

Annex P
Water Well Modification Plan

Table P1	Summary of data Concerning Wells Sampled
Table P2	Summary of New Pump Characteristics

Annex P: Water Well Modification Plan

P.1 General

Water wells existing along the lower Snake River supply domestic water, agricultural water, and some commercial uses. This annex addresses modifications required for the water wells that may be affected by reservoir lowering. (Annex O discusses modifications required for the agricultural water supply for irrigation users on the Ice Harbor Reservoir.) Modifications to water wells are not considered as part of the project implementation costs. The plan and costs were developed for economic evaluations of local, regional, and national impacts.

The water wells evaluated for this study range from shallow wells collecting water from surface sources to deep wells drawing from the deep basalt formations. Drawdown of the water surface in the four lower Snake River reservoirs ranges would result in a water surface change of only less than a meter (a few feet) at the upper reservoir locations to as much as 30 meters (100 feet) upstream of each dam site. The aquifers adjacent to the river could be greatly affected by the change in water surface. The degree of impact would depend, in part, on the geologic formation supplying the water to the well, the proximity of the well to the river, and the depth of the well. While it is not possible to characterize each well along the affected river reach, the study team believes that the most adverse effect from drawdown would be to wells drawing water from the shallow aquifers.

Water users whose wells are affected by reservoir drawdown have few options for water during drawdown. Drilling other wells in advance of drawdown is not a viable option since groundwater conditions cannot be accurately predicted. It is highly probable that groundwater water users will experience loss of water after drawdown and may never be able to restore groundwater.

This report summarizes the method by which the study team determined an estimate of well modifications and presents plans for a reasonable modification to those wells. The study team also determined cost estimates for the modifications needed to maintain the current water supplies.

P.2 Methods

To begin this effort, the study team developed an inventory of the existing water wells within approximately 1.6 kilometer (1 mile) of the Snake River based on information presented on the logs of the drilled wells as recorded by the Washington Department of Ecology, Spokane Office. Approximately 180 water wells are recorded in the designated study area. Since it was not feasible for this study team to perform a detailed evaluation of each well, the team analyzed a representative sampling of the 180 recorded wells.

Of the approximately 180 wells distributed over the area, a representative sample of 38 wells was selected and analyzed. The water well locations, as presented on the well logs, were plotted on U.S. Geological Survey topographic maps, 7.5 minute, 1:24,000 scale. The well log data coupled with topographic features of the area provided information on well depth, stratigraphy, surface elevation, and, ultimately, which wells would likely be affected by the change in water surface elevation. It should be noted, however, that the response of the aquifers to variations in water surface is a complex relationship, and detailed analysis of that relationship was far beyond the scope of this task.

The study team determined that only 15 of the 38 wells in the representative sample would potentially be affected by the drawdown of the four lower Snake River dams. The resulting information, shown in Table P1, is presented in tabular form for convenience and for ease of reference.

For each of the affected wells, the study team determined that modifications should include increasing the depth of the well below the estimated new groundwater surface and installing a new pump and associated hardware to pump against the increased head. This additional depth of drilling and pumping head data is also shown in Table P1. The required pump size, calculated from the information in Table P1, is shown in Table P2 for the 15 modified wells.

P.3 Conclusion and Recommendation

Based on the representative sample results, 71 of the 180 wells (39 percent) would need modification as a result of lower reservoir water surfaces. It is very difficult to determine how much each well would produce after drawdown, or how deep they would need to be drilled to produce water at pre-drawdown rates. Therefore, this study team recommends that all well modifications be performed after drawdown has occurred.

The cost estimate does not include provisions or costs for providing temporary water to users during the period after drawdown and when well can be re-established. The potential water usage during that time period is uncertain.

P.4 Construction Schedule

All well modifications would be performed after drawdown. The installation and subsequent performance of new wells cannot be determined until the postdrawdown groundwater conditions have stabilized.

Table P1. Summary of Data Concerning Wells Sampled

Well Number	Location	Well Information				Stratigraphy (ft. el.)	Pump Test					New Well Development				Total Head (ft)	Remarks	
		Surface Elevation	Bottom of Hole (BOH)	Current River Water Elevation	Static Water Level (SWL) Elevation		Pump Size	Length Of Test (hrs)	Quantity (gpm)	Drawdown (ft)	Drawdown Water Surface Elevation (DWSE)	DWSE-BOH	Hole Diameter (in)	Avail. Water Column	Additional Drilling			Quantity Required (gpm)
Ice Harbor Reservoir																		
97	T.9N.,R.31E.	490	348	440	410	alluvium to 360	100 hp turbine	4	1,200	21	330	-18	12	0	250	1200	390	Drawdown is anticipated to lower the water table 18 feet below the current BOH. Additional drilling would be needed.
95	T.9N.,R.31E.	510	368	440	430	alluvium to 380	100 hp turbine	4	1,000	15	330	-38	12	0	250+	1000	390	Drawdown is anticipated to lower the water table 38 feet below the current BOH. Additional drilling would be needed.
99	T.9N.,R.31E.	470	370	440	427	alluvium to 375	350 hp.	2	3,000	14	340	-30	16	0	250	3000	350	Drawdown is anticipated to lower the water table 40 feet below the BOH. No water column would remain and additional drilling would be needed.
195	T.9N., R.32E.	570	320	440	405	overburden to 473	75 hp	Not Avail-able (NA)	550	NA	350	30		30	200	550	400	Drawdown is anticipated to lower the water table to an elevation 30 feet above the BOH. An additional 100 feet of drilling would be needed.
206	T.9N., R.32E.	630	230	440	480	overburden to 595	NA	1.5	12	360	350	120		120	0	12		Drawdown is expected to lower the water table to an elevation 120 above the BOH. No additional drilling anticipated.
198	T.9N., R.32E.	650	323	440	540	overburden to 598	NA	NA	60	NA	350	27		27	0	60		Drawdown is anticipated to lower the water table to an elevation 27 feet above the BOH. No additional drilling would be needed.
187	T.9N., R.32E.	510	255	440	368	overburden to 492	airtest	1	20	NA	350	95		95	0	20		Drawdown is expected to lower the water table to an elevation 146 feet above the BOH. No additional drilling is needed.
184	T.9N., R.32E.	480	270	440	390	overburden to 358	pump	NA	700	40	350	80		80	0	700		Drawdown is expected to lower the water table to an elevation 80 feet above the BOH. No additional drilling is needed.
182	T.9N., R.32E.	460	334	440	410	alluvium to 334	none	none	none	none	350	16	16	16	150	1,080	276	Drawdown is expected to lower the water table to an elevation 16 feet above the BOH. 50 feet of additional drilling is needed to accommodate seasonal river level fluctuations.

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Table P1 continued. Summary of Data Concerning Wells Sampled

Well Number	Location	Well Information					Pump Test					New Well Development					Remarks	
		Surface Elevation	Bottom of Hole (BOH)	Current River Water Elevation	Static Water Level (SWL) Elevation	Stratigraphy (ft. el.)	Pump Size	Length Of Test (hrs)	Quantity (gpm)	Drawdown (ft)	Drawdown Water Surface Elevation (DWSE)	DWSE-BOH	Hole Diameter (in)	Avail. Water Column	Additional Drilling	Quantity Required (gpm)		Total Head (ft)
208	T.10N., R.32E.	760	337	440	NA	overburden to 756	airtest	4	30	NA	350	13	8	13	100	30	500	Drawdown is expected to lower the water table to an elevation 13 feet above the BOH. Static water level is not dependent on river water level. No additional drilling anticipated.
215	T.10N., R.32E.	480	360	440	417	alluvium to BOH	NA	48	500	1	350	-10	16	0	50	300	170	Drawdown is expected to lower the water table to an elevation 10 feet below the BOH. It is anticipated that at least 50 feet of additional drilling is needed to maintain water supply.
218	T.10N., R.33E.	480	260	440	440	alluvium to BOH	Layne Pump	8	4,400	25	380	120		120	0	4,400		Drawdown is expected to lower the water table to an elevation 120 feet above the BOH. It is anticipated that no additional drilling is needed to maintain water supply.
220	T.10N., R.33E.	920	680	440	880	overburden to 850	NA	NA	NA	NA	380	-300		0	0	100		Drawdown is expected to lower the water table to an elevation 300 feet below the BOH. It is anticipated that no additional drilling would be required to maintain water supply. The current BOH is 240 above pool and is not dependent on river level.
228	T.11N., R.33E.	450	224	440	NA	alluvium to 395	bailed	NA	17	0	390	166		166	0	17		Drawdown is expected to lower the water table to an elevation 166 above the BOH. It is anticipated that no additional drilling would be required to maintain water supply.
231	T.12N., R.34E.	540	338	440	436	overburden to 426	3 hp.	8.	43	0.2	440	102		102	0	43		Drawdown is expected to lower the water table to an elevation 62 feet above the BOH. It is anticipated that no additional drilling would be required to maintain water supply.

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Table P1 continued. Summary of Data Concerning Wells Sampled

Well Number	Location	Well Information					Pump Test					New Well Development					Remarks	
		Surface Elevation	Bottom of Hole (BOH)	Current River Water Elevation	Static Water Level (SWL) Elevation	Stratigraphy (ft. el.)	Pump Size	Length Of Test (hrs)	Quantity (gpm)	Drawdown (ft)	Drawdown Water Surface Elevation (DWSE)	DWSE-BOH	Hole Diameter (in)	Avail. Water Column	Additional Drilling	Quantity Required (gpm)		Total Head (ft)
Lower Monumental Reservoir																		
235	T.12N., R.34E.	470	370	440	434	alluvium to 371	127 hp.	70	300	0	420	50	50	0	300			Drawdown is expected to lower the water table to an elevation 50 feet above the BOH. It is anticipated that no additional drilling would be required to maintain water supply.
239	T.13N., R.34E.	590	476	540	515	alluvium to 476	165 hp	NA	1500	10	445	-31	12	0	250	1000	365	Drawdown is expected to lower the water table to an elevation 81 feet below the BOH. It is anticipated that at least 250 feet of drilling would be required to maintain water supply.
251	T.13N., R.35E.	525	235	540	490	overburden to 380	15 hp.	NA	130	34	445	240	240	0	130			Drawdown is expected to lower the water table to an elevation 240 feet above the BOH. It is anticipated that no additional drilling would be required to maintain water supply.
255	T.13N., R.36E.	595	420	540	467	alluvium to 442	15 hp.	22	215	4	445	25	8	25	200 ft +	170	375	Drawdown is expected to lower the water table to an elevation 25 feet above the BOH. It is anticipated that at least 200 feet of drilling would be required to maintain water supply.
264	T.13N., R.37E.	640	318	540	573	alluvium to 283	NA	40	5700	3.5	490	172	172	0	5700			Drawdown is expected to lower the water table to an elevation 209 feet above the BOH. It is anticipated that no additional drilling would be required to maintain water supply.

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Table P1 continued. Summary of Data Concerning Wells Sampled

Well Number	Location	Well Information					Pump Test					New Well Development					Remarks	
		Surface Elevation	Bottom of Hole (BOH)	Current River Water Elevation	Static Water Level (SWL) Elevation	Stratigraphy (ft. el.)	Pump Size	Length Of Test (hrs)	Quantity (gpm)	Drawdown (ft)	Drawdown Water Surface Elevation (DWSE)	DWSE-BOH	Hole Diameter (in)	Avail. Water Column	Additional Drilling	Quantity Required (gpm)		Total Head (ft)
273	T.13N., R.37E.	590	452	540	516	alluvium to 452	NA	8	750	0	490	40		40	0	750		Drawdown is expected to lower the water table to an elevation 40 feet above the BOH. It is anticipated that no additional drilling would be required to maintain water supply.
279	T.13N., R.38E.	590	475	540	520	alluvium to 482	80 hp	4	600	3	490	15	8	15	150	450	265	Drawdown is expected to lower the water table to an elevation 15 feet above the BOH. It is anticipated that 150 feet of additional drilling is required to maintain water supply.
282	T.13N., R.38E.	590	395	540	500	overburden to 61	3 hp	2	49	10	490	95		95	0	50		Drawdown is expected to lower the water table to an elevation 95 feet above the BOH. It is anticipated that no additional drilling would be required to maintain water supply.

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Table P1 continued. Summary of Data Concerning Wells Sampled

Well Number	Location	Well Information					Pump Test					New Well Development					Remarks	
		Surface Elevation	Bottom of Hole (BOH)	Current River Water Elevation	Static Water Level (SWL) Elevation	Stratigraphy (ft. el.)	Pump Size	Length Of Test (hrs)	Quantity (gpm)	Drawdown (ft)	Drawdown Water Surface Elevation (DWSE)	DWSE-BOH	Hole Diameter (in)	Avail. Water Column	Additional Drilling	Quantity Required (gpm)		Total Head (ft)
Little Goose Reservoir																		
286	T.13N., R.39E.	690	370	640	590	overburden to 131	NA	NA	1,036	23	540	170	170	0	1,036		Drawdown is expected to lower the water table to an elevation 170 feet above the BOH. It is anticipated that no additional drilling would be required to maintain water supply.	
294	T.13N., R.40E.	765	550	640	615	overburden to 764	bailer	4	15	0	540	-10	8	0	100	4	365	Drawdown is expected to lower the water table to an elevation 10 feet below the BOH. It is anticipated that at least 100 feet of additional drilling is required to maintain water supply.
300	T.13N., R.40E.	655	590	640	618	overburden to 600	1 1/2 hp	4	30	1/2	540	-50	8	0	150	300	215	Drawdown is expected to lower the water table to an elevation 50 feet below the BOH. It is anticipated that at least 150 feet of additional drilling is required to maintain water supply.
290	T.13N., R.40E.	655	430	640	515	overburden to 488	NA	NA	600	11	540	110	110	0	600		Drawdown is expected to lower the water table to an elevation 110 feet above the BOH. It is anticipated that no additional drilling is required to maintain current water supply.	
317	T.14N., R.40E.	650	-76	640	600	overburden to 550	150 hp	4	2090	80	540	615	615	0	2,090		Drawdown is expected to lower the water table to an elevation 615 feet above the BOH. It is anticipated that no additional drilling is needed to maintain current water supply.	
315	T.14N., R.40E.	660	460	640	575	overburden to 535	airtest	1	75	NA	540	80	80	0	100		Drawdown is expected to lower the water table to an elevation 80 above the BOH. It is anticipated that no additional drilling is needed to maintain current water supply.	
322	T.14N., R42E.	645	555	640	615	overburden to 555	NA	NA	37	13	540	-15	6	-15	150	150	240	Drawdown is expected to lower the water table to an elevation 15 feet below the BOH. It is anticipated that 100 feet additional drilling is needed to maintain current water supply.
328	T.14N., R.43E.	670	495	640	635	overburden to 605	NA	32	300	40	540	45	45	0	300		Drawdown is expected to lower the water table to an elevation 45 feet above BOH. It is anticipated that no feet additional drilling is needed to maintain current water supply.	

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Table P1 continued. Summary of Data Concerning Wells Sampled

Well Number	Location	Well Information					Pump Test					New Well Development					Remarks	
		Surface Elevation	Bottom of Hole (BOH)	Current River Water Elevation	Static Water Level (SWL) Elevation	Stratigraphy (ft. et.)	Pump Size	Length Of Test (hrs)	Quantity (gpm)	Drawdown (ft)	Drawdown Water Surface Elevation (DWSE)	DWSE-BOH	Hole Diameter (in)	Avail. Water Column	Additional Drilling	Quantity Required (gpm)		Total Head (ft)
Lower Granite Reservoir																		
324	T.13N., R.43E.	840	590	740	780	overburden to 825	bailer	1	20	60	630	40	10	40	100	34	350	Drawdown is expected to lower the water table to an elevation 40 above the BOH. It is anticipated that 100 feet of additional drilling is needed to maintain current water supply. Post-drawdown river level is 70 feet below current water zone in well.
340	T.11N., R.45E.	750	370	740	490	overburden to 748	airtest	1	6	NA	680	310		310	0	6		Drawdown is expected to lower the water table to an elevation 310 feet above the BOH. It is anticipated that no additional drilling is needed to maintain current water supply.
343	T.11N., R.45E.	750	450	740	590	overburden to 730	airtest	1	30	NA	700	250		250	0	30		Drawdown is expected to lower the water table to an elevation 250 feet above the BOH. It is anticipated that no additional drilling is needed to maintain current water supply.
348	T.11N., R.45E.	750	635	740	720	overburden to 655	NA	NA	NA	NA	700	65		65	0	100		Drawdown is expected to lower the water table to an elevation 65 feet above the BOH. It is anticipated that no additional drilling is needed to maintain current water supply.
356	T.11N., R.45E.	1150	870	740	965	overburden to 1,120	airtest	4	100	35	700	-170	6	-90	200	100		Drawdown is expected to lower the water table to an elevation 170 feet below the BOH. It is anticipated that 710 feet additional drilling is needed to maintain current water supply.
351	T.11N., R.45E.	750	570	740	675	overburden to 748	airtest	1	400	NA	700	130		90	0	400		Drawdown is expected to lower the water table to an elevation 130 feet above the BOH. It is anticipated that no additional drilling is needed to maintain current water supply.
357	T.11N., R.45E.	800	720	740	747	overburden to 788	pump	6	30	4	700	-20	8	-40	150	180	230	Drawdown is expected to lower the water table to an elevation 20 feet below the BOH. It is anticipated that 150 feet additional drilling is needed to maintain current water supply.

Note: Negative DWSE-BOH indicates that the river would be drawn down below the bottom of the well.

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Table P2. Summary of New Pump Characteristics

Well No.	Flow (gpm)	Lift (ft)	Pump	New Pumps	
			Efficiency (assumed)	Calculated Horsepower	Nominal Horsepower
97	1,200	390	0.8	235	250
195	550	480	0.8	124	1,500
95	1,000	390	0.8	196	200
99	250	350	0.8	46	50
182	1,080	276	0.8	173	200
208	30	525	0.8	7	10
215	300	170	0.8	38	40
239	1,000	365	0.8	188	200
255	170	375	0.8	33	40
279	450	265	0.8	70	75
294	4	365	0.8	1	1
300	300	215	0.8	42	50
322	150	240	0.8	22	25
324	34	350	0.8	6	10
357	180	230	0.8	26	25

Note: For wells pumping less than 25 gpm, it is assumed that 60 psi (139 ft) is needed beyond the ground surface. For wells 25 gpm or greater, it is assumed that 100 psi (231 ft) is needed beyond the ground surface.