 82 million tons (a 30% increase). Steel imports, which averaged 30 million tons annually from 2000 through 2008, fell to 14.7 million tons in 2009, but then increased by 50% in 2010 to 22 million tons.[8]

Steel imports to the Delaware River peaked in 2006 at 4.9 million tons in 2006, but fell to 0.6 million tons in 2009 (Table 3-1). Steel imports to the Delaware River are received by multiple facilities along the river. Some of these facilities are upstream of the reaches that are being deepened. The 2002-2004 Re-Analysis and the 2011 Updated Assessment focus on vessels that arrive with drafts in excess of 36 feet, which is the maximum without-project condition unrestricted sailing draft. Typically a large proportion of vessels delivering steel arrive at drafts greater than 36 feet (Table 3-2) through use of the tide. Only vessels projected to sail at drafts greater than 36 feet in the without project condition, and the cargo carried on those vessels, are included in the benefits calculations. These vessels call at multiple facilities along the Delaware River including Packer Avenue Marine terminal, Gloucester City Terminal, Kinder Morgan Camden Marine Terminal, Kinder Morgan Fairless Terminal, and other locations.

Table 3-1: Delaware River Steel Imports (2005 - 2010)

Year	All Steel Imports	Vessel Calls Drafting >36 feet	Tons on vessels Drafting >36 feet	% Tons on Vessel Drafting >36 feet
2005	3,013,576	48	2,099,952	70%
2006	4,859,272	80	3,499,920	72%
2007	2,550,964	46	2,012,454	79%
2008	2,190,823	30	1,312,470	60%
2009	553,007	5	218,745	40%
2010	unavailable	4	174,996(1)	--

(1) Estimate based on observed number of calls and historical tonnage per call

Sources: WCSC and Maritime Exchange for the Delaware River and Bay

A review of historic data determined that the 2002-2004 Re-Analysis substantially underestimated steel imports and the projected number of benefiting Delaware River vessel calls

[8]US Geological Survey, Mineral Commodity Summaries, various years.

compared to actual reported data for the early years of the projection period (Table 3-1). The maximum number of annual benefiting vessel calls throughout the 50-year period of analysis was estimated to be 36 vessel calls, which was not projected to be achieved until the latter part of the study period. However, actual growth greatly exceeded expectations and more than double the projected maximum of 36 vessels calls (observed = 80 vessel calls) actually occurred in 2006 (Table 3-1). One potential cause for the underestimation of vessel calls in the original forecast was the relaxation of steel tariffs which occurred in 2003, based on a World Trade Organization ruling. Steel tariffs have not been re-imposed since the ruling, resulting in a more competitive environment for steel imports.

Historically from 1960 to 1980, total U.S. apparent steel consumption grew at a very low average annual rate of 1%, accelerating to 3.3% from 1980 to 2000. Due to the reduction in U.S. steel manufacturing capacity, steel imports grew at a much faster rate than consumption during this same period: 7.9% from 1960 to 1980 and 4.3% from 1980 to 2000. Steel imports increased more than tenfold from 1960 (3.2 million tons) to 2000 (34.4 million tons). The 2010 level of apparent steel consumption (82 million tons) is roughly equivalent to levels experienced in the 1980's, which is substantially different from cement which fell, during this recent recession, to levels similar to total apparent consumption experienced in the 1960's. Total apparent steel consumption for 2010 and preliminary Delaware River data for 2011 indicate that recovery of steel import tonnage from the recession is already underway. Therefore, the growth projection for steel is based on the observed 20-year average annual growth rate for the period prior to recent recession (i.e., from 1988-2008; 1.91%), using 2010 as the starting (base) year for the projection.

Total US steel imports (Table 3-2) are projected as a percentage of total apparent consumption. Delaware River steel imports on vessels arriving with drafts greater than 36 feet are estimated as a proportion of total US steel imports. The proportion used in the projection is the observed average annual proportion of Delaware River steel imports on vessels greater than 36 feet to total US steel imports for the years 2003 – 2010 (5.3%). This projection method results in an estimate that the Delaware River market will recover to 1.27 million steel import tons by 2015 (the base year) for vessels arriving at drafts greater than 36 feet.

The model used to estimate steel benefits for the 2002-2004 Re-Analysis was rerun for this 2011 Updated Assessment, adjusting for the FY 2011 Federal discount rate (4.125%), new base year (2015), and revised commodity forecast. Additional adjustments were made to account for a shift in commodity origin from mostly Brazil previously to a mix of countries including Russia, Brazil, Indonesia, and China, with a weighted average distance increase of 15% (4,521 miles to 5,200 miles). The original model was based on the observed fleet in 2001, which had an average dead weight tonnage (DWT) of 43,800. This vessel size was adjusted in the model to 55,900 DWT to reflect the actual fleet observed in 2009-2010. The without project vessel fleet was also adjusted from vessels ranging from 63,000 to 79,000 DWT in the original model to 76,000 DWT to 86,000 DWT to reflect the observed use of larger vessels in recent years.

Table 3-2: Delaware River Steel Import Projections for Selected Years (millions of tons)

Year	Total US Steel Imports	Tons on Delaware River Bound Vessels Drafting >36 feet	Number of Delaware River Vessel Calls Drafting > 36 feet
2015	23.7	1.27	29
2020	26.1	1.39	32
2025	28.7	1.53	35
2030	31.5	1.68	38
2035	34.6	1.85	42
2040	38.1	2.03	47
2045	41.8	2.24	51
2050	46.0	2.46	56
2055	50.5	2.70	62
2060	55.6	2.97	68
2065	61.1	3.26	75

Overall, the revised estimation of transportation cost savings related to steel imports have been affected by

- The relaxation of steel tariffs;
- The shift in commodity origin; and
- An increase in observed vessel sizes.

These model adjustments resulted in average annual benefits for imported steel increasing from $3.6 million, estimated for the 2002-2004 Re-Analysis to $5.8 million estimated for the 2011 Updated Assessment.

4 Crude Oil

Crude oil is the largest single commodity (by tonnage) transported on the Delaware River, typically accounting for more than one-half of all Delaware River annual cargo tonnage. Refineries in Pennsylvania, New Jersey, and Delaware receive imported crude oil from oil producing countries in Africa, the Middle East, the North Sea, the Caribbean, and Canada. Delaware River refineries are connected to pipeline and rail distribution systems, which deliver

refined products throughout the northeast US. Refined products are also distributed by truck, ship, and barge.

Crude oil benefits for both the 2002-2004 Re-Analysis and the 2011 Updated Assessment are based on reduced lightering of vessels arriving from oil producing countries. Ocean going tankers (i.e., "mother ships") arrive at Delaware Bay with drafts often in excess of 50 feet. These vessels are typically lightered to a draft of 40 feet prior to navigating the Federal channel upriver of the Big Stone Beach Anchorage (designated by the Coast Guard for lightering operations), and use tidal advantage during the transits to the refineries. For these vessels, benefits were calculated based on the reduced lightering volumes and costs resulting from deepening the project to 45 feet and therefore requiring less crude oil to be removed from the "mother ships".

During the investigations conducted for the 2002-2004 Re-Analysis, vessels destined for the Valero (now PBF) refinery in Paulsboro, NJ operated differently from the other refineries in that they selected vessel sizes to minimize their lightering requirements. Benefits for vessels bound to this refinery in the Reanalysis were based on the ability to arrive at the Delaware River more deeply loaded for the improved condition 45 foot channel depth and to continue their operational practice of transiting the Federal channel at the deepest draft possible without undertaking lightering. Investigations for the 2011 Updated Assessment indicate that vessels destined for the Valero facility now typically are larger sized and load in a manner similar to vessels destined for the other refineries, and, thus, now regularly conduct lightering operations. Therefore, benefits for these vessels are now similarly based more on reduced lightering than on increased channel transit drafts for the "mother ship" as are those benefits calculated for vessels bound for the other refineries.

At the time of the 2002-2004 Re-Analysis there were six operating refineries along the Delaware River that had a long history of receiving imported crude and producing refined petroleum products. Since the Re-Analysis four of the refineries have changed ownership:

- Coastal Eagle Point, NJ became El Paso/Coastal, which was purchased by Sunoco in 2004;
- TOSCO Trainer, PA became ConocoPhillips Trainer, PA;
- Valero Paulsboro, NJ became PBF Paulsboro; and
- Motiva Delaware City, DE became Valero/Premcor Delaware City, which has subsequently become PBF Delaware City

In addition to changes in ownership, the Sunoco Eagle Point facility was idled in the fourth quarter of 2009 and permanently closed in the first quarter of 2010. The Delaware City refinery was idled in the fourth quarter of 2009 and has been undergoing refurbishing. PBF has announced that the Delaware City refinery is scheduled to resume operations in the second quarter of 2011. Overall, refining capacity at Delaware River refineries has decreased by 12% with the closure of the Eagle Point facility (Table 4-1) and including the scheduled re-opening of the Delaware City refinery.

Table 4-1: Delaware River Refineries

Facility	Capacity (bbl/day)	2002-2004 Re-Analysis Status	2011 Updated Assessment Status
Sunoco Philadelphia[1]	335,000	Operating	Operating
Sunoco Marcus Hook	178,000	Operating	Operating
Sunoco Eagle Point	150,000	Operating	Permanently closed
ConocoPhillips Trainer	185,000	Operating	Operating
PBF Paulsboro	185,000	Operating	Operating
PBF Delaware City	190,000	Operating	Idle until Spring 2011
2002-2004 Re-Analysis Capacity = 1,223,000 bbl/day		**2011 Updated Assessment Capacity = 1,073,000 bbl/day**	

[1] Note: Sunoco Philadelphia includes Sunoco Fort Mifflin and Sunoco Hog Island

There has also been one major infrastructure change at the PBF Delaware River refinery. At the time of the Re-Analysis, the Delaware City refinery (Motiva) maintained its approximately three-mile access channel to a depth of 35 to 37 feet. At that time, Motiva expressed no interest in deepening their access channel to take advantage of the proposed deepening of the main channel to 45 feet, since it was not fully taking advantage of the existing 40-foot main channel. Since acquiring the facility, PBF dredged the access channel in 2010 to the deepest depth allowed by Delaware Department of Natural Resources and Environmental Control, which is equivalent to the current depth of the main channel (40 feet). This action by PBF indicates that the new owners of the Delaware City refinery intend to take full advantage of the depth of the main channel in a manner similar to the other refineries, thereby creating an additional opportunity for benefits under improved channel conditions.

Crude oil imports to the Delaware River have been stable through 2005 – 2009, although the impact of the two refinery closures (one temporary, one permanent) can be seen in the 8% reduction in crude oil imports from 2008 to 2009 (Table 4-2). The US Department of Energy projects a continued stable flow of crude oil imports, which is projected to have near zero annual growth (-.021%) from 2015 – 2035[9]. Vessels have decreased in size slightly since 2009, in part because the very large Stena class vessels which brought West African crude to Sunoco refineries no longer call on Delaware River refineries. The importance of lightering for crude oil vessels is displayed in the data showing the number of crude oil vessels that need to offload (lighter) cargo to achieve a reduced draft of 40 feet. Most crude oil vessels arrive at the

[9] Annual Energy Outlook April 2011, USDOE, US Energy Information Administration, Appendix A Reference Case, Table A1 Total Energy Supply, Disposition, and Price Summary. Note also that the same table projects Liquid Fuels Consumption to also remain very stable, with an annual growth of 0.32%.

Delaware Bay anchorage with drafts greater than 45 feet and lighter prior to transiting up-river to offload at the refineries.

Table 4-2: Crude Oil Imports to the Delaware River

		Arrival Draft (number of calls)		
Year	**Tons**	**>40 feet**	**>45 feet**	**Average DWT**
2005	58,901,393	310	232	150,053
2006	57,136,312	267	222	150,752
2007	60,842,164	269	219	151,594
2008	55,527,910	280	200	143,847
2009	51,301,905	272	202	136,856
2010	unavailable	263	216	143,703

Note: Average DWT for vessels arriving with drafts greater than 40 feet

Sources: WCSC and Maritime Exchange for the Delaware River and Bay

There have been two major changes to crude oil lightering operations at Delaware Bay since the 2002-2004 Re-Analysis. One change is that lightering operations are now conducted by OSG America, which in 2006 acquired the lightering company (Maritrans) that formerly conducted Delaware River lightering operations. The other change is that OSG America reconfigured the lightering fleet and now deploys a smaller, more efficiently sized fleet exclusively consisting of articulated tug barges (ATB). This is entirely consistent with the economic efficiency argument made during the 2002-2004 Re-analysis that the lightering fleet would be adjusted in the future to account for changes in future lightering requirements and was not a fixed resource that could not be redeployed in an economically efficient manner.

The Maritrans fleet used at the time of the 2002-2004 Re-Analysis consisted of a larger capacity ATB and also employed a self-propelled tanker. Previous versions of the reanalysis argued for the economically rational assumption that future Delaware River lightering fleets would adjust to changes in the demand for lightering services to eliminate any excess capacity. Actual observed changes in the lightering fleet since 2004 have proven this assumption to be true. The current fleet operates at a lower cost than the fleet observed in the 2002-2004 Re-Analysis (Table 4-3), updating the IWR provided vessel operating costs. Therefore, this assumption has been used in the current 2011 Updated Assessment, specifically that the lightering fleet will be appropriately sized to meet the needs of the industry under both without and with project conditions, and that any “freed up” lightering capacity will be deployed productively elsewhere in the industry.

Table 4-3: Lightering Fleet Comparison (2002 Dollars)

Re-Analysis Fleet (2002)

	Maritrans 300	Maritrans 400	Integrity
Tonnage Capacity	32,898	61,600	42,241
Fixed Annual Cost	$4,262,400	$6,431,300	$7,131,600
Fuel Cost At-Sea/hour	$189	$269	$312
Fuel Cost In-Port/hour	$21	$31	$166

Updated Assessment Fleet (2010)

	OSG 192	OSG 350	OSG 400
Tonnage Capacity	22,000	54,074	54,074
Fixed Annual Cost	$2,714,669	$5,668,007	$5,668,007
Fuel Cost At-Sea/hour	$126	$241	$241
Fuel Cost In-Port/hour	$14	$27	$27

As discussed above, vessel operations at the PBF Paulsboro (previously Valero) refinery have changed in response to the introduction of the new lightering company and fleet adjustment. The crude oil carriers calling at the PBF Paulsboro refinery, under the previous lightering regime, were typically arriving at the Delaware River with operating drafts ranging from 38 to 40 feet and therefore that refinery required a relatively small amount of lightering (Table 4-4). From an NED perspective, arriving at the Delaware River with smaller vessels and shallow operating drafts was very inefficient; however it did allow the refinery to avoid lightering. Most of the benefits related to this refinery were calculated as the reduced transportation costs for crude oil carriers arriving more deeply loaded, but not requiring lightering prior to entering the Federal channel. Since the 2002-2004 Re-Analysis (and under the new lightering regime), crude oil carriers now calling at the Paulsboro refinery are arriving with an operating draft distribution that is far more similar to the other refineries, which is far more efficient from an NED perspective even though it requires substantially more lightering. This change in vessel operations at the PBF Paulsboro (formerly Valero) refinery increased the economic efficiency of the without-project condition, thereby having a negative influence on overall project benefits. Table 4-4 presents the draft distributions for PBF Paulsboro (formerly Valero) tankers from the 2002-2004 Re-Analysis and the 2011 Updated Assessment.

Table 4-4: PBF Paulsboro (formerly Valero) Refinery Tankers

Arrival Draft	2000	2010
50 feet and deeper	3	14
41 feet – 49 feet	2	39
36 feet – 40 feet	84	15
Total	89	68
Total requiring lightering	5	53
Total Tons	7,172,924	6,830,784
Average tons per call	76,189	100,453

The Re-Analysis identified $4,560,300 in transportation cost savings for PBF Paulsboro-bound tankers projected to arrive at the Delaware River with a 45-foot draft under with-project conditions, which would arrive with a 40-foot draft under without-project conditions. The 2011 Updated Assessment identifies only $146,000 in transportation cost savings for PBF Paulsboro-bound tankers, which is similar in scale to tanker-based transportation cost savings at the other refineries (Table 4-5). This substantial reduction in benefits is due to the increased efficiency of PBF Paulsboro-bound tankers under the updated without-project condition. Note that the former Motiva refinery is projected to potentially operate in a manner similar to other refineries when it re-commences operations in 2011, but no benefits are claimed for this facility in the Updated Assessment.

Table 4-5: Tanker Average Annual Transportation Cost Savings Comparison

Refinery	2002-2004 Re-Analysis [1]	2011 Updated Assessment[2]
Eagle Point (now permanently closed)	$83,652	---
Sun Fort Mifflin	$127,019	$98,583
Sun Hog Island	$23,644	$5,078
Sun Marcus Hook	$79,558	$105,431
Tosco (now ConocoPhillips)	$327,918	$198,437
Valero (now PBF Paulsboro)	$4,560,303	$146,056
Total	$5,180,795	$553,585

[1] 50 years at 5.625%; [2] 50 years at 4.125%

The change to a more efficient lightering fleet and change to more efficient tanker operations at the PBF Paulsboro facility, which have occurred since the Re-Analysis, have increased the projected amount of lightering under without-project conditions and thereby have increased the overall reduction in Delaware River lightering (due to the project) by 10%. Project benefits due to reduced lightering have increased by a smaller proportion than the increase in barrels lightered mainly because lightering is now occurring with a more efficient fleet (Table 4-6).

Table 4-6: Lightering Savings Comparison

	2002-2004 Re-Analysis	**2011 Updated Assessment**
Average with-project lightering reduction per year	26,538,328 barrels	29,212,968 barrels
Average annual lightering cost savings	$6,290,710[1]	$6,300,031[2]

[1] 50 years at 5.625%; [2] 50 years at 4.125%

The increase in lightering benefits due to changes in the lightering fleet and changes in tanker operations is more than offset by a reduction in benefits resulting from the use of larger more efficient vessels calling at the PBF Paulsboro refinery (Table 4-7).

Table 4-7: Summary Crude Oil Benefits Comparison

	2002-2004 Re-Analysis	**2011 Updated Assessment**
Average annual tanker transportation cost savings	$5,180,795	$553,585
Average annual lightering cost savings[1]	$6,290,710[2]	$6,300,031[3]
Total	$11,472,000	$6,854,000

[1] Excludes $343,000 in pre-base year benefits; [2] 50 years at 5.625%; [3] 50 years at 4.125%;

5 Petroleum Products

Subsequent to the 2002-2004 Re-Analysis in 2005, Magellan Midstream Partners purchased and now operates the former Delaware Marine Terminal facility. The terminal is a 32 tank facility which receives, stores, and distributes a variety of petroleum products. The facility does not handle crude oil. During interviews conducted previously for the 2002-2004 Re-Analysis, the facility operators indicated that they were planning to deepen their access channel to 40 feet and would load vessels to take advantage of a deeper main channel. However, current interviews

conducted for the 2011 Updated Assessment reveal that there are severe shoaling problems in the access channel. The current owners do not foresee dredging their access channel frequently enough to be able to regularly take advantage of a deeper Federal channel. The 2002-2004 Re-Analysis identified $336,600 in transportation cost savings for petroleum product tankers. However, due to changed conditions, the 2011 Updated Assessment now does not identify any transportation cost savings at this facility.

6 Containerized Cargo

Container handling at the Packer Avenue Terminal has increased from 198,680 TEUs[10] in 2000 to 264,059 TEUs in 2010, exhibiting an average annual growth rate of 2.9% (Table 6-1) and showing total TEU volumes to be relatively unaffected by the recent recession. Although the Packer Avenue Terminal provides carriers and shippers with intermodal access through three railroads, on-dock access, and a large regional population that can support substantial cargo volume, many carriers bypass Philadelphia and use the Port of NY/NJ (PONYNJ) as a substitute port. Multiple carriers have indicated during interviews that the 40-foot channel depth and the 7 to 8 hour transit with the tide for vessels drafting more than 36 feet currently offsets the prospective benefits of calling at Philadelphia. The limited and unattractive choices provided by an unrestricted draft constraint of 36 feet, or an operational decision to spend time waiting for and transiting 40 foot draft vessels with the tide, do not presently support the shipping industry's trend towards larger, more efficient vessels, resulting in relatively low container traffic for the Delaware River ports.

Containerized cargo on the world's trade routes is moved through direct call services and transshipment services. Direct call services link multiple ports as ports-of-call on a single ocean voyage. Transshipment services also link ports, but require that a container be off-loaded from one vessel and placed onto another vessel at a transshipment port. Transshipment allows containers to be shipped between two ports that do not share a direct call service, thereby greatly increasing the potential for cargo from any given world port to reach many other ports via ocean carrier.

The carriers who develop and operate the liner services that ply the world's trade routes, establish the size of vessels deployed on each service and port rotation schedule for each service based on the projected volume of cargo (both imports and exports) and the operational characteristics of each potential port-of-call. The carriers determine whether cargo will use a direct call service or will be transshipped, the preference being direct call services where ever possible, since they do not require costly rehandling (unloading and reloading) of containers at a transshipment port. However, transshipment may allow carriers to use large vessels that stop only at high volume, deep water ports, thereby improving economies of scale and reducing overall origin to destination costs.

[10] Twenty-foot Equivalent Units, which is the standard unit of measurement for containerized cargo. Most containers handled at the Delaware River and other ports are forty-foot containers, which is the equivalent of two TEUs.

Table 6-1: Packer Avenue Marine Terminal Total TEUs 2000 - 2010

Year	Total TEUs
2000	198,868
2001	178,834
2002	215,061
2003	147,413
2004	178,046
2005	204,912
2006	247,211
2007	253,492
2008	255,994
2009	222,900
2010	264,059

Source: American Association of Port Authorities

In order to capture the benefits of economies of scale associated with the largest container ships, these vessels must travel with a high level of utilization. The container shipping industry has been consolidating services through partnerships and slot-sharing agreements to maximize the loading of increasingly larger container ships. As a result, there is an overall trend towards more total container handling capacity in the world fleet, which is being consolidated on fewer, but much larger ships, which service the world's major trade routes. One aspect of this trend is that new, ever larger containerships are put into service on the highest volume liner services, which displaces the previous generation of then-largest vessels from those services and makes them available to upgrade the size of vessels on the next largest volume liner services. The vessels on these services are then, in turn displaced to the next smaller volume services. This "cascade effect" has recently made Post-Panamax[11] vessels available for service to the US east coast. Post-Panamax vessels currently call on US east coast ports from Southeast Asia via the Suez Canal. Completion of the Panama Canal expansion project in 2014 will relax the Canal's constraint on vessel sizes and allow this trend towards increasingly larger vessels to positively

[11] Post-Panamax refers to vessel which are larger, typically too wide, than Panama Canal dimensions. Panamax vessels, until the Panama Canal Expansion is completed in 2014, are vessels which are designed to the maximum transit width of the Panama Canal (currently 106 feet).

affect services to US east coast ports from Asia, the west coast of South America, and Australia/New Zealand.

The busiest trade routes in the world, which are currently being serviced by the world's largest container ships (>10,000 TEUs), are the Asia to Middle East services and Asia to Europe services. Asia to US West Coast services are being upgraded to vessels in the 8,000 – 10,000 TEU range. Vessels currently on these services (6,000 - 8,000 TEU range) are being made available for the next tier of major container shipping trade routes, including Asia and Europe to the US East Coast. In addition, new vessels are being constructed in the 6,000 - 8,000 TEU range to meet the needs of these "next tier" trade routes.

Four of the world's major container-shipping trade routes in this next tier include Philadelphia's Packer Avenue Terminal as a port-of-call. These trade routes include:

- East coast of South America to the US east coast;
- West coast of South America to the US east coast;
- Australia/New Zealand to the US east coast; and
- North Europe to the US east coast.

East Coast of South America to US East Coast

Philadelphia (Packer Avenue Marine Terminal) is a port-of-call on the east coast of South America to US east coast trade route operated by the Mercosur liner service – a partnership by three shipping lines (Alianca, CSAV, and Hamburg-Sud) that also includes a slot sharing agreement with Evergreen Line. This liner service calls at ports in Argentina and Brazil, then calls the US East Coast at the PONYNJ, Philadelphia, Norfolk, Charleston, Jacksonville, and Port Everglades, before returning to South America. This liner service does not call at any of the major Central American or Caribbean transshipment ports. The last South American port prior to the first US East Coast port of PONYNJ is Pecem, Brazil, which has a controlling depth of 52 feet. The PONYNJ currently has a controlling depth of 45 feet, which will increase to 50 feet in 2014, when the current construction project is completed. Norfolk currently has a controlling depth of 50 feet.

Currently the Mercosur service uses vessels ranging in size from 3,100 TEUs to 4,250 TEUs with maximum design drafts ranging from 40 to 41 feet. Refrigerated meat and produce from South America is an important component of vessel cargo on this service. In 2004, the carrier switched Philadelphia from being the first port of call from South America, which is preferred because Philadelphia is closer to the major refrigerated warehouse complexes that are the intermediate destinations for time sensitive cargo, to the PONYNJ (-45 feet) being the first port of call. The reason the carrier gave for making the switch was that the carrier needed to load northbound vessels more deeply than can be accommodated by the current controlling operational depth at Philadelphia (limitation of 36 feet unrestricted).

These conditions have persisted since 2004. The vessels on the Mercosur service arrive at the PONYNJ directly from South America with drafts greater than 36 feet and discharge sufficient cargo at PONYNJ to arrive at Philadelphia (the next port) with drafts typically at 35 to 36 feet (50% of calls). This arrival pattern at Philadelphia verifies that the vessels regularly arrive at or about the maximum unrestricted operating draft for the existing 40-foot channel (Table 6-2). Some of the time sensitive refrigerated cargo offloaded at the PONYNJ is trucked to the

refrigerated warehouses near Philadelphia and southern New Jersey. If Philadelphia were deep enough to be the first port of call from South America, this cargo could be off loaded in Philadelphia and would require a shorter ground transportation haul to the warehouse. In 2004, at the time that the carriers had first decided to switch from Philadelphia to the PONYNJ as the first port of call, the carrier estimated that 112 TEUs per call were offloaded in the PONYNJ and trucked to Philadelphia-based destinations. In discussion with the carrier in 2011, the carrier identified that this condition continues today and that 122 TEUs per call (on average) [12] are offloaded at the PONYNJ and trucked to Philadelphia and southern New Jersey refrigerated warehouses for inspection, processing, and distribution.

Table 6-2: Mercosur Service 2010 Arrival Drafts

Arrival Draft	Vessel Calls
39 feet	1
38 feet	2
37 feet	5
36 feet	12
35 feet	9
34 feet	2
33 feet	5
32 feet	2
31 feet	1
30 feet	2

Source: Maritime Exchange for the Delaware River and Bay

Under with-project conditions that would be provided by the deepening of the Delaware River to 45 feet, Philadelphia could again become the first port of call, and transportation cost savings would result from reduced trucking costs for the 122 TEUs per call currently trucked from the PONYNJ to Philadelphia. If this number of TEUs continues to increase at the historical rate of

[12] Phone interview with Rainer Dehe, Vice-President Hamburg-Sud (04April11). This estimate is based on Mr. Dehe's confirmation of his original estimate of 112 TEUs in 2004. Mr. Dehe recommended that the 2004 estimate be updated by historical growth in maritime trade between the US and South America. The historical growth rate used to update the 2004 estimate is based on maritime trade between the east coast of South America and the US as reported by the American Association of Port Authorities.

growth on this trade (1.38% per year[13]), then the average annual equivalent transportation cost savings for TEUs offloaded at the PONYNJ and trucked to South Jersey and Pennsylvania locations would be $2,488,300 (based on a 50 year planning horizon and the FY11 discount rate of 4.125%).

The forecasted annual growth in containerized cargo between the east coast of South America and Packer Avenue (1.38%) is equivalent to the observed historical annual growth rate (2004 – 2010) in sea trade tonnage between Paraguay, Uruguay, Argentina, Brazil, and the United States, as reported by the American Association of Port Authorities (aapa-ports.org). An alternative growth rate is provided by MDS Transmodal as presented in the December 2010 issue of Containerisation International (page 5). This forecast predicts rapid growth in 2011 and 2012, with a reduction to less than 2% annual growth by 2013. This forecast includes the same South American countries as are included in the observed historical annual growth rate, but includes trade from these counties to the United States, Canada, and Mexico. This alternative forecast is used in a sensitivity analysis.

Currently, the Mercosur liner service is a mixture of vessels in the Cap San Marco class (3,740 TEUs, 41-foot maximum draft) and vessels in the Cap Gregory class (4,300 TEUs, 42-foot maximum draft). The introduction of Cap Gregory class vessels is being made because of realized growth in trade with Brazil, Argentina, and the US East coast. In the near future, prior to the base year of the analysis (2015), the Mercosur liner service is projected to transition into Monte class vessels, which are in in the 5,500 – 5,900 TEU range[14] with a maximum draft of 44 feet. This transition is based on the carrier's cargo growth projection and because Hamburg Sud is taking delivery of a fleet of 7,100 TEU vessels (Santa Isabel class) in 2011 and 2012, which will make the Monte class vessels available for re-deployment. The Santa Isabel class vessels (7,100 TEUs, 47-foot maximum draft) have the world's largest reefer TEU slot capacity (1,600 reefer TEUs) and are being introduced into the South America to Asia trade route. The first vessels in the Santa Isabel class were delivered in early 2011.

The carrier has indicated that, under without-project conditions, the 40-foot controlling depth at Philadelphia, which allows unrestricted access for vessels up to 36 feet operating draft, would pose too restrictive a constraint on the Monte class vessels. Philadelphia's without-project condition controlling depth (40 feet) would be 12 feet less than Pecem (52 feet), 10 feet less than the PONYNJ (50 feet in 2014), and 10 feet less than Norfolk (50 feet), which are the ports preceding and following Philadelphia in the Mercosur port rotation. Due to the without-project condition depth constraint at Philadelphia, the carrier projects that the Monte class vessels on the Mercosur service will not call at Philadelphia. This projected by-passing of Philadelphia by the next-larger vessel size class on this service was identified as the most likely future without project condition in two separate interviews; one with a local Philadelphia Hamburg Sud representative and a one with a regional (North America) Hamburg Sud representative.

Under future without project conditions, the Monte class vessels will go directly to the PONYNJ from the east coast of South America and then continue down the US east coast to Norfolk

[13] Based on American Association of Port Authorities data on sea-trade between the U.S. and Argentina, Brazil, Paraguay, and Uruguay 2004 – 2010.

[14] Based on two separate phone interviews with Hamburg-Sud personnel. One interview was with Rainer Dehe, Vice-President Hamburg-Sud (02Apl11) and the second phone interview was with Jeff Parker, Hamburg-Sud local Philadelphia Operations Manager (28Feb11). Both interviews provided similar details.

without calling at Philadelphia. Philadelphia-bound cargo on the Mercosur service will most likely be shifted to off loading at the PONYNJ because this service is already carrying the cargo. A less likely alternative would be that a new direct call service, using vessels smaller than the Monte class, could include Philadelphia as a port of call. This smaller vessel alternative is less likely because of the continuing trend for larger vessels on services calling at the US east coast and because the other ports on this service are all capable of handling substantially larger vessels than Packer Avenue under without-project conditions.

If the Philadelphia cargo on the Mercosur service (42,881 TEUs in 2010) shifts to the PONYNJ, then that cargo would get trucked from the PONYNJ to its Philadelphia origins and destinations. Each TEU would incur an average additional $335.84 landside transportation cost, based on additional truck miles and higher port fees at the PONYNJ than port fees at Philadelphia. Each shifted TEU would also incur a waterborne transportation cost savings of $2.36 because of the waterborne transportation cost efficiencies of the larger Monte class vessel. Thus, applying the methodology developed for the 2002-2004 Re-analysis, with trade between the east coast of South America and the US east coast projected to continue to grow at the historical rate of 1.38% per year, the average annual transportation cost savings for the 50-year period of analysis (2015 – 2065) is $19,868,000.

In response to the Mercosur service by-passing Philadelphia, another service on the east coast of South America to the US east coast trade route could add Philadelphia as a port of call. This alternative service would necessarily need to use vessels smaller than the Monte class or it would incur the same operational difficulties that will cause the Mercosur service to by-pass Philadelphia. If the alternative service used vessels that are the same size as the Cap Gregory vessels on the existing Mercosur service, then it would be reasonable to project that this service would continue the current port rotation and continue offloading some Philadelphia TEUs at the PONYNJ. Growth in this trade would also need to be either handled at the PONYNJ or carried on an alternative service.

Currently, the only other service on this trade route (MSC's ECNA-ECSA service) uses vessels that are larger than Cap Gregory class vessels. This service does not call at Philadelphia. Projected growth in South American trade at Philadelphia would unlikely be accommodated by vessels on a service using Cap San Marco class size vessels or smaller. Projected trade growth would likely be carried on larger vessels, which are more efficient and result in a lower waterborne transportation cost per TEU. These vessels, like the Monte class vessels and the vessels on the MSC ECNA-ECSA service, would not call at Philadelphia due to without-project channel constraints, and would likely service the projected growth in Philadelphia's South American trade through the PONYNJ.

The growth in Philadelphia's hinterland trade with the east coast of South America (1.38% per year) would likely by-pass Philadelphia under without-project conditions and be shipped through the PONYNJ on vessels of the Monte class size or larger. These TEUs and time sensitive cargo would be trucked from the PONYNJ to/from their Philadelphia hinterland destination/origin. Under with-project conditions, the Mercosur service would be able to deploy Monte class vessels to Philadelphia.

Under the most likely without-project future condition, applying the conceptual approach initially established for the 2002-2004 Re-Analysis, the Hamburg Sud service from the east coast of South America would by-pass Philadelphia because of channel depth constraints on the

vessels projected to be deployed on this service. The average annual with-project transportation cost savings would be $19,868,300. Under a less likely without-project future condition, the departed Hamburg Sud service would be replaced by a new service using vessels similar in size to the existing fleet. The with-project transportation cost savings would be based on Philadelphia-bound time sensitive cargo, which would be offloaded in the PONYNJ, and on additional cargo volume growth, which would also need to be handled at the PONYNJ.

Australia/New Zealand to US East Coast

At the time of the 2002-2004 Re-Analysis, P&O Nedlloyd, in coordination with five slot sharing partners[15], operated two round-the-world weekly services delivering goods between Australia-New Zealand (ANZ) and the U.S. east coast, EBANZ and WBANZ. The EBANZ was an east bound round-the-world service that originated in Australia, passed through the Panama Canal, stopped at the port of Manzanillo, Panama (located on the Atlantic Ocean side of the Canal, then calls on U.S. east coast ports before continuing east to Europe and then on through the Suez Canal, returning to ANZ. The EBANZ service consisted of ten 4,100 TEU vessels that are specialty containerships which include 1,300 reefer slots[16]. These specialty vessels were ordered and built specifically for this service because of the high volume of refrigerated imports for ANZ to the U.S. East Coast (specifically, the Philadelphia region). These vessels have a maximum sailing draft of 42'02". The EBANZ service started as a regularly scheduled service in December 2002 and was reconfigured as an ANZ – Asia service in 2005.

One of the major commodities imported to Philadelphia by the EBANZ service was Australian meat. Other commodities imported to Philadelphia on this service included Australian wine and produce, and New Zealand meat, produce, and dairy products. Historically, imported meat was frozen for shipping, but the availability of large reefer containerships on a weekly service resulted in an increase in the volume of chilled meat imports from Australia (chilled meat was previously transported solely via air, at much greater cost). These commodities are now shipped from Australia/New Zealand to Asia and to Europe on services using the same or similar vessels as were used on the EBANZ service. The shift in this service from the US east coast to Asia and Europe has been attributed to the drop in the relative value of the dollar to other currencies, increasing the attractiveness of Asia & Europe as ANZ trading partners, relative to the US.

Trade with ANZ and the US east coast, with Philadelphia as a port of call, still continues on the AANZ/ANP service, which is a partnership between Hamburg Sud, Hapag Lloyd, and Maersk. The AANZ/ANP is one of the four new services calling at Packer Avenue since the 2002 – 2004 Re-Analysis. The vessels deployed on this service are currently within the 2,800 – 3,400 TEU range. These vessels typically operate at Philadelphia unconstrained by existing channel dimensions. The vessels in the existing fleet and vessels in the projected without-project condition fleet, which are similar in size to the existing fleet, would not be constrained by without-project channel dimensions. Therefore, this service is not projected to now provide transportation cost savings under with-project conditions. The 2002-2004 Re-Analysis identified $5,323,000 in average annual benefits for this service. The 2011 Updated Assessment now identifies no benefits for this service.

[15] Columbus Line, Contship, CMA CGM, Compagnie Maritime Marfret, and Hapag-Lloyd

[16] According to World Cargo News (Issue: Mar 2002), at the time of their introduction in 2002, this class of vessels was the largest reefer containerships in the world fleet.

West coast of South America to the US east coast

Currently, MSC operates a service between ports on the west coast of South America and the US east coast, which includes Philadelphia as a port of call. This service did not exist during the time the 2002-2004 Re-Analysis was being conducted and is one of the four new services calling at Packer Avenue. Vessels on this service range from 2,470 TEUs (maximum draft of 37.4 feet) to 4,860 TEUs (maximum draft of 44.4 feet). In 2010, 75% of vessel arrival drafts from Freeport, Bahamas (the previous port) were 34 feet or less. Vessels arrived with drafts ranging between 36 and 38 feet on 25% of calls. MSC also operates a service between the same west coast of South America ports and Europe using slightly larger vessels.

In recent (March 2011) discussions with the carrier, the carrier indicated that vessels on this service would likely be upgraded to larger vessels after the Panama Canal expansion is completed. The carrier did not indicate when the upgrade in vessel size would occur, which vessel size would be selected, or which ports would be called on by the larger vessels. The uncertainty of future plans for this service coupled with the typically unconstrained operation of this fleet at Philadelphia under current without-project conditions precludes any identification of with-project transportation cost savings for this service at this time. However, it is important to note that MSC currently operates 8,000 TEU vessels to the US east coast at other ports on other services and that MSC has been an industry leader in using large containerships. It would be consistent with MSC's recent historical use of large vessels to consolidate the west coast of South America to Europe service with the west coast of South America to US east coast service, using substantially larger vessels than the existing fleet, after the Panama Canal expansion is completed. If this change in service were to occur, it is likely that these large Post-Panamax vessels would not call at Philadelphia and Philadelphia-bound cargo would be offloaded at the PONYNJ and other ports. Therefore, it is likely that deepening the Delaware River to 45 feet could provide benefits for cargo on this service, but, to be cautious, these benefits have not been calculated or quantitatively included in this analysis.

The CMA CGM SA shipping line also operates a west coast of South America to US east coast service, known as the Black Pearl, which includes Philadelphia as a port of call. This service did not exist during the time the 2002-2004 Re-Analysis was being conducted and is one of the four new services calling at Packer Avenue. Ports of call on this service also include Caribbean and Central American ports. The vessels on this service range from 1,100 to 1,300 TEUs, with maximum drafts ranging from 26 to 36 feet. These vessels typically are not constrained by the without-project channel depth. Imminent plans to upgrade the size of vessels on this service have not been identified and this service is not projected to benefit from channel deepening.

North Europe to the US east coast

MSC also operates a service between Europe and the US east coast, with Philadelphia as a port of call, using vessels ranging from 4,550 TEUs to 5,060 TEUs (maximum draft 44.3 feet). These vessels had arrived from the PONYNJ as the previous port of call in 2010, but the port rotation has been changed (2011) so that Boston is now the previous port of call. The next port of call on this service is typically either Baltimore or Norfolk. This service did not include Philadelphia as a port of call during the time that the 2002-2004 Re-Analysis was being conducted and is one of

the four new services calling at Packer Avenue. In 2010, vessels on this service operated with drafts of 35 feet or less on 72% of arrivals. Operating drafts ranged from 36 feet to 38 feet on the remaining 28% of calls.

This service has not been identified by the carrier as a near-future candidate for a vessel size upgrade. However, it is important to note that all of the other ports on this service, foreign and domestic, are currently called on by Post-Panamax vessels. It would not be unlikely that services with smaller vessels may be consolidated into a single service using large containerships. If this consolidation were to occur, as it has on other trade routes, then deepening the Delaware River to 45 feet could provide benefits for cargo on this service, but these benefits also have not been calculated or quantitatively included in the current analysis.

Overall, the existing 40-foot channel depth will become an even greater constraint to containership operations on the Delaware River in the future than observed today. Interviews with carriers currently using the Delaware River (Hamburg-Sud and MSC) and with carriers that call at the PONYNJ but not at the Delaware River (COSCO and Hanjin) have identified the carriers' intent to include ports other than the PONYNJ as a northern US east coast port of call. The carriers recognize that the PONYNJ is used as a substitute port for cargo which could more efficiently be shipped through Philadelphia. The Philadelphia Regional Port Authority has identified[17] more than 29,000 TEUs which would likely shift from using the PONYNJ to using Philadelphia if an all-water service from Asia to Philadelphia were in effect. Philadelphia has not been and will likely not be included in an all-water service to Asia in the future (with a 40-foot channel) because insufficient channel depth and the long, slow transit needed to maintain tidal advantage works against the efficiency carriers are looking to gain by using increasingly larger vessels. Under with-project conditions (45-foot channel depth) larger containerships would be able to operate more efficiently within the Delaware River and would be more likely to include Philadelphia as a port of call, as the carriers have indicated during interviews.

7 Sensitivity Analyses

Five sensitivity analyses were conducted to assess the impact of changes to critical factors on project benefits. These sensitivity analyses include:

- An alternative negative cargo growth rate;
- An increase in lightering vessel utilization;
- Alternative landside transportation costs;
- Alternative container volumes; and
- Alternative amounts of Philadelphia-bound containers landed at the PONYNJ.

The negative cargo growth rate sensitivity analysis imposes a -0.05% growth rate on all commodities from 2015 – 2065. The effect of a negative growth rate throughout the period of analysis is to reduce project benefits.

[17] The Philadelphia Regional Port Authority has collected letters of support indicating a willingness to shift from using the PONYNJ to using Philadelphia from more than 50 local shippers representing more than 29,000 TEUs.

The base case analysis uses an 81% lightering vessel availability rate, meaning that the lightering vessels are available for lightering service in the Delaware River 295 days out of 365 days. This level of availability was based on observations made for the 2002-2004 Re-Analysis, which included lightering offshore, lightering and at alternative ports (New York and Yorktown, VA), and equipment maintenance. As a sensitivity analysis an alternative availability rate of 90% (330 available days per year) was imposed on the analysis. The additional availability allows for more efficient use of the fleet under without-project conditions and slightly reduces benefits.

A 20% reduction in landside transportation costs reduces container benefits for cargo projected to be landed at the PONYNJ under without-project conditions. A 20% reduction in the container forecast reduces container benefits in a similar manner. An alternative forecast for containerized trade between the east coast of South America and the east coast of North America (including Canada and Mexico), which was identified in Section 6, is the short term forecast provided by MDS Transmodal for the December 2010 issue of Containerisation International. This forecast projects 13.4% growth in 2011, with a drop off to 1.7% growth, which is sustained throughout the period of analysis. This alternative forecast increases container benefits by 19.9%.

A final sensitivity analysis assesses the impact of some containers shifting to smaller vessels and continuing to call directly at Philadelphia under without-project conditions. This would require a new service to be developed, which would operate smaller vessels that presumably would be unconstrained under without-project conditions (maximum 36-foot sailing draft; approximately 2,000 TEUs). These smaller vessels would be competing with the Monte class vessels, which are in in the 5,500 – 5,900 TEU range with a 44-foot maximum operating draft. Based on the FY08 IWR Vessel Operating Costs, a 2,000 TEU vessel operates at 150% greater cost per TEU per 1,000 miles ($36.16) than a 5,900 TEU vessel ($24.05). This cost differential identifies the relative inefficiency of using smaller vessel, which indicates that a smaller service competing on this route is unlikely to be a sustainable condition. A shift of 40% of east coast of South American cargo to smaller vessels would reduce total transportation cost savings by 33%.

Table 7-1: Sensitivity Analyses: Average Annual Benefits by Commodity-Type and Benefit-Cost Ratio

	Transportation Cost Savings				
Analysis	**Crude Oil**	**Bulkers**	**Containers**	**Total**	**BCR**
2002-2004 Re-Analysis	$12,130,000	$5,412,000	$6,124,000	$23,665,000	1.2
2011 Update Base Case	$6,853,616	$7,854,285	$19,868,295	$34,576,197	1.6
-0.05% Growth rate	$6,255,357	$5,319,484	$14,364,213	$25,939,054	1.2
OSG 90% Availability	$6,381,283	$7,854,285	$19,868,295	$34,103,864	1.6
20% Decrease in Landside Transport Costs	$6,853,616	$7,854,285	$15,853,192	$30,561,094	1.4
20% Decrease in Number of Containers	$6,853,616	$7,854,285	$15,894,636	$30,602,538	1.5
Alternative CI Forecast	$6,853,616	$7,854,285	$23,836,684	$38,544,585	1.8
40% of Containers Use Smaller Vessels	$6,853,616	$7,854,285	$11,920,977	$26,628,879	1.3

Note: 2002-2004 Re-Analysis Crude Oil benefits include benefits for petroleum products; Benefit-Cost ratios include benefits from beneficial use of dredged material

8 Conclusion

This 2011 Updated Assessment identified those conditions that have changed since the 2002-2004 Re-Analysis, and re-evaluated project benefits based on those changes. The 2002-2004 Re-Analysis calculated project benefits related to bulk cargo, liquid bulk cargo, and containerized cargo. Overall, the benefits calculated for this 2011 Updated Assessment are greater than the benefits calculated in 2004 for the Re-Analysis (Table 8-1) and the benefit-cost ratio has improved by more than 40%, from 1.15 to 1.64. The Remaining Benefit-Remaining Cost Ratio (RBRCR) is 1.85 (the average annual remaining costs are $19,017,000, netting out the $31 Million expended as part of the first construction contract and the actual expended (sunk) costs of $4 Million to meet Air Conformity requirements.)

The marine transportation industry has continued the trend towards greater efficiency identified in the 2002-2004 Re-Analysis. This trend includes the re-configuration of the Delaware River lightering fleet and the use of larger vessels, especially containerships. These trends towards greater efficiency in marine transportation are consistent with and would be further supported by deepening the Delaware River channel to 45 feet. The deeper channel would facilitate a greater increase in marine transportation efficiency by allowing vessels to transit the channel with deeper drafts (larger loads) and by allowing larger vessels to use the channel as identified in the 2002-2004 Re-Analysis and verified in the 2011 Updated Assessment.

The temporary impacts of the recent economic recession have not diminished the long-term and well established need for efficient marine transportation on the Delaware River. The existing industrial infrastructure along the Delaware River, including refineries and slag processing facility, will continue to be supplied by imported commodities well into the foreseeable future. Recent and ongoing improvements to these facilities, such as the refurbishing of the PBF Paulsboro refinery and the capacity upgrade to the slag processing facility, indicate the intention to continue and improve operations at these facilities into the future. Philadelphia remains an industrial transportation hub with access to three major railroads and immediate access to two interstate highways. Landside transportation accessibility, which makes Philadelphia an efficient inter-modal destination, will continue to provide the necessary distribution network for containerized cargo and imported steel. These factors relating to the stability of marine transportation on the Delaware River, and relating to the robustness of projected deepening project benefits, have been verified by the 2011 Updated Assessment.

Table 8-1: Average Annual Benefits by Commodity-Type for the Re-Analysis and the Updated Assessment

Commodity Type	2002-2004 Re-Analysis	Updated Assessment
Crude Oil	$11,778,000	$6,854,000
Petroleum Products	$352,000	--
Containerized Cargo	$6,124,000	$19,868,000
Slag	$1,807,000	$2,014,000
Steel	$3,605,000	$5,840,000
Total Transportation Cost Savings	**$23,665,000**	**$34,576,000**
Broadkill Beach	$583,000	$591,000
Total Average Annual Benefits	**$24,249,000**	**$35,167,000**
Total Average Annual Costs	**$21,025,000**	**$21,502,000**
Total Average Annual Net Benefits	**$3,223,000**	**$13,665,000**
Benefit-Cost Ratio	**1.15**	**1.64**

This 2011 Updated Economic Assessment has quantified benefits of the 45-foot deepening project. Additional potential benefits, not claimed at this time, but still likely to be ultimately realized by the project, include increased use of the Packer Avenue Marine Terminal by large containerships. The carriers, including those that do not currently call at Packer Avenue, have indicated their intention to bring more Post-Panamax vessels to the U. S. east coast and to use

ports other than the PONYNJ. The recent announcement of COSCO's new Asia - U.S. east coast service via the Suez Canal, which uses Post-Panamax vessels and calls at Boston Harbor, is an example of the carriers executing their stated intentions. COSCO had considered including Philadelphia as a port of call on this service, but determined that the current 40-foot channel depth constraint and the time needed to use a tidal advantage would be too costly[18]. Similar opportunities will arise, and likely with greater frequency, after the Panama Canal expansion has been completed. Although there is strong indication that Philadelphia, with a 45-foot channel depth, will become a port of call on services that would not call with the current 40-foot channel depth, benefits for these future services have not been quantified in this 2011 Updated Assessment. Nonetheless, project benefits have proven to be robust and are greater than estimated by the Re-Analysis in 2004.

[18] Phone interview (06Apl11) with Sam Martinovic, Vice President, Marine Operations, COSCO.