

MEMORANDUM

August 31, 2004

FOR: FCRPS Remand File

FROM: Richard Domingue, NOAA Hydrologist

SUBJECT: Method for Calculating Seasonal Average Flows for Remand BiOp

Purpose: To define the seasonal average flows for alternative operating scenarios for the purpose of modeling differences in fish survival based on those flow differences. Two alternatives were considered: the 2000 BiOp base case (proposed action) and the Reference Operation (designed to minimize discretionary system-induced fish mortality). The objective was to define flow differences during the juvenile salmon and steelhead outmigration seasons and the chum spawning season.

Model Used: HYDSIM, All HYDSIM model runs were conducted by the Bonneville Power Administration (Roger Schwiewe and Jennie Tran). Data aggregation and manipulation were performed using Excel.

Methods:

Step 1

The period of record for the input files to the HYDSIM model and the outputs of simulated operations cover the period August 1929 through July 1978. It was therefore necessary to identify years with similar hydrologic conditions to the years 1994 through 2003, which were being used to estimate fish survival differences between operations scenarios. The first step in the process for determining the HYDSIM simulated seasonal average flows for the reference years 1994 through 2003 was to identify three years with April-through-August runoff volumes that were similar to the year of interest. This was done by collecting the actual April-through-August runoff volumes for the years of interest and identifying the years in the HYDSIM record period with the nearest runoff volume to the subject year, as well as the next higher and next lower years. This comparison was conducted using data from Crook (1993) that have been modified to simulate hydrologic conditions that would exist if the 1990 level of irrigation had been in place throughout the period and flows were unaffected by storage and release patterns of dams throughout the Columbia basin. Spreadsheets displaying these surrogate years follow as Table 1 and Table 2.

Step 2

A series of HYDSIM model runs was conducted and analyzed for both the proposed action and the reference operation. Only the final models are discussed herein. Details of the constraints placed on each of these runs are available elsewhere in the record. HYDSIM output files including detailed outputs for each project in the system are also available elsewhere in the record. For this

analysis, discharge data from Lower Granite, McNary, and Bonneville dams were chosen to represent conditions in the lower Snake River, the lower Columbia River, and downstream from Bonneville Dam, respectively. The periods of interest for juvenile fish passage are:

- Spring
  - at Lower Granite: April 3 - June 20 (79 days)
  - at McNary: April 10 - June 30 (82 days)
- Summer
  - at Lower Granite: June 21 - Sept. 30 (102 days)
  - at McNary: July 1 - Sept. 30 (92 days)

Stream flow conditions downstream from Bonneville Dam are pertinent to the survival of chum salmon from spawning through incubation, emergence, and outmigration (Nov. 1 through April 15 [166-167 days]). Data from the two operating alternatives for Lower Granite and McNary dams for the spring and summer period for the surrogate years were collated into individual spreadsheets. Tables 3, 4, 5 provide simulated flow conditions under the proposed action for Lower Granite Dam, McNary Dam, and Bonneville Dam, respectively. Tables 6, 7, and 8 provide the same information for the reference operation.

The seasonal averages for the summer period include data from August and September for the subsequent operating year (August-July), because the HYDSIM operating year ends in July, and the migration period extends through the end of September. Hence, if the 1940 operating year is chosen as a surrogate, data from the HYDSIM run for August 1941 become part of the summer average of interest.

### Step 3

Data from the HYDSIM simulation of operations under the proposed action (consistent with 2000 BiOp) and the reference operation were compared and the flow differences displayed. Tables 8, 9, and 10 provide dam-specific summaries and comparisons of the seasonal averages under the two operating scenarios. These are the data used in the estimating the survival gap between the two alternative operating scenarios.

**Table 1.** 2000 BiOp Remand Hydrologic Analysis – Snake River Runoff Comparison. 1994-2003. Observed April-July Runoff Compared to Equivalent Historical Runoff Years in 1928-78 Record.

| <b>2000 BiOp Study Year</b> | <b>Observed Apr-Jul Runoff Volume, in Maf</b> | <b>Historical Runoff Years</b> | <b>Historical Apr-Jul Runoff Volume, in Maf</b> | <b>3-year average Apr-Jul Runoff Volume, in Maf</b> |
|-----------------------------|---|--------------------------------|---|---|
| 1994                        | 11.3  | 1934                           | 12.52   | 11.83   |
|                             |   | 1973                           | 12.21   |   |
|                             |   | 1931                           | 10.77   |   |
| 1995                        | 21.0  | 1946                           | 22.01   | 21.30   |
|                             |   | 1933                           | 21.00   |   |
|                             |   | 1959                           | 20.93   |   |
| 1996                        | 28.4  | 1975                           | 29.26   | 28.49   |
|                             |   | 1976                           | 28.48   |   |
|                             |   | 1957                           | 27.72   |   |
| 1997                        | 33.5  | 1974                           | 35.68   | 33.94   |
|                             |   | 1971                           | 34.59   |   |
|                             |   | 1943                           | 31.56   |   |
| 1998                        | 23.7  | 1951                           | 24.11   | 23.83   |
|                             |   | 1949                           | 23.78   |   |
|                             |   | 1953                           | 23.61   |   |
| 1999                        | 25.8  | 1950                           | 27.20   | 25.92   |
|                             |   | 1964                           | 26.10   |   |
|                             |   | 1969                           | 24.47   |   |
| 2000                        | 17.2  | 1942                           | 18.49   | 17.13   |
|                             |   | 1961                           | 17.05   |   |
|                             |   | 1940                           | 15.86   |   |
| 2001                        | 10.3  | 1973                           | 12.21   | 10.54   |
|                             |   | 1931                           | 10.77   |   |
|                             |   | 1977                           | 8.64  |   |
| 2002                        | 19.0  | 1955                           | 19.93   | 19.23   |
|                             |   | 1960                           | 18.97   |   |
|                             |   | 1963                           | 18.78   |   |
| 2003                        | 16.7  | 1961                           | 17.05   | 16.10   |
|                             |   | 1940                           | 15.86   |   |
|                             |   | 1968                           | 15.40   |   |
| 10-yr. mean                 | 20.7  |                                |   | 20.8  |
| 61-yr. mean                 | 21.39   |                                |   |   |

**Table 2.** 2000 BiOp Remand Hydrologic Analysis – Columbia River Runoff Comparison. 1994-2003. Observed April-August Runoff Compared to Equivalent Historical Runoff Years in 1928-78 Record.

| <b>2000 BiOp Study Year</b> | <b>Observed Apr-Aug Runoff Volume, in Maf</b> | <b>Historical Runoff Years</b> | <b>Historic Apr-Aug Runoff Volume, in Maf</b> | <b>3-year Average Apr-Aug Runoff Volume, in Maf</b> |
|-----------------------------|---|--------------------------------|---|---|
| 1994                        | 67.2  | 1940<br>1937<br>1930           | 70.82<br>67.10<br>65.81                       | 67.91   |
| 1995                        | 86.1  | 1962<br>1934<br>1936           | 90.49<br>87.89<br>84.44                       | 87.61   |
| 1996                        | 111.0   | 1950<br>1954<br>1965           | 114.20<br>111.90<br>109.00                    | 111.70  |
| 1997                        | 133.1   | 1974<br>1972<br>1956           | 134.60<br>129.60<br>125.80                    | 130.00  |
| 1998                        | 90.1  | 1949<br>1962<br>1934           | 91.15<br>90.49<br>87.89                       | 89.84   |
| 1999                        | 110.3   | 1954<br>1965<br>1943           | 111.90<br>109.00<br>108.20                    | 109.70  |
| 2000                        | 84.2  | 1934<br>1936<br>1970           | 87.89<br>84.44<br>83.63                       | 85.32   |
| 2001                        | 52.8  | 1931<br>1944<br>1977           | 59.32<br>55.97<br>49.58                       | 54.96   |
| 2002                        | 93.8  | 1947<br>1955<br>1960           | 94.17<br>93.96<br>91.43                       | 93.19   |
| 2003                        | 73.8  | 1945<br>1939<br>1940           | 75.68<br>74.93<br>70.82                       | 73.81   |
| 10-yr. mean                 | 90.2  |                                |   | 90.4  |
| 61-yr. mean                 | 91.91   |                                |   |   |

**Table 3.** Lower Granite Discharge under the BiOp Base Case (proposed action).

Data from: FRIII\_03SN6704S1.XLS 8/5/2004

Data presented are water year data (e.g., AUG1(WY1934)=AUG1(CY1935))

| BiOp Study Year | HYDSIM Surrogate Years | Total discharge in cfs |       |       |       |       |       |       |       |       |        |        |        |        |       |
|-----------------|------------------------|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|-------|
|                 |                        | AUG1                   | AUG2  | SEP   | OCT   | NOV   | DEC   | JAN   | FEB   | MAR   | APR1   | APR2   | MAY    | JUN    | JUL   |
| <b>1994</b>     | 1934                   | 26668                  | 15467 | 20934 | 22178 | 21905 | 44271 | 53837 | 40292 | 48568 | 89158  | 96646  | 59731  | 29314  | 29909 |
|                 | 1973                   | 31155                  | 18653 | 25567 | 33095 | 24099 | 33896 | 40301 | 31696 | 34522 | 38706  | 42039  | 68286  | 51406  | 37616 |
|                 | 1931                   | 26168                  | 14747 | 20567 | 22291 | 15550 | 12259 | 20501 | 21102 | 29654 | 54590  | 41502  | 62617  | 33559  | 28945 |
|                 | average                | 27997                  | 16289 | 22356 | 25855 | 20518 | 30142 | 38213 | 31030 | 37581 | 60818  | 60062  | 63545  | 38093  | 32157 |
| <b>1995</b>     | 1946                   | 34961                  | 27946 | 28675 | 27169 | 20815 | 33785 | 40426 | 41148 | 64880 | 95649  | 125995 | 112640 | 76651  | 46186 |
|                 | 1933                   | 33325                  | 27509 | 24959 | 21976 | 19810 | 17828 | 23588 | 24571 | 33366 | 49935  | 86212  | 79729  | 138242 | 48359 |
|                 | 1959                   | 36171                  | 30506 | 33130 | 25583 | 26142 | 38234 | 55087 | 50346 | 49390 | 74499  | 64978  | 86043  | 111769 | 49317 |
|                 | average                | 34819                  | 28654 | 28921 | 24909 | 22256 | 29949 | 39700 | 38688 | 49212 | 73361  | 92395  | 92804  | 108887 | 47954 |
| <b>1996</b>     | 1975                   | 43481                  | 43975 | 32995 | 32897 | 18614 | 27734 | 36176 | 47869 | 62292 | 62307  | 81666  | 110761 | 166031 | 90744 |
|                 | 1976                   | 43200                  | 41107 | 35105 | 41844 | 29041 | 65444 | 54809 | 50949 | 64360 | 122254 | 106768 | 150903 | 116831 | 54560 |
|                 | 1957                   | 35882                  | 27207 | 27548 | 27053 | 21906 | 34568 | 29528 | 44103 | 65991 | 105321 | 104031 | 172789 | 118860 | 48098 |
|                 | average                | 40854                  | 37430 | 31883 | 33931 | 23187 | 42582 | 40171 | 47640 | 64214 | 96627  | 97488  | 144818 | 133907 | 64467 |
| <b>1997</b>     | 1974                   | 42837                  | 38942 | 30130 | 28973 | 33008 | 45550 | 82541 | 73192 | 91841 | 112804 | 141633 | 143208 | 194672 | 69888 |
|                 | 1971                   | 42698                  | 37716 | 36432 | 34417 | 27471 | 41549 | 73393 | 96147 | 75706 | 104679 | 113731 | 175645 | 166851 | 69907 |
|                 | 1943                   | 42046                  | 36398 | 28504 | 23521 | 19307 | 30741 | 45574 | 60502 | 77381 | 149826 | 163113 | 118254 | 131032 | 78908 |
|                 | average                | 42527                  | 37685 | 31689 | 28970 | 26595 | 39280 | 67169 | 76614 | 81643 | 122436 | 139492 | 145702 | 164185 | 72901 |
| <b>1998</b>     | 1951                   | 38670                  | 33956 | 26786 | 38306 | 34883 | 49882 | 49224 | 72879 | 61359 | 106919 | 106725 | 113608 | 90799  | 53533 |
|                 | 1949                   | 32902                  | 25007 | 24946 | 25324 | 19655 | 23123 | 30582 | 41351 | 74239 | 96905  | 112320 | 149935 | 77966  | 41456 |
|                 | 1953                   | 38886                  | 35422 | 27110 | 23687 | 16229 | 20759 | 44760 | 53353 | 46134 | 48221  | 83604  | 87039  | 144733 | 61135 |
|                 | average                | 36819                  | 31462 | 26281 | 29106 | 23589 | 31255 | 41522 | 55861 | 60577 | 84015  | 100883 | 116861 | 104499 | 52041 |

**Table 3.** Lower Granite Discharge under the BiOp Base Case (proposed action)

| BiOp Study Year | HYDSIM Surrogate Years | AUG1  | AUG2  | SEP   | OCT   | NOV   | DEC   | JAN   | FEB   | MAR   | APR1   | APR2   | MAY    | JUN    | JUL   |
|-----------------|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|-------|
| <b>1999</b>     | 1950                   | 41747 | 36032 | 30751 | 25379 | 20120 | 25363 | 32155 | 52135 | 80358 | 105350 | 100777 | 100655 | 138051 | 64098 |
|                 | 1964                   | 40132 | 36352 | 30600 | 24872 | 19198 | 19576 | 27076 | 27892 | 37667 | 89841  | 79511  | 100111 | 164201 | 53425 |
|                 | 1969                   | 35257 | 27031 | 26411 | 32263 | 30420 | 33585 | 64615 | 51542 | 60909 | 105208 | 117641 | 142453 | 83016  | 46769 |
|                 | average                | 37624 | 31884 | 27683 | 26772 | 21535 | 25610 | 41282 | 43856 | 59645 | 100133 | 99310  | 114406 | 128423 | 54764 |
| <b>2000</b>     | 1942                   | 33973 | 26588 | 24874 | 27169 | 25045 | 38751 | 33948 | 32049 | 32602 | 73560  | 90076  | 85331  | 89218  | 50479 |
|                 | 1961                   | 29604 | 21483 | 24898 | 23396 | 19597 | 18767 | 22146 | 48728 | 46257 | 56212  | 69837  | 83487  | 90466  | 36935 |
|                 | 1940                   | 28811 | 16829 | 24489 | 21558 | 15328 | 17142 | 24798 | 35760 | 54811 | 76369  | 79402  | 90568  | 53039  | 34941 |
|                 | average                | 30796 | 21633 | 24754 | 24041 | 19990 | 24887 | 26964 | 38846 | 44557 | 68714  | 79772  | 86462  | 77574  | 40785 |
| <b>2001</b>     | 1973                   | 31155 | 18653 | 25567 | 33095 | 24099 | 33896 | 40301 | 31696 | 34522 | 38706  | 42039  | 68286  | 51406  | 37616 |
|                 | 1931                   | 26168 | 14747 | 20567 | 22291 | 15550 | 12259 | 20501 | 21102 | 29654 | 54590  | 41502  | 62617  | 33559  | 28945 |
|                 | 1977                   | 26108 | 16641 | 23474 | 30463 | 18251 | 26148 | 25208 | 26371 | 22738 | 30228  | 38187  | 37776  | 33752  | 31363 |
|                 | average                | 27810 | 16680 | 23203 | 28616 | 19300 | 24101 | 28670 | 26390 | 28971 | 41175  | 40576  | 56226  | 39572  | 32641 |
| <b>2002</b>     | 1955                   | 36177 | 32452 | 24688 | 23513 | 17460 | 21182 | 27565 | 26729 | 23963 | 59110  | 69302  | 85896  | 114046 | 50473 |
|                 | 1960                   | 34405 | 26640 | 25800 | 41883 | 29892 | 32475 | 36375 | 38980 | 57398 | 99488  | 84618  | 80952  | 93821  | 42559 |
|                 | 1963                   | 36655 | 28857 | 28174 | 34317 | 25638 | 38426 | 34345 | 63403 | 38273 | 50601  | 51694  | 97172  | 103495 | 50469 |
|                 | average                | 35746 | 29316 | 26221 | 33238 | 24330 | 30694 | 32762 | 43037 | 39878 | 69733  | 68538  | 88007  | 103787 | 47834 |
| <b>2003</b>     | 1961                   | 29604 | 21483 | 24898 | 23396 | 19597 | 18767 | 22146 | 48728 | 46257 | 56212  | 69837  | 83487  | 90466  | 36935 |
|                 | 1940                   | 28811 | 16829 | 24489 | 21558 | 15328 | 17142 | 24798 | 35760 | 54811 | 76369  | 79402  | 90568  | 53039  | 34941 |
|                 | 1968                   | 35788 | 32665 | 31165 | 27174 | 25100 | 30681 | 34081 | 59167 | 46501 | 41284  | 38575  | 71127  | 91469  | 43754 |
|                 | average                | 31401 | 23659 | 26851 | 24043 | 20008 | 22197 | 27008 | 47885 | 49190 | 57955  | 62605  | 81727  | 78325  | 38543 |

**Table 3.** Lower Granite Discharge under the BiOp Base Case (proposed action)

Lower Granite Avg. Period Discharge in cfs

|             | Spring<br>April 3 -<br>June 20 | Summer<br>June 21 -<br>Sept 30 |
|-------------|--------------------------------|--------------------------------|
| <b>1994</b> | 55990                          | 26760                          |
| <b>1995</b> | 93600                          | 43370                          |
| <b>1996</b> | 125140                         | 53980                          |
| <b>1997</b> | 145370                         | 59740                          |
| <b>1998</b> | 105290                         | 44140                          |
| <b>1999</b> | 112740                         | 47910                          |
| <b>2000</b> | 80020                          | 35200                          |
| <b>2001</b> | 53950                          | 27330                          |
| <b>2002</b> | 85300                          | 42280                          |
| <b>2003</b> | 73320                          | 35620                          |

**Table 4.** McNary Period Average Discharge.

Data Derived from BPA HYDROSIM Model Run: FRIII\_03SN6704S1.XLS

8/5/2004

**Total Discharge in cfs**

| BiOp Study Year | HYDSIM Surrogate Years | AUG1   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
|-----------------|------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>1994</b>     | 1937                   | 147903 | 110794 | 88569  | 100803 | 118057 | 119271 | 102990 | 99584  | 106918 | 116726 | 131034 | 137497 | 173290 | 160663 |
|                 | 1940                   | 140419 | 111630 | 90138  | 103671 | 117690 | 115317 | 140558 | 113751 | 160103 | 161701 | 194842 | 209855 | 191642 | 148495 |
|                 | 1930                   | 155896 | 116479 | 88502  | 100288 | 118063 | 116675 | 96898  | 120940 | 107885 | 120577 | 120350 | 129835 | 166900 | 149449 |
|                 | average                | 148073 | 112968 | 89070  | 101587 | 117937 | 117088 | 113482 | 111425 | 124969 | 133001 | 148742 | 159062 | 177277 | 152869 |
| <b>1995</b>     | 1934                   | 143370 | 116444 | 92579  | 120423 | 161390 | 231247 | 300465 | 240584 | 179966 | 280961 | 293083 | 272537 | 162627 | 186182 |
|                 | 1962                   | 180387 | 139398 | 91652  | 101990 | 113604 | 113432 | 169643 | 117823 | 109436 | 250471 | 271037 | 247015 | 235271 | 197428 |
|                 | 1936                   | 161338 | 122092 | 90787  | 98629  | 117341 | 119307 | 107927 | 96316  | 113364 | 135082 | 214737 | 322278 | 213045 | 159180 |
|                 | average                | 161698 | 125978 | 91673  | 107014 | 130778 | 154662 | 192678 | 151574 | 134255 | 222171 | 259619 | 280610 | 203648 | 180930 |
| <b>1996</b>     | 1954                   | 230840 | 201370 | 155689 | 106653 | 121438 | 146643 | 178197 | 192403 | 152800 | 199639 | 218224 | 318359 | 371064 | 265034 |
|                 | 1950                   | 200000 | 163922 | 102952 | 102702 | 114206 | 118679 | 166274 | 201045 | 227552 | 233154 | 257236 | 287194 | 413075 | 270792 |
|                 | 1965                   | 200000 | 164725 | 100576 | 125344 | 124479 | 206345 | 271505 | 235434 | 194165 | 206007 | 305909 | 332524 | 318397 | 212064 |
|                 | average                | 210280 | 176672 | 119739 | 111566 | 120041 | 157222 | 205325 | 209627 | 191506 | 212933 | 260456 | 312692 | 367512 | 249297 |
| <b>1997</b>     | 1974                   | 206295 | 196994 | 105221 | 101497 | 106369 | 179577 | 316538 | 278067 | 219904 | 279913 | 337015 | 395318 | 476730 | 324601 |
|                 | 1972                   | 216367 | 200000 | 108286 | 110299 | 115858 | 138979 | 204521 | 237411 | 316173 | 312428 | 235695 | 407335 | 478861 | 285484 |
|                 | 1956                   | 196166 | 157245 | 98949  | 116774 | 144864 | 201932 | 260614 | 164937 | 209596 | 259452 | 370997 | 435026 | 417652 | 249904 |
|                 | average                | 206276 | 184746 | 104152 | 109523 | 122364 | 173496 | 260558 | 226805 | 248558 | 283931 | 314569 | 412560 | 457748 | 286663 |
| <b>1998</b>     | 1962                   | 180387 | 139398 | 91652  | 101990 | 113604 | 113432 | 169643 | 117823 | 109436 | 250471 | 271037 | 247015 | 235271 | 197428 |
|                 | 1949                   | 143104 | 115328 | 84345  | 110087 | 117654 | 127870 | 152543 | 142907 | 199198 | 176289 | 277735 | 345861 | 259697 | 150246 |
|                 | 1934                   | 143370 | 116444 | 92579  | 120423 | 161390 | 231247 | 300465 | 240584 | 179966 | 280961 | 293083 | 272537 | 162627 | 186182 |
|                 | average                | 155620 | 123723 | 89525  | 110833 | 130883 | 157516 | 207550 | 167105 | 162867 | 235907 | 280618 | 288471 | 219198 | 177952 |



**Table 4.** McNary Period Average Discharge.

| BiOp Study Year | HYDSIM Surrogate Years | AUG1   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
|-----------------|------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>1999</b>     | 1965                   | 200000 | 164725 | 100576 | 125344 | 124479 | 206345 | 271505 | 235434 | 194165 | 206007 | 305909 | 332524 | 318397 | 212064 |
|                 | 1954                   | 230840 | 201370 | 155689 | 106653 | 121438 | 146643 | 178197 | 192403 | 152800 | 199639 | 218224 | 318359 | 371064 | 265034 |
|                 | 1943                   | 196894 | 146531 | 91822  | 103351 | 112102 | 136573 | 187479 | 173700 | 175436 | 310670 | 314293 | 323534 | 290350 | 241787 |
|                 | average                | 209245 | 170875 | 116029 | 111783 | 119340 | 163187 | 212394 | 200512 | 174134 | 238772 | 279475 | 324806 | 326604 | 239628 |
| <b>2000</b>     | 1936                   | 161338 | 122092 | 90787  | 98629  | 117341 | 119307 | 107927 | 96316  | 113364 | 135082 | 214737 | 322278 | 213045 | 159180 |
|                 | 1934                   | 143370 | 116444 | 92579  | 120423 | 161390 | 231247 | 300465 | 240584 | 179966 | 280961 | 293083 | 272537 | 162627 | 186182 |
|                 | 1970                   | 137207 | 110882 | 87170  | 102749 | 118040 | 126701 | 181432 | 167403 | 119456 | 118110 | 184704 | 249007 | 318122 | 164849 |
|                 | average                | 147305 | 116473 | 90179  | 107267 | 132257 | 159085 | 196608 | 168101 | 137595 | 178051 | 230841 | 281274 | 231265 | 170070 |
| <b>2001</b>     | 1977                   | 139396 | 107855 | 88514  | 111072 | 116755 | 122666 | 145161 | 95506  | 89079  | 101816 | 103007 | 144005 | 144478 | 120874 |
|                 | 1931                   | 138885 | 115898 | 91038  | 102316 | 117676 | 119743 | 95908  | 92882  | 99902  | 141025 | 110278 | 136487 | 153920 | 140050 |
|                 | 1944                   | 131173 | 111686 | 89632  | 103132 | 116639 | 124285 | 145022 | 97883  | 98711  | 112319 | 112098 | 128389 | 161059 | 132600 |
|                 | average                | 136485 | 111813 | 89728  | 105507 | 117023 | 122231 | 128697 | 95424  | 95897  | 118387 | 108461 | 136294 | 153152 | 131175 |
| <b>2002</b>     | 1955                   | 202185 | 182254 | 97060  | 114724 | 139050 | 145546 | 132704 | 103718 | 97756  | 130423 | 143066 | 199780 | 380670 | 299954 |
|                 | 1947                   | 178253 | 121978 | 95641  | 102829 | 117787 | 186127 | 203585 | 180963 | 185649 | 161451 | 217658 | 299698 | 249229 | 212518 |
|                 | 1960                   | 186686 | 118767 | 92530  | 171202 | 171324 | 186905 | 193021 | 136525 | 147133 | 293370 | 261983 | 248343 | 270717 | 211992 |
|                 | average                | 189041 | 141000 | 95077  | 129585 | 142720 | 172859 | 176437 | 140402 | 143513 | 195081 | 207569 | 249274 | 300205 | 241488 |
| <b>2003</b>     | 1939                   | 175835 | 124095 | 90920  | 103985 | 116676 | 120153 | 147432 | 99533  | 118632 | 141716 | 162567 | 231857 | 168165 | 158442 |
|                 | 1945                   | 142846 | 121627 | 85269  | 97648  | 116950 | 119419 | 98447  | 108147 | 104745 | 116155 | 119957 | 207084 | 245058 | 176517 |
|                 | 1940                   | 140419 | 111630 | 90138  | 103671 | 117690 | 115317 | 140558 | 113751 | 160103 | 161701 | 194842 | 209855 | 191642 | 148495 |
|                 | average                | 153033 | 119117 | 88776  | 101768 | 117105 | 118296 | 128812 | 107144 | 127827 | 139857 | 159122 | 216265 | 201622 | 161151 |

**Table 4.** McNary Period Average Discharge.

McNary Average Period Discharge in cfs  
Periods as Defined in 2000 FCRPS

|             | <b>Spring</b>                | <b>Summer</b>               |
|-------------|------------------------------|-----------------------------|
|             | <b>April 10-<br/>June 30</b> | <b>July 1 -<br/>Aug. 31</b> |
| <b>1994</b> | 161930                       | 124340                      |
| <b>1995</b> | 244340                       | 139130                      |
| <b>1996</b> | 315890                       | 188060                      |
| <b>1997</b> | 401750                       | 196320                      |
| <b>1998</b> | 257840                       | 136050                      |
| <b>1999</b> | 310880                       | 182410                      |
| <b>2000</b> | 246200                       | 130990                      |
| <b>2001</b> | 156140                       | 115160                      |
| <b>2002</b> | 256310                       | 167720                      |
| <b>2003</b> | 194860                       | 128920                      |

**Table 5.** Bonneville Period Average Discharge during Chum Spawning and Incubation Period.

Data Derived from BPA HYDROSIM Model Run: 03SN6704S1 Dated 8-05-04

| BiOp Study year | HYDSIM Surrogate year | Total discharge in cfs |        |        |        |        |        |        |        |        |        |        |        |        |        |
|-----------------|-----------------------|------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                 |                       | AUG1                   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
| <b>1994</b>     | 1937                  | 170058                 | 129543 | 98643  | 105975 | 125000 | 125000 | 105815 | 106272 | 119186 | 129214 | 157838 | 153453 | 192423 | 171787 |
|                 | 1940                  | 184694                 | 130298 | 98326  | 108737 | 125000 | 126035 | 148665 | 132437 | 183498 | 179267 | 219124 | 224971 | 204818 | 157761 |
|                 | 1930                  | 145055                 | 118689 | 93055  | 105368 | 125000 | 125000 | 100508 | 138139 | 118788 | 133878 | 144710 | 141226 | 178768 | 159355 |
|                 | average               | 166602                 | 126177 | 96675  | 106693 | 125000 | 125345 | 118329 | 125616 | 140491 | 147453 | 173891 | 173217 | 192003 | 162968 |
| <b>1995</b>     | 1934                  | 211090                 | 204486 | 112171 | 127386 | 172018 | 277071 | 343131 | 263659 | 204688 | 302095 | 328095 | 288497 | 177402 | 196271 |
|                 | 1962                  | 162472                 | 141096 | 95852  | 107256 | 125000 | 131188 | 185518 | 133468 | 127592 | 269595 | 295933 | 260731 | 253928 | 206913 |
|                 | 1936                  | 210158                 | 142573 | 103431 | 104025 | 125000 | 125000 | 121409 | 103967 | 128294 | 143066 | 252586 | 343157 | 230650 | 169362 |
|                 | average               | 194573                 | 162718 | 103818 | 112889 | 140673 | 177753 | 216686 | 167031 | 153525 | 238252 | 292205 | 297462 | 220660 | 190849 |
| <b>1996</b>     | 1954                  | 200522                 | 155217 | 103134 | 113288 | 131339 | 164066 | 194029 | 214855 | 171611 | 215007 | 243719 | 329924 | 385889 | 275717 |
|                 | 1950                  | 152148                 | 122295 | 91998  | 108444 | 125000 | 131828 | 177792 | 221146 | 255280 | 252951 | 285644 | 306185 | 438196 | 285217 |
|                 | 1965                  | 206162                 | 181333 | 114382 | 129659 | 134025 | 250567 | 299198 | 266286 | 209518 | 215827 | 329602 | 344627 | 330560 | 222462 |
|                 | average               | 186277                 | 152948 | 103171 | 117130 | 130121 | 182154 | 223673 | 234096 | 212136 | 227928 | 286322 | 326912 | 384882 | 261132 |
| <b>1997</b>     | 1974                  | 145727                 | 108006 | 87614  | 107508 | 126006 | 211189 | 351287 | 296870 | 239554 | 297542 | 357714 | 403668 | 475051 | 329996 |
|                 | 1972                  | 203583                 | 187703 | 108885 | 113662 | 128318 | 153988 | 231314 | 264579 | 351090 | 323688 | 248689 | 407143 | 473603 | 285170 |
|                 | 1956                  | 215391                 | 190479 | 106562 | 125949 | 162569 | 232866 | 292884 | 181643 | 232151 | 281613 | 403139 | 461906 | 441333 | 262456 |
|                 | average               | 188234                 | 162063 | 101020 | 115706 | 138964 | 199348 | 291828 | 247697 | 274265 | 300948 | 336514 | 424239 | 463329 | 292541 |
| <b>1998</b>     | 1962                  | 162472                 | 141096 | 95852  | 107256 | 125000 | 131188 | 185518 | 133468 | 127592 | 269595 | 295933 | 260731 | 253928 | 206913 |
|                 | 1949                  | 208483                 | 201817 | 117048 | 115462 | 128234 | 140180 | 159861 | 161072 | 223656 | 192600 | 310828 | 370904 | 277303 | 160648 |
|                 | 1934                  | 211090                 | 204486 | 112171 | 127386 | 172018 | 277071 | 343131 | 263659 | 204688 | 302095 | 328095 | 288497 | 177402 | 196271 |

**Table 5.** Bonneville Period Average Discharge during Chum Spawning and Incubation Period.

|                 | average               | 194015 | 182466 | 108357 | 116701 | 141751 | 182813 | 229503 | 186066 | 185312 | 254763 | 311619 | 306711 | 236211 | 187944 |
|-----------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| BiOp Study Year | HYDSIM Surrogate Year | AUG1   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
| <b>1999</b>     | 1965                  | 206162 | 181333 | 114382 | 129659 | 134025 | 250567 | 299198 | 266286 | 209518 | 215827 | 329602 | 344627 | 330560 | 222462 |
|                 | 1954                  | 200522 | 155217 | 103134 | 113288 | 131339 | 164066 | 194029 | 214855 | 171611 | 215007 | 243719 | 329924 | 385889 | 275717 |
|                 | 1943                  | 205826 | 157446 | 104119 | 108472 | 125000 | 154269 | 205094 | 194215 | 195826 | 338460 | 359909 | 342447 | 311642 | 255657 |
|                 | average               | 204170 | 164665 | 107212 | 117140 | 130121 | 189634 | 232774 | 225119 | 192318 | 256431 | 311077 | 338999 | 342697 | 251279 |
| <b>2000</b>     | 1936                  | 210158 | 142573 | 103431 | 104025 | 125000 | 125000 | 121409 | 103967 | 128294 | 143066 | 252586 | 343157 | 230650 | 169362 |
|                 | 1934                  | 211090 | 204486 | 112171 | 127386 | 172018 | 277071 | 343131 | 263659 | 204688 | 302095 | 328095 | 288497 | 177402 | 196271 |
|                 | 1970                  | 178174 | 117368 | 96413  | 107328 | 125000 | 136630 | 215404 | 190219 | 138130 | 128517 | 200982 | 257677 | 323868 | 165879 |
|                 | average               | 199807 | 154809 | 104005 | 112913 | 140673 | 179567 | 226648 | 185948 | 157037 | 191226 | 260554 | 296444 | 243973 | 177171 |
| <b>2001</b>     | 1977                  | 259404 | 237039 | 171195 | 117313 | 125000 | 132440 | 154399 | 101764 | 96735  | 110944 | 117329 | 150101 | 151588 | 124858 |
|                 | 1931                  | 163665 | 123190 | 95864  | 107459 | 125000 | 125000 | 101859 | 100027 | 111584 | 158978 | 131125 | 150490 | 167249 | 150767 |
|                 | 1944                  | 207482 | 153267 | 99337  | 108907 | 125000 | 132089 | 151009 | 106712 | 107143 | 123217 | 128931 | 138605 | 173632 | 141276 |
|                 | average               | 210184 | 171165 | 122132 | 111226 | 125000 | 129843 | 135756 | 102834 | 105154 | 131046 | 125795 | 146399 | 164156 | 138967 |
| <b>2002</b>     | 1955                  | 242992 | 209008 | 163611 | 121207 | 149076 | 156175 | 143340 | 114614 | 106939 | 142898 | 161541 | 214690 | 394102 | 316045 |
|                 | 1947                  | 206053 | 142860 | 109107 | 107891 | 129141 | 212360 | 218160 | 200985 | 204070 | 176225 | 241709 | 316586 | 264669 | 222199 |
|                 | 1960                  | 209290 | 147878 | 153776 | 180053 | 180586 | 199969 | 201241 | 157160 | 165019 | 315235 | 288238 | 260286 | 283799 | 221411 |
|                 | average               | 219445 | 166582 | 142165 | 136384 | 152934 | 189501 | 187580 | 157586 | 158676 | 211453 | 230496 | 263854 | 314190 | 253218 |
| <b>2003</b>     | 1939                  | 159848 | 125048 | 105971 | 109411 | 125000 | 128745 | 156516 | 109764 | 134078 | 157620 | 185126 | 246687 | 181046 | 167989 |
|                 | 1945                  | 138654 | 118635 | 96597  | 102542 | 125000 | 125000 | 108720 | 122052 | 116585 | 126921 | 138137 | 223313 | 260855 | 185948 |
|                 | 1940                  | 184694 | 130298 | 98326  | 108737 | 125000 | 126035 | 148665 | 132437 | 183498 | 179267 | 219124 | 224971 | 204818 | 157761 |
|                 | average               | 161065 | 124660 | 100298 | 106897 | 125000 | 126593 | 137967 | 121418 | 144720 | 154603 | 180796 | 231657 | 215573 | 170566 |

**Table 5.** Bonneville Period Average Discharge during Chum Spawning and Incubation Period.

Bonneville Average Period Discharge (cfs)

Chum Spawning/Rearing Nov 1 - Apr 15

| <b>BiOp<br/>Study<br/>year</b> | <b>Chum<br/>Flows<br/>(cfs)</b> |
|--------------------------------|---------------------------------|
| <b>1994</b>                    | 128844                          |
| <b>1995</b>                    | 177456                          |
| <b>1996</b>                    | 199211                          |
| <b>1997</b>                    | 237032                          |
| <b>1998</b>                    | 191628                          |
| <b>1999</b>                    | 199457                          |
| <b>2000</b>                    | 179293                          |
| <b>2001</b>                    | 121014                          |
| <b>2002</b>                    | 173378                          |
| <b>2003</b>                    | 133473                          |

**Table 6.** Lower Granite Reference Operation.

Data from: BPA HYDSIM Study 03FSH05D9 Dated 08-10-04

|                       |                                 | <b>Total Discharge in cfs</b> |       |       |       |       |       |       |       |       |        |        |        |        |       |
|-----------------------|---------------------------------|-------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|-------|
| BiOp<br>Study<br>Year | HYDSI<br>M<br>Surrogate<br>Year | AUG1                          | AUG2  | SEP   | OCT   | NOV   | DEC   | JAN   | FEB   | MAR   | APR1   | APR2   | MAY    | JUN    | JUL   |
|                       | <b>1994</b>                     | 1934                          | 26668 | 25735 | 24394 | 22178 | 22599 | 29767 | 48949 | 37545 | 56097  | 83648  | 101309 | 64653  | 29314 |
|                       | 1973                            | 31155                         | 20937 | 25567 | 30092 | 27896 | 33896 | 35637 | 30135 | 34522 | 37319  | 54739  | 68286  | 50469  | 37616 |
|                       | 1931                            | 26168                         | 17129 | 20567 | 22291 | 16243 | 12259 | 20501 | 21102 | 29654 | 53203  | 54202  | 57965  | 30745  | 28945 |
|                       | average                         | 27997                         | 21267 | 23509 | 24854 | 22246 | 25307 | 35029 | 29594 | 40091 | 58057  | 70083  | 63635  | 36843  | 32157 |
| Add irrig. depletions |                                 | 5                             | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40     | 40     | 27     | 17     | 3     |
|                       | New avg                         | 28002                         | 21272 | 23513 | 24858 | 22248 | 25307 | 35030 | 29597 | 40105 | 58097  | 70123  | 63662  | 36860  | 32160 |
| <b>1995</b>           | 1946                            | 34961                         | 32821 | 35424 | 27169 | 21508 | 33785 | 36617 | 34156 | 60565 | 85216  | 123012 | 119112 | 81585  | 46186 |
|                       | 1933                            | 33325                         | 31726 | 32538 | 21976 | 20503 | 17828 | 23036 | 20716 | 31510 | 44835  | 75212  | 68059  | 154323 | 48359 |
|                       | 1959                            | 36171                         | 34655 | 40000 | 25583 | 26835 | 35379 | 41148 | 45218 | 46761 | 78029  | 74695  | 83574  | 122496 | 49317 |
|                       | average                         | 34819                         | 33067 | 35987 | 24909 | 22949 | 28997 | 33600 | 33363 | 46279 | 69360  | 90973  | 90248  | 119468 | 47954 |
| Add irrig. depletions |                                 | 5                             | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40     | 40     | 27     | 17     | 3     |
|                       | New avg                         | 34824                         | 33072 | 35991 | 24913 | 22951 | 28997 | 33601 | 33366 | 46293 | 69400  | 91013  | 90275  | 119485 | 47957 |
| <b>1996</b>           | 1975                            | 43481                         | 43975 | 40000 | 27646 | 24734 | 27734 | 33020 | 35746 | 53736 | 67694  | 86007  | 105525 | 175741 | 94315 |
|                       | 1976                            | 43200                         | 41107 | 40000 | 34169 | 36876 | 54092 | 50813 | 47682 | 62207 | 107046 | 110024 | 160387 | 126511 | 59181 |
|                       | 1957                            | 35882                         | 33506 | 33277 | 27053 | 22600 | 34568 | 29528 | 44103 | 65991 | 85000  | 91951  | 168424 | 129450 | 48098 |
|                       | average                         | 40854                         | 39529 | 37759 | 29623 | 28070 | 38798 | 37787 | 42510 | 60645 | 86580  | 95994  | 144779 | 143901 | 67198 |
| Add irrig. depletions |                                 | 5                             | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40     | 40     | 27     | 17     | 3     |
|                       | New avg                         | 40859                         | 39534 | 37763 | 29627 | 28072 | 38798 | 37788 | 42513 | 60659 | 86620  | 96034  | 144806 | 143918 | 67201 |
| <b>1997</b>           | 1974                            | 42837                         | 38942 | 40000 | 27684 | 35033 | 45550 | 67563 | 66100 | 86289 | 98802  | 123596 | 144488 | 223515 | 73468 |
|                       | 1971                            | 42698                         | 37716 | 40000 | 31133 | 31557 | 39291 | 61012 | 82719 | 72999 | 94024  | 114001 | 178867 | 181445 | 72014 |
|                       | 1943                            | 42046                         | 36398 | 40000 | 23521 | 20001 | 30741 | 42658 | 51851 | 66535 | 131357 | 149909 | 130926 | 143886 | 81266 |
|                       | average                         | 42527                         | 37685 | 40000 | 27446 | 28864 | 38527 | 57078 | 66890 | 75274 | 108061 | 129169 | 151427 | 182949 | 75583 |
| Add irrig. depletions |                                 | 5                             | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40     | 40     | 27     | 17     | 3     |
|                       | New avg                         | 42532                         | 37690 | 40004 | 27450 | 28866 | 38527 | 57079 | 66893 | 75288 | 108101 | 129209 | 151454 | 182966 | 75586 |

**Table 6.** Lower Granite Reference Operation.

| BiOp<br>Study<br>Year | HYDSI<br>M<br>Surrogate<br>Year | AUG1        | AUG2  | SEP   | OCT   | NOV   | DEC   | JAN   | FEB   | MAR   | APR1   | APR2   | MAY    | JUN    | JUL    |
|-----------------------|---------------------------------|-------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|
|                       |                                 | <b>1998</b> | 1951  | 38670 | 35191 | 33056 | 33096 | 38541 | 42412 | 42775 | 69146  | 64913  | 93883  | 115000 | 117781 |
|                       | 1949                            | 32902       | 31654 | 30603 | 25324 | 20348 | 23123 | 28128 | 38361 | 64169 | 84518  | 111152 | 154611 | 83159  | 41456  |
|                       | 1953                            | 38886       | 35422 | 39810 | 23687 | 16923 | 20759 | 44760 | 46038 | 41048 | 54409  | 84604  | 84567  | 145608 | 61496  |
|                       | average                         | 36819       | 34089 | 34490 | 27369 | 25271 | 28765 | 38554 | 51182 | 56710 | 77603  | 103585 | 118986 | 108102 | 52912  |
| Add irrig. depletions |                                 | 5           | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40     | 40     | 27     | 17     | 3      |
|                       | New avg                         | 36824       | 34094 | 34494 | 27373 | 25273 | 28765 | 38555 | 51185 | 56724 | 77643  | 103625 | 119013 | 108119 | 52915  |
| <b>1999</b>           | 1950                            | 41747       | 36032 | 40000 | 25379 | 20813 | 25363 | 32155 | 44439 | 65294 | 91261  | 100154 | 97464  | 157504 | 68021  |
|                       | 1964                            | 40132       | 36352 | 40000 | 24872 | 19891 | 19576 | 27076 | 27874 | 35541 | 64754  | 77021  | 95661  | 173290 | 60000  |
|                       | 1969                            | 35788       | 39094 | 38114 | 32263 | 31113 | 33266 | 52348 | 42110 | 60915 | 100804 | 115000 | 153012 | 86360  | 46769  |
|                       | average                         | 39222       | 37159 | 39371 | 27505 | 23939 | 26068 | 37193 | 38141 | 53917 | 85606  | 97392  | 115379 | 139051 | 58263  |
| Add irrig. depletions |                                 | 5           | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40     | 40     | 27     | 17     | 3      |
|                       | New avg                         | 39227       | 37164 | 39375 | 27509 | 23941 | 26068 | 37194 | 38144 | 53931 | 85646  | 97432  | 115406 | 139068 | 58266  |
| <b>2000</b>           | 1942                            | 33973       | 32033 | 28917 | 27169 | 25738 | 38751 | 28593 | 32049 | 32602 | 72173  | 101242 | 81003  | 85205  | 51204  |
|                       | 1961                            | 29604       | 29006 | 30191 | 23396 | 20291 | 18767 | 22146 | 41506 | 38292 | 46327  | 60168  | 89795  | 98769  | 36935  |
|                       | 1940                            | 28811       | 27272 | 27896 | 21558 | 16022 | 17142 | 24798 | 35760 | 50576 | 71963  | 89119  | 86211  | 49669  | 34941  |
|                       | average                         | 30796       | 29437 | 29001 | 24041 | 20684 | 24887 | 25179 | 36438 | 40490 | 63488  | 83510  | 85670  | 77881  | 41027  |
| Add irrig. depletions |                                 | 5           | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40     | 40     | 27     | 17     | 3      |
|                       | New avg                         | 30801       | 29442 | 29005 | 24045 | 20686 | 24887 | 25180 | 36441 | 40504 | 63528  | 83550  | 85697  | 77898  | 41030  |
| <b>2001</b>           | 1973                            | 31155       | 20937 | 25567 | 30092 | 27896 | 33896 | 35637 | 30135 | 34522 | 37319  | 54739  | 68286  | 50469  | 37616  |
|                       | 1931                            | 26168       | 17129 | 20567 | 22291 | 16243 | 12259 | 20501 | 21102 | 29654 | 53203  | 54202  | 57965  | 30745  | 28945  |
|                       | 1977                            | 15207       | 15803 | 23656 | 30106 | 19313 | 26148 | 25208 | 26371 | 22738 | 28841  | 50887  | 37776  | 33752  | 31363  |
|                       | average                         | 24177       | 17956 | 23263 | 27496 | 21151 | 24101 | 27115 | 25869 | 28971 | 39788  | 53276  | 54676  | 38322  | 32641  |
| Add irrig. depletions |                                 | 5           | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40     | 40     | 27     | 17     | 3      |
|                       | New avg                         | 24182       | 17961 | 23267 | 27500 | 21153 | 24101 | 27116 | 25872 | 28985 | 39828  | 53316  | 54703  | 38339  | 32644  |

**Table 6.** Lower Granite Reference Operation

| BiOp Study year       | HYDSIM Surrogate year | AUG1  | AUG2  | SEP   | OCT   | NOV   | DEC   | JAN   | FEB   | MAR   | APR1  | APR2  | MAY   | JUN    | JUL   |
|-----------------------|-----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|
| <b>2002</b>           | 1955                  | 36177 | 32452 | 35018 | 23513 | 18153 | 21182 | 25900 | 26729 | 23963 | 44792 | 59897 | 77972 | 116948 | 59666 |
|                       | 1960                  | 34405 | 32377 | 31973 | 41883 | 30487 | 26748 | 29974 | 36339 | 54709 | 86056 | 79070 | 90605 | 101551 | 42559 |
|                       | 1963                  | 36655 | 34398 | 33064 | 34317 | 26331 | 38426 | 29296 | 57312 | 38273 | 49214 | 64394 | 91513 | 104620 | 51721 |
|                       | average               | 35746 | 33076 | 33352 | 33238 | 24990 | 28785 | 28390 | 40127 | 38982 | 60021 | 67787 | 86697 | 107706 | 51315 |
| Add irrig. depletions |                       | 5     | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40    | 40    | 27    | 17     | 3     |
| New avg               |                       | 35751 | 33081 | 33356 | 33242 | 24992 | 28785 | 28391 | 40130 | 38996 | 60061 | 67827 | 86724 | 107723 | 51318 |
| <b>2003</b>           | 1961                  | 29604 | 29006 | 30191 | 23396 | 20291 | 18767 | 22146 | 41506 | 38292 | 46327 | 60168 | 89795 | 98769  | 36935 |
|                       | 1940                  | 28811 | 27272 | 27896 | 21558 | 16022 | 17142 | 24798 | 35760 | 50576 | 71963 | 89119 | 86211 | 49669  | 34941 |
|                       | 1968                  | 35788 | 39094 | 38114 | 27174 | 25793 | 30681 | 32091 | 50580 | 42067 | 39897 | 49480 | 65281 | 95783  | 43754 |
|                       | average               | 31401 | 31791 | 32067 | 24043 | 20702 | 22197 | 26345 | 42615 | 43645 | 52729 | 66256 | 80429 | 81407  | 38543 |
| Add irrig. depletions |                       | 5     | 5     | 4     | 4     | 2     | 0     | 1     | 3     | 14    | 40    | 40    | 27    | 17     | 3     |
| New avg               |                       | 31406 | 31796 | 32071 | 24047 | 20704 | 22197 | 26346 | 42618 | 43659 | 52769 | 66296 | 80456 | 81424  | 38546 |

| Average Period Discharge in cfs |      | Spring            | Summer            |
|---------------------------------|------|-------------------|-------------------|
| BiOp Study Year                 |      | April 3 - June 20 | June 21 - Sept 30 |
|                                 | 1994 | 57190             | 27760             |
|                                 | 1995 | 94380             | 47180             |
|                                 | 1996 | 125750            | 57850             |
|                                 | 1997 | 148070            | 64840             |
|                                 | 1998 | 106530            | 47590             |
|                                 | 1999 | 113090            | 54520             |
|                                 | 2000 | 79670             | 37790             |
|                                 | 2001 | 47850             | 26900             |
|                                 | 2002 | 84060             | 46410             |
|                                 | 2003 | 73460             | 38740             |



**Table 7.** McNary Period Average Discharge under Reference Operation

Data Derived from BPA HYDROSIM Model Run: 03FSH05D9 Dated 8-10-04

|                       |                       | <b>Total Discharge in cfs</b> |        |        |        |        |        |        |        |        |        |        |        |        |        |  |
|-----------------------|-----------------------|-------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--|
| BiOp Study Year       | HYDSIM Surrogate Year | AUG1                          | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |  |
| <b>1994</b>           | 1937                  | 200000                        | 179560 | 124420 | 101108 | 116865 | 107767 | 104109 | 82997  | 84076  | 82651  | 146598 | 130553 | 166342 | 210000 |  |
|                       | 1940                  | 200000                        | 169651 | 114486 | 109142 | 118665 | 103422 | 121894 | 101530 | 106605 | 205424 | 244691 | 182532 | 181194 | 210000 |  |
|                       | 1930                  | 200000                        | 169862 | 121736 | 94805  | 115197 | 110294 | 100781 | 94879  | 97493  | 99496  | 147614 | 116496 | 150923 | 210000 |  |
|                       | average               | 200000                        | 173024 | 120214 | 101685 | 116909 | 107161 | 108928 | 93135  | 96058  | 129190 | 179634 | 143194 | 166153 | 210000 |  |
| Add irrig. depletions |                       | 5                             | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |  |
| New avg               |                       | 200005                        | 173029 | 120218 | 101689 | 116911 | 107161 | 108929 | 93138  | 96072  | 129230 | 179674 | 142923 | 166559 | 209976 |  |
| <b>1995</b>           | 1934                  | 200000                        | 200000 | 125000 | 119731 | 165865 | 190780 | 266193 | 229444 | 189663 | 293331 | 332450 | 279245 | 193673 | 210000 |  |
|                       | 1962                  | 200000                        | 200000 | 125000 | 108438 | 118604 | 112244 | 114125 | 114355 | 111845 | 222635 | 263551 | 207641 | 264686 | 210000 |  |
|                       | 1936                  | 200000                        | 197014 | 125000 | 121298 | 122341 | 124307 | 116518 | 111855 | 110437 | 121821 | 270638 | 285770 | 194519 | 210000 |  |
|                       | average               | 200000                        | 199005 | 125000 | 116489 | 135603 | 142444 | 165612 | 151885 | 137315 | 212596 | 288880 | 257552 | 217626 | 210000 |  |
| Add irrig. depletions |                       | 5                             | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |  |
| New avg               |                       | 200005                        | 199010 | 125004 | 116493 | 135605 | 142444 | 165613 | 151888 | 137329 | 212636 | 288920 | 257281 | 218032 | 209976 |  |
| <b>1996</b>           | 1954                  | 267431                        | 211011 | 157533 | 120059 | 120099 | 112577 | 114169 | 149170 | 170677 | 195700 | 237963 | 293606 | 387201 | 323804 |  |
|                       | 1950                  | 203852                        | 200000 | 125000 | 107334 | 119206 | 116851 | 118482 | 99118  | 208858 | 240611 | 267832 | 242202 | 444823 | 297322 |  |
|                       | 1965                  | 200000                        | 200000 | 125000 | 122378 | 120454 | 160955 | 237703 | 210009 | 203631 | 237609 | 356280 | 325217 | 347360 | 244512 |  |
|                       | average               | 223761                        | 203670 | 135844 | 116590 | 119920 | 130128 | 156785 | 152766 | 194389 | 224640 | 287358 | 287008 | 393128 | 288546 |  |
| Add irrig. depletions |                       | 5                             | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |  |
| New avg               |                       | 223766                        | 203675 | 135848 | 116594 | 119922 | 130128 | 156786 | 152769 | 194403 | 224680 | 287398 | 286737 | 393534 | 288522 |  |

**Table 7.** McNary Period Average Discharge under Reference Operation.

| BiOp Study Year       | HYDSIM Surrogate Year | AUG1   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
|-----------------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>1997</b>           | 1974                  | 238651 | 200000 | 125000 | 111422 | 110363 | 98387  | 244995 | 226722 | 204236 | 290959 | 346753 | 363720 | 557818 | 355316 |
|                       | 1972                  | 244636 | 200000 | 125000 | 123331 | 117541 | 114991 | 143228 | 209831 | 315857 | 300179 | 267243 | 385030 | 549780 | 319718 |
|                       | 1956                  | 200000 | 200000 | 125000 | 117518 | 112295 | 162955 | 230790 | 153067 | 214316 | 267845 | 360472 | 476143 | 451014 | 280750 |
|                       | average               | 227762 | 200000 | 125000 | 117424 | 113400 | 125444 | 206338 | 196540 | 244803 | 286328 | 324823 | 408298 | 519537 | 318595 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 227767 | 200005 | 125004 | 117428 | 113402 | 125444 | 206339 | 196543 | 244817 | 286368 | 324863 | 408027 | 519943 | 318571 |
| <b>1998</b>           | 1962                  | 200000 | 200000 | 125000 | 108438 | 118604 | 112244 | 114125 | 114355 | 111845 | 222635 | 263551 | 207641 | 264686 | 210000 |
|                       | 1949                  | 200000 | 179473 | 125000 | 121318 | 119420 | 117690 | 90254  | 111834 | 214862 | 201762 | 298135 | 392037 | 244764 | 210000 |
|                       | 1934                  | 200000 | 200000 | 125000 | 119731 | 165865 | 190780 | 266193 | 229444 | 189663 | 293331 | 332450 | 279245 | 193673 | 210000 |
|                       | average               | 200000 | 193158 | 125000 | 116496 | 134630 | 140238 | 156857 | 151878 | 172123 | 239243 | 298045 | 292974 | 234374 | 210000 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 200005 | 193163 | 125004 | 116500 | 134632 | 140238 | 156858 | 151881 | 172137 | 239283 | 298085 | 292703 | 234780 | 209976 |
| <b>1999</b>           | 1965                  | 200000 | 200000 | 125000 | 122378 | 120454 | 160955 | 237703 | 210009 | 203631 | 237609 | 356280 | 325217 | 347360 | 244512 |
|                       | 1954                  | 267431 | 211011 | 157533 | 120059 | 120099 | 112577 | 114169 | 149170 | 170677 | 195700 | 237963 | 293606 | 387201 | 323804 |
|                       | 1943                  | 200000 | 200000 | 125000 | 121572 | 117102 | 112304 | 95892  | 147693 | 188631 | 290194 | 368922 | 290050 | 317335 | 265224 |
|                       | average               | 222477 | 203670 | 135844 | 121336 | 119218 | 128612 | 149255 | 168957 | 187646 | 241168 | 321055 | 302958 | 350632 | 277847 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 222482 | 203675 | 135848 | 121340 | 119220 | 128612 | 149256 | 168960 | 187660 | 241208 | 321095 | 302687 | 351038 | 277823 |
| <b>2000</b>           | 1936                  | 200000 | 197014 | 125000 | 121298 | 122341 | 124307 | 116518 | 111855 | 110437 | 121821 | 270638 | 285770 | 194519 | 210000 |
|                       | 1934                  | 200000 | 200000 | 125000 | 119731 | 165865 | 190780 | 266193 | 229444 | 189663 | 293331 | 332450 | 279245 | 193673 | 210000 |
|                       | 1970                  | 200000 | 175699 | 125000 | 114155 | 123040 | 120070 | 96028  | 107184 | 130616 | 196571 | 219737 | 239206 | 315064 | 210000 |
|                       | average               | 200000 | 190904 | 125000 | 118395 | 137082 | 145052 | 159580 | 149494 | 143572 | 203908 | 274275 | 268074 | 234419 | 210000 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 200005 | 190909 | 125004 | 118399 | 137084 | 145052 | 159581 | 149497 | 143586 | 203948 | 274315 | 267803 | 234825 | 209976 |

**Table 7.** McNary Period Average Discharge under Reference Operation.

| BiOp Study Year       | HYDSIM Surrogate Year | AUG1   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
|-----------------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>2001</b>           | 1977                  | 168343 | 162905 | 125000 | 120453 | 121755 | 120226 | 120761 | 123742 | 119665 | 99412  | 150599 | 108273 | 137350 | 208998 |
|                       | 1931                  | 190852 | 164573 | 111774 | 86473  | 106960 | 100464 | 98496  | 77627  | 92889  | 119526 | 151772 | 103618 | 133130 | 210000 |
|                       | 1944                  | 164517 | 155516 | 121518 | 120919 | 121639 | 122196 | 124012 | 115326 | 118970 | 97998  | 145827 | 113191 | 150328 | 209272 |
|                       | average               | 174571 | 160998 | 119431 | 109282 | 116785 | 114295 | 114423 | 105565 | 110508 | 105645 | 149399 | 108361 | 140269 | 209423 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 174576 | 161003 | 119435 | 109286 | 116787 | 114295 | 114424 | 105568 | 110522 | 105685 | 149439 | 108090 | 140675 | 209399 |
| <b>2002</b>           | 1955                  | 228377 | 200000 | 125000 | 120211 | 132130 | 121161 | 119363 | 119104 | 120817 | 132409 | 168301 | 162754 | 402778 | 324763 |
|                       | 1947                  | 200000 | 200000 | 125000 | 121631 | 118646 | 103766 | 149702 | 150814 | 196696 | 166496 | 250675 | 313477 | 257840 | 239888 |
|                       | 1960                  | 200000 | 200000 | 125000 | 165144 | 186873 | 153914 | 159455 | 132336 | 129637 | 269688 | 280015 | 274089 | 308340 | 252979 |
|                       | average               | 209459 | 200000 | 125000 | 135662 | 145883 | 126280 | 142840 | 134085 | 149050 | 189531 | 232997 | 250107 | 322986 | 272543 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 209464 | 200005 | 125004 | 135666 | 145885 | 126280 | 142841 | 134088 | 149064 | 189571 | 233037 | 249836 | 323392 | 272519 |
| <b>2003</b>           | 1939                  | 200000 | 194243 | 125000 | 121267 | 121676 | 121408 | 120916 | 116395 | 110538 | 151312 | 198078 | 183298 | 139593 | 210000 |
|                       | 1945                  | 200000 | 191589 | 125000 | 87199  | 112723 | 96878  | 97628  | 99054  | 95119  | 89781  | 138300 | 184056 | 227615 | 210000 |
|                       | 1940                  | 200000 | 169651 | 114486 | 109142 | 118665 | 103422 | 121894 | 101530 | 106605 | 205424 | 244691 | 182532 | 181194 | 210000 |
|                       | average               | 200000 | 185161 | 121495 | 105869 | 117688 | 107236 | 113479 | 105660 | 104087 | 148839 | 193690 | 183295 | 182801 | 210000 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 200005 | 185166 | 121499 | 105873 | 117690 | 107236 | 113480 | 105663 | 104101 | 148879 | 193730 | 183024 | 183207 | 209976 |

**Table 7.** McNary Period Average Discharge under Reference Operation.

Average Period Discharge in cfs

| Surrogate<br>Year | Spring<br>April 10-<br>June 30 | Summer<br>July 1 -<br>Sept 30 |
|-------------------|--------------------------------|-------------------------------|
| <b>1994</b>       | 157230                         | 172660                        |
| <b>1995</b>       | 245390                         | 178740                        |
| <b>1996</b>       | 321330                         | 213430                        |
| <b>1997</b>       | 424800                         | 220030                        |
| <b>1998</b>       | 268530                         | 177720                        |
| <b>1999</b>       | 319190                         | 209610                        |
| <b>2000</b>       | 252200                         | 177330                        |
| <b>2001</b>       | 143540                         | 165970                        |
| <b>2002</b>       | 269210                         | 201530                        |
| <b>2003</b>       | 182490                         | 175190                        |

**Table 8.** Bonneville Chum Spawning/incubation Period Average Discharge under Reference Operation.

Data Derived from BPA HYDSIM Model Run: 03FSH05D91 Dated 8-10-04

Using Same Surrogate Years Used for McNary.

**Total Discharge in cfs**

| BiOp Study Year       | HYDSIM Surrogate Year | AUG1   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
|-----------------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>1994</b>           | 1937                  | 208720 | 204465 | 132857 | 99586  | 123808 | 113497 | 106934 | 89685  | 96345  | 113121 | 169253 | 146509 | 185475 | 221124 |
|                       | 1940                  | 208859 | 200446 | 132406 | 107515 | 125975 | 114141 | 130000 | 120216 | 130000 | 240970 | 264826 | 197646 | 194372 | 219266 |
|                       | 1930                  | 207581 | 173299 | 132257 | 93192  | 122134 | 118620 | 104391 | 112078 | 108396 | 130780 | 167824 | 127888 | 162791 | 219906 |
|                       | average               | 208387 | 192737 | 132507 | 100098 | 123972 | 115419 | 113775 | 107326 | 111580 | 161624 | 200634 | 157348 | 180879 | 220099 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
| New avg               |                       | 208392 | 192742 | 132511 | 100102 | 123974 | 115419 | 113776 | 107329 | 111594 | 161664 | 200674 | 157077 | 181285 | 220075 |
| <b>1995</b>           | 1934                  | 268461 | 208257 | 133327 | 120000 | 176493 | 236603 | 308859 | 252519 | 214385 | 332442 | 363318 | 295203 | 208449 | 220090 |
|                       | 1962                  | 208472 | 209417 | 132888 | 107010 | 130000 | 130000 | 130000 | 130000 | 130000 | 259739 | 284301 | 221356 | 283343 | 219485 |
|                       | 1936                  | 210158 | 206849 | 132796 | 120000 | 130000 | 130000 | 130000 | 119506 | 125368 | 147785 | 304341 | 306650 | 212124 | 220182 |
|                       | average               | 229030 | 208174 | 133004 | 115670 | 145498 | 165534 | 189620 | 167342 | 156584 | 246655 | 317320 | 274403 | 234639 | 219919 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
| New avg               |                       | 229035 | 208179 | 133008 | 115674 | 145500 | 165534 | 189621 | 167345 | 156598 | 246695 | 317360 | 274132 | 235045 | 219895 |
| <b>1996</b>           | 1954                  | 206925 | 206786 | 133402 | 120000 | 130000 | 130000 | 130000 | 171622 | 189487 | 229047 | 259311 | 305171 | 402026 | 325787 |
|                       | 1950                  | 209044 | 186440 | 132654 | 106381 | 130000 | 130000 | 130000 | 119219 | 236586 | 278388 | 292093 | 261194 | 469943 | 303047 |
|                       | 1965                  | 235691 | 206988 | 131263 | 120000 | 130000 | 205177 | 265396 | 240861 | 218984 | 265408 | 375826 | 337320 | 359524 | 254910 |
|                       | average               | 217220 | 200071 | 132440 | 115460 | 130000 | 155059 | 175132 | 177234 | 215019 | 257614 | 309077 | 301228 | 410498 | 294581 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
| New avg               |                       | 217225 | 200076 | 132444 | 115464 | 130002 | 155059 | 175133 | 177237 | 215033 | 257654 | 309117 | 300957 | 410904 | 294557 |

**Table 8.** Bonneville Chum Spawning/incubation Period Average Discharge under Reference Operation.

| BiOp Study Year       | HYDSIM Surrogate Year | AUG1   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
|-----------------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>1997</b>           | 1974                  | 202790 | 160827 | 130000 | 110739 | 130000 | 130000 | 279744 | 245525 | 223886 | 326568 | 363306 | 372071 | 556139 | 352011 |
|                       | 1972                  | 209294 | 202642 | 130070 | 120000 | 130000 | 130000 | 170022 | 236999 | 350774 | 329419 | 276090 | 384838 | 544523 | 310703 |
|                       | 1956                  | 259563 | 208225 | 134502 | 120000 | 130000 | 193889 | 263061 | 169773 | 236872 | 307986 | 388467 | 503023 | 474694 | 293302 |
|                       | average               | 223882 | 190565 | 131524 | 116913 | 130000 | 151296 | 237609 | 217432 | 270511 | 321324 | 342621 | 419977 | 525119 | 318672 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
| New avg               |                       | 223887 | 190570 | 131528 | 116917 | 130002 | 151296 | 237610 | 217435 | 270525 | 321364 | 342661 | 419706 | 525525 | 318648 |
| <b>1998</b>           | 1962                  | 208472 | 209417 | 132888 | 107010 | 130000 | 130000 | 130000 | 130000 | 130000 | 259739 | 284301 | 221356 | 283343 | 219485 |
|                       | 1949                  | 208483 | 206880 | 131459 | 120000 | 130000 | 130000 | 97572  | 130000 | 239319 | 236053 | 327082 | 417080 | 262370 | 220402 |
|                       | 1934                  | 268461 | 208257 | 133327 | 120000 | 176493 | 236603 | 308859 | 252519 | 214385 | 332442 | 363318 | 295203 | 208449 | 220090 |
|                       | average               | 228472 | 208185 | 132558 | 115670 | 145498 | 165534 | 178810 | 170840 | 194568 | 276078 | 324900 | 311213 | 251387 | 219992 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
| New avg               |                       | 228477 | 208190 | 132562 | 115674 | 145500 | 165534 | 178811 | 170843 | 194582 | 276118 | 324940 | 310942 | 251793 | 219968 |
| <b>1999</b>           | 1965                  | 235691 | 206988 | 131263 | 120000 | 130000 | 205177 | 265396 | 240861 | 218984 | 265408 | 375826 | 337320 | 359524 | 254910 |
|                       | 1954                  | 206925 | 206786 | 133402 | 120000 | 130000 | 130000 | 130000 | 171622 | 189487 | 229047 | 259311 | 305171 | 402026 | 325787 |
|                       | 1943                  | 208814 | 205960 | 132026 | 120000 | 130000 | 130000 | 113507 | 168208 | 209021 | 335964 | 410391 | 308963 | 338627 | 279094 |
|                       | average               | 217143 | 206578 | 132230 | 120000 | 130000 | 155059 | 169634 | 193564 | 205831 | 276806 | 348509 | 317151 | 366726 | 286597 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
| New avg               |                       | 217148 | 206583 | 132234 | 120004 | 130002 | 155059 | 169635 | 193567 | 205845 | 276846 | 348549 | 316880 | 367132 | 286573 |
| <b>2000</b>           | 1936                  | 210158 | 206849 | 132796 | 120000 | 130000 | 130000 | 130000 | 119506 | 125368 | 147785 | 304341 | 306650 | 212124 | 220182 |
|                       | 1934                  | 268461 | 208257 | 133327 | 120000 | 176493 | 236603 | 308859 | 252519 | 214385 | 332442 | 363318 | 295203 | 208449 | 220090 |
|                       | 1970                  | 205841 | 205323 | 130137 | 112041 | 130000 | 130000 | 130000 | 130000 | 149290 | 224958 | 231869 | 247877 | 320810 | 211030 |
|                       | average               | 228153 | 206810 | 132087 | 117347 | 145498 | 165534 | 189620 | 167342 | 163014 | 235062 | 299843 | 283243 | 247128 | 217101 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
| New avg               |                       | 228158 | 206815 | 132091 | 117351 | 145500 | 165534 | 189621 | 167345 | 163028 | 235102 | 299883 | 282972 | 247534 | 217077 |

**Table 8.** Bonneville Chum Spawning/incubation Period Average Discharge under Reference Operation.

| BiOp Study Year       | HYDSIM Surrogate Year | AUG1   | AUG2   | SEP    | OCT    | NOV    | DEC    | JAN    | FEB    | MAR    | APR1   | APR2   | MAY    | JUN    | JUL    |
|-----------------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>2001</b>           | 1977                  | 287394 | 246272 | 175955 | 120000 | 130000 | 130000 | 130000 | 130000 | 127321 | 126521 | 160774 | 114370 | 144458 | 212982 |
|                       | 1931                  | 207769 | 176573 | 129098 | 84922  | 114284 | 105722 | 104446 | 84772  | 104571 | 155458 | 168472 | 117620 | 146459 | 220718 |
|                       | 1944                  | 210588 | 206736 | 132515 | 120000 | 130000 | 130000 | 130000 | 124155 | 127403 | 126876 | 158514 | 123407 | 162901 | 217949 |
|                       | average               | 235250 | 209860 | 145856 | 108307 | 124761 | 121907 | 121482 | 112976 | 119765 | 136285 | 162587 | 118466 | 151273 | 217216 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 235255 | 209865 | 145860 | 108311 | 124763 | 121907 | 121483 | 112979 | 119779 | 136325 | 162627 | 118195 | 151679 | 217192 |
| <b>2002</b>           | 1955                  | 297563 | 218649 | 165455 | 120000 | 142156 | 131791 | 130000 | 130000 | 130000 | 162861 | 182633 | 177664 | 416209 | 332154 |
|                       | 1947                  | 209135 | 206537 | 131679 | 120000 | 130000 | 130000 | 164277 | 170836 | 215117 | 199248 | 270582 | 330363 | 273281 | 249569 |
|                       | 1960                  | 237656 | 207025 | 143889 | 167301 | 196135 | 166978 | 167674 | 152971 | 147523 | 309533 | 302123 | 286032 | 321422 | 262398 |
|                       | average               | 248118 | 210737 | 147008 | 135767 | 156097 | 142923 | 153984 | 151269 | 164213 | 223881 | 251779 | 264686 | 336971 | 281374 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 248123 | 210742 | 147012 | 135771 | 156099 | 142923 | 153985 | 151272 | 164227 | 223921 | 251819 | 264415 | 337377 | 281350 |
| <b>2003</b>           | 1939                  | 209940 | 206892 | 132702 | 120000 | 130000 | 130000 | 130000 | 126627 | 125985 | 185194 | 216493 | 198128 | 152474 | 219547 |
|                       | 1945                  | 171998 | 162465 | 128484 | 85400  | 120774 | 102459 | 107901 | 112958 | 106959 | 118527 | 152333 | 200285 | 243412 | 219431 |
|                       | 1940                  | 208859 | 200446 | 132406 | 107515 | 125975 | 114141 | 130000 | 120216 | 130000 | 240970 | 264826 | 197646 | 194372 | 219266 |
|                       | average               | 196932 | 189934 | 131197 | 104305 | 125583 | 115533 | 122634 | 119934 | 120981 | 181564 | 211217 | 198686 | 196753 | 219415 |
| Add irrig. depletions |                       | 5      | 5      | 4      | 4      | 2      | 0      | 1      | 3      | 14     | 40     | 40     | -271   | 406    | -24    |
|                       | New avg               | 196937 | 189939 | 131201 | 104309 | 125585 | 115533 | 122635 | 119937 | 120995 | 181604 | 211257 | 198415 | 197159 | 219391 |

**Table 8.** Bonneville Chum Spawning/incubation Period Average Discharge under Reference Operation.

Bonneville Average Period Discharge in cfs  
Chum Spawning/rearing Nov 1 - Apr 15

| <b>BiOp<br/>Study<br/>Year</b> | <b>Chum<br/>Flows</b> |
|--------------------------------|-----------------------|
| <b>1994</b>                    | 118758                |
| <b>1995</b>                    | 172382                |
| <b>1996</b>                    | 178483                |
| <b>1997</b>                    | 212356                |
| <b>1998</b>                    | 180705                |
| <b>1999</b>                    | 180237                |
| <b>2000</b>                    | 172504                |
| <b>2001</b>                    | 121744                |
| <b>2002</b>                    | 160076                |
| <b>2003</b>                    | 126409                |



**Table 9.** Snake River at Lower Granite Dam Seasonal Average Flow Comparison.

These data compare the average seasonal flows at Lower Granite Dam of 3 years with similar runoff volumes to the BiOp study years (1994-2003).

**2000 BiOp Proposed Action** [2000 BiOp base case 3-yr\_averages 08-06-04]

Average Period Discharge in cfs

Average flows derived from BPA HYDSIM model study 03SN6704S1 dated 8-06-04.

**Reference Operation** [Reference ops case 3-yr\_averages 08-10-04]

Average Period Discharge in cfs

Average flows derived from BPA HYDSIM model study 03FSH05D9 dated 8-10-04.

| BiOp Study Year | Surrogate Runoff Years |      |      | Spring                                     | Summer                                      | BiOp Study Year | Surrogate Runoff Years |      |      | Spring                                     | Summer                                       |
|-----------------|------------------------|------|------|--|---|-----------------|------------------------|------|------|--|--|
|                 |                        |      |      | April 3- June 20 Season Average Flow (cfs) | June 21 - Sept 30 Season Average Flow (cfs) |                 |                        |      |      | April 3- June 20 Season Average Flow (cfs) | June 21 - Sept 30 Season Average Flow (cf s) |
| 1994            | 1934                   | 1973 | 1931 | 55990                                      | 26760                                       | 1994            | 1934                   | 1973 | 1931 | 57190                                      | 27760  |
| 1995            | 1946                   | 1933 | 1959 | 93600                                      | 43370                                       | 1995            | 1946                   | 1933 | 1959 | 94380                                      | 47180  |
| 1996            | 1975                   | 1976 | 1957 | 125140                                     | 53980                                       | 1996            | 1975                   | 1976 | 1957 | 125750                                     | 57850  |
| 1997            | 1974                   | 1971 | 1943 | 145370                                     | 59740                                       | 1997            | 1974                   | 1971 | 1943 | 148070                                     | 64840  |
| 1998            | 1951                   | 1949 | 1953 | 105290                                     | 44140                                       | 1998            | 1951                   | 1949 | 1953 | 106530                                     | 47590  |
| 1999            | 1950                   | 1964 | 1969 | 112740                                     | 47910                                       | 1999            | 1950                   | 1964 | 1969 | 113090                                     | 54520  |
| 2000            | 1942                   | 1961 | 1940 | 80020                                      | 35200                                       | 2000            | 1942                   | 1961 | 1940 | 79670                                      | 37790  |
| 2001            | 1973                   | 1931 | 1977 | 53950                                      | 27330                                       | 2001            | 1973                   | 1931 | 1977 | 47850                                      | 26900  |
| 2002            | 1955                   | 1960 | 1963 | 85300                                      | 42280                                       | 2002            | 1955                   | 1960 | 1963 | 84060                                      | 46410  |
| 2003            | 1961                   | 1940 | 1968 | 73320                                      | 35620                                       | 2003            | 1961                   | 1940 | 1968 | 73460                                      | 38740  |
| <b>Average</b>  |                        |      |      | <b>93072</b>                               | <b>41633</b>                                | <b>Average</b>  |                        |      |      | <b>93005</b>                               | <b>44958</b>                                 |

**Table 9.** Snake River at Lower Granite Dam Seasonal Average Flow Comparison.

**Flow Comparison (Proposed Action Minus Reference Operation)**

Average Period Discharge in cfs

Periods as Defined in 2000 FCRPS BiOp Table 9.6-1

| BiOp Study Year           | Surrogate Runoff Years |      |      | Relative Difference                                  |   |  |  |
|---------------------------|------------------------|------|------|--|---|--|--|
|                           |                        |      |      | Spring<br>April 3-<br>June 20<br>difference<br>(cfs) | Summer<br>June 21 -<br>Sept 30<br>difference<br>(cfs) | Spring<br>Relative<br>Change to<br>Ref. Op.,<br>in % | Summer<br>Relative<br>Change to<br>Ref. Op.,<br>in % |
| 1994                      | 1934                   | 1973 | 1931 | -1200  | -1000   | -2.1%  | -3.6%  |
| 1995                      | 1946                   | 1933 | 1959 | -780   | -3810   | -0.8%  | -8.1%  |
| 1996                      | 1975                   | 1976 | 1957 | -610   | -3870   | -0.5%  | -6.7%  |
| 1997                      | 1974                   | 1971 | 1943 | -2700  | -5100   | -1.8%  | -7.9%  |
| 1998                      | 1951                   | 1949 | 1953 | -1240  | -3450   | -1.2%  | -7.2%  |
| 1999                      | 1950                   | 1964 | 1969 | -350   | -6610   | -0.3%  | -12.1%   |
| 2000                      | 1942                   | 1961 | 1940 | 350  | -2590   | 0.4%   | -6.9%  |
| 2001                      | 1973                   | 1931 | 1977 | 6100   | 430   | 12.7%  | 1.6%   |
| 2002                      | 1955                   | 1960 | 1963 | 1240   | -4130   | 1.5%   | -8.9%  |
| 2003                      | 1961                   | 1940 | 1968 | -140   | -3120   | -0.2%  | -8.1%  |
| <b>Average Difference</b> |                        |      |      | <b>67</b>  | <b>-3325</b>  | <b>0.1%</b>  | <b>-7.4%</b>   |

**Table 10.** Columbia River at McNary Dam Seasonal Average Flow Comparison.

These data compare the average seasonal flows at McNary Dam during three years with similar runoff volumes to the surrogate year (1994-2003).

**2000 BiOp Proposed Action** [2000 BiOp base case 3-yr\_averages 08-06-04]

Average Period Discharge in cfs

Average flows derived from BPA HYDSIM model study 03SN6704S1 dated 8-06-04.

Periods as defined in 2000 FCRPS BiOp Table 9.6-1

**Reference Operation** [Reference ops case 3-yr\_averages 08-10-04]

Average Period Discharge in cfs

Average flows derived from BPA HYDSIM model study 03FSH05D9 dated 8-10-04.

Periods as defined in 2000 FCRPS BiOp Table 9.6-1

| BiOp Study year | Surrogate Runoff Years |      |      | Spring                               | Summer                              | BiOp Study year | Surrogate Runoff Years |      |      | Spring                               | Summer                              |
|-----------------|------------------------|------|------|--------------------------------------|-------------------------------------|-----------------|------------------------|------|------|--------------------------------------|-------------------------------------|
|                 |                        |      |      | April 10- June 30 Seasonal Ave (cfs) | July 1 - Sept 30 Seasonal Ave (cfs) |                 |                        |      |      | April 10- June 30 Seasonal Ave (cfs) | July 1 - Sept 30 Seasonal Ave (cfs) |
| 1994            | 1940                   | 1937 | 1930 | 161930                               | 124340                              | 1994            | 1940                   | 1937 | 1930 | 157230                               | 172660                              |
| 1995            | 1962                   | 1934 | 1936 | 244340                               | 139130                              | 1995            | 1962                   | 1934 | 1936 | 245390                               | 178740                              |
| 1996            | 1950                   | 1954 | 1965 | 315890                               | 188060                              | 1996            | 1950                   | 1954 | 1965 | 321330                               | 213430                              |
| 1997            | 1974                   | 1972 | 1956 | 401750                               | 196320                              | 1997            | 1974                   | 1972 | 1956 | 424800                               | 220030                              |
| 1998            | 1949                   | 1962 | 1934 | 257840                               | 136050                              | 1998            | 1949                   | 1962 | 1934 | 268530                               | 177720                              |
| 1999            | 1954                   | 1965 | 1943 | 310880                               | 182410                              | 1999            | 1954                   | 1965 | 1943 | 319190                               | 209610                              |
| 2000            | 1934                   | 1936 | 1970 | 246200                               | 130990                              | 2000            | 1934                   | 1936 | 1970 | 252200                               | 177330                              |
| 2001            | 1931                   | 1944 | 1977 | 156140                               | 115160                              | 2001            | 1931                   | 1944 | 1977 | 143540                               | 165970                              |
| 2002            | 1947                   | 1955 | 1978 | 256310                               | 167720                              | 2002            | 1947                   | 1955 | 1978 | 269210                               | 201530                              |
| 2003            | 1945                   | 1939 | 1940 | 194860                               | 128920                              | 2003            | 1945                   | 1939 | 1940 | 182490                               | 175190                              |
| <b>Average</b>  |                        |      |      | <b>254614</b>                        | <b>150910</b>                       | <b>Average</b>  |                        |      |      | <b>258391</b>                        | <b>189221</b>                       |

**Table 10.** Columbia River at McNary Dam Seasonal Average Flow Comparison.

**Flow Comparison (Proposed Action Minus Reference Operation)**

Average Period Discharge in cfs

| BiOp Study Year           | Surrogate Runoff Years |      |      | Relative Difference                                   |  |  |  |
|---------------------------|------------------------|------|------|---|--|--|--|
|                           |                        |      |      | Spring<br>April 10-<br>June 30<br>Difference<br>(cfs) | Summer<br>July 1 -<br>Sept 30<br>Difference<br>(cfs) | Spring<br>Relative<br>change to<br>Ref. Op., in<br>% | Summer<br>Relative<br>change to<br>Ref. Op., in<br>% |
| 1994                      | 1940                   | 1937 | 1930 | 4700  | -48320   | 3.0%   | -28.0%   |
| 1995                      | 1962                   | 1934 | 1936 | -1050   | -39610   | -0.4%  | -22.2%   |
| 1996                      | 1950                   | 1954 | 1965 | -5440   | -25370   | -1.7%  | -11.9%   |
| 1997                      | 1974                   | 1972 | 1956 | -23050  | -23710   | -5.4%  | -10.8%   |
| 1998                      | 1949                   | 1962 | 1934 | -10690  | -41670   | -4.0%  | -23.4%   |
| 1999                      | 1954                   | 1965 | 1943 | -8310   | -27200   | -2.6%  | -13.0%   |
| 2000                      | 1934                   | 1936 | 1970 | -6000   | -46340   | -2.4%  | -26.1%   |
| 2001                      | 1931                   | 1944 | 1977 | 12600   | -50810   | 8.8%   | -30.6%   |
| 2002                      | 1947                   | 1955 | 1978 | -12900  | -33810   | -4.8%  | -16.8%   |
| 2003                      | 1945                   | 1939 | 1940 | 12370   | -46270   | 6.8%   | -26.4%   |
| <b>Average Difference</b> |                        |      |      | <b>-3777</b>  | <b>-38311</b>  | <b>-1.5%</b>   | <b>-20.2%</b>  |

**Table 11.** Columbia River at Bonneville Dam.

These data compare the average seasonal flows at McNary Dam during 3 years with similar runoff volumes to the surrogate year (1994-2003).

**Proposed Action** [2000 BiOp base case 3-yr\_averages 08-17-04]

Average Period Discharge in cfs

Average flows derived from BPA HYDSIM model study 03SN6704S1 dated 8-06-04.

Period is Nov 1 through April 15

**Reference Operation** [Reference ops case 3-yr\_averages 08-10-04]

Average Period Discharge in cfs

Average flows derived from BPA HYDSIM model study 03FSH05D91 dated 8-10-04.

Period is Nov 1 through April 15

| BiOp Study Year | Surrogate Runoff Years |      |      | Fall/Winter November 1 - Apr 15 (cfs) |
|-----------------|------------------------|------|------|---------------------------------------|
|                 | 1940                   | 1937 | 1930 |                                       |
| 1994            | 1940                   | 1937 | 1930 | 128844                                |
| 1995            | 1962                   | 1934 | 1936 | 177456                                |
| 1996            | 1950                   | 1954 | 1965 | 199211                                |
| 1997            | 1974                   | 1972 | 1956 | 237032                                |
| 1998            | 1949                   | 1962 | 1934 | 191628                                |
| 1999            | 1954                   | 1965 | 1943 | 199457                                |
| 2000            | 1934                   | 1936 | 1970 | 179293                                |
| 2001            | 1931                   | 1944 | 1977 | 121014                                |
| 2002            | 1947                   | 1955 | 1978 | 173378                                |
| 2003            | 1945                   | 1939 | 1940 | 133473                                |
| <b>Average</b>  |                        |      |      | <b>174079</b>                         |

| BiOp Study Year | Surrogate Runoff Years |      |      | Fall/ Winter November 1 - Apr 15 (cfs) |
|-----------------|------------------------|------|------|--|
|                 | 1940                   | 1937 | 1930 |  |
| 1994            | 1940                   | 1937 | 1930 | 118758                                 |
| 1995            | 1962                   | 1934 | 1936 | 172382                                 |
| 1996            | 1950                   | 1954 | 1965 | 178483                                 |
| 1997            | 1974                   | 1972 | 1956 | 212356                                 |
| 1998            | 1949                   | 1962 | 1934 | 180705                                 |
| 1999            | 1954                   | 1965 | 1943 | 180237                                 |
| 2000            | 1934                   | 1936 | 1970 | 172504                                 |
| 2001            | 1931                   | 1944 | 1977 | 121744                                 |
| 2002            | 1947                   | 1955 | 1978 | 160076                                 |
| 2003            | 1945                   | 1939 | 1940 | 126409                                 |
| <b>Average</b>  |                        |      |      | <b>162365</b>                          |

**Table 11.** Columbia River at Bonneville Dam.

**Flow Comparison (Proposed Action Minus Reference Operation).**

Average Period Discharge in cfs

| <b>BiOp Study Year</b>    | <b>Surrogate Runoff Years</b> |      |      | <b>Fall November 1 -Apr 15 Difference</b> | <b>Fall Relative Change to Ref. Op., in %</b> |
|---------------------------|-------------------------------|------|------|---|---|
| <b>1994</b>               | 1940                          | 1937 | 1930 | 10086                                     | 8.5%  |
| <b>1995</b>               | 1962                          | 1934 | 1936 | 5074                                      | 2.9%  |
| <b>1996</b>               | 1950                          | 1954 | 1965 | 20727                                     | 11.6%   |
| <b>1997</b>               | 1974                          | 1972 | 1956 | 24676                                     | 11.6%   |
| <b>1998</b>               | 1949                          | 1962 | 1934 | 10923                                     | 6.0%  |
| <b>1999</b>               | 1954                          | 1965 | 1943 | 19221                                     | 10.7%   |
| <b>2000</b>               | 1934                          | 1936 | 1970 | 6789                                      | 3.9%  |
| <b>2001</b>               | 1931                          | 1944 | 1977 | -729                                      | -0.6%   |
| <b>2002</b>               | 1947                          | 1955 | 1978 | 13302                                     | 8.3%  |
| <b>2003</b>               | 1945                          | 1939 | 1940 | 7063                                      | 5.6%  |
| <b>Average difference</b> |                               |      |      | <b>11713</b>                              | <b>7.2%</b>                                   |