Table 3.4.2

MEAN CHANGE IN END OF PERIOD RESERVOIR ELEVATIONS (feet)
20-YEAR AVERAGE COMPARISIONS FOR LIBBY
(BASE CASE)

Average Over Low Water Years (Bottom 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	2451.0	2446.3	2426.4	2399.0	2380.9	2364.8	2361.5	2361.9	2365.9	2396.8	2423.9	2427.0	2425.7	2425.7	2405.8
Change Resulting from Proposal															
Opportunity	0.8	1.1	1.8	1.9	1.6	3.1	2.8	2.7	2.6	1.9	1.2	1.5	1.6	1.6	1.8
Firm	1.0	1.1	1.2	2.6	0.0	1.0	1.1	1.2	1.2	1.0	1.7	4.0	5.4	5.7	1.8

Average Over Typical Water Years (Mid 80 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	2451.7	2447.7	2433.1	2406.6	2375.6	2347.2	2342.6	2346.5	2356.9	2399.8	2447.5	2458.5	2458.0	2457.6	2410.4
Change Resulting from Proposal															
Opportunity	0.7	0.9	0.9	0.6	0.6	0.5	0.5	0.6	0.5	0.2	0.2	0.0	0.2	0.3	0.5
Firm	0.8	0.8	-0.5	0.5	-0.1	0.0	0.1	0.2	0.2	0.1	0.1	0.0	0.2	0.3	0.2

Average Over High Water Years (Top 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	2453.1	2452.9	2439.1	2410.9	2363.5	2323.9	2309.0	2306.9	2327.9	2397.6	2459.0	2459.0	2459.0	2459.0	2404.6
Change Resulting from Proposal															
Opportunity	0.7	0.4	0.2	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Firm	0.5	-0.1	-0.9	0.1	0.0	-0.2	-0.3	-0.5	-0.4	0.0	0.0	0.0	0.0	0.0	-0.1

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*/ AP1 = April 15; AP2 = April 30; AG1 = August 15; AG2 = August 31.

Table 3.4.3

MEAN CHANGE IN END OF PERIOD RESERVOIR ELEVATIONS (feet)
20-YEAR AVERAGE COMPARISIONS FOR HUNGRY HORSE
(BASE CASE)

Average Over Low Water Years (Bottom 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	3530.5	3525.0	3518.4	3510.4	3492.2	3474.9	3462.3	3463.3	3470.1	3502.3	3502.8	3482.9	3469.6	3459.1	3494.2
Change Resulting from Proposal															
Opportunity	2.5	2.7	3.1	3.4	4.1	5.0	5.3	5.2	4.9	4.0	4.1	4.7	4.9	3.9	4.0
Firm	2.7	2.8	3.1	3.3	2.9	3.3	4.9	5.9	5.9	4.4	6.3	8.2	8.8	9.0	4.7

Average Over Typical Water Years (Mid 80 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	3532.2	3529.8	3528.9	3526.5	3510.8	3493.5	3478.1	3478.1	3484.3	3520.7	3550.7	3556.5	3555.4	3553.5	3522.1
Change Resulting from Proposal															
Opportunity	2.2	2.3	2.3	2.3	1.8	1.4	0.9	0.9	0.8	0.5	0.3	0.2	0.5	0.9	1.3
Firm	2.4	2.5	2.5	2.4	2.0	1.7	1.7	1.8	1.8	1.2	0.9	0.6	0.8	1.1	1.7

Average Over High Water Years (Top 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	3536.1	3541.0	3543.1	3541.8	3521.6	3497.3	3470.2	3466.4	3468.9	3518.9	3553.2	3559.6	3559.7	3559.7	3525.9
Change Resulting from Proposal															
Opportunity	2.1	1.8	1.5	1.4	0.6	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.7
Firm	1.4	1.3	1.3	1.1	0.6	1.1	1.0	1.0	0.7	0.5	0.3	0.2	0.2	0.2	0.8

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* AP1 = April 15; AP2 = April 30; AG1 = August 15; AG2 = August 31.

Table 3.4.4

MEAN CHANGE IN END OF PERIOD RESERVOIR ELEVATIONS (feet)
20-YEAR AVERAGE COMPARISIONS FOR GRAND COULEE
(BASE CASE)

Average Over Low Water Years (Bottom 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	1288.7	1288.6	1288.5	1287.9	1286.6	1285.8	1278.0	1281.5	1281.3	1261.6	1281.2	1289.3	1289.6	1289.6	1283.9
Change Resulting from Proposal															
Opportunity	0.1	0.1	0.1	0.1	0.2	0.3	0.5	0.4	0.5	0.6	0.3	0.0	0.0	0.0	0.2
Firm	0.0	0.0	0.0	0.1	0.6	0.8	0.7	1.0	0.8	-0.5	0.9	0.1	0.1	0.1	0.3

Average Over Typical Water Years (Mid 80 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	1288.8	1288.7	1288.9	1288.5	1276.8	1259.7	1232.2	1223.2	1217.4	1247.5	1285.6	1290.0	1290.0	1290.0	1271.2
Change Resulting from Proposal															
Opportunity	0.1	0.1	0.0	0.0	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Firm	0.0	0.0	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Average Over High Water Years (Top 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	1288.8	1289.2	1289.3	1288.9	1282.6	1266.1	1227.6	1214.7	1211.8	1250.6	1290.0	1290.0	1290.0	1290.0	1272.1
Change Resulting from Proposal															
Opportunity	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.3	-0.3	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1

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*/ AP1 = April 15; AP2 = April 30; AG1 = August 15; AG2 = August 31.

Table 3.4.5

MEAN CHANGE IN END OF PERIOD RESERVOIR ELEVATIONS (feet)
20-YEAR AVERAGE COMPARISIONS FOR DWORSHAK
(BASE CASE)

Average Over Low Water Years (Bottom 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	1568.8	1564.7	1550.0	1533.7	1521.1	1511.1	1513.0	1522.0	1533.2	1538.7	1537.1	1524.8	1519.4	1516.4	1534.4
Change Resulting from Proposal															
Opportunity	1.7	1.6	1.7	2.9	3.4	3.5	3.2	2.6	2.4	2.4	2.5	2.3	2.0	1.8	2.4
Firm	1.8	1.8	1.5	2.4	3.5	2.1	2.1	1.7	1.8	1.6	4.1	8.5	7.4	6.9	3.2

Average Over Typical Water Years (Mid 80 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	1569.7	1566.2	1556.0	1546.2	1526.3	1504.1	1501.3	1498.8	1511.9	1567.5	1593.9	1596.1	1594.8	1593.2	1552.7
Change Resulting from Proposal															
Opportunity	1.3	1.3	0.9	1.2	0.8	0.5	0.5	0.2	0.1	0.1	0.1	0.1	0.4	0.8	0.6
Firm	1.5	1.5	0.6	0.7	0.6	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.5	0.9	0.5

Average Over High Water Years (Top 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action	1572.2	1571.1	1561.4	1554.5	1525.5	1491.3	1505.4	1515.0	1511.3	1584.7	1600.0	1600.0	1600.0	1600.0	1556.5
Change Resulting from Proposal															
Opportunity	1.2	0.7	0.3	0.2	0.1	0.1	0.1	0.3	0.3	0.1	0.0	0.0	0.0	0.0	0.3
Firm	0.9	1.0	0.4	0.2	0.3	0.1	-0.4	-0.7	-0.9	-0.3	0.0	0.0	0.0	0.0	0.1

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*/ AP1 = April 15; AP2 = April 30; AG1 = August 15; AG2 = August 31.

Opportunity Storage

Reservoir elevations are higher at each of the major U.S. storage reservoirs when the proposed NTSA is used for opportunity storage.

In typical water conditions, operation of additional non-Treaty storage results in only slight elevation increases at Libby, Hungry Horse, and Dworshak reservoirs. Only Hungry Horse reservoir, with an annual average elevation increase of 1.3 feet, has an increase greater than 1 foot. Grand Coulee shows little change in reservoir level. Reservoir elevation changes on a monthly average basis are generally 1 foot or less for all U.S. reservoirs as a result of operating additional non-Treaty storage.

The greatest changes in reservoir levels resulting from expanded non-Treaty storage occur in low water conditions, as non-Treaty storage, rather than the additional drafting of U.S. reservoirs, is used to meet firm load. When non-Treaty storage is used for opportunity storage, Libby, Hungry Horse, and Dworshak elevations increase in low runoff years by an annual average of approximately 2 feet, 4 feet, and 2 feet, respectively. Average annual elevations at Grand Coulee change by less than 1 foot. Somewhat greater elevation increases occur on a monthly average basis. The elevation at Dworshak increases about 2.5 feet April through July and approximately 1.8 feet August through December, with a maximum increase of 3.5 feet in February. Hungry Horse spring and summer elevations increase between 4 and 5 feet, while elevations September through November increase 2 to 3 feet. Libby reservoir levels increase between 1 and 2 feet throughout most of the year, with a maximum increase of 3.1 feet in February.

The proposed agreement results in little change in reservoir elevations in high runoff years.

Firm Resource Use

Reservoir elevations are also higher than the No-Action alternative in low and average runoff conditions when the expanded non-Treaty storage is used as a firm resource.

Elevation gains in typical runoff conditions are small. Maximum elevation increases occur in the fall, with little elevation change in the spring and summer months. Dworshak monthly average elevations increase by 1.5 feet or less with the proposal. The maximum elevation increase at Hungry Horse is 2.5 feet, September through December. Changes in Libby reservoir levels average less than 1 foot in all months.

The proposed NTSA results in the greatest reservoir elevation increases during the summer months of low runoff years. Dworshak elevations increase by a maximum monthly average of 8.5 feet in July when compared to those for the No-Action alternative, fall and winter elevations increase about 2 feet. Hungry Horse reservoir elevations are also higher with the proposed agreement than with the No-Action alternative: Average monthly differences range from 2.7 feet in September to a maximum of 9.0 feet in August. Libby has an average elevation gain of just over 1 foot from September through June, and just under 5 feet in July and August.

In high runoff years, reservoir elevations generally increase in the fall, decrease slightly in the winter and early spring, and remain the same throughout the summer months with the proposed agreement. Monthly average reservoir elevation decreases are less than 1 foot in all cases. Elevation changes at Grand Coulee did not exceed 1 foot up or down in any water condition.

3.4.1.4 Columbia and Snake River Flows

The use of non-Treaty storage space affects Columbia River flows by shifting some water releases from the spring to the fall and from wet years to dry years. Use of non-Treaty storage under the proposed NTSA as either opportunity storage or as a firm resource produces small flow changes. Non-Treaty storage has very little effect on Snake River flows in either case. Tables 3.4.6 through 3.4.8 present study results for Priest Rapids flows, changes in Lower Granite flows, and The Dalles flows as 20-year averages for each study period for low, typical, and high runoff conditions. Flow data for each contract year are provided in Appendix G. The following discussion refers to potential flow changes as 20-year averages, unless otherwise stated. The effects of flow changes on anadromous fish survival are discussed in Section 3.4.3.

Opportunity Storage Use

In typical water conditions, the proposed NTSA results in slightly higher flows at Priest Rapids during the fall and slightly lower flows during the winter and spring periods (Figure 4). The greatest monthly average increase in flow, 5 kcfs, occurs in September. The greatest monthly average decreases in flow, 2 to 3 kcfs, occur during the February through July period. These flow changes represent approximately 4 percent of the total flow at Priest Rapids. Snake River flows (at Lower Granite) are essentially unaffected by the proposed NTSA, so flow changes at The Dalles (the sum of Lower Granite and Priest Rapids flow changes) are essentially the same as those at Priest Rapids. Because the level of flow at The Dalles is larger than at Priest Rapids, the changes in flow as a percentage of total flow are somewhat smaller, 3 percent.

In the driest 10 percent of runoff conditions, Priest Rapids flows increase slightly, 1 to 7 kcfs on a monthly average basis, in all months except May and August, which have no change in flow. As in typical water years, flow changes at The Dalles follow those at Priest Rapids and represent about 2 percent of the total flow on an annual average basis. Snake River flows are unchanged.

Table 3.4.6

CHANGE IN AVERAGE DISCHARGE (kcfs)
20-YEAR AVERAGE COMPARISIONS FOR PRIEST RAPIDS
(BASE CASE)

Average Over Low Water Years (Bottom 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	73	79	82	102	100	86	86	87	94	133	78	63	73	78	87
Change Resulting from Proposal															
Opportunity	7	4	3	2	7	7	2	2	1	0	4	2	0	0	3
Firm	4	2	2	1	4	3	1	1	3	0	2	2	-2	1	2

Average Over Typical Water Years (Mid 80 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	78	83	88	112	153	141	131	116	129	158	152	145	110	85	122
Change Resulting from Proposal															
Opportunity	5	2	2	1	-1	-3	-3	-2	-2	-2	-1	-3	2	2	0
Firm	3	1	2	0	-1	-2	-2	-1	0	-2	0	-1	1	1	0

Average Over High Water Years (Top 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	75	92	101	120	146	143	164	140	156	224	275	185	125	109	149
Change Resulting from Proposal															
Opportunity	7	1	1	-1	0	-3	-4	-1	-2	-6	-5	-5	-2	-2	-2
Firm	4	0	1	0	-1	-1	-1	-1	0	-6	-3	-3	-1	-1	-1

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* AP1 = April 1-15; AP2 = April 16-30; AG1 = August 1-15; AG2 = August 16-31.

Table 3.4.7

CHANGE IN AVERAGE DISCHARGE (KCFS)
20-YEAR AVERAGE COMPARISONS FOR LOWER GRANITE (ESTIMATED)
(THE DALLES FLOW - PRIEST RAPIDS FLOW)
(BASE CASE)

Average Over Low Water Years (Bottom 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	31	33	40	42	38	43	44	49	52	77	64	39	28	23	44
Change Resulting from Proposal															
Opportunity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Firm	0	0	0	0	0	0	0	0	0	0	-1	-1	1	0	0

Average Over Typical Water Years (Mid 80 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	33	37	43	52	54	70	72	93	105	107	102	49	33	28	62
Change Resulting from Proposal															
Opportunity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Firm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Average Over High Water Years (Top 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	31	35	52	69	76	80	78	97	143	165	186	58	35	26	82
Change Resulting from Proposal															
Opportunity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Firm	0	0	0	0	0	-1	2	0	0	0	0	0	0	0	0

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* AP1 = April 1-15; AP2 = April 16-30; AG1 = August 1-15; AG2 = August 16-31.

Table 3.4.8

CHANGE IN AVERAGE DISCHARGE (Kcfs)
20-YEAR AVERAGE COMPARISIONS FOR THE DALLES
(BASE CASE)

Average Over Low Water Years (Bottom 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	104	112	121	144	138	129	130	136	146	210	141	102	101	101	131
Change Resulting from Proposal															
Opportunity	6	4	3	2	7	7	3	2	1	0	4	2	0	0	3
Firm	4	2	2	1	4	3	1	1	3	0	1	1	-1	1	2

Average Over Typical Water Years (Mid 80 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	110	121	131	164	207	212	204	209	235	265	255	194	143	113	184
Change Resulting from Proposal															
Opportunity	5	2	2	1	-1	-3	-3	-2	-2	-2	-1	-3	2	2	0
Firm	3	2	2	0	-1	-2	-2	-1	0	-2	0	-1	1	1	0

Average Over High Water Years (Top 10 Percent)

ALTERNATIVE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	AP1 */	AP2 */	MAY	JUN	JUL	AG1 */	AG2 */	AVG
No-Action Flow	106	127	153	189	222	223	243	236	299	389	460	243	160	135	231
Change Resulting from Proposal															
Opportunity	7	1	1	-1	0	-3	-4	-1	-2	-6	-5	-5	-2	-2	-2
Firm	4	1	1	0	-1	-2	0	0	0	-6	-4	-3	-1	-1	-1

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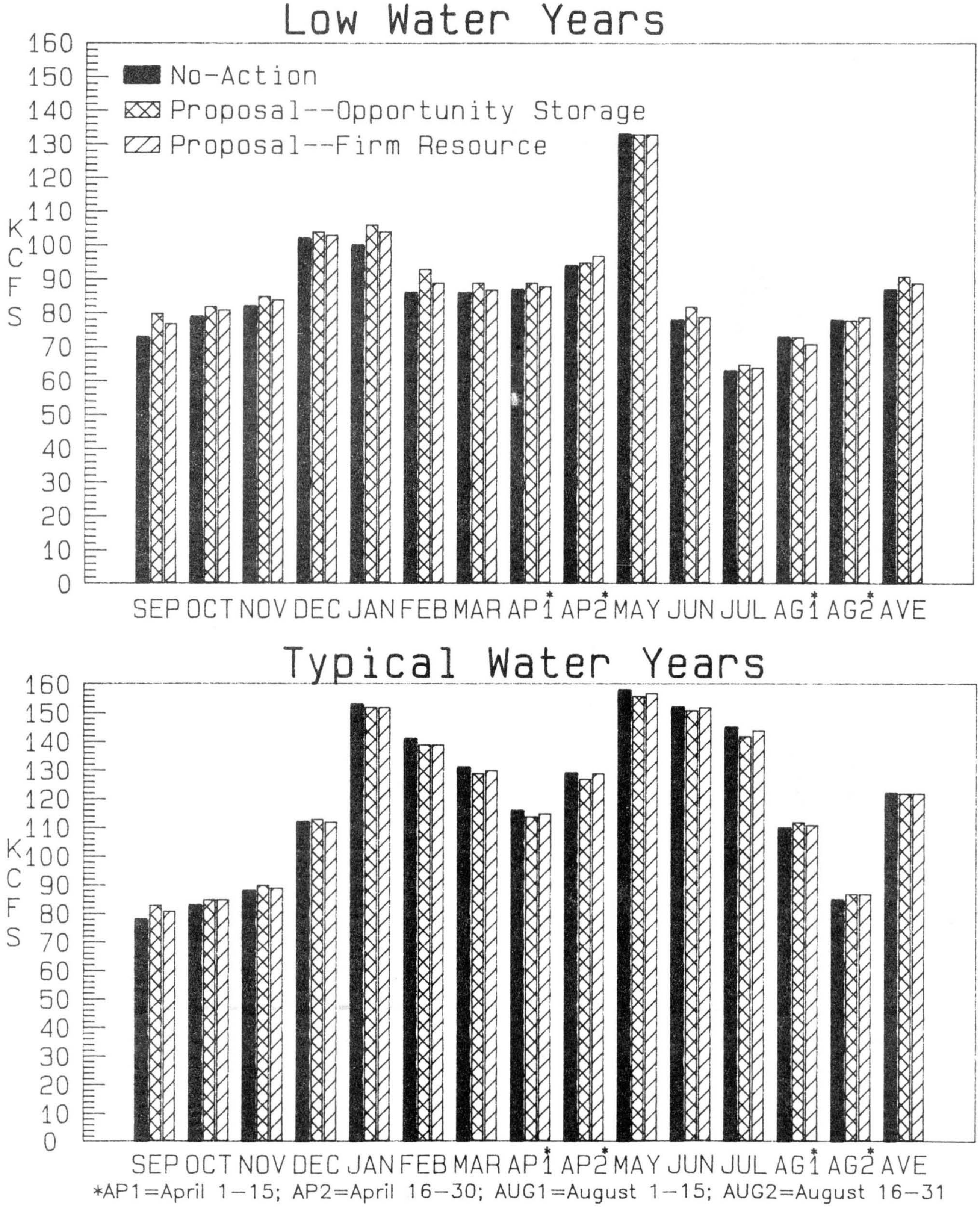
* AP1 = April 1-15; AP2 = April 16-30; AG1 = August 1-15; AG2 = August 16-31.

Figure 4
Monthly Average Flow at Priest Rapids in kcfs for the No-Action Alternative and the Proposal



*AP1=April 1-15; AP2=April 16-30; AUG1=August 1-15; AUG2=August 16-31

In the highest 10 percent of runoff conditions, Priest Rapids flows generally increase in the fall months, up to 7 kcfs in September, while decreasing in the high-flow winter and spring months by 1 to 6 kcfs. The maximum monthly spring flow reduction at Priest Rapids represents about 4 percent of the flow. Again, Snake River flows are not changed by the proposed NTSA, and flow changes at The Dalles are of the same order of magnitude as those at Priest Rapids.

Firm Resource Use

Study results indicate that flow changes associated with use of non-Treaty storage as a firm resource have the same monthly pattern as flow changes resulting from opportunity use of non-Treaty storage. The magnitude of flow changes is slightly smaller in the firm resource case, however.

In typical water conditions, flows are increased at Priest Rapids and The Dalles during the August through November period, with slight flow reductions January through May. The greatest monthly average increase in flow, 3 kcfs, occurs in September, and decreases of up to 2 kcfs on a monthly average basis occur during the winter and early spring months. Flows on the Snake River are essentially unaffected by the proposed NTSA.

As with opportunity storage, low runoff conditions result in generally increased flows in most months on the Columbia River, with no change in Snake River flows. Flow increases are slightly smaller, averaging 2 kcfs annually, when non-Treaty storage is used a firm resource.

High runoff years result in slightly increased fall flows and slightly decreased flows during the remainder of the year on the Columbia River. Columbia River flows decrease by as much as 6 kcfs in May, although flows at Priest Rapids are relatively high, averaging 218 kcfs. There is little change in Snake River flow.

3.4.1.5 Overgeneration

Spring runoff usually provides more energy than can be used in the Pacific Northwest. Much of this energy is stored or sold outside the region, and the remainder must be spilled. The water which is spilled due to lack of available market is called "overgeneration." Overgeneration spill can help anadromous fish bypass turbines. Overgeneration spill can be moved on the system to wherever it is most useful to fish. Effects of the proposal on anadromous fish are discussed in Section 3.4.3.

SAM was used to project monthly amounts of overgeneration in megawatts for the non-Treaty storage study alternatives. Results of 200 simulations were averaged to obtain average monthly overgeneration amounts for each of the 20 years in the studies (Table 3.4.9). Differences between studies were analyzed to determine the effects of each alternative on system spill.

Table 3.4.9

COMPARISON OF OVERGENERATION SPILL */
(Average Annual MW)

Alternative	JAN	FEB	MAR	APR	MAY	JUN	JUL
No-Action	4.1	10.4	32.6	61.2	215.0	457.6	142.1
Change resulting from Proposal							
Opportunity	-0.2	-2.3	-3.3	-6.7	-26.3	-42.5	-30.7
Firm	-0.2	-0.1	-.57	-7.9	-17.7	-32.1	-17.1

* Months not shown had zero overgeneration spill.

Overgeneration varies greatly between years, but averages about 80 MW annually over the 20-year study horizon. In the No-Action alternative, almost 90 percent of the overgeneration occurs in May, June, and July. Operating the proposed NTSA for opportunity storage produces a 12 percent annual average reduction in overgeneration spill. During the April through August period, overgeneration reductions also average 12 percent. The greatest change in spill occurs during the month of July, when spill decreases by an average of 21.6 percent.

Operating the expanded non-Treaty storage space as a firm resource produces an average annual overgeneration reduction of only 9 percent. When non-Treaty storage is operated as a firm resource, storage space is frequently full prior to the spring period when overgeneration generally occurs. Therefore, there is less non-Treaty space available for storing flows in excess of marketing needs. The greatest change in spill, decreases of just over 12 percent, occurs in both April and July.

3.4.1.6 Results of Sensitivity Studies

Several studies were conducted to determine the sensitivity of the results to the assumptions used in modeling non-Treaty storage use. Analysis shows that while different assumptions might affect the operation of the system as a whole, potential effects of the proposed NTSA on the PNW hydro system are similar to the Base Case. Sensitivity study results support the Base Case and demonstrate that the assumptions used do not greatly change the effects of the proposed NTSA.

In the sensitivity studies, reductions in overgeneration spill average about 9 percent. The exception is the "Alternative Dispatching Criteria" case, which reduces overgeneration by 19 percent. A greater reduction in overgeneration occurs in this case because non-Treaty storage more frequently has space available during the spring months. This allows greater storage of energy that would otherwise be spilled, than do the other cases studied.

The "PNW High Load," firm use case shows a slight increase in overgeneration spill associated with the proposed agreement, although the average change is only 0.8 MW. The "PNW High Load" case also produces the greatest elevation changes at Libby, Hungry Horse, and Dworshak reservoirs. The variations from the changes found in the Base Case are generally less than 1 foot.

Flow changes also show little sensitivity to the assumptions studied. Effects of the proposed NTSA on flows at The Dalles in low and typical runoff conditions generally differ from the base case by 1 kcfs or less for all sensitivities. The "Alternative Dispatching Criteria" sensitivity study shows that the proposal results in slightly smaller flow increases in low runoff years than the base case study. It shows an additional decrease of 4 kcfs from the Base Case No-Action flow of 240 kcfs in July of wet runoff years.

An examination of several other parameters showed that none of the sensitivity factors studied had any significant effect on the changes produced by the proposed NTSA. The results from the sensitivity studies can be found in Appendix M.

3.4.2 Resident Fish

Resident fish are freshwater fish that live and migrate within the streams and lakes of the Columbia River Basin but do not travel to the ocean as do anadromous fish. They have become particularly important to areas where anadromous fish runs are blocked by natural or manmade obstructions.

3.4.2.1 Production in Reservoirs

Drawdown of reservoirs for power production, irrigation, or flood control can affect resident game fish populations by altering the physical and biological characteristics within the reservoir. Lowered elevations reduce the productive shallow areas near the shoreline. This can result in reduced habitat (particularly spawning habitat) for game fish and their food organisms. Reservoir fluctuations can change water temperatures or expose nests, killing the eggs. Table 3.4.10 contains information on critical months for spawning of resident game fish.

TABLE 3.4.10

CRITICAL MONTHS FOR RESERVOIR GAME FISH SPAWNING

Species	Hungry Horse	Libby	Grand Coulee	Dworshak
Kokanee	N/A	Sept.-Nov.	Sept.-Nov.	Sept.-Nov.
Cutthroat	May-July	May-July	N/A	May-July
Rainbow Trout	April, May	April, May	April, May	April May
Walleye	N/A	N/A	April, May	N/A
Smallmouth Bass	N/A	N/A	April-July	June-July
Mountain Whitefish	Nov.-Jan.	Nov.-Jan.	Nov.-Jan.	Nov.-Jan.

The primary Federal reservoirs of concern are Hungry Horse and Libby in northwestern Montana, Grand Coulee in central Washington, and Dworshak in Idaho. Common game fish species in Hungry Horse include westslope cutthroat trout, Dolly Varden, and mountain whitefish. Common game fish species in Libby Reservoir include western cutthroat trout, rainbow trout, Dolly Varden, and kokanee salmon. Grand Coulee supports an economically valuable recreational fishery for walleye and rainbow trout. Sport fish caught in Dworshak include kokanee salmon, rainbow trout, and smallmouth bass.

Information remains limited on the extent of biological impacts to resident fish associated with changes in seasonal draft of the reservoirs. Based on past consultations with the Corps of Engineers and the Montana Department of Fish, Wildlife, and Parks (MDFWP), decreased reservoir elevations are considered to have the potential for adverse fishery impact if they occur during the April through November period of biological activity. September through November are the most important months for fish growth. Likewise, increases in reservoir elevations in the same time period may benefit the fishery.

Analytical Methods

Changes in reservoir elevations associated with the alternatives under study, as simulated by the SAM, were analyzed for Hungry Horse, Libby, Grand Coulee, and Dworshak. The following reservoir statistics were evaluated:

a. The average end-of-period elevations (14 periods, 20 contract years). Analyses are broken out into three groups by runoff condition: (1) the lowest 10 percent of the runoff years; (2) the middle 80 percent of the runoff years; and (3) the highest 10 percent of the runoff years. (Appendix G.)

b. Frequency of end-of-period elevation changes from the No-Action alternative greater than 5 feet for the years 1991, 1993, 1995, 1997, 2001, and 2005. (Appendix H.)

Results

Potential reservoir elevation changes resulting from the proposed NTSA are discussed in Section 3.4.1.3. Of particular interest in evaluating impacts of the proposal on resident fish are decreases that occur in the April through November period. Reservoir elevations at the major storage projects during this time period generally remain unchanged or show an increase. The only exception is when non-Treaty storage is used as a firm resource. Reservoir elevations decreased during the months of October and November at Libby and during the months of April, May, September, October, and November at Grand Coulee. The decreases are never greater than 1 foot from the No-Action alternative. System operating and planning requirements are unchanged as a result of the proposed agreement, so reservoir operations will remain similar to those under the No-Action alternative.

The frequency of end-of-period elevations changes from the No-Action alternative (analysis of 200 games per year) are more likely to show increased elevations of greater than 5 feet than decreases for either opportunity or firm use under the proposal.

The minimal changes in reservoir elevations are not expected to affect resident fish.

3.4.2.2 Production in Streams

The Kootenai River below Libby Dam and the Flathead River below Hungry Horse Dam support important populations of resident game fish, including kokanee in the Flathead river system and westslope cutthroat, rainbow trout, and Dolly Varden in the Kootenai River. Reduced flows below the dams can interfere with spawning, incubation, emergence, rearing, and migration of resident fish and can lower the production of aquatic fish food organisms. In addition, lack of high spring flushing flows can create sediment problems. To protect fish populations in the Kootenai River, the Northwest Power Planning Council has recommended that Libby Dam be operated to provide a minimum flow of 4 kcfs except in years of extremely low runoff, when no less than 3 kcfs should be provided.

To aid reproduction of kokanee in the Flathead River, the Council has recommended that Hungry Horse Dam be operated to provide specified flows at Columbia Falls on the mainstem Flathead River. For spawning (October 15 through December 15), flows should be between 3.5 and 4.5 kcfs. An instantaneous minimum flow of at least 3.5 kcfs is recommended at Columbia Falls year round.

The kokanee that spawn in the Flathead River system below Hungry Horse migrate upstream from Flathead Lake. Currently, this population of kokanee is severely depressed. MDFWP is developing a mitigation plan for the Flathead system, which may or may not include rebuilding the kokanee population.

Analytical Methods

The changes in flows in the Kootenai River below Libby Dam and in the Flathead River at Columbia Falls below Hungry Horse Dam were analyzed for all months of the years 1991, 1993, 1995, 1997, 2001, and 2005. The following flow changes were evaluated:

a. The average change in flow for each period. (Appendix H.)

b. The frequency of monthly average flows at Columbia Falls that are: (1) less than 3.5 kcfs (all periods); (2) greater than 4.5 kcfs October through December (kokanee spawning period); and (3) less than 4.5 kcfs January through September (kokanee incubation, emergence, and migration). (Appendix H.)

c. The frequency of occurrence of flows at Libby Dam that are less than 4.0 kcfs. (Appendix H.)

Results

Little change in streamflow downstream of Libby and Hungry Horse dams occurs as a result of the proposed agreement when operated as either opportunity storage or as a firm resource. The greatest change in streamflow at Columbia Falls occurs in September when flows average 6.8 kcfs, well above the recommended minimum of 3.5 kcfs. Neither opportunity nor firm use under the proposal causes flows to fall below 3.5 kcfs. The frequency of flows greater than 4.5 kcfs October through December and less than 4.5 kcfs January through September varies only slightly from the No-Action alternative. The average flow at Libby remains above 4.0 kcfs. However, the possibility for flows less than 4.0 kcfs increases between 0.5 and 4.5 percent during the months of May through July when non-Treaty storage is used as a firm resource.

Changes in streamflows below Libby and Hungry Horse do not vary from the Council's Program such that they would affect resident fish inhabiting these streams.

3.4.3 Anadromous Fish

The Columbia River Basin supports a large number of anadromous fish (species that migrate downriver to the ocean to mature, then return upstream to spawn). The principal anadromous fish runs in the Columbia Basin are species of salmon (chinook, coho, sockeye, and steelhead trout). These fish remain an important resource to the PNW, both for their substantial economic value to the sport and commercial fisheries, and for their high cultural and religious value to Columbia River Basin Tribes and others.

The development of hydroelectric projects on the Columbia and Snake Rivers has reshaped the natural flows of the rivers. Storage reservoirs have allowed flows to be reduced during the spring and early summer when juvenile salmon and steelhead are migrating downstream to the ocean. But, more importantly, water velocities have been reduced as a result of the increased cross-sectional area of the river due to run-of-river hydroelectric projects. These changes have caused prolonged delays, exposing juvenile salmon and steelhead to predation and disease and causing them to lose their ability to adapt to saltwater when they reach the ocean. Additional mortality occurs as fish attempt to pass each dam.

3.4.3.1 Water Budget and Flow

In 1982, the Council established a water budget to increase river flows during the April 15 through June 15 period. This coincides with the peak out-migration of spring fish, predominately yearling chinook, steelhead, and sockeye, which depend on adequate river flow (velocity) for a successful migration. The water budget is a specified volume of water totaling 4.64 MAF. Fish Passage Managers are responsible to call upon this volume to enhance flows when it will provide the greatest benefit to migrating fish.

Separate water budgets were established for the mid-Columbia and Snake Rivers. Priest Rapids and Lower Granite Dams are the respective points of water budget measurement.

Analytical Methods

Flow data, as simulated by SAM, were analyzed for The Dalles, Priest Rapids, and Lower Granite Dams for each period of the 20 contract years. An average decrease in flow of greater than 5 kcfs at Lower Granite and 10 kcfs at Priest Rapids, April through June, was used to indicate the potential for delayed travel time. (Karr, M.H. 1982. Evaluation of Fish Flow Options: Biological/Hydrological Correlations.) Columbia River Inter-Tribal Fish Commission. Portland, OR. Decreases of this magnitude could increase travel time by approximately 1 day for fish entering the Lower Snake or Mid-Columbia projects, depending on flow levels during that period.

SAM analysis presented in Section 3.4.1.4 shows potential effects of the proposal on flow during the lowest 10 percent of the water conditions (those in which the January through July runoff at The Dalles is less than 70 MAF), the middle 80 percent of the runoff conditions, and the highest 10 percent of the runoff conditions (The Dalles January through July runoff greater than 125 MAF).

In addition to the SAM analysis, BPA examined the maximum amount of water that could be stored in non-Treaty space in 50 historical water years (1929-1978) as simulated by the hydro regulator model. This study and the results are described in Section 3.2.3 and in Appendix C.

BPA evaluated daily non-Treaty storage transactions and resulting flows from April 1984, when the current NTSA was signed, through September 1989, and compared these results to the simulated analysis (see Section 3.2.2.4).

The following flow statistics were analyzed:

a. The mean change in monthly average flow at The Dalles, Priest Rapids, and Lower Granite based on SAM study results. (Appendix G.)

b. The frequency of water budget flows less than 134 kcfs at Priest Rapids during the month of May based on SAM study results. (Appendix I.)

c. The maximum potential storage for the months of April through August based on the 1996 Level of the 1988 Whitebook Study. (Appendix C.)

d. Actual daily transactions and flows from April 1984 to September 1989. (Appendix C.)

Results

The operation of non-Treaty storage both for opportunity purposes and as a firm resource increased monthly average flows slightly in most months of low flow years. Flows increased during the fall months and decreased during the spring months of average and high water years. During the primary period of juvenile anadromous fish migration, April 15 through June, Treaty flow requirements at Mica limit the amount which may be stored on any day to a maximum of 10 KSFD. Therefore, unless exceptionally high flows refill Treaty storage prior to June 30, the maximum decrease in flow that can take place on any day or as a monthly average is 10 kcfs during this period.

The average change in spring flows, April 15 through June, during typical water conditions when non-Treaty storage is used as an opportunity resource is a decrease in flow of about 2 kcfs or about 1.4 percent of the Columbia River flow. When operated as a firm resource, this change is less than 1 kcfs. In low water years flows increase an average of about 1.5 kcfs during this period for both opportunity and firm resource use. In high water conditions flows decrease about 5.5 kcfs during the spring period. In high water conditions flows during this period are well above 300 kcfs at The Dalles. Section 3.4.1.3 gives a more complete description of flow changes as simulated by SAM. SAM study results were similar to what has occured in actual operation under the existing agreement.

The Columbia River water budget is nearly always met, with or without the use of non-Treaty storage. In both average and high water conditions, spring flows at Priest Rapids remains well above 140 kcfs May through July, and flows at The Dalles above 220 kcfs April 15 through June.

Results from the hydro regulation study indicate that some storage can occur in non-Treaty storage space between April and August in nearly all water years. The probability of having water available for storage increases throughout the season, as reservoirs refill and more nonfirm energy and overgeneration spill become available for storage. A discussion of maximum potential non-Treaty storage based on hydro regulation study results from the 1988 Whitebook is provided in Section 3.2.3, and additional information is contained in Appendix C. Again, storage amounts are limited by Treaty flow requirements at Mica (10 kcfs) until such time as Mica is refilled, usually in July. The maximum potential storage in a single month was 59.8 KSFD/day. This occurs in July of Water Year 1968. Flows at Priest Rapids average 160 kcfs during this period. Because this estimate does not include nonfirm sales, displacement of medium-priced thermal plants, short-term operating requirements, or transmission line limitations between BPA and BC Hydro, such an amount could not be stored in actual practice.

The proposed NTSA used as either a firm or opportunity resource does not alter flows enough to cause adverse affects on anadromous fish migration.

3.4.3.2 Vernita Bar Flow Regulation

In 1988 BPA and the mid-Columbia operators signed a long-term Vernita Bar Agreement, which specifies protection requirements for fall chinook spawning, incubation and emergence on Vernita Bar (located downstream of Priest Rapids Dam in the Hanford Reach). Mid-Columbia operators are required to reverse load factor to maintain low daytime flows during the spawning season, approximately October 15 through November, provided inflows to Priest Rapids are below 125 kcfs. This action promotes lower spawning elevations on the bar, as spawning occurs primarily during daylight hours. Flows required for incubation and emergence are determined by the spawning elevations that occurred the preceding fall, but are not required to exceed 70 kcfs.

Analytical Methods

Analyses include the results of 200 SAM simulations of monthly average Priest Rapids flows for each contract year. The following flow statistics for each simulation were evaluated:

a. The frequency of flows greater than 125 kcfs in October and November at Priest Rapids. (Appendix I.)

b. The frequency of flows less than 70 kcfs December through April at Priest Rapids. (Appendix I.)

Results

Priest Rapids flows seldom exceed 125 kcfs during the fall chinook spawning period, with or without the operation of additional non-Treaty storage space. When non-Treaty storage is used for opportunity storage, flows are 0.85 percent less likely to exceed 125 kcfs during October and November and 0.98 percent more likely to remain above 70 kcfs December through April. When non-Treaty storage is used as a firm resource, flows were more likely to exceed 125 kcfs in the fall by 0.43 percent, and 1.10 percent more likely to remain above 70 kcfs in the spring.

Neither operation of the proposed NTSA is expected to have an impact on fall chinook spawning in the Hanford Reach. The additional flexibility created by the proposed NTSA may make it easier to provide spring emergence flows.

3.4.3.3 Spill

Until adequate bypass systems are installed at the dams, spill remains a necessary means of moving juvenile fish past dams. Three types of spill occur: planned fish spill, forced spill, and overgeneration spill. Planned fish spill now includes the negotiated Spill Agreement as well as a restricted operation at Bonneville Dam provided by the Corps. (Because the Spill Agreement was not signed when analysis of the NTSA began, it is evaluated as a sensitivity study.) Planned spill also includes spill levels specified by

Federal Energy Regulatory Commission (FERC) for non-Federal projects. Planned spill does not include overgeneration spill and is not changed as a result of the proposed NTSA. Forced spill occurs when flows exceed the hydraulic capacity of the powerhouse at a particular project. Overgeneration spill is water that is spilled when energy markets are not sufficient to require powerhouse generation of all inflow. All three types of spill are useful in moving fish past dams. Changes in river operations have the greatest effect on overgeneration spill. Planned fish spills are automatically met under all water conditions.

Analytical Methods

The change in mean monthly hydro system overgeneration spill, in megawatts, was analyzed based on SAM data from 200 simulations for each period and year of the analysis. (Appendix G.)

Results

Potential changes in overgeneration spill resulting from the proposed agreement are discussed in Section 3.4.1.5. Overgeneration spill amounts have decreased substantially with the increased intertie capacity as analyzed in the IDU Final EIS. The reduction in the remaining overgeneration spill caused by the proposed agreement averages about 12 percent, April through August, when used as an opportunity resource and approximately 9 percent when used as a firm resource. The analysis of effects of the proposal on anadromous fish survival, presented in Section 3.4.3.4, includes the effects of spill changes as well as flow changes resulting from the proposal.

These changes in overgeneration spill when compared to the IDU Final EIS analysis are small and will not substantially affect anadromous fish migration. Planned spill and spill as required by the Spill Agreement are not affected by changes in overgeneration spill.

3.4.3.4 Survival

The analysis of downstream anadromous fish passage survival, as it may be affected by changes in spill and flows, was performed using a modified version of the Corps' FISHPASS model. (A detailed description of the FISHPASS model is given in the Corps' model documentation titled "FISHPASS Model Concept and Application," March 1986.) BPA's version of FISHPASS has been revised to include the Mid-Columbia Public Utility District dams and to accept spill and flow data from the SAM model.

BPA's FISHPASS model simulates downstream fish passage survival for anadromous fish passing the Lower Snake, Mid-Columbia, and Lower Columbia hydro projects during the April through August period. Juvenile fish survival is calculated from the point of entry into the hydro system to below Bonneville Dam. Survival projections are developed for species entering at specific projects.

FISHPASS simulates project-specific system survival for yearlings (spring chinook and Snake River summer chinook salmon), subyearlings (fall chinook and

Mid-Columbia summer chinook salmon), steelhead trout, and sockeye salmon. Yearling, steelhead, and sockeye tend to migrate in the spring, April through June, and subyearlings in the summer, June through August.

Analytical Methods

Given the time, location, and number of hatchery and natural stocks of fish entering each pool, and the project/species specific characteristics for dam passage survival, pool survival, and travel time, FISHPASS uses flow and spill information from SAM to compute the relative system survival (from point of origin) and the overall system survival for each species. Inputs and assumptions for the FISHPASS model can be found in Appendix B. A more detailed description of the FISHPASS model can be found in Appendix E.3 of the IDU Final EIS.

FISHPASS uses 40 rather than 200 simulations from SAM to determine average survival for a given year. Analysis is then performed on 6 years of the 20-year sequence. The years of study are 1991, 1993, 1995, 1997, 2001, and 2003. The survival statistics evaluated include:

a. The relative change in mean survival. (The difference in mean survival between the proposal and the No-Action alternative divided by the No-Action alternative survival). (Appendix I.)

b. The frequency of relative survival increases or decreases of greater than 1 and 5 percent. (Appendix I.)

A potential for impact is considered to exist if the mean relative survival decreases by more than 1 percent, if relative survival decreases greater than 1 percent occur in more than than 30 percent of the simulations for any year, or if relative survival decreases greater than 5 percent occur in more than 5 percent of the simulations for any year. These criteria are used to flag stocks for inclusion in the stock assessment. For critical stocks (critical stock being those stocks which are substantially below escapement goals, are not increasing on a clear trend, and for which harvest and production management actions reflect the stocks' critical condtion), all changes in survival are evaluated. A biological assessment for the critical and noncritical stocks potentially affected by the proposal is included in Appendix I.

Results

Changes to flow and spill resulting from the opportunity and firm use alternatives have insignificant effects on the downstream migrant survival of juvenile fish through the Columbia and Snake River systems. The analysis of survival changes under the opportunity storage alternative shows projected average relative changes in survival throughout the contract for all yearling, subyearling, steelhead, and sockeye ranged respectively, from increases of 1.5, 1.0, 0.7, and 0.4 percent to decreases of 0.2, 0.9, 0.2, and 0.1 percent.

Results were similar when non-Treaty storage was used as a firm resource, although the magnitude of the changes were less than when the space was used for opportunity storage. Under the firm resource alternative the projected average relative changes in survival throughout the contract for all yearling, subyearlings, steelhead, and sockeye ranged respectively, from increases of 0.8, 0.5, 0.6, and 0.4 percent to decreases of 0.2, 0.9, 0.2, and 0.0 percent.

The relative change in mean survival and the frequency of relative survival increases and decreases greater than 1 and 5 percent for each category of fish stocks, for each pool of origin, was determined and provided in Appendix I, Part 2, for each year of analysis and for each alternative studied. Overall, these effects are minor relative to each stock's current population and productivity status, current smolt passage survival, and expected increases in passage survival due to planned improvements in fish passage facilities. Given planned bypass improvements, no significant effects to anadromous fish passage would be expected to result from any of the alternatives studied. A complete stock assessment of all stocks potentially affected by the Non-Treaty Storage Agreement, including the sensitivity analyses, can be found in Appendix I, Part 4.

3.4.3.5 Sensitivity Studies

Results of SAM Sensitivity Studies

The various sensitivities - high Northwest and Southwest load growth, alternative dispatch criteria, the signed spill agreement, and the expiration of the proposed NTSA in the year 2003 (see descriptions, Section 3.1.2.2) - were analyzed to determine their effect on anadromous and resident fish. Little change is noted from the Base Case studies for any of the parameters analyzed. These changes do not result in different conclusions about impacts to anadromous or resident fish than the Base Case.

Results of FISHPASS Sensitivity Studies

In addition to the SAM sensitivity studies, a sensitivity analysis was performed to determine if reservoir mortality assumptions would affect survival results of the NTSA studies. Reservoir mortality values used in the FISHPASS model were increased and decreased by 50 percent. Evaluation included the same parameters as those evaluated in the Base Case studies (Section 3.4.3.3). (Appendix I.)

The sensitivity analysis showed that the reservoir mortality assumptions used in FISHPASS have little effect on the difference in survival between the No-Action alternative and the proposal. While the absolute survival values changes substantially, as a result of the altered mortality assumptions, the relative differences in survival change only slightly, usually less than 0.5 percent. However, the case in which reservoir mortality was assumed to increase 50 percent causes the relative survival of subyearling fish originating in Wells pool to decrease slightly more than 1 percent. It also increases the frequency of relative survival decreases being greater than 1 and 5 percent.

Other FISHPASS model parameters were evaluated for their sensitivity in the IDU Final EIS, Section 4.2.3.4.1. These include spill efficiency, turbine mortality, subyearling reservoir mortality, transportation survival, and fish guidance efficiency (FGE). These sensitivity analyses showed that the assumptions for FISHPASS input parameters had only minor effects on the difference in relative survival between the No-Action alternative and the test case alternative. The largest change in impacts occurred for Lower Monumental subyearlings with the FGE changes. The relative change in survival was slightly greater than one percent under high and low FGE's. All other FISHPASS parameter variables changed the average relative survival impacts less than 1 percent for all stocks.

3.4.4 Wildlife and Vegetation

Reservoir water level fluctuation can affect wildlife and vegetation, both directly and indirectly, through the timing, duration, and amount of releases from the reservoir. The proposed NTSA generally results in either no change to reservoir operations or a decrease in reservoir fluctuations. All current and future reservoir operations will remain within the operational constraints set by the operating agencies and the physical characteristics of the dams.

The greatest effect on wildlife of reservoir water level fluctuations in the Columbia Basin is changes in wildlife habitat. Any effect on prey or browse species of plants or animals will have a corresponding effect on wildlife species. This is especially important if vegetation is damaged at critical times of the year, such as when deer and elk need it for winter food or waterfowl need it for shelter or nesting. Erosion of islands can also affect wildlife by decreasing habitat available for bird nesting and deer fawning. It may also decrease the amount of shoreline available for reptiles laying eggs. Land bridges may be formed during low water periods, allowing predators access to habitat that would otherwise be isolated. This is a particular concern when birds are nesting and deer fawning. Changes in reservoir levels that impact resident fish populations can also impact wildlife that utilize those fish as a primary food source. Changes in hydro operations can also affect vegetation along shorelines, on islands, and in the drawdown zone.

Changes in hydro operations that could affect vegetation and wildlife are not expected to occur as a result of the proposed NTSA. Fluctuations in reservoir elevations are minimal and are not expected to cause significant impact.

BPA has consulted with the U.S. Fish and Wildlife Service (USFWS) regarding potential effects of the proposed NTSA on plant and animal species and critical habitat protected by the Endangered Species Act (16 USC 1536). A list of species is included in Appendix J. A Biological Assessment analyzing potential effects of the project on the listed species was prepared and forwarded to the USFWS. The USFWS agreed with BPA's opinion that the proposed NTSA is not likely to affect Federally-listed species or their habitats.

3.4.5 Recreation and Irrigation

Recreation

Federal hydro projects provide numerous recreation opportunities for activities such as boating, swimming, water skiing, fishing, camping, picnicking, sightseeing, and hiking. Changes to reservoir elevation or to project discharge resulting from additional non-Treaty storage use may influence recreation. Generally, elevation changes would affect recreation in the reservoir, while discharge changes would influence downstream recreation. Recreational facilities such as boat ramps, docks, and swimming areas are typically designed for optimal use at full pool. Downstream recreational activities, such as fishing, swimming, rafting, and boating, are influenced by project discharge. Constraints have been developed limiting the rate of change in project discharge to protect downstream users.

Potential effects of additional use of non-Treaty storage space were assessed using data from the SAM studies. Reservoir elevation data were examined to determine if recreational use of reservoirs is likely to be affected. PNW reservoir elevations are the same or slightly higher with use of additional non-Treaty storage space. This is particularly true in low water conditions. Over all water conditions, reservoir levels are the same or higher in the summer months with additional non-Treaty storage. Because reservoir levels are the same or slightly higher with the proposed agreement than without, no adverse effects on recreation are expected.

It is more difficult to assess potential impacts on downstream recreation because effects are related to short-term fluctuations in flow. Non-Treaty storage transactions have been and would continue to be energy transactions in which energy deliveries are typically scheduled flat throughout the day. Downstream flow fluctuations are expected to be similar to those experienced under the existing NTSA resulting in no change in downstream recreation.

Irrigation

Levels of allowable irrigation withdrawals are determined by the individual States and are established water rights. Hydro operation planning is developed around flows that include irrigation withdrawals. In most areas of the Columbia River Basin, river operations affect irrigation only to the extent that coordination is sometimes necessary to allow irrigators to move their pump intakes in response to changes in reservoir or river levels. These types of impacts would not be changed by the proposed NTSA. However, at Grand Coulee, pumps for the Columbia Basin Project are located at the plant. As reservoir levels drop, pumping becomes more difficult; at some levels, pumps will not operate or may be damaged if run. There is currently a requirement for the reservoir to be at or above 1,240 feet at the end of May for irrigation. If that constraint is not met, there would be some potential for drawdown of Banks Lake, which would have an adverse effect on the fishery and recreation.

The streamflows used in SAM have been adjusted for irrigation depletion. it is assumed that irrigation depletions will change over time; however, the models used in this analysis do not have the ability to do this. As an assumption, the 1999 level of estimated irrigation depletion was used in these studies. Consequently, irrigation depletions are probably slightly over estimated in the near term and under estimated in the later years. Because all alternatives are affected equally, an error in the irrigation assumptions does not affect incremental results of alternative comparisons.

To assess the potential impact of the proposed NTSA on irrigation, the results of SAM studies were used. The results were converted to give the probability of being at or above 1,240 feet at the end of May at Grand Coulee. The probability of achieving a 1,240 feet elevation at Grand Coulee at the end of May is not changed by the proposed NTSA. Therefore, no effect on irrigation is expected as a result of the proposal whether it is operated for opportunity storage or as a firm resource.

3.4.6 Cultural Resources

Changes in operation at hydroelectric projects may have effects on cultural resources in and around Federal storage reservoirs in the PNW, Grand Coulee (Lake Roosevelt), Dworshak, Libby (Lake Koocanusa), and Hungry Horse. Changes in elevations at these reservoirs may change the rate of site erosion and may make cultural resource sites more or less accessible to vandals. Other hydroelectric projects in the FCRPS are operated either as run-of-river or primarily for flood control and are generally not expected to be influenced by the proposed NTSA.

BPA is continuing to develop a Programmatic Agreement with the Advisory Council on Historic Preservation; the Idaho, Montana, and Washington State Historic Preservation Officers; the Bureau of Reclamation; the Corps; and others to survey, evaluate, and protect potentially affected cultural resources. This Programmatic Agreement was initiated as mitigation for potential impacts on these cultural resources from marketing activities analyzed in BPA's IDU Final EIS. It also will effectively satisfy BPA's responsibilities under section 106 of the National Historic Preservation Act (16 U.S.C. 470, et seq.) for all Federal actions taken with respect to hydroelectric operations at Libby, Hungry Horse, Albeni Falls, Grand Coulee, and Dworshak.

There are not substantial differences between reservoir levels expected with the no-action alternative and the proposed NTSA. Changes in reservoir levels that could affect cultural resources are minimal. All current and future reservoir operations will remain within prescribed constraints.

The Programmatic Agreement also will insure consistency with the American Indian Religious Freedom Act (42 U.S.C. 1996), by providing for BPA participation in the disposition of Native American burials if such sites are discovered.

3.4.7 Thermal System Operations

Analysis of the proposed NTSA with SAM showed some changes in annual generation by existing coal-fired generating units and CT's supplying power to the PNW. These coal-fired plants are Valmy, Colstrip, Corette, Boardman, Centralia, and Bridger. The CT plants are Beaver; Whitehorn 1, 2, and 3; Bethel; Frederickson 1 and 2; and Fredonia 1 and 2. Appendix K also provides information concerning the locations and characteristics of these plants. Changes in generation at these plants have the potential to affect the environment, primarily through changes in air quality, fuel usage, annual amounts of land disturbed for mining, and water consumption. Operation of nuclear generation would not be affected, since the variable costs of these plants are low enough that they tend to be run as much as possible regardless of circumstances.

3.4.7.1 Changes in Annual Generation at Existing Coal and CT Plants

Annual generation changes of existing coal plants serving the PNW between No-Action alternative and the proposed NTSA in units of annual average megawatts are tabulated in Appendix K.

The proposed NTSA is projected by SAM to result in only small differences in annual coal plant generation for any one plant in any year when compared to the annual generating capability of the plants, whether the proposed NTSA is presumed to be used for opportunity storage or as a firm resource. Differences in coal plant generation are universally less than 8 percent and are typically much less. Changes for individual plants are larger on a percentage basis when the comparison is between the values projected by SAM for the No-Action alternative and the values projected for the proposed NTSA. However, with the exception of differences for the Valmy and Boardman plants in the early years (circa 1989 through 1995) of the study, they are still small on this basis as well.

Opportunity Storage Use

Over 200 games, SAM projects slight increases in annual average generation relative to the No-Action alternative at Colstrip, Corette, and Bridger. At Valmy, Boardman, and Centralia, decreases in generation relative to the No-Action alternative occur on average in the earlier years of the SAM study; this effect is more pronounced for plants with higher variable costs. Use of additional opportunity storage under the proposed NTSA results in greater usage of the hydro system to displace higher-cost, coal-fired generation. Existing coal plants show a small net increase in total in all years except 1990.

Lower-cost coal plants increase generation because less surplus hydroelectric energy is available for export markets (because it tends to get stored for later use by the PNW). This effect is supported by the large difference in the degree to which Boardman and Valmy are displaced in 1993 as compared to 1994. The existing NTSA expires in 1993, making the difference in the amount of non-Treaty storage between the No-Action alternative and the proposal much larger in 1994 than in 1993.

As overall demand for electric power increases with time, it becomes more economical to use plants with higher variable costs for both export and PNW use. Generation in 1997 and thereafter is slightly higher at all the coal plants with the proposed NTSA used for opportunity storage than under the No-Action alternative. Generation at the higher cost plants, even under the No-Action alternative, generally trends higher with the passage of time in the study.

When the proposed NTSA is used for opportunity storage, CT generation is decreased relative to the No-Action alternative. The increased amount of storage available with the proposal allows greater displacement of these CT's with stored hydro or low-cost thermal-generated energy. CT's, especially simple cycle designs, tend to have very high variable costs and, therefore, tend to be the first resources displaced. In the PNW, CT resources have historically been run very little for this reason, and the SAM studies show significant operation of only the Beaver plant. The Beaver plant, a combined-cycle plant, has lower variable operating costs than the other CT's and, therefore, is generally used first by SAM. With use of the proposed NTSA for opportunity storage, SAM projects Beaver to generate between 3 and 38 aMW less with the proposal than with the No-Action alternative, depending on the year. On a percentage change basis, these reductions range from about 10 to 38 percent of the generation projected for the No-Action alternative.

Firm Resource Use

Using the proposed NTSA as a firm resource means that the U.S. half of the non-Treaty storage it makes available would be operated under rules similar to those that govern other reservoirs in the PNW hydro system. The non-Treaty storage would have to be initially filled prior to its commitment as a firm resource and then be planned to refill each operating year by July 31. The SAM studies for use of non-Treaty storage as a firm resource include an additional 165 MW firm load that is equal to the average FELCC increase (in SAM) of the non-Treaty storage.

In low runoff years, most thermal resources run to serve regional firm load, and non-Treaty storage is drafted to serve firm load including the additional firm contract. In typical water years, drafting of non-Treaty storage does not always provide enough energy to serve the additional firm load, and additional thermal resources may be run. In high runoff years, higher-cost thermal plants are displaced in the No-Action alternative and the proposed alternative. Under the No-Action alternative in 1989 through 1993, the existing NTSA is still in effect, and high-cost thermal resources are displaced by non-Treaty storage used as opportunity storage. Thus, generation by Boardman and Valmy increases as a result of the proposed agreement when used as a firm resource in the period 1989 through 1993 by 30 to 40 percent. Other coal-fired plants have only slightly higher generation on average in these years with the proposed NTSA used as a firm resource relative to the No-Action alternative.

Bridger, however, has slightly lower generation in 1989 through 1992, and Colstrip has slightly lower generation than under the No-Action alternative in 1993. Bridger and Colstrip are among the plants with the lowest variable costs. These plants are less likely to be displaced with the proposed agreement than in the No-Action alternative because of the obligation to fill the non-Treaty storage space when it is used as a firm resource.

After 1994, all the coal-fired plants generate slightly more, with a couple of exceptions, in all years with the proposed NTSA used as a firm resource than under the No-Action alternative. The exceptions are small decreases in annual generation at the Boardman plant in 1994 and 1996. In effect, on average over the 1994 to 2008 period, with the proposed NTSA used as a firm resource, about 60 aMW of additional coal-fired generation operates per year to provide a 165 aMW firm resource.

With the proposed NTSA used as a firm resource, CT generation also tends to be higher than in the No-Action alternative. Again, differences for all but the Beaver plant are negligible, and only the Beaver facility is operated to a significant degree in either alternative. Average Beaver generation increases by between 1 and 18 aMW over the course of the study, 1989 to 2008, and decreases slightly, by 3 aMW, in one year, 2001. Expressed as a percentage, the range of change was about from -2 to 59 percent from the No-Action value. Similar to the high cost coal-fired plants, the largest percentage increases in generation occur in the first 3 years of the analysis. Beaver generation trends generally higher through the course of the study such that it is generating about 135 aMW in the last years of the study in either alternative. As a reference for comparison, the Beaver facility operated in a combined cycle mode has a peak capacity of 601 MW, and a maximum capacity of 534 MW.

3.4.7.2 Air Quality Impacts

A method for projecting changes in ambient air quality from changes in annual average generation for the coal plants serving the PNW was developed for BPA's IDU Final EIS. The method is discussed in Appendix G of that EIS. Briefly, there are linear relationships between average annual generation in aMW and ambient concentrations of sulfur dioxide (SO_2) and total suspended particulate (TSP). Differences in computed ambient concentrations of these pollutants were compared to ambient air quality standards and Prevention of

Significant Deterioration (PSD) criteria. The IDU Final EIS analysis showed, in all cases, very small or negligible effects on air quality in the environs impacted by the coal-fired power plants supplying the PNW, which were the same ones as are addressed in this analysis of the proposed NTSA. (Air quality impacts of the Corette plant were not quantitatively analyzed in the IDU Final EIS or for this EA. However, in both cases, the changes in generation between alternatives for the Corette plant were very small (at most 1 aMW in the analysis for this document), and when considering the small effects shown by the air quality analysis of the other plants, are very unlikely to be significant.)

For all plants except Valmy and Boardman, larger differences in generation between alternatives were projected in the analysis for the IDU Final EIS than are projected in the analysis of the proposed NTSA for this EA. The air quality changes identified in the IDU Final EIS were very small and found not to be significant. Therefore, it can be concluded that air quality impacts of the proposed NTSA with respect to coal-fired plants other than Valmy and Boardman are very small or negligible. For Valmy, the largest differences in annual average ambient air quality that are projected from the NTSA analysis (i.e., computed using the largest difference in annual generation between the No-Action alternative and the proposed NTSA using the methodology of the IDU Final EIS) are increases of 0.022 micrograms per cubic meter ($\mu g/m^3$) for SO_2 and 0.00075 $\mu g/m^3$ for TSP in 1993 with NTSA used as a firm resourceN Similarly, for Boardman, the maximum impacts are increases of 0.018 $\mu g/m^3$ for SO_2 and 0.0016 $\mu g/m^3$ for TSP in 1993 with NTSA used as a firm resource. These impacts are negligible when compared with PSD criteria (19 $\mu g/m^3$ for TSP, and 20 $\mu g/m^3$ for SO_2) or ambient air quality standards.

A methodology for analyzing air quality impacts from changes in generation from existing CT facilities included in the SAM had not been developed for the IDU Final EIS.

Only the Beaver facility is affected to any substantial degree in the SAM analysis of the proposed NTSA (see Section 3.4.7.1). A field measurement program using sulfur hexaflouride (SF_6) as a tracer showed that ambient air concentrations of nitrogen oxides and SO_2 from the Beaver CT facility, when operated in combined cycle mode, are far below the air quality regulatory standards (Air Quality Impact Study of Combined Cycle Operation at the Beaver CT Plant, Phase I: Summary of Field Measurement Programs, Portland General Electric, 12/80).

Because the above study indicates that ambient concentrations of air pollutants from the Beaver CT facility are small in comparison with air quality standards, an increase in generation of up to 18.4 aMW in one year, the projected largest increase in Beaver's generation in the SAM study resulting from the proposed NTSA, would not make any substantial difference in annual average concentrations of air pollutants. Maximum air quality impacts from the plant would not be affected by any of the alternatives, because these could occur at any time the plant is operated at capacity coincident with adverse dispersion conditions.