A brief review of the impacts to irrigated farmland from breaching the four dams on Lower Snake River (LSR).

2/19/18, 6/4/18, 6/21/18, Rob Sampson

Irrigation will be impacted if the lowest of the four LSR dams, Ice Harbor is removed. The dam has an effective height of 100 feet, with a maximum pool of about elevation 440. Elevation 340 is used here as the water surface if the earthen embankment of the dam is removed.

Current irrigated acreage dependent on Ice Harbor reservoir is variously reported as 34,000 to 44,000 acres on about 13 farms. For perspective Walla Walla County, Washington has 494 farms irrigating 91,108 acres, and Franklin County has 637 farms irrigating 203,297 acres (cropland only, pastureland removed). Source: USDA NASS FRIS 2013.

This report uses **40,000 irrigated acres** as a basis for breaching impact, unless another specific acreage is indicated. Crops in the area were assumed to be ¼ orchards, ½ potatoes and other vegetables, and ¼ grains, including corn. This is slightly different from the crop mix used in the ACE EIS, but is conservative (higher) than most other crop mixes.

The USDA Natural Resources Conservation Service Irrigation Guide for the State of Washington was used to calculate project flow requirements using the Walla Walla climatic station, this is presented in Table 1.

Crop	Percent of Land	May	Jun	Jul	Aug	Sep	Net Annual
Orchard (Cherries w/ Cover)	25%						inches/year
inches / month		4.17	7.99	12.93	10.12	6.12	42.21
inches / day**		0.16	0.33	0.55	0.42	0.24	
Grains, Spring Grain	50%						
inches / month		2.86	6.01	7.79	4.18	0	20.85
inches / day**		0.11	0.24	0.32	0.16	0.00	
Vegetables, Potato	25%						
inches / month		0.28	2.92	10.53	9.26	4.78	27.79
inches / day**		0.01	0.11	0.44	0.38	0.19	
Weighted Combined CU, in/d		0.10	0.23	0.41	0.28	0.11	27.93

Table 1 – Crop water use, Walla Walla climatic station, NRCS Irrigation Guide.

Using the proportion of crops and assumed acreage, the project requires 0.41 inches per day at the peak rate in July, and an annual net volume of 28 inches per season. On larger projects this is generally considered an upper bound as farmers will often water at different times, desynchronizing the demand.

Table 2 shows the gross water needs at a low application efficiency of 65%. These gross flows are then calculated at an application efficiency of 80% to provide a sensitivity envelope.

		in/day	June in/day	July in/day	Aug in/day	Sept in/day		
App. Eff.	0.65	0.15	0.35	0.63	0.44	0.17	43.0	in/yr
App. Eff.	0.80	0.12	0.29	0.51	0.35	0.14	34.9	in/yr
		gpm / acre	gpm / acre	gpm / acre	gpm / acre	gpm / acre		
Flow	0.65	2.8	6.7	11.8	8.2	3.1	1,166,509	gal/acre/yr
Flow	0.80	2.3	5.4	9.6	6.7	2.5	947,788	gal/acre/yr
		cfs	cfs	cfs	cfs	cfs		
Total Q	0.65	248	593	**1,056**	732	279	143,205	ac-ft/year
Total Q	0.80	201	482	**858**	594	227	116,354	ac-ft/year
	0.65						3.58	ac-ft/ac
	0.80						2.91	ac-ft/ac

Table 2. Project flow at application efficiencies of 65 and 80%. Bold is peak demand.

Given the assumptions of crop distribution, the peak demand is between 1,060 and 860 cfs. It is not unusual in design of large irrigation works, to use a project flow of 80% of the average of the high and low, this flow is 770 cfs. This derated flow accounts for the fact that not everyone irrigates every acre all the time.

First, gravity pressurized pipelines were examined. Since the next dam is upstream over 31 miles, and only gains 100 feet of elevation (40 psi), gravity pressure was ruled out quickly. The upstream pool at Lower Monumental is at elevation 540, which is below a great deal of the cropland around Ice Harbor.

Three cost estimates are provided, one for replacing all the horsepower with new pumps at full TDH (Total Dynamic Head, feet). The second is a lift pump to put water up near the existing pumps, so the project is only charged for the 100 foot increase in head. A third variation is included that gives each farmer a separate mainline and pumps. This third estimate is considered to be the most costly and the high end of the cost envelope.

Several side calculations from independent sources were used to cross check the costs, the Marysville pipeline near Ashton, Idaho and the A&B pumping plant near Rupert, Idaho. Costs come from the Natural Resources Conservation Service Payment Schedule for the Environmental Quality Incentives Program (NRCS – EQIP). These costs are updated every year and are in the public domain. They are often published with discounts. For instance, a normal EQIP contract will contain costs that are 50% of actual. The NRCS will ultimately pay about half of the cost of a certain project. If the NRCS want to incentivize a certain group, they may pay 90% of the estimated cost of the project. Hence, although NRCS has the most comprehensive cost databases for irrigated agriculture, it must be used with care. All of the costs used herein are the full cost of implementation. The 2016 EQIP cost list is the primary source.

Examining the caveats and assumptions in Appendix D, and I and Annex O of the EIS, several of them should be heeded. Several should be debated. Alphabetic footnotes are added to the original EIS text and addressed in the body of the report.

> *The area irrigated by the 12 pumping stations totals approximately 15,000 hectares (37,000 acres) of land. Approximately 11 percent of the irrigated acreage is used for fruit trees, 6 percent for grape vineyards, 23 percent for hybrid poplar and cottonwood harvested for pulp for cardboard manufacture, and 46 percent for annual row crops*[a]*. Approximately 14 percent of the acreage is undefined. A total of 40 percent of the acreage is used for mature tree-like plants that are not capable of surviving a season without irrigation*[b]*. The primary assumption on which this irrigation system modification is based is that the current water demand must be met by a replacement system and be operational prior to the initiation of the drawdown of the Ice Harbor Reservoir. The system must function through a full range of river stages without interruption. The design, operation, or scheduled maintenance must address the presence of large quantities of suspended sediment in the water for extended periods of time for several irrigation seasons*[c]*.*

[a,b]Timing of the installation is important, to minimize impact to irrigators and to minimize crop damage from a lack of irrigation. However, many different strategies can be employed to keep trees alive with very little water.

From Annex O, 2002 EIS:

> *The majority of this stretch of the river has a rather wide, flat bottom with substantial silt, sand, and gravel deposits. It is possible that, as material in the river erodes and deposits, serious problems would occur with this type of pumping arrangement. The river may meander, affecting the availability of water for pumping. Deposited material could reduce intake screen submergence or could cover and plug the screens. Erosion could undermine the pumps, piping, and intake screens, affecting the structural integrity of the system. The submerged equipment would be susceptible to damage due to impact from debris. This type of system, regardless of the sediment concerns, would be difficult to operate and maintain. Finally, in addition to the questionable reliability, installing this type of system prior to or during drawdown would be difficult and costly.*

The assumption above that the river is unstable after dam removal is incorrect. While it is obvious there will be more sediment, many irrigation pumpers across the Northwest deal with this regularly. The statement regarding '*The river may meander…*" is easily disproved by looking at the aerial images of the river. For the most part it is encased by rock walls. The analysis in Annex O would differ greatly if several miles of very large pipe were excluded. This layout stemmed from the concern of the river moving around drives the ACE to conclude that only a very large group main line, 10,000 feet from the current pump stations will be stable.

> *After considering the alternatives, the study team focused on building one large pumping station and distribution system. The team selected this alternative because it avoided many of the problems associated with the other alternatives. In the vicinity of existing pumping plant IH11, the river is narrow and is contained within steep basalt walls.*

From Appendix I, Economics, 2002 ACE EIS:

> *The cost of modifying the Ice Harbor pumping stations to provide current water supplies following dam breaching would be more than twice the value of the land they currently irrigate.*

USDA (NASS Census of Agriculture 2015) lists the value of irrigated land in Walla Walla as $7,850 per acre. Thus buying out the irrigators land ($7,850 * 37,000 acres ~ 300M). is significantly less on a gross basis than repairing the irrigation systems.

The USACE shows the amount of HP needed for the replacement design on D-O-8, and the subsequent flow rates as copied below. The paragraph below adds up to 5,250 hp pumping 600 cfs at 60 feet of TDH.

EIS in Part D 0.0.3. *To provide a range of flows between partial and full irrigation demand, numerous pumps at the main pumping station would be required. The study team selected an arrangement of 15 250-hp pumps and 10, 150-hp pumps. For 18 meters (60 feet) of head, the 250-hp pumps would each provide 51 m3/m (13,440 gpm), and the 150-hp pumps would each provide 25 m3/m (6,720 gpm). The head required of these pumps is small because the settling pond elevation is equivalent to the highest anticipated elevation of the pipeline. The 18 meters (60 feet) of design head assures at least 6 meters (20 feet) of surplus head that exist along the entire length of the pipeline. The study team assumed that canned vertical turbine pumps would be used in order to take advantage of the greater efficiencies possible with this type of pump. The pumps would be supported from a slab with water reaching the pump intakes through buried piping that extends out into the settling pond.*

Cost 1. Full Pump Replacement

Using the elevations of the current irrigation configuration, and adding the 100 feet of lowered water surface to the total dynamic head (TDH), the 770 cfs design flow would require about 70,000 hp. This estimate is refined in the cost estimate (for example #3) to account for actual crop field elevations.

The mainline from the pumping plant would be a single, 12 foot diameter pipe, or two 8 foot pipes or four 6 foot pipes to distribute to the on-farm irrigation systems (similar to ACE Selected Configuration in O.3 of Appendix D). This assumes all acreage is at the same elevation (~800 feet), a conservative estimate as there is some cropland much closer to the river, and much lower, and some slightly higher (~1200 feet).

A study from the 1990's (Burkholder, 1992) lists the farmers and their irrigation lift. These data were tempered with a comparison of the existing water rights in the area, and the data from the 2002 FR/EIS, and this is attached. There are two farms close to the reservoir, who currently have about 30 feet of lift. Their pumps will need replaced to meet the higher head demand.

Burkholder, 1992 inventoried 36,224 acres and using the pumping head in his report, 10 gpm/acre and 70% efficiency. existing pump HP in 1992 was 55,000 hp, or 1.5 hp/ac (compared to estimates in this report of 40,000 acres that require between 70,000 (1.75hp/ac) and 90,000 hp (2.25 hp/ac)). Annex O (2002 EIS) inventoried 44,000 hp pumping 700 cfs.

If water is delivered to the farm at 55 psi, and the high end of the range of Total Dynamic Head (TDH) (~640 feet) is used along with the project flow of 770 cfs to estimate pipe size and energy usage, and further assuming a wire to water efficiency of 70%, then 79,000 hp is needed to lift the water and pressurize the system. This horsepower would cost about $3.6 M (all costs are 2016 dollars) a year at 0.05 $/kWh. This breaks down to about 90 $/acre for pressurized water delivered to the farm, and this is in the normal range for other similar areas in the Northwest.

For the first estimate, four pump stations, four group mainlines each with 2 pipes, 10,000 LF long (20,000 LF total per pump station) of 6' diameter pipe are assumed. All pumps will be replaced. Costs are from the NRCS Payment Schedule for 2016 EQIP, a funding program that includes irrigation systems. Costs are corrected to allow for the 'NRCS Cost Sharing Discount'. Published values are 50-90% of the actual cost depending on the level of incentive required. Back calculating using these factors provides the total cost of installation allowing payment schedule to be used for project estimating. The ACE 2002 EIS used a 1998 to 2002 dollar basis. Using the Consumer Price Index (CPI), this is about 2/3 of 2016 dollars.

Component Prices, NRCS, 2016 Payment Schedule, corrected to 100% of construction cost.

63 inch HDPE (largest currently manufactured), installed. 350 #/ft at 2.50 $/# = $625 per foot

Pumps, 270 $/hp, installed

Structures, concrete pump bays $34,000 for each 10 cfs

Screens, active, 1 per 10 cfs, $9,400 each installed with electrical

Option 1. Provide new pumps and pressurized delivery through 4 group mainlines.

Cost 1. $113M (2016 dollars)

***TOTAL* Annual Energy Cost = 90 $/ac at $0.05 per kWhr**

Cost 2. 100 feet TDH and No Pump Replacement

Currently, the farmers have a certain cost for water currently, so the actual incremental cost will be the cost to lower the pump stations 100 feet, and redesigning the farmers pump intake screens so that it meets all current fish requirements (which it probably does now). Some of the pumps may need to be replaced or retooled to meet the higher head requirements.

This second estimate will provide each owner 260 feet of pipe, and enough hp to pump an additional 130 feet of head to their existing pumps.

Total Cost = $18M (2016 dollars)

***INCREASED* annual energy cost = $23 per acre at $0.05 per kW-hr**

Option 3. Provide a new pumping plant and individual mainline for each landowner.

A variation on the above alternatives used the existing pumping data from the EIS, taking into account the actual location of the pumps compared to the existing pumping plant, and the land being irrigated. Significantly higher horsepower was reported in the EIS than in any other report. The average elevation of the land served by each pumping plant is estimated. Costs for an individual mainline for each farm are included. This cost is the upper end of the price range for retrofitting the Ice Harbor reservoir irrigation systems. In any parameter (flow, acres) that was reported as a range, the upper end of the range is used to assure a maximum estimate.

Option 3

Total Cost = $ 134,561,756

Total annual energy cost = $178 per acre at 2,000 hours and $0.05 per kWhr

42,913 acres, 102,372 hp, 10,605 cfs (acres and flow are conservative (high) in order to envelope the upper cost).

Convert to 1998 dollars (roughly) using the CPI, by multiplying by 0.67

Table 3. Construction Costs for different alternatives described above.

	Cost	Cost	Acres	Flow	Total Horsepower[3]	hp/acre (efficiency)	[1]Operating Cost 2016 $ per acre
	2016 Dollars	Approximate 1998-2002 Dollars		cfs			
1	113,000,000	75,710,000	40,000	770	79,000	2.0	147
2	18,000,000	12,060,000	40,000	770	20,000	0.5	37
3	134,600,000	90,182,000	42,913	10,605	102,375	2.4	178
Corp EIS Option 3		300,000,000					

[1]2000 hours per year, $0.05 per kWhr

Alternatives:
1. Replace all pumps. Use 4 Group Pump Intakes
2. Provide pumps at the lowered water surface that pump up to the existing pumps
3. Provide new pumps that replace all of the old pumps and provide a single pipeline and screening system to each landowner.