3.1 Water Supply

3.1.1 Introduction

This report focuses on the evaluation of Snake River water users and the potential effects to these groups as a result of actions to improve anadromous fish returns. Although there are four different alternatives under consideration to improve anadromous fish returns, only Alternative A3—Dam Breaching would directly affect the operation of river pump stations and wells used for irrigation and other purposes.

Irrigation water for farm purposes is the dominant consumptive use of the water pumped from the river. Other potentially impacted water user groups that are included in the following analysis are municipal and industrial (M&I) pump operators and private well users.

Section 3.4.2 of this analysis focuses on effects to irrigated agriculture. Section 3.4.2.1 provides a description of irrigated agriculture in Franklin and Walla Walla Counties and section 3.4.2.2 describes more specifically the farms that withdraw water from the lower Snake River at the Ice Harbor reservoir. Three separate approaches to measuring the economic effect to irrigators under dam breach conditions are included. Section 3.4.2.3 describes the economic effects based on the modified cost approach. Section 3.4.2.4 indicates the economic effects based on the change in farmland values under dam breaching. Whereas section 3.4.2.5 provides an estimate of economic effects based on the change in net farm income. Conclusions about the effect of dam breaching on irrigated agriculture are presented in section 3.4.2.6.

Section 3.4.3 of this report discusses the effect on other water users, particularly users of municipal and industrial (M&I) pumps and privately owned wells. The required modification costs to M&I pump stations and private wells provide the measurement of the economic effects to these other water users.

Section 3.4.4 of this report summarizes the economic effects to water users. Section 3.4.5 describes the sensitivity analysis of the economic effects to irrigated agriculture.

Basic Assumptions

- The economic analysis of water supply effects relied heavily on existing studies and data. In general, the analysis of economic effects was primarily limited to estimating the capital costs of system modifications. The rationale for the limits on the analysis were that the data from existing studies appeared reasonably good, net farm income analysis would be an extensive and expensive effort with probable limited returns, and relative to other NED costs water supply effects are small. For instance, under dam breach conditions the total water supply NED effects are less than 10 percent of the hydropower costs.

- Irrigated farmland operators that currently pump water from the Ice Harbor Reservoir will no longer be able to pump water from the reservoir under dam breach conditions, and the value of the impacted 37,000 acres of farmland would be reduced to non-irrigated grazing land. This change in farmland value represents the economic effect of dam breaching on pump irrigators.

- Economic effects under dam breach conditions to municipal and industrial pump station operators and privately owned well users are determined by estimating the system modification costs.

- The economic effects to water users that are described in this report would be incurred the year that dam breaching is implemented.

3.1.2 Irrigated Agriculture

3.1.2.1 Profile of Irrigated Agriculture, Franklin and Walla Walla Counties

The counties of Franklin, Walla Walla, Whitman, Columbia, Garfield and Asotin in Washington and Nez Perce County in Idaho border the four lower Snake River reservoirs. However, this water supply analysis focuses on only those portions of the counties that are served by water from the four reservoirs or would be impacted by changes in these reservoirs.

Of the counties listed above irrigated agriculture is dominated by Franklin and Walla Walla. The very large river pumping stations used for irrigated farming that would most directly be impacted under dam breach conditions are located in these two counties. Irrigation water is withdrawn from both the Columbia and Snake Rivers out of the McNary and Ice Harbor pools, respectively. However, this analysis is concerned with the lower Snake River water users located near Ice Harbor reservoir in the counties of Franklin and Walla Walla.

Since the construction of Ice Harbor Dam in the early 1960s, private entities have financed the development of infrastructure necessary to grow irrigated crops in the region. The majority of the irrigated farmland adjacent to Ice Harbor reservoir is irrigated by pumping water from the Snake River. Some additional land is irrigated using wells.

A review of irrigated acreage information from several sources indicates that there are about 37,000 acres using pumped Snake River water at Ice Harbor reservoir. The Columbia River System Operation Review study that was completed in 1995 identified 36,400 acres of irrigated farmland using Snake River water pumped out of Ice Harbor reservoir (Corps, 1995). A recent inventory effort completed by Corps of Engineers, Portland District economists documented about 34,000 acres of irrigated cropland using water pumped out of Ice Harbor. Although specific documentation is not readily available some local agriculture experts indicated that they believe the actual number of acres irrigated with water pumped from Ice Harbor is somewhat greater than what the above estimates indicate. For instance, the Natural Resources Conservation Service (NRCS) regional field office estimated that there are over 50,000 acres of irrigated farmland adjacent to Ice Harbor. However, a breakdown between the acres irrigated with pumped water and well water was not provided. Consequently, it is surmised that a substantial amount of this additional acreage is irrigated using well water.

For purposes of analyzing the economic effects to pump irrigators under dam breach conditions, it is estimated that approximately 37,000 irrigated acres in Franklin and Walla Walla counties would be impacted. Table 3.4-1 compares the statewide number of irrigated acres with these two counties. In addition, the table displays the number of acres of specific crops within these two counties.

Comparing the number of irrigated acres that would be impacted by the breaching of Ice Harbor dam to the total amount of irrigated acres within the two counties and statewide show that the quantity of impacted farmland is relatively small percentage. The 37,000 acres represents about 12-percent of the irrigated farmland in Franklin and Walla Walla counties and about 2-percent of the irrigated farmland in Washington State.

Table 3.4-1. Acres by Crop Type: State of Washington Compared to Franklin and Walla Walla Counties

Crops	State of Washington Acres	Franklin County and Walla Walla County Acres	Two County Percentage of State Total
Total Irrigated Acres	1,705,000	318,281	18.7%

Field Corn	170,000	33,400	19.7%
Potatoes	161,000	55,500	34.5%
Asparagus	23,000	13,000	56.5%
Peas	42,200	5,900	14.0%
Onions	13,400	4,600	34.3%
Sweet Corn, proc.	75,300	18,400	24.4%
Apples	142,000	9,400	6.6%
Cherries	14,000	1,700	12.1%
Vineyards	31,000	2,300	7.4%

Source: Washington Agricultural Statistics, 1996-1997, Washington State Department of Agriculture. U.S. Census Bureau, 1997 (Agriculture)

Information in Table 3.4-1 also shows the relative importance of specific crops in these two counties compared to the state total. Both Franklin and Walla Walla counties are important field corn producers, together accounting for a fourth of the state's production in 1995. Potatoes are an important crop as well. Franklin and Walla Walla counties contribute to the state harvest significantly and comprise about a third of the state production. Both Franklin and Walla Walla counties also have a lot of acreage devoted to vegetable crops, including asparagus, carrots, peas, onions and sweet corn. Some vegetable crops are found on farms that irrigate from the Ice Harbor reservoir, however the total acreage is not large. Both Franklin and Walla Walla counties have significant acreage in orchards for the production of apples, cherries and grapes as well. A fairly large amount of orchard crops are also grown on farmland adjacent to Ice Harbor reservoir.

3.1.2.2 Profile of Irrigated Agriculture at Ice Harbor Reservoir

This section provides information about non-federal agricultural water users who pump from the Ice Harbor reservoir.

It has been determined, based on a survey of farms that at least 37,000 acres of land are presently irrigated with water pumped out of Ice Harbor reservoir. Table 3.4-2 summarizes information about the pumping stations that are used to withdrawal Snake River water for agricultural purposes. Data about the farm operations indicate that some additional acreage is irrigated using wells rather than the Snake River pumps. For instance, one of the orchard operators has more horsepower than the river station pumps, and total irrigated acreage is considerably greater than the amount identified in Table 3.4-2. Changes to the economics of the pump irrigated land component of these farms may directly impact the economic viability of the land that relies on wells. It was, however, assumed for this study that as long as irrigation water is available the land remains economically viable.

Only a portion of the acreage is in permanent crops like fruit tree orchards or vineyards, and, therefore, acreage by crop varies from year to year as crops are rotated. Potatoes, for example, are grown on the same land only one year in three or four for disease control. An estimate of farmland relying on Ice Harbor water, by crop type is presented in Table 3.4-3.

As Table 3.4-3 shows, cottonwood is the largest crop in percentage terms and is grown for pulp and paper production. Potatoes are the next biggest crop although this will vary year to year. Fruit tree orchards and vineyards are high valued crops, and recently the number of acres has been expanded primarily due to the planting of apple trees in the last two years. Also, a relatively minor amount of acreage is in asparagus, peas and other crops.

Table 3.4-4 summarizes river station pump plant data on size and output for these farms. There are about 75 pumps with a total of about 42,000 horsepower. This does not include booster pumps that are situated between the river station and point of use at a higher elevation than the river station.

Electrical usage is for 1996 except for IH-2 and IH-5, and IH-16. Those data are for 1997. Table 3.4-4 was developed using information from a previous consultant's report (Anderson Perry, 1991), Walla Walla District engineers data, and farm manager interview data.

Table 3.4-2. Crop Data for Agricultural Pumpers from Snake River, 1996/1997

Pump Stations (Ref. No.)	Total Acreage	Total Acreage Irrigated from Snake	Primary Crops	Notes
IH-1	1,500	1,500	Sweet corn, onions, potatoes	Shared ownership with IH-12
IH-2	4,500	4,500	Hybrid cottonwood	Land/station leased.
IH-3	12,000	9,500	Potatoes, wheat, field corn, onions, sweet corn	
IH-5	4,100	4,100	Hybrid cottonwood	Land/station leased.
IH-6	5,000	2,200	Field corn, wheat, potatoes	
IH-7	2,900	2,700	Grapes, apples	
IH-9	540	540	Apples	Shared station with IH-10
IH-10	4,000	1,800	Apples, cherries	
IH-11	6,017	4,008	Apples and cherries, sweet corn, potatoes, wheat, peas, field corn	Includes 1000 acres of orchards
IH-12	900	900	Field corn, potatoes, asparagus, wheat	Owns 30% of IH-1 station
IH-16	600	320	Apples, cherries	
IH-17	1,200	1,200	Potatoes, onions	
IH-18	225	165	Vineyards, apples	
IH-19	500	500	Not determined	Future station.
ICE HARBOR TOTAL		33,933		

5 Source: Survey of Farms, 1997/1998.

Table 3.4-3. Estimated Percentage of Crops by Type

Crop	% of Crop Types
Cottonwood/Poplar	23.2
Potatoes	14.9
Field Corn	13.5
Fruit Tree Orchards	11.1
Wheat	9.5
Vineyards	6.2
Sweet Corn	5.4
Onions	3.0
Undefined Percentage	13.2
Total (37,000 acres)	100

Primary Source: Survey of Farms, 1997/1998.

Table 3.4-4. River Station Pump Plant Data, Ice Harbor Reservoir

Ref. No.		River Mile	Number of Pumps	Horse-Power	Head (ft)	Electrical Usage	Water Usage (a-f)	Notes
IH-1		12	8	2,650	360	$217,000	7,917 (95)	Station 30% by IH12.
IH-2		12	5	4,500	260	11,000,000 kW	14,000 (97)	
IH-3		17	11	13,500	460	$941,000 30,636,500 kW	29.5 in/ac average	
IH-5		12	5	4,700	260	9,000,000 kW	8,800 (97)	
IH-6		14	8	2,260	260	$112,440 4,591,000 kW	4,341 (96)	
IH-7		12	9	4,900	462	$229,688	12,216 (96)	
IH-9			6					Shared with IH-10.
IH-10			8	4,400	410	$234,195	NA	
IH-11		20	6	3,900	310	$182,607	7,275 (96)	
IH-12		12			415	about $72/ac	23 in/ac average	
IH-16		10	2	300	360	330,000 kW	2 af/acre (97)	Water usage will increase when trees mature.
IH-17			4	1,300	350	$133,000		
IH-18			2	240	230		18in/ac	
IH-19			1	125	6			Planned Station.

Source: Anderson Perry, 1991 and Survey of Farms, 1997/1998.

3.1.2.3 Economic Effects: Pump Modification Cost Approach

Introduction

The objective of the analysis of irrigation water users is to estimate the net economic losses under dam breaching conditions as compared to the base condition. A total of three different approaches are presented in this report. These are the pump modification cost approach, the farmland value approach, and the net farm income approach. The first approach and the one presented in this section of the report is the estimation of the cost to modify or replace river pump stations so that the current water supply capability is maintained under dam breaching conditions.

The modification costs provide an upper bound estimate of the economic effects to irrigators under dam breach conditions. This approach to measuring the economic effects to irrigators is not intended to imply such investments are necessarily economic when compared to farm production and income. The true NED costs would be no greater and may be less than the cost to continue to provide equivalent quantities of water.[2] That is, the farmer can always limit cost increases to the cost of modifying the pumping station (and higher O&M costs) but may be able to do better by changing crops, production techniques, etc.

Initially, the modification cost approach was to be the only analysis applied to measure the economic effects to water users under dam breach conditions. As a result of significant increases in the estimated cost to modify the pump systems, the study group determined that the modification cost approach overstated the economic effects and additional economic analysis was warranted.

Sections 2.4 and 2.5 of this report describe the other two approaches used to assess the economic effects to Ice Harbor water users. As is shown later in this document the high cost to modify the pumping system makes the farmland value approach summarized in section 2.4 the most reasonable (least cost) estimate of economic effects to Ice Harbor water users.

The remainder of this section of the report summarizes the pumping station modification costs.

System Modification Options

Three significantly different options to supply equivalent water quantities were identified and considered. Each option is briefly described below. For additional details, refer to the Engineering Appendices (Technical Appendices D and E).

Important requirements of an acceptable modified irrigation system are that the system will be: operational prior to breaching of the Ice Harbor reservoir dam; function through a full range of river stages without interruption; and able to handle a potentially large quantity of suspended sediment.

Under current conditions, the pump stations withdraw water from the Ice Harbor reservoir and pump the water uphill several hundred feet to the individual farm distribution systems. The majority of pumps are vertical turbine type. Without the pool of water created by the Ice Harbor dam, the pumping station intakes would be completely out of the water. Following are the modified systems that were considered.

Option 1:

The first option, investigated conceptually in at least one previous study, is to modify each existing pump station by extending pipes and installing additional or bigger pumps according to increases in lift requirements (Anderson-Perry, 1991).

It was initially thought that this approach would function similar to the existing system and minimize the extent and cost of modifications. Unfortunately, during the review of this concept, the engineering study team identified a number of technical concerns. The team was not able to identify acceptable locations to place the new pump stations that would work with the fluctuating and meandering river conditions under dam breaching conditions. This stretch of the river has a wide, flat bottom with substantial silt, sand, and gravel deposits, and as the material erodes under dam breaching conditions, the river would likely meander and affect the availability of water at the pump stations. In addition, erosion at the pump stations could undermine the pump, piping, and intake structures. The engineering study team also indicated serious concern about how the sediment could be managed at many of the locations new pump stations would need to be established. Another issue raised by the team is the technical problems with constructing this new system without causing some interruption in irrigation water deliveries. Any untimely interruption of irrigation water would severely impact permanent crops such as orchard and vineyards.

Option 2:

Replacement of river stations with groundwater sources is the second option that was considered. Based on discussions with Dr. Robert Evans, irrigation specialist in the County Extension office in Prosser, Washington, this option does not appear to be a feasible option. Wells present numerous problems. There would likely be difficulties in receiving Department of Ecology approval. These wells would need to be drilled deep, increasing both first costs and operating costs. Additionally, the well water would require treatment in order to counter high pH levels; and high sodium content in the well water could lead to soil sealing problems. There is also concern that this system could not be installed without some interruption in irrigation water deliveries, and the interruption of irrigation water deliveries would severely impact permanent crops such as orchard and vineyards.

Option 3:

After consideration of options 1 and 2, the study team focused its efforts on a third approach that they determined would technically work and would satisfy the other criteria noted above. This option includes one large pumping station and distribution system with a sediment basin. This system would provide water via a single river pump station and the water would be delivered to each farm through a main pipeline distribution system. Each farm level pump would also require modifications in order to connect to the main pipeline distribution system. A sediment basin/reservoir is included as a component of the one large pump station system because it is anticipated that sediment effects will be significant

Locating the pump station at a narrow point in the river reduces problems with river fluctuation and meandering. Under dam breaching conditions, the water levels would still be deep in this stretch of the river and the rock channel would ensure that erosion would not impact the availability of water for pumping. Another advantage of this one pump station system is that sediment problems can be addressed using only a single sediment control basin.

Option 3 was selected to carry forward in this analysis because it avoids the problems and uncertainties associated with the others. In other words, option 3 was the only approach that the engineering study team agreed would technically work. Some additional discussion of the selected modification system follows in the next subsection. For additional details, refer to the Engineering Appendices (Technical Appendices D and E).

Description and Costs Associated with the Modified Irrigation System

The selected irrigation system to quantify economic costs under dam breaching conditions is a pressure supply system that will withdraw water at one river location (option 3). The primary irrigation system consists of six main components: the pumping plant at the river; the pipe network; connections to existing irrigation systems; secondary pumping plants; a control system; and a sediment control reservoir.

Pumping Plant:

The intake structure would be divided into five bays with a peak capacity of 850 cubic feet per second (CFS). Three 1500 horsepower (HP) and two 600 HP vertical turbine pumps would be secured above each of the five bays. Electrical switchgear, valves to allow each pump to be isolated from the system for maintenance work, and appropriate screening would be included.

Pipe Network:

The pipeline network would be epoxy lined and polyethylene coated steel pipe. The pipeline would begin at the pump station near river mile 20 on the south shore of the Snake River, and would be 12 feet in diameter at the main pumping plant. The pipeline would then extend downstream about 5,200 feet at which point a branch of the system would cross the river. The branch of the pipe network would cross the river 2700 feet to Emma Lake and then continue another 4,500 feet to the existing pump station at IH11. The main pipeline would extend along the south shore of the lower Snake River for approximately 47,500 feet with branches as needed to connect the other stations to the main pumping plant.

Existing Irrigation System Connections, Secondary Pumping Plants, Control System:

Two of the existing pumping plants are multi-pump configurations that would require reconfiguration in order to connect to the pipe network. Several of the existing pumping plants would require manifolds to be constructed and installed to connect each pump to the piping network. Additionally, at each existing and secondary plant, isolation valves would be required to allow for individual plant maintenance. Flow meters would also be installed. It is anticipated that about six air release/vacuum valves would be required for the system. Drain valves and discharge piping would be required to allow the pipeline to be drained. At each branch pipe and each significant directional change in the pipe network, concrete thrust blocks would be used to control potential thrust damage.

Sediment Control Reservoir:

The construction of a reservoir addresses sediment concerns and surge control. The reservoir would be a holding pond with approximately 14,000 acre-feet storage which would be required to detain the water sufficient time for the settling of suspended solids.

In order for the modified irrigation system to be functional in time for use by irrigators, construction of the river intake, the pipeline network, and the reservoir would need to be initiated 18 months in advance of dam breaching.

Total construction costs for option 3, the large pumping station with a sediment reservoir, are summarized in Table 3.4-5. The total construction costs are equal to $291,481,000.

Table 3.4-5. Cost of Modifying Ice Harbor Agricultural Pumping Stations, 1998 Dollars

Component	Construction Costs	
Mobilization, Demobilization & Prep.	$11,896,148	
Earthwork for Structures	$5,207,616	
Utilities	$6,997,734	
Access Road	$4,849,592	
Pipelines	$71,865,100	
Pumping Plant	$9,243,520	
Pumping Machinery	$52,678,290	
Subtotal, Pump Plant System		$162,738,000
Subtotal, Sediment Reservoir		$128,743,000
Pump Plant & Reservoir Total		$291,481,000

Source: Cost estimate was developed by U.S. Army Corps of Engineers, Walla Walla District Engineers, 1998.

The modified agricultural pump system will likely result in increased energy and other operation and maintenance expenses as well. Additional lift of the irrigation water with new pumps or the conversion of existing pumps will result in higher operating costs. Specifically, the greater horsepower will increase the cost of power to the water user. Added equipment may also require greater maintenance expenditures and may increase the future replacement costs.

Increased maintenance necessary to treat sediment-related problems, even with a sediment control reservoir in place, is not easily predictable. Replacement of worn parts of pumps, valves, sprinklers, and filters may initially be significant.

Therefore, the extent of increased operation and maintenance (O&M) expense associated with the modified irrigation system is not fully understood. Information documented in the Anderson Perry study (1991) is used as a placeholder value because no specific estimate of the additional O&M costs was completed. That study identified additional O&M expenses associated with modifying the existing pump stations equal to $3,573,000/year (1998 dollars).

Construction costs are estimated to equal $291,481,000 with the added O&M expenses associated with the modifications to the irrigation pump stations at Ice Harbor reservoir equal to $3,573,000/year. The estimated modification cost provides an upper bound measurement of the economic effects to irrigators; and the true NED costs would be no greater than this estimate.

3.1.2.4 Economic Effects: Farmland Value Approach

Introduction

In this section of the report the measurement of the economic effects to irrigators under dam breach conditions is determined based on a change in farmland values. In order to accomplish this, typical land values for farm properties at Ice Harbor reservoir are presented. This information was compiled through discussions with farm managers, cooperative extension agents, farmland appraisers, agricultural economics professors, and the use of published enterprise budget sheets for a number of crops. An analysis of this data provides an estimate of typical farmland value and permits the quantification of the economic effect to the farmland under dam breach conditions.

Approximately 37,000 acres of irrigated farmland currently rely on pumped water from the Snake River, specifically Ice Harbor reservoir. In addition to the estimated 28,400 acres of the more traditional irrigated cropland there are 8,600 acres of poplar plantations.

Farmland Value

Following is a summary of the estimated value of the different types of irrigated farmland in southeastern Washington State.

Row Crops:

A local farm manager knowledgeable about market values indicated that supply of land on the market is currently limited and demand is high, resulting in high prices for land. He estimates that row cropland, anchored by potatoes in the crop rotation, has an approximate value of $2,500 to $3,500 per acre. This estimate is based on potatoes generating net income of $450 per acre and other crops (wheat, sweet corn, alfalfa, beans, field corn) generating net income of $225 per acre. Assuming potatoes are grown one year in four, average net income per acre is approximately $280. Land appraisal data from other sources confirms that this is a reasonable estimate of the value of row cropland. Of course there are many variables that could cause actual values to vary from this range, such as terrain, soil, and accessibility to water.

Apples, Cherries:

The Farm Business Management Report for red delicious apples states that the value "varies considerably depending on the age of trees and their current and potential production levels. The better apple orchards in this area are 10 to 20 years old with an annual production level of 40 bins or more per acre. Such an orchard is currently valued at about $12,000 per acre. Eventually the value of the orchard will decrease due to age of trees and the irrigation system to about $5,000 per acre."

In the opinion of an extension economist for Washington State University, valuation of $12,000 per acre for apple orchards is probably low for the Ice Harbor farms. The Farm Business Management Report is based on Wenatchee, Washington orchards. The orchards in the Ice Harbor vicinity are probably younger and more productive than Wenatchee orchards. His estimate of value is near $15,000.

Another, higher value estimate for fruit orchards was put forth by Benton County Cooperative Extension. Value increases with tree density, quality of irrigation system, frost-control equipment, trellised orchards, and tree maturity. In general, the Ice Harbor orchards are dense with good irrigation and frost control systems, and are trellised and have mature crops. For these farms establishment costs run from $25,000 to $32,000 per acre. Initial tree costs alone, assuming 1,000 trees per acre at $7 per tree, may account for $7,000 per acre of these establishment costs. The market value should reflect these establishment costs.

Appraised value data for four orchards sold within the last two years in southeastern Washington documented that the values of these properties ranged from $9,900 to $11,900 per acre. In the opinion of a local appraiser, $10,000 per acre is a reasonable average value to use for apple orchard land.[1]

Vineyards:

Washington State University Farm Business Management Reports also provide estimates of the costs of establishing a Concord grape vineyard. For this perennial crop four years are needed to develop a mature vineyard. Total investment costs over the four year period, net of revenues, are about $7,000. Including the value of raw land, estimated at $2,500 per acre, raises the total value of a mature vineyard to $9,500. This assumes the market equilibrium price would eventually stabilize at a level to cover costs.

Local appraiser information indicates that $5,500 per acre for vineyard property is a reasonable average value estimate for the study area.

Poplars:

Estimating the value of poplar/cottonwood acreage is difficult because of the lack of available historical market value data. Pacific Northwest Regional Extension Bulletin “High Yield Hybrid Poplar Plantations in the Pacific Northwest” (PNW356) is one source of value information. The net present value per acre of the crop, defined as discounted future revenues less discounted future costs, varies with assumptions about product price, age at harvest, and productivity, among others. Table 9 of the bulletin lists present values for different combinations of these factors. For example, as pulp price varies from $20 to $32 the net present value per acre with harvest at age 7 ranges from $-44 to $431. This range reflects net present value sensitivity to price. Presumably, the market value of the property would be a combination of the raw land value and the market’s assessment of the net present value of the cottonwood crop at any point in the crop’s cycle. In addition, the market value should include the value of the irrigation system, if any.

Information provided by local appraisers indicates that the tree farms are generally appraised similarly to row crop property. Therefore, the estimated market value of this type of farmland is $2,500 to $3,500 per acre.

Farmland Value Summary:

Table 3.4-6 is a summary of the estimated market value of the primary types of irrigated farmland in the region. In addition, local farm appraisers and agricultural experts have indicated that farmland near Ice Harbor reservoir is generally not suitable for growing non-irrigated crops such as wheat because of low rainfall. Therefore, this farmland without irrigation water is limited to some grazing a short period of the year and would sell for $75 to $150 per acre.

Table 3.4-6. Farmland Value Estimates for Selected Crops

Type of Cropland	Value per Acre
Row Crops	$2,500 to $3,500
Vineyards (at maturity)	$5,500 to $9,500
Orchards (at maturity)	$10,000 to $32,000

[1] Regional land valuation experts that were contacted by the Walla Walla District economist provided appraisal data. Because this type of data for specific properties is usually confidential, the appraiser names and properties are not disclosed.

Poplars	$2,500 to $3,500
Non-irrigated Farmland	$75 to $150

Estimated Economic Effect Based on a Change in Land Value

Detailed crop information for about 20,000 of the irrigated acres at Ice Harbor was collected through interviews with farm operators. The crop information in conjunction with the farmland value data described above is used to determine the average per acre value of irrigated farmland in the region. Table 3.4-7 summarizes the results of the analysis of the six farms constituting over 20,000 of the irrigated acres that would be impacted under dam breach conditions. Based on the farmland value approach, the average per acre value of irrigated farmland equals $4,100. Corps of Engineers planning guidance suggests that any economic analysis of the change in land values should be based on the market value of the property.

The procedure used to estimate the per acre value of farmland associated with Ice Harbor reservoir is summarized in Table 3.4-7 and briefly described in this paragraph. The low end range of the per acre crop land values presented in Table 3.4-6 were applied to the list of crops presented for each farm in table 3.4-7. Multiplying the number of acres of each crop by the per acre value provided a total farm value estimate. The average per acre value of each farm was determined by dividing the total farm value by the total number of farm acres. The overall per acre value of irrigated acreage served by pumped water from Ice Harbor reservoir was estimated by multiplying the average per acre value of each farm by the percentage of total acreage associated with that farm to determine, and then summing the values for all farms.

By applying this average per acre value to the total amount of irrigated crop acreage, and adding the value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland an estimate of the net economic impact to pump irrigators under dam breach conditions is estimated.

Therefore: ($4,100 * 28,400 acres) + ($2,500 * 8,600 acres) - ($100 * 37,000 acres) =

$116,440,000 + $21,500,000 - $3,700,000 = $134,240,000.

The economic effect of dam breaching measured on the basis of a change in farmland value is equal to $134,240,000.

Table 3.4-7. Estimated Market Value of Irrigated Acreage Served by Pumped Water from Ice Harbor Reservoir, Sample Farms

Farm / Crop Distribution	Acres	Per Acre Farmland Value	Total Value	Value / Acre by Farm	% of Sample Acreage by Farm	Average Per Acre Value of Total Farmland
Farm A						
Potatoes	*	$ 2,500	-			
Winter Wheat	*	$ 2,500	-			
Grain Corn	*	$ 2,500	-			
Onions	*	$ 2,500	-			
Sweet Corn	*	$ 2,500	-			
Total	9,500		$ 23,750,000	$2,500	47%	
Farm B						
Potatoes	*	$ 2,500	-			
Winter Wheat	*	$ 2,500	-			

Farm / Crop Distribution	Acres	Per Acre Farmland Value	Total Value	Value / Acre by Farm	% of Sample Acreage by Farm	Average Per Acre Value of Total Farmland
Grain Corn	*	$ 2,500	-			
Total	2,210		$ 5,525,000	$2,500	11%	
Farm C						
Red Delicious Apples	*	$ 10,000	-			
Concord Grapes	*	$ 5,500	-			
Total	2,700		$ 16,650,000	$6,167	13%	
Farm D						
Red Delicious Apples	*	$ 10,000	-			
Sweet Cherries	*	$ 12,000	-			
Total	1,800		$ 18,100,000	$10,056	10%	
Farm E						
Potatoes	*	$ 2,500	-			
Winter Wheat	*	$ 2,500	-			
Sweet Corn	*	$ 2,500	-			
Hay	*	$ 2,500	-			
Seed Peas	*	$ 2,500	-			
Grain Corn	*	$ 2,500	-			
Subtotal	2,913		$ 7,282,500	$2,500	14%	
Farm F						
Red Delicious Apples	*	$ 10,000	-			
Sweet Cherries	*	$ 12,000	-			
Subtotal	1,030		$ 10,560,000	$10,252	5%	
Average Value Per Acre, Sample Farms:						$4,100

* Distribution of acreage by crop confidential.

3.1.2.5 Economic Effects: Net Farm Income Analysis

Introduction

This analysis is included to verify that the previously described market value approach provides reasonable land value estimates. For the net farm income analysis typical crop budgets and the associated net returns are evaluated. The capitalized value of net farm income for the different crops in the base condition compared to the dam breaching condition provides a measure of the economic effects to irrigation water users. Including the analysis of typical crop budgets provides an indication as to whether or not the land value analysis approach presents a realistic estimate of economic effects.

Approximately 37,000 acres of irrigated farmland currently rely on pumped water from the Snake River reservoirs. In addition to the estimated 28,400 acres of the more traditional irrigated cropland there are 8,600 acres as poplar plantations.

Estimated Economic Effect Based on a Change in Net Farm Income

An analysis of typical crop budgets and agricultural statistics is summarized in this section. All data are based on Farm Business Management Reports of Washington State University (Table 3.4-8 lists the crop budgets). The typical farm values discussed in the previous section are recalculated in this section by applying net economic returns using the crop budgets. For each crop they are calculated as the difference between revenues less variable costs and net fixed costs. Net fixed costs are defined as total fixed costs less land rents and establishment charges. Typically, the establishment charge includes costs such as the purchase and planting of trees/vines with the initial development of the farm property. By excluding land rents and establishment charges from fixed costs, the net return estimate reflects a return to land and investments over time in the enterprise. It is believed this return corresponds well to the market value of the enterprise on a capitalized basis.

Net Return = Total revenues – (Total Variable Cost + Net Fixed Costs)

Where Net Fixed Cost equals Total Fixed Cost less Land Rent and Establishment Charge.

Table 3.4-8 is a summary of the crop budget data for all crops but cottonwoods. The table identifies the specific Washington State University crop budgets used in the analysis.[2] The last column in this table provides an estimate of net returns per acre. These estimates do not, in fact, represent any one particular operation. Therefore, the farm income and value estimates must be viewed as general guidelines about typical income levels generated by the types of crops grown in Franklin and Walla Walla counties.

Applying the net returns shown in Table 3.4-8 to the crop distributions of specific farms in the Ice Harbor area provides another method of determining the average per acre value of farmland. Net returns are applied only to the acreage now served by irrigation water from the Ice Harbor reservoir. The acreage and crop distribution information was collected through interviews with the farm operators.

The crop information in conjunction with the crop budget data is used to determine the average per acre value of irrigated farmland in the region. Table 3.4-9 summarizes the results of the analysis of the six farms constituting over 20,000 of the irrigated acres that would be impacted under dam breach conditions. Total return is the product of acreage and net return per acre. For each farm, total return per crop is summed to derive a total for all acreage irrigated from the Snake. This represents total annual net returns per farm. This annual value is capitalized in the column labeled "Present Value". A discount rate of 6.875 percent and a horizon of 20 years were assumed in calculating present value. This present or capitalized value of each farm, weighted by the number of acres provides an estimate of the market value of the land. This evaluation indicates that the average per acre value of irrigated farmland equals $4,500, a similar result compared to the land value approach.

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[2] Note budgets reflecting 1997 costs and returns are now available, but were not when the analysis was initiated. A brief review of the 1997 budgets and comparison to the older versions indicates that the overall per acre net income would be slightly higher than what has been used in this analysis.

Table 3.4-8. Per Acre Revenue, Cost, and Profit Data for Irrigated Cropland Served by Ice Harbor Reservoir Water

Crop	Price ($/unit)	Quantity (unit/acre)	Total Revenue ($/acre)	Total Variable Cost ($/acre)	Total Fixed Cost ($/acre)	Land Rent ($/ac)	Amortized Establishment Charge ($/acre)	Total Fixed Cost Less Land Rent & Establishment Charge ($/acre)	Per Acre Return to Land & Establishment
Potato	85	28.5	2,423	1,770	654	400	-	254	399
Alfalfa	95	8	760	258	340	180	59	101	401
Winter wheat	3.5	120	420	220	169	125	-	44	156
Grain Corn	102	5	510	430	193	125	-	68	12
Silage Corn	20	30	600	532	198	125	-	73	(5)
Sweet Corn	64	9	576	376	256	180	-	76	124
Concord Grapes	7	250	1,750	979	1,454	125	915	414	357
Sweet Cherries	925	7	6,475	3,916	2,628	240	1,528	860	1,699
Red Delicious Apples	125	40	5,000	2,325	1,916	-	765	1,151	1,524
Asparagus	0.50	4,000	2,000	1,431	752	150	301	301	268
Onions	90	27	2,430	1,671	561	200		361	398
Seed Peas	15	30	450	325	220	125		95	30

Source: Selected Farm Business Management Reports Produced by Washington State University, Cooperative Extension.
EB1609, Cost of Establishing and Producing Sweet Cherries In Central Washington, Hinman et al, 1991.
EB1720, 1992 Estimated Cost of Producing Red Delicious Apples In Central Washington, Hinman et al, 1992.
EB1667, 1992 Enterprise Budgets for Alfalfa Hay, Potatoes, Winter Wheat, Grain Corn, Silage Corn, and Sweet Corn Under Center Pivot Irrigation, Hinman et al, 1992.
EB1572, Economics of Establishing and Operating a Concord Grape Vineyard, Schimmel et al, 1990.
EB1588, Establishment and Annual Production Costs for Washington Wine Grapes, Chvilicek et al, 1990.
EB1753, 1993 Estimated Cost and Returns for Producing Onions Under Rill Irrigation Columbia Basin, Washington, Hinman et al, 1993.
EB1666, 1992 Enterprise Budgets for Fall Potatoes, Winter Wheat, Dry Beans, and Seed Peas Under Rill Irrigation, Hinman et al, 1992.
EB1779, Asparagus Establishment and Production Costs in Washington, Joshua et al, 1994.

Table 3.4-9. Estimated Total Return and Market Value of Acreage Served by Pumped Water from Ice Harbor Reservoir, Sample Farms

Farm / Crop Distribution	Acres	Net Return per Acre (based on crop budgets)	Total Return	Present Value by Farm	Value / Acre by Farm	% of Sample Acreage by Farm
Farm A						
Potatoes	*	$ 399	-			
Winter Wheat	*	$ 156	-			
Grain Corn	*	$ 12	-			
Onions	*	$ 398	-			
Sweet Corn	*	$ 124	-			
Total	9,500		$ 2,000,700	$21,477,819	$ 2,261	47%

Farm / Crop Distribution	Acres	Net Return per Acre (based on crop budgets)	Total Return	Present Value by Farm	Value / Acre by Farm	% of Sample Acreage by Farm
Farm B						
Potatoes	*	$ 399	-			
Winter Wheat	*	$ 156	-			
Grain Corn	*	$ 12	-			
Total	2,210		$ 274,040	$2,931,604	$ 1,327	11%
Farm C						
Red Delicious Apples	*	$ 1,524	-			
Concord Grapes	*	$ 357	-			
Total	2,700		$ 1,430,000	$15,305,233	$ 5,669	13%
Farm D						
Red Delicious Apples	*	$ 1,524	-			
Sweet Cherries	*	$ 1,699	-			
Total	1,800		$ 2,751,950	$29,439,599	$ 16,355	10%
Farm E						
Potatoes	*	$ 399	-			
Winter Wheat	*	$ 156	-			
Sweet Corn	*	$ 124	-			
Hay	*	$ 12	-			
Seed Peas	*	$ 30	-			
Grain Corn	*	$ 12	-			
Subtotal	2,913		$ 588,681	$6,297,541	$ 2,162	14%
Farm F						
Red Delicious Apples	*	$ 1,524	-			
Sweet Cherries	*	$ 1,699	-			
Subtotal	1,030		$ 1,592,470	$17,035,803	$ 16,540	5%
Avg. Value Per Ac., Sample Farms:						$4,500

* Distribution of acreage by crop confidential.

By applying this average capitalized net return value to the irrigated crop acreage and adding the value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland an estimate of the economic impact to pump irrigators under dam breach conditions is estimated.

Therefore: ($4,500 * 28,400 acres) + ($2,500 * 8,600 acres) - ($100 * 37,000 acres) =
$127,800,000 + $21,500,000 - $3,700,000 = $145,600,000.

3.1.2.6 Conclusions about the Effect of Dam Breaching on Irrigated Agriculture at Ice Harbor

As noted in the introduction the purpose of this analysis is to determine the direct economic effects to agricultural users of pumped water from the lower Snake River under dam breach conditions. As a result of unanticipated escalation in the estimated cost to modify the pump stations, the evaluation of farmland values and typical net returns using available information were introduced into the analysis. This approach was added to the analysis for comparison to the modification cost approach, and to determine whether or not it provides an acceptable estimate of NED costs. A summary of the estimated economic effects measured by each approach is provided in Table 3.4-10. This table shows that the economic effects to pump irrigators under dam breaching condition range from $134.2 to over $300 million ($291.5 million construction plus O&M) based on the three approaches used in this analysis. The pump modification costs are significantly higher than the estimate of the change in land value, therefore, it is reasonable to conclude that this option is not economically viable, and is an overstatement of the economic effects. The land value approach is therefore carried forward as the approach to measure the economic effects to pump irrigators at Ice Harbor reservoir.

Table 3.4-10. Comparison of the Approaches to Measure Direct Economic Effects to Pump Irrigators, Under Dam Breach Conditions

Approaches to Measure Direct Economic Effects	Economic Effect	Average Annual (6.875% Discount Rate)	Average Annual (4.75% Discount Rate)	Average Annual (0.0% Discount Rate)
Pump Modification Cost Approach				
--Construction:	$291,481,000	$20,065,550	$13,979,400	$2,914,800
--O&M:		$3,573,000	$3,573,000	$3,573,000
Loss of Irrigated Farmland Value:	-	-	-	-
(2) Assessed Value Approach	$134,240,000	$9,241,100	$6,438,100	$1,342,400

Table 3.4-10 summarizes the present value estimates for the pump modification approach and the irrigated farmland value approach. Included are the average annual costs using different discount rates. It has been determined that the most reasonable (least cost) estimate of the NED costs is provided by the approach that estimates the change in farmland value under dam breaching conditions.

3.1.3 Other Water Users

3.1.3.1 Introduction

In this chapter, potential economic effects to other water user groups under dam breaching conditions are described and analyzed.

Specifically, the economic effects to municipal and industrial (M&I) water users and private well users in close proximity to the reservoirs are measured. For these other water categories, the measurement of economic effects are based on the required system modification costs. These modification costs serve as a proxy measurement of the true NED costs.

This report is intended to provide only a brief summary of the modification costs. Additional details about the specific modifications required are provided in the Engineering Appendices (Technical Appendices D and E).

3.1.3.2 Municipal and Industrial Pump Stations

There are several M&I pump stations all located on the Lower Granite pool. Uses range from municipal water system backup, golf course irrigation, industrial process water for paper production, and concrete aggregate washing.

Table 3.4-11 lists these facilities. The largest station is owned and operated by the Potlatch Corporation. Two of the stations of Public Utility District (PUD) #1 in Clarkston have not been operated in the past few years and there are no plans to use them in the immediate future. The District is considering moving one plant to a new location. One of the stations is a shared station between Atlas Sand and Rock and Lewiston Golf Club. Atlas uses water pumped from a 100 HP plant for washing aggregate and the golf club uses the smaller 60 HP pump to irrigate the course. The remaining plants are small with limited horsepower. These smaller plants are used to irrigate golf courses and parks. Data for these plants are summarized in Table 3.4-11. Sources for this information include managers of the stations, Walla Walla District engineers, and previous consultant documentation (Anderson-Perry, 1991).

Table 3.4-11. Municipal & Industrial Pump Stations on Lower Granite Reservoir

Ref. No.	Station	River Mile	Use	Number of Pumps	Horsepower	Head (ft)	1996 Water Usage
GR-1	PUD #1	143	Water System Backup	3	450	300	Not used in several years
GR-2	PUD #1	143	Water System Backup	3	1,200	400	Not used in several years
GR-3	Clarkston Golf Course	137	Golf Course Irrigation (90 acres)	1	10	40	460,000 gal/day
GR-4	Potlatch Corp. (Clearwater R)	CW 4	Mill process water and steam generation	6	1,050	80	12,287,000,000 gal
GR-11a	Atlas Sand & Rock	142	Concrete aggregate washing	1	100	120	Na
GR-11b	Lewiston Golf Club	142	Golf Course Irrigation	1	60	160	1.0-1.5 mgd in June to Aug.

Sources: Survey of Station Managers; Walla Walla District Engineers 1997/1998; Anderson-Perry, 1991.

Following is a summary of the proposed pump modifications.

- The two PUD stations have not been used in several years and will not be modified.
- The Clarkston Golf Course will require modifications including construction of a utility building, water intake system, and power supply.

- The Potlatch Corporation station modifications are extensive and include the primary plant intake and the plant diffuser, and potentially a water cooling facility.[3]
- The Atlas Sand and Rock facility will require modifications including construction of a utility building, water intake system, power supply.
- The Lewiston Golf Course will require modifications including construction of a utility building, water intake system, power supply.

The total modification costs for these municipal and industrial pump stations on Lower Granite reservoir (excluding the park stations) are $11,514,000 to $55,214,000. There is a cost range because the required modification costs for Potlatch Corporation depends on whether or not a discharge water cooling facility will be necessary. The Potlatch Corporation system modifications are either $10.8 million or $54.5 million of the total.

Increased energy costs for the modified M&I pump stations have not been quantified. Of the subset of M&I pump stations the largest pumps are owned by PUD #1 and the Potlatch Corporation which account for over 90 percent of total M&I horsepower. The PUD pumps, which are backup water supply pumps, have not been used in several years and there are no immediate plans for their use. Therefore, quantifying increased energy costs for the systems would be very speculative. The Potlatch pump does not face increased head and consequently energy costs would not be greater under dam breaching conditions compared to current conditions. The remainder of M&I pumps would experience increased pumping costs but the magnitude of those increased costs would be negligible compared to energy costs for agricultural stations.

3.1.3.3 Privately Owned Wells

The number of water wells within approximately one-mile of the Snake River was compiled from well water reports. The well logs were obtained by searching and copying records of the Washington Department of Ecology. Wells within the one-mile distance were included because the Walla Walla District staff determined that this range encompasses all wells that might be affected under dam breaching conditions. The topographic features of the area, stratigraphy, and surface elevation directly influence which wells would be affected by the change in river water surface elevation.

A total of 228 well reports were counted. Review of the well reports showed that 9 reports were for test wells, 1 for an abandoned well, 2 for replacement wells, and 7 reports for wells that were deepened but not matched with original well reports. Adjusting the number of reports for test wells, abandoned wells, replacement wells, and possible duplication for deepened wells indicates the actual number of functioning wells may be as low as 209.

Some of the reports provided information about what the wells are used for and where they are located. Table 3.4-12 provides a breakdown of the well reports by county and use. In terms of

Table 3.4-12. Number of Well Reports Disaggregated by Use and County

Use	Asotin	Columbia	Franklin	Garfield	Walla Walla	Whitman	Total	Percent of Total
Domestic	40	2	9	3	12	12	78	35%
Industrial				1	2	3	6	3%
Irrigation	7	1	18	1	9	4	40	18%
Multiple	5	5	4	4	3	4	25	11%

[3] Final determination about the extent of required system modifications has not been made.

Municipal	7				2	1	10	4%
Other	2		9	2	2	1	16	7%
Test Well	3		4			2	9	4%
Not Reported	3	4	5	2	15	12	41	18%
Total	67	12	49	13	45	39	225	
Percent of Total	30%	5%	22%	6%	20%	17%	100%	

Note: County data could not be read on 3 well reports. Uses for these three included 1 test well and 2 not reported. Source: Well record data, Washington State Department of Ecology.

the number of well reports, domestic use appears to be the dominant use, followed by irrigation. About 11 percent of the reports had more than one use checked off. In almost all cases where more than one use was indicated, both irrigation and domestic use were indicated. Many of the older reports did not include any usage information.

Only 55 of the well reports indicated the horsepower of the pump. Many of the pumps were smaller sized although horsepower did range up to as large as 700 HP. Average horsepower was 70 and the median horsepower was 10. The average depth of the wells was about 270 feet. Table 3.4-13 summarizes information about the distribution of well pump capacities.

Table 3.4-13. Distribution of Pump Horsepower for Wells

Horsepower	Number of Pumps
< 2	17
2 – 10	11
10 – 100	17
> 100	10

Source: Well record data, Washington State Department of Ecology.

Examination of the individual reports indicates the larger pumps appear to be associated with irrigation usage. From previous information [Anderson-Perry, 1991] and recent phone conversations with farm operators, it is known that some of the agriculture operations have significant irrigation capability from wells. The Carr operation, for example, has 4 well pumps with 1,300 total horsepower irrigating 1,200 acres of potatoes, wheat, sweet corn and onions. Gordon Brothers has two wells with 240 horsepower irrigating 170 acres of vineyards and orchards. Broetje Orchards indicates it has two 700 horsepower and five 500 horsepower well pumps (in addition to its 8 river station pumps) for irrigation of orchards. It is likely that other agricultural operations also irrigate from wells, but identification of all irrigation well stations was beyond the scope of this analysis.

Engineers from the Walla Walla District analyzed a representative sample of the existing wells to determine what modifications to the wells would be required and at what cost. A total of 50 wells were selected and analyzed. Well log data coupled with topographic features of the area provided information on well depth, stratigraphy, surface elevation, and ultimately which wells would be affected by the change in river water surface elevation. Results of the analysis showed that 21 of the 50 sampled wells would be impacted under dam breaching conditions. Refer to the engineering appendices for a description of each of the 50 sampled wells and modification cost estimate details (Technical Appendices D and E).

For these 21 affected wells in the sample the amount of additional drilling and head that would be required for effective operation at natural river levels was determined. With this information the

Walla Walla District Design Branch calculated the necessary modifications, particularly in pump size and increases in well depth that would be required to maintain a constant water supply. Then the Cost Engineering Branch calculated the modification cost for the average well.

The average cost per well was then applied to the entire number of wells anticipated to be affected, as determined from percentages calculated in the representative sample. About 40 percent or 95 wells are expected to require modifications. Table 3.4-14 presents the total well modification cost by reservoir. Total costs are equal to $56,447,000, which includes direct, contingency, project management, and overhead costs.

Table 3.4-14. Well Modification Costs by Pool, 1998 Dollars

Pool		Well Modification Cost
Ice Harbor		$ 18,373,000
Lower Monumental		$ 12,462,000
Little Goose		$ 7,797,000
Lower Granite		$ 17,815,000
Total		$ 56,447,000

Source: Cost estimate was developed by U.S. Army Corps of Engineers, Walla Walla District Engineers, 1998.

The cost estimate was based on a typical cost per well with average increases in pump size and well depth. As a practical matter, each well would have to be considered individually under dam breach conditions. Only by observing conditions after dam breaching has occurred can one determine exactly how deep a well would have to be drilled to produce water at current rates. Walla Walla District engineers have recommended that all well modifications be performed after dam breaching has occurred. It is unclear what the water well users would do in the interim. An estimate for additional O&M expenses associated with the well modifications has not been determined.

3.1.3.4 Conclusions about the Effect of Dam Breaching on Other Water Users

Table 3.4-15 summarizes the cost of the water supply modifications that are required under dam breaching conditions. These modifications will allow the water users to continue to operate as they currently do. Estimated water supply economic losses are based on the costs of modifying pump stations and wells. Therefore, the water supply economic effects to M&I and private well users are equal to the total modification costs. Average annual costs are calculated using three different discount rates for the 100-year evaluation period.

Table 3.4-15. Summary of Other Water Supply Modification Costs, M&I and Private Wells, 1998 Dollars

Water Supply Category	Construction Cost	Average Annual (6.875% Discount Rate)	Average Annual (4.75% Discount Rate)	Average Annual (0.0% Discount Rate)
Municipal and Industrial Pump Stations	$11,514,000 to $55,214,000	$792,600 to $3,800,900	$552,200 to $2,648,100	$115,000 to $552,000
Privately Owned Wells	$56,447,000	$3,885,800	$2,707,200	$564,500
Total	$67,961,000 to $111,661,000	$4,678,400 to $7,686,700	$3,259,400 to $5,355,300	$679,500 to $1,116,500

Source: Cost estimate was developed by U.S. Army Corps of Engineers, Walla Walla District Engineers, 1998. M&I cost range is due to the current uncertainty about the required modifications to the Potlatch Corporation system.

3.1.4 Summary of Economic Effects to Water Users

Table 3.4-16 summarizes results of the analysis of effects to water users under dam breaching conditions. Loss of irrigated farmland value, municipal and industrial pump station modifications, and private well modifications are the three water user categories that were evaluated in this report. Results of the analysis of the economic effects are presented using three different discount rates.

The total economic effect associated with the three categories ranges between $202,201,000 to $245,901,000 (in present value terms). The range is due to unresolved issues about the system modifications required at the Potlatch facilities. The loss in Irrigated farmland value represents over 50 percent of the total water supply economic effects.

It is anticipated that economic effects summarized in Table 3.4-16 would be incurred the year that dam breaching occurred.

Table 3.4-16. Summary of Economic Effects to Water Users, 1998 Dollars

Water Supply Category	Economic Effect	Average Annual (6.875% Discount Rate)	Average Annual (4.75% Discount Rate)	Average Annual (0.0% Discount Rate)
Loss of Irrigated Farmland Value	$134,240,000	$9,241,100	$6,438,100	$1,342,400
Municipal and Industrial Pump Stations	$11,514,000 to $55,214,000	$792,600 to $3,800,900	$552,200 to $2,648,100	$115,000 to $552,000
Privately Owned Wells	$56,447,000	$3,885,800	$2,707,200	$564,500
Total	$202,201,000 to $245,901,000	$13,919,500 to $16,927,800	$9,697,500 to $11,793,400	$2,021,900 to $2,458,900

Source: M&I and private wells engineering cost estimates developed by U.S. Army Corps of Engineers, Walla Walla District Engineers, 1998.

3.1.5 Sensitivity Analysis of the Economic Effects to Irrigated Agriculture

A sensitivity analysis of key variables of the irrigated agriculture study is summarized in this section. The results of this sensitivity analysis do not change the estimated economic effects already described, but rather provide an indication of how the estimates would change given different assumptions. The results of the irrigated agriculture analysis present the most likely economic effect of dam breaching, given the available data and necessary assumptions. The intent of this sensitivity analysis is to provide some perspective about the uncertainty in our estimates and demonstrate how the application of different assumptions could change the results.

The sensitivity analysis is focused on two key components of the irrigated agriculture study: (1) the actual number of irrigated acres that would be taken out of production; and (2) the impact of varying the net income estimates. Three separate sensitivity scenarios are presented.

3.1.5.1 Sensitivity Analysis Scenarios

Scenario 1: Orchard and Vineyard Acreage Remains in Production Under Dam Breaching Conditions

The irrigated agriculture analysis concluded that the most likely consequence of dam breaching would be the removal of about 37,000 acres access to irrigation water. This was concluded because no technically and economically viable modified irrigation delivery system was identified under dam breach conditions. Early on in this study it was determined that not all system modification possibilities, including farm level modifications would be analyzed. And since all combinations were not evaluated it is possible, although speculative, that some of the farm operators would find a way to continue to provide irrigation water to a portion of the farmland, under dam breaching conditions. For this scenario it is assumed that all fruit orchards and vineyards could be kept in production under dam breaching conditions. A summary of the change in economic effects under this scenario follows.

Of the 37,000 acres that are likely to be impacted by dam breaching, approximately 7,750 acres or 21 percent are vineyards and fruit orchards. This 21 percent represents about 51 percent of the estimated value of the 37,000 acres of irrigated land. Consequently, if we assume in this sensitivity analysis that these permanent croplands could be kept in production the overall economic effect on the region would be reduced by about half. Under the assumption that all 37,000 acres go out of production the estimated value of the property is reduced about $134,240,000. Whereas, keeping the permanent crops in production reduces the impact to a little more than $64,170,000.

As noted earlier, the intent of presenting these numbers is to show the sensitivity of the estimated economic effect to a reduction in the number of acres that are impacted. Again, no specific irrigation system was identified to permit this acreage to remain in production. In addition, on-farm or other irrigation system modification costs that would be required to allow irrigation to continue is not included, so the $64,170,000 estimate is unrealistically low. However, it is reasonable to conclude that under these assumptions the economic effects would be no less than $64,170,000.

Scenario 2: Additional Irrigated Acreage Impacted Under Dam Breach Conditions

This irrigated agriculture report has concluded that the most likely consequence of dam breaching would be the removal of access to irrigation water for about 37,000 acres. The estimated number of acres impacted under dam breach conditions was determined through interviews with current farm operators. It is believed that the information compiled from the interviews provides a census of pump irrigated acreage that would be impacted under dam breach conditions. However, during the development of this document some individuals indicated that they felt the actual number of acres that would be impacted is significantly higher. For instance, the Natural Resources Conservation Service (NRCS) indicated there are over 50,000 acres of irrigated farmland adjacent to Ice Harbor. In this analysis it was assumed that the majority of this additional acreage is irrigated with well water, and therefore the economic impacts under dam breaching conditions are captured in the well modification cost estimate. However, if this assumption is incorrect then it is possible, although speculative, that the economic effect under dam breach conditions is significantly higher. Following is a summary of the change in economic effects under this scenario.

Assuming the additional 13,000 acres are the same mix of crops as the 37,000 acres that were previously evaluated, the economic effects are 35 percent higher. Under the assumption that 37,000 acres go out of production the estimated value of the property is reduced about $134,240,000. Whereas, if we assume that 50,000 acres are impacted then the total economic effect increases to $181,224,000.

The intent of presenting these numbers is to show the sensitivity of the estimated economic effect to an increase in the number of acres that are impacted. Although there has been some speculation that the number of acres that would be impacted as a result of dam breaching may be greater than 37,000, no specific documentation could be identified. However, if 50,000 acres are impacted, the economic effects are equal to $181,224,000.

Scenario 3: Net Return Estimates Decreased by as much as 25 Percent

A major conclusion of the irrigated agriculture report is that breaching of the dams will eliminate access to irrigation water for about 37,000 acres of farmland. In determining the economic effect associated with the removal of irrigation water, an analysis of generic crop budgets for the primary crops was completed and an estimate of the value of impacted farmland was developed. Applying generic budgets to these 37,000 acres required significant generalization of many factors. Variables such as regional differences in irrigation pumping costs, adjustments for salvage values, and real estate taxes were not adjusted/incorporated in the crop budget analysis. In addition, uncertainty about what the political and economic future may hold for agriculture in terms of crop subsidies, impacts to capitalized land values due to changing risk factors, and crop prices received by farmers was not addressed.

As a result of the use of generalized crop budgets in this analysis, the true net return values for the major crops near the Ice Harbor reservoir may actually be lower than what was calculated and used to estimate farmland values. To test the influence of the applied net returns on the estimate of economic impacts, the net returns for all crops are reduced by 25 percent. Following is a summary of the change in economic effects under this scenario.

It was determined in this irrigated agriculture report that the weighted value of farmland, based on net returns generated from generic crop budgets is $4,100 per acre. Assuming that the net returns are actually 25 percent lower than what was used in the irrigated agriculture report the weighted value of farmland is $3,075 per acre. The estimated market value of poplar/cottonwood acreage is $1,875 per acre under this assumption. Applying the revised average value per acre to the total amount of irrigated crop acreage, adding the revised value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland results in the following estimate:

($3,075*28,400)+($1,875*8,600)-($100*37,000) = $87,330,000 + $16,125,000 - $3,700,000 = $99,755,000

As noted earlier, the intent of presenting these numbers is to show the sensitivity of the estimated economic effect to a change in farmland value estimates. Based on the results of this sensitivity analysis it is reasonable to conclude that the actual economic effect on irrigators is likely between $99,755,000 and $134,240,000.

Conclusions of Sensitivity Analysis

The different sensitivity analysis scenarios are not directly combinable. However, the ranges of economic effects presented under the different scenarios do show how key variables influence the results.

The results presented in the preceding sections of this analysis reflect our best estimate of what is the most likely economic effect of dam breaching, given the available data and necessary assumptions. This sensitivity analysis provides some perspective about the uncertainty in our estimate and demonstrates how the application of different assumptions in this analysis could change the results.

3.1.5.2 Unresolved Issues

Although it is generally agreed that the water supply effects of breaching are not large when compared to the effects on hydropower, navigation, and recreation, reviewers and contributors to this document have identified issues which have not been resolved. Following is a list of the unresolved issues associated with the water supply analysis.

Irrigated Agriculture Effects

- Acceptance of the estimated land value for irrigated and non-irrigated acreage used to measure NED effects. Limited land value appraisal data were available. Therefore, generalized crop budgets were analyzed to verify the conclusions reached with appraisal/local expert opinion information. Questions as to whether the use of the generalized budgets truly corroborate the land value estimates continue. In addition the inclusion of a sensitivity analysis for this same issue does not fully address the issue. Further verification of land values would require supplementing existing appraisal data.
- Agreement as to whether or not it would be possible to keep some of the irrigated acres in production under dam breach conditions.
- Acceptance of the modified irrigation system engineering cost estimates.

Effects to Municipal and Industrial Water Users and Privately Owned Wells

- Acceptance of the modified M&I water system engineering cost estimates.
- Acceptance of the procedures used to measure the number of wells that would be affected by dam breaching and the engineering cost estimates.