1. INTRODUCTION, SUMMARY OF FINDINGS, UNRESOLVED ISSUES AND CONCLUSIONS

1.1 INTRODUCTION.

1.1.1 Purpose of the Analysis.

The Lower Snake River Juvenile Salmon Migration Feasibility Study has as its objective the assessment of a variety of structural and nonstructural measures intended to improve conditions for juvenile anadromous fish stocks that migrate through the lower Snake River system. In conjunction with this study, the economic effects that would result from implementation of these measures are also being addressed. Economic analyses have been conducted for each of the operational functions that characterize the Federal dams on the lower reach of the Snake River. These dams, between the mouth and Lewiston, Idaho, include Ice Harbor, Little Goose, Lower Monumental, and Lower Granite. As part of the overall economic assessment, the Economics Section of the Corps of Engineers' Portland District was tasked with conducting an analysis of impacts on the use of the Columbia-Snake River inland navigation system. (CSRS) This system represents one element of the regional transportation infrastructure and provides a means for movement of commodities and cruise-ship passengers into and out of the region. The Institute for Water Resources (IWR) and various sub-contractors assisted the Portland District in this effort.

The purpose of the analysis of the transportation system was to measure the effect that breaching of the four Federal dams would have on the costs of transporting products and commodities that are presently shipped from Snake River ports via the Columbia/Snake River system. In addition, potential impacts on cruise-ships that operate between the Portland area and Lewiston, Idaho were to be addressed. While the feasibility study will evaluate a number of measures aimed at restoration of anadromous fish stocks, the transportation analysis herein addresses only the dam breaching measure, which would involve drawdown of the river to pre-dam levels. The analysis examines two scenarios. One is a base condition that reflects continued utilization of the CSRS in its present configuration as a navigable waterway between the Pacific Ocean and Lewiston, Idaho. The second is a scenario in which the four dams on the lower Snake would be breached, such that the head of commercial navigation would effectively be limited to the Tri-Cities of Pasco, Richland and Kennewick, Washington on the Columbia River (Drawdown Alternative).

1.1.2 Geographic Scope of the Analysis.

The geographic area for this analysis is made up of the region served by the Columbia-Snake River navigation system. The system includes the shallow-draft waterway on the Columbia and Snake Rivers between Portland, Oregon (river-mile 105) and Lewiston, Idaho, deep-water terminals on the Columbia and Willamette Rivers below Bonneville dam. The region includes those areas within and outside of the Columbia River Basin that produce and receive products via the Columbia/Snake navigation system.

1.1.3 Methodology.

The methodological approach applied in the analysis is in accordance with planning policies and guidance developed and used by the Corps of Engineers. Corps policies and guidance was developed pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The specific basis are the following two documents: (1) The Economic and Environmental Principles for Water and Related land Resources Implementation Studies, February, 1983; and (2) The Economic and Environmental Guidelines for Water and Related Land Resources Implementation Studies, March 10, 1983. These documents, referred to as the Principles and Guidelines set forth criterion for the assessment of national economic development (NED) effects. The transportation analysis is not intended to be a benefit-cost analysis per se, and economic benefits and costs associated with the navigation system (locks and channels) are not specifically addressed. Transportation-related impacts of drawdown are expressed as changes in national economic development costs related to commodity movement within the study area under existing conditions, compared to conditions wherein the lower Snake would be closed to commercial tug-barge access. In addition, the need for and cost of improvements to transportation infrastructure are addressed. The cost of services provided by these improvements are accounted for the in transportation, storage and handling costs incurred in moving products and commodities via the alternative transportation modes.

The NED approach to evaluating the costs and benefits of federal projects is founded on the premise of the need to identify and quantify the value or resources required to be expended on a project (costs) or saved by a project (benefits). These impacts are measured are direct effects of the federal action at their point of occurrence. In addition to direct costs and benefits, federal actions, such as drawdown of the Snake River, have indirect effects. Indirect effects are the economic consequences of the federal action as measured by changes in economic activities not directly required or benefited by the project. For example, with drawdown, the Snake River would be closed to commercial navigation and products and commodities now shipped from ports on the river would have to be shipped by an alternate mode and from an alternate point. The direct cost of the change in the cost of transporting, storing and handling the products and commodities is a NED cost. In addition, the cost of improving transportation system infrastructure so that the products and commodities can continue to be moved to market is a NED cost. Generally, however, these latter costs are accounted for in the transportation, storage and handling costs used in computing total transportation costs and are not added the total transportation costs. By comparison, examples of indirect or regional economic development (RED) effects of drawdown would be the jobs created for truckers, assuming, it was to become necessary for more grain to be shipped by truck. Regional income created by the multiplier effect, as money spent to implement the project moves through the economy would also be an indirect or RED effect. The RED analysis focuses on changes in the level and distribution of regional economic activity that result from a federal action to drawdown the Snake River. RED effects are addressed in a separate section of the report.

The objective of analyzing commodity movements within the region served by the Columbia-Snake River system, therefore, is to identify and quantify the National Economic Development (NED) costs resulting from disruption of the existing transportation system. The measure of direct economic costs is the difference in total system-related transportation costs resulting from river drawdown, compared to these same costs incurred under existing conditions. Realization of this objective requires evaluating the physical impacts of river drawdown on commercial use of the waterway, identifying alternative routing of commodity movements and associated costs, and determining the most likely alternative means of commodity transport under those conditions.

A computer database program was utilized to compile and compare total transportation-related costs for the base condition and river drawdown scenarios. The database utilizes origin and destination data for movements of grain and non-grain commodities. In the base case, grain movements are from (1) farms direct to river ports to export terminals; and, (2) farms to country elevators to river ports to export terminals. In the drawdown scenario, the database evaluates movement of grain from (1) farms direct to river ports to export terminals; (2) farms direct to unit-train railheads to export terminals; (3) farms to country elevators to alternative river ports or unit-train railheads to export terminals. Origins and destinations for the base case were determined by an analysis of actual movements. For the drawdown case, origins and destinations were based on an assessment of the most likely routing that shippers would use. For each movement with drawdown, the database includes at least two alternative shipping modes and routes. Nevertheless, the database is not a least-cost transportation model. It simply computes transportation, storage and handling costs associated with two predefined alternative routes and selects the cheapest alternative. Costs related to transport of these shipments, including handling and storage costs incurred at interim destinations, are aggregated within the program. A similar approach was also used for non-grain commodities that are presently shipped up and down the Columbia-Snake waterway. For non-grain commodities shipped on the waterway actual origins and destinations were used. In cases where commodities have a dispersed origin, such as grain and other farm commodities, the origin is defined as the county of origin rather than the specific farm of origin.

For this study, modal costs for truck, barge and rail were computed using transportation cost models developed and copywrited by Reebie Associates. Costs were computed for each segment of each shipping route that is currently used (base case) and for each alternative route for each alternative route (drawdown case). These costs were then input to the database model to compute total transportation costs with and without drawdown.

1.2 ORGANIZATION OF THE REPORT

The report is organized into nine Sections. Section 1 includes an introduction and a summary of the findings of the analysis. Section 2 consists of a discussion of the methodology and assumptions used to estimate transportation system costs for the base and drawdown conditions. Section 3 includes a description of the existing Columbia-Snake River navigation system (CSRS). Section 4 includes information on historic and current water-borne commerce on the CSRS and an explanation of the derivation of the forecasts of growth in commodity shipments for both the lower CSRS and for the Snake River portion of the system. Section 5 includes information on development of transportation system costs for the current system and presents costs as estimated by the model. In Section 6 transportation system costs for the drawdown case are presented and the need for infrastructure improvements with drawdown is discussed. Also, needed improvements are identified and cost estimates are developed and presented. Section 7 consists of a comparison between the base condition (Section 5) and the drawdown condition (Section 6). In making the analysis, a number of assumptions had to be made. Risks and uncertainties about the assumptions made are presented and discussed in Section 8. In addition, the report includes the following Technical Exhibits:

A. Survey of Snake River Grain Facilities, Jack Faucett Associates, Inc., September 1998.

B. The Incremental Cost of Transportation Capacity in Freight Railroading: An Application to the Snake River Basin, The Tennessee Valley Authority, Knoxville, Tennessee and The Center For Business and Economic Research, Lewis College of Business, Marshall University, Huntington, West Virginia, July 1998.

C. Lower Snake River Juvenile Migration Feasibility Study Transportation Study—Implication of Changes in the Columbia-Snake River System Waterway on Grain Logistics from the Traditional Portland Market Gathering Territory, Upper Great Plains Transportation Institute, August 1999.

D. Assumptions, Input Values and Example Reebie Modal Cost Estimates for Barge, Rail and Truck Transport.

E. Documentation of Review Process.

1.3 SUMMARY OF FINDINGS, UNRESOLVED ISSUES AND CONCLUSIONS

1.3.1 Summary Of Findings.

Closure of the Snake River would increase transportation costs for all commodities now shipped on the river and would shift some of it, especially grain, to the railroads for transport to lower Columbia River destinations. The estimated increase in transportation, storage and handling costs amounts to about $22 million annually or an average of 17.3 cents per bushel (Table 1-1). To accommodate the modal shift, infrastructure improvements costing from an estimated low of $210 million to a high of $535 million would need to be made. The improvements would be needed to improve and expand existing infrastructure or replace infrastructure that would be abandoned with closure of the Snake River to commercial navigation. Since these improvements are needed to accommodate a shift in grain among existing modes, in theory, the unit cost of the improvements are accounted for in the annual cost increase mentioned earlier. Investments in infrastructure that would be abandoned with drawdown are sunk costs and were not estimated or included in the analysis.

Loss of access to the Snake River by the cruise-ship industry could have a significant impact on the marketability of extended cruises on the Columbia River. Industry representatives indicate that operations could become infeasible and vessels would be relocated to other rivers. The result would be the loss of approximately $2.6 million annually to the Snake River area economy and as much as $5 million annually to the region as a whole. This, however, may not be the case and the industry may be able to continue operations even with dam removal. If so, impacts would be limited to the Lewiston/Clarkston area ($2.6 million annually) and those expenditures would be made in the lower Columbia River region. If this were to occur there would be no region-wide impact from removal of the dams.

Data are presented in Table 1-1 below that summarize the volume of grain diverted and increased direct costs resulting from closure of the Lower Snake River to commercial-navigation. Costs are shown by State in terms of totals and per-unit (per bushel and per ton) for transportation, storage and handling. The volume of grain shipments and costs shown are those projected for 2007. The analysis included projected growth through 2017, after which shipments were assumed to remain constant at that level for the remainder of the period of analysis (2007 – 2106). Costs for other years are not shown because the projected growth did not have a significant effect on costs at either the per-bushel or per-ton level. As can be seen in Table 1-1, in terms of the costs per bushel, the increase in costs ranges from a high of 21 cents per bushel for Montana to a low of 6.3 cents per bushel for Oregon. The total cost increase with drawdown for the region as a whole is estimated to be 17.3 cents per bushel or $5.75 per ton. This represents an increase of 18 percent over the base case. Cost data related to the base condition and drawdown scenario are presented in more detail in Sections 5 and 6, and the comparison between the two cases is presented in Section 7. Finally, the data show that the increases are concentrated primarily in Washington (nearly 64 percent of the total increase) and Idaho (nearly 29 percent of the total increase).

In reviewing the results of the study, it is important that readers keep in mind that there will be significant differences between estimated cost increases for specific counties and regions and the averages shown in Table 1-1 for the region and the States. The actual increase would be much higher, for example, for producers who are located near the CSRS (and relatively far away from the Tri Cities) and currently ship direct from the farm to the river. In general, the further removed a producer is from the CSRS and the Tri Cities alternate port with drawdown, the lower the increase in costs will be. Montana and North Dakota are unique cases because the economies of truck shipments of grain from those states to the CSRS are based on the fact that the primary haul for these shippers is building products from the Northwest. Without the availability of the backhaul rate for grain, truck shipment of grain would cease.[1]

Table 1-1. Increase in Grain Shipments and Shipping Costs With Drawdown for 2007 Projected Volume, by State.[2]

State/ Unit Cost	Volume	Transportation	Storage	Handling	Total	Share of Cost
	(bushels)	($)	($)	($)	($)	(%)
Idaho	32,289,941	4,954,984	894,385	410,294	6,259,663	28.6%
Cost per bu (cts)	32,289,941	15.3	2.8	1.3	19.4	
Cost per ton ($)	969,668	5.11	0.92	0.42	6.46	
Montana	6,537,310	1,376,031	0	0	1,376,031	6.3%
Cost per bu (cts)	6,537,310	21.0	0.0	0.0	21.0	

1 The reason truck transport of grain from these states could be expected to cease without the primary haul from the Northwest to mid-west markets is that grain is currently being transported at rates that are below full costs (Upper Great Plains Transportation Institute, August 1999).

2 Totals for the states and the region exclude a net adjustment of $794,781 that was calculated by the model and added to the regional total. The adjustment prevents the cost of any movement of grain from being less than it was in the base condition.

Cost per ton ($)	196,139	7.02	0.00	0.00	7.02	
N. Dakota	2,458,172	261,556	0	0	261,556	1.2%
Cost per bu (cts)	2,458,172	10.6	0.0	0.0	10.6	
Cost per ton ($)	73,753	3.55	0.00	0.00	3.55	
Oregon	980,218	61,328	0	0	61,328	0.3%
Cost per bu (cts)	980,218	6.3	0.0	0.0	6.3	
Cost per ton ($)	29,409	2.09	0.00	0.00	2.09	
Washington	84,355,029	11,586,875	1,580,001	737,028	13,903,904	63.6%
Cost per bu (cts)	84,355,029	13.7	1.9	0.9	16.5	
Cost per ton ($)	2,530,904	4.58	0.62	0.29	5.49	
Totals	126,620,670	18,240,774	2,474,386	1,147,322	33,623,532	100%
Cost per bu (cts)	126,620,670	14.4	2.0	0.9	17.3	
Cost per ton ($)	3,802,423	4.80	0.65	0.30	5.75	

1.3.1.1 Average Annual Costs – Grain.

The additional costs estimated for grain transport as a result of drawdown have been converted to average annual values through the period of analysis, 2007-2106. These annual amounts, computed at zero, 4.75, and 6.875 percent, are expressed in 1998 dollars and displayed below in Table 1-2. The costs shown do not include the adjustment that was computed by the model (see footnote 2).

Table 1-2. Summary of the Increase in Transportation, Storage and Handling Costs for Grain with Drawdown

Interest Rate	Transportation Cost Increase	Storage Cost Increase	Handling Cost Increase	Total Annual Cost increase
6.875%	$18,827,428	$2,553,967	$1,184,223	$22,565,628
4.75%	$18,965,029	$2,572,632	$1,192,877	$22,730,538
0.00%	$19,319,712	$2,620,745	$1,215,186	$23,155,643

1.3.1.2 Average Annual Costs – Non-Grain Commodities.

The additional costs estimated for non-grain commodity transport as a result of drawdown have been converted to average annual values through the period of analysis, 2007-2106. These annual amounts, computed at zero, 4.75, and 6.875 percent, are expressed in 1998 dollars and displayed below. In addition, the estimated cost per ton, based on the tonnage projected for 2007 is also shown.

Table 1-3. Summary of Total Tonnage of Non-Grain Commodities and Increased Transportation Costs with Drawdown

		Average Annual Cost Increase	
Interest Rate	2007 Tonnage	Total	Cost/Ton
6.875%	1,018,000	$ 4,623,910	$ 4.54
4.75%	1,018,000	$ 4,709,693	$ 4.63
0.00%	1,018,000	$ 4,904,266	$ 4.82

1.3.1.3 Average Annual Costs – All Commodities.

Data presented below summarize the average annual direct costs and the cost per ton (based on tonnage projected for 2007) of transport of all commodities attributable to closure of the Lower Snake River to commercial navigation.

Table 1-4. Summary of Total Tonnage and Increased Transportation Costs for All Commodities with Drawdown

		Average Annual Cost Increase – All Commodities	
Interest Rate	2007 Tonnage	Total	Cost/Ton
6.875%	4,820,000	$27,189,538	$ 5.64
4.75%	4,820,000	$27,440,231	$ 5.69
0.00%	4,820,000	$28,059,909	$ 5.82

Note: Costs exclude the adjustment computed for grain.

1.3.1.4 Adjustment of Annual Costs to a Base Year of 2005.

The annual amounts below have been adjusted to reflect a projected implementation date of 2005. This was done to achieve comparability among all of the fish restoration actions that are being considered in the feasibility study. Average annual additional costs as of 2005 are displayed below.

Table 1-5. Summary of Increased Transportation Costs with Drawdown, Adjusted to a Base Year of 2005

Interest Rate	Average Annual Cost Increase – All Commodities
6.875%	$23,803,980
4.75%	$25,008,043
0.00%	$28,059,909

Note: Costs exclude the adjustment computed for grain.

1.3.1.4 Infrastructure Requirements and Costs.

Closure of the Snake River portion of the CSRS by breaching the four dams on the Snake River would shift grain and non-grain commodities to alternatives modes and/or ports on the CSRS below the Snake River. The analysis determined, for example, that about 1.1 million tons of grain would shift to rail. The remainder would continue to be shipped on the CSRS but would enter the river in the Tri Cities area. The result would be a significant increase in truck traffic, especially in southeastern Washington.

The study included an assessment of impacts to the rail and highway systems, river elevator capacity, country elevators, the availability of rail cars, rail car storage at terminal elevators and congestion on both highways and the rail system. The findings were that some improvements would be needed, as follows:

- Upgrade mainline railroads, primarily expansion of interchanges with the short-line railroads and construction of additional rail car storage in the downriver export terminal area.
- Upgrade short-line railroads.
- Upgrade and improve traffic controls on impacted highways in southeast Washington.
- Expand river elevator capacity in the Tri Cities area.
- Improve handling/rail car loading facilities at some country elevators.
- Acquire rail cars to insure a reliable supply to the region.

A summary of the improvements and ranges of costs are presented below in Table 1-2. Infrastructure needs and costs are discussed in detail in Section 6.

Table 1-6. Summary of Estimated Costs of Infrastructure Improvements Needed with Drawdown.

	Estimated Costs	
Infrastructure Improvements	Low	High
Mainline Railroad Upgrades	14,000,000	24,000,000
Short-Line Railroad Upgrades	19,900,000	23,800,000
Additional Rail Cars	14,000,000	26,850,000
Highway Improvements	84,100,000	100,700,000
River Elevator Capacity	58,700,000	335,400,000
Country Elevator Improvements	14,000,000	16,900,000
Tidewater Rail Car Storage	5,273,000	7,394,000
Total	**$209,973,000**	**$535,044,000**

1.3.2 UNRESOLVED ISSUES

1.3.2.1 General.

There are a number of unresolved issues relating to the analysis, especially the modeling of the transportation system with and without drawdown. These issues are identified and briefly described below.

1.3.2.2 Commodity Forecasts.

Commodity forecasts used for the analysis were developed from forecasts of commodity movements on the lower Columbia River deep-draft navigation channel. These forecasts were developed for the Corps' study of the feasibility of deepening the deep-draft channel from Portland to the ocean. The forecasts developed for the analysis were obtained by simply prorating the forecast for the lower river to the Snake River on the basis of the Snake River's historic share of shipments on the lower Columbia River. Arguments have been made that this type of forecast is inappropriate because it does not actually include consideration of sources of commodities in the Snake River hinterland.

1.3.2.3 Modeling Logic and Use of Adjustments.

The transportation system model is based on the logic that the current pattern of commodity shipments must be an optimized least-cost system. On this basis, modelers designed the model to prevent the cost of any commodity movement from being less costly with drawdown than it was without drawdown. The modeler's objective was accomplished by including an adjustment in the model that is equal to the difference between the cost of commodity movement with drawdown and cost without drawdown. If the cost of the movement with drawdown is less than it was estimated to be without drawdown, the difference is added to the estimated cost with drawdown, thus making the costs the same for both conditions.

The IEAB questions the validity of the use of the adjustment on the basis that it distorts (or rigs) the results of the modeling effort. They point out that all models are extractions from reality and that it is inappropriate to make adjustments to try to make them match reality. In the case of the DREW model, there are a number of reasons why the model would show lower costs for some movements with drawdown than without drawdown. First, and foremost is the fact that some people do things for other than economic reasons. This kind of non-economic behavior cannot be captured in a model. Secondly, the problem could be due to errors in the model: i.e., errors in transportation, storage or handling costs. The IEAB has stated that the adjustment should be deleted from the model.

1.3.2.4 Truck Costs.

Truck costs used in the transportation system model are significantly higher than truck costs estimated for the Corps in a study by the Upper Great Plains Transportation Institute. A preliminary review of Reebie Model truck costs for a sampling of movements showed that there is an error in the way driver costs were calculated, making them much higher than they apparently should be. For example, the UPGTI study reported a total allocated cost for long-haul truck movement of grain of $1.04 per mile, with a driver cost of $0.29 per mile. By comparison the cost for one movement of 870 miles (round-trip) in the transportation system model has a cost of $2.716 per mile, with a driver cost of $1.315. Correction of errors in truck costs used in the model would significantly lower the cost of truck movements of commodities and could change (decrease) the volume of grain that is predicted to shift to rail with drawdown.

1.3.2.5 Barge Costs.

There is a large difference between barge costs as estimated by the Reebie Barge Model and rates that are actually charged by the barge industry. For example, the cost estimated by the Reebie Model for shipping grain from Almota, WA to Portland is $3.07 per ton compared with the actual rate charged by the industry of about $6.07 per ton. Industry representatives have stated on numerous occasions that the costs estimated by the Reebie Barge Model are incorrect (too low). In response to the comments by representatives of the barge industry, Corps analysts reviewed three other studies of barge costs. The finding was that all of the studies showed that rates are significantly higher than costs. In addition, input data for the Reebie Model was provided to an industry representative for review and comment. That review has not been completed. If barge costs are in fact higher than the Reebie Model costs used in the transportation system model, use of actual costs in the model would tend to offset the effect of using lower truck costs as described above.

1.3.2.6 Storage and Handling Costs.

Model estimates of storage and handling costs for grain shipped to the Northwest from the states of Montana and North Dakota amount to nearly $6.50 per bushel. This is almost double the market value of wheat and clearly is not representative of the long-run equilibrium condition that the model is supposed to represent. Corps modelers are aware of this problem and, in fact, have corrected the problem. However, revised model results were not available for inclusion in the draft report. For the draft report, it is important for readers to understand that the error has no effect on the primary objective of the model—to estimate the change in costs with drawdown—because these costs are the same with and without drawdown.

Another issue with storage and handling costs is the use of “rates” rather than costs. In this regard, the model is inconsistent because costs are used for alternative transportation modes, but rates are used for handling and storage. One effect of the use of rates is that the model uses the same handling rate for rail and barge shipments at the downriver export terminals. This is consistent with actual practice because the terminals do in fact charge the same handling rate for both rail and barge shipments. However, industry representatives have stated that handling costs for rail shipments are actually about 40 percent higher than for barge shipments.

1.3.2.7 NED Effects of Redirected Cross-River Road Traffic.

The Lower Monumental Dam is the connecting link between Lower Monumental Road (south side) and Devils Canyon Road (north side) and the Lower Granite Dam is the link between Lower Deadman Road (south side) and Almota Road (north side). Alternate routes are Washington 126 that crosses the river at Lyons Ferry and Washington 127 that crosses the river at Central Ferry, respectively. Use of the alternate routes could increase overall travel distance of users, depending on their origin and destination. While the other two dams, Ice Harbor and Little Goose, have road crossings, they do not appear to link major state or county roads and so appear to be primarily used by project operators and tourists. The IEAB has stated that the NED effects of severing the roadways that are linked by the Snake River dams should be quantified.

1.3.2.8 Inconsistency in Truck Long-Haul Distances.

The transportation system model defines long-haul truck movements of grain as movements of 150 miles or more and uses a cost that is based on the availability of a two-way haul (backhaul). However, the study conducted for the Corps by the Upper Great Plains Transportation Institute found that the break between short-haul (local market) and long-haul truck movements is 250 miles. This distance was defined on the basis of the finding that this is the distance where rail shipment of grain becomes competitive with truck shipment. The UGPTI study further found that long-haul shipment of grain only occurs in the presence of two-way haul opportunities. This finding is consistent with modeling done by the Corps that assumes the presence of backhaul for all long distance (150 miles or more) truck shipments of grain. The IEAB has stated that there should be consistency in long-haul assumptions between the two studies.

1.3.2.9Continued Use of Existing Snake River Elevators With Drawdown.

With drawdown and closure of the Snake River to barge traffic, 12 river elevators could become abandoned. In 1998 these facilities handled a combined total of over 100 million bushels of grain.[3] With drawdown, the alternate river port becomes the Tri Cities area. Construction of replacement facilities in the Tri Cities could cost over $300 million. A less costly alternative may be to continue using some of the existing facilities as railroad loading facilities. In particular, the location of the facilities at Central Ferry might make them an attractive railhead alternative. Additional study would be needed to determine if conversion of these facilities to a railhead would lower overall costs.

3 Tidewater Barge Lines, Inc. July 1999. "Yearly Estimated Volumes of Grain by Facility—1998."

1.3.2.10 Cruise Ship Industry Impacts

The industry position is that with dam removal, cruise operators would most likely abandon the Columbia River and relocate vessels to other rivers where longer cruises are possible. However, the Corps believes that this may not actually happen and that in fact the industry will remain in the region, even with removal of the dams. Additional study is needed to determine the feasibility of cruise operations on the Columbia River without access to the Snake River to the Lewiston/Clarkston area. Without these studies estimates of potential regional impacts of dam removal range from no impact to a total of about $5 million annually. Also, it is not known whether dam removal would result in any NED impacts to the industry—the present analysis is based on an assumption there would be no NED impacts.

1.3.3 CONCLUSIONS

The analysis of transportation system impacts includes a high degree on uncertainty in terms of estimates of the potential volume of commerce that would be shifted from the CSRS to the railroads and at what cost. In addition, there is a high degree of uncertainty about infrastructure improvements that would be needed with drawdown. In modeling movements on the system, a number of simplifying assumptions were made and there are known errors in the transportation system model. The use of an adjustment to prevent the cost of a given movement from being lower with drawdown than without drawdown strongly suggests that additional work on the model could be done to better define costs and movement characteristics. For example, the origins for grain could be made more specific than just the county of origin. Also, there is the issue of known errors in truck costs used in the model. Correction of the known errors would reduce truck costs by as much 20 percent. Even with this correction, however, long-haul truck costs estimated by the Reebie Truck Model would still be higher than actual rates for truck shipments from Montana and North Dakota. Finally, barge costs used in the model may be low. The effect of correcting these known and possible errors would increase the cost of the truck/barge alternative and decrease system cost impacts of drawdown. Also, the predicted shift of volume to rail could increase.

The case of the railroads and their role with drawdown was relatively easy to model. Because of federal regulations that require the railroads regularly report costs, estimates of costs used in the model were easier to develop and appear to be more accurate than either the truck or barge costs. The railroad system is fairly well developed in the region and there are an adequate number of elevators with unit-train loading capacity (26 cars or more) to accommodate rail shipment of the grain that might be diverted from the river with drawdown. However, there is significant uncertainty about whether the railroads would provide the same quality of service that is provided by the existing system. A basic cause of this uncertainty is that the railroads do not currently ship a significant amount of grain from the region. Also, there is uncertainty about what if any improvements would be needed by the rail system. Estimates are provided in the report but representatives of the railroads state that the volume of shipments predicted with drawdown (about 1.1 million tons) could be shipped by rail now without any improvements or acquisition of new rail cars. Thus, the range of costs for rail system improvements may actually be from zero up to the levels shown in the report. Further analysis would be required to obtain a more accurate estimate of costs.

Significant improvements to other public and private infrastructure may also be required with drawdown, including improvements to highways and construction of new river elevator capacity. These costs are not part of the Federal cost of removing the dams and would be the responsibility of the various owners/operators.

A significant concern of highway officials in the Snake Rive grain shed is damage to highways that is caused by trucks moving grain to the CSRS. To encourage shipment of grain by rail, the State of Washington has established a Grain Train. The Grain Train insures that grain cars are available for shipment of grain from origins in eastern Washington to export terminals. The success of diverting grain from the highways to the railroads is unknown. Transportation system model estimates are that truck traffic would significantly increase with drawdown, especially in Washington. Much of the increase, however, is due to two factors. The first factor is the presence of the back-haul shipments of grain from Montana and North Dakota by carriers whose primary haul is Northwest building materials that are destined to points as far to the east as Chicago. If the primary haul were to become unprofitable, grain shipments by truck from these two states would probably cease. The second factor is that the model only includes a limited number of unit-train facilities and does not account for all of the miles of shipment with or without drawdown. This is due to the assumption that the origins of grain movements that are either direct to the river or to a railhead are the center of the county. The distance that grain is transported from farms to country elevators is not accounted for in the model. Greater definition in the model in terms of grain origins would be needed to determine if highway mileage would actually increase or decrease with drawdown.

Finally, costs to shippers will increase with drawdown. While the actual amount of the increase would certainly be different from the estimate developed through use of the system transportation model, the model estimate is considered to be indicative of the potential magnitude of the increase. A post analysis assessment of the transportation model suggests that the estimated increase of $27 million may be higher than the actual increase would be and that revisions to the model to correct known and suspected errors would decrease the estimated cost. Regardless of the actual magnitude of the increase, the increase would not be the same for all shippers. The increase in costs to individual shippers will vary based on the relative location of the shipper to the river and to alternative shipping modes. Shippers that will experience the greatest increase will be those located near the CSRS but relatively far away from the alternate river port at the Tri Cities. Their costs could more than double. On the other hand, shippers in southeastern Idaho should not be significantly impacted. In addition, with drawdown truck highway mileage would be significantly decreased in that state, but would significantly increase in Washington.

2. ANALYTICAL METHODS, PROCEDURES AND ASSUMPTIONS

2.1 METHODOLOGICAL APPROACH

2.1.1 General. The methodological approach and analysis of commodity transportation costs contained in this technical appendix is based in part upon analytical techniques that were employed in System Operation Review studies (SOR) performed during 1992-93. That interagency study evaluated a variety of alternative system operating scenarios for the Columbia-Snake River system (CSRS) and quantified the economic effects of each scenario applying national economic development (NED) criteria. The evaluation of breaching the lower Snake River dams and the resulting economic effects on the existing transportation system contained herein utilizes the same general approach as the SOR and builds upon the methodology and data developed for that study. Elements of the SOR that were used are identified and how they were used is explained in the discussions below. The Institute for Water Resources (IWR) and other sub-contractors performed numerous work tasks for this analysis involving the collection and verification of relevant data.

In addition to the analysis of transportation system costs, a cursory assessment of potential impacts on the cruise-ship industry was also conducted. This assessment was limited to a review of current levels of activity and potential impacts of drawdown on future activity. The assessments without and with drawdown are presented in Sections 5 and 6, respectively. In addition, a general description of the industry and a summary of current levels of activity on the Snake River are presented in Section 4.

2.1.2 National Economic Development (NED). For this evaluation, the direct economic costs resulting from breaching the four lower Snake River federal dams are measured and expressed as changes in NED. NED costs represent the opportunity costs of resource use, measured from a national rather than a regional perspective. In the case of drawdown, the change in the cost of transporting products and commodities now shipped from ports on the Snake River are an NED cost, but the loss of revenue and profit by barge companies is not. Thus, in the NED analysis only the costs of resources actually used are included. Although market prices often reflect total opportunity cost of resources, this is not always the case and surrogate costs must sometimes be used to adjust or replace market prices (or published or contract rates). In this study, for example, it was necessary to use modal costs computed through analysis of the actual fixed and variable costs of each transportation mode—barge, rail and truck. Published rates could not be used because they often reflect market-share strategies of the particular firms involved, rather than actual costs. Also, published and contract rates often reflect short-term rather than long-term conditions. For example, both truck and rail rates could be artificially low because of real or perceived competition from the barge industry and barge industry rates could be artificially high because the relatively higher costs of truck and rail transport. Thus, published rates may under or overstate actual costs.

To avoid distortions of actual resource costs which are frequently found in market prices (published and contract rates, in the case of this study) the NED principle articulates a very specific perspective to be used in valuing project outputs, or benefits, and project inputs, or costs. In general, NED analyses limit the costs of resources to their opportunity cost. In addition, costs must be based on long-run equilibrium conditions. The NED approach to valuing resources is a principle that is founded on economic principles. In addition, it is a federal normative economic policy which federal water resource agencies are required to follow. As such, it is a matter of law, policy and interpretation rather than one of economic fact or theory, although it is a policy firmly rooted in economic theory. National policy has directed that the proper perspective for Federal water project evaluations is a national, rather than a regional perspective

2.1.3 Regional Economic Development (RED). In contrast to the national perspective of NED analysis, regional economic development (RED) analysis provides a measure of the change in regional economic activity that results from alternative plans. As such, it is analogous to principles of accounting rather than economics. The RED analysis typically measures income effects on all sectors of the regional economy through use of input-output models. These models are driven by direct expenditures, regardless of the source, and account for the effects of those expenditures on the rest of the economy as the initial direct expenditure moves through the system in the form of purchases of additional goods and services. Costs included in the RED analysis include the real or NED costs and transfers of income or wealth from one segment of society to another. In effect, the RED analysis tracks the cash-flow of a region's economy. In this study the RED analysis will measure the regional effects of federal and regional expenditures to implement alternative plans, including drawdown. In addition, it will track effects of changes in revenue to each mode of transportation resulting from closure of the Snake River to commercial navigation and the shift of commodities to alternative transportation modes. The analysis accounts for changes in employment, by economic sector and region, as well as economic activity. As such, the RED analysis is frequently more relevant than the NED analysis to regional interests. A RED analysis has been prepared for this feasibility study that measures indirect economic impacts, or secondary effects that would occur on the local or regional level as a result of implementation of drawdown and the associated change or disruption within the established transportation network. This analysis of local and regional economic effects resulting from breaching of the Federal projects is presented in the Regional Economic Appendix.

2.1.4 Measure of Direct Economic Effects. Breaching federal dams along the lower Snake River would result in changes in the way products and commodities are shipped to markets. This change could result in net gains or losses to the nation's output of goods or services, or an increase or decrease in the costs of achieving a given level of goods and services on a nationwide basis. The measure of direct economic effects related to the Columbia-Snake River navigation system is, therefore, expressed as the change in the direct costs of transporting, storing and handling products as a result of eliminating slack-water navigation on the lower Snake River. A net increase in the costs of transporting products would represent direct economic losses that would not be offset by gains elsewhere within the nation's economy. These changes may take the form of increased unit costs of transport, storage, handling, or costs related to changes in facilities or infrastructure requirements, provided that these latter costs represent an increase in long-run marginal costs and increased modal costs or rates. Given closure of the lower Snake River to commercial navigation, commodity transport on that segment of the system would shift to alternative modes and routes, thereby potentially reducing some efficiencies that are now provided by waterborne transport.

In addition to direct transportation cost increases, the loss of commercial navigation on the lower Snake River would reduce the level of competition among mode of transportation. The presence of a navigation alternative can enhance the level of competition in two distinct ways. Available navigation may win the patronage of some shippers – presumably by reducing their transportation costs and/or offering better service. At the same time, the mere presence of a barge alternative may also reduce the rates paid by other shippers who continue to opt to use alternative modes of transportation. Within the context of assessing the benefits of transportation projects or policies, these two outcomes must be treated differently, but the competitive force that brings them to evidence is, in fact, the same. The distinction between the savings that accrue directly to barge users, and the water-compelled rate savings enjoyed by rail or motor carrier-customers, is important. The former set of benefits reflects net additions to overall economic welfare, while the latter set of effects largely represents transfers from carriers to shippers. Thus, shipper savings are counted as National Economic Development (NED) benefits, while water-compelled rate savings are tallied in regional accounts.

2.2 MODELING REQUIREMENTS AND ASSUMPTIONS

2.2.1 Information Requirements. Measurement of direct economic effects required the assessment of permanent drawdown on commercial navigation activity, including the consideration of alternative shipping modes and costs, and determination of the most probable combination of storage, handling, and transport modes that would emerge in response to curtailment of waterborne transport. Specific information requirements of the analysis included the following: (1) establishment of base and projected future commodity shipments; (2) identification of commodity origins and destinations with and without drawdown; (3) estimation of modal costs and storage and handling costs at throughput facilities; (4) assessment of regional rail and truck capacity; and, (5) a variety of other elements that characterize the regional transportation system. A synopsis of how these data were derived, and a description of the procedures and assumptions applied in the evaluation process, are presented within this section.

2.2.2 Base and Projected Future Commodity Shipments. Projections of future commodity shipments were through an analysis of waterborne commerce data for the Columbia-Snake River System for the decades of the 1980s and 1990s. The analysis included assessments of exports, the volume of shipments on the Snake River, and the types of commodities shipped. Forecasts of future shipments were developed for each of eight commodity groups and later combined into five groups for the analysis of transportation system costs. Details of the analysis of current and future commodity shipments are presented in Section 4.

2.2.3 Commodity Origins and Destinations. The study area considered in the study encompasses grain producing areas as well as origins and destinations for non-grain commodity groups that utilize the CSRS. In studying the effects of river closure, areas that constitute transportation corridors and grain-growing regions were identified as areas of primary emphasis. Previous studies conducted in 1992 by a consultant to Portland District, Transportation Research and Analysis Center, Inc, (TRAC) identified off-river origins of grain transported by barge on the lower Snake River. This work is documented in the System Operation Review (SOR) Transportation Model, Final Report, dated December 1993. These off-river origins include areas within northeastern Oregon, eastern Washington, northern Idaho, and a small number of grain production areas in Montana and North Dakota. Off-river origins or destinations for non-grain commodity groups in the lower Snake River region (such as petroleum or fertilizers) also generally fall within the sizeable area that comprises the hinterland for barged grain. The origins of all non-grain shipments were taken from the data developed by TRAC for the SOR. Origins included actual origins for some commodities and the county of origin for others. In general, county origins were used for bulk commodities such as non-grain farm products, which in fact has a dispersed origin. Due the relative insignificance of the non-grain commodity groups to the overall volume of Snake River shipments, origins of these commodities defined by TRAC for the SOR were not updated for this study.

The navigation analysis deals with major groupings of commodities that are presently shipped by water and would thus be impacted by closure of the Lower Snake River to commercial traffic. Data maintained by the Corps' Waterborne Commerce Statistics Center (WCSC) were used to identify river origins/destinations for 10 aggregated commodity groups. To facilitate analysis, commodities were further consolidated into 5 major groupings consisting of grain, petroleum products, wood chips and logs, wood products, and other products including those shipped by container. Origin-destination movements were also obtained for all CSRS barge traffic originating or terminating above Bonneville Lock and Dam at mile 145 on the Columbia River for the period 1987-1996. Movements with origins or destinations above Ice Harbor Dam on the lower Snake were then separated from the larger data set. These data were used as a base in forecasting future commodity growth within the study area.

For waterborne movements of wheat and barley, Portland District provided IWR detailed data developed in previous SOR studies that identified the percentages of grain moved from country elevators to elevators on the Snake River. Also provided was a list of river elevators on the lower Snake River and information on routing and distance by mode of transport for barged-grain. A sub-contractor to IWR (Jack Faucett and Associates) surveyed each elevator on the lower Snake River to establish grain origin and movement patterns for a “representative year” of operations. In some cases the data obtained was for May 1997 through April 1998. In others, facility operators provided adjustments to the data compiled by TRAC for the SOR but did not provide any actual data. The result was development of a new data set that represents current volume and movement patterns for grain shipped on the Snake River, but the data set is not associated with a particular year. From interviews, information was obtained on receipts by river elevators and compared to the percentages used in SOR studies. The new data were utilized to adjust the TRAC data to reflect current grain movements to the river from country elevators. The updated information accurately reflect the current operations of the elevators to varying degrees and varying levels of detail, depending upon the amount of information obtained. In one case, no information was obtained. In others, river elevator operators fully updated all the information contained in the ‘snapshot’ of prior TRAC data. In most cases, some amount of extrapolation was utilized in updating the TRAC data. Although the data are not completely accurate, they are considered to be the best available and are judged to be sufficient for use in this study. The resulting data is presented in Section 5 in tables which show volume of grain moved on the Snake River by pool and the origin of the grain by county or region (Montana and North Dakota) and state. Also, the percent of grain from each origin is shown. The distribution of the total volume of grain among the various origins thus established was the basis for allocating projected future volumes of grain shipments to each origin. Thus, the analysis of future shipments was made looking backwards from forecasts of exports to regions of production, rather than from production regions to exports.

Information obtained through this process indicated that the total number of bushels currently moved through the river elevators located on the lower Snake River in 1997 exceeded volumes developed for the SOR by approximately 20 percent. This change is mainly attributable to a significant increase (42 percent) in grains originating in Washington, which originates more grain barged on the Snake River than any other state. Conversely, it was found that the volume of grain originating in several Idaho counties has declined by approximately 25 percent since the 1992 SOR survey. Four counties in the Lewiston area – Idaho, Latah, Lewis, and Nezperce – have experienced declines in total bushels shipped and as a result, the total amount moved through the Port of Lewiston has declined by four million bushels, or 15.5 percent. During the contractor’s investigation, data were not obtainable for two river elevators; Walla Walla Burbank, (owned by Cograin and Cargill) and a relatively new facility on the Lower Monumental pool located near the Windust elevator (Cograin). With the exception of these two elevators, the database was adjusted to reflect the current volume of wheat and barley receipts. For the latter two elevators, TRAC data for all movements originating at an Odessa union Warehouse facility with destination to anywhere other than Walla Walla/Burbank were assigned to the new Cograin facility. For the Walla Walla/Burbank facility, the volume of grain from each off-river origin identified in the TRAC study was increased by the same growth factor that was developed for the overall growth in Washington off-river-to-river grain shipments since 1992.

During interviews with the river elevator operators, information was obtained regarding the location and current ownership of the country elevators moving grain through the river facilities. Since 1992, ownership of several country elevators has changed, resulting in shifts of grain volumes moving from those facilities to various river elevators. Overall, it was determined that change of ownership of these elevators has had relatively little impact on the operation or patterns of off-river origins of grain shipped to the river elevators. For volume lost or gained due to an ownership change of a country elevator facility, the river elevators have generally replaced the lost grain with business from another location. Overall, the location and operational status of the country elevators has not changed significantly since the SOR studies were performed. The overriding influence affecting changes in off-river to river grain movements since 1992 has been the substantial increase in volume, and a shift in volume reported for Washington State and away from several counties in Idaho.[4] The Survey of Snake River Grain Elevator Facilities is included in this report as Technical Exhibit A.

2.2.4 Commodity Growth Forecasts. The basis for commodity growth forecasts is the volume of grain and non-grain shipments that originate from the Snake River above Ice Harbor Dam. Thus the forecasts presented here and the analysis of transportation system impacts of drawdown are limited to the volume of shipments on just the Snake River, rather the combined CSRS. The actual forecasts, however, were derived from forecasts developed by the Portland District for the Columbia River Channel Deepening Feasibility Study, in conjunction with historical data and anticipated trends in the volume of relevant commodities now moving on the Snake River. Using data developed for that study, waterborne traffic forecasts were developed by IWR for the 1997 to 2017 period for the Snake River segment of the CSRS from Ice Harbor Lock and Dam to the head of navigation at Lewiston, Idaho, a reach of about 130 river miles. It is this segment of the CSRS that would be closed to commercial navigation under a plan to breach the dams. Projections for this 20-year period were made at five-year intervals for the various commodity groups. Due to the degree of uncertainty inherent in long range forecasting, projected volumes were assumed to remain level beyond 2017. The commodity forecasts included a detailed assessment of relevant supply and demand factors that influence each

4 Survey of Snake River Grain Elevator Facilities, Jack Faucett Associates, Inc., September 1998.

commodity group. As stated above, the development of commodity forecasts is discussed in Section 4, as are the forecasts.

2.2.5 Transportation System Cost Estimating Procedures. A Microsoft ACCESS database was developed utilizing Visual Basic software to compile and allow comparison of transportation-related costs associated with the base condition and a drawdown scenario. The database was used to quantify the costs (transportation, storage and handling) of shipping commodities under existing conditions and in the absence of commercial navigation on the lower Snake segment (drawdown). The results of these two analyses were then compared to determine the effect that river closure would have on transportation system costs. This comparison is simply the difference between transportation costs with drawdown versus transportation costs without drawdown.

Within the region, grain makes up the overwhelming majority of commodity volume moved via the river. This is reflected in the data files in the database, which contain data on flow links (movements from origin to destination), for grain products. As noted above, origin-destination files for grain were updated from prior drawdown studies conducted during the SOR to reflect existing conditions. For analytical purposes, farms and/or country elevators are treated as points of origin for down bound grain.

For non-grain commodities, a similar procedure was followed. Origins and destinations for non-grain commodity movements by water were also taken from data developed by TRAC for the SOR but were not updated to adjust for any changes which may have occurred since the data for that study was compiled in 1992. Origins range from specific locations (cities and towns, for example) for some commodities to dispersed origins for others. In general, commodities with dispersed origins were non-grain agricultural commodities. In these cases, origins are the counties of origin and the distance of the movement is assumed to be from the center of the affected counties.

The model is not an optimization model. It is simply a database of existing routings (base case) and alternative routings (with drawdown case) of grain and non-grain commodity movements from origins to destinations. In the base case existing routings are used and in the with drawdown case, most likely alternative routings are used. With drawdown, at least two routings for commodities from each origin are included in the database and the model is designed to select the least cost routing. Storage and handling costs are associated with routing alternatives, with these costs being added to the transportation cost to determine the total cost associated with a particular routing. The model accumulates transportation, storage, handling and total costs for the least-cost routings and prepares summary reports on movements and costs by state, county or region and mode of transportation. In addition, miles (bushel-miles for grain) and ton-miles for non-grain) are similarly accumulated and reported.

2.2.6 Modal Cost Estimating Procedures. As the basis for estimating changes in transportation system costs that could result from river closure, modal costs for barge, rail and truck were developed using transportation analysis models (TAMs) for each mode. The models were developed and copyrighted by Reebie Associates, Transportation Management Consultants. Reebie costing models are used extensively by both the public and private entities. The specific models used are briefly described as follows:

- **Barge Cost Analysis Model (BCAM).** The BCAM is designed to facilitate the analysis of barge-load shipments on the nation's inland waterways. The design concept involves bringing data about the river systems, locks and dams, barges, towboats, and commodities to the processing capabilities of the personal microcomputer. All of the inland waterways on which commercial barge-load shipments are made are built into the model. This includes the Mississippi River System, in the central part of the country and the Columbia/Snake River System in the Pacific Northwest. In running the model, the user specifies shipment characteristics; cost factors; operating factors; and, routing.
- **Rail Cost Analysis Model (RCAM).** The RCAM is an enhanced personal computer application of the Interstate Commerce Commission's Uniform Rail Costing System (URCS) methodology. URCS was adopted by the ICC as a General Purpose Costing System for all regulatory costing purposes in Ex Parte 431, 1989. The URCS itself is a complex set of procedures which transforms annually reported railroad expense and activity data into estimates of the costs of providing specific services. It is based an analysis of cause and effect relationships between the production of railroad output ("service units" such as car miles or gross ton miles) and the incurrence of expenses as defined within the accounting system. These relationships define a series of "unit costs" (e.g. crew costs per train mile) which are applied to the service units generated by a shipment to produce the estimated cost of providing the service.

The Carload Module in the RCAM is designed to enable the user to analyze a carrier's revenue needs and underlying costs for any type of carload shipment. Costs vary with the type of car, commodity, payload, equipment utilization and service level required for the shipment, as well as the specific route and carriers involved in the movements. The model also allows the introduction of costs for highly specialized services when they are part of a shipment being analyzed.

- **Truck Cost Analysis Model (TCAM).** The TCAM provides the ability to determine the underlying cost and revenue requirements for truck shipments. The TCAM data input process is divided into three sections: primary shipment specifications (11 variables); driver and utilization factors (10 variables); and, detailed costing factors (25 variables). Default values are built into the model for all input variables.

The assumptions made in establishing rail and truck costs are shown in Tables 2-1 and 2-2, respectively.

Table 2-1. Assumptions and Costs for Establishing Rail Shipping Costs.

Assumption or Cost Item	**Condition Assumed or Cost Used**
Size of train	Unit train of 25 cars
Rail car type	Covered hopper
Rail car capacity	95 tons per car
Backhaul	None—empty return
Routing	1st choice—single rail carrier
Terminal costs (loading & unloading)	None 1/
Rail car turnover rate	Two trips per month
Note: 1. Terminal costs of $1.88/ton ($0.0564/bu.) were identified for barge, but were not utilized in the analysis.	

Table 2-2. Assumptions and Costs for Establishing Truck Shipping Costs.

Assumption or Cost Item	Condition Assumed or Cost Used
Wages of drivers 1/	$10.00/hr.
Load—short-haul 3/	830 bushels (25 tons)/truck @ 30 mph
Load—long-haul	1000 bushels (30 tons)/truck @ 50 mph
Backhaul	Assumed for one-way distances over 150 miles
Trips per day	Less than 15 miles: 5 trips 15-30 miles: 4 trips 31-50 miles: 3 trips 51-100 miles: 2 trips Over 100 miles: 1 trip
Truck trailer type	Dry Van—48 feet
Additional Driver Time Enroute	1 hour for trips over 100 miles
Truck overhead	18.75% (calibrated against rates from SOR).
Non-revenue tractor and trailer time	20 percent
Basis for tractor/trailer days	Total driver hours / 8 hours per day
Terminal costs (loading & unloading)	None 4/

Notes:

1. Wages: Drivers are paid on a mileage basis for longer hauls. But studies showed that grain is generally carried as a back-haul for shipments of building materials. Without the primary shipment of building materials, long-distance truck shipments of grain (over 250 miles) would essentially cease. For example, deliveries from Southern Idaho and Western Montana (about 350 miles 1-way) cost about $360 for the load, with the driver receiving about $10/hr. for and 8-hour day
2. Traffic share: Continental's Lewiston elevator receives about half its grain deliveries from these longer haul operators and about half from local country elevators or directly from farms.
3. Short Haul: Deliveries from within a radius of 100 miles usually do not have a backhaul. Trucks may make 3 deliveries per day for short haul trips. Driver wages may be higher during peak harvest between mid-July through September, with some drivers earning up to $30/hour.
4. Terminal costs of $1.88/ton ($0.0564/bu.) were identified for barge, but were not utilized in the analysis.

For purposes of confirmation, tug-barge cost data were also requested from local towboat companies. However, a complete determination of cost elements could not be made due to concerns with disclosure of proprietary information. Information that was collected, however, was generally consistent with the Reebie costing model for tug–barge operation. Data detailing line haul costs, as well as sample data from the Reebie models for barge, truck and rail modes are contained in Technical Exhibit D.

2.2.7 Grain Storage and Handling Costs and Assumptions. Storage costs are a function of two factors, the duration of storage and the monthly cost of storage. As initially constructed, the model was setup with a different duration of storage for the base and drawdown cases. Review of this logic determined that the duration of storage is actually a function of the relationship between harvest and demand. On this basis, if, for example, harvest occurred over a period of two months and demand were equal for each month of the year, the average duration of storage for a typical bushel of grain would be about 5 months (assumes that during harvest grain is moved directly to export). Elevator storage costs at country and river elevators were reviewed for this study. The review revealed that monthly storage costs at country elevators are about $0.006 per bushel higher than storage costs at river elevators. In the present version of the model, the duration of storage is held constant for both the base and drawdown cases. Thus, the difference in storage cost is due to use of country elevator storage with drawdown, rather than the cheaper river elevator storage. Storage costs are incurred at each elevator type, except the export terminal. A cost for on-farm storage is not estimated on the basis that it would remain the same with and without drawdown. Storage costs are assumed to be the same for all country elevators, including those with unit-train loading facilities.

Handling costs are a function of the number of times grain is required to transfer to a different mode of transportation or to go into or out of storage. The types of movements included in the model are as follows:

- **Base Case:**

- Farm-to-River-to-Export Terminal
- Farm-to-Country Elevator-to-River-to-Export Terminal
  Note: The model does not include any farm-to-rail-to-river movements, even though these types of movements have been reported for ports in the Lewiston area and the Port of Wallula.

- **With Drawdown:**
- Farm-to-Alt River-to-Export Terminal
- Farm-to-Country Elevator-to-Alt River-to-Export Terminal
- Farm-to-Railhead-to-Export Terminal
- Farm-to-Country Elevator-to-Railhead-to-Export Terminal

Handling costs are incurred at each elevator type, including the export terminal. Handling costs at river elevators are typically $0.076 per bushel less than handling costs at country elevators. This difference is reflected in the model. The handling cost at the export terminals is assumed to be the same both river and rail shipments and is not computed. Handling costs are assumed to be the same for all country elevators, including those with unit-train loading facilities.

2.2.8 Capacity Assumptions. Two general assumptions about capacity are fundamental to the analysis and the construction of the transportation system model. The first assumption is that the current system is in equilibrium in terms of storage, handling and transport mode capacity. On the basis of this assumption, it was unnecessary to model capacity in the base case. The second assumption is that with drawdown, modal, handling and storage capacity can be expanded on a regional basis to meet geographic shifts in demand without significant increases in long-run marginal and average costs. The Economic Procedures and Guidelines used by the U.S. Army Corps of Engineers to determine project benefits and costs reason that if inland navigation capacity is reduced, competing surface transport modes either possess or would add the capacity necessary to accommodate additional traffic. Similarly, it is assumed that elevator throughput capacity could be increased with little impact upon long-run marginal and average costs. As a consequence, it is judged possible that additional transportation capacity could be made available with no significant increase in its unit cost. For non-grain commodities, storage and handling costs were assumed to be generally equivalent under either scenario. On the basis of this second assumption, modeling of capacity in the with-drawdown case was also unnecessary. Notwithstanding the view that it was unnecessary to specifically inventory existing system capacity and model capacity requirements with drawdown, specific assessments of capacity infrastructure improvements that would be needed with drawdown were made. These assessments are discussed and the findings are presented in Section 6. The uncertainties surrounding the assessments are discussed in Section 8.

2.2.9 Seasonality of Shipments. Shipment of both grain and non-grain commodities experience some month-to-month or season-to-season fluctuation in volume. On a year-to-year basis much of this fluctuation is due to fluctuations in market conditions rather than the underpinning demand factors. Thus, grain exports from the lower Columbia River may vary significantly from one month to the next because of market conditions while the demand for grain remains relatively constant. Despite the fact that volume of shipments, especially of grain, has historically varied from month-to-month, such variations were not built into the model. In stead, the model was constructed and operates on the premise that the volume of shipments of both grain and non-grain commodities are uniform from month to month. The issue of seasonality of shipments is discussed and a sensitivity assessment of capacity needs is presented in Section 8.

2.2.10 Operation of the Model Without and With Drawdown. In the without drawdown case, the model is constructed to attempt to replicate a non-optimized base condition that takes into account commodity movements on the river under present conditions, but using the projected future volume of shipments. In the with drawdown case, the model is constructed to evaluate transportation, storage and handling costs resulting from the shift of projected future volumes of commodities to alternative modes of transportation and routings. For the drawdown scenario, alternative routings and transportation modes for each commodity origin identified in the base case were identified and substituted in place of the base case routing that included barge transport on the affected river segment. In all cases, the model includes at least two alternative routings for commodities from each origin in the base case. In general, alternative routings developed for the SOR were used. These alternatives were, however, reviewed and updated to take into account changes in unit-train rail loading facilities at country elevators. In constructing routings that include rail transport to final destinations, alternative rail origins for grain were limited to those having a car loading capacity of at least 25 cars. This requirement was imposed because in order for rail transport to be feasible a minimum unit-train loading capability of 25 to 26 cars is needed. Imposition of this requirement reduced the number of country elevators identified in the base case as having rail access from over 100 to 14. Those facilities that were eliminated are those with a loading capacity of fewer than 25 cars. In addition, facilities within 15miles of a facility included in the model were excluded on the basis that costs associated with these facilities would be the same as for those already in the model.

Construction of the model further assumes that as grain or other commodity transport is impaired by drawdown, shipments would be rerouted by motor carriers to river elevators located on the McNary pool and transshipped by barge, or would be shipped by rail directly to lower Columbia export elevators. The types of movements included in the model for both the base and drawdown cases are discussed above (see paragraph 2.27). A further assumption in the model is that the cost of specific movements cannot be lower with drawdown than without drawdown. In cases where this occurs, an adjustment equal to the amount of the difference between costs with drawdown and without drawdown is calculated. The sum of the adjustments is then subtracted from total transportation costs with drawdown (adjustments are not made to individual movements). The model includes unit costs for transportation, storage and handling associated with each of the alternative routings for each origin-destination pair affected by waterway closure. Distances between origins and destinations were identified and are included in the model. The overall method employs the assumption that current and projected levels of exports from the region would continue to be maintained. Changes in the operation of the system are considered to reflect long-term conditions. Thus, the analysis attempts to define changes to the transportation system in terms of long-run equilibrium.

2.2.11 Adjustment of Model Results. A fundamental assumption made by modelers was that the existing transportation of grain represents the least-cost condition. Therefore, modelers assumed that the cost of all movements of grain with drawdown should be at least as costly as without drawdown. Actual operation of the model, however, showed that this was not the case. The model results showed that a number of grain movements were found to be less costly with drawdown than with the existing transportation system. Since this violated the assumption that the existing system is the least-cost system, the model includes a check to determine if the cost of a movement is less with drawdown than without drawdown. If the cost with drawdown is less, the difference is calculated and is added to the transportation costs with drawdown. The adjustments computed, however, are not tracked in the model by movement, etc., but are simply summed and added to total transportation costs with drawdown. The use of this type of adjustment is somewhat unconventional and is opposed by the IEAB. The use of the adjustment is an unresolved issue.

2.2.12 Taxes, Subsidies and Price Level Changes. The analysis does not take into consideration the effects of taxes or subsidies, which represent transfer payments within the national economy. Because of the inherent uncertainty about future conditions, no attempt is made to forecast future price level changes or specific market conditions.

2.2.13 Effects on Quantity of Land in Grain Production. In the short-term, it is possible that some marginal land now used for production of grain could become unprofitable and some grain farmers could be forced out of business. The actual impact on individual operators will depend on a number of factors, including the productivity of the land; the fixed cost of land, in the form of capital and interest payments and taxes; and, the actual increase in transportation costs. This latter factor is a function of the relative location of the land to the CSRS and to alternative modes. In some cases, especially in cases of recently purchase farms with a high debt load, the economic viability of individual farms could be jeopardized by the increased transportation costs combined with debt service requirements. However, for most farms the increase in transportation costs would simply mean that the return to fixed capital (such as land) would be reduced. On this basis, it is possible that some land now used for grain production could go out of production, at least in the short term. However, assuming that grain production is the highest and best use of the land currently used for this purpose, in the long-run the reduced economic return to land because of higher transportation costs would be reflected in a reduced value of land and the land would continue to be used for grain production. Therefore, this analysis is based on the assumption that implementation of drawdown would have no effect on the amount land used for grain production in both the short- and long-terms.

The effect of assuming that croplands would not go out of production or be subject to changes in cropping patterns in the short-term, could result in an overstatement of the increase in net transportation costs. However, this would only be the case if current net farm income for some growers were less than the increase in transportation costs that would result from drawdown. The reason for this is that the maximum NED loss that can be attributed to transportation is the loss of net farm income to the producer. For this to occur, however, the transportation cost increase would have to higher than net income based only on variable costs and revenue, in the short-term. The assumption that drawdown would not result in a decrease in land used for grain production is consistent with conclusions reached in the recently completed Washington State Legislative Transportation Committee Study on drawdown which likewise discounted the possibility of significant reductions in wheat and barley production in Eastern Washington as a result of breaching the dams. Given the 100-year period of analysis, it is inevitable that deviations from forecasted conditions will occur. The forecasts used in this analysis thus try to avoid giving disproportionate weight to short-run events.

2.2.14 Period of Analysis, Price Level and Interest (Discount) Rates. Planning horizons for Corps projects typically cover from 50 to 100 years. The period of analysis for this evaluation is 100 years. A long-run perspective consists of conditions that are reasonably representative of the entire planning horizon. In applying a long-run planning perspective, the decision-maker adheres to secular trends in data and events, rather than cyclical, seasonal, or random effects.

The initial year of project implementation is estimated to be 2007, and NED effects are measured over the 100-year period, 2007 to 2106. For purposes of comparison with other fish restoration measures being evaluated in the feasibility study, economic costs associated with both the base case and the drawdown case were adjusted to a base year, 2005, and amortized over the life of the project. The costs reflect current (1998) price levels and are expressed as average annual dollar amounts. In order to accommodate the analytical requirements of the Federal agencies and the Tribes, three rates of interest are utilized in expressing NED costs. Where applicable, the current (FY 1999) Federal discount rate of 6.875 percent is utilized. For analytical purposes, a rate of 4.75 percent, (utilized by the Bonneville Power Administration) and a zero percent rate applicable to Tribal circumstances have also been applied. This process allows impacts that occur at different points in time to be directly compared.

2.2.15 Uncertainty. While NED methodology focuses upon resource costs, it is nevertheless recognized that river closure would initially cause significant dislocations within the system. A considerable amount of uncertainty exists in this regard, particularly with respect to modal rate behavior, infrastructure and capacity requirements, the potential for lost grain sales to export markets, and overall financial impacts. In addition, uncertainty exists with regard to the length of the transition period until equilibrium could be reestablished within both commodity markets and the regional transportation system. These issues are addressed in Section 8, Risk and Uncertainty. Section 8 also includes a discussion of the sensitivity of the estimates to alternative assumptions.

3. COLUMBIA-SNAKE RIVER TRANSPORTATION SYSTEM

3.1 GENERAL

The Columbia-Snake River system is Pacific Northwest's river highway. Its flows stem from highlands in Canada, Washington, Oregon, Idaho, Montana, Wyoming and Nevada. The volume of water within the system totals 200 million acre-feet annually. The Columbia River and its tributaries, including the Snake, provide hydropower, navigation, irrigation, recreation, fish and wildlife habitat, and water supply for communities, agriculture, commerce and industry. Resource-based economic activities within the region such as agriculture, timber and tourism all derive benefits from the CSRS.

The Columbia River has been an active commercial waterway since the early nineteenth century. Oceangoing vessels began sailing up the river first to the Vancouver, Washington and Portland, Oregon areas and then later on up the Willamette River to Oregon City in the early 1800's. It is recorded that in 1949 when gold was discovered in California, more than 50 ships crossed the dangerous bar at the mouth of the river and on up to the Portland/Vancouver area. When gold was discovered in Idaho in 1862, steamers began traveling from The Dalles, Oregon, to Lewiston, Idaho. They occasionally made trips beyond Lewiston on the Clearwater River to the Orofino mines. With construction of the Cascades Canal by the Corps of Engineers in 1896 and The Dalles-Celilo Canal in 1915, navigation between the upstream and downstream reaches of the river became possible. The modern Columbia-Snake River navigation system is comprised of two segments, a downstream portion that provides a deep-draft shipping channel and an upstream segment, which is characterized by a shallow-draft channel and a series of navigation locks.

3.2 DEEP DRAFT SEGMENT

The Federally-developed deep-draft navigation channel begins at the Pacific Ocean, where the Columbia River entrance extends two miles (3.2 km) seaward and three miles (4.8 km) landward from the outer ends of the Columbia River jetties at the river's mouth. The entrance channel, which was deepened to 48 feet (14.6 m) in 1957 and then to 55 feet (16.8 m) in 1984, provides navigability of the bar. From the entrance, the deep-draft river channel is maintained at a depth of 40-foot (12.2 m) over a length of 106 river- miles (R.M.) to Vancouver, Washington, and also up the Willamette River from its confluence with the Columbia to the Broadway Bridge at Portland, Oregon. Studies are currently underway by the Corps of Engineers to deepen the downstream channel to 43'. Oceangoing vessels transporting products and commodities to and from national and international markets use the lower river channel extensively. In addition to the channel and turning basins, there are numerous small harbors along the lower reach of the river. Deep-draft anchorage sites are located at Astoria, Longview, Kalama, Woodland, Henrici Bar, Willow Bar, Kelley Point, and Hayden Island.

A number of marine terminals are located adjacent to the 40-foot channel between the river's entrance and its upstream terminus at Vancouver. These terminals handle and transship a variety of products and commodities. The Port of Vancouver exports wheat, barley, lumber, paper, newsprint, and linerboard, and imports such products as alumina, cement, iron and steel products and fertilizers. The Port of Portland exports wheat, barley, logs, lumber, soda ash and metal scraps, and imports autos and parts, iron and steel products, limestone, salt (crude) and alumina. At Longview, exports consist of logs, soda ash, coke, wood chips and paper products, and imports include alumina, salt (crude), coal tar pitch, fertilizers, sand and zircon. The Port of Kalama specializes in the transshipment of grains such as corn, sorghum, wheat, and barley. Imports include toluene and chemicals. With the exception of Longview, and the Port of Astoria at the river's entrance, all of the major terminals with deep-water access transship grain destined for foreign markets. Summary information related to lower Columbia River grain export facilities is provided below in Table 3-1.

Table 3-1. Lower Columbia River Grain Export Facilities.

Operator	**Location**	**Operating Storage Capacity**	**Receiving Facilities**	**Rail Car Unload Capacity**	**Barge Unload Capacity**
		(Bushels)		(tons/day)	(tons/day)
United Harvest	Vancouver, WA	4,230,000	barge, rail	14,000	10,000
Louis Dreyfus Corp.	Portland, OR	1,500,000	barge, rail	3,000	7,000
Cargill, Inc. IrvingElevator	Portland. OR	1,500,000	barge, rail, truck	5,500	10,000
Cargill Inc. Terminal 4	Portland. OR	7,500,000	barge, rail, truck	5,500	7,000
Columbia Grain Terminal 5	Portland. OR	4,000,000	barge, rail, truck	10,000	10,000
United Harvest	Kalama, WA	6,000,000	barge, rail, truck	7,000	7,000
Kalama Export Co.	Kalama, WA	2,000,000	barge, rail	40,000	12,000

Source: Corps staff personal conversations with facility representatives.

The majority of oceangoing cargo ships calling at lower Columbia River ports operate under foreign flag. These include liquid and dry bulk carriers, container ships, auto carriers, tankers, and general cargo ships. General cargo, tanker and container ships that use the lower Columbia River range in size from 15,000 to 50,000 deadweight tons (15,240 to 50,800 metric tons) and draft 25 to 40 feet (7.6 to 12.2 meters) loaded. Dry bulk carriers designed to carry non-containerized, non-liquid products such as corn, wheat, logs, lumber and wood chips to export markets range up to 60-80,000 deadweight tons, (60,960-81,280 metric tons) with design drafts of 37 to 44 feet (11.4 to 14.4 m) and lengths exceeding 700 feet. (213 m) Approximately 12 percent of the grain vessel fleet calling at lower Columbia River ports are panamax-sized vessels (the largest vessel that can transit the Panama Canal), with the remainder ranging in length from 450 to 650 feet. (137 to 198 meters) The initiation of Midwest corn export operations at Kalama, Washington in 1983, and deepening of the river entrance in 1984 have both contributed to the increased number of deep-draft vessel transits of the lower Columbia River since the mid-1980s.

3.3 SHALLOW DRAFT SEGMENT

A federally constructed and maintained channel and system of locks between Vancouver, Washington and Lewiston, Idaho characterize the shallow draft segment of the waterway. The channel extends upriver from Vancouver at river mile 106 to Richland, Washington, (R.M. 345) and from the mouth of the Snake River (Columbia River Mile 325) to Lewiston, Idaho at R.M. 141. The commercially navigable barge channel has a minimum authorized depth of 14 feet (4.3 m) at minimum operating pool (MOP) elevations of each of the upstream projects. Lock sills are at -15 feet (-4.6 m) at MOP while the channel is maintained to -14 feet (-4.3 m) at MOP. Under normal operation, pool elevations generally fluctuate between full and two feet (.6 m) below full pool, providing an average channel depth of about 18 feet. (5.5 m)

The system of locks in the dams allows passage of commercial barge traffic and access to the inland areas as far upriver as Lewiston, Idaho. The channel and locks are utilized by commercial tug and barge operators to move products and commodities to and from upstream and downstream locations along the waterway. The opening of the Bonneville Lock in 1938 initiated the development of the CSRS for modern commercial tows. The system now consists of a total of eight dams, each with high-lift locks. The original Bonneville Lock, at 500 x 76 feet, could handle only two barges per lockage and by the early 1980s had become a serious bottleneck to traffic. In 1993, a replacement lock chamber at Bonneville became operational, which standardized lock sizes within the Columbia and lower Snake system and eliminated tow delays of up to eight hours. The four locks located on the lower Snake River, Ice Harbor (R.M. 9.7), Lower Monumental (R.M. 41.6), Little Goose (R.M. 70.3), and Lower Granite (R.M. 107.5) became operational in 1962, 1969, 1970 and 1975, respectively. Completion of Lower Granite Lock and Dam allowed modern river tows to reach Lewiston, Idaho.

The present system, consisting of eight locks and dams, provides a commercially navigable waterway 465 miles in length between the Pacific Ocean and Lewiston, Idaho. The eight locks combined provide a total vertical lift in elevation of 734 feet. Their dimensions are 675 feet long by 86 feet wide, with sills of 15 feet at MOP. These dimensions allow the passage of river tows of up to five barges and a towboat in a single lockage, based on typical covered hopper barge dimensions of 220 x 42 feet. A summary of lock characteristics is shown in Table 3-2

Table 3-2. Lock Characteristics of the Columbia/Snake River System.

River/Lock	River Mile	Year Opened	Age in 2000 (Yrs)	Chambers (Feet)		
				Width	Length	Lift
Columbia River						
Bonneville (Main)	146.0	1993	7	86	675	65
Bonneville (Aux.)*	146.0	1938	62	76	500	65
The Dalles	190.0	1957	43	86	675	88
John Day	215.0	1968	32	86	675	110
McNary	292.0	1953	47	86	675	83
Snake River						
Ice Harbor	9.7	1962	38	86	675	103
Lower Monumental	41.6	1969	31	86	675	103
Little Goose	70.3	1970	30	86	675	101
Lower Granite	107.5	1975	25	86	675	105

* Old lock that was replaced by the new lock for normal operations but is still available for service.
Source: USACE, Navigation Data Center.

Riverside facilities managed by port districts and other public or private entities are located on the pools created by the system of locks and dams. Within the shallow-draft segment there are 27 barge-loading facilities, thirteen located above Ice Harbor Dam and the remainder below, including seven on the Oregon side of the river.

3.4SHALLOW DRAFT FLEET

Commodities are transported on the inland waterway system by non-powered barges propelled by towboats. The barges are rectangular, with flat-bottomed hulls, and vary in size and design depending on the type of cargo they are intended to carry. (open-deck, tank, bin, etc) The size and weight of the tow determines the size or horsepower of the towboat required. To facilitate efficient movement through the system of locks on the Columbia and Snake Rivers, barges are assembled together in tows of up to five barges—the maximum size tow that can pass through the upstream locks as a unit. A typical tow configuration consists of four barges and a push towboat.

The data below provide a general description of the types of barges utilized for navigation within the study area and the kinds of products they transport.

- Standard and Jumbo Combination Barge - Grain and petroleum products, alfalfa, potatoes, paper
- Standard & Jumbo Covered Bin - Dry bulk cargo such as grain under protective cover.
- Open Bin - Dry bulk commodities such as wood chips and sawmill scrap.
- Flat Deck - Logs, construction equipment and materials, containers.
- Tank Barges - Bulk liquid commodities, petroleum products, anhydrous ammonia (fertilizer).
- Log Rafts - The standard log raft is 455 feet (138.7 m) long by 65 feet (19.8 m) wide, and
contains 250,000 board feet net Scribner Scale, (590 m^3) or 937 tons (952 metric tons).

Towboats operating on the waterway vary in size from about 42 to 127 feet in length (12.8 to 38.7 meters) and draft from 6 to 12 feet (1.8 to 3.7meters). Horsepower ranges from 250 to 3,600.

Data that describe shallow draft vessel activity on the Columbia and Snake Rivers during 1995 were acquired from the Waterborne Commerce Statistics Center (WCSC) of the Corps of Engineers. These data and information from the Columbia River System Operation Review EIS, 1995, are provided for illustrative purposes to provide additional detail about the types and sizes of vessels, transport capacities, ownership, commodities transported and number of trips recorded. A tabular summary of the data is presented in the following paragraphs.

Major characteristics of the shallow-draft vessels are displayed in Table 3-3. The records indicate that 198 different vessels, owned by 21 individual companies, moved cargo within the Columbia and Snake River system during 1995. Seventy-five percent of the vessels operating were dry cargo barges, with the remainder made up of liquid cargo tankers. This table also provides information about vessel capacities and recorded trips. A total of 7,835 trips were recorded involving 10.8 million tons of commodities.

A listing of different companies that were operating shallow-draft vessels in 1995 is displayed in Table 3-4. This information indicates that certain companies accounted for the majority of vessels operated, as well as the majority of traffic. Tidewater Barge Lines, Inc. operated 72 vessels that transported a little over 50 percent of the total commodity tonnage. Their fleet is comprised of 29 dry cargo barges and 43 liquid tankers. Given that only 56 tanker vessels were in use in 1995, Tidewater operated 77 percent of all tankers in use. Eight companies operate 89 percent of all shallow-draft vessels while the remaining 22 vessels are distributed among 13 different other companies.

Table 3-3. Columbia and Snake River Shallow Draft Vessels, Summary of Characteristics of Different Vessels—1995.

Vessel Type	Characteristics	# of Different Vessels	% of Total Vessels	Total (in Tons) Transported	% of Total (in Tons) Transported	# of Trips	% of Total Trips	Vessel Capacity (tons) Average	Largest	Smallest	Most Common Capacity (# of)
Dry Cargo	Open Hopper Barge	19	9.6	1,088,293	10.1	807	10.3	2,150	3,500	1,000	1,700 (4)
	Covered Hopper Barge	23	11.6	1,754,075	16.2	583	7.4	3,150	4,000	1,800	3,000 (7)
	Flat/Deck Barge	32	16.2	603,302	5.6	919	11.7	2,450	8,400	550	2,000 (4)
	Open Dry Cargo Barge	25	12.6	1,036,440	9.6	604	7.7	2,300	4,300	900	3,000 (6)
	Covered Dry Cargo Barge	42	21.2	1,806,940	16.7	2,337	29.8	1,700	4,300	600	600 (9)
	Container Barge	1	0.5	20,265	0.2	22	0.3	2,400	2,400	2,400	2,400 (1)
Tanker	Single hull Liquid Cargo	49	24.7	4,090,990	37.8	2,308	29.5	2,700	4,800	750	3,600 (10)
	Double Hull Liquid Cargo	2	1.0	149,362	1.4	133	1.7	2,100	2,500	1,750	-
	Other Liquid, NEC	5	2.5	270,682	2.5	122	1.6	3,600	5,950	2,500	2,500 (2)
Total		198	100	10,820,349	100	7,835	100				

Table 3-4. Columbia and Snake River Shallow Draft Vessels, Tonnage and Number of Vessel Trips, by Company—1995.

Company	Total Number Vessels Operated	Number of Barges	Number of Tankers	Tons	% of Total Tons	Trips	% of Tot. Trips
TIDEWATER BARGE LINES, INC.	72	29	43	5,588,539	51.6	2,674	34.1
JAMES RIVER / WESTERN TRANSPT.	36	36	0	1,268,692	11.7	2,305	29.4
SHAVER TRANSPORTATION CO.	14	14	0	1,150,500	10.6	368	4.7
SAUSE BROS. OCEAN TOWING CO.	5	5	0	41,148	0.4	11	0.1
BRIX MARITIME CO.	24	18	6	886,214	8.2	1,290	16.5
BERNERT BARGE LINES	14	14	0	519,185	4.8	364	4.6
SDS LUMBER CO.	5	5	0	310,400	2.9	125	1.6
ROSS ISLAND SAND & GRAVEL CO.	6	6	0	54,450	0.5	121	1.5
OTHER COMPANIES (13)	22	15	7	1,001,190	9.3	577	7.4
Total (1995)	198	142	56	10,820,318	100	7,835	100

Note: Since these data were assembled, Tidewater Barge Lines has purchased Western Transportation, and Foss Maritime Co has purchased Brix Maritime.

Although over 45 different commodities were transported in 1995, a relative few constituted the majority of total tonnage shipped. Over 80 percent of the tonnage transported were agriculture commodities, paper/paperboard, wood material/products, and fuel oils.

3.4 OTHER TRANSPORT MODES

Both rail and truck provide alternative or complementary modes of commodity transport within the Columbia Basin. Grain moved to export elevators via rail is normally delivered by truck to country elevators where it is loaded on rail cars. Within the study area, Union Pacific and Burlington Northern Railroads, both Class 1 carriers, are the predominant rail companies. Rail classes are determined by the track and grade, rather than operating characteristics. BN and UP both run north-south in Western Washington, but BN is predominantly an east-west line through Washington. They are connected to Idaho via lines that run through Pasco and Spokane. The rail freight system has three types of inter-modal connections, ports (deep-water marine and river), road terminals, and shipper connections such as grain elevators.

At the present time, only one facility in the four Northwest states, located at Bliss, Idaho, is designed to assemble 100-car unit trains. Snake River region grain shippers, however, do not use this type of unit train, nor do they use private covered hopper cars. However, there are a number of grain storage/handling facilities in the region that are designed to load and assemble 25-26 (or more) car trains. These facilities are primarily used for shipping grain by rail to export elevators. However, the majority of grain from the Camas Prairie area of Idaho is moved from that area to the Snake River for transshipment by barge from the ports of Lewiston and Wilma. In addition, occasionally all rail shipments are made to the export terminals.

The region is also served by a number of short-line railroads. In contrast to the Class 1 carriers, the short-line railroads serve as secondary or feeder rail lines and carry low-traffic volumes and do not provide the same levels of maintenance, infrastructure, and rail car capacity. Additional information on the short-line railroads is presented in Section 6 along with an assessment of the impact of drawdown on these railroads.

For the period 1988 – 1997, volume of all grain movements to lower Columbia River export elevators, averaged nearly 11 million tons annually, with a high of about 12.7 million tons in 1988 and a low of about 8.7 million tons in 1997. Table 3-5 below provides data on historical monthly grain rail movements for the period 1988 – 1997.

Table 3-5. Historical Monthly Grain Rail Movements to Export Elevators (Lower Columbia River).

All Grain (tons)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average 1988 –97
Jan	927,575	994,291	1,230,034	922,564	835,396	748,066	805,010	826,870	1,470,507	1,103,483	986,380
Feb	1,469,373	820,493	1,102,078	899,745	1,266,872	921,710	801,012	877,534	1,183,701	1,162,380	1,050,490
Mar	1,293,514	1,195,215	940,799	958,358	1,014,436	944,311	783,986	904,822	1,399,886	837,873	1,027,320
Aprl	1,346,114	1,250,633	1,070,023	772,256	841,797	729,346	648,567	700,903	1,187,859	724,676	927,217
May	1,286,842	1,257,592	793,874	444,273	535,352	540,051	479,048	828,314	602,855	515,375	728,358
June	655,528	825,333	799,184	795,108	604,410	463,480	446,856	1,130,972	701,969	338,426	676,127
July	803,918	627,873	957,916	697,323	743,502	654,157	698,606	1,014,790	614,127	430,029	724,224
Aug	880,681	1,040,544	1,040,852	538,546	755,066	800,818	539,588	1,328,258	996,257	907,917	882,853
Sept	825,639	1,051,814	733,700	1,118,522	787,101	1,089,308	813,505	1,440,141	788,166	755,326	940,322
Oct	1,044,959	804,804	1,046,917	876,943	841,164	910,086	1,087,376	1,114,790	961,933	862,810	955,178
Nov	930,016	1,148,151	1,193,270	854,614	983,352	879,592	1,185,608	971,308	983,415	726,361	985,569
Dec	1,227,405	1,282,020	797,506	1,006,852	973,668	1,175,352	1,517,071	960,731	930,854	349,115	1,022,057
Total	12,691,564	12,298,763	11,706,153	9,885,104	10,182,116	9,856,277	9,806,233	12,099,433	11,821,529	8,713,771	10,906,094

During the last decade, rail grain traffic from all sources has remained relatively constant at Portland. Traffic has declined at Seattle and exhibited substantial cyclical fluctuations at Tacoma. Vancouver has experienced sustained increases in rail throughput, while Longview has ceased as a point of grain exports. The most dramatic change in rail traffic during the 1980's was the increase in volume of mid-west corn moving to Kalama, Washington for export. Receipts of wheat and barley at lower Columbia export elevators by mode of transportation for the period, 1980-81 to 1996-97, are shown below in Table 3-6. As the data shows, receipts by rail have increased from about 50 percent of the total in 1980-81 to 55 percent in 1996-97. During the same period, barge receipts declined slightly from 44.1 percent to 43.2 percent and truck receipts declined significantly from nearly 6 percent to just 1.7 percent.

Table 3-6. Receipts of Wheat and Barley at Columbia River Export Houses – By Mode of Transportation.

(Thousands of Bushels)

Crop Year	Rail	%	Barge	%	Truck	%	Total
80-81	247,686	50.20%	217,687	44.10%	28,024	5.70%	493,397
81-82	227,475	49.30%	205,289	44.50%	28,681	6.20%	461,245
82-83	203,748	50.90%	170,254	42.60%	26,054	6.50%	400,056
83-84	229,029	54.80%	171,542	41.00%	17,234	4.10%	417,985
84-85	215,575	53.20%	169,235	41.80%	20,123	5.00%	404,933
85-86	178,411	57.40%	116,722	37.50%	15,819	5.10%	310,952
86-87	233,612	60.00%	140,075	36.00%	15,720	4.00%	389,407
87-88	274,825	55.90%	199,855	40.60%	17,032	3.50%	491,712
88-89	247,441	53.80%	198,185	43.10%	14,707	3.20%	460,333
89-90	226,714	56.20%	165,197	40.90%	11,798	2.90%	403,709
90-91	254,514	57.30%	179,528	40.40%	10,505	2.40%	444,547
91-92	251,942	59.60%	162,067	38.40%	8,406	2.00%	422,415
92-93	267,143	61.60%	155,888	36.00%	10,456	2.40%	433,487
93-94	317,299	61.90%	185,589	36.20%	9,353	1.80%	512,241
94-95	315,989	63.00%	176,540	35.20%	9,282	1.80%	501,811
95-96	343,136	59.40%	227,163	39.30%	7,564	1.30%	577,863
96-97	258,778	55.00%	203,353	43.20%	8,055	1.70%	470,186
Average	252,548	56.52%	179,069	40.07%	15,224	3.41%	446,840

Source: EWITS Working Paper No. 9.

Trucks are also used for non-grain commodity transport, particularly for movement of petroleum and chemical products to inland destinations. In the case of grain shipments, they are used almost exclusively in moving grain from farm to country or river elevators, country elevators to river elevators and also to transport upbound products arriving at river terminals to their final destinations.

Presented in Table 3-7 below is a listing of types of grain transport modes and the respective capacity of each in terms of both bushels and tons.

Table 3-7. Transportation Mode Comparison – Grain Movements

Mode	Ton Capacity	Bushel Capacity (Wheat)*
Barge	3,600	120,000
5-Barge Tow	18,000	600,000
Jumbo Hopper Rail Car	100	3,300
26-Car Unit Train	2,600	85,800
100-Car Unit Train	10,000	333,000
Large Semi-Truck	26	870
* Note that wheat weighs 60 lbs/bushel, while corn weighs 56 lbs/bushel.		

4. WATERBORNE COMMERCE

4.1 COLUMBIA RIVER DEEP-DRAFT CHANNEL

The Columbia River serves an extensive region that covers much of the western United States. Within the region a variety of commodities, foodstuffs, and other products are produced. Of those industries within the region that generate waterborne commerce, agriculture predominates, particularly with respect to the production of grains such as wheat and barley. In addition, corn, which is produced outside of the region, represents a significant volume of shipments from export terminal on the lower Columbia River. Other regional industries that utilize water to transport products include aluminum, pulp and paper, petroleum products, and logs and wood products.

In terms of volume, wheat and corn represent the major share of total commodities shipped on the deep draft segment of the Columbia River channel. Other products include autos, containerized products, logs, petroleum, chemicals and other miscellaneous products. Countries involved in the region's export trade are Japan, Korea, and Taiwan, as well as other Pacific Rim countries. The amount of export products shipped via the Columbia River to the top five countries during 1996 is shown in Table 4-1, below.

Table 4-1. Columbia River Exports: Top Five Destinations, Commodities and Tonnage, 1996.

Country	Export Commodities	Short Tons
Japan	Wheat, Logs, Corn, Other	10,534,959
Korea	Wheat, Corn, Soda Ash, Other	3,818,321
Taiwan	Corn, Wheat, Soda Ash, Other	2,497,543
Philippines	Wheat, Corn, Soybeans, Other	2,357,663
Pakistan	Wheat, Metal Scrap, Metal, Other	2,049,207

Source: The Great Waterway 1998

Columbia River export products ranked by tonnage are displayed below in Table 4-2 for the years 1994-96. Many of these commodities, principally wheat, barley, logs and lumber, utilize the inland waterway for delivery to deep draft export terminals and ultimately, to world markets.

Table 4-2. Major Export Items from the Columbia River (short-tons).

Commodity	Volume--1994	Volume—1995	Volume--1996
Wheat	15,328,078	14,852,369	13,909,868
Corn	1,888,796	7,968,168	4,905,536

Soda Ash	1,908,876	2,065,167	2,087,820
Logs	2,315,157	2,089,069	1,932,084
Coke	570,856	617,184	663,859
Barley	215,703	1,060,327	594,814
Beet Pulp Pellets	402,800	415,457	403,018
Lumber	447,603	459,375	398,061
Soybeans	72,841	642,861	213,857
Potash	306,125	669,623	187,077
Totals	**23,456,835**	**30,839,600**	**25,295,994**
Other	2,988,042	3,192,492	2,820,825
Total Exports	**26,444,877**	**34,032,092**	**28,116,819**

Source: The Great Waterway, 1998.

4.2 COLUMBIA-SNAKE SHALLOW-DRAFT SYTEM

Products shipped on the shallow draft segment of the river system consist principally of grain, wood products, logs, petroleum, chemicals, and other agricultural products. Bulk shipments make up much of the waterborne traffic on the upstream channel. A number of commodities, principally non-grain agricultural and food products and paper products, are shipped via container. Containers are typically loaded at Lewiston, Idaho, on the Snake segment, and Pasco, Washington, and Boardman and Umatilla, Oregon on the Columbia segment. Approximately 97 percent of down-bound container shipments are destined for Portland, Oregon with the remainder going to Vancouver, Washington. Historically, the bulk of upriver barge shipments have been made up of petroleum products.

Commodity transport on the lower Snake River is dominated by grain, with wheat and barley making up approximately 75 percent of the tonnage moving downstream. Due to the relatively insignificant volume of up-bound commerce on this segment, wheat and barley represent a similar portion of the total tonnage shipped. Between 1969 and 1989, annual tonnage shipped on the Snake River grew almost ten-fold. During that period, the trend in the growth of annual commercial tonnage recorded for the Snake displayed a step-wise function, with shipments increasing from less than 1 million tons per year before 1971 and increasing to 1.7 million tons between 1972 and 1974; nearly 3 million tons in 1976 and 1977; and, nearly 4 million tons in 1978 and 1979. By 1980 commerce on the system had stabilized at approximately 5 million tons. The peak year, 1988, in which over 7 million tons were handled, was due to an unusually high rate of West Coast export grain sales, due in part to drought conditions on the Missouri River system which closed that system to most barge traffic. Table 4-3 provides a tabulation of annual commodity tonnage passing through the Snake River locks for the period 1992 through 1997. The locks are listed in order of downstream to upstream. These data are derived from the Lock Performance Monitoring System (LPMS) and show incremental volume by pool as well as the proportion of grain in relation to total tonnage. It should be noted that volumes shown vary slightly from comparable Waterborne Commerce Statistics’ data. This is due to variation in recording procedures for the respective data sets.

Table 4-3. Navigation Tonnage Summary by Project and Commodity, 1992--1997

Calendar Year 1992

Project	Paper & Pulp	Other Commodities	Petroleum	Wood Products	Grains	TOTAL
Ice Harbor	94,215	115,787	108,086	506,462	2,684,437	**3,508,987**
Lower Monumental	93,741	113,195	109,842	495,513	2,182,710	**2,995,001**
Little Goose	93,671	112,473	108,973	505,534	2,100,084	**2,920,735**
Lower Granite	93,472	84,273	108,896	493,587	1,081,119	**1,861,347**
Calendar Year 1993						
Project	**Paper & Pulp**	**Other Commodities**	**Petroleum**	**Wood Products**	**Grains**	**TOTAL**
Ice Harbor	83,861	120,367	128,682	806,296	2,766,151	**3,905,357**
Lower Monumental	84,397	122,313	128,682	797,907	2,272,092	**3,405,391**
Little Goose	84,713	116,277	128,682	797,747	2,178,861	**3,306,280**
Lower Granite	82,033	75,232	128,682	795,723	1,118,818	**2,200,488**
Calendar Year 1994						
Project	**Paper & Pulp**	**Other Commodities**	**Petroleum**	**Wood Products**	**Grains**	**TOTAL**
Ice Harbor	110,130	129,470	129,332	709,529	3,201,376	**4,279,837**
Lower Monumental	108,002	125,475	129,312	712,596	2,602,821	**3,678,206**
Little Goose	108,008	126,259	129,312	711,721	2,467,385	**3,542,685**
Lower Granite	107,126	106,879	129,312	709,590	1,260,679	**2,313,586**
Calendar Year 1995						
Project	**Paper & Pulp**	**Other Commodities**	**Petroleum**	**Wood Products**	**Grains**	**TOTAL**
Ice Harbor	126,335	113,127	143,430	696,243	3,496,521	**4,575,656**
Lower Monumental	126,965	109,065	143,430	698,134	2,846,152	**3,923,746**
Little Goose	129,457	107,849	143,430	698,167	2,697,353	**3,776,256**
Lower Granite	127,137	84,500	143,430	699,709	1,359,507	**2,414,283**
Calendar Year 1996						
Project	**Paper & Pulp**	**Other Commodities**	**Petroleum**	**Wood Products**	**Grains**	**TOTAL**
Ice Harbor	38,683	98,754	99,532	508,837	2,817,513	**3,563,319**
Lower Monumental	38,615	104,876	95,228	505,988	2,352,689	**3,097,396**
Little Goose	38,613	102,757	95,228	510,601	2,164,690	**2,911,889**
Lower Granite	36,924	75,918	101,948	508,510	1,054,893	**1,778,193**
Calendar Year 1997						
Project	**Paper & Pulp**	**Other Commodities**	**Petroleum**	**Wood Products**	**Grains**	**TOTAL**
Ice Harbor	95,480	152,348	112,049	579,401	3,266,100	**4,205,378**
Lower Monumental	93,147	148,511	110,565	2,026,398	2,744,093	**5,122,714**
Little Goose	92,828	149,844	110,565	579,861	2,247,109	**3,180,207**

Lower Granite	91,782	122,588	110,365	585,156	1,040,822	**1,950,713**
NOTE: 1 January through 9 March, 96, Ice Harbor navigation lock out of service to replace the downstream lift gate.						

Source: Lock Performance Monitoring System, Corps of Engineers.

4.3 AGGREGATION OF COMMODITIES

As discussed in Section 2, an initial task for this study was to identify appropriate commodity aggregations for use in the analysis, and in particular for the transportation line haul cost estimates. It was important to capture both the high tonnage commodities and those commodities with unique transportation requirements, while minimizing the total number of commodity groups to a manageable level for the analysis. Individual lock data obtained from the Navigation Data Center's Lock Performance Monitoring System (LPMS) database were reviewed at a 2-digit commodity code level. At this level, the number of different commodity groups ranged from 19 at Lower Granite in 1997 to 37 at The Dalles in both 1996 and 1997. Lock data averaged for 1991-95 indicated 36 2-digit commodity groups. Internal waterway traffic at the segment level (Columbia River: Mouth to International Boundary; and Snake River) was also reviewed at the 4-digit commodity level from Waterborne Commerce Statistics Center (WCSC) published data. Based on the review of both data sets, 10 commodity aggregations were derived. WCSC was then requested to provided origin/destination data for a 10-year period (1987-96), by port area, to be used for the barge line haul cost analysis. The commodity groups and the 4-digit commodity aggregations they represent are shown in Table 4-4.

Table 4-4. Columbia/Snake River System Commodity Aggregations

Commodity Group	Commodities Included at 4-Digit Level	Commodity Codes at 4-Digit Level
1. Wheat and Barley	Wheat; barley; rye	6241; 6443
2. Other Food and Farm Products	Fish; corn; soybeans; vegetable products; processed grain and animal feed; other agricultural products	6100-6199; 6344; 6444-6899
3. Petroleum Products	Crude petroleum; gasoline; distillate; residual; other petroleum products	2100-2999
4. Wood Chips and Logs	Fuel wood; wood chips; wood in the rough; lumber; forest products NEC	4100-4199
5. Wood Products	Pulp and waste paper; paper products; primary wood products	4200-4299; 5100-5199; 5500-5599
6. Chemicals	(fertilizers, other chemicals and related products,	3100-3299)
7. Metals	Iron ore and scrap; primary iron and steel products; primary non-ferrous metal products	4400-4499, 5300-5499
8. Soil, Sand, Gravel, Rock and Stone	Soil, sand, gravel, rock and stone	4300-4399
9. Containers, Empty	Containers, empty	7800
10. All Other	Sulfur; clay, salt; other non-metal minerals; lime, cement, glass; manufactured equipment; machinery & products; waste & scrap nec	4700-4999; 5200-5299; 7100-7799; 7900-8999

The data obtained from WCSC also included the following details for each aggregated commodity movement origin-destination pair:

1. Year Shipped
2. Month Shipped
3. Shipping Location Port Code (5-digit)
4. Shipping Location Port Name
5. Receiving Location Port Code (5-digit)
6. Receiving Location Port Name
7. Commodity Group
8. Commodity Group Tons
9. Direction (Upbound/Downbound)

A summary of tonnage derived from the WCSC data for 1992 – 1996 by year and commodity group is shown in Table 4-5.

Table 4-5. Summary Tonnage by Commodity Group for CSRS, 1992 - 1996

Commodity Group	Tons (000)				
	1992	1993	1994	1995	1996
1. Wheat and Barley	4612.9	4902.3	5671.4	5883.3	5710.4
2. Other Food and Farm Products	96.2	73.5	103.5	107.2	101.9
3. Petroleum Products	1567.1	1746.1	1693.1	2164.6	2023.2
4. Wood Chips and Logs	1837.3	2130.8	2056.4	1779.2	1281.9
5. Wood Products	61.3	44.7	63.1	73.4	28.1
6. Chemicals	290.5	341.3	359.5	279.0	202.1
7. Metals	1.1	1.0	4.4	39.3	10.3
8. Soil, Sand, Gravel, Rock and Stone	634.0	193.9	1.3	54.4	35.4
9. Containers, Empty	42.3	46.5	55.0	64.5	141.7
10. All Other	160.6	179.2	195.1	189.7	240.1
Total	9303.2	9658.0	10203.0	10634.5	9775.2

To facilitate the analysis, these groups were further consolidated as follows: grain, petroleum products, wood chips and logs, wood products, and other products (including containerized shipments). The final aggregation of commodities used in modeling transportation, storage and handling costs for transporting commodities without and with drawdown of the Snake River is shown below in Table 4-6. Tonnage for the years 1992—1996 is also shown.

Table 4-6. Final Aggregation of Commodities Used in Transportation System Modeling Studies.

Commodity Group	Tons (000)				
	1992	1993	1994	1995	1996
Grain	4,612.9	4,902.3	5,671.4	5,883.3	5,710.4
Petroleum Products	1,567.1	1,746.1	1,693.1	2,164.6	2,023.2
Wood Chips and Logs	1,837.3	2,130.8	2,056.4	1,779.2	1,281.9
Wood Products	61.3	44.7	63.1	73.4	28.1
Other	1,224.7	761.9	615.3	626.9	629.6
Total	9,303.3	9,585.8	10,099.3	10,527.4	9,673.2

4.4 PROJECTED GROWTH

Growth projections were prepared by IWR for the major commodity groups that are presently shipped on the lower Snake River. Historical data for Snake River shipments were compiled for aggregated commodity groupings for the period 1987 through 1996. This data set was used as the basis for projecting future growth. Projections were initially established at 5-year increments to encompass a 20-year period, 2002 through 2022. For the breaching option, the implementation date is estimated to be 2007, therefore, the evaluation utilized projections for the period 1997 to 2017, with growth held constant thereafter. The rationale and basis for estimating future growth in volume for the respective commodity groups is described below. Table 4-7 displays historical waterborne commerce with origins or destinations on the Snake River above Ice Harbor Lock and Dam for the period 1987 – 1996.

Table 4-7. Snake River Waterborne Commerce with Origins or Destinations above Ice Harbor Lock & Dam--1987-1996 (1,000 tons).

Commodity	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Avg
Wheat & Barley	2906	3981	2532	3109	3241	2612	2706	3135	3471	2821	3051.4
Other Farm	80	61	187	142	121	25	17	32	27	36	72.8
Wood Chips & Logs	461	394	320	304	375	500	854	910	857	530	550.5
Wood Prod	46	52	45	42	74	61	45	58	68	28	51.9

Petroleum	117	105	115	108	106	108	129	137	144	95	116.4
Chemicals	5	6	6	4	33	34	35	23	25	27	19.8
Sand & Gravel	0	0	0	0	0	16	0	1	0	0	1.7
Metals	0	0	0	13	0	0	0	3	16	5	3.7
Empty Containers	10	57	10	7	5	5	5	11	8	11	12.9
All Other	1	3	0	0	0	0	0	4	6	6	2
Total	**3509**	**4659**	**3215**	**3729**	**3955**	**3361**	**3791**	**4314**	**4622**	**3559**	**3871.4**

4.3.1 Wheat and Barley.

Projections for wheat and barley movements were based on the historic relationship between Snake River origin traffic and exports from the Lower Columbia deepwater ports. The origin/destination data for wheat and barley indicate that virtually all of the traffic that originates above Ice Harbor Lock & Dam moves from one of the Snake River ports of Lewiston (Clearwater River), Clarkston, Wilma, Almota, Central Ferry, Lyons Ferry, Windust, or Sheffler. The down-river destination of these movements is the Lower Columbia at Portland, Vancouver or Kalama, where it is then transshipped to deep draft vessels for export. Projected wheat and barley traffic on the Snake River was therefore linked to projected wheat and barley exports from the Lower Columbia. The projected exports were obtained from the report, “Columbia River Channel Deepening Feasibility Study, Commodity Projections, Final Report,” prepared by Jack Faucett Associates (JFA), in association with BST Associates and The WEFA Group, for the U.S. Army Corps of Engineers, Portland District, February 1996. The basis or starting point for these forecasts is average exports of wheat and barley over the period the 10-year period from 1987 to 1996, inclusive.

Historic wheat and barley exports from the Lower Columbia are compared with shallow draft wheat and barley shipments from the Snake River above Ice Harbor in Table 4-8. As the data shows, during the 1987 – 1996 period, shipments on the Snake River averaged about 23.4 percent of wheat and barley exports from the lower Columbia River and ranged from a high of 26.5 percent share in 1991 to a low of a 20.2 percent share in 1992. This is a relatively low range with fluctuations from year-to-year probably being driven by variations in grain production among the regions. Also shown in the table is the year-to-year change in percent share for the Snake River.

The data for the Snake River's percent share of wheat and barley export and the change in share from year-to-year suggests that the current transportation system is in relative equilibrium, meaning that there does not appear to be a shift among modes of transportation from one year to the next.

Table 4-8. Wheat and Barley Exports From the Lower Columbia Compared With Shipments From the Snake River Above Ice Harbor, 1987-1996. (000 tons)

Wheat & Barley	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Avg.
Lower Columbia Exports	12,085	14,945	10,458	11,778	12,233	12,762	13,428	14,908	14,603	13,691	13,089
Snake River Shipments	2906	3981	2532	3109	3241	2612	2706	3135	3471	2821	3,051
Snake River Percent	24.0%	26.6%	24.2%	26.4%	26.5%	20.5%	20.2%	21.0%	23.8%	20.6%	23.38%
Change in Percent	--	2.6%	-2.4%	2.2%	0.1%	-6.0%	-0.3%	0.9%	2.7%	-3.2%	

The average Snake River share of 23.38 percent of exports of wheat and barley from the lower Columbia River is used as the basis for forecasting future wheat and barley movements on the Snake above Ice Harbor. The forecast was made by applying this percentage to projected exports for wheat and barley developed for the JFA Columbia River deepening study. It should be noted that for the years compared, 1987 through 1996, there is a slight average decline in share for the Snake River origins at a rate of -0.38%. However, if the period 1987-1995 is assessed, the decline is insignificant, at only -0.03%, indicating the impact of the -3.2% decline in 1996. Analysis of the data, excluding 1996, showed that the average share for 1987-1995 is still only 23.7% (versus 23.38% if 1996 is included). Since this relatively insignificant change was the result of data for just one year, IWR analysts concluded that the slight trend toward a declining share could be ignored. Therefore, the overall Snake River share of exports was held constant at 23.38% of projected exports of wheat and barley for the lower Columbia River for purposes of developing Snake River projections of grain shipments in this study.

The results of applying the 23.38% share for Snake River projections to the export forecasts in the JFA Columbia River report are shown in Table 4-9.

Table 4-9. Projected Snake River Share of Forecast Wheat & Barley Exports off the Lower Columbia. (000 tons)

Wheat & Barley	1996	2000	2004	2010	2014	2020	2024	2030
Projected Lower Columbia Exports								
Low		12,136	10,580	10,577	10,575	11,108	11,463	12,795
Base	13,691	14,971	16,251	16,246	16,243	17,061	17,607	19,653
High		17,807	21,922	21,915	21,910	23,014	23,750	26,510
Projected Snake River Shipments Based on 23.38% Share								
Low		2,837	2,474	2,473	2,472	2,597	2,680	2,992
Base	2,821	3,500	3,800	3,798	3,798	3,989	4,117	4,595
High		4,163	5,125	5,124	5,123	5,381	5,553	6,198

It should be noted that characterizing the JFA export forecasts as "Low", "Base" and "High" is somewhat misleading. The study actually applied risk analysis to develop a range of probable future exports from the minimum likely to the maximum likely, based on historic variation. From this perspective, the forecast "Base" is actually the forecast with the maximum likelihood, while the "Low" and "High" represent the minimum and maximum likely extremes to the forecast in any given year. The forecast used in this study is the base or medium forecast.

4.3.2. Wood Chips & Logs

In terms of tons, the next largest commodity group using the Snake River above Ice Harbor, after wheat & barley, is wood chips & logs (see Table 4-5). Between 1987 and 1996, shipments of wood chips and logs varied between a low of 303,800 tons (1990) and a high of 909,600 (1994), with a weighted average of 716,100 tons for the period 1991-1996. Although 1997 data were not available as this report was being compiled, data from the Lock Performance Monitoring System (LPMS) suggest 1997 wood chips & logs traffic was about 594,000 tons at Lower Granite Lock & Dam. Using this information as a proxy for 1997 movements on the Snake River above Ice Harbor, it appears this commodity group recovered some of the traffic lost in 1996, but not to the robust traffic levels of the 1993-1995 period. Adding in the 1997 estimate to the weighted-average base traffic calculation reduces this value to 694,200 tons. This is the amount carried forward into the forecast analysis.

With an R-squared of .37, the historic data for 1987-1997 do not indicate a clear linear trend that could be used for credible forecasting. The traffic in wood chips & logs appears to vary around an average level, increasing or decreasing with market conditions, but without the prospect of sustained long term positive growth. This assessment has generally been confirmed in conversations between Portland District and commercial shippers who have reported future traffic expectations as “flat” or stable. For this reason, the forecast for wood chips & logs has been held steady at the adjusted (to include the 1997 estimate) weighted average of 694,200 tons. Since no growth is being forecast for the base traffic, these figures are the same in each forecast year.

4.3.3. Petroleum Products

Petroleum products are the third largest commodity category on the Snake above Ice Harbor. Most of this traffic originates in the Portland area and moves upriver to a terminal at Wilma. It appears this traffic is driven by the demand for petroleum products by commercial and residential consumers in the Snake River hinterland and by the relative competitiveness of alternate supply regions and modes. Traffic has fluctuated between a high of 143,500 tons in 1995 and a low of 95,000 tons just one year later in 1996. Until the 1996 downturn, traffic levels had increased steadily from 1991 to 1995 by nearly 35%. The 1996 downturn erased all of this growth. LPMS data suggest 1997 traffic recovered to about 110,400 tons. Conversations with terminal managers indicated that shipments of petroleum by barge tend to decline when excess refinery production in the Great Plains and Rocky Mountain regions further east becomes available by pipeline in the Spokane area. From there petroleum products can be trucked in competitively. When those supply routes tighten and prices increase, barged petroleum from the Portland area becomes more competitive.

The forecast assumes these competitive supply dynamics will continue in the future, but with a generally upward trend in barge traffic as the demand for petroleum products in the Snake River hinterland increases with general population and economic growth. Historic population data for the Snake River hinterland counties indicates an average annual increase of 1.4% since 1980 and 1.7% since 1990, as shown below in Table 4-10.

Table 4-10. Snake River Hinterland Population by County, 1980-1996, (1,000s).

State/County	1980	1990	1991	1992	1993	1994	1995	1996
IDAHO								
Clearwater	10.4	8.5	8.6	8.7	8.8	9.1	9.2	9.4
Idaho	14.8	13.8	13.9	14.2	14.3	14.6	14.9	17.9
Latah	28.7	30.6	31.2	31.3	31.8	32.5	32.9	33.2
Lewis	4.1	3.5	3.6	3.6	3.8	3.9	4.0	4.0
Nez Perce	33.2	33.8	34.5	35.1	35.7	36.2	36.5	36.7
OREGON								
Umatilla	58.9	59.2	60.1	61.1	63.0	64.0	65.2	65.2
Union	23.9	23.6	24.0	24.0	24.3	24.5	24.4	24.4
Wallowa	7.3	6.9	7.0	7.2	7.2	7.2	7.3	7.3
WASHINGTON								
Adams	13.3	13.6	13.8	14.1	14.3	14.6	15.2	15.4
Asotin	16.8	17.6	17.8	18.0	18.3	18.9	19.1	19.6
Columbia	4.1	4.0	4.0	4.0	4.1	4.2	4.2	4.2
Franklin	35.0	37.4	38.6	39.2	41.1	42.9	44.0	43.7
Garfield	2.5	2.2	2.3	2.3	2.3	2.4	2.4	2.4
Walla Walla	47.4	48.4	49.3	50.5	51.8	52.6	52.7	53.4
Whitman	40.1	38.8	38.5	38.8	39.4	39.8	40.5	41.0
TOTAL	340.5	342.1	347.1	352.0	360.1	367.3	372.3	377.7
Annual Change		0.05%	1.5%	1.4%	2.3%	2.0%	1.4%	1.5%
Average Change 80-96								1.4%

Based on the apparent recovery in up-bound barge movements of petroleum to about 110,000 tons in 1997, the annual growth between 1987 and 1997 is 1.38%, or approximately the same as the 1.4% average annual growth rate in population. Applying this annual growth rate to the weighted average barge traffic of 118,400 tons, and applying a 90% confidence interval, results in the forecast for petroleum products on the Snake River above Ice Harbor shown in Table 4-11.

Table 4-11. Projected Snake River Petroleum Products -- Traffic Above Ice Harbor (1,000 tons)

Petroleum Products Forecast	Wtd Avg 1991-97*	2002	2007	2012	2017	2022
Low (Min)		102	109	117	125	134
Base	118.4	127	136	145	156	167

High (Max)		151	162	174	186	199

For petroleum products, the 90% confidence interval was determined by calculating the standard deviation of the 1987-1997 traffic (14,088.3) and multiplying this figure by 1.64 for the 90% interval (+/-23,104.8). This interval represents +/-19.5% of the weighted-average (118,400). Therefore, the high (max) and low (min) for each projection year were calculated as +/-19.5% of the base (maximum probability) projection.

4.3.4. Wood Products, Other Farm Products, & Empty Containers

The forecast of the growth in shipment of containerized products on the Snake River above Ice Harbor was developed from projections for container exports contained in the report, “Columbia River Channel Deepening Feasibility Study, Commodity Projections, Final Report,” prepared by Jack Faucett Associates (JFA), in association with BST Associates and The WEFA Group, for the U.S. Army Corps of Engineers, Portland District, February 1996. Projections developed for that report were used as a proxy to develop projections for containerized movements on the Snake River above Ice Harbor Lock and Dam.

Of the commodity categories being assessed in the present analysis, it was observed that “Other Farm Products” (that is, all farm products other than wheat and barley) and “Wood Products” (including pulp and waste paper, paper products, and primary wood products) were most likely to be containerized. In order to adapt projections of container traffic using the Lower Columbia into projections for the Snake River, a first step was to assess the contribution of Snake River container movements to total containers handled on the Lower Columbia. Table 4-12 shows container TEUs (Twenty-foot Equivalent Units) and tons handled on the Lower Columbia, and the share of container exports delivered by barge as reported by the Port of Portland.

Table 4-12. Lower Columbia River Container Movements and Barge Share of Exports (1,000s).

Container TEUs	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Outbound	84.2	92.9	86.7	99.6	115.4	124.3	107.9	118.4	138.0	171.7	221.1	226.4	200.7	186.6
Inbound	41.6	45.0	38.3	40.2	49.2	61.7	55.0	57.6	62.9	67.8	96.8	103.3	101.5	108.3
Total	125.8	137.9	125.0	139.8	164.6	186.0	162.9	175.9	200.9	239.4	318.0	329.7	302.2	294.9
Outbound %	67.0%	67.3%	69.3%	71.2%	70.1%	66.8%	66.2%	67.3%	68.7%	71.7%	69.6%	68.7%	66.4%	63.3%
Container T	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Outbound	1037.0	1156.7	1175.9	1393.2	1592.7	1648.8	1440.0	1626.7	1826.5	2240.9	2935.9	3005.9	2664.4	2477.7
Inbound	312.0	263.7	230.5	262.9	263.2	231.6	196.5	202.7	328.2	297.3	500.8	534.5	524.9	560.1
Total	1349.0	1420.5	1406.4	1656.2	1855.9	1880.4	1636.5	1829.4	2154.7	2538.2	3411.0	3537.5	3241.6	3163.9
Outbound %	76.9%	81.4%	83.6%	84.1%	85.8%	87.7%	88.0%	88.9%	84.8%	88.3%	85.0%	85.0%	85.0%	85.0%

Barge Share (%)	17%	17%	16%	15%	15%	17%	18%	15%	16%	14%	10%	10%	11%	16%

Source: Jack Faucett Associates and Port of Portland.

The barge share of traffic varies between 10 and 18 percent. However, the Port of Portland reports that the shares between 1994 and 1996 were extraordinarily low and should be discounted. Port of Portland analysts suggest discounting data for these years because the decrease was due to a combination of unlikely events, including the following: (1) the arrival of new carrier services at the port caused a surge in rail-handled containers and (2) a temporary discontinuation of calls at Portland by the contract ocean vessel service of a key barge shipper at Lewiston, resulting in a temporary diversion of their containers to Puget Sound by rail. The weighted-average barge share, discounting 1994-1996, is 15.7%, or rounded to 16%. The extreme minimum and maximum values, other than 1994-1996, are 14% to 18%. For purposes of this analysis, therefore, a base barge share of 16% of projected container traffic was used, with low and high ranges projected as 14% and 18%, respectively. By way of comparison, the Port of Portland is projecting a future 15-20% share of container exports to arrive by barge.

The Port of Portland also reported actual box counts (not TEUs) for total CSRS barge container movements and for Lewiston origin movements. These shallow draft container movements are shown in Table 4-13.

Table 4-13. Columbia/Snake River System Movements of Containers by Barge—1993-1997..

Containers	1993	1994	1995	1996	1997
Total CSRS Boxes	25,424	24,313	25,327	24,149	33,043
Lewiston-Origin Boxes	9,482	11,248	9,660	5,971	13,418
Lewiston %	37.3%	46.3%	38.1%	24.7%	40.6%
Weighted Average %					40.7%

Discounting for 1996, when significant containers were diverted to rail due to the loss of contract service, the weighted-average share of CSRS container-on-barge traffic attributable to Lewiston is 40.7%, or rounded to 41%. The Port of Portland reports that a "box" is generally equivalent to about 1.75 TEUs, due to the mix of sizes in the marine trade.

Carrying these percentages forward (i.e., CSRS having a 14-18% share of containers handled by Lower Columbia ports, and Lewiston-origin containers comprising 41% of CSRS containers), results in the CSRS and Lewiston-origin container projections shown in Table 4-14.

Table 4-14. Projected TEUs Handled on the Columbia/Snake River System.

TEUs Handled	1997	2000	2004	2010	2014	2024
Portland – Low	294,930	420,751	480,402	576,520	648,294	848,824
Portland – Base	294,930	427,128	492,675	601,531	676,674	905,366
Portland – High	294,930	441,113	517,156	656,100	747,109	1,019,649
Shallow CSRS – Low	57,825	59,798	68,975	84,214	94,734	126,751
Shallow CSRS – Base	57,825	68,340	78,828	96,245	108,268	144,859
Shallow CSRS – High	57,825	76,883	88,682	108,276	121,801	162,966
Lewiston – Low	23,482	24,512	28,280	34,528	38,841	51,968
Lewiston – Base	23,482	28,020	32,319	39,460	44,390	59,392
Lewiston – High	23,482	31,522	36,359	44,393	49,939	66,816
Growth Rate %		Mixed	3.6%	3.4%	3.0%	3.0%

The growth rates for containers developed in the above analysis were then used to project individual containerized commodities for the Snake River above Ice Harbor -- specifically, Other Farm Products, Wood Products and Metals. Historic traffic for each of these commodities and for empty containers was shown earlier in Table 4-7.

Base traffic forecasts for each of the four commodity groups were developed by applying the growth rates for containers from Table 4-14 to the weighted averages for each group. Variations in growth rates over time intervals were adjusted for the forecast years required for the drawdown study. Low (min) and high (max) ranges were developed for each forecast year by applying +/- the percentage of the weighted average represented by the 90% confidence interval analysis. The results are displayed in Table 4-15.

Table 4-15. Projected Tons of Wood Products, Other Farm Products and Empty Containers on the Snake River above Ice Harbor, (1,000 tons).

Commodity	Wtd Avg	2002	2007	2012	2017	2022
Wood Products						
Low (Min)	51.7	34.8	41.3	53.0	67.1	77.8
Base	51.7	66.2	78.6	100.7	127.6	147.9
High (Max)	51.7	97.6	115.9	148.5	188.1	218.0
Other Farm Products						
Low (Min)	30.6	25.8	30.6	39.2	49.6	57.5
Base	30.6	39.2	46.5	59.5	75.4	87.4
High (Max)	30.6	52.5	62.3	79.9	101.2	117.3
Empty Containers						
Low (Min)	8.4	6.2	7.3	8.6	9.9	11.5
Base	8.4	11.4	13.5	15.8	18.3	21.2
High (Max)	8.4	16.6	19.7	23.1	26.7	30.9

4.3.5. Chemicals

Chemical movements on the Snake River above Ice Harbor generally originate in the Portland area and move upriver to terminals at either Central Ferry (Little Goose pool) or Wilma (Lower Monumental pool). Most of the chemical traffic is either fertilizer (generally nitrogenous fertilizer) or ammonia. About 80% of the fertilizer tonnage exits the river at Central Ferry, while the remaining fertilizer and most of the ammonia continues upriver to Wilma.

As shown in Table 4-7, chemical movements were generally less than 6,000 tons until 1991.
Following 1991, chemical movements increased by nearly a factor of five. Traffic peaked in 1993 at 35,000 tons, then declined to between 23,000 tons in 1994 before rebounding to 26,600 tons in 1996. LPMS data for 1997 suggest chemical traffic has recovered to over 33,000 tons. The average for the years 1991-1996 is 27,600 tons. This is the amount that was used as the basis for projections of future growth.

As most of the chemical traffic is for agricultural purposes, the forecast for chemical traffic was linked to the projections for wheat and barley (which are linked, in turn, to wheat and barley exports). The ratio of chemical to wheat and barley tonnage on the Snake above Ice Harbor ranges from a low of 0.71% in 1995 (the peak tonnage year for wheat and barley) to a high of 1.30% in 1992. The average for the period is 0.93%. Applying this percentage relationship to the wheat and barley forecast (base, low and high) shown in Table 4-9 results in the chemical forecast displayed in Table 4-16. The chemical forecasts are based on the wheat & barley forecasts under the “without channel deepening” scenario for the Columbia River deep-draft channel.

An alternative method for developing projections was also evaluated other than applying 0.93% weighted average ratio of chemical traffic to all three scenarios for wheat and barley traffic. Instead, the 0.93% share was applied to just the base projection (maximum likelihood) for wheat and barley. Then the 90% confidence interval for historic chemical traffic was calculated as +/- 7,800 tons, or 28.03% of the weighted-average value of 27,600 tons. This approach is more consistent with the method for developing projections for most other commodities in this analysis. However, the result is a narrower projection envelope in the study out years, the period of the greatest uncertainty. In 2022, the high (max) value is reduced by 5.1% in 2022 and low (min) value is increased by 9.5%. Given the assumption that a wider projection envelope is inherently preferable due to uncertainty in the study out years, the projections developed for chemical traffic under the first approach discussed (i.e., applying the .93% share to all three wheat & barley forecast scenarios) were the projections ultimately retained for the analysis.

4.3.6. Summary

The results of the projections for each commodity group are summarized and totaled in Table 4-14. Each commodity group is shown with a High, Medium and Low value in each projection year of 2002, 2007, 2012, 2017, and 2022. The Medium value actually represents the “base” or “most likely” value, while the High represents the “likely maximum” value and the Low represents the “likely minimum” value expected. Totals shown are the total for each commodity group summed by projection scenario. The forecast for wheat and barley accounts for more than 70% of total traffic. Since these forecasts are based on the Lower Columbia deepening study, flat years in that study’s forecast are reflected in the projections for the Snake River above Ice Harbor. Total traffic is projected to grow from 3.6 million tons in 1996 to 4.6 million tons by 2002, equaling the peak years of 1988 and 1995. Traffic then is projected to level off between 2007 and 2012 at just over 4.8 million tons, then resume at a modest growth rate through 2017 and 2022, reaching 5.2 million tons. Depending on future unforeseen events, the minimum traffic level by 2022 could be as low as 3.4 million tons or as high as 7.1 million tons, but these are projected to be the extremes.

Table 4-16. Waterborne Traffic Projections for the Snake River above Ice Harbor Lock and Dam, 2002 - 2022.

(1,000 tons)

Commodity	Avg	2002			2007			2012			2017			2022		
		Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
Wheat & Barley	3019	2649	3647	4619	2473	3799	5125	2473	3798	5123	2534	3892	5250	2638	4052	5466
Wood Chips & Logs	716	404	694	984	404	694	984	404	694	984	404	694	984	404	694	984
Petroleum	118	102	127	151	109	136	162	117	145	174	125	156	186	134	167	199
Other Farm Prod	31	26	39	53	31	46	62	39	60	80	50	75	101	58	87	117
Wood Products	52	35	66	98	41	79	116	53	101	148	67	128	188	78	148	218
Chemicals	28	25	34	43	23	36	48	23	36	48	24	36	49	25	38	51
Containers (Empty)	8	6	11	17	7	14	20	9	16	23	10	18	27	12	21	31
All Other	14	1	13	27	1	14	28	1	16	30	5	19	33	8	21	36
Total	**3985**	**3248**	**4631**	**5992**	**3090**	**4817**	**6545**	**3119**	**4865**	**6611**	**3219**	**5018**	**6819**	**3356**	**5228**	**7102**

For use in the transportation model, the commodity groups listed in Table 4-16, above, were further aggregated into just five groups: grain, wood chips and logs, petroleum products, wood products, and other. The “other” commodity group includes other farm products, chemicals, containers and all other. Each of the other commodity groups corresponds directly with the comparable group in Table 4-16. This final aggregation and the associated low, medium and high forecasts for the years 2002, 2007, 2012, 2017 and 2022 are shown below in Table 4-17. The totals are not exactly the same as those shown in Table 4-16 due to rounding that was done in computing the values in Table 4-16.

Table 4-17. Waterborne Traffic Projections for the Snake River Above Ice Harbor Lock and Dam, 2002-2022--Final Aggregation of Commodities.

Commodity Group	Avg	2002			2007			2012			2017			2022		
		Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
Grain	3019	2649	3647	4619	2473	3799	5125	2473	3798	5123	2534	3892	5250	2638	4052	5466
Wood Chips and Logs	716	404	694	984	404	694	984	404	694	984	404	694	984	404	694	984
Petroleum Products	118	102	127	151	109	136	162	117	145	174	125	156	186	134	167	199
Wood Products	52	35	66	98	41	79	116	53	101	148	67	128	188	78	148	218

Other	81	58	97	140	62	110	158	72	128	181	89	148	210	103	167	235
Total	**3986**	**3248**	**4631**	**5992**	**3089**	**4818**	**6545**	**3119**	**4866**	**6610**	**3219**	**5018**	**6818**	**3357**	**5228**	**7102**

5. BASE CONDITION

5.1 GRAIN MOVEMENTS—ORIGINS AND DESTINATIONS

One of the key elements in determining commodity transport costs is identifying origins and destinations of product movements. Within the Columbia River Basin, country elevators located in one county may collect and store grain from sources in several adjacent counties. This grain may ultimately be transshipped to river elevators located in other counties. These movements, as such, tend to have a three dimensional aspect in terms of origins and interim destinations. In order to reduce the complexity of data management, country elevators were considered to be the starting point for the movement of grain down river, with the exception of those grain shipments made directly from farm to river elevators. This eliminates the need for a three dimensional approach that would vastly enlarge the magnitude and complexity of the commodity flow data. The effect of this modeling convention on estimated costs is to understate the costs by the amount of the cost to move grain from farms to country elevators. However, it was judged that in total, the costs of moving grain from farms to country elevators or other interim holding facilities would not differ significantly between base and drawdown conditions. For modeling purposes, therefore, this simplifying assumption was applied except in those cases where grain is transported directly from farm to river elevators, without drawdown. With drawdown, modeling was based on the assumption that farm to river elevator shipments would move direct from farms to country elevators with unit train loading capacity. Obviously, this may not be the case for specific farms because some farm to river movements of grain may be determined by the relative location of farms to the river elevators. However, the assumption is considered to be valid in general because with drawdown other farms would be expected to be located near elevators with rail loading capacity.

As a starting point, origin-destination and alternative origin-destination files for each state that had been developed in prior SOR studies were reviewed. These files specified the percentages of wheat and barley from each point of origin (country elevator) arriving at respective river elevators. These data are contained in the Technical Exhibits. As noted in Section 2, river elevators on the lower Snake River were resurveyed to identify current volumes of grain (percentage) being received at each respective elevator, as well as the farm or country elevator from which the respective volumes originated. From this information, the amount and percentage of grain moving through those elevators under present conditions were verified. These data are presented in the following tables. The volume of grain moved on the

Snake River, by pool, is shown in Table 5-1. (Note: totals vary slightly due to rounding.)

Table 5-1. Off-River Origins of Snake River Barged Grains, by Pool.

Pool	**Bushels**	**% of Total**
Ice Harbor Pool	22,070,000	17.87%
Lower Monumental Pool	5,210,000	4.22%
Little Goose Pool	48,480,000	39.26%
Lower Granite Pool	47,730,000	38.65%
Total	**123,490,000**	**100.00%**

Tables 5-2 through 5-5 display the volume of grain moved from county of origin to each respective pool.

Table 5-2. Off-River Origins of Ice Harbor Pool Elevator Grain.

ORIGIN	**Bushels**	**% of Total**
Adams County, WA	8,270,000	37.51%
Franklin County, WA	960,000	4.35%
Grant County, WA	60,000	0.27%
Lincoln County, WA	2,090,000	9.48%
Spokane County, WA	1,030,000	4.67%
Walla Walla County, WA	8,280,000	37.55%
Whitman County, WA	1,360,000	6.17%
Total	**22,050,000**	**100.00%**

Table 5-3. Off-River Origins of Grain Shipped Through Lower Monumental Pool Elevators.

Origin	**Bushels**	**% of Total**
Columbia County, WA	4,700,000	90.21%
Walla Walla County, WA	510,000	9.79%
Total	**5,210,000**	**100.00%**

Table 5-4. Off-River Origins of Grain Shipped Through Little Goose Pool Elevators .

Origin	**Bushels**	**% of Total**
Benewah County, ID	620,000	1.28%
Bonner County, ID	150,000	0.31%
Boundary County, ID	230,000	0.47%

Kootenai County, ID	690,000	1.42%
Latah County, ID	2,220,000	4.58%
Adams County, WA	140,000	0.29%
Columbia County, WA	0	0.00%
Garfield County, WA	10,190,000	21.02%
Spokane County, WA	9,210,000	19.00%
Whitman County, WA	25,030,000	51.63%
Total	**48,480,000**	**100.00%**

Table 5-5. Off-River Origins of Grain Shipped Through Lower Granite Pool Elevators .

Origin	Bushels	% of Total
Idaho		
Southeast (Boise)	1,440,000	3.02%
Southwest Idaho	7,430,000	15.57%
Lewiston Area Counties	13,590,000	28.47%
Northern (Cour d' Alene)	890,000	1.86%
South Central (Twin)	130,000	0.27%
Montana	6,780,000	14.20%
North Dakota	3,270,000	6.85%
Wallowa County, OR	1,180,000	2.47%
Utah	140,000	0.29%
Washington		
Asotin County, WA	1,880,000	3.94%
Garfield County, WA	2,750,000	5.76%
Spokane County, WA	40,000	0.08%
Whitman County, WA	8,210,000	17.20%
Total	**47,730,000**	**100.00%**

The following tables identify origins of grain movements on the Lower Snake by state, as well as counties or regions within respective states.

Table 5-6. Origin of Grain Shipped on the lower Snake River, by State.

Origin	Bushels	% of Total
Oregon	1,180,000	0.96%
Idaho	27,260,000	22.10%
Washington	84,730,000	68.69%
Montana	6,780,000	5.50%
North Dakota	3,270,000	2.65%
Utah	140,000	0.11%
Total	**123,360,000**	**100.00%**

Table 5-7. Origination Data for Idaho Counties and Regions.

Origin	Bushels	% of Total
Northern Counties	21,340,000	78.31%
Southwestern Counties	1,440,000	5.28%
South Central Counties	130,000	0.48%
Southeastern Counties	4,340,000	15.93%
Total	**27,250,000**	**100.00%**

Table 5-8. Origination Data for Washington Counties.

Origin	Bushels	% of Total
Adams	8,410,000	9.93%
Asotin	1,880,000	2.22%
Columbia	4,700,000	5.55%
Franklin	960,000	1.13%
Garfield	12,940,000	15.27%
Grant	60,000	0.07%
Lincoln	2,090,000	2.47%
Spokane	10,280,000	12.13%
Walla Walla	8,790,000	10.38%
Whitman	34,610,000	40.85%
Total	**84,720,000**	**100.00%**

Table 5-9 . Origination Data for Montana Regions.

Origin	Bushels	% of Total
Central	1,440,000	21.24%
North East	250,000	3.69%
Northern	2,600,000	38.35%
South Central	860,000	12.68%
South East	240,000	3.54%
Western	1,390,000	20.50%
Total	**6,780,000**	**100.00%**

Table 5-10. Origination Data for North Dakota Regions.

Origin	Bushels	% of Total
Central	290,000	8.87%
East Central	100,000	3.06%
North Central	170,000	5.20%
Northeast	0	0.00%
Northwest	760,000	23.24%
South Central	240,000	7.34%
Southwest	870,000	26.61%
West Central	840,000	25.69%
Total	**3,270,000**	**100.00%**

The next step in computing transportation costs was to input modal costs for each origin/destination pair. As explained in Section 2, modal costs were developed for the study using models developed and maintained by Reebie Associates. Costs assigned included the cost of the grain movements by truck from country elevators to river elevators within the drawdown reach, and then the cost to move the grain by barge to export terminals. A sample of barge costs derived from the Barge Cost Model (Reebie model) based upon 1996 origin-destination data is presented in Table 5-11. Combined truck/barge costs and rates are shown in Table 12 for limited number of grain origins. Costs were likewise assigned to alternative routings and transport modes that would be utilized under drawdown conditions. The results of the analysis of transportation cost with drawdown are presented in Section 6.

TABLE 5-11. BARGE COSTS FOR WHEAT AND BARLEY MOVEMENTS FROM THE DRAWDOWN REACH – 1996.

ORIGIN	DESTINATION	BARGE COST ($/TON)	RIVER DISTANCE	NOTE	Barge Cost $/bushel
Almota, WA	Kalama, WA	$3.19	349.8		0.0957
Almota, WA	Portland, OR	$3.07	325.3		0.0921
Almota, WA	Vancouver, WA	$2.99	322.3		0.0897
Central Ferry, WA	Kalama, WA	$2.99	328.8		0.0897
Central Ferry, WA	Portland, OR	$2.87	304.3		0.0861
Central Ferry, WA	Vancouver, WA	$2.78	301.3		0.0834
Clarkston, WA	Kalama, WA	$3.54	383.8		0.1062
Clarkston, WA	Vancouver, WA	$3.33	356.3		0.0999
Clearwater River, ID	Kalama, WA	$3.56	385.8	1	0.1068
Clearwater River, ID	Portland, OR	$3.44	361.3	1	0.1032
Clearwater River, ID	Vancouver, WA	$3.35	358.3	1	0.1005
Clearwater River Mouth	Portland, OR	$3.42	359.3	2	0.1026
Lyons Ferry, WA	Kalama, WA	$2.75	307.8	3	0.0825
Lyons Ferry, WA	Portland, OR	$2.64	282.3	3	0.0792
Lyons Ferry, WA	Vancouver, WA	$2.55	279.3	3	0.0765
Monumental Dam	Kalama, WA	$2.56	287.4		0.0768
Monumental Dam	Portland, OR	$2.45	262.9		0.0735
Monumental Dam	Vancouver, WA	$2.36	259.9		0.0708
Mouth of Palouse River	Portland, OR	$2.64	282.3	4	0.0792
Mouth of Palouse River	Vancouver, WA	$2.55	279.3	4	0.0765
Sheffler, WA	Kalama, WA	$2.23	255.5	5	0.0669
Sheffler, WA	Portland, OR	$2.12	231	5	0.0636
Sheffler, WA	Vancouver, WA	$2.03	228	5	0.0609
Snake River Mile 44	Kalama, WA	$2.56	287.4	6	0.0768
Snake River Mile 44	Portland, OR	$2.45	262.9	6	0.0735
Snake River Mile 44	Vancouver, WA	$2.36	259.9	6	0.0708
Wilma – Snake River Mile 134	Kalama, WA	$3.54	383.8	7	0.1062
Wilma – Snake River Mile 134	Portland, OR	$3.42	359.3	7	0.1026
Wilma – Snake River Mile 134	Vancouver, WA	$3.33	356.3	7	0.0999

Windust, WA	Kalama, WA	$2.51	283.8	0.0753
Windust, WA	Portland, OR	$2.39	259.3	0.0717
Windust, WA	Vancouver, WA	$2.30	256.3	0.0690

Notes:
1 – Reebie Model did not have a port listing for Clearwater River, ID. Lewiston was selected to calculate trip cost.
2 – Reebie Model did not have a port listing for Clearwater River Mouth. Clarkston was selected to calculate trip cost.
3 – Reebie Model did not have a port listing for Lyons Ferry. Reebie listed "Columbia" as port at approximately the same location.
4 – Reebie Model did not have port listing for Mouth of Palouse River. Selected "Columbia" as port at approximately the same location.
5 – Reebie Model did not have port listing for Sheffler. Selected Ice Harbor Lock and Dam as origination point for costing purposes. (Ice Harbor is approximately 20 miles closer to Kalama than Sheffler. Costs shown are about $.20 lower than if calculated from Sheffler.)
6 – Reebie Model did not have a port listing for Snake River Mile 44. Selected Lower Monumental Dam as origination port for costs purposes. (Lower Monumental Dam is 2.4 miles below Mile 44.)
7 – Reebie Model did not have a port listing for Wilma - Snake River 134. Clarkston was used.

Table 5-12. Combined Truck/Barge Costs and Rates for Wheat and Barley Movements to the Drawdown Reach.

	Location	Truck/Barge $/Ton(cost)	Truck/Barge $/Ton(rate)*	Difference Rate minus Cost	Percent Difference	Truck/Barge Way Point
Washington						
Adams	FRD	7.74	12.23	4.49	58.1	Tri-Cities
Asotin	FRD	14.60	16.54	1.94	13.3	McNary
Columbia	FRD	7.67	10.86	3.19	41.6	McNary
Franklin	FRD	5.14	8.14	3.00	58.5	Tri-Cities
Garfield	Dodge	9.58	12.68	3.10	32.4	McNary
Lincoln	Odessa2	10.68	15.63	4.95	46.3	Tri-Cities
Spokane	FRD	14.41	15.55	1.14	7.9	Tri-Cities
Walla Walla	FRD	5.94	8.82	2.88	48.6	McNary
Whitman	FRD	12.50	15.10	2.60	20.8	Tri-Cities
Idaho						
Bennewah	FRD	15.83	20.85	5.02	31.7	Tri-Cities
Boundary	FRD	15.71	24.71	9.00	57.3	Tri-Cities
Idaho	FRD	16.88	21.45	4.57	27.1	Tri-Cities
Canyon	FRD	17.65				Hogue Warner
Kootenai	FRD	15.83	19.34	3.51	22.2	Tri-Cities
Latah	FRD	15.29	18.88	3.59	23.5	Tri-Cities
Lewis	FRD	17.18	17.67	0.49	2.8	Tri-Cities
Nez Perce	FRD	15.68	17.14	1.46	9.3	Tri-Cities
Oregon						
Wallowa	FRD	13.37	17.89	4.52	33.8	Kennewick

FRD= Farm to River Direct. Truck distance is from the center of the county.
*-from Table 14 TransLog Transportation Study(alternate 26-car figure)

5.2 MARKET CONSIDERATIONS

In the process of evaluating data obtained and applied in this analysis, it was recognized that market practices influence both the mechanisms and cost of product flows from point to point. An example of this is the practice of utilizing back-hauls in commodity transport, such as land-based transport of grain and lumber to and from points in North Dakota and western Montana. For this evaluation, although the extent of the use of back-hauls was not specifically studied, it was determined that movements of grain by truck from all origins greater than 150 miles distant from Snake River ports incorporate back-hauls of lumber or other products. This assumption applies primarily to grain movements from Montana and North Dakota origins. The assumption that long-haul movement of grain includes a back-haul, significantly reduces the transportation cost for grain. It was also determined that back-hauls would continue to occur in the future, with or without drawdown of the Snake River. With drawdown, it is assumed that the origin of the back-hauls would shift to Pasco, the location of the nearest river port. This simplifying assumption, which may serve to overstate the impacts slightly, was applied in lieu of attempting to identify the alternative routes and modes for back-haul products that might otherwise be used if those grain movements shifted to rail. However, the overall magnitude by which total costs are overstated is limited by the fact that long-haul movement of grain by truck constitutes a relatively small portion of total movements both with and without drawdown. For truck hauls, it was assumed that long distance grain movements (in excess of 150 miles) utilizing back-hauls of non-grain commodities would continue, with the back-haul segment still originating at Lewiston.

Within the PNW grain industry, there are instances of multiple-ownership of resources, e.g., one company may control several facilities and thus be in a position to internalize certain costs when moving or positioning grain among various facilities for staging purposes. As such, a portion of total shipping and handling costs may remain ‘hidden’ during the data collection process and not reflected as a cost incurred within the immediate region. In some instances, this factor could create some element of distortion in the raw data. This was recognized and in cases where this occurred and caused obvious distortions in the costing process, minor adjustments were made to more nearly reflect actual practices.

5.3 TRANSPORTATION COSTS - BASE CONDITION

For the base condition, grain transportation, storage and handling costs were derived based upon current and projected levels of commodity flows. The methodology and assumptions in the analysis are explained in Section 2. Model estimates of the costs displayed in Table 5-13 below are for projected grain movements for 2007. Costs are shown by State in terms of totals and costs per bushel and per ton. As shown in the table, model estimates of total costs per bushel range from a high of about $7.10 for Montana to a low of $0.34 for Oregon. The estimates for Montana should alert the reader to the fact that the costs are simply estimates. The costs, especially for storage and handling are probably much higher than actual costs. At the same time, actual costs for storage and handling are not zero in North Dakota and Oregon. These obvious errors in the model are somewhat compensated for in the overall analysis by the fact that the same storage and handling assumptions were used in the drawdown case, thus the net effect of the error is zero.

Table 5-13. Base Condition Grain Shipments and Transportation, Storage and Handling Costs for 2007 Projected Volume, by State.

State/Unit Cost	Grain Bushels/Tons	Transportation ($)	Storage ($)	Handling ($)	Total ($)
Idaho	32,289,941	11,193,026	4,758,470	6,932,211	22,883,707
Cost per bu. (cts)	32,289,941	34.7	14.7	21.5	70.9
Cost per ton ($)	968,795	11.55	4.91	7.16	23.62
Montana	6,537,310	4,687,358	20,038,366	21,655,789	46,381,513
Cost per bu. (cts)	6,537,310	71.7	306.5	331.3	709.5
Cost per ton ($)	196,139	23.90	102.16	110.41	236.47
N. Dakota	2,458,172	3,262,017	0	0	3,262,017
Cost per bu. (cts)	2,458,172	132.7	0.0	0.0	132.7
Cost per ton ($)	73,753	44.23	0.0	0.0	44.23
Oregon	980,218	331,837	0	0	331,837
Cost per bu. (cts)	980,218	33.9	0.0	0.0	33.9
Cost per ton ($)	29,409	11.28	0.0	0.0	11.28
Washington	84,355,029	17,127,974	13,258,963	18,868,710	49,255,647
Cost per bu. (cts)	84,355,029	20.3	15.7	22.4	58.4
Cost per ton ($)	2,530,904	6.77	5.24	7.46	19.46
Totals	126,620,670	36,602,212	38,055,799	47,456,710	122,114,721
Cost per bu. (cts)	126,620,670	28.9	30.1	37.5	96.4
Cost per ton ($)	3,799,000	9.63	10.02	12.49	32.14

Costs associated with grain transport under the base condition were converted to average annual amounts over the period of analysis, 2007-2106. These average annual amounts, that reflect zero, 4.75, and 6.875 percent rates of interest, are presented in 1998 dollars as follows in Table 5-14.

Table 5-14. Base Condition – Grain, Average Annual Costs – 2007 – 2106

Interest Rate	Avg. Ann. Costs
6.875%	$126,042,205
4.75%	$126,963,320
0.00%	$129,337,780

5.4 NON-GRAIN COMMODITIES

For purposes of grouping, non-grain commodities were combined into four additional groups: petroleum, logs and woodchips, wood products, and other, comprised of other farm products, containerized products, and chemicals. For the base condition, transportation costs reflect current and projected volume. Transportation costs associated with non-grain commodities for selected years under the base condition are presented below in Table 5-15.

Table 5-15. Base Condition Total Annual Costs for Non-Grain Commodities.

Year/Commodity Group	Base Case
2002	
Petroleum	$14,838,745
Logs and Wood Chips	$47,879,179
Wood Products	$4,380,282
Other	$6,125,027
Total	$73,223,233
2007	
Petroleum	$15,893,106
Logs and Wood Chips	47,879,179
Wood Products	5,242,586
Other	6,946,350
Total	$75,961,221
2012	
Petroleum	$16,936,369
Logs and Wood Chips	47,879,179
Wood Products	6,703,299
Other	8,084,392
Total	$79,603,239
2017	
Petroleum	$19,511,230
Logs and Wood Chips	47,879,179
Wood Products	8,494,810
Other	9,345,900
Total	$85,231,119

Costs associated with non-grain commodities were converted to average annual amounts over the period of analysis, 2007-2106 and are displayed below in Table 5-16. These average annual amounts, computed at zero, 4.75, and 6.875 percent, are expressed in 1998 dollars.

Table 5-16. Base Condition Average Annual Costs for Non-Grain Commodities.

Interest Rate	**Avg. Ann. Costs, 2007 - 2106**
6.875%	$82,274,899
4.750%	$83,006,143
0.000%	$84,671,628

5.5 CRUISE-SHIP COMMERCE

Cruise-ship operations began on the Columbia-Snake River in 1980. In 1999 four companies are offering cruises. One more company will begin operating on the river in 2000 and other companies are considering offering cruises. Data from just one of these companies illustrates the growth in the industry. This information is summarized in Table 5-17. Data for the industry in terms of the number of cruises, passengers and expenditures in the drawdown reach of the Snake River are presented in Section 6.

Year	**Number of Passengers**
1995	1,150
1996	3,220
1997	5,355
1998	5,500 (est.)
1999	6,322 (bookings)
2000	6,800 (adds 3 trips)

Source: American West Steamboat Company, July 1999.

5.6 SUMMARY – BASE CONDITION

Yearly transportation costs associated with all commodities under the base condition are displayed below in Table 5-17. They have been computed at zero, 4.75, and 6.875 percent, are expressed in 1998 dollars, and converted to average annual amounts for the period of analysis, 2007-2106.

Table 5-17. Summary of Base Condition Total Average Annual Costs– All Commodities.

Interest Rate	Avg. Ann. Costs: 2007 - 2106
6.875%	$208,317,104
4.750%	$209,969,463
0.000%	$214,009,408

6. DRAWDOWN CONDITION

6.1 GEOGRAPHIC SCOPE OF IMPACTS

The geographic scope of the analysis of transportation system impacts with breaching of the four lower Snake River dams of the Columbia/Snake River System includes all communities, port facilities and terminals physically located adjacent to the river that have direct access to the navigation channel. In addition, it also includes inland areas geographically distant from the CSRS but which make significant use of the navigation system. Thus, for this study, geographic scope is defined as those regions making direct use of the CSRS through loading or unloading waterborne commerce, plus the off-river origin or destination for that commerce with uninterrupted movement by a single mode of transportation. For example, for wheat and barley, the inland country elevator origins or farm origins with direct truck movements to a river elevator are part of the impacted area. Inland petroleum distribution terminals receiving product shipped on the CSRS and trucked or piped from river discharge points are also part of the impacted area. Grain export-elevators on the Lower Columbia are part of the study area but as a practical matter, export destinations, such as Pacific Rim nations in Asia, are not. However, historical trends and seasonality of exports of grain to the Pacific Rim nations are used as the basis for estimating future export demand and the seasonality of annual grain exports..

The analysis of the economic effects of drawdown on grain producers is limited to the potential changes in how grain is shipped to export terminals in the Portland area and the associated changes in costs. The analysis and results are general in nature and do not apply directly to specific grain producers. To quantify the economic effects of river drawdown on the cost of transporting grain from production areas to export market terminals, it was necessary to determine the origins of grain shipped on the CSRS. Given the time constraint attendant with this study, it was reasoned that identification of individual farm origins throughout the study region, and tracing that segment of product flows, would not be practical and would not significantly alter the overall results. Thus, origins were determined through desegregation of total grain shipments on the CSRS. Grain shipments were desegregated to the amount shipped on the Snake River segment of the CSRS, to individual elevators on that segment, and to production regions. The methodology used to accomplish the desegregation is explained in Section 2 of this report. While recognizing the highly desegregated nature of grain production and distribution, for practical purposes grain movements were presumed to originate at country elevator locations except for those movements farm direct to river. The final CSRS destination of grain shipments under drawdown remains the lower Columbia River deep-water export terminals.

6.2 ALTERNATIVE TRANSPORTATION MODES AND COSTS

With loss of access to the Snake River portion of the CSRS, commodities would move by the next available mode, such as rail direct to export elevators on the lower Columbia or by truck to river elevators located on the McNary pool. For the drawdown condition, the evaluation process in most cases considers these two alternatives; the utilization of truck-barge combination to the closest river terminal unimpaired by drawdown, or truck transport to the closest rail loading facility. Where rail access is presently available at country elevators, grain would either shift to rail direct from those locations, or be moved by truck to a rail distribution point where unit trains could be assembled. At country elevators where rail is presently the primary means of transport, this would remain the case with drawdown. As with barge movements, cost data were prepared for rail and truck movements. Combined truck/rail costs and rates are shown in Table 6-1 for a sample of grain origins.

Table 6-1. Combined Truck/Rail Costs and Rates for a Sample of Grain Origins

Origin	Location	Truck/Rail $/Ton (cost)[1]	Truck/Rail $/Ton (rate)[2]	Difference Rate minus Cost	Percent Difference	Truck/Rail Way Point
Washington						
Adams	FRD	16.34	13.24	-3.10	-18.9	Odessa1
Asotin	FRD	20.50	18.95	-1.55	-7.6	Pendleton1

Columbia	FRD	13.83	13.02	-0.81	-5.8	Pendleton1
Franklin	FRD	12.04	9.72	-2.32	-19.2	Plymouth
Garfield	Dodge	15.30	14.17	-1.13	-7.4	Pendleton1
Lincoln	Odessa2	14.69	14.20	-0.49	-3.3	Odessa1
Spokane	FRD	13.44	14.29	0.85	6.4	Spangle2
Walla Walla	FRD	12.70	9.01	-3.69	-29.1	Pendleton1
Whitman	FRD	19.20	14.37	-4.83	-25.2	Pendleton1
Idaho						
Bennewah	FRD	15.17	19.21	4.04	26.6	Spangle2
Boundary	FRD	23.83	16.69	-7.14	-30.0	Spangle2
Idaho	FRD	16.17	20.97	4.80	29.7	Grangeville
Canyon	FRD	15.24				Nampa1
Kootenai	FRD	17.33	14.60	-2.73	-15.8	Spangle2
Latah	FRD	19.15	19.39	0.24	1.2	Spangle2
Lewis	FRD	15.50	20.54	5.04	32.5	Craigmont
Nez Perce	FRD	16.71	19.99	3.28	19.6	Craigmont
Oregon						
Wallowa	FRD	15.13	16.48	1.35	8.9	Pendleton1

1. Computed using the Reebie models.
2. From the study prepared for the Corps by the Upper Great Plains Transportation Institute.

6.3 ALTERNATIVE ORIGINS

With drawdown grain now shipped on the Snake River would shift to alternative modes of transportation, specifically to truck-rail and truck-barge through river ports on the Columbia River below its confluence with the Snake River to lower Columbia River ports. To evaluate the transportation, storage and handling costs associated with this shift, it was necessary to identify alternative intermediate destinations. The alternative destinations were identified through review and revision of the alternative destinations identified for the System Operation Review (November 1995). The alternative rail origins (intermediate destinations) of grain shifted from the Snake River to rail are shown below in Table 6-2. Each of these facilities currently has the capability of loading unit-trains of 26 or more railcars. The actual number of elevator facilities with unit-train loading capability is significantly greater than the number of facilities included in the model. On the BNSF system there are actually 39 facilities in Eastern Washington and four in Northern Idaho. These facilities have a combined storage capacity of just slightly less than 53.6 million bushels. For grain now shipped through Snake River ports that would continue to be shipped by barge, the alternative barge origin (intermediate destination) is the area around the confluence of the Snake and Columbia Rivers, including the Tri Cities.

Table 6-2. Alternative Rail Origins of Grain With Drawdown.

Origin	County	Capacity (bu)	Railroad
WASHINGTON			
Coulee City	Grant	2,038,000	Palouse R. & Coulee City
Plymouth	Benton	4,129,000	Burlington No.-Santa Fe
Harrington (2)	Lincoln	2,579,000	Burlington No.-Santa Fe
Odessa (Lamona)	Lincoln	638,000	Burlington No.-Santa Fe
Spangle (3)	Spokane	1,235,000	PCC & BNSF
Spangle	Whitman	1,235,000	PCC & BNSF
IDAHO			
Craigmont	Lewis	1,744,000	Camas Prairie RailNet
Grangeville	Idaho	1,552,000	Camas Prairie RailNet
Idaho Falls		na	Union Pacific
Pocatello		na	Union Pacific
Nampa	Canyon	na	Union Pacific
Mountain Home	Elmore	na	Union Pacific
Bliss	Gooding	na	Union Pacific
Burley	Cassia	na	Union Pacific
American Falls	Power	na	Union Pacific
Blackfoot	Bingham	na	Union Pacific
OREGON			
Pendleton	Umatilla	na	Union Pacific

Note: There are multiple facilities at some locations, as indicated by the number in ( ).
na = not available.

6.4 TRANSPORTATION COSTS WITH DRAWDOWN

For the drawdown condition, grain transportation costs were derived based upon projected commodity flows diverted to alternative modes and alternate intermediate destinations. Grain transport costs that reflect projected grain movements for the affected states for 2007 are displayed in Table 6-3 below. Storage and handling costs of grain movements are also shown. Costs are shown in terms of totals and costs per bushel (in cents) and per ton (in dollars). Data for the year 2007 are shown because that is the initial year of actual drawdown and the shift of commodity shipments away from the Snake River. As the data show, the estimated range in costs with drawdown is from a high of $7.30 per bushel for Montana to a low of 40.1 cents per bushel for Oregon. It should be noted that most of the cost for Montana is due to storage and handling costs. While these charges are unrealistic, they were handled in the model the same way with and without drawdown. As a result, the difference between the two cases appears to be more realistic than the estimates for each case. The difference between the two cases is shown and discussed in Section 7.

Table 6-3. Transportation, Storage, Handling and Total Costs for Grain Shipments with Drawdown, 2007 Projected Volume.5

	Bushels/Tons	Transportation ($)	Storage ($)	Handling ($)	Total ($)
Idaho	32,289,941	16,148,010	5,652,855	7,342,505	29,143,370
Cost per bu. (cts)	32,289,941	50.0	17.5	22.7	90.3
Cost per ton ($)	968,795	16.67	5.83	7.58	30.08
Montana	6,537,310	6,063,389	20,038,366	21,655,789	47,757,544
Cost per bu. (cts)	6,537,310	92.8	306.5	331.3	730.5
Cost per ton ($)	196,139	30.91	102.16	110.41	243.49
N. Dakota	2,458,172	3,523,573	0	0	3,523,573
Cost per bu. (cts)	2,458,172	143.3	0.0	0.0	143.3
Cost per ton ($)	73,753	47.78	0.00	0.00	47.78
Oregon	980,218	393,165	0	0	393,165
Cost per bu. (cts)	980,218	40.1	0.0	0.0	40.1
Cost per ton ($)	29,409	13.37	0.00	0.00	13.37
Washington	84,355,029	28,714,849	14,838,964	19,605,738	63,159,551
Cost per bu. (cts)	84,355,029	34.0	17.6	23.2	74.9
Cost per ton ($)	2,530,904	11.35	5.86	7.75	24.96
Totals	126,620,670	54,842,986	40,530,185	48,604,032	143,977,203
Cost per bu. (cts)	126,620,670	43.3	23.0	38.4	113.7
Cost per ton ($)	3,799,000	14.44	10.67	12.79	37.90

Costs associated with grain transport under the drawdown condition were converted to average-annual amounts for the period of analysis, 2007-2016. These average annual amounts, computed at zero, 4.75 and 6.875 percent rates of interest, in 1998 dollars, are shown below in Table 6-4.

Table 6-4. With Drawdown Condition – Grain, Average Annual Costs – 2007 – 2106.

Interest Rate	Avg. Ann. Costs
6.875%	$148,870,766
4.750%	$149,958,712
0.000%	$152,763,231

6.5 NON-GRAIN COMMODITIES

For purposes of grouping, non-grain commodities were combined into four additional groupings: petroleum, logs and wood chips, wood products, and other, comprised of other farm products, containerized products and chemicals. For the drawdown condition, transportation costs reflect projected commodity volumes. Transportation costs associated with non-grain commodities for selected years under drawdown conditions are displayed below in Table 6-5.

Table 6-5. With Drawdown Condition Total Annual Costs for Non-Grain Commodities.

YEAR/COMMODITY GROUP	**Drawdown Case**
2002	
	$ 15,350,816
ım	
	$ 49,320,040
Logs and Wood Chips	
Wood Products	$ 5,444,873
	$ 6,643,160
Other	
	$ 76,758,889
Total	
2007	
	$ 16,441,562
Logs and Wood Chips	$ 49,320,040
Wood Products	$ 6,516,753
Other	$ 7,533,960
Total	$ 79,812,315
2012	
	$ 17,520,827
Logs and Wood Chips	$ 49,320,040
	$ 8,332,480
Wood Products	
Other	$ 8,768,272
Total	$ 83,941,619
2017	
	$ 20,184,544
Logs and Wood Chips	$ 49,320,040
Wood Products	$ 10,559,403
Other	$ 10,136,495

5 Totals exclude an adjustment of $794,781 that calculated by the model and added to the regional total to prevent costs for any movement with drawdown from being less than without drawdown.

Total	$ 90,200,482

Costs associated with non-grain commodities under drawdown conditions are displayed below in Table 6-6 as average annual amounts for the period of analysis, 2007-2106. These average annual amounts, computed at zero, 4.75, and 6.875 percent, are expressed in 1998 dollars.

Table 6-6. Drawdown condition average annual costs for non-grain commodities.

Interest Rate	**Avg. Ann. Costs, 2007 - 2106**
6.875%	$86,898,809
4.750%	$87,715,836
0.000%	$89,575,894

6.6 INFRASTRUCTURE REQUIREMENTS AND COSTS

With drawdown and a shift of commodities from shipment on the Snake River to shipment by rail, there would a significant increase in demand on the region's land-based transportation and grain handling infrastructure. This section addresses the need for, and cost of, improvements to the rail system, the need for additional rail cars, the need for highway improvements, and the need for expansion of elevator capacity and improvement of loading and unloading facilities.

6.6.1 Rail System Requirements

Rail system requirements with drawdown include improvements to existing rail lines in terms of interchanges between short-line and mainline carriers, track upgrades and bridge upgrades. In addition, the stock of grain cars would need to be expanded.

6.6.1.1 Mainline (Class 1) Railroads

Both mainline railroads, Burlington Northern-Santa Fe and Union Pacific, would be impacted by drawdown through the shift of grain and other commodities from the Snake River to Rail. In this analysis, it is assumed that all commodities shifted to rail would eventually require the services of these mainline carriers to reach their final destinations at ports on the lower Columbia River. As shown below in Table 6-1, the increase in grain shipments alone would increase traffic on the mainline routes by from about 840 to about 940 railcar-trips per month. Assuming a train size of 108 cars, this represents an increase of from about eight to nine additional trains per month destined to ports on the lower Columbia River. This represents a significant increase in rail traffic and improvements to the existing mainline system may be needed.

In making the assessment of mainline railroad infrastructure needs and costs, estimates of diverted traffic and generic or “rule of thumb” measures were used. Generic measures for costing the construction or modification of line capacity were developed for this purpose by civil engineers at the University of Tennessee’s Transportation Center. Preliminary estimates were discussed with engineering professionals from a number of Class 1 railroads and with experts from private construction firms that are routinely engaged in rail project construction. Officials of the BNSF, Union Pacific and others reviewed these estimates as they apply to the Pacific Northwest rail system. The range of costs using these procedures was from a low of $14 million to a high of $24 million.

By comparison, a detailed analysis of rail impacts for Washington State was recently completed for the Washington State Legislative Transportation Committee[6]. Under the maximum railroad impact scenario in that study, the estimated costs for line-haul upgrades to accommodate the increased traffic range from $17.4 to $20.9 million (excluding elevator load/unload track upgrades) for the State of Washington.

The impact of the need to make infrastructure improvements to mainline railroads on long-run marginal costs of the railroads was evaluated in a study conducted for the Corps by the TVA and Marshall University.[7] This study examined the estimated increase in

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6 Lower Snake River Drawdown Study, Technical Memorandum Number 6, HDR Engineering, Inc., February 1999.

7 The Incremental Cost of Transportation Capacity in Freight Railroading: An Application to the Snake River Basin. The Tennessee Valley Authority and The Center For Business and Economic Research Lewis College of Business Marshall University, July, 1998.

volume, assuming that all commodities now moving on the Snake River would be diverted to rail (a worst-case scenario), and a number of strategies for increasing line-haul capacity. The conclusion of the study was that the infrastructure improvements could be made without putting any upward pressure on long-run marginal costs or rates.

6.6.1.2 Short-Line (Class 2) Railroads

With drawdown, short-line railroads in Idaho and Washington are expected to experience increased shipments of grain. However, the level of detail of the study does not permit identification of the magnitude of the increase that is projected for individual railroads or even to the short-line railroads as a group. Thus, the assessment of impacts on these carriers and the estimates of costs of improvements are general in nature. Cost estimates were not specifically developed for this study. In the case of Washington railroads, costs were taken from the following report: Lower Snake River Drawdown Study, Appendix B, Technical Memoranda, prepared by HDR Engineering, Inc., February 1999. In the case of Idaho railroads, information about the potential shift to of grain to rail was provided to representatives of each of the short-line railroads, with a request that they identify any improvements that might be needed and estimated costs, if any. Short-line railroads that would be affected and estimated costs of improvements required for these lines to effectively accommodate the increased traffic are discussed in this section.

6.6.1.2.1 Short-Line Railroad Services

The assessment of potential impacts to short-line railroads is organized on a regional rather than state basis. As a result, Southern Idaho is separate from the northern part of the state, which is included with Eastern Washington. This approach to the analysis avoids duplication in the analysis, especially for Northern Idaho where all of the short-line railroads that operate there also operate in Washington.

Southern Idaho. In addition to two mainline or class 1 carriers (Union Pacific and Burlington Northern-Santa Fe), Idaho is served by six short-line railroads: Montana Rail Link, the Camas Prairie RailNet, the St. Maries River Railroad, the Eastern Idaho Railroad, the Palouse River Railroad and the Idaho Northern and Pacific Railroad. Together they comprise a 1,940-mile state rail system. Drawdown is projected to have an impact on the operations of three of the six railroads—Palouse River (Northern Idaho), Eastern Idaho Railroad (Southern Idaho) and the Camas Prairie RailNet (Northern Idaho). The Eastern Idaho Railroad operates two lines, the routes, service areas and the location of interchanges with the mainline railroads for these two lines are shown in Table 6-7, below. The other two railroads are described with Eastern Washington railroads in Table 6-8.

Table 6-7. Southern Idaho Short-Line Railroads Impacted by Drawdown.

Railroad	Route/Service Area	Mainline Interchange
Eastern Idaho (Idaho Falls)	Area north of Idaho Falls including the communities of Newdale, Menan, St. Anthony and Ashton	UP at Idaho Falls
Eastern Idaho (Menan Br)	From Ucon (Idaho Falls) to Menan (10.4 mi)	UP at Idaho Falls (w/Idaho Falls system)
Eastern Idaho (Twin Falls)	Twin Falls area, including the communities of Burley, Rupert, Buhl, Wendell and Twin Falls	UP at Minidoka
Eastern Idaho (Oakley Br)	From Oakley to Burley (11.5 mi)	UP at Minidoka (w/Twin Falls system)

Source: Idaho Rail Plan, 1998.

Washington and Northern Idaho. In addition to the mainline or class 1 carries, Union Pacific and Burlington Northern-Santa Fe, four Class 2 or short-line railroads service eastern Washington whose operations would be impacted by drawdown of the lower Snake River. These carriers are the Blue Mountain Railroad, Camas Prairie RailNet, Columbia Basin, the Coulee City and Palouse River Railroad, the CSCD Railroad and the Paloose River Railroad. The routes of each of these railroads and the location of interchanges with the mainline railroads are shown in Table 6-8, below. At present, the Camas Prairie RailNet, which operates in both Idaho and Washington, normally only loads non-grain commodities in Washington.

Table 6-8. Eastern Washington and Northern Idaho Short-Line Railroads Impacted by Drawdown.

Railroad	Route	Mainline Interchange
Blue Mountain	From Walla Walla and Dayton, WA west to Wallula, WA	UP at Hooper
Blue Mountain (Palouse River)	From Pullman and Thornton westward generally along the Palouse River to via Winona to Hooper	UP at Hooper
Camas Prairie RailNet	From Grangeville, Kooskia & Revling, ID to Riparia, WA via Lewiston, ID & the Snake River (72 mi. west of Lewiston).	UP and BNSF at Ayer, WA (82 miles west of Lewiston).
Cascade & Columbia River	From Oroville to Wenatchee (all WA)	BNSF at Wenatchee
Columbia Basin	The Columbia Basin from Scalley, Moses Lake, Schrag & Othello to Connell (all WA)	BNSF at Connell
Palouse River & Coulee City (north)	From Coulee City eastward to Cheney (all WA)	BNSF at Chenny
Palouse River & Coulee City (south)	From Moscow & Bovill, ID northward via Palouse to Marshall, WA	BNSF at Marshall

Source: Idaho Rail Plan, 19998; Washington State Freight Rail Plan, 1998; and, BNSF system map, 1999.

6.6.1.2.2 Short-Line Railroad Infrastructure Needs and Costs

Current Conditions, Needs and Costs. Infrastructure needs of the affected short-line railroads in Idaho and Washington would be relatively more impacted than the mainline railroads. The reason for this is that these rail lines are generally in poor condition at present. The poor condition of the lines stems from the fact that most of the short-line railroads are spin-offs of low volume, low revenue/profit segments of the mainline system. Lacking a favorable revenue/cost incentive the mainline owners allowed infrastructure and service on these lines to deteriorate over a number of years. In addition, as the mainline railroads have placed increasing emphasis on the more profitable long-haul service on mainlines, there has been a trend for the mainline carriers to abandon some of their short-line services and tracks. For example, in Washington since 1953 132 rail-line segments have been abandoned, amounting to 1975.34 miles of track.[8] In many parts of the country, including the Pacific Northwest, the abandoned railroad rights-of-way have been converted to hiking and bicycling trials, making these segments unavailable for future rail service. Traffic on most of the operating short-line railroads is limited to a speed of from 25 to 45 miles per hour. Assessments of current needs have been made for both Idaho and Washington and are include in the respective State railroad plans. A summary of needs identified at present and estimated costs by railroad line is shown in Table 6-9.

Table 6-9. Summary of Current Infrastructure Needs of Short-line Railroads.

Railroad	Branch/Line	Description of Need	Cost	Source
Idaho				
EIRR	Oakley	Rehabilitate 11.5 miles of track	1,400,000	(1)
EIRR	Menan	Rehabilitate 10.4 miles of track	2,600,000	(1)

8 Washington State Freight Rail Plan, 1998 Update, Washington DOT.

EIRR	Idaho Falls system	Rehabilitate 115 miles of track	13,000,000	(2)
EIRR	Burley/Twin Falls	None identified	-	(1)
Subtotal			17,000,000	
Oregon				
BLMR	Oregon	None identified	-	
Washington *				
CBRW	System	Alternate rail corridor	2,000,000	(2)
PCC	System	Track rehabilitation	650,000	(2)
BLMR	Walla Walla/Dayton	Track rehabilitation	519,000	(2)
CSCD	System	Track rehabilitation	800,000	(2)
Subtotal			3,969,000	
Total			20,969,000	

*Includes Northern Idaho
Sources: (1) Idaho Rail Plan
(2) Estimated from data in the Idaho Rail Plan
(3) Washington State Rail Plan

Railroads:
PCC--Palouse River and Coulee City
CSCD--Cascade & Columbia River
CBRW--Columbia Basin Railway
BNSF--Burlington Northern/Santa Fe

Incremental Infrastructure Needs with Drawdown. To identify incremental improvements that might be needed with drawdown, representatives of the railroads that would be impacted by drawdown were contacted and asked to identify any additional improvements that would be needed. In addition, information from other sources of information were used to identify needed improvements and costs. The improvements identified are summarized in Table 6-10 together with estimated costs, where available. The source of the cost estimates is also shown. Estimates by the Corps were developed using unit costs developed for the Corps in a study by the TVA and Marshall University.[9] Readers should be aware that potential impacts to the railroads, the need for infrastructure improvements and costs are being reviewed by the affected railroads. As a result, changes may be made in the final report.

Table 6-10. Summary of Incremental Short-Line Improvements and Costs with Drawdown.

State/Railroad	Interchange w/Mainline	Track Upgrade	Other	Total	Source
Idaho					
Camas Prairie	0	0	0	0	Railroad
Eastern Idaho (Idaho Falls)	na	na	na	na	
Eastern Idaho (Twin Falls)	na	na	na	na	
Total Cost	0	0	0	0	
Washington					
Blue Mountain	$0.0	$0.0	$0.0	$0.0	HDR Report
Columbia Basin RR	$0.5 1/	$0.0	$0.0	$0.5	Railroad
Palouse River & Coulee City	$2.0M to	$4.0M to	$1.0 M to	$7.0M to	HDR

9 The Incremental Cost of Transportation Capacity in Freight Railroading: An Application to the Snake River Basin. The Tennessee Valley Authority and The Center For Business and Economic Research Lewis College of Business Marshall University, July, 1998.

	$2.4M	$4.8M	$1.2 M	$8.4 M	Report
Camas Prairie	$2.0M to $2.4M	$0.0M	$0.0 M	$2.0M to $2.4M	HDR Report
Blue Mountain (Palouse River)	$2.8M to $3.4M	$4.6M to $5.5M	$1.0 M to $1.2 M	$8.4M to $10.1 M	HDR Report
Total	$9.3M - 11.1M	$8.6M -$10.3M	$2.0 M $2.4M	$19.9 M -23.8M	
Grand Total	$9.3M - 11.1M	$8.6M -$10.3M	$2.0 M $2.4M	$19.9 M -23.8M	

Notes: HDR Report = "Lower Snake River Drawdown Study, Appendix B, Technical Memoranda," HDR Engineering, Inc., February 1999.

Information for Idaho is from representatives of the railroad companies.

1/ Would lengthen siding track from 30-car to 80-car capacity.

na = not available.

6.6.1.3 Rail Car Capacity

In the event of a drawdown, the analysis of alternative transportation modes shows that approximately 1.1 million tons of grain would transfer to rail (see Table 7.8). In analyzing available information on current railcar availability and costs, a range of the number of cars needed and costs were developed. At present there is a large surplus of grain cars. For example, the grain car utilization rate for the BNSF for June 1999 was only about 50 percent. In spite of this, the analysis presented here is based on the premise that over the long-term additional rail cars would need to be acquired to move the grain that would shift to rail with drawdown. The assumptions used to establish the range and the resulting number of railcars needed for a "best-case" and "worst-case" scenario are shown below in Table 6-11. The assumptions regarding the turn around rate take into account actual turn rates experienced by the BNSF of up to 6.0 turns from the Plains to Gulf, up to 4.0 turns from the mid-west to the PNW and a system average of 1.4 turns. In addition, the volume of grain was also considered. In consideration of these two factors, a turn rate equal to the system average was selected as the worst case and turn rate of one-half of the 6.0 turns achieved by the BNSF in serving the Gulf was selected as the best case. The volume of grain shifted to rail is not considered to provide a strong enough incentive for the railroads to provide the kind of service that is provided to the Gulf. This same argument applies to the service from the mid-west to the PNW. However, the shorter distance should offset the lack of a strong incentive and allow a turn rate nearly equal to the mid-west/PNW turn rate. An attempt to allocate rail cars throughout the region by state or carrier was not made because it is assumed that the additional railcars would be placed in a pool and would be positioned throughout the region on the basis of demand. However, it should be understood that the number of railcars needed could increase depending on the operating relationship between mainline and short-line carriers. For example, if all of the grain shifted from the river to rail required movement by both a short-line carrier and a mainline carrier, the number of cars required could be significantly increased.

Table 6-11. Best and Worst Case Estimates of The Number and Cost of Additional Railcars for Grain.

Assumption	Best Case	Worst Case
Annual Volume of Grain (tons)	1,100,000	1,100,000
Volume per Month (tons)	91,667	91,667
Turn Around Rate per Month	3.0	1.4
Railcar Capacity (tons)	110	98
Number of Railcars Needed	278	668
Number of Railcars Needed, Rounded	280	670
Cost per Railcar	$ 50,000	$ 55,000
Total Cost on New Railcars	$ 14,000,000	$ 36,850,000
Number of Cars per Train	108	108
Number of Trains per Month	8	9

This compares with a study done for the Washington State Legislative Transportation Committee that estimated costs for new railcars to range from $50 to $55 million for their maximum railroad impact scenario[10].

6.6.1.4 Rail System Congestion. With drawdown the rail system will experience increased traffic, as has been discussed previously. This increase in traffic has the potential for causing congestion on mainlines and at loading and unloading facilities. Congestion on short-line railroads is not considered to be likely because those facilities are almost universally only lightly used at present. In the case of congestion at loading and unloading facilities, the Corps believes that with implementation of infrastructure improvements identified in this report, there will not be a significant increase in delays due to congestion. In fact, it is likely that the system will become more efficient as it adjusts to a more significant role in the transport of grain within the region. This issue was specifically addressed in a study conducted for the Corps by the TVA and Marshall University. Specific reference to

10 Lower Snake River Drawdown Study, Technical Memorandum Number 6, HDR Engineering, Inc., February 1999.

the report is included above and in Section 8. The conclusions of the study were that (1) improvements to the system may be needed to avoid congestion and (2) needed improvements could be made without increasing long-run marginal costs or putting upward pressure on rates. The potential for congestion on mainlines of the BNSF and UP railroads also reviewed by transportation analysts at both railroads.

6.6.2 Highway System Requirements

6.6.2.1 Change in Highway Use. Impacts on highway capital and maintenance cost with drawdown were determined on the basis of the change in the use of highways to transport grain. The change in highway use was computed as the change in truck miles. The number of truck miles for both the base and drawdown cases were computed from summary data from the database program used to compute transportation system costs. This program computes bushel-miles for each origin-destination pair and provides a summary of the results by state. Bushel-miles were then converted to truck miles by dividing the number of bushel-miles by the number of bushels per ton (33.33) and the number of tons of grain per truckload (26). The resulting estimates of the change in truck miles with drawdown are show below in Table 6-12. As the data shows, the range of the change is from a decrease in Idaho of about 1.4 million miles to an increase in Washington of nearly 2.6 million miles. The decrease in Idaho is explained by the shift of grain to rail and the increase in Washington is explained largely by the change in the destination of truck shipments from ports on the Snake River to ports in the Tri Cities area.

Table 6-12. Summary of the Change in Truck Miles, by State.

				No. of Alt Destinations & Change		
State	**Sum Of Total Bushels**	**Increase in Bushel-Truck Miles**	**Increase in Truck Miles 1/**	**Miles Increased**	**Miles Decreased**	**Total Alt Dest.**
Idaho	24,271,500	(1,235,193,157)	(1,419,762)	4	31	35
Oregon	736,804	30,198,573	34,711	1	0	1
Washington	63,407,459	2,577,756,664	2,962,939	11	4	15
Montana	4,913,924	757,607,372	870,813	6	0	6
N. Dakota	1,847,743	265,297,487	304,940	1	0	1
Totals	95,177,430	2,395,666,939	2,753,640	23	35	58

Notes:
*Montana is divided into regions.
**North Dakota is a single region.
1/ Number of bushels per truck equals 870.
Source: Summary8 file from the ACCESS database model, July 1999.

As shown above in Table 6-12, highway truck miles for grain shipments would increase dramatically in Washington. However, truck miles would decrease significantly in Idaho; would remain almost unchanged in Oregon; and, would increase by relatively small amounts for Montana and North Dakota. Although the increase in mileage for movements from these latter states is relatively insignificant, it becomes significant in consideration of the fact that the increase occurs exclusively on Washington highways, as grain is diverted from ports on the Snake River to ports in the Tri Cities. As a result, for this analysis, the increase in miles for both Montana and North Dakota were added to the Washington miles in determining the significance of impacts to state highways and county roads that would result with drawdown. The increase in miles in Oregon was considered to be so small as to not have a measurable impact on highway maintenance costs. Thus, the assessment of infrastructure improvements and costs applies only to Washington, including Montana and North Dakota miles. The potential savings in maintenance costs to Idaho highways were not estimated.

6.6.2.2 Highway Infrastructure Improvements Requirements. A report prepared for Washington State by HDR Engineering, Inc. (HDR Report), shows that increased truck miles in Washington would likely occur on three primary corridors, US 395, SR 124/US 12, and the Pasco-Kahlotus/SR 26 system, as grain movements are redirected from Snake River ports to ports in the Tri Cities area.[11] To obtain a sense of the potential impact of the increase in truck mileage on each of these corridors, the total increase in truck mileage, as estimated in the Corps' analysis, was allocated among the three corridors on the basis of the increased number of trucks per peak day as projected in the HDR Report. The allocation is shown in Table 6-13, below. While the resulting estimates of the increase in truck mileage are "rough," they do provide an indication of potential impacts.

Table 6-13. Allocation of Increased Washington Miles to Highway Corridors With Drawdown.

Highway Corridor	Increased No. of Trucks Per Peak Day 1/	Percent of Trucks Per Day	Increased Truck Miles 2/
US 395 (Tri Cities to Ritzville)	456	19.8	819,461
Pasco-Kahlotus/SR-26 (Tri Cities to Colfax)	408	17.7	732,548
SR-124/US-12 (Tri Cities to Clarkston/Wilma)	744	32.3	1,336,797

11 Lower Snake River Drawdown Study, Technical Memorandum Number 6, HDR Engineering, Inc., February 1999.

Tri Cities Area (Pasco/Kennewick)	696	30.2	1,249,885
Total	**2,304**	**100.0**	**4,138,691**

Notes:

1/ Source: Lower Snake River Drawdown Study, Appendix B, Technical Memoranda, HDR Engineering, Inc. February, 1999.

2/ Increased truck miles are allocated to highway corridors on the basis of the increased number of trucks per day as reported in the HDR report.

Highway improvement and other costs as a direct result of drawdown of the Snake River were evaluated in the HDR Report. Highway improvements that were identified, in order to maintain adequate highway performance and minimal travel delay include intersection improvements and more frequent maintenance and pavement replacement or overlay. Due to the fact that these costs are based on a lower level of shift of grain to rail, as compared to truck/barge by way of the Tri Cities, actual costs that would be expected on the basis of the Corps' analysis would be closer to the "low" estimates. The estimated costs for highway improvements required by the increased freight movements over Washington highways are summarized below in Table 6-14.

Table 6-14. Summary of Increased Washington Highway Costs with Drawdown.

Highway Corridor	Increased Truck Miles 1/	One Time Costs (millions)						Annual Increase in Accident Costs
		Intersection Improvement		PAVEMENT IMPROVEMENT		Total Transportation Infrastructure		
		Low	High	Low	High	Low	High	
US 395 (Tri Cities to Ritzville)	806,485	$0.0	$0.0	$20.4	$24.4	$20.4	$24.4	$0.5
Pasco-Kahlotus/SR-26 (Tri Cities to Colfax)	721,592	$0.0	$0.0	$18.9	$22.7	$18.9	$22.7	$0.5
SR-124/US-12 (Tri Cities to Clarkston/Wilma)	1,315,844	$0.2	$0.2	$31.3	$37.6	$31.5	$37.8	$1.3
Tri Cities Area (Pasco/Kennewick)	1,230,951	$8.7	$10.4	$4.6	$5.4	$13.3	$15.8	$0.1
Total	**4,074,872**	**$8.9**	**$10.6**	**$75.2**	**$90.1**	**$84.1**	**$100.7**	**$2.4**

Note:

1/ Source: Lower Snake River Drawdown Study, Appendix B, Technical Memoranda, HDR Engineering, Inc. February, 1999.

6.6.2.3 Highway Congestion. As shown in Table 6-12 above, truck transport would increase for nearly 95.2 million bushels of grain. Potential increased truck mileage for non-grain commodities was not computed, but would be relatively insignificant in comparison with grain. Based on the assumption used in this study of a truck capacity of 1,000 bushels (30 tons) of grain per truckload, this represents an increase of approximately 95,200 truck trips to the Tri Cities area. Assuming that truck shipments of grain occur five days per week throughout the year, there would be an increase of 370 average daily truck trips. Without highway and unloading facility improvements, an increase of this magnitude (about 45 trips per hour, assuming a standard workday of 8 hours) could have a significant impact on highway congestion. With the implementation of the highway improvements identified in this report, highway congestion should not increase. However, additional, more detailed engineering and traffic studies will be required to determine what highway improvements would actually be needed.

6.6.3 Elevator Capacity Requirements

With drawdown, it is projected that about 1.1 million tons of grain would shift from the river to rail. In addition, it is projected that an additional 2.7 million tons of grain would be shifted from Snake River ports by truck to the Tri Cities for barging to ports on the lower Columbia River. Additional storage and handling capacity would be needed at both export facilities located on the lower Columbia River and at river ports in the Tri Cities area.

6.6.3.1 Rail Car Unloading Capacity at Export Elevators. Data presented in Sections 3 shows that the combined rail car unloading capacity of all export terminals is 85,000 tons per day. Rail unloading capacity of existing facilities by area of location, is shown below in Table 6-14.

Table 6-14. Rail Unloading Capacity at Export Elevators.

Location	Rail Unloading Capacity (tons/day)	Rail Unloading Capacity (tons/mo.)	Percent of Rail Capacity
Vancouver, WA	14,000	280,000	16.5
Portland, OR	24,000	480,000	28.2
Kalama, WA	47,000	940,000	55.3
Totals	85,000	1,700,000	100.0

Note: Monthly capacity is based on an assumption of 20 operating days per month

To determine if existing capacity can accommodate the increased rail shipments of grain with drawdown, historical monthly rail car unloadings at Columbia River export elevators for the period 1988—1997 were analyzed. This analysis showed a maximum for a single month of slightly less than 1.47 million tons in February of 1980. In terms of averages, the months with the highest averages were February (about 1.05 million tons) and March (about 1.03 million tons). Analysis of the data further showed that in terms of the distribution of grain receipts by rail at export terminals by month, average monthly receipts ranged from a low of 6.2 percent in

June to a high of 9.6 percent in February. The months of May, June and July had receipts less than 7.0 percent of the total and the months of November through March had receipts of 9.0 percent or more of total average annual receipts.

Based on the above analysis of historic peak monthly volume and expected peak additional volume with drawdown, the maximum expected demand on rail unloading facilities with drawdown is estimated to be about 1.6 million tons, which is somewhat less than existing capacity. The derivation of this estimate is shown below in Table 6-15.

Table 6-15. Maximum Expected Rail Unloading Capacity Demand With Drawdown.

Peak Historic Monthly Demand	1,470,000	Tons
Annual Increase in Volume w/Drawdown	1,100,000	Tons
Maximum Monthly Share	9.6	Percent
Maximum Monthly Increase in Demand	105,600	Tons
Maximum Expected Monthly Demand w/Drawdown	1,575,600	Tons

The assessment of existing Columbia River Export capacity does not take into account capacity which would be provided by the grain elevator planned for completion in 2005 at Hayden Island, which would have an annual rail through-put capacity of over 6,000,000 tons. Given that rail capacity has been expanded at some elevators since 1988 and that a new grain elevator is scheduled to be in operation in 2005, actual throughput capacity could be significantly higher than it is at present. After an examination of the historical and projected tonnage by rail through the export elevators, it is not believed that additional rail-handling capacity at these elevators would be needed with drawdown. It is recognized that there are a multitude of factors that impact rail through-put capacity including congestion, export demand, and availability of rail cars to name a few. Historical rail unloadings, however, are considered to be a fair indicator of the rail throughput capacity.

6.6.3.2 Rail Car Storage at Export Elevators. The assessment of rail system requirements (see subsection 6.6.1.1 above) resulted in a finding that withdrawn there would be an increase of from eight to 12 unit-trains of per month being delivered to tidewater terminals, or from about 900 to about 1,300 cars. On the basis of an assumption of two turns per month, approximately one-half of the total number of cars would be in the process of being unloaded while the other one-half would be in the process of being loaded. Thus, rail storage at tidewater terminals or on rail sidings would be needed for from 450 to 650 additional cars. Except at Kalama, a facility that primarily handles corn, rail cars are not stored at the tidewater terminals, except for those that are actually being unloaded. Thus, on a daily basis loaded and empty cars must be shuttled between the terminals and sidings. Since rail facilities have generally been constructed to meet demand, rather than in anticipation of demand, existing rail car storage would be inadequate to accommodate the increase with drawdown.

This analysis, therefore, assumes that additional rail car storage would need to be provided. The additional storage could be provided through expansion of existing rail yards or construction of new ones, or through construction of one or more sidings. For the purpose of providing an estimate of the range of costs for additional storage capacity in the study, construction of a single new siding long enough to accommodate the additional cars is assumed. It is further assumed that in operation, loaded cars would be shuttled from this siding to the various terminals, as they were needed and empty cars would be returned. Based on this analysis, the estimated range of costs to provide new storage for the additional rail cars with drawdown is from about $2.0 million to $4.1 million, including track, rights-of-way, turnouts and control points. The assumptions and data used in the analysis are shown below in Table 6-16. This information was provided to representatives of the UP and BNSF railroads for comment.

Table 6-16. Estimated Tidewater Terminal Rail Car Storage Requirements and Costs With Drawdown

Assumption/Cost Item	Low	High
Number of rail cars	140	335
Track allowance per car (ft)	80	80
Length of track required (ft)	11,200	26,800
Length of track required (mi)	2.1	5.1
Cost of track (per mi)	$ 500,000	$ 500,000
Total cost of track	$ 1,060,606	$ 2,537,879
Cost of new right-of-way (per mi)	$ 200,000	$ 200,000
Total cost of right-of-way	$ 424,242	$ 1,015,152
Number of turnouts required	2	2
Cost per turnout	$ 100,000	$ 100,000
Total cost of turnouts	$ 200,000	$ 200,000
Number of control points required	2	2
Cost per control point	$ 150,000	$ 150,000
Total cost of control points	$ 300,000	$ 300,000
Grand Total	**$ 1,984,848**	**$ 4,053,030**

Source: Cost data are from the TVA/Marshall University study.

6.6.3.3 River Elevators. Grain that moves on the inland waterway moves in response to the market--specifically the international market. However, review of historical shipments shows that a fairly consistent pattern of commodity flow has held over many years even as the transportation system has undergone significant changes with new barge navigation becoming available; multiple car rail shipments and rates; rail car shortages and rail line abandonments; and, larger and larger ocean vessels. The ability of the transportation and marketing system to react to market signals from overseas is dependent on the capacity of the system. But the concept of capacity extends beyond the limits of physical capacity, it also includes interaction with the characteristics of the market itself. Capacity is complex, consisting of storage, loading, put through, seasonality and market fluctuations. Replacing the lost or economically displaced capacity on the Lower Snake, with its many facilities, with one or more facilities in the Tri Cities area increases possibilities of logistical problems, congestion, loss of desired market competition among firms, etc.

Determining the minimum extra capacity needed for efficient handling and movement of grains involves considering the new volume on the river at the Tri Cities, storage needed to handle the needs of the barge loading activity, turn over achieved, and the seasonality of the market flows. These variables were quantified utilizing information from the EWITS studies from Washington State University, Tidewater Barge, SOR, and various other Corps of Engineers' data.

The Tidewater and Corps data show that historically about 55 percent of the volume of grain on the CSRS originated on the Snake River above its confluence with the Columbia River. The remaining 45 percent originated on the Columbia River. The transportation analysis done in this study indicates that an additional 70 percent of the amount that originates on the Snake River (55 percent of the total), or about 2.7 million tons will now be transshipped from truck to barge in the generic Tri-Cities area. The need for additional capacity to efficiently handle this volume is dependant specifically on turnover achieved at river elevators and the seasonality of the volume to be handled.

Turnover ratios (annual or monthly volume divided by the storage capacity) of the facilities on the Snake and Columbia have been identified by the EWITS studies, the Washington Port and Transportation System study and by industry representatives to range from 2 to 20, with 4 being typical at the larger facilities and 15 common at the smaller facilities with minimal storage. Since the required new capacity could be all at one location or at several locations, differing turnover ratios are possible. If a conservative range in turnover ratios of 3 to 10 is considered then the increased river elevator capacity needed to handle the 2.7 million tons (90 million bushels) ranges from about 30 million bushels to about 9 million bushels. This method of estimating additional capacity requirements with drawdown has the effect of giving an estimate of upper and lower limits of the range in probable capacity needs and attendant construction costs.

If the grain volume were to be evenly distributed throughout the year on a monthly basis, the range of storage and put through capacity as estimated above would suffice to handle the new volume. However, grain moves in response to export market conditions that do not have a uniform pattern over the course of a year. Data from the Corps and EWITS show a remarkable consistency in the historical pattern of movements, whether the movement is by rail or barge and whether from upriver or down river origins.

Table 6.17. Percent of Total Grain Shipments Per Month.

Month	All river wheat shipments, 91-95	Lower Columbia Shipments, 1996	EWITS elevator Shipments, 1992	Rail to Port Shipments, 88-97
January	9.0	21.0	10	9.0
February	10.0	13.0	6.0	10.0
March	8.0	0.5	8.0	9.0
April	7.0	0.5	5.0	8.0
May	8.0	0.5	3.0	7.0
June	5.0	0.5	2.0	6.0
July	6.0	7.0	11.0	7.0
August	9.0	17.0	12.0	8.0
September	8.0	7.0	10.0	9.0
October	8.0	6.0	10.0	9.0
November	11.0	8.0	13.0	9.0
December	12.0	8.0	10.0	9.0

Rail is the most regular in shipments but the typical marketing year is seen here as well with a decrease in volume occurring in May-July, with strength in movements in October-March. Barge shipments, both above and below the confluence, especially below, show more variability. Most river maintenance is done in June and July, probably accounting for some of the variance, but the market does move grain in this pattern.

The approximate 20-25 percent (over the average monthly movement) higher movement by barge in November-February suggests an additional 20 percent minimum capacity may be needed to handle this seasonal variation in volume. Thus, additional capacity needed at the confluence or the Tri-Cities area would range from 10.8 million bushels to 36 million bushels of storage and put through capacity, depending on the turnover ratio ultimately achieved.

Estimates were obtained from elevator construction firms and industry representatives for the cost of constructing new elevator facilities. Estimates were obtained for both barebones and state-of-the-art facilities.

If a barebones facility is constructed, estimates of $3 per bushel of storage capacity in steel bins with an additional $2 million for pit, loader, local driveways and an additional $250,000 to $500,000 for land were received. This results in a range of costs for this minimal facility of $34.7 to $110.5 million.

If a full merchandising state-of-the-art facility of concrete with all offices, scales and quality control equipment were built, the cost goes up to $8.50 per bushel of storage capacity, plus another $500,000 each for in water work and for land costs. This capacity then could range in cost from $92.3 million dollars to $306.5 million. So, a range of $34.7 million to $306.5 million exists, depending on turnover achieved and type of facility chosen, to produce the extra capacity needed to efficiently move the increased grain in this location. It should be noted that no rail trackage or roads are included in the estimate (the HDR study for the Washington Legislative Transportation Committee did give costs to upgrade track at both river and country elevators of $24 to $28.9 million). Adding these costs to the cost of new river elevator facilities increases the cost to a range of from $58.7 million to $335.4 million.

6.6.3.4 Country Elevators. Based on information obtained from country elevator operators for the System Operation Review and updated for this study, the Corps believes that there is sufficient capacity at country elevators to accommodate the projected shift of grain from the Snake River to rail with drawdown. In addition, the Corps believes that there now are a sufficient number of country elevators with unit-train (25 or more cars) loading capacity to accommodate the shift. However, improvements to loading and unloading facilities and railcar handling tracks would be needed. The Corps did not estimate costs to upgrade these facilities at country elevators. For this report, cost estimates prepared for the State of Washington in the report, Lower Snake River Drawdown, Appendix B, Technical Memoranda (HDR Engineering, Inc., February 1999) are used. The range of estimated costs shown in this report for upgrading facilities with rail access in Washington was from a low of $14.0 million to a high of $16.9 million. Loading and unloading facilities at railhead country elevators in Idaho are considered to be adequate to accommodate the increase in rail shipment without any improvements.

6.7 CRUISE-SHIP COMMERCE

6.7.1 Industry Analysis

An assessment of cruise-ship operations revealed that no viable alternatives exist for continued service to the destinations now included in cruise itineraries. With drawdown, up river access to cruise ships would be limited to the Tri Cities area. To obtain an indication of what impact this might have on the viability of continued operations on the Columbia River, a sampling of the companies was contacted. The results were as follows:

- Passengers would not be bused to the Lewiston/Clarkston area because they do not like long bus trips and because the attraction of the Hells Canyon jet boat trips is not that strong.
- One option for extending the length of cruises that the companies could do would be to include additional side trips, such as to the Walla Walla area (some now already do this).
- Cruise customers want the experience of traveling. Thus, the duration of the cruises would have to be shortened from the current seven to eight days to about four days. In general, the industry has found that these shorter trips are difficult to market and typically do not earn enough revenue to justify long-term operation. Typically, these trips are offered to utilize vessels when they would otherwise be idle.
- With closure of the Snake River, companies would look for alternate river locations where the longer cruises could be offered, e.g. the Missouri and Mississippi.
- There is a high probability that extended cruises on the Columbia would not be marketable and the river would be abandoned by the industry, except for companies that offer day trips.

Based on the above information, drawdown of the Snake River would terminate the cruise-ship industry in the Lewiston/Clarkston area and probably, on the Columbia River, except for day-trips. Abandonment of the river by the industry could have NED economic costs associated with relocation of vessels and operations to alternative rivers. These costs were not estimated. In addition, there would be a significant loss of revenue to the ports and communities on the CSRS that are frequented by the industry. Based on expenditure data from the Port of Clarkston, and estimated passenger trips for 1999, a preliminary estimate of an annual revenue loss to the Lewiston/Clarkston economy of $2.6 million was made (see Table 6-18). This estimate does not include personal expenditures by passengers, nor does it include expenditures by the cruise ships from Astoria to the Snake River. Cruise ship operators reported to the Port of Clarkston that these expenditures are about equal to the amounts expended in the Lewiston/Clarkston area. Adding these expenditures to the estimate for the Lewiston/Clarkston area would increase total expenditures and potential revenue loss with drawdown to over $5 million annually.

Table 6-18. Estimate of Cruise Ship Revenue Loss with Drawdown--Lewiston/Clarkston Area.

Cruise Line/Vessel	No. Ships	No. Trips	Pass. /Trip	Total Pass.	Expenditures /Pass.	Expenditures/ trip 3/	Season
Adventure Cruises 1/	1	8	90	720	$ 124.00	$ 89,280.00	Apr & Oct
America West Steamboat Co.	1	55	115	6,325	$ 124.00	$ 784,300.00	
Queen of the West 2/	1	55	115				Mar-Dec

Cruise West 4/	4	37	310	11,470	$ 124.00	$1,422,280.00	
Spirit of Alaska	1	13	78				Mar,Apr,May,Sep, Oct
Spirit of Discovery	1	13	84				Mar,Apr,May,Sep, Oct
Spirit of Glacier Bay	1	5	52				Sep & Oct
Spirit of 98	1	6	96				Sep & Oct
Special Expeditions Marine	2	20	140	2,800	$ 124.00	$ 347,200.00	
Sea Lion	1	10	70				May & Jun
Sea Bird	1	10	70				Sep & Oct
Totals				21,315		$2,643,060.00	

Notes:

General--Values for each cruise line is the sum of the values for that line's vessels.

--Except as noted in specific notes, cruise ship information is from each line.

1/ Number of vessels and trips is estimated.

2/ Number of trips is estimated from capacity and bookings for 1999 (sold out).

3/ Estimated from expenditures reported by the Port of Clarkston for 1996 (fuel, laundry, utilities, jet boat trips & docking).

4/ Lands and docks at the Port of Wilma.

6.7.2 Alternative Assessment

Although the industry analysis showed that with removal of the dams it would most likely leave the Columbia/Snake River and relocate to other rivers, this may not actually happen. Because the industry is currently located and operating in the region, the Corps believes that there is a good possibility that operators will do whatever is necessary to remain in the region and continue operations. Of course, the product that would have to offer to the public would be significantly different without access to the Snake River. The industry position is that removal of the Snake River dams would shorten the length of a cruise that could be offered on the Columbia River to the point where it would not be marketable. However, there are no data to support this contention. Also, there may be opportunities to lengthen cruises without access to the Snake River. For example, if the Willamette Falls lock is sufficiently large, including a portion of the Willamette River above Willamette Falls might extend cruises. Also, including portions of the Oregon and Washington coasts might extend cruises. Additional study would be needed to determine if these options would be feasible and to determine if shorter cruises (4 to 5 days in length) would be marketable. At this point all that is know for certain that cruises of this length are not currently offered on the Columbia River.

6.7.3 Conclusion

In absence of data to support the position taken by the industry, it is not certain what the impacts of dam removal would be. In any event, there is no indication that there would be any NED costs, since even if the industry left the region vessels would simply be relocated to alternative locations and operations would continue. Potential regional impacts, however, range from the estimate of about $5 million for the region as a whole that was developed from data from the industry to no impact, assuming that operations continue on the lower Columbia River. In either case, cruise ships would no longer reach the Lewiston/Clarkston area and that region would sustain a direct loss of regional income of an estimated $2.6 million, as shown in Table 6-18.

6.8 SUMMARY – DRAWDOWN CONDITION

Annualized transportation costs associated with all commodities under the drawdown condition are displayed below in Table 6-19. They have been computed at zero, 4.75, and 6.875 percent, are expressed in 1998 dollars, and converted to average annual amounts for the period of analysis, 2007 – 2016.

Table 6-19. Drawdown Condition Summary of Average Annual Costs for All Commodities, 2007 – 2106.

Interest Rate	Average Annual Cost—2007 - 2106
6.875%	$235,769,575
4.750%	$237,674,548
0.000%	$242,339,125

In addition to the annual costs shown above expenditures on transportation infrastructure would also be required prior to actual implementation of drawdown to increase the capacity of the system. These costs are not part of the cost of the federal project to drawdown the Snake River, but would be required as a direct result of implementation of drawdown. Shipping, handling and storage costs used in the analysis include the amortized capital and operating costs of all of the components of the transportation system. A key assumption in the analysis is that capacity can be added to the system at a cost that is no higher than the cost of the capacity that now exists. On this basis, the annual cost of infrastructure improvements is already embedded in the shipping, storage and handling costs used in the analysis. Therefore, it is appropriate that infrastructure costs not be included in the estimated transportation costs with drawdown. Thus, they are presented in this report and summarized below solely for the purpose of informing regional interests of the types of improvements needed and the range of costs that might be expected. In addition, they are required for making estimates of impacts of drawdown on the regional economy: i.e., Regional Economic Development (RED) impacts. Regional interests, however, are cautioned that the estimates are not based on detailed engineering studies and are, therefore, only preliminary estimates. Infrastructure improvements and estimated ranges of costs are summarized below in Table 6-20.

Table 6-20. Summary of Estimated Costs of Infrastructure Improvements Needed with Drawdown.

Infrastructure Improvements	Estimated Costs	
	Low	High
Mainline Railroad Upgrades	14,000,000	24,000,000
Short-Line Railroad Upgrades	19,900,000	23,800,000
Additional Rail Cars	14,000,000	26,850,000
Highway Improvements	84,100,000	100,700,000
River Elevator Capacity	58,700,000	335,400,000
Country Elevator Improvements	14,000,000	16,900,000
Tidewater Rail Car Storage	1,984,848	4,053,030
Total	**$206,684,848**	**$531,703,030**

7. COMPARISON OF BASE AND DRAWDOWN CONDITIONS

This section presents the net change in transportation costs for all commodities between the base condition and a drawdown condition – breaching of the four Federal dams on the lower Snake River.

7.1 INCREASE IN TRANSPORTATION COSTS OF GRAIN.

The increased costs of transporting grain with drawdown are displayed below in Table 7-1. The costs are shown for transportation, storage, handling and total costs by state for the projected volume of grain for 2007. An increase in the volume of grain was actually projected through 2017, at which point no additional growth in volume was projected for the purposes of this analysis. Data for just on level of grain movements are shown because examination of the data for each year throughout the period over which growth was projected showed that growth did not change costs by a significant amount in terms of costs per bushel or per ton. In terms of the cost per bushel, the increase in cost with drawdown ranges from a high of about 21 cents per bushel for Montana to a low of just about 6 cents per bushel for Oregon. As stated in Section 6, storage and handling assumptions were held constant for both the base and drawdown cases. Thus, the difference in cost is due to differences in costs between country and river elevators. For example, storage costs for a country elevator were estimated to be 6 cents per bushel higher than for a river elevator. The actual increase in costs for individual point of origin car vary significantly from the averages for the region and even the States, depending on their location relative to Snake River ports and to railhead elevators. The change in transportation costs is due to the difference in cost between alternative modes and changes in distance. For example, transportation costs for grain shipments increase because of the additional distance of the truck with a terminus of the Tri Cities rather than Lewiston and they decrease because the barge rate from the Tri Cities to tidewater terminals a lower than from Lewiston.

Table 7-1. Increase in Grain Shipments and Shipping Costs With Drawdown for 2007 Projected Volume, by State.[12]

State/ Unit Cost	Volume (bushels)	Transportation ($)	Storage ($)	Handling ($)	Total ($)
Idaho	32,289,941	4,954,984	894,385	410,294	6,259,663
Cost per bu (cts)	32,289,941	15.3	2.8	1.3	19.4
Cost per ton ($)	969,668	5.11	0.92	0.42	6.46
Montana	6,537,310	1,376,031	0	0	1,376,031
Cost per bu (cts)	6,537,310	21.0	0.0	0.0	21.0
Cost per ton ($)	196,139	7.02	0.00	0.00	7.02

12 Costs shown do not include an “adjustment” costs that was calculated by the model to prevent the cost of any movement with drawdown from being less than it was estimated to be in the base condition. The total regional adjustment amounts to $794,781.

N. Dakota	2,458,172	261,556	0	0	261,556
Cost per bu (cts)	2,458,172	10.6	0.0	0.0	10.6
Cost per ton ($)	73,753	3.55	0.00	0.00	3.55
Oregon	980,218	61,328	0	0	61,328
Cost per bu (cts)	980,218	6.3	0.0	0.0	6.3
Cost per ton ($)	29,409	2.09	0.00	0.00	2.09
Washington	84,355,029	11,586,875	1,580,001	737,028	13,903,904
Cost per bu (cts)	84,355,029	13.7	1.9	0.9	16.5
Cost per ton ($)	2,530,904	4.58	0.62	0.29	5.49
Totals	126,620,670	18,240,774	2,474,386	1,147,322	21,862,482
Cost per bu (cts)	126,620,670	14.4	2.0	0.9	17.3
Cost per ton ($)	3,802,423	4.80	0.65	0.30	5.75

The estimated additional costs for transport of grain as a result of drawdown were converted to average annual values for the period of analysis, 2007-2106. These annual amounts, in terms of totals, cost per ton and cost per bushel and computed at three different rates of interest are displayed in Table 7-2. The values shown reflect 1998 price levels,

Table 7-2. Average Annual Change in Shipping Costs of Grain With Drawdown at Selected Interest Rates.[13]

	Interest Rate		
	6.875%	4.75%	0.00%
Transportation Cost Increase			
Total ($)	18,827,438	18,965,029	19,319,712
Cost per Ton ($)	4.96	4.99	5.09
Cost per Bushel (cents)	14.87	14.98	15.26
Storage Cost Increase			
Total ($)	2,553,967	2,572,632	2,620,745
Cost per Ton ($)	0.67	0.68	0.69
Cost per Bushel (cents)	2.02	2.03	2.07
Handling Cost Increase			
Total ($)	1,184,223	1,192,877	1,215,186
Cost per Ton ($)	0.31	0.31	0.32
Cost per Bushel (cents)	0.94	0.94	0.96
Total Annual Cost Increase			
Total ($)	22,565,628	22,730,538	23,155,643
Cost per Ton ($)	5.94	5.98	6.10
Cost per Bushel (cents)	17.82	17.95	18.29

Note: Unit costs are computed from the volume of grain projected for 2007.

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13 Values exclude adjustments calculated by the model to prevent estimated costs with drawdown from being less than costs without drawdown, as follows: 0.00 percent interest, $269,805; 4.75 percent interest, $264,855; and, 6.875 percent interest $262,933.

Total Bushels	126,620,670
Total Tons (33.33 bu/ton)	3,799,000

7.2 INCREASE IN TRANSPORTATION COSTS OF NON-GRAIN COMMODITIES.

The estimated additional transportation costs of non-grain commodity movements as a result of drawdown were computed for each commodity group and for the same selected years as were used for grain. As with grain, no additional increase in volume is forecast beyond 2017. These costs are shown below in Table 7-3.

Table 7-3. Average Annual Change in Shipping Costs for Non-Grain Commodities With Drawdown, by Commodity Group and at Selected Interest Rates.

Year/Commodity Group	Cost Increase
2002	
Petroleum	$ 512,071
Logs and Wood Chips	$ 1,440,861
Wood Products	$ 1,064,591
Other	$ 518,133
Total	**$ 3,535,656**
2007	
Petroleum	$ 548,456
Logs and Wood Chips	$ 1,440,861
Wood Products	$ 1,274,167
Other	$ 587,610
Total	**$ 3,851,094**
2012	
Petroleum	$ 584,458
Logs and Wood Chips	$ 1,440,861
Wood Products	$ 1,629,181
Other	$ 683,880
Total	**$ 4,338,380**
2017	
Petroleum	$ 673,314
Logs and Wood Chips	$ 1,440,861
Wood Products	$ 2,064,593
Other	$ 790,595
Total	**$ 4,969,363**

The estimated additional transportation costs of non-grain commodity movements were also converted to average annual values for the period of analysis. These annual amounts, computed at each three rates of interest, are displayed in Table 7-4, below. As with grain, costs reflect the 1998 price level.

Table 7-4. Average Annual Change in Shipping Costs for Non-Grain Commodities With Drawdown, by Commodity Group and at Selected Interest Rates.

INTEREST RATE/COMMODITY GROUP	Cost Increase
6.875%	$4,623,910
4.75%	$4,709,693
0.00%	$4,904,266

7.3 CHANGE IN TRANSPORTATION COSTS - ALL COMMODITIES

Data presented below in Table 7-5 represent the average annual costs in current dollars of commodity transport attributable to closure of the Lower Snake River to commercial navigation. The costs shown include the adjustments for grain that were excluded from Table 7-2 (see footnote 2).

Table 7-5. Average Annual Shipping Cost Increase for all Commodities.

Interest Rate	**Average Annual Cost Increase--All Commodities**
6.875%	27,452,471
4.750%	27,705,085
0.000%	28,329,717

The annual amounts above were adjusted to reflect comparable values as of 2005. This was done to allow the comparison of each of the fish restoration strategies that are being considered in the feasibility study. Average annual additional costs as of 2005 are displayed below in Table 7-6.

Table 7-6. Average Annual Shipping Cost Increase for all Commodities—2005 conditions.

Interest Rate	**Average Annual Cost Increase--All Commodities**
6.875%	24,034,173

4.750%	25,249,421
0.000%	28,329,717

7.4 SUMMARY

The volume of grain that is expected to move on the Lower Snake during the 20-year growth period that was utilized for the study is shown below in Table 7-7. These projected volumes were developed from IWR forecasts and represent anticipated waterborne grain shipments, without drawdown. They are shown at 5-year intervals. With drawdown, these volumes would shift from direct shipment from ports on the Snake River transport to alternative modes, including river transport via ports on the Columbia River.

Table 7-7. Projected Grain Shipments on the Lower Snake River Without Drawdown.

Year	Projected Tonnage	Projected Bushels
2002	3,647,000	121,554,510
2007	3,799,000	126,620,670
2012	3,798,000	126,587,340
2017	3,892,000	129,720,360

As of the initial year of project implementation, (2007) an estimated 126.6 million bushels of grain would be diverted from the lower Snake River. This amounts to approximately 3.8 million tons annually. Of this volume, it is projected that approximately 1.1 million tons would shift from the river to rail for transport, while the remaining 2.7 million tons would move by truck to river elevators in the Tri Cities area that are located on the McNary pool on the Columbia River and be transshipped by barge. A breakdown of the volumes expressed in bushels by mode of transportation and by state of origin is shown below in Table 7-8.

Table 7-8. Grain Shipments Shifted from the Snake River by Alternative Transportation Mode and State—2007 Conditions.

State	Truck-Barge		Rail		Total	
	(bushels)	(Tons)	(bushels)	(Tons)	(bushels)	(Tons)
Idaho	11,569,804	347,129	20,720,137	621,666	32,289,941	968,795
Montana	6,537,310	196,139	-	-	6,537,310	196,139
Washington	68,459,852	2,054,001	15,895,177	476,903	84,355,029	2,530,904
Oregon	980,218	29,409	-	-	980,218	29,409

N. Dakota	2,458,172	73,753	-	-	2,458,172	73,753
Total	90,005,356	2,700,431	36,615,314	1,098,569	126,620,670	3,799,000
Percent	71.1		28.9		100.0	

Of the total grain volume diverted from the Lower Snake River with drawdown, approximately 71 percent would move by truck to river elevators below Ice Harbor Dam on the McNary pool and then by barge to deep-water terminals. The remaining 29 percent would shift to rail for direct transport to export elevators via railhead elevators with the capability of loading 25 or more cars. Data on the volume diverted, the increased costs of transport, and the estimated increase in bushel-truck miles for selected years are summarized below in Table 7-9. Projected rail tonnage and bushel-miles for the same years as shown for trucks in Table 7-9 are shown in Table 7-10.

Table 7-9. Volume of Grain Diverted from the Snake River with Drawdown and Associated Increased Transportation, Storage and Handling Costs and the Increase in Truck Miles for Selected Years.

			Increase in Costs, Bushel-Truck Miles and Truck Miles				
Year	Projected Tonnage	Projected Bushels	Transportation	Storage	Handling	Bushel-Truck Miles	Truck Miles
2002	3,647,000	121,554,510	17,510,951	13,665,869	1,101,417	3,059,592,171	3,516,773
2007	3,799,000	126,620,670	18,240,774	14,235,436	1,147,322	3,187,110,133	3,663,345
2012	3,798,000	126,587,340	18,235,972	14,231,689	1,147,020	3,186,271,199	3,662,381
2017	3,892,000	129,720,360	18,687,310	14,583,922	1,175,409	3,265,130,992	3,753,024
2022	4,052,000	135,053,160	19,455,545	15,183,466	1,223,730	3,399,360,427	3,907,311

Table 7-10. Projected rail tonnage and bushel-miles for Selected Years.

Year	Projected Rail Tons	Projected Rail Bushel-Miles
2002	1,054,615	Na
2007	1,098,569	Na
2012	1,098,280	Na
2017	1,125,462	Na

Na = not available.

As a result of the drawdown there is expected to be additional rail and truck movements. The analysis indicates that approximately 29 percent of the grain movements that utilize the Snake River waterway would be diverted to rail, with the remainder diverted to river facilities below Ice Harbor Dam and loaded on barges. Based upon the foregoing analysis, the additional average cost to transport grain under a drawdown condition is estimated to be approximately 18 cents per bushel (see Table7-2).

Based on the model output, nearly 64 percent of the total increase in transportation costs is for movements that originate in Washington State; about 29 percent of the costs are for movements that originate in Idaho; and the remaining 7 percent of the costs are movements that originate in Oregon, North Dakota, and Montana. Sixty percent of the grain that would move to the Snake River without drawdown originates in five counties in Washington (Adams, Garfield, Spokane, Walla Walla, and Whitman). The amount of grain diverted from Whitman County is almost equivalent to all of the other states combined. The breakdown of the origin of grain and increased grain transportation costs, in terms of percent by state of origin, is tabulated in Table 7-11 below.

Table 7-11. Summary of the Percent of Snake River Barged Grain and Increased Transportation Costs with Drawdown, by State.

State of Origin	Percentage of Snake River Barged Grain	Percentage of Increased Transportation Costs
Oregon	1.0%	0.3%
Idaho	22.0%	28.6%
Washington	69.0%	63.6%
N. Dakota	2.5%	1.2%
Montana	5.5%	6.3%
Totals	100.00%	100.00%

7.5 COMPARISON OF RESULTS WITH SOR AND EWITS

Previous studies of impacts of drawdown on the transportation system include the System Operation Review (SOR), completed in 1995, and the Eastern Washington Intermodal Transportation Study (EWITS), competed in 1998. These studies are briefly described in this subsection and a summary comparison is presented.

7.5.1 System Operation Review (SOR). The transportation system impacts analysis completed for the SOR has the same geographic scope as this study. And, in fact, was the basis for the analysis completed for DREW. As with the DREW study, the SOR only included commodities shipped on the Snake River without drawdown. Thus, total commodities movements are not established in either study, except for movements on the CSRS. In the SOR, four drawdown alternatives were evaluated, including a natural river operation. A significant difference in the studies appears to be the inclusion of the Tri Cities in the DREW study as an alternate truck/barge link. This type of routing link does not appear to have been included in the SOR. The predictable result is that the SOR showed a much larger shift of grain to rail than the DREW study. A direct comparison of the percent shift to rail is not possible, because SOR data are shown by river-port rather than by State of origin. In the SOR, the shift to rail ranged from 100 percent of the grain shipped through Lewiston and Almota, 90 percent of the grain shipped through Wilma, 86 percent of the grain shipped through Central Ferry and 36 percent of the grain shipped through Garfield. None of the grain shipped through Lyons Ferry shifted to rail.

Except for the increase in cost with drawdown, results of the SOR are not comparable to the results for the DREW study because of different reporting methods. The change in transportation costs developed for the DREW study is compared with that developed for the SOR in Table 7-12. The percent difference between costs estimated for the DREW study and the SOR is also shown. Overall, the cost increase estimated for the DREW study is about 90 percent lower than the cost estimated for the SOR. Further, costs are lower for all of the states, except Montana and North Dakota. In the SOR, grain from these states was shifted to rail, whereas, in this study, the grain continues as a truck/barge movement, but from the Tri Cities rather than ports on the Snake River. The inclusion of a truck/barge alternative for Montana and North Dakota was possible in this study because of the use of a "back-haul" rate for the truck segment of the route.

Table 7-12. Comparison of Storage, Handling, Transportation and Total Grain Transportation Cost Increases With Costs Estimated For The SOR, by State.[14]

Year/State	Volume (bushels)	Transportation ($)	Storage ($)	Handling ($)	Total ($)	Difference (%)
DREW Analysis (1)						
Idaho	32,289,941	4,954,984	894,385	410,294	6,259,663	-106.0%
Montana	6,537,310	1,376,031	-	-	1,376,031	81.2%
N. Dakota	2,458,172	261,556	-	-	261,556	65.8%
Oregon	980,218	61,328	-	-	61,328	-6.7%
Washington	84,355,029	11,586,875	1,580,001	737,028	13,903,904	-102.5%
Totals	126,620,670	18,240,845	2,474,386	1,147,324	21,862,482	-89.7%
Cost per bu (cts)	126,620,670	14.4	2.0	0.9	17.3	
Cost per ton ($)	3,799,000	4.80	0.65	0.30	5.75	
System Operation Review						
	Volume (bushels)	**Transportation ($)**	**Storage ($)**	**Handling ($)**	**Total ($)**	
Idaho	na	8,598,033	3,225,861	1,068,549	12,892,443	
Montana	na	793,596	(184,903)	(350,195)	258,498	
N. Dakota	na	403,833	(108,649)	(205,774)	89,410	
Oregon	na	65,429	-	-	65,429	
Washington	na	23,750,807	4,087,669	318,325	28,156,801	
Totals	na	33,611,698	7,019,978	830,905	41,462,581	

Notes:

14 Totals exclude an adjustment of $794,781 that was calculated by the model and added to the totals to prevent the cost of a movement from being less with drawdown than it was without drawdown.

(1) Data for 2007.
na = not available

7.5.2 Eastern Washington Intermodal Transportation Study (EWITS). Although focused on the same issue, drawdown or breaching of the four Snake River Dams, the EWITS analysis and the analysis conducted for the DREW are quite different in objectives, geographical and commodity scope, and methodology. EWITS was a six-year research program in the Department of Agricultural Economics at Washington State University authorized and funded by the Federal government in the ISTEA bill. It produced 26 research studies and 11 working papers. The study of concern here is that reported in EWITS #24 and several previous reports.

The objectives of EWITS #24 were: (1) to develop a transportation optimization model for accurately modeling commodity movements on eastern Washington highways, railroads and river system; (2) to link the model with pavement damage models to predict accelerated pavement degradation, highway infrastructure impacts, and financial recovery needs; (3) to estimate shipper transportation costs for different policy scenarios, incorporating pricing interactions from rail and barge companies competing in the region; and, (4) to spatially identify the infrastructure network supporting grain truck shipments under different policy scenarios on eastern Washington roads and highways. Thus, the emphasis was on the impacts on shippers of the modal shifts caused by the dam breaching but was broader, providing specific information to the WSDOT on the magnitude and location of damage to roads and the attendant financial needs.

EWITS was far narrower in scope than is DREW, covering only the eastern 20 counties of Washington, as contrasted to the coverage of Washington, Oregon, Idaho, Montana and North Dakota by DREW. The only commodities considered in EWITS were wheat and barley while DREW covered all commodities moving on the river. For example, wood chips and logs account for about 17 percent of the volume. About 4.5 million tons of wheat and barley from eastern Washington on all modes were examined in the EWITS study while DREW looked only at the 3.8 million tons of grain that moved on the river by barge transportation.

An important difference in reporting in the studies was, given the clientele of the EWITS, the changes were reported as averages over all the industry grain movements because that was the focus of the work, the entire wheat and barley industry. It should be noted that barley in some cases experienced up to nine times the impact that wheat movements incurred. DREW, on the other hand, only looked at the changes and average impacts for the grains and commodities that moved initially on the river. Thus, careful attention has to be paid to the volume being reported if comparisons are attempted.

Both studies use transportation models of sorts but the EWITS model used GIS/GAM optimization software to determine least cost movements and give shippers and different locations numerous options to move the grain. Each road from township center was located and evaluated as to pavement type or condition. Such detail was necessary because of the objectives and focus of the study. DREW=s analysis uses a database approach to determining the costs of transportation, handling and storage, with only two alternative routings for commodity movements from each origin.

DREW considers capacity constraints outside of the model, along with any rate responsiveness and elasticities of modal rate change. EWITS model scenarios specifically include the impact on costs under differing capacity constraints, barge rate changes and rail rate responses. Examining the traffic flows under the different scenarios allows an average estimation of the cross elasticity of demand between modes and also gives a sense of the impact of capacity constraints.

Another important difference in the models is that EWITS used rates while DREW used costs of transportation, which probably accounts for some of the magnitude in difference for the models. Similarly, DREW provides in depth information on the transportation, handling and storage charges as individual items. The EWITS model simply incorporates these costs into one rate for each origin-destination pair. The storage and handling costs do, then, receive more importance in the DREW results.

Even with this pronounced differences it appears the two studies, in the areas that can be tracked, do find similar while not identical results. DREW estimates the costs of moving the grain that had been moved on the river will increase by 27 cents per bushel, slightly over a fifty percent increase. EWITS finds that, over all the grain moved by the industry, the costs would increase about10 cents per bushel for wheat (about a 20 percent and a 30 percent increase, respectively, for wheat and barley), with those areas close to the river that had been dependent on the river transportation experiencing up to a 32-cent per bushel increase. Many of the movements that had been rail before experienced little or no increase in some of the scenarios. The total increase for the grain from eastern Washington was about 15 million dollars while the total transportation, handling and storage cost increase for all five states under DREW was 34 million dollars. Of special note is that the Washington share of DREW costs is about 21million dollars, as contrasted to the 15 million dollars estimated in the EWITS.

8. RISK AND UNCERTAINTY

8.1. GENERAL.

Issues related to breaching of Federal dams that are not captured in the NED analysis are addressed in this section. In addition, the sensitivity to the analysis to alternative assumptions and input values is assessed. Issues of risk and uncertainty include concerns about system capacity, potential transportation rate impacts, impacts to roads and highways, and potential effects of sediment deposition in the Columbia River channel. The plan to breach the Federal dams on the lower Snake River raises a considerable level of uncertainty with regard to the magnitude of economic and/or financial impacts that could potentially be experienced with plan implementation. One primary area of uncertainty as it relates to drawdown is the capability of the existing transportation system as it is presently configured to accommodate the types of changes among modes and routings that are projected with river closure. A second area of uncertainty is the magnitude of financial impact that may be experienced by producers and shippers of commodities given the extensive transformation that would occur within the transport sector of the Pacific Northwest. In addition to the above, concerns with highway impacts, effects of siltation downstream of the dams, and modal reliability issues represent elements of uncertainty under a drawdown scenario. To address the potential impacts of these and other related issues, several sensitivity analyses were developed in an attempt to identify the range of additional economic and financial costs that could potentially be experienced with river drawdown. To address concerns such as added siltation of the Columbia River channel, modal reliability, and petroleum movements by pipeline, a discussion is provided describing the potential impacts, and how they might influence estimated NED costs.

The following sources of uncertainty are addressed in this section:

- Capacity
  - Railroad
  - Export elevators
  - River elevators
- Roads and highways
- Modal rates
- NED efficiency loss with monopoly increase in rates
- Transportation system reliability
- Potential siltation with drawdown
- Construction of a petroleum pipeline
- Grain forecast
- Potential impacts on the export market for grain
- Duration of transition to equilibrium with drawdown
- The incidence of infrastructure costs.

8.2. CAPACITY REQUIREMENS.

A major source of uncertainty involves the capacity of the infrastructure that presently characterize the storage, handling and transportation system, and how new requirements made necessary by a drawdown might be accommodated. Uncertainty also exists regarding the length of time that would be required for the regional transportation system to adapt to these changes and reestablish an equilibrium condition.

The potential exists that with drawdown, product delivery, at least in the near term, could not be maintained at present levels. This near term problem could result from lack of adequate infrastructure, loading/unloading capacity, hopper car availability, or the ability of the system to accommodate the seasonal aspect of grain deliveries because of the change in the volume of commodities shipped by each mode. Export terminals on the lower Columbia River were designed to accommodate a mix of transport modes--rail, barge and truck. If a significant shift from barge to rail were to occur, it is uncertain whether there is sufficient handling capacity at the export terminals as they are now configured to accommodate throughput of existing and projected commodity volumes. This may also be the case for highway and road capacity and added maintenance requirements within grain transportation corridors.

A detailed assessment of the infrastructure necessary to accommodate the shifts of barge traffic to alternate modes and routes as the result of a lower Snake drawdown was not performed for this study. However, a preliminary assessment has been developed based on Corps' and Washington State Transportation studies and knowledgeable industry representatives. The assessment has been separated into three primary components, rail line capacity, export elevator capacity, and river elevator capacity. These components are believed to encompass the major infrastructure requirements for transportation. The assessment of highway capacity was limited to estimates of increased maintenance costs from the increase in truck traffic and to the need for traffic controls in some locations. The assessment showed that no new roads would need to be constructed.

8.2.1. Rail Capacity.

8.2.1.1 Railcar Availabilty. The potential for rail car shortage with drawdown was addressed during technical review of studies prepared for the Washington State Legislative Transportation Committee. These studies included the Eastern Washington Intermodal Transportation Study[15] and the Eastern Washington Freight Mobility Study[16].

15 Washington State University, 1991 – 1998.
16 Lund Consulting, Inc. and HDR Engineering, Inc., 1998

Technical reviewers found that a shortage of rail car capacity is not likely to occur, for the following reasons:

- Shuttle trains of 100 or more cars, which are being successfully used in the Midwest, could be deployed.
- Shippers could utilize the railroads' Certificate of Transportation Program, in which shippers can bid for cars.
- Shippers could buy their own cars and put them into railroad pools.
- The railroads could acquire the additional cars that would be needed to operate under the assumption of the 26-car movements that were assumed in the study.

In addition to the above options, another option is for acquisition of rail cars by government. An example of this strategy is the formation of the Grain Train by the State of Washington,

in partnership Port of Walla Walla, the Blue Mountain Railroad (BLMR), and four local grain co-ops. The Grain Train consists of 29 hopper cars that are used to carry wheat from four Washington shipper co-ops located in Thornton, Endicott, Willada, and Prescott (southeast Washington) to the deep-water ports at Kalama, Seattle, and Vancouver, Washington, as well as Portland, Oregon. In the first six months of service, the state-owned grain cars transported over 25,000 tons of wheat to Columbia River ports.

Although there are uncertainties about the availability of rail cars with drawdown, a number of options for ensuring an adequate supply are available. However, acquisition of the additional cars will not occur until such time as drawdown is actually authorized and funded by Congress: i.e.; drawdown must be a certainty. Once drawdown is known to be a certainty, it is certain that grain producers, exporters, shippers and government agencies will work together to insure that sufficient rail cars are available to accommodate the shift of grain from the Snake River to rail. In addition, Corps analysts believe that the time required to design and implement drawdown is more than sufficient to allow for the acquisition of the additional rail cars, such that the availability of rail cars will not be a constraint on the flow of grain to export markets. Estimates of the number and range of costs for the additional cars are discussed in Section 6.

8.2.1.2 Line Haul Capacity. With drawdown there would be an increase in traffic on both mainline and short-line railroads, particularly in Idaho and Washington. Implications of this increased demand on line haul capacity of mainline railroads were examined in a study prepared for the Corps by the Tennessee Valley Authority and Marshall University.[17] The study included modeling shipment of waterborne traffic that would be diverted from the Snake River with drawdown by rail to export facilities on the lower Columbia River. The model was constructed and operated on the basis of the assumption that all Snake River traffic would shift to rail—which is not actually expected to be the case. Even with the assumption of full diversion of Snake River traffic to rail, the study concluded the following. "In most cases, the line-haul segments that, together, form the routes over which regional rail traffic flows could be modified to accommodate Snake River barge traffic without placing a significant upward pressure on competitively developed railroad rates. While some specific route segments might require substantial incremental expenditures to accommodate additional traffic, the adverse rate effects of these expenditures would be largely offset by the efficiencies gained through expanding the capacity of related route segments."

8.2.2. Export Elevator Capacity.

Capacity concerns and uncertainties at Lower Columbia River export elevators includes, rail unloading capacity, rail car storage capacity and throughput capacity. Each of these concerns is addressed in this subsection.

8.2.2.1 Rail Car Unloading Capacity. This study estimates that approximately 1.1 million tons (29.3%) of the grain that now moves on the Snake River would be diverted to rail with drawdown. In an average month, this is a 14.4 percent increase over the volume what would normally arrive by rail without drawdown. The ability of export facilities to handle this increased volume was addressed in the Tennessee Valley Authority/Marshall University study cited above. The findings of the study were that there is more than ample rail unloading capacity at export elevators to handle the increased rail shipments of grain with drawdown of the Snake River. Specifically, the study concluded that, "concerns regarding terminal congestion and the adverse effects this congestion may have on railroad pricing are unfounded." As a check on the adequacy of rail unloading capacity to handle the shift of grain to rail, rail movements by month for the 1988 – 1997 period were evaluated together with the projected increase with drawdown and compared with rail unloading capacity at existing facilities. This analysis, which is discussed in Section 6, resulted in the conclusion that increased rail shipments of grain with drawdown could be handled without any infrastructure improvements.

While aggregate unloading capacity appears to be adequate, there is a significant amount of uncertainty about the adequacy of capacity at individual facilities. On an individual basis, facilities may experience unloading capacity shortages, depending on market conditions for users of individual facilities.

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17 Tennessee Valley Authority and Marshall University, "The Incremental Cost of Transportation Capacity in Freight Railroading: An Application to the Snake River Basin," July 1998 (draft).

8.2.2.2 Rail Car Storage at Export Elevators. Rail car storage is yet another concern of export grain facility users. Although the analyses conducted for this study provide an estimate of the additional capacity that may be needed and a range of costs, based on low and high estimates of the number of additional cars that would be needed, there remains significant uncertainty about the actual amount of storage that would be needed; the cost of the additional storage; and, the location of the storage. In addition, it is certain that any shift of grain from barge to rail will cause concern and uncertainty in the grain export industry about the reliability and efficiency of the expanded rail system, including storing and handling rail cars at the tidewater terminals. This is a concern and uncertainty that exists and is real, but cannot be quantified.

8.2.3. River Grain Elevator Capacity.

With drawdown, the volume of grain projected to be moved through river elevator facilities in the Tri Cities and confluence of Snake and Columbia Rivers area would increase from a range of 35 to 55 million bushels over the last ten years to a range of 125 to 145 million bushels, an increase of 90 million bushels. In all, as many as nine river elevators could be closed with closure of the Snake River. Clearly, additional capacity will be needed. However, there is a significant amount of uncertainty about the actual amount of additional capacity that would be needed and where it would actually be located. The assessment presented in Section 6 is based on the assumption that grain would be diverted to the Tri Cities area. However, it may be more cost-effective to construct unit-car rail loading facilities at existing elevators located on the lower Snake River (e.g. Elevators in the Lewiston/Wilma and Central Ferry areas.). This would allow grain to continue to be trucked to existing river elevators (rather than to the Tri Cities) for reshipment by rail to tidewater terminals, or shuttled to terminals in the Tri Cities for reshipment by barge.

8.3 HIGHWAY IMPROVEMENTS AND POTENTIAL CONGESTION

With diversion of nearly 90 million bushels of grain from the Snake River to the Tri Cities area on the Columbia River by truck, the potential exists for a significant impact on highway congestion in the Tri Cities. It is estimated that transport of this volume of grain would require 370 truck trips per day, on average. This assumes a five-day workweek. Although highway improvements needed to mitigate for the increase in traffic and estimates of the cost of the improvements have been made, there remains a significant amount of uncertainty about the improvements and costs that would actually be required. Resolution of this uncertainty was beyond the scope of this study. Therefore, prior to actual implementation of drawdown, detailed engineering studies would need to be made and highway improvements would need to be constructed to avoid significant damage to highways and an increase in traffic congestion. The analyses conducted for this study show that only Washington would be significantly impacted by increased truck traffic with drawdown.

8.4 MODAL RATE IMPLICATIONS

8.4.1 General. For purposes of analyzing with and without-project conditions for transportation, modal costs were estimated and applied in both scenarios. The Corps of Engineers and DREW consider the use of costs, as compared to rates, appropriate inasmuch as they represent resource costs. Modal costs were derived from transportation costing models developed and maintained by Reebie Associates. Although modal costs are utilized in the NED analysis of transportation, there remained a need to identify the potential for, and magnitude of rate increases by competing modes assuming the absence of barge competition in the region served by the Lower Snake. It is recognized that competition between and among different modes serves to promote economic efficiency and also maintain competitive rates among different modes of transport. Effective competition between transportation modes in the region is an important force needed in the region to keep rates reasonable and promote efficient movement of commodities. Disturbing this competition could be one of the most important consequences of permanent drawdown. Although not considered an NED effect, the potential for railroads to increase rates given a less competitive environment could significantly affect shipping costs borne by producers in moving their grain to export markets.

To address this concern, the transportation analysis was expanded to examine potential rate impacts under drawdown conditions. Two conditions were considered: First, could drawdown result in a rail rate increase imposed on new movements in the affected region, that is, movements that would switch from barge to rail in the event of drawdown. The second, condition considered a phenomenon referred to as water-compelled rates, wherein the presence of a water alternative acts as a disciplining force in that rates on existing movements are less than would be likely in the absence of potential alternatives. In effect, does the presence of a waterborne alternative act to restrain rates charged to users who, for whatever reason, do not utilize the river system?

8.4.2 Water-Compelled Rates Study. The question of water-compelled rates was addressed in an analysis was performed by the Tennessee Valley Authority and the Center for Business and Economic Research. The purpose of the study was to assess potential rate impacts that might be expected to occur with closure of the Snake River. The context of the analysis was the determination of national and regional economic benefits of commercial navigation on the Snake River. The analysis developed estimates of savings that accrue to shippers directly using the Snake River portion of the CSRS, and also savings realized by shippers who, although not shipping via this system, nonetheless benefit from its competitive influence.

In analyzing savings to shippers who utilize the river, the analysis incorporated data from 1996 that covered 11 commodities. The analysis was made using a sample of 35 movements from or to the Snake River navigation system, which represented more than 79% of total 1996 traffic. Analysis of the transportation cost savings showed that by shipping by barge, shippers saved more than $5.95 per ton in transportation and handling costs, compared with the cost of the least expensive all-land transportation alternative. In total, the shipper savings attributable to CSRS navigation for those 1996 movements amounted to more than $16 million. The assessment thus estimated those cost savings for the entirety of the commercial traffic originating or terminating on the Snake River likely exceeded $20 million for the same period.

With respect to water-compelled rates, the analysis concluded that the presence of available inland navigation in the Pacific Northwest provides a disciplining force that reduced regional aggregate payments to railroad rates during 1996 by nearly $8 million. The above report provides documentation to substantiate these findings. The report is included in this report as Technical Exhibit B.

The analysis found that very little of the grain that (barley – 8% and wheat – 15%) moved by rail during 1996 to, from, or within the Pacific Northwest had its origin within the effective range of the Snake River system. With the exception of five interior counties in Washington, the vast majority of the grain loaded to rail comes from locations that are simply too distant for the Snake River system to exercise it's influence. It is also worth noting that 20% of the barley and 28% of the wheat arriving in the PNW originates outside the region as a whole. Thus, it is probable that competitive conditions in and to other export locations affect railroad rates within the Pacific Northwest. This suggests that where barge and rail are both viable options, the presence of barge transportation has a significant affect on railroad pricing. Unfortunately from the standpoint of shippers, the opportunities for this competitive interaction are limited.

While the study described above specifically addressed the effect of the presence of the CSRS on rail rates, the converse can also be expected to be true. That is, the presence of rail as an option to shippers has a lowering influence on barge rates. In either case, the magnitude of the dampening influence on rates imposed by competing modes is ultimately a function of long-run marginal costs of the respective modes. Further, the magnitude, or strength, of the dampening effect of competing modes can be determined by comparing modal long-run costs with rates and examining the magnitude of the difference between costs and rates for each mode. An effective or strong dampening influence on rates would be evidenced by relatively small differences between costs and rates and, vice versa, a relatively weak influence would be evidenced by a relatively large difference between costs and rates. A comparison of modal rates and costs is presented below as part of the discussion of a study conducted for the Corps be the Upper Great Plains Institute.

8.4.3 Studies by Whiteside and Associates. Studies performed by Whiteside and Associates suggest that the absence of viable transport alternatives in the State of Montana cost producers approximately $50 million annually. If the rate effects for other states are also taken into account, this figure could potentially range up to $100 million.

8.4.4 Analysis of Rates and Rail Pricing Behavior with Drawdown. In addition to the studies described above, the Upper Great Plains Transportation Institute (UGPTI) conducted an analysis of current rates for barge, rail and truck transport of grain. The central question asked in the analysis is "…what are the logistical impacts (rate changes and modal shifts) on grain shipments from the traditional lower Snake River origin freight territories."[18]

The study included an assessment of the ability of each transportation mode (trucks, rail and barge) to change rates in response to drawdown. The analysis considered two market areas, a long distance market (Montana and North Dakota) and a local market with a distance of up to about 250 miles from the CSRS. Actually, all of the rest of the region was included in the local market, including areas in southeastern Idaho that are more distant than 250 miles. The conclusions of the assessment for the long distance market are that this market includes truck shipments of grain only because grain is a backhaul to carriers whose primary cargo is Northwest building materials that are shipped to eastern destinations as far away as Chicago. The study found that truck shipments of grain are made at below full costs but above incremental costs (costs specific to the trip). This means that as long as the primary haul market exists, grain will continue to be trucked to the Northwest. The study further found that rail rates are determined by factors other than the truck-barge and that drawdown would have no effect on rail rates in the long distance market.

In the local market, the study found that rail shipments of grain in this market are made at rates that are below fully allocated costs. Thus, from this viewpoint, these movements are currently unprofitable. This does not mean that the railroads lose money on the movements. The revenue from the shipments cover all of the variable costs and make a contribution toward allocated fixed costs of the system. Thus, the railroads could theoretically indefinitely continue providing grain transport service to the Northwest at the current rate structure. However, because grain transport service does not provide sufficient revenue to pay the full cost of the service, the railroads do not have a strong incentive to adopt a rate strategy that would entice grain shippers away from the river, even with drawdown. Nevertheless, the study found that rail rates are likely to increase with drawdown. Lacking a strong profit incentive to increase market share, the railroads are expected to limit rate increases to the amount of the increase in the combined truck/barge rate with drawdown. This strategy would slightly improve the railroads' revenue-cost ratios for Northwest grain transport service, but would leave the relative competitiveness of the two modes unchanged.

Another factor at play in the response of the railroads to drawdown is their awareness of the sizeable margin of profit that the barge industry now has in grain transport on the CSRS. The railroads are aware that if they were to attempt to draw grain away from the CSRS, the barge industry's profit margin gives it the flexibility to adopt an aggressive rate strategy that would offset the increase in the truck component of the truck/barge transport option with drawdown. Adoption of such a strategy by barge operators could significantly reduce the volume of grain actually shifted to rail. This in turn would significantly reduce the

18 Upper Great Plains Transportation Institute, "Lower Snake River Juvenile Migration Feasibility Study, Implications of Changes in the Columbia-Snake river System Waterway on Grain Logistics from the Traditional Portland Market Gathering Territory," (Preliminary Draft) July 21 1999.

need for and cost of many of the infrastructure improvements that have been identified in this study. The UPGTI report concluded that the only strategy available to the railroads to increase market share, even with drawdown, would be to introduce more efficient service packages—26 and/or 52 car rates. This has not been done in past for two reasons. First, rail shipments of grain in the Northwest are unprofitable. And, second, there is no demand for this type of service. The report prepared for the Corps by the UGPTI is included in this report as Technical Exhibit C.

8.4.5 Use of Back-Haul Truck Rates for Long-Haul Shipments. Initial attempts to model the existing condition, led to difficulties the long-haul-truck movements, because the data consistently showed that rail should be the preferred alternative. This discovery led to further investigation into the nature of these shipments. The findings of this investigation were that long-haul shipments of grain are typically associated with a two-way shipment or back-haul arrangement, usually building materials. Initially analysts believed that grain was the primary shipment and that building materials was the back-haul. Subsequent study by the UGPTI found that the primary shipment is, in fact, building materials and that grain is the back-haul. The UGPTI further found that these shipments are currently being made at very low profit margins. The basis, therefore, for using back-haul rates for long-distance truck shipments is the finding that these movements of grain (the back-haul) would not occur in the absence of shipments of building materials (the front-haul). Actual profit margins of these truck movements have not been studied to determine their sensitivity to the increase in distance with rerouting to the Tri Cities as would be required with drawdown. Nevertheless, Corps analysts believe that long-distance shipment of grain will continue as long as shipments of building materials continue. Discontinuation of these truck movements would result in an increase in rail shipments.

8.5 NED EFFICIENCY LOSS WITH MONOPOLY INCREASE IN RATES

In a generic setting, one might expect that a system, such as the Columbia/Snake River navigation system, which enhances competition between rivals and lowers price, as explained above, would lead to aggregate gains in economic welfare extending beyond a simple transfer of wealth from seller to buyer. Indeed, there may be NED benefits attributable to a reduction of railroad rates for existing and new railroad customers. However, it is judgement of economists of the Corps of Engineers that the magnitude of these welfare gains is likely to be extremely small. In order for a change in rail rates to induce substantial changes in welfare it would be necessary for output quantities to vary considerably as rail prices change. Empirical evidence suggests that this is not the case. Even long–run elasticities of supply with respect to transport rates are very low and, in the short-run these elasticities probably approach zero. Because falling transport rates cannot significantly affect the quantities of agricultural inputs and outputs produced each year, the number of kilowatt hours of electricity generated, or the number of new housing starts, it is likely that such declines would lead to only marginal welfare gains for the economy as a whole.[19]

8.6 TRANSPORTATION SYSTEM RELIABILITY

In maintaining the flow of grain and other commodities from production areas to world markets, timeliness in delivering the product to market is a critical factor in maintaining existing levels of exchange and the region's share of export markets. Timeliness in responding to grain orders is highly dependent upon the delivery system, the availability of necessary facilities and equipment, and to a somewhat lesser extent, climatic/weather factors.

The present modal structure, comprised of rail, barge, and truck, provides both flexibility and dependability in accommodating seasonal fluctuations that characterize the grain market. Grain shipments from the region do not move at a continuous or level rate, but rather, are subject to considerable monthly fluctuations. White wheat, for example, tends to move in surges in response to market signals. In addition, some orders involve special requirements, such as specified protein levels or mixed orders. In the Columbia-Snake system, the barge system is uniquely adapted to accommodate these particular types of demands. This is due in large part to the fact that equipment and facilities are locally based, and that river traffic is generally unaffected by adverse climatic conditions that can potentially affect other modes. In terms of reliability, the shift of grain from barge transport to rail transport could be expected to have negative impacts that could impact certain specialized segments of the grain trade that make up a growing share of the Northwest export market. The loss of reliability, while not measurable, can be characterized as an increase in supply vulnerability to weather conditions, slides that occur in the Columbia Gorge and temporarily close the rail lines and to equipment problems. Since the majority of wheat would continue to be shipped by barge the loss of overall system reliability may not be sufficiently significant to have an impact on the region's ability to compete in the world grain market.

8.7 SENSITIVITY TO CONSTRUCTION OF A PETROLEUM PIPELINE

A sensitivity analysis was performed to measure the potential impact of a proposed petroleum pipeline to central Washington with regard to its effect on petroleum movements now made via the waterway. The majority of petroleum shipments on the river terminate at the Tri Cities on the Columbia River. Petroleum shipments make up about 3% of all tonnage that moves through Ice Harbor Dam, and only 3% of all up-bound barges are carrying petroleum products. Petroleum shipments are typically offloaded at the Snake River to the Port of Wilma, on the Lower Granite pool. Currently, there is no operation of

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19 If this discussion is expanded to include export markets, it is possible to demonstrate additional welfare gains from increased rail-barge competition. Still, the magnitude of these potential gains is relatively small. For a full exposition of this topic see Water-Compelled Railroad Rates and the Calculation of Navigation Project Benefits: A Preliminary Application to the Upper Mississippi River basin." (1994) Available from the Tennessee Valley Authority or the U.S. Army Corps of Engineers.

dual use barges on the upper river. Because of these factors, potential impacts associated with the development of a petroleum pipeline (Cascade Pipeline) in central Washington on barged petroleum on the lower Snake segment are considered to be very limited.

8.8 GRAIN FORECAST UNCERTAINTY AND SENSITIVITY

As explained in Section 4, the basis for the forecast for grain and non-grain shipments is average shipments over the 10-year period of from 1987 to 1996, inclusive. Inspection of the data (see Table 4-8) shows that growth in export of grain from the lower Columbia River does not occur at a uniform rate from year-to-year. In fact, the growth rate over this period has an extreme range of an increase of 23.7 percent from 1987 to 1988 and a decrease of 30 percent from 1988 to 1989. Overall, the growth rate was positive in six years and negative in four years over the 10-year period. In addition, growth was negative during the last two years, with decreases of 2.0 percent and 6.2 percent in 1995 and 1996, respectively. A number of factors could have played a part in these decreases including, economic conditions in middle and far eastern markets, grain production in these same countries, grain production in competing grain producing countries, and marketing strategies of grain exporters and exporting countries in both the U.S. and abroad. It is also possible that the Asian market for grain will continue to be soft until those economies recover. Despite the decreases in 1995 and 1996, exports increased by a total of more than 8 percent over the entire period. Although, analysis of the data clearly shows that exports are likely to continue to grow, there is substantial uncertainty about what the actual growth rate will be. If the growth in exports and grain production were actually lower than projected, the volume of grain shifted from the river would be decreased along with costs. Since a decrease in the actual volume of grain shifted would not have an effect on unit modal costs, the effect of a decrease can be estimated on a proportional basis. For example, a one-percent decrease in the volume of grain shifted should result in a one-percent decrease in costs. To extend this example, if the volume of exports for 1997, which is 25 percent below the 10-year average, were used as the basis for the forecast, volume of grain shifted and transportation costs would likewise be decreased by a similar amount.

8.9 POTENTIAL IMPACTS ON THE EXPORT MARKET FOR GRAIN

The potential that drawdown would have an impact on the export market for grain is a function of the modified shipping, storage and handling system to provide the same level of service that the existing system does. The analysis of the transportation system infrastructure requirements with drawdown indicates that there are no system modifications that would be required that could not be in place by the time the Snake River was actually drawn down and closed to commercial navigation. Except for construction of new grain handling and storage facilities on the Columbia River in the area of the Tri Cities and the confluence of the Snake and Columbia Rivers, infrastructure requirements are limited to improvements to existing facilities. However, the acceptance the significantly increase role of the railroads as a regional grain carrier will require the cooperation of growers, shippers, exporters and government. The most significant barrier to acceptance is likely to be the historic distrust of the railroads by shippers. This distrust seems to be focused on two primary concerns: First, a concern that railroads do not have the ability or interest to provide the quality of service that is needed to match that provided by the existing system. And, second, a fear that as soon as barge is no longer a competitive option, the railroads will raise rates to monopoly levels. Implementation of required system changes would require that all issues and concerns related to infrastructure and operational needs of the transportation system be addressed jointly by all stakeholders. The concern about the quality of service can be overcome by insuring that railcars will be available and that needed infrastructure improvements are made in a timely manner.

A final potential impact on the export market has to do with how growers and exporters attempt to react to the increase in the cost of grain delivered to the export market. If exporters were to attempt to pass the increase in the cost of grain (roughly 22 cents/bushel) to foreign buyers, demand for grain exports would decrease. However, this is an unlikely scenario. The world export market for grain is highly competitive and grain sellers are typically price takers. Thus, growers would be forced to absorb the cost increase and their profits (or return to fixed capital) would be decreased.

8.10 DURATION OF TRANSITION TO EQUILIBRIUM WITH DRAWDOWN

With drawdown and a shift of grain and non-grain commodities from truck/barge transport to truck/rail transport, modifications to the system infrastructure would be needed (see Section 6). Modifications would include improvements to rail lines, highways, river and country elevators, and rail car storage at tidewater terminals. In addition, the fleet of rail cars would need to be expanded. The range of costs for these improvements is from about $177 million to about $250 million. These costs represent the range of the costs to mitigate the impacts of drawdown on the transportation system.

The duration of the transition of the system from the present equilibrium to a new equilibrium with a greater reliance on rail transport of commodities is a function of two factors: the time required to overcome the uncertainty about the enevitability of drawdown and the time required to make the physical improvements. The time required for the latter is reasonably predictable. It is simply the length of time required to make the improvement with the longest design and construction time. Considering the improvements that would be needed, this would probably be the design and construction of river elevator capacity in the Tri Cities area. The design and construction period for this type of facility could be expected to range from three to possibly five years, at a maximum. This is well within the timeframe of implementation of drawdown, which is currently estimated to be 2007.

The time required to overcome uncertainty about Congressional authorization and funding of drawdown and actual implementation, is less predictable and could be the most critical determinant of the duration of the physical transition of the system. Authorization of drawdown by Congress is a critical element of the physical transition of the system, because without authorization, the uncertainty about the actual implementation of drawdown would be so high that it would be imprudent for any of the affected entities to make a commitment of scarce capital resources to making the improvements that would be needed only with drawdown. Furthermore, it is not likely that the uncertainty about the actual implementation of drawdown would end with Congressional authorization. A number of water resource projects have been authorized by Congress, but never funded or constructed and still others have been authorized and funded but terminated during construction. Notable examples of the latter are the Cross-Florida Barge Canal and, here in the Northwest, the Elk Creek Dam in Oregon. The persistence of this type of uncertainty is impossible to predict, but it is possible that it could persist to the point of delaying infrastructure improvements needed to provide reliable service to all shippers, at least in the short-term. Once the inevitability of drawdown is certain, however, infrastructure improvements could expedited and completed within a relatively short period of time (not more than two to three years).

8.11 THE INCIDENCE OF INFRASTRUCTURE COSTS

The cost of implementing drawdown, including the cost to mitigate direct impacts of drawdown on public and private infrastructure, would be the responsibility of the Federal government. The Federal responsibility for mitigation of impacts to infrastructure is expected to be limited to damages directly caused by drawdown, e.g., damage to roads and railroads along the river caused by sliding, etc. The cost of infrastructure improvements identified and discussed in Section 6 would be borne by the owners/operators of the facilities. In the case of highways, the improvements would be publicly funded but ultimately paid for by users (truckers) through payment of fees and taxes. Other infrastructure improvements would be funded by the respective owners/operators and ultimately paid for by shippers through payment of transportation, storage and handling fees.

8.12 SENSITIVITY OF MODEL RESULTS TO INPUT VALUES AND ASSUMPTIONS

The ACCESS database model used for the analysis of transportation system costs required a number of assumptions and estimated input values. Changes to any of these assumptions would change the results produced by the model. In this section, key assumptions and input values used in the model are reviewed and effects of the use of alternative assumptions and values are described. The review, however, is limited to a qualitative assessment. An attempt at establishing probable ranges of values was not made nor were additional model runs using alternative assumptions made. The assessment is presented in Table 8-1.

Table 8-1. Qualitative Assessment of the Effect of Using Alternative Assumptions and Input Values in t Transportation Analysis Model.

Variable and Existing and Alternative Assumptions	Effect on Model Re
Base Commodity Level • Assumption: Base commodity levels used are for 1996. • Alt Assumption: Use 1997 levels.	• The assumption used results in a hig than if the volume for 1997 were used. If tl representative of the future, the impact of (1997 grain shipments decreased by abou • Use of 1997 as the base would decr in the system and the amount that would This would reduce the estimated increase amount: i.e., by as much as 20 percent. I deviation from the norm rather than the ba would understate long-term impacts of dra
Commodity Forecast • Assumption: Forecasts were derived from forecasts developed for the Columbia River Channel Deepening Study. In the context of Snake River shipments, these are demand-based forecasts. • Alt Assumption: Develop forecasts specific to Snake River by analysis changes in production by commodity group.	• The accuracy of the forecast used is accuracy of the forecast developed for the Deepening Study. The effect on model re development of an alternate forecast. Cos to the forecast at the per-ton or per-bushe • The alternate forecast methodology directly to production in the Snake River l a forecast might be more defensible. It is whether this forecast would be higher or l
Commodity Origins • Assumption: Origins for grain are at the county level, except for Montana (six regions) and North Dakota (one region for the entire state). Origins for non-grain commodities (except farm commodities) are specifically defined. • Alt Assumption: Expand the model to include greater detail.	• Distance for farm direct to river or rai center of the origin county. Distance is nc country elevator movements. Accuracy o reduced for grain and other farm commod • The level of detail could be expanded improve accuracy and would allow all trar estimated. Modeling cost would be much
Storage Costs • Assumption: Storage costs are charged at country elevators and at river elevators. Duration of storage is the same. Average costs for each type of facility are used. • Alt Assumption: Base storage duration and costs on actual industry practice, including shipments during harvest that do not require harvest.	• The assumption that river elevators a is questionable. Also, the assumption tha questionable. The assumption almost cert costs. • Would increase the accuracy of the detailed data on storage costs by type of railhead) and inclusion of a demand functi would improve the accuracy of the model be expected to be reduced.
Handling Costs • Assumption: Handling costs are charged at each facility that grain moves through, except at export elevators. Costs used are for river elevators and country elevators. It is assumed that costs at railhead facilities are the same as at other country elevators. And, it is assumed that costs at export terminals are the same for both rail and barge shipments. • Alt Assumption: Develop and include in the model estimates of handling costs for all types of elevators for both rail and barge modes.	• Assumptions that handling costs at as at country elevators and that han terminals is the same for rail and ba incorrect. Handling costs may be ove • Would provide for a greater level of d estimated costs but the direction of

Table 8-1. Qualitative Assessment of the Effect of Using Alternative Assumptions and Input Values in t Transportation Analysis Model.

Variable and Existing and Alternative Assumptions	Effect on Model Re
Transportation Costs • Assumption: Reebie model estimates of modal costs are used. • Alt Assumption: Use existing rates in the model.	• Reebie model estimates may contai barge costs. Truck costs appear to b be low. Correction of the errors is ne lower than rates (except for long-hau estimated impacts of drawdown. • Use of rates would change estimate grain and costs. Truck rates are low use of rates would decrease cost im lower than rates so use of rates may significant amount. Barge rates are r costs, than rail rates so their use wo attractive alternative and would redu of drawdown.
Elevator Capacity • Assumption: The model does not include capacity or a capacity constraint. • Alt Assumption: Include a capacity function in the model.	• The absence of a capacity function i for analysis of system capacity requi potential capacity constraints at spe lead to underestimation of capacity r • To be very useful the capacity functi specific and alternative routings of gr of a capacity constraint would need This type of optimization model woul accuracy of assessment of capacity would require a significant data gath
Seasonality of Shipments • Assumption: The model does not include a demand function. • Alt Assumption: Include a demand function in the model.	• The capability of the system to mee grain shipments was assessed by exam single-month demand adjusted to what it shipments. This showed that there is su factors could cause this estimate to be e • Including a demand function in the m grain- handling constraints at hinterland a Accurate modeling would require detaile of all elevators, including rail car handlin require a significant modeling effort and i of the numerous variables to consider. T not predictable.