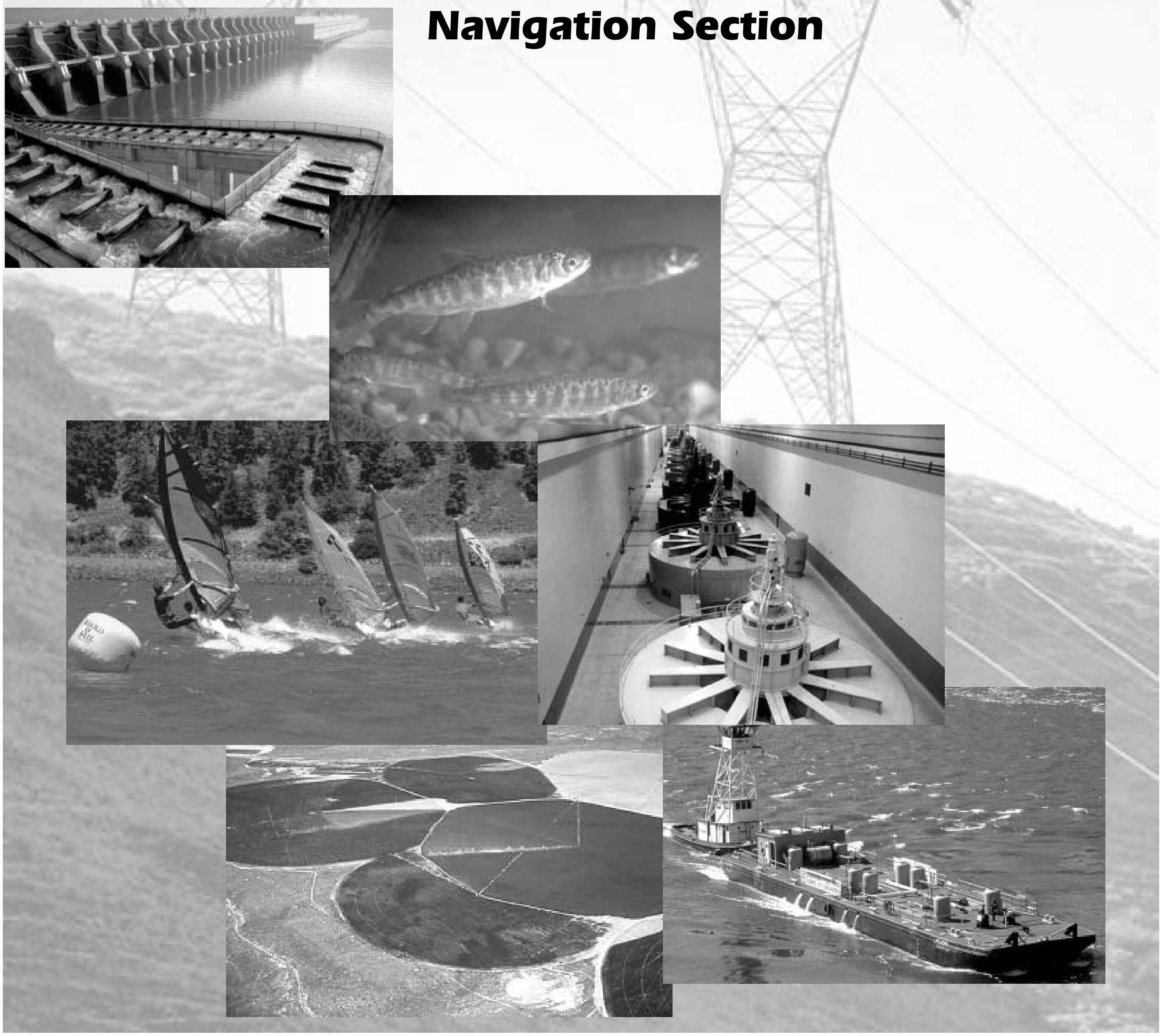
US Army Corps of Engineers ®
Portland District

Salmon Recovery through John Day Reservoir

John Day Drawdown
Phase I Study

Economic Analysis Technical Appendix
Navigation Section



September 2000

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SECTION 1. Summary

A drawdown of the John Day Dam to either Spillway Crest or Natural River conditions would close a 70-mile stretch of the Columbia-Snake River System (CSRS) to commercial navigation. This closure would end the current practice of barging commodities on the river, as nearly all of the commodities shipped on the CSRS pass through this pool. Closure of the pool would force producers throughout Idaho, Montana, North Dakota, Oregon, and Washington to seek alternative modes and routes for shipping their commodities to export facilities on the Lower Columbia. This would mean an annual transfer of roughly 9 million tons of goods from barge to truck and rail. The loss of the barge system would entail increased National Economic Development (NED) costs resulting from a loss in economic efficiency. As shown in Table 1, this increase was estimated at between $83 and $103 million each year through the period of record (2013 to 2112).

Table 1.
Summary of Average Annual Costs under Existing and Drawdown Conditions (in thousands of dollars)

	Existing Conditions	Drawdown Scenario[1]	Increased Costs
Low	$153,703	$237,067	$83,365
Base	$166,316	$260,938	$94,621
High	$178,459	$281,547	$103,089

The "Navigation" appendix completed as a part of this study identifies one-time capital costs for dredging a new navigation channel at $490 million under the Spillway Crest alternative, and $1.5 billion under the Natural River alternative. These costs translate into $31.5 and $96.6 million per year through the period of record.

Further refinement of these costs and a more complete analysis of costs affecting the region and its infrastructure should be performed if this study is pursued at the Phase 2 level.

SECTION 2. Introduction

This technical appendix section documents the results of the navigation economics evaluation for the John Day Drawdown Phase I Study. This Phase I Study is a reconnaissance-level evaluation of the potential consequences and benefits of the proposed drawdown of the John Day Reservoir. This technical appendix section supplements the main report, which describes more fully the alternatives, purpose, scope, objectives, assumptions, and constraints of the study.

[1] Drawdown Scenario refers to both a drawdown to Natural River conditions and a drawdown to Spillway Crest. For both of these scenarios, with and without flood control, the navigation costs are identical. Refer to Section 5 of this study for a more detailed discussion of the differences between these scenarios.

SECTION 3. Background of the Project

In 1991, the National Marine Fisheries Service (NMFS) proposed that Snake River wild sockeye, spring/summer chinook, and fall chinook salmon be granted “endangered” or “threatened” status under provisions of the Endangered Species Act. Natural resource agencies believe that the drawdown of the 76-mile John Day Reservoir may provide substantial improvements in migration and rearing conditions for juveniles by increasing river velocity, reducing water temperature and dissolved gas, and restoring riverine habitat. It is also speculated that drawdown may improve spawning conditions for adult fall chinook by restoring spawning habitat and the natural flow regimes needed for successful incubation and emergence.

As a result, the NMFS Reasonable and Prudent Alternative Action #5 of its’ Biological Opinion on Operation of the Federal Columbia River Power System (FCRPS), and subsequent reports recommended that USACE investigate the feasibility of lowering John Day Reservoir. In compliance with appropriation conditions, only two alternatives were to be evaluated: reduction of the current water surface elevation 265 Navigation Geodetic Vertical Datum[2] (NGVD) to the level of the spillway crest that would vary between elevations 217 and 230, or reduction to natural river level elevation 165. Both alternatives were proposed by NMFS. These two alternatives were then expanded to consider each alternative with 500,000 acre-feet of flood storage and without such storage. Flood storage and hydropower are the current approved authorizations for the John Day project.

SECTION 4. Description of the Study Area

The Columbia River originates in Canada and flows for 300 miles through eastern Washington to Oregon and continues west to the Pacific Ocean, as shown in Figure 1. The adjoining region is mostly open country, with widely scattered population centers. The climate of the region is semiarid. Agriculture, open space, and large farms are prevalent. Lands adjacent to the reservoir are used to grow grains and other crops. The reach of the Columbia River under consideration in this report extends from John Day Lock and Dam at river mile (RM) 215.6, to McNary Lock and Dam RM 291. The body of water impounded by John Day Dam, Lake Umatilla, is referred to as the John Day Reservoir throughout this report. The John Day is the second longest reservoir on the Columbia River, extending 76 miles upstream to McNary Dam.

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[2] All elevations referred to in this Phase I Study are referenced in feet to the National Geodetic Vertical Datum.

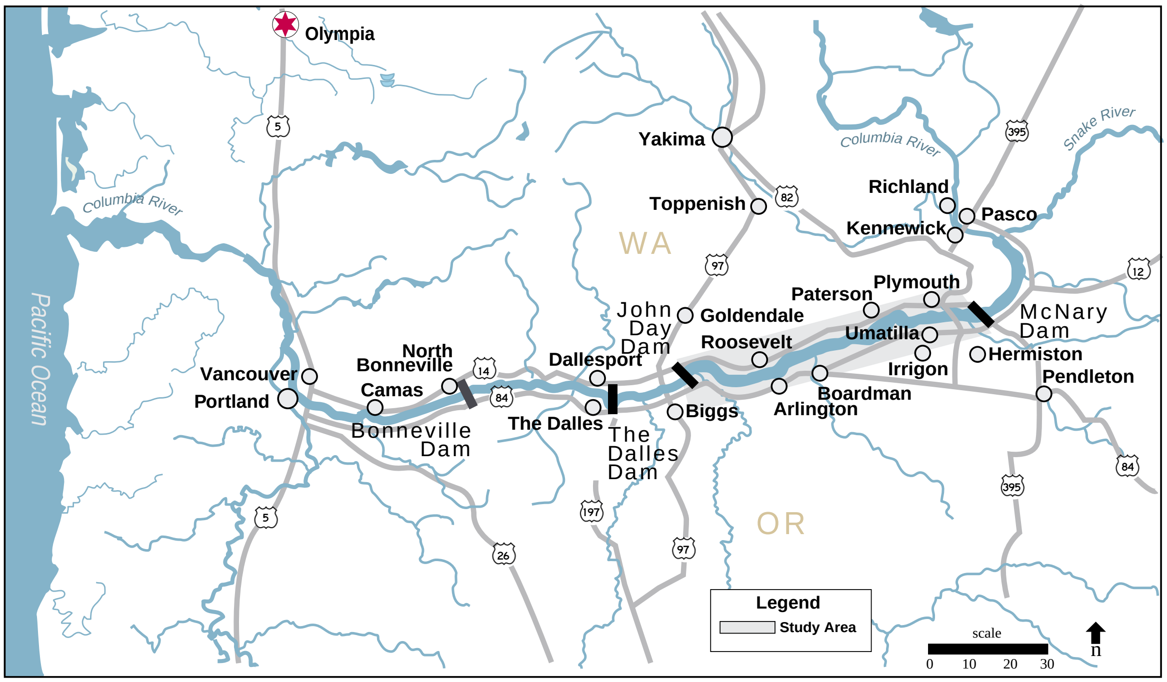

Figure 1. John Day Drawdown Phase 1 Study Area

John Day Dam and Reservoir are part of the Columbia-Snake Inland Waterway. This shallow-draft navigation channel extends 465 miles from the Pacific Ocean at the mouth of the Columbia River to Lewiston, Idaho. The entire channel consists of three segments. The first is the 40-foot-deep water channel for ocean-going vessels that extends for 106 miles from the ocean to Vancouver, Washington. The second is a shallow-draft barge channel that extends from Vancouver to The Dalles, Oregon. Although this section is authorized for dredging to a depth of 27 feet, it is currently maintained at 17 feet. The third section of the channel is authorized and maintained at a depth of 14 feet and extends from The Dalles to Lewiston. In addition to the main navigation channel, channels are dredged to numerous ports and harbors along the river.

The middle Columbia River area is served by a well-developed regional transportation system consisting of highways, railroads, and navigation channels. Railroads and highways parallel the northern and southern shores of the reservoir. Interstate 84 (I-84), a divided multilane highway, runs parallel on the south shore with the Columbia River from Portland, Oregon, to points east. Washington State Route 14 (SR-14) also parallels the Columbia River from Vancouver to McNary Dam on the north shore. Umatilla Bridge at RM 290.5, downstream from McNary Dam, is the only highway bridge linking Oregon and Washington across the Columbia River in the John Day Reservoir.

The study area includes lands directly adjacent to the reservoir as well as those directly and indirectly influenced by the hydrology of the reservoir (e.g., irrigated lands). It includes the reservoir behind the John Day Dam, and adjoining backwaters, embayments, pools, and rivers.

SECTION 5. Alternatives

The Phase 1 Study includes a preliminary evaluation of the impacts of the drawdown scenarios relative to the "without project condition," which is defined as the condition that would prevail into the future in the absence of any new federal action at John Day. The four alternatives are summarized below. One of the most important constraints on the alternatives is the requirement to pass fish for river flows up to the 10-year flood flow of 515,000 cfs. Under the four alternatives, John Day Reservoir would be drawn down at a rate of one foot per day. For greater detail, please refer to the main report, *John Day Drawdown Phase 1 Study*, and *John Day Drawdown Phase 1 Study, Engineering Technical Appendix, Structural Alternatives Section*.

5.1 Spillway Drawdown without Flood Control (Alternative 1)

The first drawdown alternative is based on requirements for improved downstream fish passage conditions during both low and flood flow conditions on the Columbia River. The existing 20-bay spillway will be operated differently from current operations, but without any structural modifications. All project inflows will be directly passed through the dam spillway with the spillway gates fully opened in free overflow condition, resulting in a pool elevation that will vary from elevation 217 to 230.

5.2 Spillway Drawdown with Flood Control (Alternative 2)

The second study alternative is based on requirements for improved downstream fish passage conditions during low flow periods, while maintaining authorized flood control for the John

Day Project. The existing 20-bay spillway will be operated differently from current operations, but without any structural modifications. During low flow periods, project inflows will be directly passed through the dam spillway with the spillway gates set in fully open, free overflow condition. During a flood event, however, the spillway gates will be controlled to reduce downstream flood flows based on using 500,000 acre-feet of allocated project storage space. Ponding will occur upstream from the dam.

5.3 Natural River Drawdown without Flood Control (Alternative 3)

The third study alternative is based on a natural river drawdown for fish passage "without flood control" condition. Natural river conditions pertain to an opening at the John Day Dam that permits acceptable upstream fish passage conditions. The size of the total dam opening must conform to two criteria based on an invert elevation at the dam of 135. The first criterion is that the opening must be sufficiently large to meet maximum allowable stream velocity criteria for sustained swim speed for the weakest salmon species, which is estimated to be 10 feet per second (fps). The second criterion is that fish passage for this opening must correspond to the 10-year annual flood peak (515,000 cfs). This alternative will require extensive modifications to John Day Dam even beyond modification of the 1,228-foot long spillway structure.

5.4 Natural River Drawdown with Flood Control (Alternative 4)

This fourth study alternative is based on natural river conditions for fish passage and includes the "with flood control" condition. It requires natural fish passage conditions for both upstream and downstream directions at the dam and includes a requirement for fully authorized flood control. The calculated width of the total dam opening will correspond to that previously calculated for natural river conditions without flood control (Alternative 3).

5.5 Impacts of Alternatives on Existing Transportation System

At present, federal law dictates that the Corps maintain a navigable channel 14-feet deep from Lewiston, Idaho, until it intersects with the deep-draft channel that serves the export ports of Portland and Vancouver. The navigation appendix that the Corps completed as a part of this Phase 1 Study (Foster Wheeler Environmental Inc, 1999) concludes that, without significant modifications, the proposed alternatives described above would end commercial navigation on the John Day pool. Closure of the John Day pool would end shallow draft barging on the entire CSRS, as the upper reaches of the system would be cut off from the main outlet for their goods, and ports and facilities below John Day provide too short a haul for barges to operate competitively. As a result, the alternatives identified above have the same impact in terms of cost to the transportation system, and the alternatives (for comparison) can be reduced to existing conditions and drawdown. The navigation appendix also identified modifications that include several possibilities for maintenance of the navigation channel. These alternatives are not considered to be a part of the drawdown scenarios, but rather means of mitigating effects of the drawdown. For the discussion of potential modifications in Section 8 of this report, the Spillway Crest and Natural River alternatives are separated to consider the differences in modification costs.

5.6 Impacts of a Drawdown of Four Snake River Dams

The Corps is currently examining the impacts of a drawdown of four dams on the Snake River. A drawdown of the John Day pool to either Natural River or Spillway Crest would close the entire river above John Day to commercial navigation, and as a result, no additional impacts of a Snake River drawdown are anticipated. The goods that would be forced off of the river for a Snake River drawdown would be forced off the river under a John Day drawdown as well. For the calculation of impacts of a John Day drawdown, it is therefore not necessary to assess additional scenarios comparing the "with" and "without" drawdown alternatives for the Snake River. For the analysis of the potential modifications, however, the "with" or "without" Snake River drawdown alternatives become significant; therefore, a discussion of the drawdown occurs in Section 8, Potential Modifications.

SECTION 6. Methods

This analysis captures the costs of a drawdown through a comparison of the total cost of shipping goods on the Columbia and Snake Rivers under existing conditions to the total cost of shipping the same quantity of goods without the option of shipping by barge. This analysis is not meant to represent the real costs that producers will realize in terms of the rates that they will pay for transportation. Instead, this analysis measures the loss in economic efficiency resulting from a change from the (current) most efficient mode of transport, to other modes. This type of analysis is consistent with NED guidelines, which restrict the measurement of impacts to those costs, which affect the national economy as a whole. Under NED guidelines, increased rates paid by producers are considered a transfer payment, not a cost. Section 10 of this report attempts to address some of the non-NED impacts of the proposed actions.

There are essentially three components of this analysis: 1) commodity tonnage data, 2) projections of this data through the life of the project, and 3) costs for shipping each commodity to its destination using a variety of modes and routes. With this information, it is possible to calculate the total cost of transporting goods on the CSRS through each of the project years, and then to calculate an annual averaged cost for both existing and drawdown scenarios.

6.1 Commodity Data

The quantities of goods traveling past the John Day lock were collected from several sources including the following:

- Corps' *Snake River Drawdown Study, Navigation Economics Appendix*
- Data requested from the Waterborne Commerce Data Statistics Center (WCDSC)
- Lock Performance Monitoring System Data (LPMS)
- Information gathered through interviews with representatives of the barge industry

There are slight differences in the way each of these datasets captures the movement of commodities, and so it is necessary to explain not only how each of the sources was used, but also how the discrepancies between sets was resolved.

6.1.1 Snake River Drawdown Study Navigation Economics Appendix

This analysis used the data from 1987-1996 presented in the Navigation Economics Appendix of the Snake River Drawdown Study (reprinted below as Table 2) for all commodities that pass through both the John Day lock and the Ice Harbor lock (the furthest downstream lock on the Snake River). The Corps used data from detailed surveys of elevator operators as well as data from the WCDSC to develop these quantities

Table 2.
Snake River Waterborne Commerce with Origins or Destinations above Ice Harbor Lock and Dam* (1,000 tons)

Commodity	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Wheat and Barley	2906	3981	2532	3109	3241	2612	2706	3135	3471	2821
Other Farm	80	61	187	142	121	25	17	32	27	36
Wood Chips and Logs	461	394	320	304	375	500	854	910	857	530
Wood Products	46	52	45	42	74	61	45	58	68	28
Petroleum	117	105	115	108	106	108	129	137	144	95
Chemicals	5	6	6	4	33	34	35	23	25	27
Sand and Gravel	0	0	0	0	0	16	0	1	0	0
Metals	0	0	0	13	0	0	0	3	16	5
Empty Containers	10	57	10	7	5	5	5	11	8	11
All Other	1	3	0	0	0	0	0	4	6	6
Total	**3626**	**4659**	**3215**	**3729**	**3955**	**3361**	**3791**	**4314**	**4622**	**3559**

*Source: Snake River Drawdown Navigation Economics Appendix (Corps of Engineers,, Portland District, 1999

6.1.2 Waterborne Commerce Data Statistics Center

For goods that do not pass through the Ice Harbor lock, but are put on or taken off the river above the John Day lock, this analysis relies on commodity data from the WCDSC. This data represents a 100 percent sample of all goods shipped on the river, and includes tonnage, originating dock, destination dock, and commodity type. The data encompasses the entire CSRS for the years 1994 through 1997. This data provides detailed information relating to the commodity types associated with each movement between ports. For consistency, however, commodities were grouped together into the categories identified in Table 3, which originally appeared as Table 4.2 in the Snake River Drawdown Navigation Economics Appendix.

Table 3. Columbia/Snake River System Commodity Aggregations*		
Commodity Group	**Commodities included at 4-digit Level**	**Commodity Codes at 4-digit Level**
Wheat and Barley	Wheat; barley; rye	6241; 6443
Other Food and Farm Products	Fish; corn; soybeans; vegetable products; processed grain and animal feed; other agricultural products	6100-6199; 6344; 6444-6899
Petroleum Products	Crude petroleum; gasoline; distillate; residual; other petroleum products	2100-2999
Wood Chips and Logs	Fuel wood; wood chips; wood in the rough; lumber; forest products NEC	4100-4199
Wood Products	Pulp and waste paper; paper products; primary wood products	4200-4299; 5100-5199; 5500-5599
Chemicals	Fertilizers; other chemicals and related products	3100-3299)
Metals	Iron ore and scrap; primary iron and steel products; primary non-ferrous metal products	4400-4499, 5300-5499
Soil, Sand, Gravel, Rock and Stone	Soil, sand, gravel, rock, and stone	4300-4399
Containers, Empty	Containers, empty	7800
All Other	Sulfur; clay, salt; other non-metal minerals; lime, cement, glass; manufactured equipment; machinery and products; waste and scrap nec	4700-4999; 5200-5299; 7100-7799; 7900-8999
*Source: Snake River Drawdown Navigation Economics Appendix (Corps of Engineers, Portland District, 1999)		

The data provided by the WCDSC contains proprietary information, and so it can only be released in summary form. Table 4 provides the 4-year average tonnage by commodity for goods entering or exiting the river system between John Day and Ice Harbor.

Table 4. Commodity Tonnages Based on Data Provided by the WCDSC (1, 000 tons)	
Commodity Classification	**Average of 1994-1997**
All Other	199
Chemicals	194
Empty Containers	141
Metals	10
Other Food and Farm Products	68
Petroleum and Related Products	1,857
Soil, Sand, Gravel, Rock and Stone	24
Wheat and Barley	2,295
Wood Chips and Logs	286
Wood Products	4
TOTAL	**5,078**

6.1.3 Lock Performance Monitoring System

Data from the LPMS provided a check for the quantities discussed above. The Corps collects LPMS data from every barge passing through a navigation lock on the CSRS. The data is grouped together by month and year, and includes the name of the lock, the tonnage, number of vessels, direction, and commodity type. The LPMS data is considered by many people familiar with operations on the river to be less reliable than the WCDSC data detailed in Section 2.1.2. The LPMS data is less accurate than the WCDSC data in terms of both quantities and commodity classification; however, the LPMS data does provide a benchmark for checking the reasonableness of other data sources. The combined quantities for both sets of data were compared with data from the LPMS data for the years 1994-1997 as shown in Table 5. One issue of note in comparing the quantities presented in Table 5, is that the LPMS data is categorized differently than the WCDSC data, and so it is difficult to make a direct comparison, particularly for containerized goods.

Table 5.
Comparison of LPMS and WCDSC Data: Total Tonnage Passing John Day Dam (1,000 tons)

Commodity	Sum of WCDSC Data and Snake River Navigation Economics Study Data	LPMS Data
All Other	213	390
Chemicals	222	263
Empty Containers	149	No data
Metals/Stone etc.	34	44
Other Food and Farm Products	99	201
Petroleum and Related Products	1,975	1,946
Wheat and Barley	5,314	5,474
Wood Chips and Logs	1,002	958
Wood Products	56	105
TOTAL	9,064	9,381

Note: Categorization of commodities is not uniform between the datasets. Some commodities such as Wheat and Barley, Chemicals, Petroleum, and Wood Chips and Logs provide a direct comparison, but others are not equivalent.

6.1.3.1 Verification Process

The final step in determining the base data for use in the analysis was a verification process in which both the WCDSC data and the LPMS data were provided in summary form for comments from representatives of the barging industry, ports, grain elevators, and others. In addition, tonnage information was requested from the American Waterways Association, which represents the barging industry on the Columbia and Snake Rivers. This information appears in Table 6. Comments from these representatives, and the additional data provided by the barge operators were used to refine the information taken from the Snake River Drawdown Study, and from the WCDSC. In particular, significant changes were made to the estimates for chemicals and for petroleum.

Interviews with a representative of one of the barging companies that transports chemicals on the river revealed that a major shipper of anhydrous ammonia found an alternative means of supplying its Tri-Cities facility, and as a result, the quantity of chemicals being shipped dropped significantly in 1996 and 1997. Because this decrease is expected to be permanent, it is believed that a four-year average from 1994 to 1997 would overpredict future quantities of chemicals being shipped on the river. Therefore, a 2-year average from 1996 and 1997 was substituted (identifying goods loaded between Ice Harbor and John Day). The quantity of anhydrous ammonia being shipped on the Snake River was assumed to be unchanged. As shown in Table 6, the American Waterways Operators Association data indicates 480,000 tons of chemicals shipped in 1996, one of the years when the shipment of chemicals dropped significantly. This statistic, then, introduces some doubt about the assumption that chemical shipments would drop as low as 122,000 tons.

Another change instituted after conversations with representatives of the barge industry was a significant increase in the quantities of petroleum and petroleum-related products traveling between Portland and the Tri-Cities. On October 15, 1998, Chevron announced that it would reverse its pipeline operation between Boise and Pasco in June 2000 (Chevron Press release "Chevron to Reverse Pipeline Direction Between Boise, Idaho and Pasco, Wash.", October 15, 1998). The pipeline, which currently conveys petroleum products into the Pasco area, will be used to convey petroleum to the southern Idaho and Utah markets. To implement this change, Chevron expects to ship approximately 20,000 barrels a day from Portland to Pasco. This quantity translates roughly into one million tons/year of additional petroleum. Although this increase has not yet occurred, the nearly one million tons were added to the four-year weighted average for petroleum products being shipped between John Day and Ice Harbor.

Table 6
Comparison of Federal Data Sources with Commodity Figures Provided by AWOA*
(1,000 tons)

Commodity	AWOA data*	WCDSC and COE Snake River Data	LPMS Data
All Other	0	213	390
Chemicals	480	222	263
Empty Containers	51,500 TEU's	149	No data
Metals/Stone etc.	32	34	44
Other Food and Farm Products	584	99	201
Petroleum and Related Products	1627	1,975	1,946
Wheat and Barley	5768	5,314	5,474
Wood Chips and Logs	528	1,002	958
Wood Products	124	56	105
TOTAL (not including TEU's)	**9,143**	**9,064**	**9,381**

***1996 data**

Table 7 shows the final quantities used in the calculation of cost for this analysis. Discounting the projected increase in shipments of petroleum, the total quantity of goods being shipped is slightly lower than the quantities suggested by both the AWOA and LPMS data. Differences in the classification of commodities make it difficult to identify changes that might be appropriate (if any). Future verification of commodity levels could help resolve some of the discrepancies.

Table 7. Base Commodity Figures (1,000 tons)			
Commodity	**Goods loaded or unloaded between John Day and Ice Harbor**	**Goods loaded or unloaded above Ice Harbor**	**Total**
All Other	199	14	213
Chemicals	94	28	122
Empty Containers	141	8	149
Metals	10		10
Other Food and Farm Products	68	31	99
Petroleum and Related Products	2,846	118	2,964
Soil, Sand, Gravel, Rock, and Stone	24		24
Wheat and Barley	2,295	3,019	5,314
Wood Chips and Logs	286	716	1,002
Wood Products	4	52	56
TOTAL	**5,967**	**3,986**	**9,953**

6.1.4 Assumptions: Data

- Data for wheat and barley loaded onto the river between John Day and Ice Harbor is based on shipping receipts, while data for wheat and barley loaded on the Snake River is based on information gathered from producers and grain elevator operators. There may be some double counting of these commodities. If this study is pursued into Phase 2, production levels for commodities should be updated for goods loaded between John Day and Ice Harbor through the same process the Corps followed in updating the grain model for the Snake River study.
- If this analysis is carried into Phase 2, some of the tonnage and classification information provided by the WCDSC should be verified for accuracy. It is apparently the best data available at this time; however, the categorization system used by the WCDSC and the subsequent reclassification into the Corps summary categories may misrepresent some of the commodity types being moved. In particular, the categories for "Other Food and Farm Products," "Metals," and "All Other" are of concern.
- The impacts of changed shipment patterns for "Chemicals" need to be examined in greater detail. There is a significant discrepancy between data provided by the AWOA and the WCDSC. For consistency, WCDSC data was used in this analysis, however a Phase 2 analysis would require greater degree of confidence in the base data.

6.2 Projections

The limited scope of this Phase 1 Study did not permit the development of new projections. However, the project authorization does request an assessment of the costs of each of the proposed scenarios over the 100 year Period of Record, which extends from 2013 to 2112. In order to meet the requirements of the authorization, this study makes use of projections prepared for the Corps' Snake River Drawdown Study. John Day Drawdown commodity projections are derived from a ratio of the projected levels for the Snake River Drawdown Study to the base values for that study as indicated by the equation shown below.

$$\textit{New projected value for John Day} = \left(\frac{\textit{Snake River projected tons}}{\textit{Snake River base tons}} \right) x \textit{ John Day base tons}$$

The report prepared by the Corps for the Snake River drawdown analysis includes projections for the commodities shipped on the Snake River for 2002, 2007, 2012, 2017, and 2022. This projection includes a base projection as well as high and low estimates based on the levels of variation from year to year for each of the commodities. These projections are shown in Tables 8 and 9. The assumptions that justify these projections are located in Section 4.3 of the Navigation Economics Appendix of that report. A brief synopsis of each projection method is provided below.

Table 8.
Commodity Projections for Goods Shipped on the Snake River (1,000 tons)

		All Other	Chemicals	Containers (Empty)	Other Food and Farm Products	Petroleum	Wheat and Barley	Wood Chips and Logs	Wood Products	Soil, Sand, Gravel, Rock and Stone	Metals	Total
Average		14	28	8	31	118	3,019	716	52			**3,986**
2002	Low	1	25	6	26	102	2,649	404	35			**3,248**
	Med	13	34	11	39	127	3,647	694	66			**4,631**
	High	27	43	17	53	151	4,619	984	98			**5,992**
2007	Low	1	23	7	31	109	2,473	404	41	**No Data**		**3,089**
	Med	14	36	14	46	136	3,799	694	79			**4,818**
	High	28	48	20	62	162	5,125	984	116			**6,545**
2012	Low	1	23	9	39	117	2,473	404	53			**3,119**
	Med	16	36	16	60	145	3,798	694	101			**4,866**
	High	30	48	23	80	174	5,123	984	148			**6,610**
2017	Low	5	24	10	50	125	2,534	404	67			**3,219**
	Med	19	36	18	75	156	3,892	694	158			**5,048**
	High	33	49	27	101	186	5,250	984	188			**6,818**
2022	Low	8	25	12	58	134	2,638	404	78			**3,357**
	Med	21	38	21	87	167	4,052	694	148			**5,228**
	High	36	51	31	117	199	5,466	984	218			**7,102**

Table 9.
Commodity Projections for Goods Loaded or Unloaded between John Day Dam and Ice Harbor Dam* (1,000 tons)

		All Other	Chemicals	Containers (Empty)	Other Food and Farm Products	Petroleum	Wheat and Barley	Wood Chips and Logs	Wood Products	Soil, Sand, Gravel, Rock and Stone	Metals	Total
4-year average		199	94	141	68	2,846	2,295	286	4	24	10	**5,967**
	Low	14	71	104	57	2,594	2,014	286	2	24	1	**5,167**
2002	Med	185	135	192	87	2,987	2,772	286	4	24	9	**6,682**
	High	384	197	279	116	3,365	3,511	286	7	24	19	**8,189**
	Low	14	59	123	68	2,704	1,880	286	3	24	1	**5,162**
2007	Med	199	145	227	103	3,129	2,888	286	5	24	10	**7,016**
	High	399	230	331	138	3,538	3,896	286	8	24	19	**8,869**
	Low	14	59	145	87	2,830	1,880	286	4	24	1	**5,329**
2012	Med	228	230	266	132	3,270	3,894	286	7	24	11	**8,348**
	High	427	144	388	177	3,727	2,887	286	10	24	21	**8,092**
	Low	71	63	166	110	2,956	1,926	286	5	24	3	**5,611**
2017	Med	270	151	308	167	3,444	2,958	286	9	24	13	**7,630**
	High	470	238	449	224	3,916	3,991	286	13	24	23	**9,633**
	Low	114	70	193	127	3,097	2,005	286	5	24	6	**5,928**
2022	Med	299	161	356	194	3,617	3,080	286	10	24	14	**8,041**
	High	512	252	519	260	4,120	4,155	286	15	24	25	**10,168**

*except those goods which are shipped on the Snake River above Ice Harbor Dam

6.2.1 Wheat and Barley

Projections for wheat and barley are based on figures prepared by Jack Fawcett and Associates et. al. for the U.S. Army Corps of Engineers, Portland District for the *"Columbia River Channel Deepening Feasibility Study, Commodity Projections, Final Report."* This report provided estimated increases in grain exports at Columbia River export elevators. The percentage of grain shipped to these elevators from the Snake River was assumed to remain constant. No information on the projected "high" and "low" limits for the years being projected by this study was available in the Corps' drawdown study, and so a "base" quantity was assumed for each projection year.

6.2.2 Woodchips and Logs

Commodity data indicates that the quantities of woodchips and logs on the CSRS do not follow a discernable pattern in terms of either growth or loss. While a high and low range was established, these quantities were projected to remain relatively constant throughout the study period.

6.2.3 Petroleum and Related Products

For the Snake River study, the growth rate for petroleum was assumed to be roughly equivalent to the 1.4 percent annual population growth rate in the Snake River basin. While this growth rate does not exactly reflect the conditions leading to increased demand for petroleum products in the Pasco area, it is relatively close to the two to three percent growth rate suggested by persons familiar with the movement of this commodity (Conversation with Skip Hart, Tidewater Barge Lines, July 27, 1999). More importantly, a major increase in petroleum shipments was introduced into the weighted average for this commodity as a result of conversations with representatives of the barge industry (Conversation with Skip Hart, Tidewater Barge Lines, July 27, 1999). A slightly lower growth rate may be appropriate given the significant jump in the base level tonnage already assumed.

6.2.4 Other Food and Farm Products, Wood Products, and Empty Containers

These commodity groups were judged by the Corps to be the most likely to be shipped in containers. Like wheat and barley, projections for container traffic were derived from the 1996 *"Columbia River Channel Deepening Feasibility Study, Commodity Projections, Final Report."* The percentage of Columbia River container traffic shipped by barge was based on figures provided by the Port of Portland.

6.2.5 Chemicals

Since most of the chemicals shipped on the Snake River are used for fertilizer on wheat and barley, chemicals were projected through the study period based on projections for wheat and barley. The most significant exception to this rule has historically been the shipments of anhydrous ammonia to a fertilizer company in Kennewick, WA. Much of this commodity was apparently shipped to other regions, and so would not be linked entirely with grain production in the region served by the CSRS. With the near removal of anhydrous ammonia shipments to this firm as described in Section 2.1 above, the assumption that most chemicals will be associated with wheat and barley production appears sound.

6.2.6 All Other

No method for projecting commodities in this category was identified in the Snake River Drawdown Study, however projections were provided in a summary table. To be consistent with other commodity categories, projections for this category were based on the figures provided in the Snake River study.

6.2.7 Metals, Sand, Stone, and Gravel

These two categories were not included in the Snake River analysis, and so no projections were available. The growth rate used for containerized commodities was also employed to project increases in the shipment of metals. For sand, stone and gravel, there was not enough information available to identify trends from year to year, and so projected costs are based on an assumed constant level throughout the study period.

6.2.8 Assumptions: Projections

- If this study proceeds to a second phase, projections for petroleum and chemicals should be further refined based on specific uses and demand for those goods in the Tri-Cities area.
- A detailed understanding of the types of goods categorized as “metals” and “all other” should be pursued to project these commodities more accurately. This should include an identification of the Corps’ methods for projecting commodities in the “All Other” category for the Snake River Drawdown Study.
- A Phase 2 analysis of the John Day drawdown scenarios will require a more detailed understanding of the goods categorized as Stone, Sand, and Gravel.
- The “high” and “low” projections for all targeted commodities should be reviewed to ensure that the confidence intervals they express are applicable to the commodities loaded or unloaded between John Day and Ice Harbor Dams.

6.3 Origin, Destination, and Trip Cost Data

This analysis relies on origin, destination, and trip cost data taken from two important sources: the Corps’ Snake River Drawdown Study, and information requested from the WCDSC specifically for this project. For commodities shipped on the Snake River, two elements from the Corps’ study were used. For grain, the study’s grain model supplied the information. For all other commodities, the Corps provided spreadsheets from the Snake River study, which included costs for shipping by truck barge and by rail. Background on each of these information sources and their uses is provided below.

6.3.1 Snake River Drawdown Study Grain Model

The grain model prepared by the Corps for the Snake River Drawdown Study was adapted from information originally collected in support of the 1992 System Operations Review (SOR). For the SOR, a contractor for IWR and the Corps conducted interviews with grain elevator operators throughout Idaho, Montana, North Dakota, Oregon, and Washington. From these interviews, the Corps was able to ascertain the quantities of grain produced in the region, as well as the origins, destinations, and modes by which the grain was shipped. It should be noted that this data was collected to reflect a “representative year,” and does not provide specific information for a particular year. For the Snake River Drawdown Study, a contractor resurveyed the elevator operators to update the information in the grain model, this information was then provided to analysts at the Institute of Water Resources (IWR), where a transportation analysis model (developed and copyrighted by Reebie Associates) calculated transportation costs for each point-to-point movement. Included in IWR's cost analyses were costs for shipping by alternative modes for all of the commodities that had either their origin or destination on the Snake River. The results of IWR's work were then used as part of the base data for analysis in the Corps' grain model. In addition to transportation costs, the Corps' model also captures probable increases in storage and handling costs under a drawdown scenario. The basic functions of the model are shown below as Figure 2. For a more detailed description of the model's function, refer to Section 2 of the Navigation Economics Appendix of the Corps' Snake River Drawdown Study.

Base Data: Origin, destination and percentage of origin state's total grain production information

Base Data: Total grain production for Idaho, Montana, North Dakota, Oregon, and Washington.

Base Data: Trucking costs from all origin points to Snake River ports, Columbia River ports and elevators with rail access. Every origin will have a movement to a Columbia River port and a rail elevator. Origins that currently ship to ports on the Snake River will also have a route to this port.

Base Data: Barge/Rail costs of shipping from port to port and from railheads to export ports.

Step 1: Multiply percentages by the total grain production for each state.

Step 2:Add trucking cost to barge/rail costs to arrive at a unit cost for shipping from origin to destination by three alternative routes.

Step 3: Select least-cost route

Step 4:Multiply total bushels for each origin-destination pair from Step 1 by least cost route from Step 3.

Step 5: Based on the route and mode of transportation selected for each origin-destination pair, add the appropriate storage and handling costs. This is the total *Base Conditions Cost.*

Step 6: To measure drawdown costs for John Day Drawdown, raise costs for shipping by barge to an extent that makes the rail alternative the cheapest available route for all origin-destination pairs. Repeat Steps 4 and 5. This is the total *Drawdown Cost.*

Figure 2. Basic Functions of the Corps' Snake River Drawdown Study Grain Model

For this analysis, the Corps' model was altered to reflect some of the differences between a drawdown of the Snake River dams and a John Day drawdown. Under the model conditions set for the Snake River drawdown, each movement had two alternative routes that could be used to transport grain to export elevators under drawdown conditions. The first of these routes was a truck-barge option, generally shifting commodities from Snake River ports to ports in the Tri-Cities area. The second option was a rail option transporting commodities from their origin to an export destination. Because Tri-Cities ports would be effectively closed under a drawdown of the John Day pool, the model was altered to force commodities onto the rail option. With this completed, the model successfully generated costs for wheat and barley movements in the base case, as well as the increased cost for wheat and barley under a drawdown scenario. Because the update to the model completed for the Snake River Drawdown Study did not update quantities of grain being loaded onto the river between John Day and Ice Harbor, the model could not accurately calculate the increased costs of shipping these commodities. Increased costs for wheat and barley loaded on the system between John Day and Ice Harbor dams were calculated separately as described below. It is important to note that the effects of a John Day drawdown on the storage and handling costs for shipping grain have not been explored. It is believed that much of the increased cost in storage and handling fees for grain identified during the Snake River Drawdown Study was based on overcrowding at port facilities in the Tri-Cities area. A drawdown of the John Day dam would likely cause overcrowding in other areas, particularly grain elevators with rail service in eastern Washington and elsewhere. The costs associated with crowding at these facilities have not been calculated as a part of this study, but the assumed increases from the drawdown of the Snake River have been kept in place. It should be noted that the costs of a drawdown were increased proportionately to projected increases in commodity tonnages, the ratio of tons of grain to base and drawdown condition costs was kept constant throughout the projection period.

6.3.2 Other Commodities Shipped on the Snake River

The Snake River Drawdown Study also sought to capture cost increases associated with shipments of non-grain commodities on the Snake River. The Snake River analysis was based on origins and destinations identified during the SOR. For this analysis only a portion of the information used in the Snake River Study was available. For this analysis, the contractor used the Reebie transportation analysis model to calculate the cost of shipping a variety of commodities from origin port to destination port, both by barge and by rail. For some commodities, such as woodchips and wood products, an additional trucking cost was also assumed. This cost data has some limitations, in that it does not provide any detail as to the actual origins and destinations of these goods. It can be assumed that many of these commodities are trucked a significant distance before being loaded on the river, and many of them will travel a significant distance after reaching their destination port. In the case of wood products, woodchips, and logs, there will often be intermediate stops at mills for processing as well. It follows that if commodities were trucked a significant distance to reach their shipping port or final destination, then the least-cost shipping route under a drawdown would most likely circumvent the port. By examining cost differences from port to port however, the analysis presents a worst-case scenario in terms of cost impacts, and avoids the problems associated with gathering more origin and destination information on these commodities. It should be noted that these cost estimates were used to develop a weighted cost per ton for each commodity. The origins, destinations, and tonnages varied between the base case spreadsheets and the drawdown spreadsheets, and so a weighted average was used to resolve these inconsistencies.

6.3.3 Waterborne Commerce Data Statistics Center Data

As described above, this data was requested for all commodities (including wheat and barley) traveling on the CSRS for the years 1994-1997. The data-sets for each year were combined into a single table, and filtered to arrive at only those commodity movements which had their origin or destination between Ice Harbor and John Day dams, and which did not have an origin or destination on the Snake River. This list of origin and destination pairs for each commodity studied was sent to the IWR where cost calculations were completed for movements both by barge and by rail. These cost calculations were combined with the 4-year weighted average tonnage for each movement to derive an average cost per ton for each commodity group under existing and drawdown conditions. The average cost-per-ton was used to resolve apparent differences in the quantities of goods being shipped under the base and drawdown scenarios. It was decided that consistency in terms of tonnages being shipped was essential, and so some generalization of costs was allowed within specific commodity groups. The origin-destination pairs with their associated cost data are provided in Appendix A of this report. Because of the proprietary nature of the data, the tonnages traveling between these locations have been removed.

For wheat and barley loaded between John Day and Ice Harbor, these port to port cost calculations were used to determine the increase in costs under a drawdown. Base costs including trucking to the port, handling and storage were calculated for this commodity group by the Corps' grain model, but alternative routes (i.e. rail from elevator origin to export destination) were only developed for commodities shipped on the Snake River. The model by itself calculates the cost for non Snake River grain as if it was unaffected by drawdown. By measuring the increase in cost for moving port to port by rail instead of by barge, an approximation of the increased costs for this commodity can be generated.

6.3.4 Assumptions: Origin, Destination, and Trip Cost Data

If this study is carried forward into Phase 2, the following steps should be taken to increase the accuracy of the study:

- The base case costs and tonnages for grain loaded between John Day and Ice Harbor have not been updated since the SOR was prepared and should be re-examined.
- Alternative routes should be provided for grain movements, so that the existing model can be used to capture both base and drawdown costs for wheat.
- The commodity movements and costs for non-grain commodities on the Snake River are inconsistent in terms of origins and destinations, tonnages, and commodity classifications between the base case and drawdown scenarios. These discrepancies should be resolved, and transportation costs should be revisited.
- At present, the shipment patterns for containers from Lewiston, the Tri-Cities area, and the ports of Umatilla and Morrow lack detail. Because of the higher value of many of these commodities, and competition between export ports, a more detailed understanding of origins and destinations would provide a more robust analysis of the potential impacts of a drawdown.
- The Corps' grain model is extremely complex. At the time of this report, the Independent Economic Advisory Board had indicated some concern related to the difficulty of

verifying the model's results, and some apparent inconsistencies. If this grain model is used in a Phase 2 analysis, significant effort may be required to verify the operation of the model, and demonstrate that its cost functions and origin-destination pairs are accurate.

6.4 Cost Calculations

The cost calculations used for this analysis are the product of the predicted tonnages and the average cost per ton. Costs in the projected cost tables presented in this report are shown in 1999 dollars. It should be noted that the costs for some transportation movements were generated using October 1998 dollars, no cost increase was calculated to bring these costs up to reflect 1999 dollars.

For the calculation of the average annual costs, a discount rate of 6.875 percent was used, with the period of record extending from 2013 to 2112. The net present value was calculated from this information, and then amortized over 100 years.

6.4.1 Assumptions: Cost Calculations

- The Corps' Snake River grain model does not differentiate between grain loaded on the Snake River and grain loaded elsewhere. As a result, the costs for shipping grain loaded between John Day and Ice Harbor was not included in the summary costs table (Table 11) for the John Day base scenario. The Snake River grain model only captures increased costs experienced by shippers using the Snake River, assuming other costs will remain consistent with the base scenario. As a result, it was necessary to calculate the increased costs for shipment of grain loaded between Ice Harbor and John Day. One effect of this method of calculating costs is that the handling and storage costs for Columbia River grain remain constant in the two scenarios, while equivalent costs for Snake River grain are increased. If Phase 2 of this study were pursued, modifications to the Corps' grain model would remedy this problem.
- The average annual costs calculated for this analysis rely on only nine years of growth. Projections for commodities were only completed out to 2022. Because the period of record extends from 2013 to 2112, the projected costs remain constant for 91 of the 100 years included in the study.

6.5 Study Assumptions and Constraints

This John Day Drawdown Study is based on numerous assumptions and constraints, specific to the technical disciplines analyzed. While summarized in the main report, these assumptions and constraints are detailed in the technical appendices that accompany the main report.

This navigation economics analysis was based on the following project assumptions and constraints:

- A drawdown of the John Day pool would end the practice of barging commodities between downstream facilities and ports on the Snake and Columbia Rivers unless significant modifications in the form of a new channel suitable for 14-foot draft vessels can be constructed.

- Commodities currently being shipped on the Columbia and Snake Rivers would continue to travel from their current origins to their current destinations. No losses in production quantities or alterations in shipping destinations are assumed
- Projected quantities of commodities being shipped are held constant at 2022 levels from 2023 until the close of the period of record in 2112.
- No costs resulting from a loss of competition were calculated in this analysis. The loss of barge service would reduce the number of potential transportation providers, and could result in less competitive or even monopolistic pricing strategies by the remaining transportation providers. Any costs associated with this loss of competition are assumed to be transfer payments from producers to transportation providers, and therefore not NED costs. Loss of competition is discussed further in Section 6, Sensitivity Analyses.
- Costs for increasing the capacity of roads and shipping terminals including export facilities and inland rail facilities have not been included in this analysis. For the Snake River Drawdown analysis, these costs were assumed to be paid through increased revenues and/or taxes generated by the increased volumes. This assumes that states collect taxes that cover the full cost of truck use, and that the opportunity for increased business would be profitable enough to warrant investment in elevators and rail facilities by providers of these services. If the John Day Drawdown Study is carried into Phase 2, these assumptions should be re-examined for their applicability to the conditions where the entire river is closed to barge traffic. This assumption is discussed in greater detail in Section 6, Sensitivity Analyses.

SECTION 7. Existing Conditions

Between the mouth of the Willamette River near Portland, Oregon, and the mouth of the Clearwater River near Lewiston, Idaho, there are more than 80 major docks engaged in the shipment of goods by barge. In an average year, roughly 8 to 10 million tons of commodities are shipped through the Navigation Lock at the John Day Dam. There are approximately 185 barges operating on the river, most of them specialized for a single cargo. As shown in Table 2.6, their primary cargoes are grain, petroleum, chemicals, woodchips, and logs, and containerized goods such as farm and wood products.

7.1 Snake River Costs

The navigable portion of the Snake River extends from Lewiston, Idaho, to its confluence with the Columbia at the Tri-Cities. Grain makes up as much as 75 percent of the total tonnage of goods moving on the river, with the ports of Lewiston, Almota, Central Ferry, Lyons Ferry, Windust, and Sheffler contributing to the total. Woodchips and logs coming from Clarkston, Lewiston, and Wilma are also significant contributors to the tonnage. Container traffic from Lewiston, while making a smaller contribution to the overall tonnage, plays a significant role in terms of commodity value, and has the potential for significant growth in the future. These products are largely bound for export facilities at Camas, Portland, and Kalama. In addition, upstream movements of petroleum and chemicals from Portland and the Tri-Cities supply the region with necessary fuel and fertilizer. Cost estimates for goods shipped on the Snake River were prepared from cost and tonnage information developed for the Corps' Snake River Drawdown Study. Table 10. shows the costs associated with transporting these commodities from 2002 through 2022.

7.2 John Day to Ice Harbor Costs

The section of the CSRS between John Day Dam and Ice Harbor Dam is approximately 115 miles long, and includes numerous ports such as Pasco, Kennewick, Benton, Umatilla, Morrow, Arlington, and Boardman, as well as other docks and elevators. Currently grain accounts for the largest percentage of the commodities being loaded and unloaded on this section of river. By 2002, however, it is expected that petroleum will overtake wheat in terms of volume. These two commodity groups make up the vast majority of the commodities being shipped on the river, with containerized goods, chemicals, and woodchips and logs making up the majority of the remainder. Table 11. shows the projected costs for shipping these commodities from 2002 until 2022. It should be noted that the Corps' grain model that was used to calculate the costs of shipping wheat and barley on the Snake River actually captures the costs of shipping most of the grain produced in Idaho, Montana, North Dakota, Oregon, and Washington. As such, the cost shown in Table 10. includes costs for shipping grain that is never loaded onto the Columbia or Snake Rivers. Because of its broad scope, the model also captures the costs for grain loaded between Ice Harbor and John Day. Subsequently, no base costs are identified for grain shipments in Table 11.

Table 10.
Costs for Goods Shipped on the Snake River: Base Condition ($000)

		Wheat and Barley(A)	Wood Chips and Logs	Petroleum	Other Farm Products	Wood Products	Chemicals	Containers (Empty) (B)	All Other(C)	Total
	Low	$117,228	$7,329	$723	$89	$713	$147	$21	$3	$126,252
2002	Med	$117,228	$12,589	$900	$134	$1,344	$199	$38	$45	$132,477
	High	$117,228	$17,850	$1,070	$182	$1,995	$252	$58	$93	$138,729
	Low	$122,114	$7,329	$773	$106	$835	$135	$24	$3	$131,319
2007	Med	$122,114	$12,589	$964	$158	$1,608	$211	$48	$48	$137,741
	High	$122,114	$17,850	$1,148	$213	$2,362	$281	$69	$96	$144,133
	Low	$122,083	$7,329	$829	$134	$1,079	$135	$31	$3	$131,623
2012	Med	$122,083	$12,589	$1,028	$206	$2,056	$211	$55	$55	$138,284
	High	$122,083	$17,850	$1,233	$275	$3,013	$281	$79	$103	$144,918
	Low	$125,104	$7,329	$886	$172	$1,364	$141	$34	$17	$135,047
2017	Med	$125,104	$12,589	$1,106	$258	$3,217	$211	$62	$65	$142,612
	High	$125,104	$17,850	$1,318	$347	$3,828	$287	$93	$113	$148,940
	Low	$125,104	$7,329	$950	$199	$1,588	$147	$41	$27	$135,385
2022	Med	$125,104	$12,589	$1,184	$299	$3,013	$223	$72	$72	$142,556
	High	$125,104	$17,850	$1,410	$402	$4,439	$299	$106	$124	$149,734

Notes

(A) Costs for "Wheat" and "Barley" are taken directly from the Corps' Snake River Drawdown Study. No "high" and "low" cost predictions were available from this study for these costs

(B) Cost for empty containers was considered to be the same as cost for full containers due to a lack of available information.

(C) Cost for this category assumed to be equivalent to cost of shipping containers.

Table 11.
Costs for Goods Loaded or Unloaded between John Day and Ice Harbor Dams: Base Condition ($1,000)

		Wheat and Barley(A)	Wood Chips and Logs	Petroleum	Other Farm Products	Wood Products	Chemicals	Containers (Empty)	Soil, Sand, Gravel, Rock and Stone	Metals	All Other
	Low	$ -	$960	$13,494	$305	$14	$355	$457	$43	$8	$89
2002	Med	$ -	$960	$15,541	$464	$27	$679	$840	$43	$105	$1,154
	High	$ -	$960	$17,505	$621	$40	$994	$1,223	$43	$219	$2,397
	Low	$ -	$960	$14,067	$362	$17	$298	$538	$43	$8	$89
2007	Med	$ -	$960	$16,277	$550	$32	$728	$995	$43	$113	$1,243
	High	$ -	$960	$18,405	$737	$47	$1,158	$1,451	$43	$227	$2,486
	Low	$ -	$960	$14,722	$464	$22	$298	$634	$43	$8	$89
2012	Med	$ -	$960	$17,014	$704	$41	$1,158	$1,164	$43	$130	$1,420
	High	$ -	$960	$19,388	$946	$61	$728	$1,702	$43	$243	$2,663
	Low	$ -	$960	$15,377	$587	$27	$318	$729	$43	$40	$444
2017	Med	$ -	$960	$17,914	$893	$52	$758	$1,348	$43	$154	$1,687
	High	$ -	$960	$20,370	$1,198	$77	$1,199	$1,967	$43	$267	$2,930
	Low	$ -	$960	$16,114	$681	$32	$352	$847	$43	$65	$710
2022	Med	$ -	$960	$18,815	$1,035	$61	$810	$1,562	$43	$170	$1,864
	High	$ -	$960	$21,434	$1,388	$89	$1,269	$2,277	$43	$292	$3,196

Notes

(A)All shipment costs for wheat and barley are captured in the base case analysis for the Snake River. Increases in cost for commodities loaded or unloaded between John Day and Ice Harbor are shown in the drawdown condition table for John Day goods.

Table 12.
Costs for All Goods Loaded or Unloaded above the John Day Dam: Base Condition ($1,000)

		Wheat and Barley	Wood Chips and Logs	Petroleum	Other Farm Products	Wood Products	Chemicals	Containers (Empty)	Soil, Sand, Gravel, Rock and Stone	Metals	All Other	Total
	Low	$117,228	$8,289	$14,217	$395	$727	$502	$477	$43	$8	$92	$141,978
2002	Med	$117,228	$13,550	$16,441	$598	$1,371	$878	$878	$43	$105	$1,199	$152,290
	High	$117,228	$18,810	$18,575	$803	$2,035	$1,246	$1,281	$43	$219	$2,490	$162,732
	Low	$122,114	$8,289	$14,840	$469	$852	$433	$562	$43	$8	$92	$147,701
2007	Med	$122,114	$13,550	$17,241	$708	$1,641	$939	$1,043	$43	$113	$1,291	$158,683
	High	$122,114	$18,810	$19,554	$950	$2,409	$1,440	$1,520	$43	$227	$2,582	$169,649
	Low	$122,083	$8,289	$15,551	$598	$1,101	$433	$665	$43	$8	$92	$148,863
2012	Med	$122,083	$13,550	$18,042	$910	$2,098	$1,369	$1,219	$43	$130	$1,475	$160,918
	High	$122,083	$18,810	$20,621	$1,221	$3,074	$1,009	$1,781	$43	$243	$2,766	$171,652
	Low	$125,104	$8,289	$16,263	$759	$1,392	$459	$764	$43	$40	$461	$153,573
2017	Med	$125,104	$13,550	$19,020	$1,150	$3,269	$969	$1,410	$43	$154	$1,752	$166,421
	High	$125,104	$18,810	$21,688	$1,545	$3,905	$1,486	$2,060	$43	$267	$3,043	$177,951
	Low	$125,104	$8,289	$17,063	$880	$1,620	$498	$889	$43	$65	$738	$155,188
2022	Med	$125,104	$13,550	$19,998	$1,333	$3,074	$1,033	$1,634	$43	$170	$1,936	$167,876

7.3 Total Costs

Table 12. shows the total cost of shipping Columbia and Snake River goods given existing conditions through the year 2022. The period of record for this analysis extends from 2013 to 2112. Based on the assumption that costs would remain constant after the end of the projection period (that is, in 2022), the average annual costs under the existing conditions are shown in Table 13. These costs were calculated using the 6.875 percent federal discount rate. The basic precept of this methodology is that the costs associated with the movement of goods can be spread out equally over the lifetime of the project in order to avoid massive one-time expenditures. This methodology is standard practice when calculating impacts associated with Federal actions.

Table 13.
Average Annual Cost: Existing Conditions

Scenario	Average Annual Cost ($1000)
Low	$153,703
Base	$166,316
High	$178,459

SECTION 8. Impacts of Drawdown Alternatives

As part of this reconnaissance study, the Corps is examining four drawdown alternatives that would impact the flow of commodities on the Columbia and Snake rivers. These four alternatives are natural river drawdown with and without flood control, and drawdown to spillway crest with and without flood control. All four of these scenarios would make the John Day pool too shallow for the current fleet of 14-foot draft barges and tugs. The closure of the John Day pool would end commercial barge navigation on the river, and so all four scenarios result in the same navigation costs. Modifications are possible under all four scenarios in the form of a newly dredged channel through the lowered pool. Because the pool would be lowered to different degrees under the spillway and natural river drawdown scenarios, the cost of mitigating the impacts does vary between scenarios. However, for the calculation of impacts in this section, all four drawdown scenarios will be considered at once.

The closure of the John Day pool would force producers and manufacturers to find alternate routes and modes for shipping goods. For most commodities, this will mean a switch to either truck or a combination of truck and rail. For a number of reasons, the current practice of shipping goods on the river by barge is the most efficient means of transporting many commodities. The loss of this efficiency, by forcing a switch to truck and rail, constitutes a cost under NED guidelines. This cost does not consider the increased rates that producers and manufacturers might realize as a result of reduced competition, nor does it capture the cost of infrastructure improvements to shift to new modes. As a result, the costs described in this section should not be construed as the total costs that would be faced by the region, but as an analysis of economic efficiency on a national scale. Many of the more localized impacts are described in Section 6, Sensitivity Analyses.

The costs of shipping commodities under a drawdown scenario are shown in Tables 14. and 15. Note that the costs for shipping wheat on the John Day (Table 15.) reflect only the increase in costs for port-to-port movements. Base costs such as trucking to the port, as well as shipping and handling costs, are included in the costs presented for wheat and barley in Table 14. It should be emphasized that the costs in Table 14. include increases in cost for grain loaded above Ice Harbor Dam, but do not include any change in base costs for grain loaded between Ice Harbor and John Day.

Table 14. Costs of Shipping Goods on the Snake River–Drawdown Condition ($1,000)

		Wheat and Barley (E) (F)	Wood Chips and Logs (D)	Petroleum	Other Farm Products	Wood Products (C)	Chemicals	Containers (Empty) (A)	All Other (B)	Total
	Low	171,175	7,329	1,182	379	713	256	87	15	181,135
2002	Med	171,175	12,589	1,471	568	1,344	348	160	189	187,845
	High	171,175	17,850	1,750	772	1,995	440	248	393	194,623
	Low	178,310	7,329	1,263	451	835	235	102	15	188,540
2007	Med	178,310	12,589	1,576	670	1,608	368	204	204	195,529
	High	178,310	17,850	1,877	903	2,362	491	291	408	202,492
	Low	178,265	7,329	1,356	568	1,079	235	131	15	188,977
2012	Med	178,265	12,589	1,680	874	2,056	368	233	233	196,298
	High	178,265	17,850	2,016	1,165	3,013	491	335	437	203,572
	Low	182,676	7,329	1,448	728	1,364	246	146	73	194,009
2017	Med	182,676	12,589	1,807	1,092	3,217	368	262	277	202,289
	High	182,676	17,850	2,155	1,471	3,828	502	393	480	209,355
	Low	182,676	7,329	1,553	844	1,588	256	175	116	194,537
2022	Med	182,676	12,589	1,935	1,267	3,013	389	306	306	202,481
	High	182,676	17,850	2,306	1,704	4,439	522	451	524	210,471

Notes

(A) Cost for empty containers was considered to be the same as cost for full containers due to a lack of available information.

(B) Cost for this category assumed to be equivalent to cost of shipping containers.

(C) Costs from Reebie model for wood products were lower than base costs. Because this is unlikely to be the case, no change was projected for this commodity.

(D) Costs for woodchips and logs were lower under drawdown condition than under base condition. Therefore, no change in cost was assumed.

(E) Costs for Wheat and Barley are derived from costs provided in the COE's Snake River Drawdown Study.

Costs resulting from a drawdown were calculated using a revised version of the COE's cost spreadsheets for the Snake River study, and increased over time in proportion with the increase in costs under the base condition.

(F) Costs reflect base costs for all wheat and barley movements on Columbia Snake system plus cost increases for wheat and barley shipped on the Snake River. This includes base costs for wheat and barley loaded between John Day and Ice Harbor dams,

but does not include increases in these costs which are captured in Table 4.2

Table 15.

Costs of Shipping Goods Loaded or Unloaded between John Day and Ice Harbor Dams- Drawdown Condition ($1,000)

		Wheat and Barley(A)	Woodchips and Logs	Petroleum	Other Farm Products	Wood Products	Chemicals	Containers (Empty)	Soil, Sand, Gravel, Rock and Stone
	Low	$ 10,090	$ 2,664	$ 22,555	$ 449	$ 19	$ 602	$ 1,298	$ 165
2002	Med	$ 13,891	$ 2,664	$ 25,975	$ 683	$ 36	$ 1,150	$ 2,387	$ 165
	High	$ 17,594	$ 2,664	$ 29,259	$ 914	$ 53	$ 1,684	$ 3,475	$ 165
	Low	$ 9,420	$ 2,664	$ 23,513	$ 533	$ 23	$ 505	$ 1,528	$ 165
2007	Med	$ 14,470	$ 2,664	$ 27,207	$ 810	$ 43	$ 1,233	$ 2,826	$ 165
	High	$ 19,521	$ 2,664	$ 30,764	$ 1,085	$ 64	$ 1,962	$ 4,124	$ 165
	Low	$ 9,420	$ 2,664	$ 24,607	$ 683	$ 29	$ 505	$ 1,800	$ 165
2012	Med	$ 19,514	$ 2,664	$ 28,438	$ 1,036	$ 55	$ 1,961	$ 3,308	$ 165
	High	$ 14,467	$ 2,664	$ 32,406	$ 1,391	$ 81	$ 1,233	$ 4,836	$ 165
	Low	$ 9,652	$ 2,664	$ 25,702	$ 864	$ 37	$ 539	$ 2,073	$ 165
2017	Med	$ 14,825	$ 2,664	$ 29,943	$ 1,313	$ 70	$ 1,285	$ 3,831	$ 165
	High	$ 19,997	$ 2,664	$ 34,047	$ 1,762	$ 103	$ 2,031	$ 5,590	$ 165
	Low	$ 10,048	$ 2,664	$ 26,933	$ 1,001	$ 43	$ 596	$ 2,408	$ 165
2022	Med	$ 15,434	$ 2,664	$ 31,448	$ 1,522	$ 81	$ 1,372	$ 4,438	$ 165
	High	$ 20,820	$ 2,664	$ 35,826	$ 2,042	$ 119	$ 2,149	$ 6,469	$ 165
Notes									

(A)Costs calculated for wheat and barley being shipped out of ports below Ice Harbor are not equivalent to costs calculated for Snake River grain. Costs do not include cost of trucking t

Table 16.
Total Increase in Costs of Shipping Goods (Total Cost under Drawdown – Total Base Costs) ($000)

		Wheat and Barley	Wood Chips and Logs	Petroleum	Other Farm Products	Wood Products	Chemicals	Containers (Empty)	Soil, Sand, Gravel, Rock and Stone	Metals	All Other	Total
	Low	$64,037	$1,704	$9,520	$433	$5	$356	$908	$122	$0	$75	**$77,160**
2002	Med	$67,839	$1,704	$11,006	$652	$9	$620	$1,669	$122	$0	$973	**$84,594**
	High	$71,541	$1,704	$12,433	$882	$14	$878	$2,441	$122	$0	$2,020	**$92,036**
	Low	$65,615	$1,704	$9,936	$515	$6	$307	$1,068	$122	$0	$75	**$79,350**
2007	Med	$70,666	$1,704	$11,541	$771	$11	$663	$1,987	$122	$0	$1,048	**$88,513**
	High	$75,717	$1,704	$13,087	$1,037	$16	$1,013	$2,895	$122	$0	$2,095	**$97,688**
	Low	$65,601	$1,704	$10,411	$652	$7	$307	$1,267	$122	$0	$75	**$80,148**
2012	Med	$75,695	$1,704	$12,076	$999	$14	$961	$2,322	$122	$0	$1,197	**$95,091**
	High	$70,648	$1,704	$13,801	$1,335	$21	$715	$3,390	$122	$0	$2,245	**$93,981**
	Low	$67,224	$1,704	$10,887	$833	$9	$326	$1,454	$122	$0	$374	**$82,934**
2017	Med	$72,396	$1,704	$12,730	$1,255	$18	$684	$2,683	$122	$0	$1,422	**$93,014**
	High	$77,569	$1,704	$14,514	$1,688	$26	$1,046	$3,923	$122	$0	$2,469	**$103,062**
	Low	$67,620	$1,704	$11,422	$966	$11	$353	$1,694	$122	$0	$599	**$84,491**
2022	Med	$73,006	$1,704	$13,384	$1,455	$21	$728	$3,110	$122	$0	$1,571	**$95,102**
	High	$78,392	$1,704	$15,287	$1,956	$30	$1,103	$4,537	$122	$0	$2,694	**$105,825**

8.1 Total Costs of Drawdown Scenario

Table 16. above shows the increased costs for transporting commodities under the four proposed drawdown scenarios. The projected implementation date for the natural river and spillway alternatives, if they were selected, is proposed to be 2013, therefore annual costs are calculated for the period 2013 to 2112. When the increased costs from Table 16. are extended through the project's period of record (2013 to 2112), the average annual cost for a drawdown is estimated to be between $237 and $281 million per year. This amounts to an increase ranging from $83 to $104 million dollars per year. Table 17. shows the estimated annual costs in detail.

Table 17.
Average Annual Costs ($000)

	Existing Conditions	Drawdown Scenario*	Increased Costs
Low	$153,703	$237,067	$83,365
Base	$166,316	$260,938	$94,621
High	$178,459	$281,547	$103,089

*Drawdown scenario includes drawdown to both Natural River and Spillway Crest levels with and without flood control

SECTION 9. Modification Opportunities

As a part of this Phase 1 study, the Corps has pursued an analysis of the impacts to navigation on the river. As a part of this analysis, the Corps has developed cost estimates for mitigating the effects of a drawdown through the dredging and maintenance of a navigation channel. This analysis looked at maintaining the existing channel, at providing a shallow draft (7-foot) channel, and at developing two designs for a new channel, based on the hydrographic analysis of the John Day pool. The analysts involved in the navigation appendix (Foster Wheeler Environmental, Inc.1999) concluded that the best option for modification under the Spillway Crest alternatives would cost approximately $490 million. The best option under the Natural River scenarios would cost approximately $1.5 billion. Structural modifications at John Day and McNary dams were not included in these costs, nor were annual operations and maintenance costs. For further detail on these proposed channels and their designs refer to the Navigation Section of the Engineering Technical Apppendix.

Table 18.
Navigation Channel Costs
Natural River and Spillway Crest Alternatives ($000)

	Spillway Crest	Natural River
Provide 14-foot Draft Navigation Channel	490,000	1,500,000

The average annual costs of these the proposed alternatives are shown in Table 19. When compared to the average annual increase in costs (shown in Table 17.) ranging from 83 to

104 million dollars, the potential modification under the Spillway Crest alternatives appears to merit further consideration. The benefits of potential modifications under Natural River conditions are somewhat less certain; however, costs are at least close enough to merit further study of these potential modification alternatives. There are however, limitations in the proposed modifications. Implementation and funding of such a significant project could be difficult, and the environmental impacts of such a large-scale change to the river were not fully addressed in the Navigation Analysis. A more detailed analysis of these modification opportunities will be required if this study is carried into a Phase 2.

Table 19.
Average Annual Cost of Modifications Alternatives ($000)

	Spillway Crest	Natural River
Provide 14-foot Draft Navigation Channel	31,561	96,616

9.1 Potential Modifications and the Snake River Drawdown

The proposed drawdown of four Snake River dams would have a significant effect on the potential for modifications of a drawdown of the John Day pool. If there is no drawdown on the Snake River, then modifications for the John Day pool will allow barge traffic on the CSRS to continue with comparatively little change. A drawdown of the Snake River, however, would add significant additional annual costs to the operation of the system, in the range of 65 to 95 million dollars. When these costs are added to the costs of modifications, then closure of the system as a whole seems to be more economically efficient than attempting to mitigate the effects of the John Day drawdown through maintaining a navigable channel. Ramifications of a drawdown on the Snake River should be explored in greater detail if this study is pursued at the Phase 2 level.

9.2 Other Potential Modifications Opportunities

No other potential modifications opportunities were identified for analysis as a part of this study. If this study is pursued at a Phase 2 level, other opportunities for potential modifications should be considered, such as infrastructure and capacity improvements for affected facilities including roads, grain elevators and export terminals.

SECTION 10. Sensitivity Analyses

Because of the limited scope of this analysis, and the restrictions inherent in using NED criteria, it is important to address topics which could not be captured in the main body of the analysis, but which are of significant importance to the region. These topics include areas of uncertainty, potential costs that could not be adequately captured, and costs which, while significant, are not considered NED costs.

10.1 Crop Selection and Production

Evidence suggests that increased transportation costs under drawdown conditions could cause some producers to select alternative crops, or to cease production entirely. Other evidence suggests that cost increases would be capitalized into agricultural land values, but that the overall production of grain and other commodities would remain relatively constant.

The analysis completed by the Corps for the *Snake River Drawdown Study* concluded that production levels would remain constant, and this is the assumption that this study operated under. If a Phase 2 analysis is pursued, it should include more complete study of the potential for marginal lands to be taken out of production, and an analysis of the impacts of the subsequent drop in volume at export facilities.

10.2 Destination Changes

Another potential outcome of a drawdown of John Day could be a shift in the quantities of goods being shipped to downstream export elevators. An increase in transportation costs could cause producers to select an alternative destination for their goods. This analysis assumes that goods will continue to go to their current destinations. As such, it serves as a worst-case scenario from an NED perspective, since producers are likely to select an alternative destination if it is price competitive with the current destination. However, when the potential for destination changes is examined from a regional perspective rather than an NED perspective, there exists the possibility that lower Columbia River ports could feel significant effects. In particular, the shipment of containers out of Lewiston is currently one of the major revenue sources for the Port of Portland. Under drawdown conditions, containers would most likely be shipped by rail. Once containers are loaded onto rail cars, there is very little cost difference between Portland and Seattle or Tacoma. Because these Washington ports have more frequent service from ocean-going vessels, the potential exists for the Port of Portland to be bypassed entirely. The loss of the westbound containers could have other ramifications, including fewer stops by container freight lines, and a subsequent lower level of service for the Port’s local customers. A Phase 2 analysis should examine the relative costs and decisions involved in the shipment of containers in significant detail.

10.3 Rail Capacity, Reliability, Competitiveness, and Rates

The cost estimates provided in this study are based almost entirely on the assumption that goods currently being shipped on the river will be forced onto the rail lines. This raises some serious questions about capacity, reliability, competitiveness, and rates. For many of the region’s producers, rail service is not currently considered to be a viable transportation alternative, and in many cases commodities are driven many miles from elevators with rail access to be loaded onto barges and shipped on the river. The underlying economic cause of this problem with rail service is two-fold. On the one hand, rail carriers can make higher profits by using their cars to ship commodities longer distances. On the other hand, the areas that typically send goods to the CSRS have not invested in consolidated and higher speed loading facilities, particularly for grain, that are becoming the norm in other regions. Because shipping by barge is so cost competitive with shipping by rail or truck, areas near the river system have little incentive to pursue modes other than barging. For those areas that border the area of influence of the CSRS, the quantities of goods are small enough that they are often overlooked by rail carriers during periods of high demand for rail cars. With a relatively small quantity of grain at stake, and strong competition from the barge service providers, there has been little incentive to modernize rail facilities, and as a result, rail service in the region has declined.

10.3.1 Capacity

The discussion of capacity has three components: capacity on the mainline facilities of Class I railroads; capacity on shortline railroads; and capacity at facilities for loading and unloading commodities.

Assuming a roughly equal distribution of shipments throughout the year, it appears that mainline capacity would be available to meet the needs of increased shipments. The ability of mainline facilities to handle the spikes in demand that characterize the grain industry in particular, and other commodities to a lesser extent, is somewhat more difficult to ascertain. Representatives of the rail industry have suggested that mainline capacity would be available to handle the seasonal peaks of the goods shipped on the Snake River. If this study is pursued into a Phase 2, a more quantitative analysis of mainline rail capacity should be considered.

Shortline railroads would probably vary widely in their ability to handle significant tonnages of additional cargo. Some shortline representatives have publicly stated that they have significant excess capacity at this time (e.g. Camas Prairie Railnet). Again, a more detailed analysis of shortline capacity should be considered for a Phase 2.

Capacity at loading and unloading facilities served by rail is an area of significant concern. In many areas, sidings and leads serving these facilities have not been maintained, and many would need to be replaced. In addition, many of the loading facilities are designed to handle small numbers of cars, and do not have the speed or capacity to handle traffic by today's standards. In addition to being small, the collection system for commodities is dispersed over a large area. This lack of centralization would decrease the competitiveness of these facilities for limited rail cars.

In the *Snake River Drawdown Study*, the Corps assumed that capacity improvements at these facilities could be paid for through revenues generated by increased volumes. While this assumption has some merit, in order to be efficient, it may be necessary to centralize some loading facilities, so that full-length trains can be loaded quickly. This centralized system has developed in other parts of the country; however, it is unclear how soon these facilities would develop without intervention. If collection facilities failed to provide efficient loading and staging, then capacity and reliability would likely continue to be a serious concern, with significant costs. If this study is pursued further, a more detailed assessment of the requirements for developing a centralized loading facility, and the consequences of a gradual centralization need to be considered.

Capacity is also a concern at unloading facilities, particularly for wheat and barley. While percentages vary between facilities, approximately 45 percent of the grain exported from the Lower Columbia are shipped by barge. Shipping all of the grain by rail would therefore nearly double the quantities that elevators would have to handle by a single mode. Some elevators are significantly constrained by space, and/or have limited rail access. Many of the facilities are located in or near developed metropolitan areas, further restricting staging and storage capacity. These facilities would have difficulty adjusting to the changed environment. Capacity restrictions at export elevators are a major concern for shippers, and a switch to shipment entirely by rail would have severe impacts on some export facilities. Despite significant concerns, however, there is no consensus as to the impact that the increases in rail shipment would have on the export elevators. Opportunities do exist for expansion at some facilities, and the Port of Portland's proposed expansion at Hayden Island could handle a significant portion of the increased load. If a Phase 2 study is pursued, the examination of infrastructure costs at export facilities will be an important element.

10.3.2 Reliability

Concerns over reliability are based on the fact that many of the commodities shipped on the CSRS are shipped based on time-sensitive export demands. For example, grain is often contracted in huge quantities, and this sudden demand temporarily increases prices and encourages farmers to ship products. One such large order increases the demand for barge and rail service throughout the study area. Faced with the choice of shipping from eastern Washington or Idaho, or shipping from Montana or North Dakota, rail carriers often choose to provide their limited supply of hopper cars for the long-haul trips further east. This means that when producers have a time-sensitive need for service, rail cars are often unavailable in areas served by the CSRS. Without reliability, producers have serious concerns about their ability to fulfill their contracts and to ship their goods profitably.

Changed economic relationships under drawdown conditions confound attempts to state definitively whether or not rail service would be adequate. At present, rail carriers face competition with highly cost-efficient barging operations throughout much of the study area. Areas in eastern Washington and Idaho, where rail has the potential to be price competitive with barge, are hampered by a dispersed collection system, and comparatively low volumes of grain. As discussed above, drawdown conditions would most likely require a consolidation of collection facilities. In addition, a drawdown would provide an opportunity for substantially increased volumes. With more efficient loading and unloading and higher volumes, rail carriers would be better able to efficiently use their equipment on short-haul trips. It remains to be proven quantitatively whether or not the volumes and potential for loading and unloading improvements would adequately shift the economics of shipment by rail enough to provide reliable service to producers currently served by barge. Resolving this question is beyond the scope of this analysis, but its potential impacts need to be considered in the evaluation of navigation costs. A Phase 2 analysis, if pursued, should attempt to resolve questions relating to the reliability of service

10.3.3 Competitiveness

The loss of barge service raises concerns over the range of shipping choices that producers would have under drawdown conditions. Currently, two Class I railroads serve much of the area of influence of the CSRS. A shortline railroad, Camas Prairie Railnet, serves both of these railroads from eastern Washington and western Idaho. However, large portions of the Columbia-Snake region, most notably the greater part of Montana, are served by essentially one railroad. These areas would have little recourse if rates were increased, and could face significant regional costs. NED guidelines suggest that increased costs faced by producers from monopolistic pricing should be considered transfer costs rather than NED costs, and so these costs are not captured in this analysis. Further examination of the potential impacts of non-competitive pricing should be pursued in a Phase 2 analysis.

10.3.4 Rates

Associated with concerns over competitiveness are concerns about increases in rates faced by producers. Current rates for shipment by rail could provide one estimate of the rate increase felt by producers. However, changes in the system of collection and export via rail could make rail more cost efficient, and allow rates to be lowered. Countering this increased efficiency would be the tremendous capital cost of upgrading facilities in the short term, and also the long-term loss in competition. The result of these conflicting rate pressures is uncertain, but it is clear that there would be some effect on the region. NED guidelines suggest that rate increases should be considered transfer payments from producers to transportation providers, and therefore not NED costs. Regardless of categorization of rate increases as NED costs or transfer payments, rate increases would have a significant impact on the region, and on producers in particular. A Phase 2 analysis should attempt to include some quantification of likely rate increases as a means of addressing regional impacts.

10.4 Shallow Draft Navigation

One of the scenarios proposed for preliminary examination under this study was the maintenance of a 7-foot-deep navigation channel that could support barging configurations comparable to those that were used prior to the construction of the dams. Faster currents and tighter turns required that early tows comprise a tug and a single barge, as opposed to the four barges that comprise a tow today. The costs of barging under these conditions have not been quantified. However, the need to purchase a new fleet of equipment, and the loss of much of the volume that makes barging efficient, would suggest that this mode of transportation could not compete with modern truck or rail operations.