EXHIBIT M
ECONOMIC ANALYSIS
(REVISED)

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Exhibit M
Economic Analysis (Revised)

1. Introduction

The purpose of this analysis is to revise the benefits for the 43-foot channel. This does not constitute a reformulation of the project; rather, this analysis assesses the benefits of the 43-foot channel based on current information. This analysis presents the revised benefits for only the Columbia River portion of the deepening project, and assumes that the Willamette River portion of the deepening project will be deferred.

Average annual benefits have been reduced from $34.4 million to $18.8 million. The reduction in benefits is due to a number of factors, including reductions in export projections and adjustments to fleet forecasts. Numerous other factors have been adjusted and are discussed in the analysis below.

Throughout this analysis, the original work done in the 1999 Final Integrated Feasibility Report / Environmental Impact Statement (1999 Final IFR/EIS) will occasionally be referenced as 'the original analysis' or 'the original projection'. Several of the primary updated elements are listed below, but the specific changes for each commodity group are detailed in separate sections.

- Commodity Projections. Each of the commodity projections has been updated. For all of the original commodities analyzed, exports have been down since the mid 1990's, reflecting a number of factors, starting with the Asian economic crisis. The best new information for this update is a study that has been completed by DRI-WEFA, in association with BST Associates and Cambridge Systematics. The study, *Commodity Flow Forecast Update and Lower Columbia River Cargo Forecast,* was commissioned by the Port of Portland, Metro, ODOT, the Port of Vancouver, and the Regional Transportation Council (July 2002[1]). DRI-WEFA and BST were two of the firms that worked on the original cargo forecasts used in the FEIS. This revised analysis will reference that report, which is publicly available.

- Fleet Projections. Each of the fleet projections has been updated using recent data. Vessel movements for 1999, 2000, and 2001, and available data from the beginning of 2002 were used in this analysis. The data was compiled by the Port of Portland, and was gathered from PIERS (for vessel movements), Lloyds Registry (vessel characteristics), Clarkson (vessel characteristics), and Columbia River pilots logs (departure drafts).

- The interest rate used to evaluate the project is now 5.875% (the 1999 rate was 6.625%). The interest rate is calculated in accordance with Section 80 of Public Law 93-251, and is provided in Corps of Engineers Economic Guidance Memorandum Number 03-02: Fiscal Year 2003 Interest Rates[2].

[1] http://www.portofportlandor.com/Marine/MTMP/Key_Information.htm
[2] At the time of this publication, EGM 03-02 is still in draft form.

- Vessel operating costs change every year as well, and the update of the benefits will use the current vessel operating costs. The vessel operating costs are based on 2002 price levels, and are documented in Economic Guidance Memorandum 02-06. The fiscal year (FY) 2003 interest rate has been applied to the annual capital cost calculation.

- The Willamette River. This analysis assumes that the Willamette River portion of the project is deferred, and the costs and benefits of deepening the Willamette River have been excluded from this analysis.

- The first full year that the entire project will be constructed is 2007. The majority of the construction activities will take place in FY 05 and FY 06. All costs and benefits are brought to the beginning of FY 07. In the original analysis it was assumed that the portion of the river from the mouth to Kalama would be done in the first year of construction. The revised construction schedule has the entire project completed after the second year of construction, meaning there are no longer benefits during construction. The construction period is a 24-month period from June of 2004 to July of 2006. The original analysis assumed that construction would be completed in 2004.

2. Wheat

Relative to the original analysis, the average annual transportation cost savings associated with wheat exports have decreased from $8.9 million to $2.1 million. The deferment of the Willamette River navigation channel improvements represents a 50 percent reduction in wheat benefits. Wheat export projections have decreased by approximately 20 percent. Adjustments to the fleet projections and vessel operating costs have also reduced benefits.

2.1. Wheat Export Projections

The Columbia River wheat export projections have been reduced substantially relative to the original analysis, dropping from a projected 14.5 million short tons in 2004 to a new projection of 11.5 million short tons in 2007. Exports are expected to grow at an average annual rate of 0.46 percent from 2007 to 2037. For all commodity groups, the analysis uses DRI-WEFA/BST projections that exclude interregional shifts in cargo that cannot be properly counted as NED benefits.

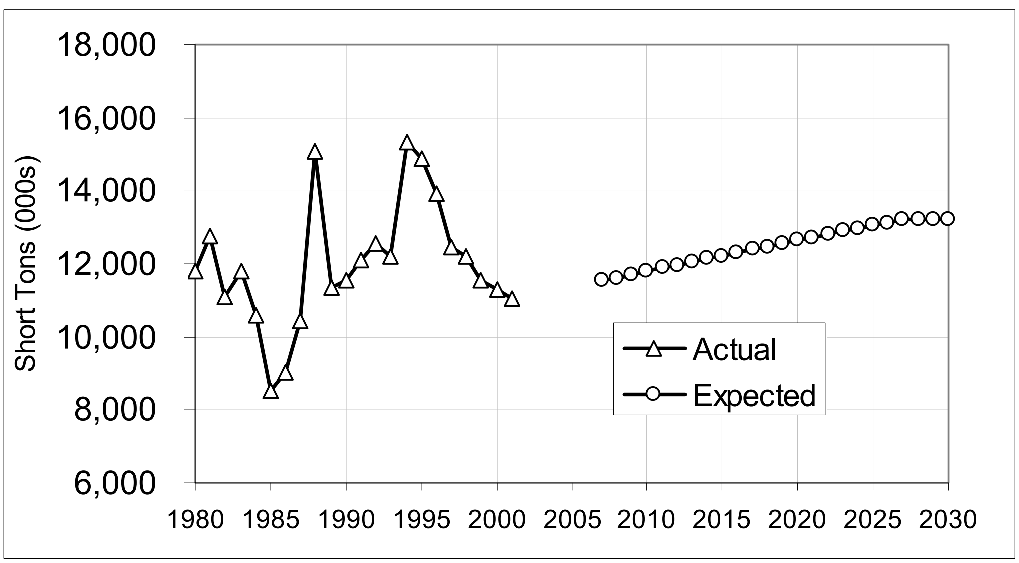
Table 1. Columbia River Wheat Projections (short tons)

Year	Original Projection	Year	Revised Projection
2004	14,518,651	2007	11,528,504
2014	14,729,680	2017	12,394,901
2024	15,972,270	2027	13,215,377
2034	19,065,140	2037	13,230,430
2044	19,427,940	2047	13,230,430
2054	19,427,940	2057	13,230,430

In comparison, wheat exports were over 12 million short tons each year from 1991 to 1998, hitting a high of 15.3 million short tons in 1994. While global demand for wheat is expected to increase over the term of the project, Columbia River exports are not expected to change appreciably from historic levels due to strong international competition.

The DRI-WEFA/BST projections present high and low forecasted growth rates that range from –0.5 percent to 1.3 percent from 2000 to 2030. This analysis has taken the midpoint of those projections. For example, in 2010, the low range of the estimate is 10.8 million short tons and the high range of the estimate is 12.8 million short tons. This update uses the midpoint of those two values, 11.8 million short tons.

Figure 1. Actual and Projected Columbia River Wheat Exports, 1980 - 2030



2.2. The Willamette Reach

Benefits associated with deepening the Willamette River have been removed from the analysis. For the purposes of this analysis, it has been assumed that all of the grain that is shipped out of the Willamette River will never benefit from the deepening of the Columbia River, and that the distribution of vessels serving various trade routes will be equally distributed across all facilities. In 2000 and 2001, about half (48 percent) of the exported wheat and barley came from Willamette River facilities, and that has been assumed to continue throughout the analysis.

It was assumed in the original analysis that the larger, benefiting grain vessels would be equally distributed across all facilities. With the deferment of the Willamette, it is possible that some greater portion of the benefiting vessels would be served by the deeper facilities on the Columbia River. For example, wheat being exported to Indonesia often moves in the maximum possible load size given the current channel constraint. With a deepening, it is possible that some portion of this tonnage will shift to existing facilities on the Columbia River, rather than being distributed across all facilities. It is difficult to quantify this potential shift, but the fleet projections should be viewed in the light that they are being applied only to 50 percent of the total tonnage, meaning that if the fleet projection for one of the trade routes predicts that 25 percent of the wheat would benefit from a channel deepening, the calculations only apply to 50 percent of the total tonnage, and only 12.5 percent of the actual tonnage will benefit.

2.3. Distance between Ports

In the original analysis, all wheat transportation costs were calculated using a uniform round-trip distance to the destination port (11,500 nautical miles), which is appropriate for countries such as Japan, but is not appropriate for Pakistan, Bangladesh, The Philippines, Yemen, etc. The number of days at sea for each trade route has been adjusted appropriately for each trade group, and has been increased to more accurately reflect actual distances. This adjustment increases the benefits of the project relative to the distances assumed in the original analysis. Voyage distances have also been adjusted to reflect that approximately 35 percent of handymax vessels have a U.S. backhaul, reducing total roundtrip voyage distances for those vessels. For all other vessels, voyage distances have been adjusted to reflect that most vessels arriving from overseas are coming from Japan, Taiwan, or South Korea, rather than making a full roundtrip voyage from further destinations.

The at-sea portion of the transportation costs for wheat moving to the Other Asia group has been changed from 34.0 days to 32.5 days for handymax vessels and 46 days for panamax vessels. Currently, the major importer in this group is The Philippines, but the group also includes Pakistan and Bangladesh. This calculation is a weighted average based on export data from 2000 and 2001.

The at-sea portion of the transportation costs for wheat moving to the Rapidly Developing Asia group has been changed from 34.0 days to 28.8 days for handymax vessels and 37.9 days for panamax vessels. The two major importers in this group are South Korea and Taiwan, but the group also includes Malaysia, Indonesia, and Thailand.

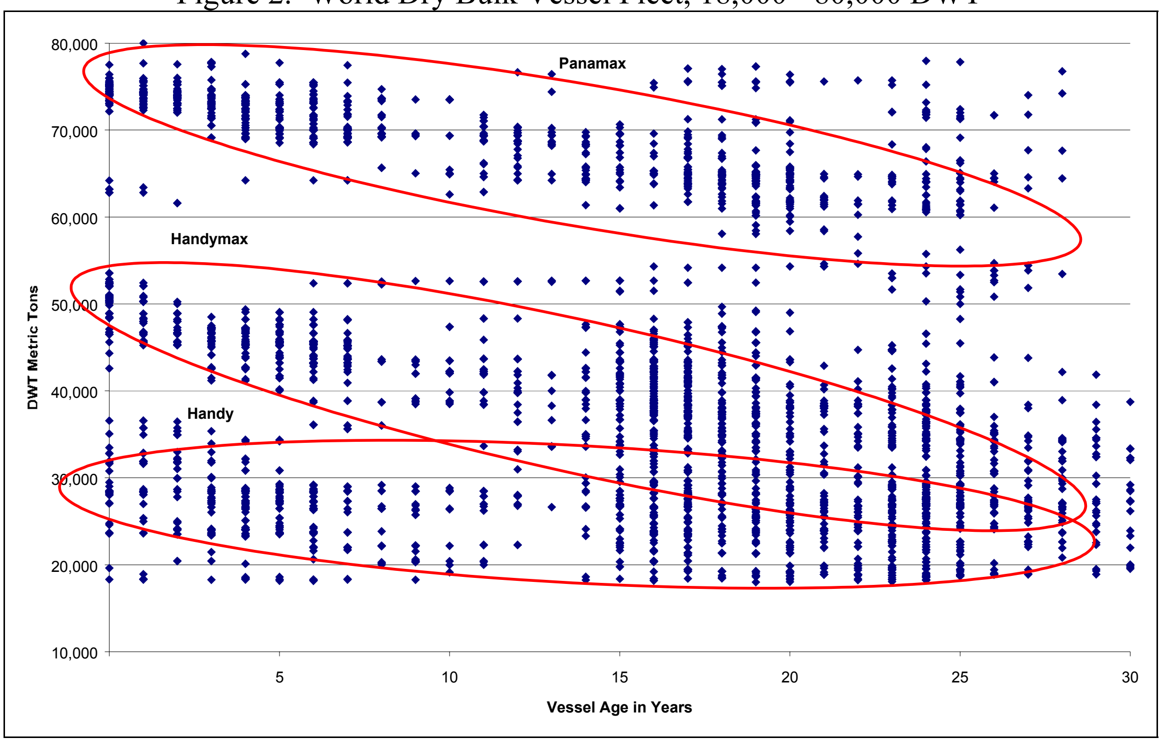
The at-sea portion of the transportation costs for wheat moving to the Other group has been changed from 34.0 days to 48.4 days (only panamax vessels benefit in this trade route). The two major importers in this group are currently Egypt and Yemen.

2.4. Wheat Fleet Projections

New vessel builds in the world bulk fleet have shown upward trends in vessel size. Figure 2 displays the trends that have developed over the last 30 years. The panamax class has grown to the point where the smallest vessels built in the last three years are 72,000 deadweight ton (dwt) vessels, much larger than the average panamax vessel built in 1990. These larger panamax vessels are calling on the Columbia River today.

The handymax class has shown a significant upward trend in size as well, and 50,000 to 53,000 dwt vessels have become common new builds, with fresh water design drafts between 40 and 41 feet. It is expected that this trend will continue, and that the trade routes that are currently using older 38-foot and 39-foot vessels will be using larger 40 and 41-foot vessels by 2017.

Figure 2. World Dry Bulk Vessel Fleet, 18,000 - 80,000 DWT



Source: Lloyd's Registry.

2.4.1. Rapidly Developing Asia

The following section describing the analysis for Rapidly Developing Asia (RDA) is presented in detail to illustrate the methodology used for all grain segments. Following the RDA section, the analyses for the other segments are presented in a summary form.

Table 2 displays the original projected wheat fleet for the RDA trade group for 2004. The fleet projections in 2004 predicted that 20 percent of the tonnage would move in vessels of design draft 40-foot or greater. The projections also show that 9 percent of the tonnage would move in vessels that could fully benefit from a 43-foot channel. The primary importers in this group are South Korea, Taiwan, Indonesia, and Thailand.

Table 2. Original Projected Wheat Fleet, 2004, Rapidly Developing Asia

Design Draft (fresh water, feet)	Projected Tonnage Distribution
31	3%
32	5%
33	10%
34	20%
35	10%
36	25%
37	7%
38	0%
39	0%
40	0%
41	5%
42	6%
43	5%
44	4%
45	0%
	100%

Table 3 displays the actual tonnage distribution by design draft for the RDA wheat fleet in 2000 and 2001. In this period, 16 percent of the tonnage moved on vessels with design drafts of 40 feet or greater, and 8 percent moved in vessels that would fully benefit from a 43-foot channel.

Table 3. Actual Fleet Distribution, Wheat, Rapidly Developing Asia, 2000-2001

Design Draft (fresh water, feet)	Actual Tonnage Distribution
32	3%
33	10%
34	3%
35	22%
36	17%
37	6%
38	13%
39	12%
40	3%
41	3%
42	1%
43	2%
45	2%
46	2%
47	2%
53	1%
(blank)	1%
Total	100%

Table 4 displays the actual tonnage distribution by departure draft. The original projected distribution and the actual distribution have some similarities. In the actual data, 22 percent of the tonnage departed at drafts of 39 or 40 feet. The projections assumed that 20 percent of the cargo would move at the channel constraint.

Table 4. Distribution of Tonnage by Departure Draft, RDA Wheat, 2000-2001

Actual Outbound Draft (feet)	Actual Tonnage Distribution
20	0%
23	1%
24	1%
25	1%
26	0%
29	1%
30	0%
31	2%
32	2%
33	8%
34	10%
35	19%
36	13%
37	9%
38	11%
39	13%
40	9%

The differences between today's fleet and the original projected fleet in 2004 are small. By 2014, however, the fleet projections assume that 25 percent of the cargo would fully benefit from a 43-foot channel, and that an additional 25 percent would gain some benefit as well, which would mean that a significant portion of the tonnage shifts from handymax vessels to panamax vessels. By 2024, it was expected that 66 percent of the tonnage would benefit to some degree with a deeper channel, and that 36 percent would take full advantage of the channel deepening.

In evaluating the reasonableness of the projections at 2014 and 2024, it is useful to look at some of the trend data. Table 5 displays the distribution of Columbia River wheat exports in 2000 and 2001. South Korea and Taiwan combine for almost three-quarters of the tonnage, with Indonesia and Thailand combining for the majority of the remaining share. This group of countries accounted for 33 percent of wheat exports over the last two years, and the calculations in the FEIS assumed that they would total 31 percent in 2004.

Table 5. Distribution of Tonnage, Wheat, RDA, 2000-2001

Country	Percent of Total
South Korea	40%
Taiwan	32%
Indonesia	14%
Thailand	11%
Malaysia	2%
Vietnam	1%

South Korea represents a large portion of this group, and is expected to continue to do so. Historically, exports to South Korea have moved in handymax vessels, with the most common design draft being about 35 feet. Over time, the average vessel size for vessels on this trade route has been increasing, but has not grown to panamax levels, and is not using even the larger vessels in the handymax class.

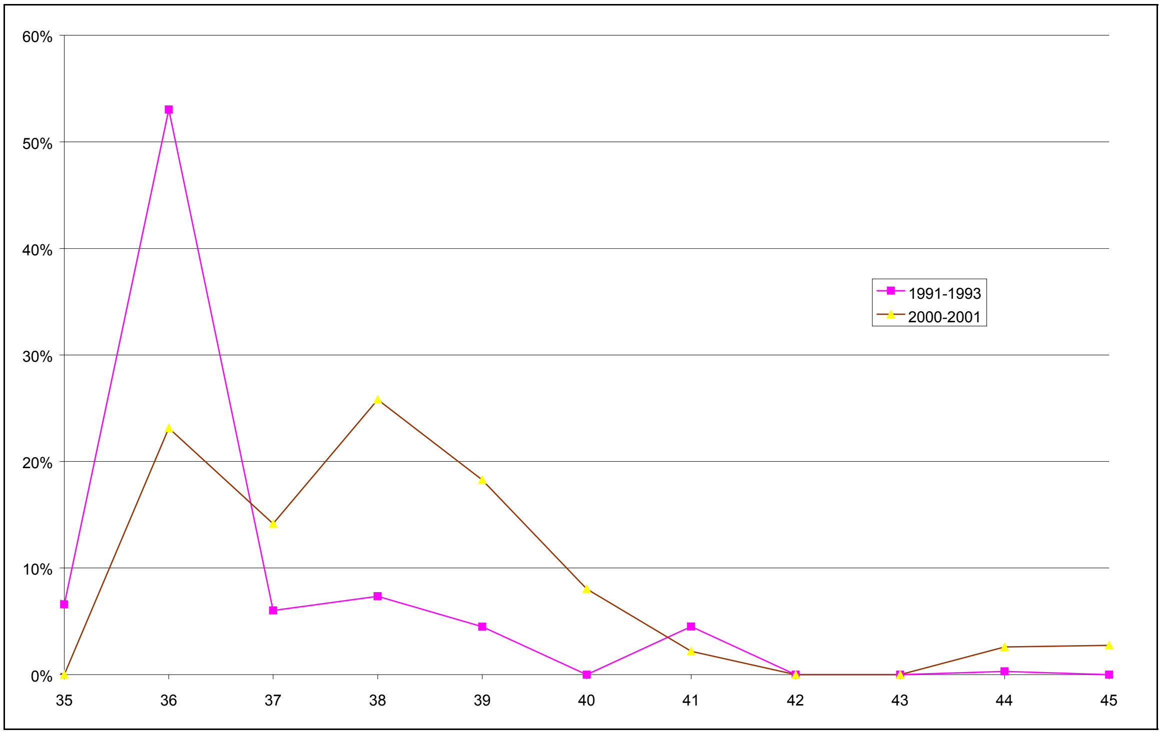
Table 6. Weighted Average Fresh Water Design Draft, Wheat to S. Korea

Year	Average Design Draft (fresh water, feet)
1991	31.0
1992	32.8
1993	34.1
2000-2001	34.6

While it is likely that exports to South Korea could shift to panamax or the larger handymax vessels at some point in the future, this analysis has adopted the conservative assumption that all of this tonnage will continue moving on smaller handymax vessels. Specifically, the revised fleet projections reflect that 40 percent of this tonnage is expected to never benefit from a channel deepening.

Taiwan is the second biggest importer of wheat in the RDA group, and, like South Korea, most of the wheat is currently moving in handymax vessels. Unlike South Korea, however, there were panamax movements in 2000 and 2001, and the majority of the tonnage is moving in the largest handymax vessels. Relative to the vessels in 1991 to 1993, the size of the vessels on this trade route has shift upward significantly. From 1991 to 1993, almost 80 percent of the tonnage on this route moved in vessels of design drafts ranging from 34 feet to 36 feet. Over the last two years, only 26 percent of the tonnage moved in that same vessel size. The average design draft has shifted from 36.2 feet to 38 feet. Figure 3 displays a comparison of the distribution of wheat exports to Taiwan by design draft.

Figure 3. Distribution of Wheat by Design Draft, Taiwan, 1991-1993 and 2000-2001



In the short term, the fleet used to ship wheat to Taiwan is expected to look much like today's fleet. In the long term, by 2017, it is expected that much of what is seen moving in 38-foot and 39-foot vessels will be moving in 40-foot and 41-foot vessels. It is expected that there will continue to be some level of panamax shipments, but that portion of the fleet will remain small.

Indonesia receives a small portion of the wheat in this group, and imported only 970,000 short tons of wheat over the last two years, but 60 percent of that wheat moved in panamax vessels. This trend is expected to continue in the future, with likely further shifts into panamax vessels on this trade route.

Thailand is the last significant importer in this trade group, importing 11 percent of the RDA wheat total over the last two years. Approximately 95 percent of this tonnage went out in the largest handymax size vessels, with design drafts of 38 feet to 41 feet.

The current data can be used to estimate some reasonable bounds for future benefits. For example, South Korea does not show any signs of an immediate shift even to larger handymax vessels, and it is probably reasonable to project that wheat exports to South Korea are not going to benefit from a channel deepening in the near future, and that any benefit that might occur could be a decade or more away. The projections assume that 40 percent of the tonnage on this trade route will never benefit from a channel deepening.

Approximately 15 percent of the RDA wheat tonnage is moving in vessels that could benefit immediately from a channel deepening. Another 25 percent of the tonnage is moving in larger handymax vessels with design drafts of 38 and 39 feet, and has the potential to shift upward into 40 to 42-foot vessels by 2017.

The majority of the remaining 20 percent of the tonnage is moving in smaller vessels to Taiwan and Indonesia, and has some potential to benefit in the long run, but also represents that there will, for the foreseeable future, be some of this cargo that will not require a 43-foot channel.

Table 7 displays the revised fleet projections for the Rapidly Developing Asia trade group. The difference between the actual recent data and the projection for 2007 is minor, but by 2017 it is projected that much of the grain that is moving in the largest handymax vessels today will shift upward by about two feet. While this projection has been adopted as the expected future, there is a potential upside benefit if some greater portion of the tonnage shifts into the larger panamax vessels. However, the fleet projections for this revised analysis have been held constant from 2017 to 2057.

Table 7. Revised Fleet Projections, Wheat RDA

Design Draft (feet)	Actual Tonnage Distribution (2000-2001)	2007	2017
32	3%	0%	0%
33	10%	8%	8%
34	3%	5%	5%
35	22%	20%	5%
36	17%	20%	20%
37	6%	6%	20%
38	13%	11%	4%
39	12%	11%	4%
40	3%	4%	10%
41	3%	3%	10%
42	1%	3%	3%
43	2%	2%	2%
44	0%	2%	3%
45[3]	2%	5%	6%
46	2%	0%	0%
47	2%	0%	0%
53	1%	0%	0%
Per Ton Costs 40-foot Channel		$ 14.03	$ 13.62
Per Ton Costs 43-foot Channel		$ 13.87	$ 13.41
Per Ton Savings[4]		$ 0.16	$ 0.22

[3] For the purposes of calculating benefits, bulk vessels at 45' design draft and larger benefit at approximately the amounts for a three-foot deepening, and have been grouped together.
[4] This is the average reduction in transportation costs spread across the entire tonnage exported. The actual per ton benefit for the vessels that benefit is much greater. For example, the per-ton benefit for a 45' vessel is $1.33.

2.4.2. Other Asia

The primary country in the Other Asia trade group is currently The Philippines, which accounted for 72 percent of Columbia River wheat exports in this trade group. Other significant importing countries are Bangladesh, Pakistan, and North Korea. In 2000 and 2001, about 25 percent of this cargo moved in vessels that could have benefited from a channel deepening. Table 8 displays the distribution of exports to this trade group in 2000 and 2001. The large portion of the distribution at the 38-foot and 39-foot design drafts consists primarily of exports to the Philippines.

Table 8. Distribution of Wheat Exports to the Other Asia Trade Group by Design Draft, 2000-2001

Design Draft (fresh water, feet)	Distribution of Wheat Exports
31	1%
32	1%
33	0%
34	2%
35	3%
36	3%
37	8%
38	29%
39	22%
40	5%
41	7%
42	4%
44	5%
45+	10%

Exports to The Philippines have moved primarily in the largest handymax (38 and 39-foot design drafts) vessels, with a small percentage moving in panamax vessels. As was the case with Taiwan, the average vessel has grown in size over the last decade. In 1993, the average vessel carrying wheat to The Philippines had a design draft of 37 feet. From 2000 to 2001, the average grew to 38.9 feet, reflecting the trend in handymax vessels. Assuming that this trend can continue, in 2017 this tonnage could be moving on vessels that are constrained by a 40-foot channel. On the high side, there is the potential that this cargo could eventually shift into larger panamax vessels. There has been heavy investment in panamax capable grain importing facilities in The Philippines.

The revised projections for this analysis assume that the fleet in 2007 will look much like the fleet today. By 2017 a portion of this wheat will shift to the 40 and 41-foot design draft vessels that are being built today. The fleet projections are held constant after 2017.

Table 9. Revised Fleet Projections Other Asia

Design Draft (fresh water, feet)	2007	2017
33	1%	1%
34	2%	2%
35	1%	1%
36	10%	10%
37	10%	10%
38	25%	1%
39	25%	5%
40	1%	25%
41	5%	25%
42	5%	5%
43	5%	5%
44	5%	5%
45	5%	5%
Per Ton Cost 40-foot Channel	$ 14.49	$ 13.97
Per Ton Cost 43-foot Channel	$ 14.17	$ 13.59
Savings	$ 0.32	$ 0.38

2.4.3. Other

The Other trade group consists primarily of the African countries, with Egypt and Yemen making up 90 percent of the exports to this trade group from 2000 to 2001. Exports to Egypt have moved almost completely in panamax vessels, while exports to Yemen have been primarily in handymax vessels. Approximately 50 percent of the total tonnage to this trade group moved in panamax vessels in 2000 and 2001. The original projections assumed that, by 2004, 60 percent of the tonnage would move in panamax vessels. It is expected that trade to this group will continue to move in about the same mix of vessels as was observed in the recent data, meaning that the benefiting tonnage has been reduced relative to the original analysis.

Table 10 displays the actual distribution of tonnage in 2000 and 2001. Table 11 displays the revised projected fleet. This fleet has been held constant throughout the analysis. The average cost per short ton for this trade route is $18.26 in the base condition, and $17.45 with a 43-foot channel, representing a savings of approximately $0.81 per short ton.

Table 10. Distribution of Wheat Exports to the Other Trade Group by Country and Design Draft, 2000-2001

Design Draft (fresh water, feet)	Egypt	Yemen	All Other	Total
32	0%	1%	0%	1%
34	1%	0%	0%	1%
35	0%	1%	1%	2%
36	1%	5%	0%	7%
37	0%	14%	1%	15%
38	0%	13%	1%	14%
39	0%	4%	1%	5%
40	0%	3%	1%	4%
41	0%	0%	0%	0%
42	4%	1%	0%	5%
43	2%	0%	0%	2%
44	0%	0%	0%	0%
45+	39%	1%	3%	44%
Total	48%	44%	8%	100%

Table 11. Revised Fleet Projections, Wheat Other Trade Group, 2007-2057

Design Draft (fresh water, feet)	Tonnage Distribution
31	0%
32	0%
33	0%
34	0%
35	5%
36	5%
37	12%
38	12%
39	9%
40	6%
41	0%
42	5%
43	2%
44	0%
45	44%
Total	100%

3. Corn

Relative to the original analysis, the average annual transportation cost savings associated with corn exports have decreased from $7.4 million to $3.8 million. Corn export projections have decreased by approximately 36 percent. Adjustments to the fleet projections and vessel operating costs have also reduced benefits.

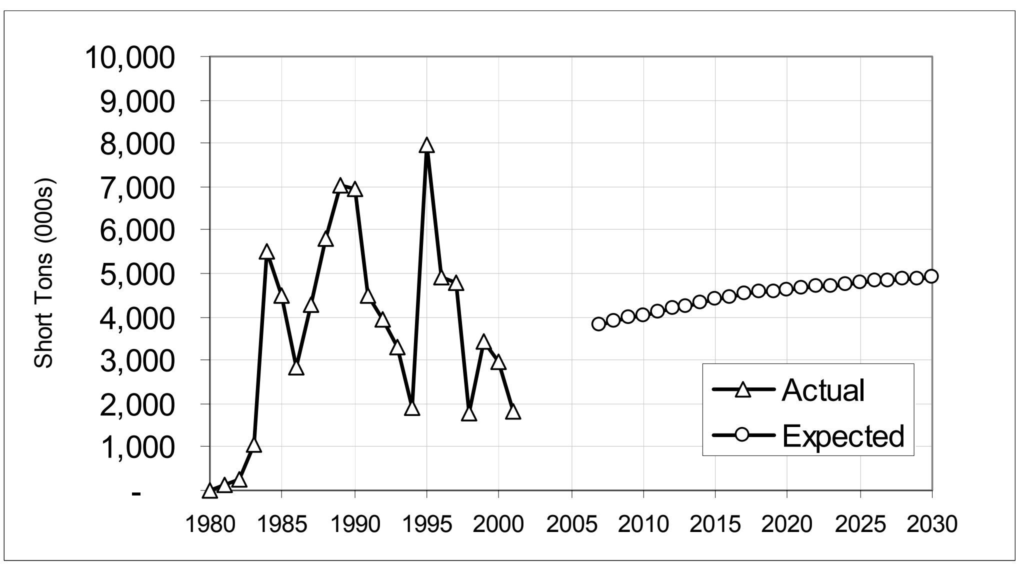
3.1. Corn Export Projections

Table 12 displays the original and revised export projections for corn on the Columbia River. The DRI-WEFA/BST study projects that Columbia River corn exports will grow at an annual rate between of 0.9 percent and 3.3 percent from 2000 to 2030. This revised analysis uses the midpoint between the low and high estimates. Over the first thirty years of the project, corn is projected to grow at an average annual rate of 0.9 percent. Figure 4 displays the actual and projected corn exports for the Columbia River from 1985 to 2030.

Table 12. Export Projections for Corn (short tons)

Year	Original Projection	Year	Revised Projection
2004	6,020,000	2007	3,832,972
2014	6,980,000	2017	4,535,873
2024	7,934,000	2027	4,841,875
2034	8,167,000	2037	5,016,538
2044	8,315,000	2047	5,016,538
2054	8,315,000	2057	5,016,538

Figure 4. Actual and Projected Columbia River Corn Exports, 1980 - 2030



3.2. Corn Fleet Projections

The fleet projections for corn are divided into two groups: 1) Japan; and 2) Rapidly Developing Asia (RDA), which, for the purposes of corn, is Taiwan and South Korea. China was originally expected to become a net corn importer at some point in the future, but has not become so yet, and is not included in this analysis. This analysis assumes that exports to Japan will experience little growth. For this revised analysis, most of the growth in the future is expected to come from exports to Taiwan and South Korea.

3.2.1. Japan

Over the last ten years, the corn fleet to Japan has decreased in terms of the portion of the tonnage moving in panamax vessels. Table 13 displays the distribution of average design draft for corn exports to Japan, comparing 1991-1993 to 2000-2001. The average design draft has not shifted very much, but the portion of the corn moving on vessels of 42-foot design draft or greater has decreased dramatically. At the same time, however, almost half of the total corn exports have shifted to the largest handymax vessels that can be used on the river.

Table 13. Distribution of Corn Exports to Japan by Design Draft

Fresh Water Design Draft	1991	1992	1993	2000 - 2001
31	0%	0%	0%	0%
32	1%	0%	0%	5%
33	1%	1%	0%	3%
34	0%	0%	0%	0%
35	2%	4%	0%	0%
36	4%	8%	16%	1%
37	23%	10%	31%	11%
38	15%	23%	13%	6%
39	5%	0%	0%	47%
40	6%	3%	0%	9%
41	3%	3%	0%	5%
42	23%	13%	6%	0%
43	3%	7%	18%	3%
44	11%	25%	12%	0%
45	3%	2%	3%	2%
46	1%	0%	0%	2%
47	0%	0%	0%	7%
Grand Total	100%	100%	100%	100%
Average	39.8	40.3	39.5	39.3
Design 42 or >	41%	48%	40%	13%
Design 39+	54%	53%	40%	73%

Table 14 displays the distribution of corn exports to Japan by departure draft for selected years. From a departure draft perspective, the majority of the corn vessels continue to leave at their maximum design draft. Recent history shows that, while the total number of vessels leaving at the authorized channel depth has dropped to 18 percent, the total tonnage departing at 39 or 40 feet has increased to 59 percent from 47 percent in 1991 and 1992, and 40 percent in 1993.

Table 14. Distribution of Corn Exports to Japan by Departure Draft

Actual Departure Draft	1991	1992	1993	2000 – 2001
24	0%	0%	0%	0%
25	0%	0%	0%	0%
26	2%	0%	0%	1%
27	0%	0%	0%	1%
28	0%	2%	0%	0%
29	0%	0%	0%	0%
30	0%	0%	0%	1%
31	0%	0%	0%	1%
32	0%	2%	0%	2%
33	2%	2%	0%	2%
34	2%	4%	3%	0%
35	0%	2%	4%	2%
36	20%	8%	28%	1%
37	25%	20%	19%	10%
38	2%	12%	6%	19%
39	5%	6%	0%	41%
40+	42%	41%	40%	19%
Grand Total	100%	100%	100%	100%
Average	38.0	37.9	37.8	38.0
Departure 39+	47%	47%	40%	59%

The future fleet is likely to see two changes. It is likely that the handymax vessels deployed to the Columbia River will continue to get larger, and what we see in 39-foot design draft vessels will likely be in 40 and 41-foot vessels by 2017. Further, it is likely that tonnage moving on this trade route will shift out of handymax and into panamax vessels with a channel deepening. Looking to the Puget Sound can be useful in estimating the range of that shift. In 2000 and 2001, 30 percent of the corn exported to Japan out of the Puget Sound moved on panamax vessels of design draft 43 feet or greater. Another six percent moved at 41 or 42 feet. Corn moving to Japan out of the

Puget Sound can be reasonably compared with corn moving out of the Columbia River. It is the same commodity, moving to the same destinations, with the same origins.

The most likely benefit for this trade route assumes that exports from the Columbia River and the Puget Sound will look more alike with a channel deepening than in the base condition.

Looking at the Pacific Northwest as one corn-exporting region, the exports out of the Puget Sound and the Columbia River can be combined to calculate an average demand for panamax lot sizes. Table 15 displays the combined exports of the two sub regions, and the portion of the combined tonnage that is moving at both greater than 41 and 42 feet, and 43 feet and greater. Based on this calculation, the initial total benefiting tonnage out of the Columbia River would be about 29 percent, much less than the original estimate of 45 percent.

Table 15. Combined Puget Sound and Columbia River Corn Exports to Japan, 2000-2001

Design Draft Range	Corn Exports (Short Tons)	Share of Total
Combined Tonnage	5,875,364	
Combined Tonnage 41, 42	325,281	6%
Combined Tonnage 43+	1,351,759	23%

Table 16 displays the revised fleet projections for corn exports to Japan in 2007 and 2017. By 2017, it is expected that the largest handymax vessels to be deployed on the Columbia River will have shifted to slightly deeper drafting vessels, resulting in a portion of the handymax fleet benefiting from the channel deepening. As in 2007, it is also expected that there will be a small shift from some of the larger handymax shipments into panamax vessels with a channel deepening. The fleet projections have been held constant after 2017.

Table 16. Revised Columbia River Fleet Projections, Corn to Japan

Design Draft (fresh water, feet)	40-foot Channel 2007	43-foot Channel 2007	40-foot Channel 2017	43-foot Channel 2017
36	8%	8%	8%	8%
37	12%	10%	12%	10%
38	6%	5%	6%	5%
39	47%	42%	5%	5%
40	9%	6%	26%	25%
41	5%	3%	25%	21%
42	0%	3%	5%	3%
43	3%	3%	3%	3%
44	0%	4%	0%	4%
45	2%	8%	2%	8%
46	8%	8%	8%	8%
$/per ton	$12.19	$11.91	$11.97	$11.59
Savings		$0.28		$0.38

3.2.2. Rapidly Developing Asia

The Rapidly Developing Asia trade group consists of South Korea and Taiwan for the purposes of revising the benefits associated with corn exports. The original analysis had assumed that growth in corn exports would eventually include other countries in this trade group, but that has not developed, and the fleet projections have been revised to reflect actual current operating practices and trade patterns.

Currently, 82 percent of this cargo moves in vessels of 42-foot design draft or greater. It was projected that only 69 percent of the cargo would be in that size group in 2004, increasing to 82 percent in 2024. Additionally, the trend in panamax vessels has been toward larger vessels, and the existing fleet is clustered around the 45-foot design draft, whereas the previous projections clustered around 43-foot design drafts.

In 1991, 88 percent of the cargo moved at 42 feet or greater. Table 17 displays the historical share of RDA corn moving in vessels of 42-foot design draft or greater, followed by the current share moving out of the Puget Sound. Today's level of cargo moving in those vessels is slightly lower than in 1992, but, unlike 1992, the corn that is moving in shallower draft vessels is moving almost exclusively in partial loads with soybean exports.

Table 17. Historical Share of Columbia River RDA Corn Exports, 42-foot+ Design Draft

Year	Share
1991	88%
1992	83%
1993	90%
1995-1996	90%
2000-2001	82%
Puget Sound 2000-2001	93%

The fleet projections have been revised to reflect the most recent levels of panamax loads, meaning closer to 82 percent rather than the higher historic levels and what is seen in the Puget Sound. The fleet projection has been held constant for the entire period of analysis. The base condition per-ton transportation costs are $12.06. With a 43-foot channel, costs are reduced to $11.04, resulting in a savings of $1.02 per short ton.

Table 18. Distribution of RDA Corn Exports by Design Draft, Actual and Projected

Fresh Water Design Draft (feet)	Actual 2000-2001	Expected Projection (2007-2057)
36	4%	4%
37	5%	5%
38	7%	5%
39	1%	4%
40	2%	0%
41	0%	0%
42	9%	8%
43	0%	0%
44	13%	14%
45	30%	30%
46	15%	30%
47	5%	0%
48	9%	0%

3.3. Corn Distribution of Tonnage

In the original analysis, 5 percent of the corn was assumed to go out of facilities on the Willamette. For this revised analysis, that has been reduced to zero percent based on recent data.

4. Barley

Relative to the original analysis, the average annual transportation cost savings associated with barley exports have decreased from $1.1 million to $185,000. The deferment of the Willamette River results in a 48 percent decrease in the benefits. Barley export projections have decreased by about 50 percent. Adjustments to the fleet projections and vessel operating costs have also reduced benefits.

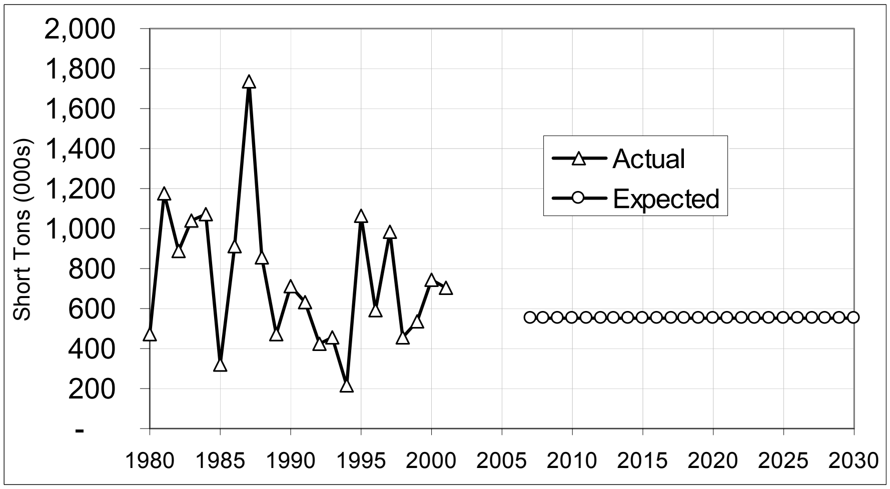
4.1. Barley Export Projections

The export projections for barley have been reduced substantially from the original analysis. The original analysis assumed that export levels would range from 900,000 to 1,000,000 short tons. The DRI-WEFA study projects that barley exports will range from 440,000 to 660,000 short tons over the period of analysis. This update adopts the midpoint, assuming a constant 550,000 short tons over the period of analysis. Approximately 48 percent of that tonnage is expected to move on the Willamette and will not benefit from a channel deepening, meaning that the actual benefiting tonnage is 287,000 short tons annually. Figure 5 displays the actual and projected Columbia River barley exports from 1980 to 2030.

Table 19. Export Projections for Barley

Year	Original Projection	Year	Revised Projection
2004	899,000	2007	550,000
2014	983,000	2017	550,000
2024	1,086,000	2027	550,000
2034	1,043,000	2037	550,000
2044	1,064,000	2047	550,000
2054	1,064,000	2057	550,000

Figure 5. Actual and Projected Barley Exports, Columbia River, 1980-2030



4.2. Fleet Projections

Over 2000 and 2001, the two primary destination countries for barley were Japan and Saudi Arabia. Movements to Japan were handy-sized vessels, and movements to S. Arabia were panamax vessels. About 40 percent of the tonnage moved in vessels that could have benefited from a channel deepening. The future fleet has been revised to reflect today's fleet, and has been held constant through the period of analysis.

Table 20. Columbia River Barley Exports by Design Draft (2000-2001)

Fresh Water Design Draft (feet)	Japan	Saudi Arabia	All Other	Total
31	5%	0%	0%	5%
32	16%	0%	0%	16%
33	1%	0%	0%	19%
34	1%	0%	2%	3%
35	1%	0%	0%	1%
36	1%	0%	0%	1%
37	2%	0%	0%	2%
38	5%	0%	2%	8%
39	3%	0%	0%	3%
40	1%	0%	0%	1%
41	2%	0%	0%	2%
42	0%	0%	4%	4%
43	0%	8%	0%	8%
44	0%	4%	0%	4%
45	0%	8%	8%	16%
46	0%	8%	0%	8%
Grand Total	57%	28%	16%	100%

Table 21. Columbia River Barley Fleet Projection (2007-2057)

Fresh Water Design Draft	Tonnage Distribution
33	39%
34	3%
35	1%
36	1%
37	2%
38	8%
39	3%
40	1%
41	2%
42	4%
43	8%
44	4%
45	24%

5. Soybeans

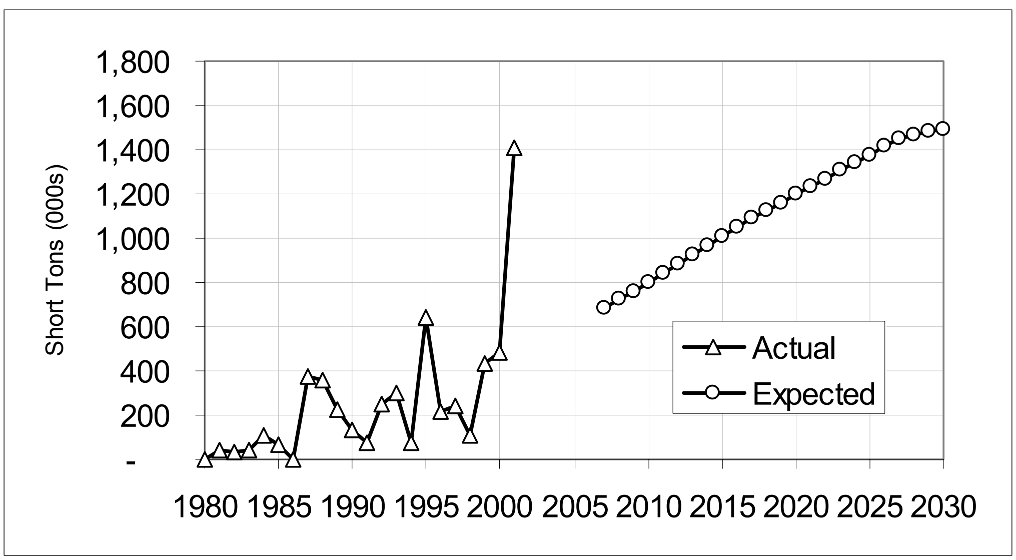
5.1. Soybean Export Projection

Soybeans are a new commodity in the benefit analysis, and were not included in the original analysis. In 2001, exports of soybeans exceeded one million short tons, and 2002 shows a similar trend. Columbia River soybean exports are projected to range between 880,000 short tons and 2.3 million short tons 2030, or at average annual rates of growth of 2.3 percent (low) and 6.6 percent (high) between 2000 and 2030. The initial range of exports is projected to be between 514,000 short tons and 846,000 short tons in 2007. Over the first 30 years of the analysis the expected average annual growth rate is 2.9 percent. Figure 6 displays the actual and projected Columbia River soybean exports from 1980 to 2030.

Table 22. Columbia River Soybean Export Projection

Year	Short Tons
2007	680,230
2017	1,088,770
2027	1,450,065
2037	1,598,677
2047	1,598,677
2057	1,598,677

Figure 6. Actual and Projected Columbia River Soybean Exports, 1980 - 2030



5.2. Fleet Projection

In 2000 and 2001, 67 percent of the soybeans exported moved in vessels that could have benefited from a deeper channel. The fleet projections for soybeans have been modeled to reflect that data. China, Taiwan and The Philippines are currently the three biggest markets for Columbia River soybean exports, combining for 85 percent of the exports in 2000 and 2001. Table 23 displays the distribution of soybean exports in 2000 and 2001 by destination and design draft.

Table 23. Distribution of Columbia River Soybean Exports by Destination and Vessel Design Draft (2000-2001)

Fresh Water Design Draft	China	Taiwan	The Philippines	All Other
31	0%	0%	0%	0%
32	0%	0%	0%	0%
35	0%	0%	0%	1%
36	0%	2%	0%	0%
37	0%	2%	2%	1%
38	0%	5%	10%	0%
39	0%	1%	6%	1%
40	0%	0%	1%	0%
42	0%	0%	0%	1%
44	6%	0%	0%	6%
45	10%	7%	1%	3%
46	10%	1%	0%	0%
47	10%	1%	0%	0%
48	7%	4%	0%	0%

Using a fleet projection that matches the vessel movements from 2000 to 2001 results in an average base condition per-ton transportation cost of $12.90. With a channel deepening, the average cost drops to $12.06 per short ton. The total transportation cost savings associated with soybean exports are $976,000 on an average annual basis. Table 24 displays the fleet projection for soybeans on the Columbia River. The fleet projection has been held constant through the period of analysis.

Table 24. Columbia River Soybean Fleet Projection (2007-2057)

Design Draft (Fresh Water, Feet)	Tonnage Distribution
33	0.0%
34	0.0%
35	2.0%
36	2.0%
37	4.5%
38	14.5%
39	7.5%
40	1.5%
41	0.0%
42	1.0%
43	0.0%
44	13.0%
45	54.0%

6. Containerized Cargo

Relative to the original analysis, average annual container transportation costs savings have been reduced from $15.7 million to $11.7 million. Container export projections have been reduced by about 25 percent over the first ten years. Benefiting tonnage has been reduced an additional 20 percent due to changes in vessel rotational patterns that have resulted in Canadian cargo being carried on Portland-calling vessels. In accordance with NED guidelines, only U.S. cargo can be used to calculate NED benefits. The average size of the vessels calling on the Columbia River has increased substantially relative to the original analysis.

In the original analysis, containerized cargo was divided into two categories, last-port and mid-port. Last-port cargo moves on vessels using the Port of Portland as their last U.S. port of call. Mid-port cargo is loaded onto vessels making at least one more stop at a U.S. port after Portland. Recent data shows little indication that there will be a benefit for mid-port cargo in the near term, and, while there is some potential for future benefits, the mid-port category has been dropped from this revised benefit analysis.

6.1. Container Export Projections

Table 25 displays the original and revised container export projections. Expectations have been reduced substantially. In the original projections, the average annual growth rate for the entire 50-year period of analysis was approximately 3 percent. In the revised projections the growth rate over the same period is 1.03 percent. The revised projections have been capped after 2030. Over the first 30 years of the analysis, the average annual growth rate is 1.73 percent. In comparison, projections produced by PIERS show an expected annual growth rate of 5.8 percent in total U.S. transpacific westbound containerized cargo from 2000 to 2010. The PIERS projections are general and not specific to the Columbia River, but they represent the expected growth in demand from the Asian economies.

The cargo projections used in this study are based on forecasts done by BST Associates with DRI-WEFA. The BST forecasts are initially based on DRI-WEFA commodity forecasts that are demand driven, meaning that they are unconstrained with respect to regional production capabilities and transportation logistics. However, export commodities may be constrained by production limitations such as changes in the inputs of production (acres in production and harvest, availability of water or other inputs). For certain commodities, this may preclude achieving the volumes forecast by DRI-WEFA based upon demand conditions overseas. BST Associates reviewed the DRI-WEFA demand forecasts on a commodity specific basis to determine where the demand forecasts exceeded realistic supply constraints. In cases where the demand forecasts appeared too high, they were ratcheted downward to reflect the potential supply constraint. This process is described in greater detail in the DRI-WEFA/BST study.

BST Associates started with the DRI-WEFA export growth rate projections for the North Pacific port range. The total demand driven annualized growth rate for the 2000 to 2030 period ranged from 2.7 percent (low) to 4.8 percent (high). Applying the supply constraints, as described above, BST Associates adjusted the annualized growth rates to a range of 1.6 percent (low) to 3.1 percent (high). These growth rates were projected for each major trade route.

BST Associates then estimated the size of the local transpacific cargo base in the Columbia River hinterland and projected how much of that hinterland market would be captured by Portland as compared to alternate ports in the Puget Sound. BST Associates also projected intermodal cargo volumes for the transpacific trade route, and export volumes for the non-transpacific routes.

In the revised analysis, the projections have been capped after 2030, but this has a minor impact on the benefit estimate due to discounting. In the original analysis, it was assumed that about 3.5 percent of the exported teu's[5] would be empty. This revised calculation excludes empties in the projections. Figure 7 displays the actual and projected Columbia River container exports (full TEUs) from 1980 to 2030.

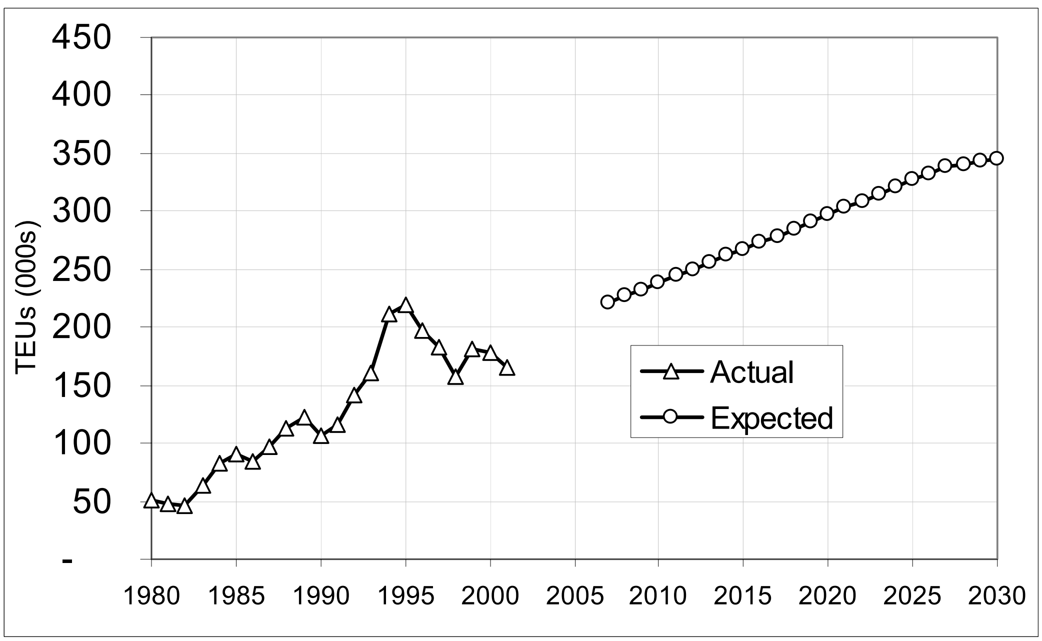
[5] A TEU is a Twenty-foot Equivalent Unit. Containers generally come in 40-foot and 20-foot varieties, and, when discussing volumes, are broken down into teu's.

Table 25. Columbia River Container Export Projections

Year	Original Projection, Outbound TEU's*	Year	Revised Projections, Full Teu's
2004	263,000	2007	221,000
2014	359,000	2017	279,000
2024	482,000	2027	339,000
2034	634,000	2037	358,000
2044	829,000	2047	358,000
2054	1,045,000	2057	358,000

* Twenty-foot Equivalent Units, full and empty.

Figure 7. Actual and Projected Columbia River Full Container Exports (TEUs) 1980 - 2030



As noted above, interregional shifts in cargo are excluded from the projections. The projections do assume that a greater share of the local Portland cargo base moves through Portland as opposed to alternative ports.

Unlike the commodity forecasts for the grains, this analysis uses an expected value that is two-thirds the difference between the low and high estimates produced in the DRI-WEFA/BST projections, reflecting a judgment by the DRI-WEFA/BST analysts that the expected case falls somewhere between the midpoint and the high forecasts[6]. In comparison to previous export levels, taking two-thirds the difference results in exports

[6] Conversation with Paul Sorenson, BST Associates.

reaching pre-Asian currency crisis levels of exports in 2007, meaning that there is expected to be a little more than a decade between the most recent peak and a recovery to that level of export. Exports hit 213,000 full teu's in 1995, and were 199,000 in 1996.

Further calculations are necessary in order to estimate the total amount of cargo that benefits from a channel deepening on the Columbia River. Table 26 displays an example of the calculation of total benefiting tonnage. Line 1 shows the projected number of full export teu's from the Port of Portland. In Line 2, the teu's are converted to short tons, using the average value calculated over the most recent two years. This value has increased from 11.8 short tons to 12.4 short tons. In Line 3, that tonnage is multiplied by 77.5 percent to estimate the amount of the tonnage that is last-port. In the original analysis only 70 percent of the cargo was moving last-port. Finally, the other cargo on board the vessels is added. This factor has been reduced from 1.026 to 0.6208, reducing the total benefiting tonnage by 20 percent, reflecting the development of increased Canadian tonnage on board the vessels. Canadian cargo has been excluded from the analysis, in accordance with NED guidelines.

In the original analysis, it was assumed that Canadian cargo comprised zero percent of the overall tonnage. In the revised analysis, taking into account recent changes in vessel rotations, the percentage of Canadian cargo has been increased to 20 percent of overall tonnage carried.

Prior to 1999, Vancouver B.C. was infrequently included on transpacific rotations calling Portland and the percentage of Canadian on-board tonnage carried on last-port Portland vessels was, on average, negligible. In recent years, with the inclusion of a Vancouver call on two Portland services, the percentage of Canadian cargo carried on last-port vessels calling Portland has increased significantly.

The revised analysis assumes that the surge in Canadian on-board tonnage is a permanent condition, even though this a very recent phenomenon. Direct transpacific container service to Vancouver B.C. has grown over the past five years as a result of favorable currency exchange rates relative to the U.S. dollar, the development of the Deltaport container terminal, improved rail service to and from eastern Canada and the U.S., and the deployment of larger vessels requiring more port calls to fill. Today, of the 23 transpacific vessel strings that call North Pacific ports, 15 call Vancouver B.C. Thus, about two out of every three North Pacific services call in Canada. This is consistent with the current service mix in Portland and the long-term assumptions made in this analysis.

Table 26. Example Calculation, Container Export Benefiting Tonnage, 2007

1	Number of Full Export Teu's	221,348
2	Conversion to Short Tons (12.4 short tons per teu)	2,744,715
3	Last Port Portion (77.5 percent)	2,127,154
4	Additional Tons on Board (U.S. Only) (0.6208)	1,320,537
5	Total Benefiting Short Tons	3,447,692

With regard to port capacity, Terminal 6, Portland's primary container facility, is a 200-acre, three-berth facility with seven container cranes and a berth length of 2,850 feet. The container storage area covers 125 acres. Vessel berth capacity at Terminal 6 is estimated to be 770,000 TEUs annually[7]; in 2001, 278,000 TEUs were loaded and discharged from vessels. Terminal 6 operates a two-stage gate (9 inbound lanes, 4 outbound lanes) that has an estimated capacity of 187 moves per hour; in 2002, the gate averaged 51 moves per hour. The terminal is served by a 53-acre on-dock intermodal rail yard with a capacity of 82 double-stack railcars. In 2001, the rail yard handled 228 moves per day on average; capacity for the rail yard is estimated to be 3,336 moves per day.

6.2. Fleet Projections

6.2.1. Vessel Size

In reviewing the fleet projections for the last-port container vessels, the most significant recent development is that vessels have gotten larger faster than was anticipated. This has a significant impact on the benefit analysis. In the original analysis, it was projected that 34 percent of the Columbia River fleet would still be 39-foot design draft vessels in 2004, and that 22 percent would still remain in 2014. Today, all last port tonnage is carried on vessels larger than 39-feet design draft. Since the original analysis, container carriers have rapidly deployed newer and larger vessels to the Port of Portland. Today's vessels have design drafts ranging from 41 to 46 feet, compared to 38 to 40-foot design drafts just a few years ago.

Present last-port services calling Portland are operated by K Line, Hyundai Merchant Marine, and Hanjin.

Table 27 displays the distribution of cargo by design draft from 1999 through the beginning of 2002.

[7] Port of Portland Marine Terminal Master Plan (draft), January 2003

Table 27. Distribution of Last-Port Container Tonnage by Design Draft, 1999-2002 and Original Fleet Projections

Design Draft	1999	2000	2001	2002	FEIS Projection 2004	FEIS Projection 2014	FEIS Projection 2054
36	0%	0%	0%	0%	1%	0%	0%
37	0%	0%	0%	0%	1%	1%	0%
38	13%	10%	0%	0%	1%	1%	1%
39	52%	13%	1%	4%	34%	22%	8%
40	31%	42%	28%	18%	13%	17%	15%
41	1%	13%	13%	13%	10%	13%	17%
42	1%	19%	46%	48%	24%	26%	30%
43	3%	3%	0%	0%	11%	13%	17%
44	0%	0%	12%	12%	3%	4%	7%
46	0%	0%	0%	6%	2%	3%	5%
Total	100%	100%	100%	100%	100%	100%	100%

Source: Clarkson Container Ship Register 2001 for design drafts, Port of Portland Terminal Management System for cargo tons.

Vessel size projections have been revised to reflect current practices (shown in Table 28). The fleet in 2007 looks much like what is expected to happen in 2003.

Table 28. Revised Columbia River Container Fleet Projections

Design Draft (fresh water, feet)	2007	2017	2027-2057
40	0%	0%	0%
41	0%	0%	0%
42	30%	0%	0%
43	0%	0%	0%
44	35%	50%	50%
45	0%	0%	0%
46	35%	50%	50%

The fleet in 2017, fifteen years from now, assumes that the smaller 42-foot vessels have been removed from the Columbia River, and only 44-foot and 46-foot vessels remain. Those portions are held constant through the remainder of the analysis.

The implication of this shift in design drafts both on the Columbia River and in the world fleet is that the pool of vessels that can fully benefit from a three-foot deepening is larger than was anticipated.

6.2.2. Operating Practices

6.2.2.1. Underkeel Clearance

Container vessels have underkeel clearance[8] requirements that reflect the schedule-driven nature of the business. Unlike bulk carriers that are able to accept any reasonable delay to depart at 40 feet in a 40-foot authorized channel (using tide and other river stage factors for underkeel clearance), container carriers are on a scheduled rotation that generally cannot facilitate significant delays. At the time of the original analysis, the most common underkeel clearance was four feet, with one carrier using one foot, and the analysis reflected those practices. Currently, there are three services calling at Portland as a last port of call, two of those services target 38 feet (two feet of underkeel clearance) as their departure draft and one has targeted 36 feet (four feet of clearance) in the past, but has switched to 38 feet recently with the arrival of a larger class of ship in 2002. It is expected that all the services will target two feet of underkeel clearance. One of the implications of this assumption is that the fleet projections will appear to have more of the vessels moving at deeper departure drafts than have been observed in the last few years. This is an assumption that reduces benefits, as a more efficient base condition reduces the incremental benefit of an equally efficient fleet with a channel deepening.

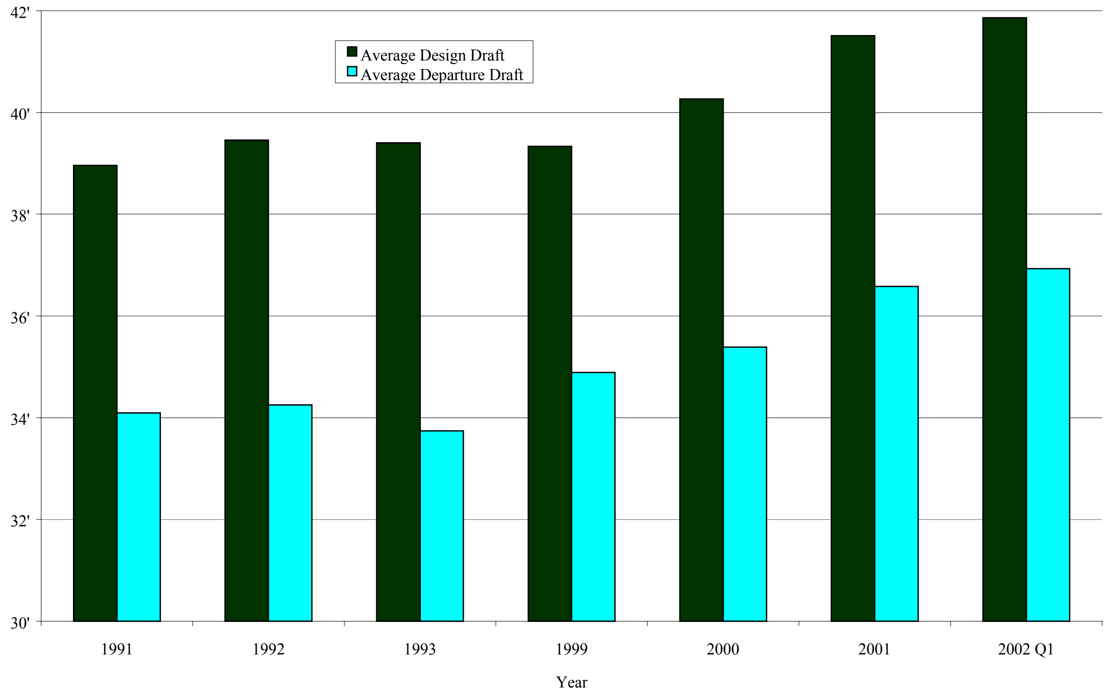
6.2.2.2. Container Vessel Efficiency

At the heart of the benefit estimate is an assumption about the degree to which container vessel operators will take advantage of the additional three feet of channel depth offered though deepening. In the original analysis, the average gain in departure draft for a three-foot deepening was only 1.5 feet. In other words, it was assumed that the vessels would only use about 50 percent of the additional draft that would be available. The FEIS fleet projections also assumed that 29 percent of the cargo would move within a foot of the authorized channel depth for the existing channel, but that share dropped to 7 percent with a 43-foot channel. This tended to reduce benefits, as the existing channel was being optimized much more than the deepened channel in terms of vessel utilization.

Figure 8 displays a comparison of design and departure drafts from 1991-1993 and 1999-2002. From 1991 to 1993 the average departure draft was 34.0 feet. In 2001 that average shifted up to 36.6 feet. Without any change in the physical constraints of the channel, average departure drafts increased by more than 1.5 feet over the last ten years.

[8] Underkeel clearance, for the purposes of the analysis, is being discussed relative to the authorized channel depth.

Figure 8. Design and Departure Drafts, Columbia River Container Fleet



Source: PIERS (for vessel movements), Lloyds Registry (vessel characteristics), and Columbia River pilots' logs (departure drafts). Includes last-port and mid-port container vessels.

This revised analysis assumes that vessel efficiencies remain essentially the same with a channel deepening. In terms of draft, efficiency can be defined as how frequently operators meet their target drafts (target draft is the authorized channel depth minus underkeel clearance). On average, over the last three years, the three existing services have come within one foot of their target drafts about 73 percent of the time. With a three-foot deepening, target drafts increase by three feet, and it can be assumed that operators will meet their new target drafts about as frequently as they do today, given a short period of adjustment.

Table 29 displays the actual and projected departure draft projections in 2007. It is expected that there will be a brief period of capacity utilization adjustment as container carriers begin to make use of the additional capacity created by the new channel depth. According to vessel operators, this adjustment period should be short (could be as short as a few months) and should not exceed a year. This analysis assumes that the initial change in departure drafts with a channel deepening is only 1.9 feet, meaning that the vessel operators only use about 65 percent of the additional draft available during the first year of the project. The average per-ton transportation costs in the first year drop from $14.30 to $12.41, a benefit of $1.89 per short ton.

Table 29. Actual and Revised Projected Container Departure Draft Distribution, 2007

Departure Draft	Actual 2000-2002 Q1	Actual 2001-2002 Q1	40-foot Channel 2007	43-foot Channel 2007
33	8%	3%	1%	1%
34	8%	7%	5%	0%
35	16%	15%	10%	5%
36	18%	16%	10%	5%
37	20%	23%	33%	6%
38	20%	26%	33%	13%
39	7%	8%	8%	13%
40	1%	2%	0%	26%
41	0%	0%	0%	25%
42	0%	0%	0%	6%
Total	100%	100%	100%	100%
Average Departure Draft	35.8	36.7	37.0	38.9

By 2008, it is expected that the operators will have fully adjusted to the new channel depth. The average departure draft shifts upward by three feet, meaning that, after a year of lower efficiencies, vessel operators are able to return to operating at current levels of efficiency. Per ton transportation costs shift from $14.30 to $11.83, a transportation cost savings of $2.48 per short ton.

Table 30. Projected Container Departure Draft Distribution, 2008

Departure Draft	40-foot Channel 2008	43-foot Channel 2008
33	1%	1%
34	5%	0%
35	10%	0%
36	10%	0%
37	33%	5%
38	33%	10%
39	8%	10%
40	0%	33%
41	0%	33%
42	0%	8%
Total	100%	100%
Average	37.0	40.0

Departure drafts are essentially the same from 2008 onward, but increases in vessel size in 2017 slightly increase the per-ton benefit from $2.48 in 2008 to $2.68 in 2017. The fleet projections are held constant after 2017.

Other factors that impact draft are expected to remain the same over the period of analysis. For example, most projections assume that U.S. imports will continue to exceed exports, which means that it will always be necessary to move empty containers back to Asia. The analysis assumes that a portion of vessel capacity will be used to carry empties, regardless of channel deepening, and no benefits are calculated for empty containers.

The analysis also assumes that cargo densities remain about the same, and that exports from the Pacific Northwest will continue to be primarily agricultural and forestry products, rather than lower density goods.

6.2.3. Calculation Details

The following paragraphs describe all of the calculations that take place in the process of estimating the benefits of deepening.

- **Vessel Characteristics and Operating Costs.** Vessel characteristics and operating costs are provided by the Corps of Engineers in *Economic Guidance Memorandum 02-06, Deep Draft Vessel Operating Costs*[9].

- **Vessel Cargo Capacity**. The analysis excludes empty containers and the weight of the containers (tare weight) from the benefiting tonnage. On average, about 80.8 percent of the tonnage loaded at the Port of Portland is cargo, with the remaining 19.2 percent consisting of the weight of the containers (both empty and full). This is assumed to be the case for all cargo loaded on the vessels.

- **Immersion Rates**. Immersion rates are also adjusted by about 80.8 percent to account for the assumption that, for every foot made available by channel deepening, a portion of the additional capacity will be taken by the weight of the containers and returning empties.

- **Distance to Destination**. The original analysis assumed that container vessels would spend about 13 days in transit to their Asian destinations. Currently, all of the services calling on the Columbia River as a last port of call use Japanese ports as their next port of call. This is approximately a 10-day transit. The analysis has reduced transit times to 10 days, which is the shortest possible transit time. The change has the effect of reducing benefits. If, as container traffic grows in the future, a carrier shifts its next port of call to any other country, benefits could

[9] http://www.usace.army.mil/inet/functions/cw/cecwp/General_guidance/EGM02-06Memo.pdf

increase substantially. Table 31 displays transit times for Pacific Northwest container services.

Table 31. Transit Days, Transpacific Container Services, PNW Ports

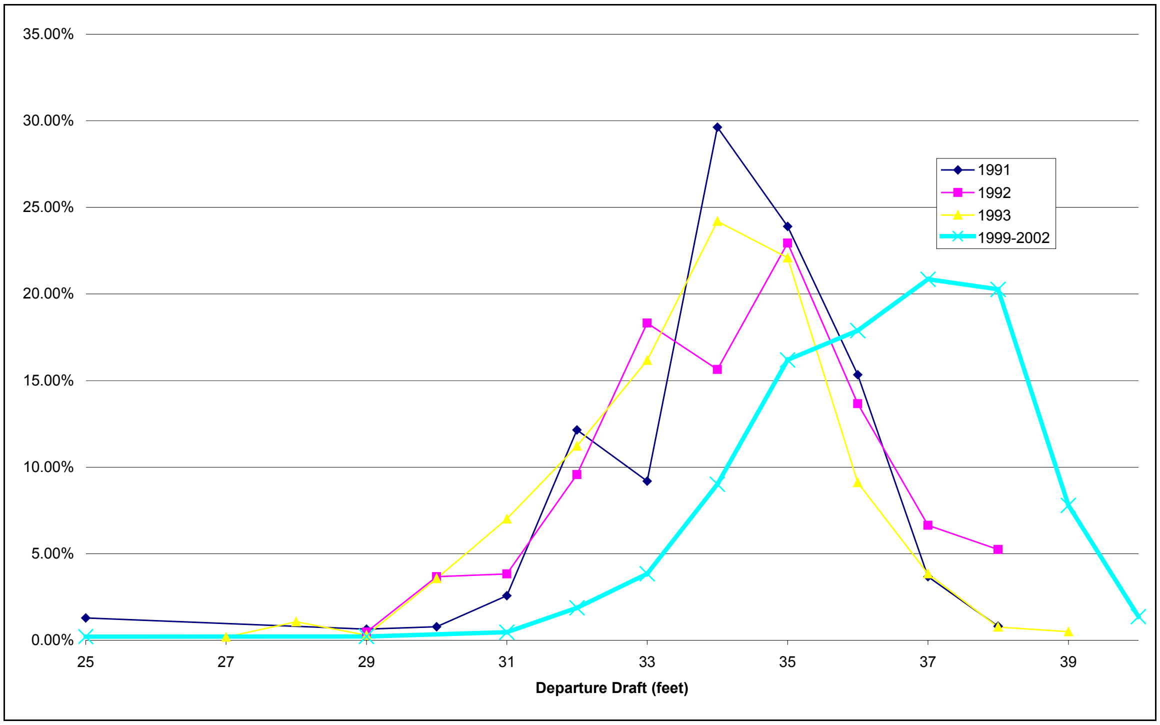
Consortium	**Service**	**Last Port-Next Port**	**Transit Days**
China Shipping	AAT	Seattle-Pusan	11
China Shipping	ZPS	Seattle-Pusan	11
CKYHS	CAX (staring August 2002)	Portland-Tokyo	10
CKYHS	NOWCO A	Portland-Tokyo	10
CKYHS	PDN	Seattle-Pusan	10
CMA-CGM	TPD1	Vancouver-Pusan	14
Columbus/Lykes	PNW	Seattle/VBC-H. Kong	14
COSCO	PNWX	Seattle-Shanghai	14
Evergreen/LT	CPN	Vancouver-Pusan	13
Evergreen/LT	TPS	Vancouver-Kaohsiung	12
Evergreen/LT	WAE	Vancouver-Tokyo	10
Global Alliance	PNW	Portland-Yokohama	10
Global Alliance	PS3	Vancouver-Tokyo	11
Grand Alliance	CKX	Seattle-Pusan	12
Grand Alliance	PNX	Seattle-Kaohsiung	14
Maersk SeaLand	TP6	Tacoma-Yokohama	10
Westwood	PNW	Seattle/VBC-Japan	14
		Average	11.8

Source: Port of Portland, Pacific Shipper (May 27, 2002) and carrier web sites.

- **One Percent Tail.** The analysis assumes that approximately one percent of the cargo will move on particularly shallow drafts regardless of the channel condition. A comparison of data from 1991 to 1993 with data from 1999 to 2002 shows that there are consistently some movements that are significantly below the channel constraint, and are unlikely to change with a channel deepening. From 1999 to 2002, approximately 0.7 percent of the containerized cargo moved at departure drafts of 31 feet or less. From 1991 to 1993, the amount of cargo moving at 31 feet or less ranged from 5 to 12 percent.

  Figure 9 displays the distribution of containerized cargo by departure draft, comparing 1991 to 1993 with 1999 to 2002. It is evident that cargo moving at the shallowest drafts in the early 1990's has shifted upward into deeper departure drafts a decade later. The cargo that was moving at 30 and 31 feet is now moving at 32 to 34 feet, but there is a small tail of cargo throughout the entire data series.

Figure 9. Distribution of Columbia River Containerized Cargo by Departure Draft (1991-1993, 1999-2002)



- **Container Tonnage Distribution Response to Channel Improvement.** As shown in the distributions of container tonnage, 16 percent of the container cargo is expected to move at departure drafts at three or more feet less than the vessel target draft in the without-project condition (cargo moving at 35-feet or less in a 40-foot channel). This is a technical issue that has been disputed, but represents a small portion of the overall benefits.

  In the early 1990's all of the container vessels had target drafts of 36 feet. By 1999, two of three services had target drafts of 38 feet, and by 2002 the third service also shifted to a 38-foot target draft. Comparing the two distributions, it is clear that the entire tonnage distribution, rather than only the deepest segment, has shifted with the change in target drafts.

- **Service Implications of Fewer Vessel Calls.** One of the results of the method used to calculate benefits is an apparent decrease in vessel calls in the with-project condition relative to the without-project condition. This implies reduced service to Portland, which could lead to lower volumes. In the short-term, it is unlikely that the additional capacity created by channel improvement would result in existing carriers deciding to discontinue Portland service. In the long-term, it is likely that the greater utilization of the larger container vessels would have the effect of reducing the overall number of vessel calls to the Columbia River as cargo volumes increase over time. This is the same effect that was observed with the deepening of the channel from 35 feet to 40 feet. While total Columbia River cargo volumes have tripled over the 40 years since the deepening was authorized in 1962, the number of annual commercial marine vessel calls has declined slightly over that same period of time. Service frequency is a legitimate issue that arises out of the deployment of larger vessels. However, it seems unlikely that deepening the channel will have a negative impact on Portland service frequency, rather it seems more likely that a deeper channel will lead to improved service in Portland due to improved vessel operating efficiencies. It should also be noted that the analysis does not assume that vessels immediately make full use of the additional capacity created by deepening, allowing for a one-year adjustment period. A sensitivity analysis also shows that extending the adjustment period to three years has a small impact on the benefits (see Section 8.)

7. Summary of Benefits and Costs

Table 32 displays the summary of transportation cost savings for the 43-foot channel. As noted earlier, benefits for each of the commodity groups are reduced relative to the original analysis. Relative to the original analysis, container benefits have increased in proportion to the total benefit, increasing from about 50 percent to 63 percent of the total transportation cost savings.

Table 32. Revised Benefit Summary by Commodity

Commodity	Original Benefit Estimate[10]	Revised Benefit
Corn	$7,352,000	$3,842,000
Wheat	$8,901,000	$2,054,000
Barley	$1,144,000	$185,000
Soybeans	$0	$976,000
Containers Last Port	$15,671,000	$11,748,000
Container Mid Port	$911,000	$0
Total	$34,419,000	$18,806,000

Table 33 displays the delay component of the total benefits. Delay benefits are approximately 0.7 percent of total benefits.

[10] Includes both Columbia River and Willamette River transportation cost savings.

Table 33. Average Annual Transportation and Delay Benefits

	Ocean Transportation Cost Reduction	Delay Cost Reduction
Corn	$3,797,000	$45,000
Wheat	$1,977,000	$78,000
Barley	$184,000	$1,000
Soybeans	$970,000	$6,000
Containers	$11,744,000	$4,000
Total	$18,672,000	$134,000
Total Average Annual Benefit		$18,806,000

Table 34 displays the average annual costs and benefits of the project. Total first costs, including interest during construction, are $119 million. Costs are amortized over 50 years at the FY03 interest rate of 5.875 percent. Total annual Operations and Maintenance (O&M) costs are approximately $3.6 million. Total average annual costs are $11.0 million.

Table 34. Average Annual Costs and Benefits

Total First Costs	$118,924,000
Average Annual Capitol Costs	$7,414,000
Average Annual O&M Costs	$3,619,000
Total Average Annual Costs	$11,033,000
Average Annual Benefits	$18,806,000
Net Benefits	$7,773,000
Benefit to Cost Ratio	1.7

8. Risk and Uncertainty

While this analysis has attempted to present a most likely scenario, it is certain that things will happen that will be considered unlikely at the time of this analysis. In no particular order, and without identifying specific numbers of upside or downside risks, some of the potential issues that could impact the benefits are:

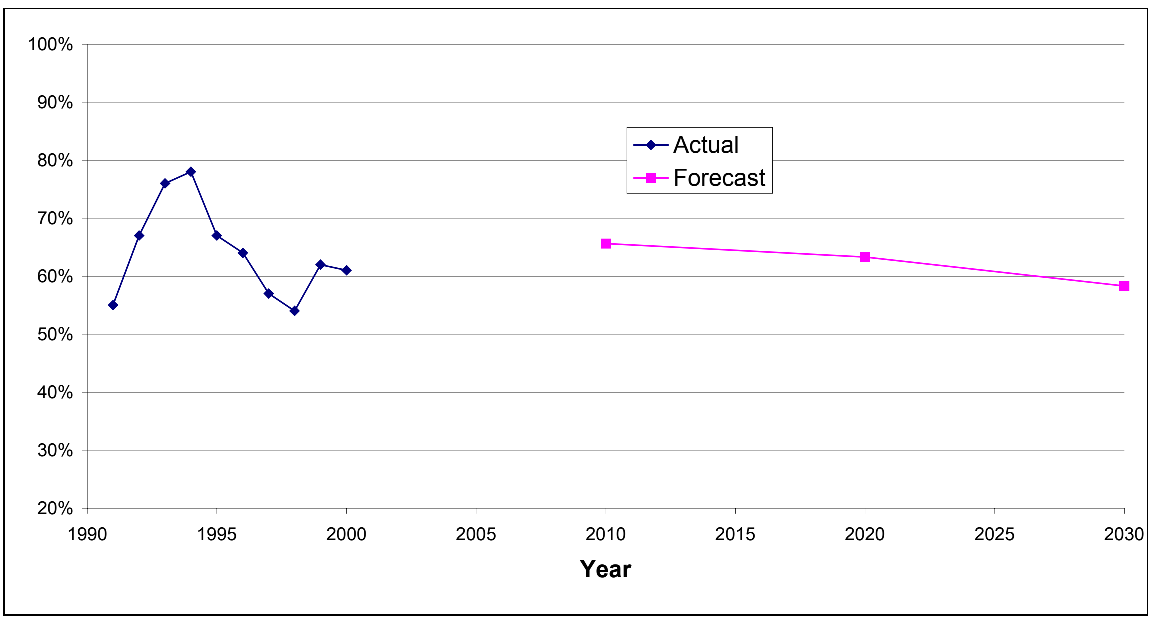
- **Bulk Fleets, upside.** For the most part, all of the bulk fleets were assumed to be the same 50 years from now as they are today. It was assumed that handymax vessels would increase in size between 2002 and 2017, but, generally speaking, the analysis assumed that the mix of handymax and panamax vessels would remain about the same over the next 50 years. This is an assumption that tends to mean that, for the bulk fleet, the benefit risk is almost completely upward relative to vessel size. Also, during the 2000 to 2001 period that was used to assess the bulk fleet, there were periods of time when vessel draft was restricted to a maximum of 38 or 39 feet due to shoaling and low water conditions. The analysis also assumed that 40-foot and 41-foot design draft handymax vessels would only gradually become common on the Columbia River over the first ten years of the analysis. Given that some of those vessels are already transiting the Columbia River today, it is possible that they will be common by 2007. Table 35 displays the impact of assuming that large handymax vessels are common on the Columbia by 2007. It should be noted that only certain trade wheat and corn routes use these vessels, resulting in a relatively small impact.

Table 35. Comparison of Alternative Large Handymax Assumptions - Average Annual Wheat and Corn Benefit

	Combined Wheat and Corn Benefit	Percentage Change
Base Value (2017 utilization of large handymax)	$5,897,000	
2007 Utilization of large handymax	$5,994,000	2%

- **Containerized Cargo volume, capture rate.** The analysis has assumed that the Columbia River loses containerized cargo market share to Puget Sound ports. Figure 10 displays the historical and forecasted Port of Portland capture rate for the Portland hinterland. At the beginning of the period of analysis, the capture rate is approximately identical to the ten-year average. Over time, the capture rate is expected to decline, dropping to 58 percent by 2030.

Figure 10. Portland Hinterland Capture Rates (1991-2000 and Projected)



Overcapacity in Pacific Northwest container terminals has been a part of the base condition of the Columbia River container market over the past decade has likely already contributed to a decline in Columbia River market share over that period. Given the expansion plans of Puget Sound ports, especially Tacoma, the concentration of Pacific Northwest container activity and terminal capacity at Puget Sound ports is expected to continue into the future and over the duration of the project. This could cause additional loss of Columbia River port market share. This reduced market share is already reflected in the project forecasts. The impact of Puget Sound port expansion on Columbia River container cargo volumes could be more or less than anticipated by the forecasts, however.

It is likely that most of the growth in container terminal capacity will occur at the Port of Tacoma. The Port of Tacoma's "2020 Vision" plans suggests an aggressive program of container terminal development over the next 20 years in response to expected growth in West Coast international container volumes. In the first phase of its development plan, the Port plans to build a 170-acre container terminal at its Pierce County terminal location. The Port is presently negotiating with Evergreen Marine to occupy the new terminal, which could be available as soon as 2005. Evergreen Marine presently occupies a 75-acre terminal at the Port of Tacoma. In addition to the redevelopment of the Pierce County Terminal, over the next twenty years, the Port of Tacoma envisions an expansion of the Maersk Sealand terminal on the Sitcum Waterway, an expansion of the Terminal 3 and 4 complex on the Blair Waterway, an expansion of the Hyundai Marine terminal on the Blair Waterway, and the creation of a new container terminal on the east side of the Blair Waterway. In December 2002, the Port of Tacoma announced plans to purchase an idled aluminum smelter and 96 acres on which it sits from Kaiser Aluminum and Chemical Corp. This land is on the east side of the Blair Waterway.

Future container development at the Port of Seattle is likely to be far more modest as compared to Tacoma's plans. In the long-term, future container cargo activity is likely to be focused on the two largest container terminals in the harbor: Terminal 5 and Terminal 18. In 2001, Hanjin Shipping signed a 10-year lease at Terminal 46. The Port has indicated that it is considering redeveloping the 88-acre terminal for non-marine cargo uses once the Hanjin lease expires. The Terminal 25/30 complex is no longer used for container cargo handling. The Port of Seattle has publicly indicated that Terminal 91, used in the past for breakbulk and automobile operations, is likely to be redeveloped for non-marine cargo uses.

There is some uncertainty in the projection of future Portland capture rates. The capture rate has fluctuated over time, and it is reasonable to consider the possibility that the capture rate could differ between the with-project and without-project conditions. Assigning values that differed from historic levels would be problematic, however. This analysis has assumed that the Portland capture rate will decline from 65.6 percent (slightly higher than the 10-year average) to 58.3 percent over the period of analysis. This represents a substantially more conservative approach than was taken in the 1999 Final IFR/EIS, in which it was assumed that the Portland market share stayed constant at the historical average over the period of analysis. The current low capture rates, particularly the low that occurred in 1998 coincide with weak overall exports, and the Portland capture rate is likely to recover with the recovery of the export market.

Table 36 displays a comparison of the container benefits under alternative assumptions. Relative to the base value, if the capture rate is held constant over the period of analysis at the 10-year average (64.1 percent), average annual container benefits increase by 2.3 percent to $12,017,000. Dropping the capture rate to 60 percent decreases container benefits by 3.1 percent, and increasing the capture rate to 66 percent increases benefits by 5.1 percent. Finally, if the Portland capture rate drops immediately to 50 percent, well below the lowest market shares observed over the last decade.

Table 36. Comparison of Alternative Capture Rate Assumptions - Average Annual Container Benefit

	Container Benefit	Percentage Change
Base Value	$11,748,000	
Capture Rate 64.1 Percent	$12,017,000	2.3%
Capture Rate 60 Percent	$11,385,000	-3.1%
Capture Rate 66 Percent	$12,348,000	5.1%
Capture Rate 50 percent	$10,157,000	-13.5%

- **Container Fleet, vessel size, upside.** It is unlikely that vessels on the Columbia River will get smaller than they are today, and the upside risk of having vessels get larger faster than is anticipated is substantial. The one last port of call service that is currently using the smallest vessels on the river today indicated that those vessels could be completely gone from the Columbia River by 2007, and, for that particular line, could be replaced by much larger 5,500 teu vessels. While the analysis should not depend on speculations about the future actions of a particular service, it is an indication that there is an upside risk in terms of vessel size. Table 37 displays the average annual container benefits assuming that the shallowest vessels (42-foot design draft) are phased out by 2007 rather than 2017, replacing them with both 44-foot and 46-foot vessels (50 percent each).

Table 37. Comparison of Alternative Vessel Design Draft Assumptions - Average Annual Container Benefit

	Container Benefit	Percentage Change
Base Value (10 day transit time)	11,748,000	
Earlier Elimination of 42' Vessels	11,959,000	2%

- **Container Fleet, vessel size, downside.** The downside potential with regard to vessel size is the potential scenario in which vessels get so large in the future that the Port of Portland loses an even greater share of local cargo, even with a channel deepening. By 2030, with a channel deepening, the DRI-WEFA forecasts assume that 45 percent of the cargo generated in the Portland hinterland will be shipped out of the Puget Sound due to vessel capacity constraints and increases in vessel size. However, as long as there are 4,000 to 6,000 teu panamax and post-panamax vessels in the transpacific trade, it is reasonable to assume that there will continue to be services that find it profitable to pick up cargo in Portland.

- **Container Fleet, transit times, upside.** As noted earlier, the transit times used for container vessels are as short as possible, representing an expectation that all of those container vessels using Portland as a last port of call are destined for Japan. If a single service changes that practice, the benefits of the project (for containerized cargo) could increase by 5 to 10 percent. The average transpacific transit time for Pacific Northwest carriers is 11.8 days. Table 38 displays the container transportation benefits assuming longer transit times. The Pacific Northwest average of 11.8 days increases container benefits by 17 percent.

Table 38. Comparison of Alternative Transit Time Assumptions - Average Annual Container Benefit

	Container Benefit	Percentage Change
Base Value (10 day transit time)	$11,748,000	
PNW Average (11.8 days)	$13,751,000	17%
11 Day transit time	$12,861,000	9%

- **Past and Projected ratios of empties to loaded containers.** There are a number of factors that have contributed to the increase in empties loaded at Portland. Empty containers comprised 24 percent of Portland export containers in 2001. This has grown from only a few percent five years ago. The increase followed the 1998 Asian economic crisis, which worsened the imbalance of transpacific trade and created the need to transport increasing volumes of empty containers back to Asia. We expect this to be a long-term situation; that is, imports will continue to grow faster than exports, and that a significant imbalance in the trade will persist.

  In addition to the imbalance, vessel size has also had an impact on the percent of empties loaded on vessels in Portland. As vessels get larger and deeper, the percentage tends to increase. This is because the vessel will reach the target outbound draft well before it "cubes" out. The vessel operator will desire to cube out the ship, and therefore will need to allocate slots and deadweight to the carriage of empties on each voyage. If the vessel is draft constrained, the percent of the vessel's cubic capacity that is empty, as measured in TEUs, will increase with the size and draft of the ship.

  An additional factor contributing to the increase in empties loaded at Portland is the extension of vessel rotations calling Portland into new port areas, especially mainland China. These are destinations that carriers must position empty equipment into to capture the higher revenue eastbound headhaul cargo.

Container carriers come to Portland to load export cargo. There is a balancing act that occurs every week for every service, balancing the need to get empties back to Asia with the need to carry enough revenue generating cargo to justify the additional time and expense of a call to Portland. The result of this balancing act is a very consistent utilization of the available draft in the Columbia River navigation channel. With the additional capacity created by channel deepening, carriers are likely to continue the trend of maximizing export cargo within the new draft constraint of the river.

The Corps' analysis assumes that the additional three feet of capacity does not change the total ratio of empties to fulls on board each vessel. Analytically, there are a few other reasonable scenarios.

- **Empties increase as a percentage in both with- and without-project conditions.** The benefits of the project increase in this case, as the total voyage costs are spread over less cargo in both conditions.
- **Empties decrease as a percentage in both with- and without-project conditions.** The benefits of the project decrease in this case, as the total voyage costs are spread over more cargo.
- **Empties decrease as a percentage in the with-project condition.** The benefits of the project increase in this case. This case essentially assumes that the average vessel cubes out in the without-project condition, and that full containers in the with-project condition displace empties.
- **Empties increase as a percentage in the with-project condition.** The benefits of the project decrease in this case, representing a scenario in which carriers choose to use the additional capacity created by channel deepening to load more empties rather than fulls.

Table 39 displays a range of benefits under alternative assumptions for total tare. Decreasing tare to 15 percent represents a scenario in which every container on board the vessel is loaded with heavy cargo, and is an extremely unlikely possibility.

Table 39. Comparison of Alternative Tare Assumptions - Average Annual Container Benefit

	Container Benefit	Percentage Change
Base Value (Tare is 19.2%)	$11,748,000	
Tare increased to 25% (with and without project)	$12,651,000	8%
Tare decreased to 15% (with and without project)	$11,164,000	-5%
With-Project Tare 17.2%	$12,327,000	5%
With-Project Tare 21.2%	$11,185,000	-5%

- **Container Vessel Adjustment Period.** The analysis assumes that a one-year period of adjustment for container vessel operators after channel deepening. Table 40 displays the impact of different assumptions regarding the container vessel transition period. A three-year adjustment period, in which operators only take advantage of 65 percent of the additional capacity created through channel deepening, results in a reduction of the benefits by 1.3 percent.

Table 40. Comparison of Alternative Adjustment Periods – Average Annual Container Benefit

	Container Benefit	Percentage Change
Base Value (One year adjustment)	$11,748,000	
Immediate Adjustment	$11,865,000	1.0%
Three Year Adjustment	$11,593,000	-1.3%