

# RECLAMATION

*Managing Water in the West*

## **Annual Operating Plans**

### **Upper Missouri River Basin**

**Water Year 2006**

*Summary of Actual Operations*



U.S. Department of the Interior  
Bureau of Reclamation  
Great Plains Region

*Lake Elmer (Tiber Dam)*

## ***INTRODUCTION***

Annual reports on actual operations and operating plans for reservoir regulation activities were initiated in 1953. The Montana Area Office, Wyoming Area Office, Dakota Area Office and the Regional Office are all responsible for preparing reports on actual operations and operating plans for reservoir within the Upper Missouri River Basin above Sioux City, Iowa. This report briefly summarizes weather and streamflow conditions in the Upper Missouri River Basin during water year 2006, which are principal factors governing the pattern of reservoir operations. This report also describes operations during water year 2006 for reservoirs constructed by the Bureau of Reclamation (Reclamation) for providing flood control and water supplies for power generation, irrigation, municipal and industrial uses, and to enhance recreation, fish, and wildlife benefits.

This report includes operating plans to show estimated ranges of operation for water year 2007, with a graphical presentation on a monthly basis. The operating plans for the reservoirs are presented only to show possible operations under a wide range of inflows, most of which cannot be reliably forecasted at the time operating plans are prepared; therefore, plans are at best only probabilities. The plans are updated monthly, as the season progresses, to better coordinate the actual water and power requirements with more reliable estimates of inflow.

A report devoted to “Energy Generation” is included at the end of this report. The energy generation and water used for power at Reclamation and Corps of Engineers’ (Corps) plants are discussed, and the energy generated in 2006 is compared graphically with that of previous years. Energy produced at the Reclamation and Corps mainstem plants is marketed by the Department of Energy. Table CET6, entitled “Total Reservoir Storage Contents at the End of Water Years 2005 and 2006,” compares the water storage available at the beginning of water year 2007 to that available at the beginning of water year 2006. Table CET7 is a summary of the end of month storage contents for each reservoir during water year 2006. The Montana Area Office also assists in the preparation of plans for operation of the Corps reservoir on the main stem of the Missouri river by furnishing depletion estimates based upon the operating plans presented in this report.

All references to a year in this report will mean the water year extending from October 1 through September 30, unless specifically stated otherwise.

## **SUMMARY OF HYDROLOGIC CONDITIONS AND FLOOD CONTROL DURING 2006**

### **Antecedent Conditions:**

The conditions that existed following the 2005 water year indicated a slight overall improvement of precipitation patterns. The temperatures and precipitation for water year 2005 varied significantly between seasons. The mountain and valley precipitation for most basins in Montana east of the Continental Divide and the Bighorn basin in Wyoming were near to above normal during early fall. Conversely the winter precipitation in most basins was much below average. This again reversed in early spring and precipitation patterns were much closer to usual spring activity. By mid summer extremely hot and dry conditions returned to the Upper Missouri and Bighorn basins. The total precipitation ended the water year near to slightly below normal, even with moderately improved precipitation conditions in August and September.

The 2005 snowpack as of April 1 was below normal in the river basins in Montana and Wyoming. It ranged from 47 percent of normal in the St. Mary basin to 82 percent of normal in the Wind River basin. The below normal snowpack in Montana and Wyoming was somewhat offset with the near to above average precipitation during March and April. The overall below normal snowpack conditions were reflected in the below normal inflows for the year.

Inflows for water year 2005 were generally much below average; however slightly improved from the previous water year. Total inflows for most of the basins continued to reflect the cumulative drought conditions experienced in the Upper Missouri and Bighorn basins since water year 2000.

The end of September storage for Reclamation reservoirs ranged from much below average to above average. Releases during 2005 were generally conservative at Reclamation projects. At three major Reclamation projects, Yellowtail, Clark Canyon and Canyon Ferry Dams releases were below the minimum desired for the fishery as recommended by the Montana Fish, Wildlife, and Parks (MFWP) through most of the 2005 water year. However after the snowmelt runoff the storage conditions improved in Yellowtail and Canyon Ferry Dams allowing releases to be increased to the recommended flows during the latter part of the water year.

### **October through December:**

Precipitation for the 2006 water year began similar to the previous year after a Pacific system brought moist and cooler weather to the area. Precipitation for many locations in Montana was much above normal during October and November. The exceptions were the higher elevations of the Sun and Marias River basins which received much below average precipitation during this time period. During December dry conditions returned to many basins in Montana. However by the end of December the snowpack in Montana basins located east of the Continental Divide and the Bighorn basin in Wyoming was improved from the previous year. The total precipitation for these areas, during October through December, ranged from below normal to much below normal. For some basins, the early precipitation patterns indicated there may be some reprieve from the drought

conditions. However other areas such as the St. Mary, Marias and Sun basins, the beginning of water year 2006 did not provide any indication the drought conditions were improving, Tables MTT3A and MTT3B.

October through December inflows were below normal at all Reclamation reservoirs in Montana east of the Continental divide with the exception of Lake Sherburne. During October the inflow to Lake Sherburne was the second highest of record and inflow to Willow Creek Reservoir was the third highest of record. For the month of November, inflow to Canyon Ferry Reservoir was the sixth lowest of record.

### **January through March:**

On January 1, the Natural Resources Conservation Service reported mountain snowpack in Montana east of the Continental Divide where Reclamation facilities are located ranged from 56 percent of normal in the St. Mary River Basin to 128 percent of normal in the Milk River Basin, Table MTT1. The mountain snowpack was 89 percent of normal in the Bighorn River Basin in Wyoming. Mountain snow water content statewide was 99 percent of average and 140 percent of last year. West of the Continental Divide, mountain snow water content was 87 percent of average and 131 percent of last year. East of the Continental Divide, mountain snow water content was 104 percent of average and 135 percent of last year. Mountain precipitation during January was above average for most basins in Montana and slightly below normal for the Bighorn basin in Wyoming. The valley precipitation during January was much more varied between basins ranging from 83 percent of average in the Bighorn basin to 135 percent of average in the headwaters of the Beaverhead basin. Overall, January precipitation across the state was 126 percent of average and 208 percent of the previous year.

In February, precipitation around the state varied significantly between basins. The Upper Missouri basin received much below average precipitation, while basins along the Rocky Mountain Front received above average precipitation in both the valley and mountain areas. By March 1, mountain snow water content for the state was 104 percent of average and 200 percent of last year, while east of the Continental Divide snow water content was 99 percent of average and 165 percent of last year. Precipitation during March for mountain and valley areas east of the Continental Divide was 88 percent of average and 83 percent of last year. The dry conditions during March resulted in below average snowpack accumulations leading into the final month of the snowfall period.

January through March inflows were below normal to much below normal. The exception was Lake Sherburne which was 129 percent of average. Inflows for March were fourth lowest on record for Clark Canyon. The total inflow from January through March was seventh lowest for Clark Canyon Reservoir and fifth lowest for Gibson Reservoir.

TABLE MTT1  
2006 MOUNTAIN SNOW WATER CONTENT  
AS A PERCENT OF NORMAL

| DRAINAGE BASIN                   | JAN 1 | FEB 1 | MAR 1 | APR 1 | MAY 1 |
|----------------------------------|-------|-------|-------|-------|-------|
| Beaverhead                       | 114   | 117   | 101   | 103   | 110   |
| Jefferson                        | 109   | 113   | 103   | 103   | 108   |
| Madison                          | 112   | 119   | 107   | 105   | 105   |
| Gallatin                         | 124   | 120   | 111   | 105   | 99    |
| Missouri Headwaters above Toston | 110   | 104   | 104   | 98    | 100   |
| Sun                              | 68    | 88    | 94    | 83    | 77    |
| Marias                           | 58    | 66    | 90    | 89    | 77    |
| Milk River                       | 128   | 107   | 117   | 103   | 21    |
| St. Mary                         | 56    | 95    | 103   | 99    | 84    |
| Wind                             | 91    | 83    | 81    | 81    | 58    |
| Shoshone                         | 86    | 87    | 82    | 79    | 67    |
| Bighorn (Boysen-Bighorn)         | 89    | 82    | 85    | 83    | 64    |

TABLE MTT2  
2006 WATER SUPPLY FORECASTS

| RESERVOIR    | JAN 1 <sup>1/</sup> |             | FEB 1 <sup>1/</sup> |             | MAR 1 <sup>1/</sup> |             | APR 1 <sup>2/</sup> |             | MAY 1 <sup>3/</sup> |             | JUN 1 <sup>4/</sup> |             | ACTUAL<br>APRIL-JULY <sup>5/</sup> |             | % OF<br>APRIL<br>FORE-<br>CAST<br>REC'D |
|--------------|---------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|-------------|------------------------------------|-------------|-----------------------------------------|
|              | 1,000<br>AC-FT      | % OF<br>AVG | 1,000<br>AC-FT      | % OF<br>AVG | 1,000<br>AC-FT      | % OF<br>AVG | 1,000<br>AC-FT      | % OF<br>AVG | 1,000<br>AC-FT      | % OF<br>AVG | 1,000<br>AC-FT      | % OF<br>AVG | 1,000<br>AC-FT                     | % OF<br>AVG |                                         |
| Clark Canyon | 65.3                | 58          | 75.5                | 67          | 74.1                | 66          | 80.3                | 71          | 74.0                | 81          | 31.0                | 49          | 64.0                               | 57          | 80                                      |
| Canyon Ferry | 1,795.0             | 89          | 2,030.0             | 100         | 1,966.0             | 97          | 2,012.0             | 99          | 1,739.0             | 104         | 798.7               | 72          | 1,687.4                            | 83          | 84                                      |
| Gibson       | 362.0               | 76          | 343.0               | 72          | 416.0               | 87          | 381.0               | 80          | 320.0               | 73          | 158.0               | 59          | 359.9                              | 75          | 94                                      |
| Tiber        | 286.0               | 59          | 363.0               | 75          | 392.0               | 81          | 373.0               | 77          | 297.0               | 70          | 108.0               | 42          | 297.6                              | 61          | 80                                      |
| Sherburne    | 85.0                | 82          | 94.5                | 91          | 97.2                | 93          | 96.6                | 93          | 83.0                | 87          | 50.6                | 81          | 109.7                              | 105         | 114                                     |
| Fresno       | 76.0                | 91          | 69.0                | 83          | 70.0                | 84          | 49.0                | 81          | 29.0                | 69          | 17.8                | 91          | 58.8                               | 61          | 73                                      |
| Yellowtail   | 800.2               | 67          | 911.8               | 76          | 957.3               | 80          | 835.0               | 70          | 629.0               | 62          | 265.7               | 35          | 528.0                              | 44          | 63                                      |

1/ Runoff Forecast for April-July; Fresno Reservoir is March-July.

2/ Runoff Forecast for April-July.

3/ Runoff Forecast for May-July.

4/ Runoff Forecast for June-July.

5/ Actual Runoff for April-July; Fresno Reservoir is March-July.

**TABLE MTT3A**  
**PRECIPITATION IN INCHES AND PERCENT OF AVERAGE**  
**2006 VALLEY PRECIPITATION**

| BASIN                                | OCT  |     | NOV  |     | DEC  |     | JAN   |     | FEB   |     | MAR   |     | APR   |     | MAY   |     | JUN   |     | JUL   |     | AUG   |     | SEP   |     |
|--------------------------------------|------|-----|------|-----|------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
|                                      | IN.  | %   | IN.  | %   | IN.  | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %   |
| Beaverhead                           |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 0.89 |     | 0.43 |     | 0.39 |     | 0.39  |     | 0.28  |     | 0.65  |     | 1.16  |     | 2.20  |     | 1.92  |     | 1.37  |     | 1.28  |     | 1.09  |     |
| Monthly Precip and % of Average      | 1.29 | 145 | 0.79 | 185 | 0.36 | 91  | 0.33  | 85  | 0.26  | 91  | 0.31  | 47  | 1.71  | 147 | 1.02  | 46  | 1.86  | 97  | 0.91  | 66  | 0.70  | 54  | 0.49  | 45  |
| Year-to-Date Precip and % of Average | 1.29 | 145 | 2.07 | 158 | 2.43 | 143 | 2.76  | 132 | 3.01  | 127 | 3.32  | 110 | 5.02  | 120 | 6.04  | 95  | 7.90  | 95  | 8.80  | 91  | 9.50  | 87  | 9.99  | 83  |
| Jefferson                            |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 0.80 |     | 0.58 |     | 0.47 |     | 0.48  |     | 0.35  |     | 0.71  |     | 1.13  |     | 2.14  |     | 2.12  |     | 1.47  |     | 1.36  |     | 1.13  |     |
| Monthly Precip and % of Average      | 1.59 | 200 | 1.00 | 174 | 0.44 | 94  | 0.42  | 86  | 0.22  | 62  | 0.39  | 55  | 1.66  | 147 | 1.19  | 56  | 2.39  | 113 | 0.98  | 67  | 0.64  | 47  | 0.79  | 70  |
| Year-to-Date Precip and % of Average | 1.59 | 200 | 2.60 | 189 | 3.04 | 165 | 3.45  | 149 | 3.67  | 137 | 4.06  | 120 | 5.72  | 127 | 6.91  | 104 | 9.31  | 106 | 10.29 | 100 | 10.93 | 94  | 11.71 | 92  |
| Madison                              |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 1.49 |     | 1.77 |     | 2.04 |     | 1.87  |     | 1.55  |     | 1.88  |     | 1.70  |     | 2.78  |     | 2.71  |     | 1.81  |     | 1.61  |     | 1.67  |     |
| Monthly Precip and % of Average      | 2.35 | 158 | 2.76 | 156 | 1.94 | 95  | 2.98  | 160 | 1.74  | 113 | 1.68  | 90  | 3.16  | 186 | 1.43  | 51  | 2.74  | 101 | 1.62  | 89  | 0.67  | 42  | 1.21  | 73  |
| Year-to-Date Precip and % of Average | 2.35 | 158 | 5.11 | 157 | 7.05 | 133 | 10.03 | 140 | 11.77 | 135 | 13.45 | 127 | 16.62 | 135 | 18.05 | 120 | 20.79 | 117 | 22.40 | 114 | 23.08 | 109 | 24.29 | 106 |
| Gallatin                             |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 1.61 |     | 1.10 |     | 0.79 |     | 0.84  |     | 0.70  |     | 1.40  |     | 2.06  |     | 3.22  |     | 2.85  |     | 1.44  |     | 1.48  |     | 1.79  |     |
| Monthly Precip and % of Average      | 2.97 | 184 | 2.67 | 243 | 1.03 | 130 | 1.10  | 131 | 0.13  | 19  | 1.31  | 94  | 3.55  | 172 | 1.77  | 55  | 2.48  | 87  | 1.24  | 86  | 1.89  | 128 | 1.41  | 79  |
| Year-to-Date Precip and % of Average | 2.97 | 184 | 5.64 | 208 | 6.67 | 191 | 7.77  | 179 | 7.90  | 157 | 9.21  | 143 | 12.76 | 150 | 14.53 | 124 | 17.01 | 117 | 18.25 | 114 | 20.14 | 115 | 21.55 | 112 |
| Missouri Above Toston                |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 1.06 |     | 1.01 |     | 1.02 |     | 0.97  |     | 0.78  |     | 1.16  |     | 1.38  |     | 2.44  |     | 2.37  |     | 1.57  |     | 1.46  |     | 1.37  |     |
| Monthly Precip and % of Average      | 1.96 | 185 | 1.75 | 172 | 1.00 | 98  | 1.33  | 138 | 0.70  | 90  | 0.96  | 83  | 2.44  | 177 | 1.35  | 55  | 2.59  | 110 | 1.18  | 75  | 0.78  | 54  | 0.98  | 72  |
| Year-to-Date Precip and % of Average | 1.96 | 185 | 3.71 | 179 | 4.71 | 152 | 6.04  | 149 | 6.74  | 139 | 7.69  | 128 | 10.13 | 137 | 11.48 | 117 | 14.07 | 116 | 15.26 | 111 | 16.04 | 105 | 17.02 | 103 |
| Sun-Teton                            |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 1.17 |     | 1.29 |     | 1.22 |     | 1.33  |     | 1.09  |     | 1.12  |     | 1.41  |     | 2.63  |     | 2.55  |     | 1.54  |     | 1.67  |     | 1.43  |     |
| Monthly Precip and % of Average      | 2.19 | 188 | 0.97 | 75  | 0.82 | 67  | 1.58  | 64  | 1.28  | 118 | 1.16  | 103 | 2.73  | 193 | 2.38  | 90  | 3.16  | 124 | 0.52  | 34  | 1.63  | 98  | 1.62  | 113 |
| Year-to-Date Precip and % of Average | 2.19 | 188 | 3.17 | 129 | 3.98 | 108 | 5.57  | 111 | 6.85  | 112 | 8.01  | 111 | 10.73 | 124 | 13.11 | 116 | 16.28 | 118 | 16.80 | 110 | 18.42 | 108 | 20.04 | 109 |
| Marias                               |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 0.57 |     | 0.43 |     | 0.38 |     | 0.39  |     | 0.28  |     | 0.59  |     | 0.93  |     | 2.11  |     | 2.43  |     | 1.41  |     | 1.56  |     | 1.13  |     |
| Monthly Precip and % of Average      | 1.17 | 203 | 0.33 | 77  | 0.24 | 63  | 0.18  | 45  | 0.40  | 142 | 0.92  | 156 | 1.09  | 117 | 1.48  | 70  | 2.94  | 121 | 0.59  | 42  | 0.62  | 40  | 0.99  | 88  |
| Year-to-Date Precip and % of Average | 1.17 | 203 | 1.49 | 149 | 1.73 | 126 | 1.91  | 108 | 2.31  | 113 | 3.22  | 122 | 4.32  | 121 | 5.80  | 102 | 8.74  | 108 | 9.33  | 98  | 9.96  | 90  | 10.95 | 90  |
| Milk                                 |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 0.60 |     | 0.43 |     | 0.42 |     | 0.41  |     | 0.30  |     | 0.52  |     | 0.86  |     | 2.01  |     | 2.23  |     | 1.58  |     | 1.18  |     | 1.20  |     |
| Monthly Precip and % of Average      | 1.17 | 194 | 0.66 | 153 | 0.34 | 80  | 0.38  | 93  | 0.49  | 161 | 0.73  | 139 | 1.09  | 128 | 1.74  | 87  | 2.30  | 103 | 0.17  | 11  | 0.67  | 57  | 1.18  | 99  |
| Year-to-Date Precip and % of Average | 1.17 | 194 | 1.83 | 177 | 2.17 | 149 | 2.55  | 137 | 3.04  | 140 | 3.76  | 140 | 4.86  | 137 | 6.60  | 119 | 8.90  | 114 | 9.07  | 97  | 9.74  | 92  | 10.92 | 93  |
| St. Mary                             |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 1.47 |     | 1.98 |     | 1.94 |     | 1.86  |     | 1.36  |     | 1.04  |     | 1.52  |     | 2.82  |     | 2.97  |     | 1.86  |     | 2.00  |     | 1.75  |     |
| Monthly Precip and % of Average      | 1.23 | 84  | 1.56 | 79  | 0.59 | 30  | 1.33  | 72  | 2.00  | 147 | 0.86  | 83  | 1.35  | 89  | 2.10  | 74  | 4.65  | 157 | 0.95  | 51  | 1.11  | 55  | 1.82  | 104 |
| Year-to-Date Precip and % of Average | 1.23 | 84  | 2.79 | 81  | 3.38 | 63  | 4.71  | 65  | 6.71  | 78  | 7.57  | 78  | 8.92  | 80  | 11.01 | 79  | 15.66 | 92  | 16.61 | 88  | 17.71 | 85  | 19.53 | 87  |
| Bighorn Above Yellowtail             |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |       |     |
| Monthly Precip Average               | 0.82 |     | 0.47 |     | 0.33 |     | 0.34  |     | 0.29  |     | 0.61  |     | 1.17  |     | 1.95  |     | 1.35  |     | 0.97  |     | 0.73  |     | 1.05  |     |
| Monthly Precip and % of Average      | 1.41 | 172 | 0.54 | 115 | 0.20 | 61  | 0.08  | 23  | 0.28  | 96  | 0.39  | 64  | 0.78  | 67  | 0.65  | 33  | 0.49  | 37  | 0.45  | 46  | 0.23  | 32  | 1.15  | 110 |
| Year-to-Date Precip and % of Average | 1.41 | 172 | 1.94 | 151 | 2.14 | 132 | 2.22  | 113 | 2.51  | 111 | 2.90  | 101 | 3.67  | 91  | 4.32  | 72  | 4.81  | 66  | 5.27  | 63  | 5.50  | 61  | 6.65  | 66  |

A composite of the following National Weather Service stations was used to determine monthly valley precipitation and percent of average for the drainage basins:

Beaverhead.....Lima and Dillon

Jefferson.....Lima, Dillon, Virginia City, and Boulder

Madison.....Hebgen, West Yellowstone, and Norris Madison

Gallatin.....Bozeman

Missouri Above Toston.....Townsend, Lima, Dillon, Virginia City, Boulder, Hebgen, West Yellowstone, Norris Madison, and Bozeman

Sun-Teton.....Summit, Choteau, Fairfield, Augusta, and Gibson

Marias.....Cut Bank, Conrad, Valier, Gold Butte, and Chester

Milk.....Havre, Chinook, Harlem, Malta, and Rudyard

St. Mary.....Babb and East Glacier

Bighorn Above Yellowtail....Buffalo Bill, Sunshine, Boysen Dam, Dubois, Gas Hills, Lander, Riverton, Basin, Lovell, Thermopolis, and Worland

# TABLE MTT3B

## PRECIPITATION IN INCHES AND PERCENT OF AVERAGE

### 2006 MOUNTAIN PRECIPITATION

| BASIN                                | OCT   |     | NOV    |     | DEC    |     | JAN    |     | FEB    |     | MAR    |     | APR    |     | MAY    |     | JUN    |     | JUL    |     | AUG    |     | SEP    |     |
|--------------------------------------|-------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|
|                                      | IN.   | %   | IN.    | %   | IN.    | %   | IN.    | %   | IN.    | %   | IN.    | %   | IN.    | %   | IN.    | %   | IN.    | %   | IN.    | %   | IN.    | %   | IN.    | %   |
| Lima Reservoir                       |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 8.70  |     | 12.60  |     | 14.20  |     | 14.20  |     | 13.10  |     | 15.70  |     | 13.00  |     | 16.00  |     | 14.20  |     | 8.70   |     | 8.40   |     | 9.40   |     |
| Monthly Precip and % of Average      | 13.50 | 155 | 15.30  | 121 | 16.80  | 118 | 19.20  | 135 | 5.60   | 43  | 15.70  | 100 | 21.60  | 166 | 6.50   | 41  | 16.20  | 114 | 7.20   | 83  | 3.40   | 40  | 7.90   | 84  |
| Year-to-Date Precip and % of Average | 13.50 | 155 | 28.80  | 135 | 45.60  | 128 | 64.80  | 130 | 70.40  | 112 | 70.40  | 110 | 107.70 | 118 | 114.20 | 106 | 130.40 | 107 | 137.60 | 106 | 141.00 | 102 | 148.90 | 100 |
| Clark Canyon Reservoir               |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 13.50 |     | 20.20  |     | 21.40  |     | 20.30  |     | 17.10  |     | 22.00  |     | 21.30  |     | 27.00  |     | 21.20  |     | 12.40  |     | 11.70  |     | 12.90  |     |
| Monthly Precip and % of Average      | 13.70 | 101 | 26.10  | 129 | 17.90  | 84  | 22.50  | 111 | 9.80   | 57  | 20.30  | 92  | 26.10  | 123 | 10.90  | 40  | 22.60  | 107 | 8.00   | 65  | 4.40   | 38  | 13.40  | 104 |
| Year-to-Date Precip and % of Average | 13.70 | 101 | 39.80  | 118 | 57.70  | 105 | 80.20  | 106 | 90.00  | 97  | 110.30 | 96  | 136.40 | 100 | 147.30 | 90  | 169.90 | 92  | 177.90 | 91  | 182.30 | 88  | 195.70 | 89  |
| Jefferson Drainage                   |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 31.40 |     | 45.80  |     | 48.90  |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip and % of Average      | 28.40 | 90  | 58.90  | 129 | 45.70  | 93  | 54.40  | 115 | 26.60  | 68  | 40.90  | 86  | 57.40  | 118 | 26.10  | 45  | 50.90  | 111 | 17.30  | 62  | 9.80   | 37  | 27.50  | 95  |
| Year-to-Date Precip and % of Average | 28.40 | 90  | 87.30  | 113 | 133.00 | 105 | 187.40 | 108 | 214.00 | 101 | 254.90 | 98  | 312.30 | 101 | 338.40 | 92  | 389.30 | 94  | 406.60 | 92  | 416.40 | 89  | 443.90 | 89  |
| Madison Drainage                     |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 21.30 |     | 33.10  |     | 35.30  |     | 35.90  |     | 30.90  |     | 36.40  |     | 30.20  |     | 32.90  |     | 26.00  |     | 15.90  |     | 14.90  |     | 17.90  |     |
| Monthly Precip and % of Average      | 22.30 | 105 | 45.10  | 136 | 36.30  | 103 | 36.30  | 129 | 22.52  | 73  | 33.22  | 91  | 39.54  | 131 | 17.10  | 52  | 27.60  | 106 | 10.20  | 64  | 8.30   | 56  | 14.40  | 80  |
| Year-to-Date Precip and % of Average | 22.30 | 105 | 67.40  | 124 | 103.70 | 116 | 103.70 | 119 | 172.52 | 110 | 205.74 | 107 | 245.28 | 110 | 262.38 | 102 | 289.98 | 103 | 300.18 | 101 | 308.48 | 99  | 322.88 | 98  |
| Gallatin Drainage                    |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 9.40  |     | 11.20  |     | 11.30  |     | 11.40  |     | 9.90   |     | 14.90  |     | 14.40  |     | 15.90  |     | 13.10  |     | 7.20   |     | 6.70   |     | 8.20   |     |
| Monthly Precip and % of Average      | 9.20  | 98  | 18.70  | 167 | 12.00  | 106 | 12.38  | 109 | 7.49   | 76  | 10.00  | 67  | 15.20  | 106 | 7.90   | 50  | 10.60  | 81  | 5.20   | 72  | 3.60   | 54  | 7.80   | 95  |
| Year-to-Date Precip and % of Average | 9.20  | 98  | 27.90  | 135 | 39.90  | 125 | 52.28  | 121 | 69.77  | 112 | 69.77  | 102 | 84.97  | 103 | 92.87  | 94  | 103.47 | 93  | 108.67 | 92  | 112.27 | 90  | 120.07 | 90  |
| Canyon Ferry Reservoir               |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 51.80 |     | 75.90  |     | 80.70  |     | 80.40  |     | 67.80  |     | 82.40  |     | 77.60  |     | 89.30  |     | 70.60  |     | 42.20  |     | 40.20  |     | 45.80  |     |
| Monthly Precip and % of Average      | 49.30 | 95  | 103.30 | 136 | 78.80  | 98  | 94.30  | 117 | 47.12  | 69  | 70.82  | 86  | 92.24  | 119 | 42.70  | 48  | 75.20  | 107 | 26.90  | 64  | 18.10  | 45  | 41.90  | 91  |
| Year-to-Date Precip and % of Average | 49.30 | 95  | 152.60 | 111 | 231.40 | 111 | 325.70 | 113 | 372.82 | 105 | 443.64 | 101 | 535.88 | 104 | 578.58 | 95  | 653.78 | 97  | 680.68 | 95  | 698.78 | 92  | 740.68 | 92  |
| Gibson Reservoir                     |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 9.70  |     | 13.60  |     | 13.90  |     | 13.40  |     | 11.00  |     | 11.40  |     | 11.00  |     | 14.80  |     | 15.00  |     | 7.70   |     | 9.10   |     | 8.70   |     |
| Monthly Precip and % of Average      | 6.10  | 63  | 9.20   | 68  | 7.30   | 53  | 13.90  | 104 | 14.20  | 129 | 6.60   | 58  | 14.20  | 129 | 10.30  | 70  | 11.10  | 74  | 2.90   | 38  | 7.80   | 86  | 7.40   | 85  |
| Year-to-Date Precip and % of Average | 6.10  | 63  | 15.30  | 61  | 22.60  | 61  | 36.50  | 72  | 50.70  | 82  | 57.30  | 78  | 71.50  | 85  | 81.80  | 83  | 92.90  | 82  | 95.80  | 79  | 103.60 | 79  | 111.00 | 80  |
| Lake Elwell Reservoir                |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 14.70 |     | 22.30  |     | 23.70  |     | 25.20  |     | 19.50  |     | 19.80  |     | 17.30  |     | 20.70  |     | 19.80  |     | 10.50  |     | 12.80  |     | 12.80  |     |
| Monthly Precip and % of Average      | 10.90 | 74  | 16.10  | 72  | 13.70  | 58  | 28.50  | 113 | 23.45  | 120 | 12.03  | 61  | 17.00  | 98  | 15.00  | 72  | 16.30  | 82  | 3.50   | 33  | 7.30   | 57  | 11.50  | 90  |
| Year-to-Date Precip and % of Average | 10.90 | 74  | 27.00  | 67  | 40.70  | 67  | 69.20  | 81  | 92.65  | 88  | 104.68 | 84  | 121.68 | 85  | 136.68 | 84  | 152.98 | 84  | 156.48 | 81  | 163.78 | 79  | 175.28 | 80  |
| Sherburne Reservoir                  |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 9.80  |     | 16.50  |     | 16.20  |     | 15.70  |     | 12.10  |     | 11.20  |     | 9.60   |     | 10.00  |     | 10.30  |     | 6.00   |     | 5.10   |     | 6.80   |     |
| Monthly Precip and % of Average      | 12.00 | 122 | 11.10  | 67  | 10.00  | 62  | 10.00  | 123 | 12.61  | 104 | 11.14  | 100 | 8.56   | 89  | 8.20   | 82  | 12.50  | 121 | 1.70   | 28  | 1.70   | 33  | 4.80   | 71  |
| Year-to-Date Precip and % of Average | 12.00 | 122 | 23.10  | 88  | 33.10  | 78  | 52.35  | 90  | 64.96  | 92  | 76.11  | 93  | 84.67  | 93  | 92.87  | 92  | 105.37 | 95  | 107.07 | 91  | 108.77 | 89  | 113.57 | 88  |
| Bighorn Lake                         |       |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |        |     |
| Monthly Precip Average               | 42.30 |     | 48.80  |     | 43.20  |     | 42.20  |     | 34.80  |     | 50.10  |     | 63.00  |     | 69.70  |     | 55.60  |     | 37.70  |     | 26.10  |     | 42.20  |     |
| Monthly Precip and % of Average      | 41.10 | 97  | 48.80  | 100 | 40.70  | 94  | 34.50  | 82  | 30.80  | 89  | 35.20  | 70  | 35.80  | 57  | 45.10  | 65  | 18.10  | 33  | 18.80  | 50  | 16.70  | 64  | 55.00  | 130 |
| Year-to-Date Precip and % of Average | 41.10 | 97  | 89.90  | 99  | 130.60 | 97  | 165.10 | 94  | 195.90 | 93  | 231.10 | 88  | 266.90 | 82  | 312.00 | 79  | 330.10 | 73  | 348.90 | 72  | 365.60 | 71  | 420.60 | 76  |

A composite of the following Natural Resources Conservation Service SNOTEL sites was used to determine monthly mountain precipitation and percent of average for the drainage basins:

Lima Reservoir.....Crab Creek, Island Park, Teepee Creek, Divide, and Lakeview Ridge

Clark Canyon Reservoir.....Beagle Springs, Darkhorse Lake, Lemhi Ridge, Teepee Creek, Divide, Bloody Dick, and Lakeview Ridge

Jefferson Drainage.....Beagle Springs, Clover Meadow, Darkhorse Lake, Mule Creek, Lemhi Ridge, Rocker Peak, Teepee Creek, Clavert Creek, Saddle Mountain, Lower Twin, Divide, Bloody Dick, Lakeview Ridge, Short Creek, Frohner Meadow, and Moose Creek

Madison Drainage.....Carrot Basin, Clover Meadow, Teepee Creek, Black Bear, Lower Twin, Beaver Creek, Madison Plateau, and Whiskey Creek

Gallatin Drainage.....Carrot Basin, Shower Falls, and Lick Creek

Canyon Ferry Reservoir.....Beagle Springs, Darkhorse Lake, Carrot Basin, Clover Meadow, Shower Falls, Mule Creek, Rocker Peak, Black Bear, Saddle Mountain, Lower Twin, Beaver Creek, Madison Plateau, Short Creek, Lick Creek, Whiskey Creek, Frohner Meadow, Calvert Creek, Moose Creek, Lemhi Ridge, Teepee Creek, Divide, Bloody Dick, and Lakeview Ridge

Gibson Reservoir.....Mount Lockhart, Wood Creek, Dupuyer Creek, and Waldron

Lake Elwell Reservoir.....Mount Lockhart, Badger Pass, Pike Creek, Dupuyer Creek, and Waldron

Sherburne Reservoir.....Flattop Mountain and Many Glacier

Bighorn Lake.....Kirwin, Blackwater, Evening Star, Shell Creek, Powder River, Bald Mountain, Bone Springs Divide, Owl Creek, Sucker Creek, Dome Lake, Hansen Sawmill, Timber Creek, Bear Trap Meadow, Burgess Junction, Middle Powder, Marquette, Sylvan Lake, Younts Peak, and Sylvan Road

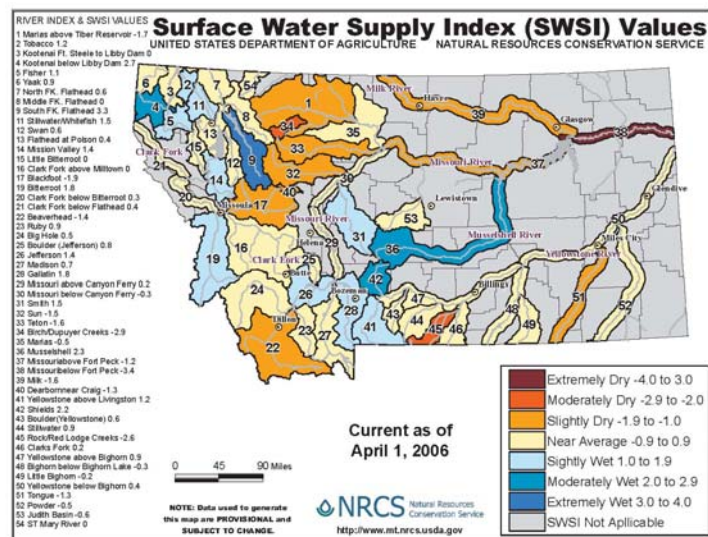
## April through June:

As of April 1, mountain snow water contents statewide were 101 percent of average and 169 percent of last year. West of the Continental Divide snowpack was 101 percent of average and 190 percent of

last year. East of the Continental Divide snowpack was 96 percent of average and 143 percent of last year. The improved water supply conditions were reflected in the Natural Resources Conservation Service's Surface Water Supply Index map. The improved conditions continued during April; precipitation was near to above average for most of Montana. Conversely, precipitation in the Bighorn basin in Wyoming was much below average during April. Overall, April mountain and valley precipitation across Montana was 133 percent of average and 134 percent of last year. April temperatures were generally 2 to 5 degrees above average across Montana thus producing increased snowmelt rates and above average streamflows in many basins.

The precipitation across Montana during May contrasted significantly from the previous month. Mountain and valley precipitation across the state was only 68 percent of average and 66 percent of last year, while east of the Continental Divide mountain and valley precipitation was 66 percent of average and 64 percent of last year. In general, all of the basins above Reclamation projects in Montana received much below average precipitation during May. Consequently, the warm temperatures in May combined with much below average precipitation did not provide good prospects for improved snowmelt runoff.

As of June 1, remaining mountain snow water contents were generally near to much below average. Precipitation conditions improved slightly during June. The Upper Missouri basin during June received near normal precipitation in the valley and mountain areas. Conversely basins along the Rocky Mountain Front received near average precipitation in the valley areas but much below average in the mountains. The exception was precipitation in the St. Mary basin during June which was much above average in both the valley and mountain areas. The improved April precipitation resulted in near average peak mountain snowpack for basins in Montana and significantly improved snowpack from the previous year. The peak snowpack for the Wind, Shoshone, and Bighorn River basins in Wyoming were below normal; albeit the overall snowpack was slightly improved from the previous year. The peak snowpack for Reclamation reservoirs occurred between March 31 and April 20. The peak generally occurs around April 15 for mountain locations. In the Bighorn basin in





Wyoming, however, warm temperatures and below average precipitation in April and May resulted in a peak snowpack slightly earlier than usual, Figure MTG1.

### **July through September:**

During July, temperatures were above average, while precipitation was much below average across Montana and the Bighorn basin in Wyoming. There was some relief by the end of July due to a low pressure system that moved in from the Pacific Northwest. August temperatures were again above average while precipitation was much below average. There was some relief in the latter part of the month from some pacific cold fronts but August did produce some record high temperatures in Montana. September temperatures and precipitation were varied; early in the month conditions were warm and dry, while in the latter part of the month a system from the Gulf of Alaska brought much needed precipitation to Montana. The basins along the Rocky Mountain Front as well as the Bighorn River basin in Wyoming received near average precipitation while areas in the headwaters of the Missouri River basin were slightly below average.

The inflow conditions for August through September ranged from near average to much below average. The total inflows for the water year ranged from 57 percent of normal at Bighorn Lake to 110 percent of normal at Lake Sherburne. Leading into water year 2007 the drought remained prominent in several Montana basins east of the Continental Divide, where Reclamation facilities are located. At the start of water year 2007, the early indications are there is moderate improvement in drought conditions for the Upper Missouri River basin but recession toward drought conditions in the Bighorn basin in Wyoming.

### **Reservoir Storage, Releases and Inflows:**

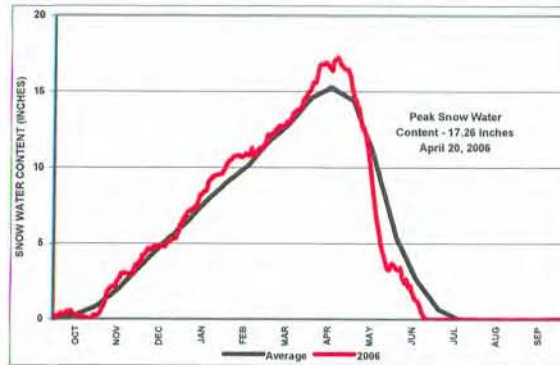
The 2006 water year storage began with Reclamation reservoirs ranging from above to much below average storage. October 1 storage in the Upper Missouri Basin was 2,442,900 acre-feet, 89 percent of average. Storage for the Milk River Project was 116,700 acre-feet, 109 percent of normal. Storage in Bighorn Lake was 1,000,500 acre-feet, 98 percent of normal. These percent of normal storage levels remained similar through the end of December for the Upper Missouri basin and Bighorn Lake. The storage in the Milk River Project did increase due to above average inflow to Lake Sherburne during this period.

The January through March storage in Reclamation reservoirs east of the Continental Divide ranged from much below average to much above average. For example, the end of March storage ranged from 34 percent of normal at Gibson Reservoir to 131 percent of normal at Fresno Reservoir. The January through end of March storage levels in Gibson Reservoir were the third lowest of record.

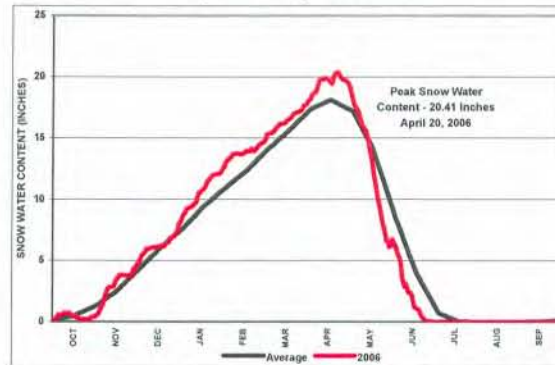
Due to the near average precipitation during April the inflows improved in many basins located in northcentral and southwest Montana to near average levels. Therefore, storage conditions improved slightly leading into May. The early precipitation patterns in conjunction with the near average snowpack indicated that drought conditions may be improving in Montana. However, dry conditions returned during May and thus put significant demands on reservoir storage. This was an indicator of

# Figure MTG1 WATER YEAR 2006 SNOW WATER CONTENT

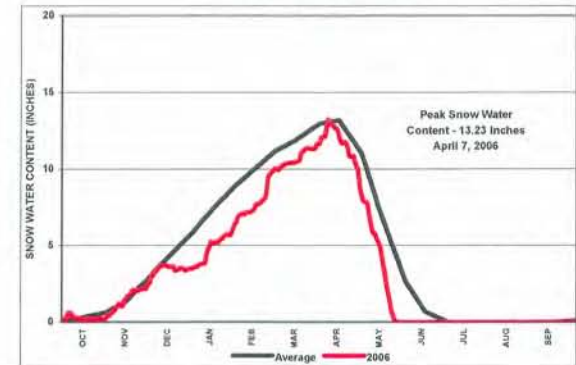
Clark Canyon Reservoir



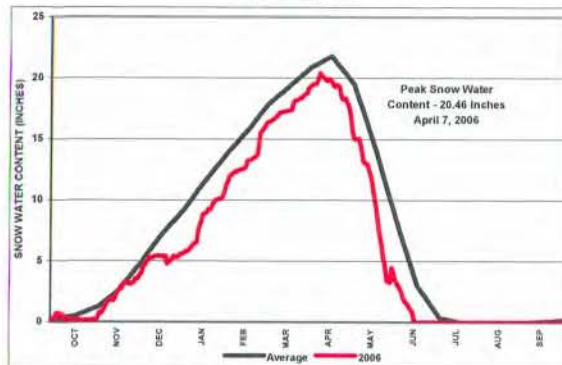
Canyon Ferry Reservoir



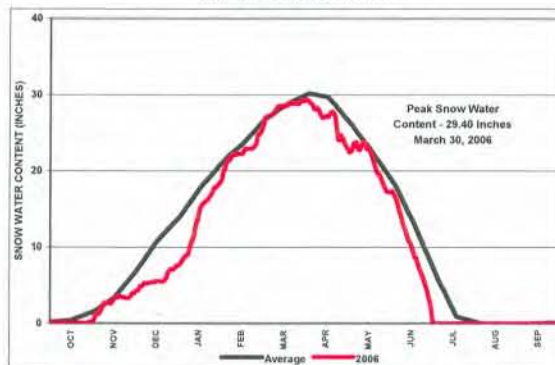
Gibson Reservoir



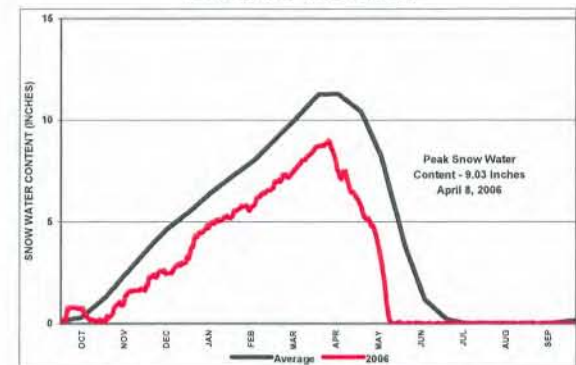
Lake Elwell



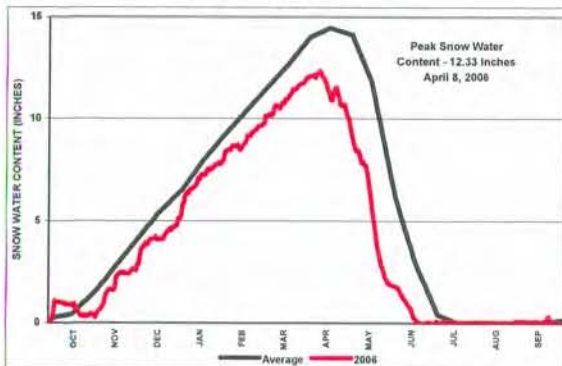
Lake Sherburne



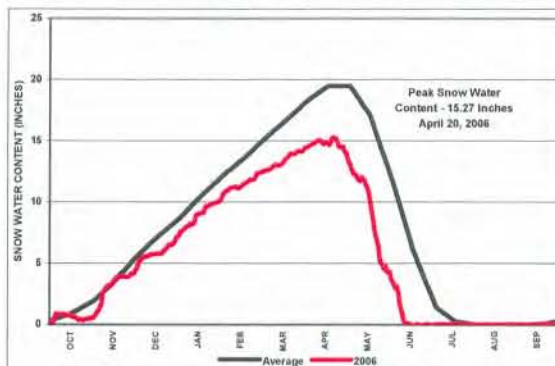
Bull Lake Reservoir



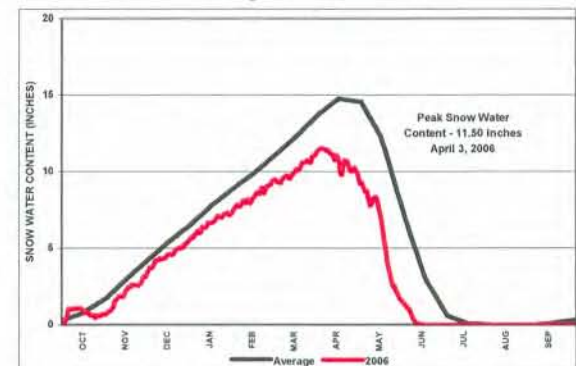
Boysen Reservoir



Buffalo Bill Reservoir



Bighorn Lake



upcoming summer conditions and demands on storage. In the Bighorn River basin in Wyoming dry conditions dominated throughout this period. The much below average precipitation in the basin during April and May resulted in increased irrigation demands upstream. Consequently inflows to Bighorn Lake were much below average; resulting in below average storage by the end of May.

The only Reclamation reservoirs in Montana that did not fill to normal full capacity were Bighorn Lake, Clark Canyon, and Tiber Reservoirs.

There was approximately \$1,980,700 in flood damages prevented during water year 2006 by Reclamation facilities in Montana east of the Continental Divide. The total flood damage prevented by these facilities since 1950 is approximately \$357,591,000.

June through August storage ranged from much below average to above average. Storage in Clark Canyon Reservoir remained much below normal throughout this period. Most areas in Montana received near average precipitation in June therefore storage conditions did not decline as rapidly as expected. However July and August precipitation was much below average resulting in significant irrigation demands from storage. By the end of August the only reservoirs at near normal levels were Willow Creek Reservoir and Lake Sherburne. The end of month content was 106 and 112 percent of normal, respectively. The inflows to Bighorn Lake during June through August were much below average principally due to the lack of precipitation and subsequent irrigation demand. The storage in Bighorn Lake ended the month of August at only 73 percent of average.

Water year 2006 ended with storage ranging from above average to much below average. The Reclamation reservoirs with the least amount of average carryover storage were Clark Canyon and Gibson Reservoirs. Bighorn Lake began the 2007 water year at the fourth lowest level since construction of the dam.

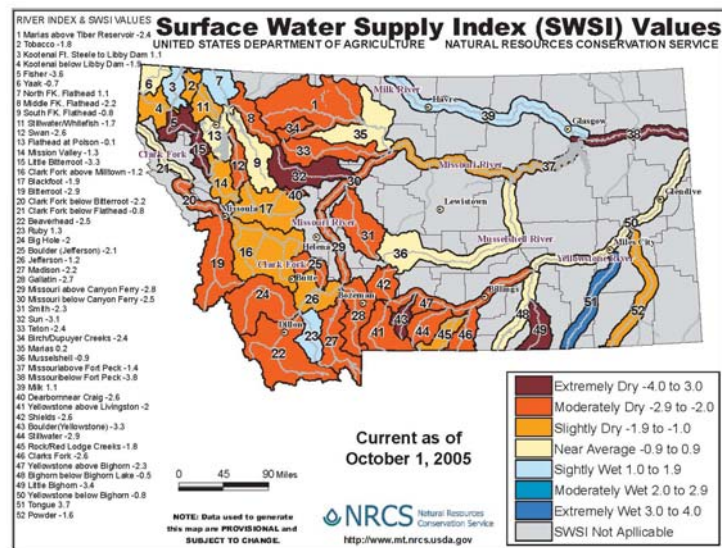
Releases from Reclamation reservoirs during the initial part of 2006 were significantly improved on the Missouri River below Canyon Ferry Dam and the Bighorn River below Yellowtail Dam. Releases at the other Reclamation facilities including Clark Canyon, Gibson and Tiber Dams were still very conservative for most of the water year because of continued drought conditions. Releases were only increased when absolutely necessary to control the spring runoff or irrigation demands. In the latter part of 2006 the flows in the Missouri and Bighorn Rivers were reduced to rates below the desired minimum fishery. This was a result of extremely hot and dry summer conditions in these basins, which reduced inflows significantly. Consequently releases were reduced to control the rate of decline in reservoir storage. Even with improved inflows, releases from Clark Canyon Dam were also set below the absolute minimum for the winter at approximately 40 cfs, beginning in early October. Entering into water year 2007 releases from all Reclamation facilities in Montana are at or below the recommended minimum fishery flow.

### **Water Supply and Runoff:**

The January 1 forecasted April-July runoff volumes ranged from 58 to 91 percent of average among Reclamation reservoirs east of the Continental Divide, MTT2. This indicated that the drought may

be continuing for most of Montana and Northwest Wyoming. There were some improvements in the snowpack in the Sun and Marias River basins by March 1. However, the overall snowpack conditions and water supply forecasts remained constant and indications were there could potentially be water shortages if the spring precipitation did not materialize. The April 1 snowpack ranged from 105 percent of average in the Madison and Gallatin River basins to 79 percent of average in the Shoshone River basin in Wyoming, Table MTT1. The resulting April-July forecasted runoff volumes ranged from 70 to 99 percent of average. In the end, due to below average spring precipitation, the actual runoff volumes for water year 2006 ranged from 41 to 105 percent of average, Table MTT2. In some areas of Montana water shortages were experienced during the irrigation season, but overall irrigation demands were satisfied.

During water year 2006 the peak release at Clark Canyon was approximately 354 cfs greater than peak inflow. Peak release was 869 cfs on July 22, while the inflow peaked at 515 cfs on June 9, which was much below average. Canyon Ferry peak inflow was 16,829 cfs on June 11, while the peak release was 6,147 cfs on May 16. In the Sun River Basin, Gibson Reservoir inflow peaked at 5,361 cfs on May 19, while the release peaked at 4,981 cfs on May 24. The peak inflow for Pishkun and Willow Creek Reservoirs were 1,526 cfs on June 26 and 95 cfs on May 4, respectively. Inflow to Lake Elwell peaked at 4,331 cfs and releases peaked at 4,750 cfs both on June 14. In the Milk River Basin, Lake Sherburne peak inflow was 1,786 on June 16 and releases peaked at 1,054 cfs on June 18. The peak inflow for Fresno Reservoir was 1,712 cfs on June 16 while the release peaked at 1,239 cfs on July 14.



Inflows to Reclamation facilities in Montana east of the Continental Divide were all much below average with the exception of the Milk River basin reservoirs. Inflows in the Milk River basin were near average for 2006.

## FLOOD BENEFITS

The Corps of Engineers evaluated the reservoir regulation data pertaining to Reclamation reservoirs within the jurisdiction of the Montana Area Office and indicated that three reservoirs provided flood relief during water year 2006. They were: Canyon Ferry on the Missouri River near Helena; Lake Elwell on the Marias River near Chester; and Bighorn Lake on the Bighorn River near Fort Smith. Canyon Ferry Reservoir played the most important role in preventing flood damages during the 2006 runoff season. The most notable examples of peak flows regulated by Bureau reservoirs during the spring runoff are as follows:

| <u>Reservoir</u> | <u>Peak<br/>Inflow<br/>(cfs)</u> | <u>River<br/>Discharge<br/>(cfs)</u> | <u>Date</u> |
|------------------|----------------------------------|--------------------------------------|-------------|
| Canyon Ferry     | 16,829                           | 3,794                                | 06/11/06    |
| Lake Elwell      | 1,386                            | 650                                  | 05/02/06    |
|                  | 2,906                            | 657                                  | 05/20/06    |
| Bighorn Lake     | 6,756                            | 2,503                                | 06/24/06    |

The Corps estimated these three Bureau reservoirs in Montana reduced flood damages by \$1,980,700 in 2006. Some of these benefits were derived by reducing local damages and other benefits were derived by storing water which would have contributed to flooding downstream on the main stem of the Missouri River below Fort Peck Reservoir. The distribution of flood damages prevented is as listed in Table MTT4. For additional information on the operations of the reservoirs within the jurisdiction of the Montana Area Office, refer to the individual "Summary of Operations for 2006" for each reservoir in this report. Figure MTG2 shows the annual flood damages prevented by Montana Area Office reservoirs since 1950.

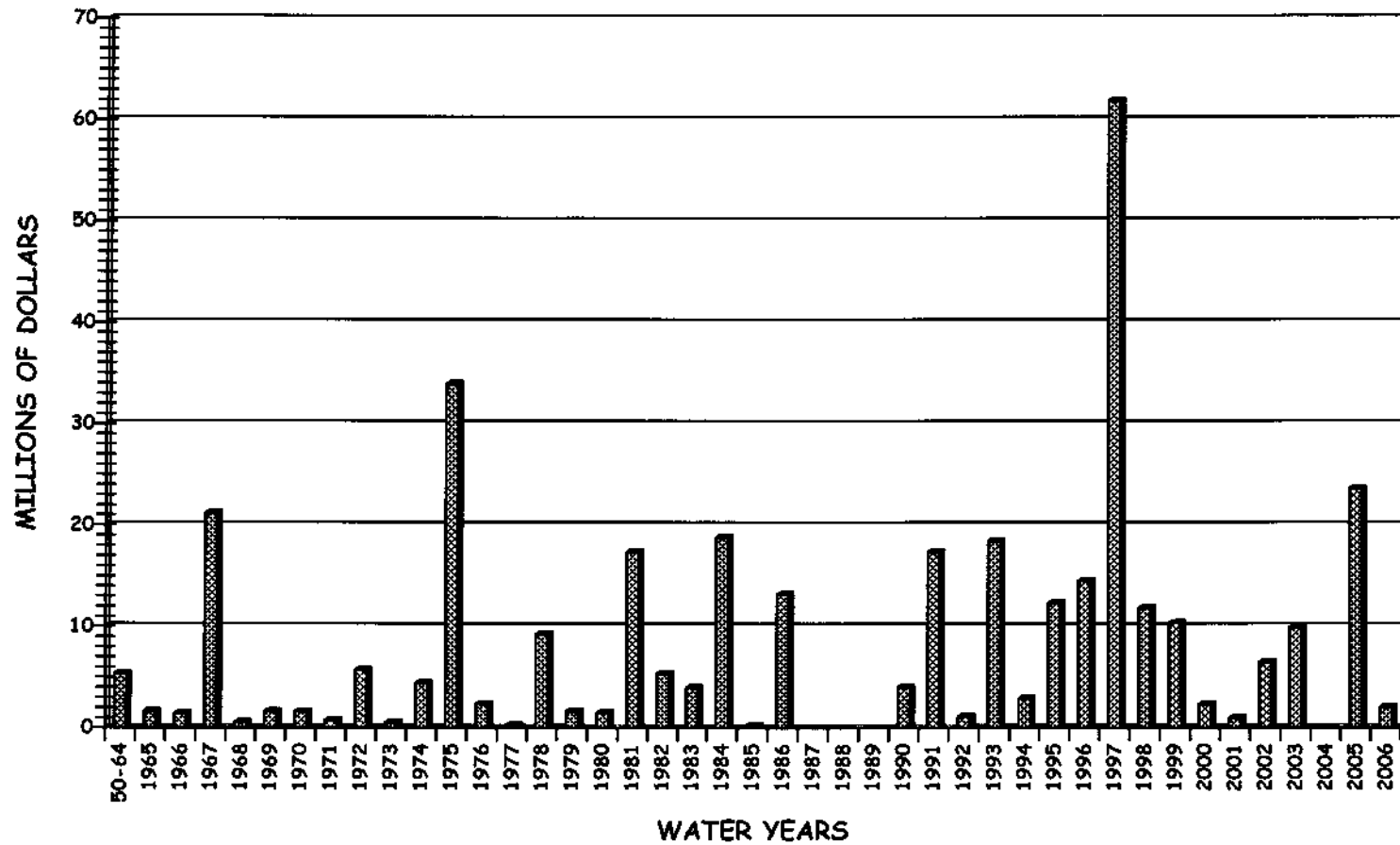
TABLE MTT4  
FLOOD DAMAGES PREVENTED  
(THOUSANDS OF DOLLARS)

| <u>Reservoir</u>    | <u>Local</u> | <u>Main<br/>Stem</u> | <u>2006<br/>Total</u> | <u>Prev.<br/>Accum.</u> | <u>1950-2006<br/>Accum. Total</u> |
|---------------------|--------------|----------------------|-----------------------|-------------------------|-----------------------------------|
| Clark Canyon        | \$ 0.0       | \$ 0.0               | \$ 0.0                | \$ 12,503.5             | \$ 12,503.5                       |
| Canyon Ferry        | 1,847.5      | 108.4                | 1,955.9               | 148,818.3               | 150,774.2                         |
| Gibson <sup>1</sup> | 0.0          | 0.0                  | 0.0                   | 3,044.5                 | 3,044.5                           |
| Lake Elwell         | 0.0          | 11.5                 | 11.5                  | 60,888.9                | 60,900.2                          |
| Lake Sherburne      | 0.0          | 0.0                  | 0.0                   | 5,537.2                 | 5,537.2                           |
| Fresno              | 0.0          | 0.0                  | 0.0                   | 13,085.5                | 13,085.5                          |
| Yellowtail          | 0.0          | 13.3                 | 13.3                  | 111,732.6               | 111,745.9                         |
| Total               | \$1,847.5    | \$ 133.2             | \$ 1,980.7            | \$326,466.6             | \$357,591.0                       |

<sup>1</sup> No space allocated to flood control, but some flood protection provided by operation for other purposes.

FIGURE MTG2

## FLOOD DAMAGES PREVENTED BY MONTANA AREA OFFICE PROJECTS



## **UNIT OPERATIONAL SUMMARIES FOR WATER YEAR 2006**

### **Clark Canyon Reservoir**

Clark Canyon Reservoir, a Pick-Sloan Missouri basin Program (P-S MBP) project, is located on the Beaverhead River approximately 20 miles upstream from Dillon, Montana. It has a total capacity of 257,152 acre-feet (255,643 acre-feet active). The reservoir is the storage facility for the East Bench Unit providing a full water supply for irrigation of 21,800 acres and a supplemental supply for about 28,000 acres. Flood control, recreation, and fish and wildlife are among the other functions served by the reservoir.



In 2000, Reclamation surveyed Clark Canyon Reservoir to develop a topographic map and compute a present storage-elevation relationship (area-capacity tables). The data were used to calculate reservoir capacity lost due to sediment accumulation since dam closure in August of 1964. The 2000 survey determined that Clark Canyon Reservoir has a storage capacity of 174,367 acre-feet and a surface area of 5,151 acres at a reservoir elevation of 5546.10. Since closure in 1964, the reservoir has accumulated a sediment volume of 4,106 acre-feet below elevation 5546.10. This volume represents a 2.3 percent loss in capacity and an average annual loss of 114.7 acre-feet. The revised area-capacity table was put into effect on October 1, 2001, reflecting the new storage levels.

Following 6 consecutive years of severe drought, weather conditions in the Beaverhead basin finally began to improve prior to the beginning of water year 2006. Valley precipitation, during August and September, was near normal at 87 and 94 percent of average while the mountain precipitation was 91 and 99 percent of average. The improved precipitation however did not change streamflows significantly. Inflow to Clark Canyon during August and September continued to remain well below normal at only 67 and 57 percent of average, respectively. Large irrigation demands during water year 2005 once again placed a heavy demand on storage in Clark Canyon Reservoir. Following the conclusion of the irrigation season, releases from Clark Canyon were gradually reduced to the fall and winter flow rate of about 40 cfs during September 19-October 6, which is much below the minimum recommended fishery flow between 100-200 cfs. Beginning in late-August, storage in Clark Canyon began to steadily increase and entered water year 2006 with a content of 43,991 acre-feet at elevation 5511.32. At 23 percent of average, this was 6<sup>th</sup> lowest level of record for this time of year and 19,262 acre-feet or 10.09 feet higher than at the beginning of water year 2005.

The 2006 water year began with significant storm activity, resulting in valley and mountain precipitation being much above average during October and November. The valley precipitation was 145 and 185 percent of average respectively, while the mountain precipitation was 101 and 129 percent of average respectively. Weather conditions changed a bit in December as the valley and mountain precipitation respectively declined to 91 and 84 percent of average.

On January 1, the Natural Resources and Conservation Service (NRCS) measured snowpack in the Beaverhead River basin at 114 percent of average. This was an improvement of 23 percent from the



snowpack experienced on January 1, 2005. Snow continued to fall in the Beaverhead River Basin at above normal rates and by February 1, the snowpack was measured at 117 percent of average. This was a 36 percent increase above the snowpack measured on February 1, 2005. However weather conditions would soon change due to below average mountain and valley precipitation during February. On March 1, the measured snowpack in the Beaverhead basin had declined to near normal and essentially remained this way through April, indicating that another year of drought may likely occur. The combination of previous drought years and much below average precipitation resulted in near record low inflows for October through March. Inflow for October through March was 72,728 acre-feet, or 64 percent of normal. This was 28,154 acre-feet or 18 percent higher than the inflows experienced in 2005.

On April 1, the NRCS measured the mountain snowpack to be 103 percent of average. Spring storms frequented the Beaverhead watershed during April, contributing to the valley precipitation increasing to 147 percent of average and the mountain precipitation increasing to 123 percent of average. In 2006, the mountain snowpack peaked on April 20 at 115 percent of average. This was near the normal time and nearly 2.0 inches above the average peak content of 15.3 inches. The mountain snowmelt in the Beaverhead River basin normally begins in late April or early May. By May 1, the snowpack remained near average at 110 percent of average.

Several years of consecutive drought have had a significant affect in southwestern Montana. While there was improved moisture in 2006, the soil moisture deficits were still very severe in many locations throughout the basin during the winter and spring of 2006. Weather conditions changed dramatically during May for the worse. Valley precipitation was 46 percent of average while the mountain precipitation was only 40 percent of average. Because of the low precipitation, soil conditions in the basin remained dry and early upstream irrigation demands were high. As a result, inflows continued to remain well below average at near record low levels.

Based on the mountain snowpack, the water supply forecast prepared on April 1, indicated the April-July runoff into Clark Canyon would be 71 percent of normal, totaling approximately 80,300 acre-feet. This was an increase of 48 percent or 54,800 acre-feet higher than at this same time in 2005. Even with the much below average storage at the beginning of April, for the first time in the past 6 years, the April forecast of inflow looked favorable for the East Bench Irrigation District (EBID) to receive a full water supply during 2006. Several meetings and conference calls were held with the Clark Canyon Joint Board prior to the beginning of the irrigation season to discuss the water supply outlook for the 2006 irrigation season. The Joint Board consisted of three representatives from each water user entity.

Snowmelt runoff during April through July was well below normal at only 57 percent of average. Daily inflows into Clark Canyon Reservoir averaged 270 cfs during April, 215 cfs during May, 249 cfs during June and 324 cfs during July. These resulted in respective monthly total inflows of 16,085 acre-feet, 13,190 acre-feet, 14,824 acre-feet and 19,905 acre-feet. These resulted in a total increase of 26,120 acre-feet greater than experienced in 2005. Releases during this time averaged 30 cfs during April, 382 cfs during May, 494 cfs during June and 698 cfs during July. As a result, storage slowly increased to a peak for the year of 123,852 acre-feet at elevation 5535.63 on May 9,



before irrigation demands in 2006 required storage to begin drafting. This was 77 percent of normal and 71 percent of full capacity. This was also 94,353 acre-feet or 15.65 feet higher than the 2005 peak storage. The peak inflow for the year was recorded on June 9 at 515 cfs. This was also the 9<sup>th</sup> lowest peak daily inflow since the construction of the dam. The total April-July inflow to Clark Canyon was 57 percent of average totaling 64,004 acre-feet and was the 14<sup>th</sup> lowest April-July inflow of record since construction of Clark Canyon Dam.

After near normal precipitation during June, the valley and mountain precipitation once again dropped to well below normal during July and August. The valley precipitation was 66 and 54 percent of average respectively, while the mountain precipitation was 65 and 38 percent of average respectively. During September, valley precipitation continued to decline to 45 percent of average, while a few fall storms brought above normal precipitation to the higher elevations.

By the end of September the total cumulative valley precipitation for the year was 83 percent of average while the total cumulative mountain precipitation for the Beaverhead basin was 89 percent of average. Unfortunately, the lack of valley precipitation during July through early September produced heavy demands on storage out of Clark Canyon to meet the downstream irrigation demands. Storage in Clark Canyon was quickly depleted until reaching a low content for the year of 58,589 acre-feet at elevation 5517.24 on September 7. With the irrigation season winding down shortly after the Labor Day Weekend, releases out of Clark Canyon were gradually reduced beginning about September 6 to the fall and winter rate of about 40 cfs by October 6.

The majority of the storage water released from Clark Canyon Reservoir during water year 2006 to meet the downstream irrigation demands was released during April 27 through October 6. During this time, releases reached a peak for the year of 870 cfs on July 22 to satisfy the downstream water needs. Beginning in early May, storage in Clark Canyon declined from a peak of 123,852 acre-feet at elevation 5535.63 on May 9 to 58,589 acre-feet at elevation 5517.24 on September 7, at which time inflows exceeded releases and storage began to increase. Storage in Clark Canyon Reservoir increased through September and ended the water year at 64,402 acre-feet at elevation 5519.31. This was 52 percent of average and 20,411 acre-feet or 7.99 feet greater than at the end of water year 2005. This was the 11<sup>th</sup> lowest end of water year storage level recorded at Clark Canyon. This storage level was about 4,400 acre-feet above the desired minimum target level of 60,000 acre-feet recommended by the Montana Fish, Wildlife and Parks as the minimum required to sustain an adequate and healthy lake fishery. This marked the first time since 1999 that year-end storage has finally been above 60,000 acre-feet. Beginning about September 6 and continuing through October 6, the releases were gradually reduced to a fall and winter flow of about 40 cfs in an effort to conserve storage for the next season. This release was again much below the minimum recommended fishery flow of between 100-200 cfs.

EBID water users received approximately 69,600 acre-feet and Clark Canyon Water Supply Company received approximately 89,800 acre-feet during water year 2006. The total annual inflow to Clark Canyon Reservoir during 2006 was 62 percent of average, totaling 165,874 acre-feet, the 11<sup>th</sup> lowest annual inflow of record. By comparison, this was 59,033 acre-feet more than the total annual inflow of water year 2005. The total annual release to the Beaverhead River from Clark

Canyon was 145,463 acre-feet or 57 percent of normal and was also the 10<sup>th</sup> lowest annual release of record since construction of the dam. This was 57,884 acre-feet more than what was released during the drought of 2005.

Lima Reservoir is a private irrigation facility located upstream of Clark Canyon Reservoir on the Red Rock River, a tributary of the Beaverhead River. Lima Reservoir filled to the top of the conservation pool in water year 2006 and peaked at 80,379 acre-feet, which was 94 percent of full capacity on May 10. The drainage area above Lima Reservoir accounts for about 25 percent of the total drainage area above Clark Canyon Reservoir.

Streamflow of the Beaverhead River at Barretts peaked at 928 cfs on July 23 due to irrigation releases from storage, but the streamflow would have peaked at 758 cfs on June 9 if Clark Canyon Reservoir would not have been controlling the releases.

The Corps of Engineers determined that during 2006, Clark Canyon did not prevent any local or main stem flood damages. Since construction of the Clark Canyon Dam in 1965, Clark Canyon Reservoir has reduced flood damages by a total of \$12,503,400.

### **Important Events - 2006**

September 26, 2005: Following the 2005 irrigation season, releases from Clark Canyon to the Beaverhead River were reduced to approximately 30 cfs to conserve storage and allow Clark Canyon Reservoir to gradually increase throughout the fall and winter.

April 27: This marked the beginning of when releases from Clark Canyon were increased to meet downstream irrigation demands.

May 9: Clark Canyon Reservoir reached a peak storage content of 123,852 acre-feet at elevation 5535.63. This was 71 percent of full capacity and 50,515 acre-feet or 10.47 feet below the top of the joint-use pool.

June 9: Inflow to Clark Canyon reached a peak for the year at 516 cfs.

July 22: Releases from Clark Canyon Reservoir reached a peak of 870 cfs to meet downstream water demands from the Beaverhead River.

September 6-October 6: Gradually reduced releases from Clark Canyon Dam to the Beaverhead River to the winter flow rate of approximately 40 cfs.

September 8: Storage in Clark Canyon Reservoir was drafted to a content of 54,589 acre-feet at elevation 5517.24. This was 31 percent of full capacity and 119,778 acre-feet or 28.86 feet below the top of the joint-use pool. After this time the reservoir began to refill due to the decrease in downstream irrigation demands.

September 30: Clark Canyon Reservoir ends the water year with the 11th lowest storage on record.

Additional hydrologic and statistical information pertaining to the operation of Clark Canyon Reservoir during 2006 can be found in Table MTT5 and Figure MTG3.

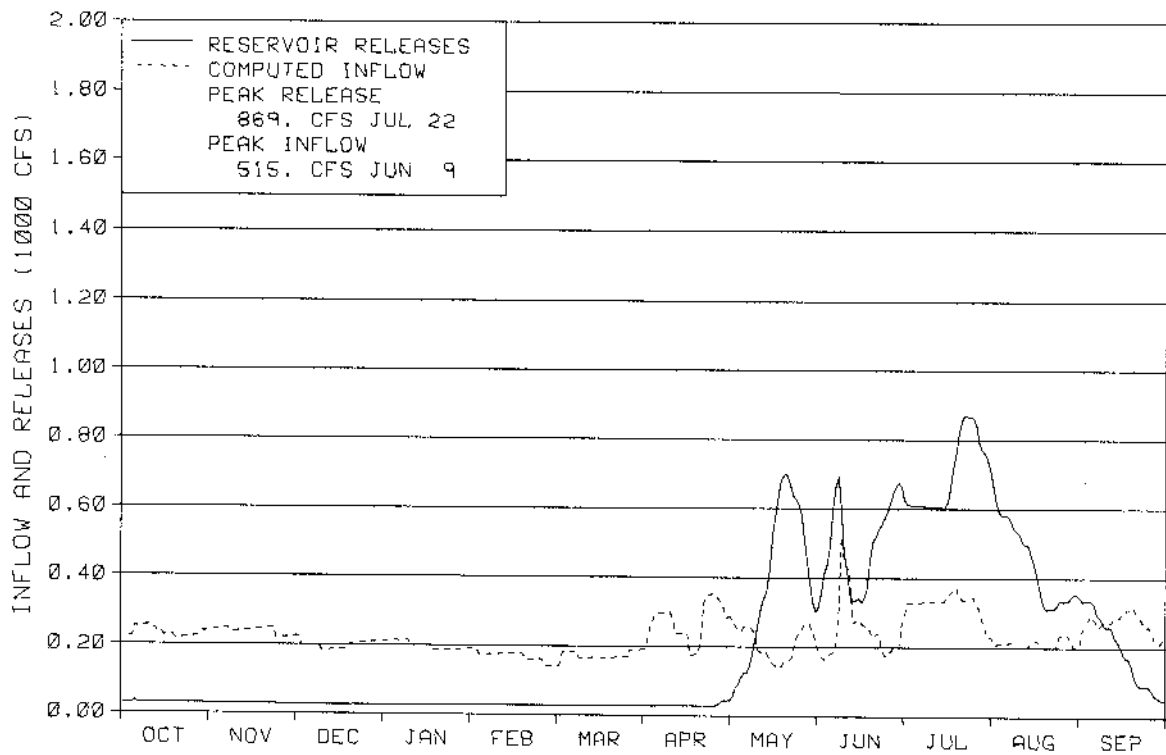
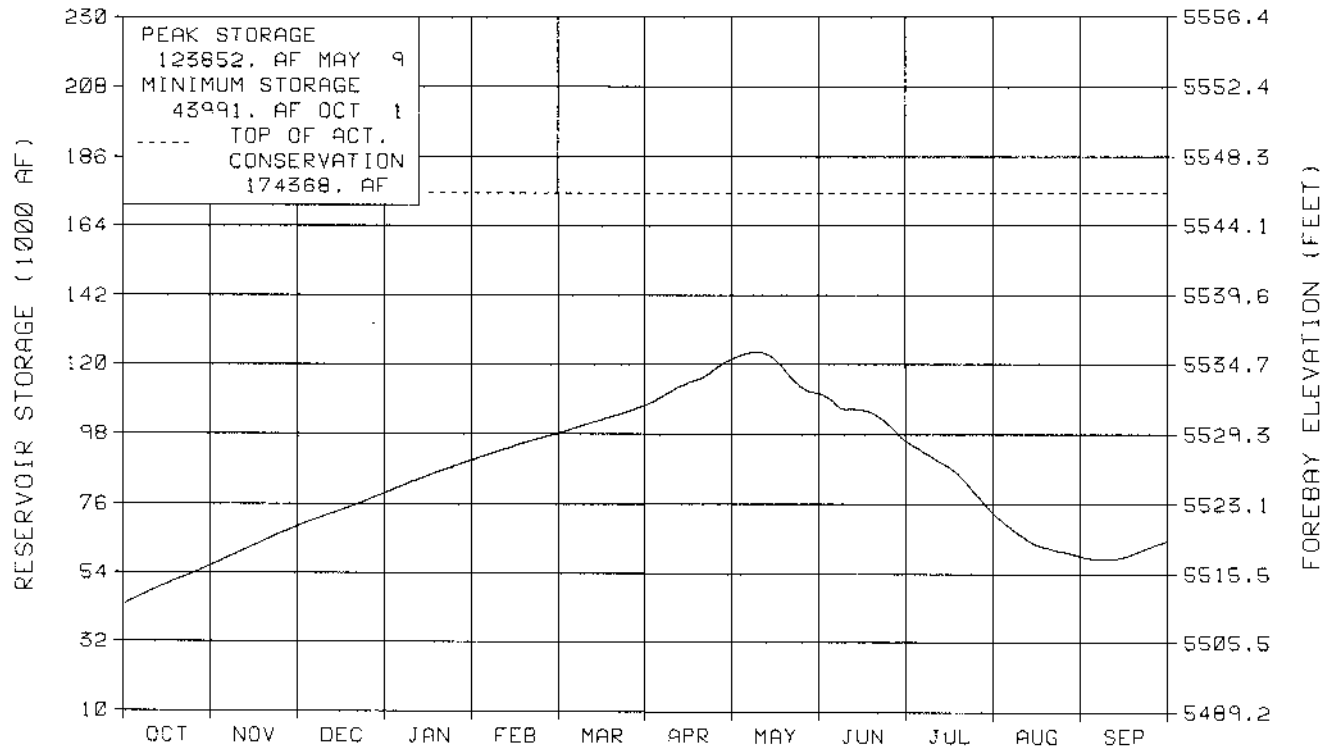
TABLE MTT5  
HYDROLOGIC DATA FOR 2006  
CLARK CANYON - EAST BENCH UNIT  
NEW SEDIMENT SURVEY DATA EFFECTIVE 10/1/2001

| RESERVOIR ALLOCATIONS                                      |            | ELEVATION<br>(FEET) |               | TOTAL<br>RESERVOIR<br>STORAGE (AF) |          | STORAGE<br>ALLOCATION<br>(AF) |          |  |
|------------------------------------------------------------|------------|---------------------|---------------|------------------------------------|----------|-------------------------------|----------|--|
| TOP OF INACTIVE AND DEAD                                   |            | 5470.60             |               | 1,061                              |          | 1,061                         |          |  |
| TOP OF ACTIVE CONSERVATION                                 |            | 5535.70             |               | 124,160                            |          | 123,099                       |          |  |
| TOP OF JOINT USE                                           |            | 5546.10             |               | 174,367                            |          | 50,207                        |          |  |
| TOP OF EXCLUSIVE FLOOD CONTROL                             |            | 5560.40             |               | 253,442                            |          | 79,075                        |          |  |
|                                                            |            |                     |               |                                    |          |                               |          |  |
| STORAGE-ELEVATION DATA                                     |            | ELEVATION (FT)      |               | STORAGE (AF)                       |          | DATE                          |          |  |
| BEGINNING OF YEAR                                          |            | 5511.32             |               | 43,991                             |          | OCT 01, 2005                  |          |  |
| END OF YEAR                                                |            | 5519.31             |               | 64,402                             |          | SEP 30, 2006                  |          |  |
| ANNUAL LOW                                                 |            | 5511.32             |               | 43,991                             |          | OCT 01, 2005                  |          |  |
| ANNUAL HIGH                                                |            | 5535.63             |               | 123,852                            |          | MAY 09, 2006                  |          |  |
| HISTORIC HIGH                                              |            | 5564.70             |               | 283,073                            |          | JUN 25, 1984                  |          |  |
|                                                            |            |                     |               |                                    |          |                               |          |  |
| INFLOW-OUTFLOW DATA                                        |            | INFLOW              | DATE          |                                    | OUTFLOW  | DATE                          |          |  |
| ANNUAL TOTAL (AF)                                          |            | 165,874             | OCT 05-SEP 06 |                                    | 145,463  | OCT 05-SEP 06                 |          |  |
| DAILY PEAK (CFS)                                           |            | 515                 | JUNE 09, 2006 |                                    | 869      | JUL 22, 2006                  |          |  |
| DAILY MINIMUM (CFS)                                        |            | 139                 | MAY 18, 2006  |                                    | 26       | NOV 24, 2005                  |          |  |
| DAILY FLOW AT BARRETTS (CFS)                               |            |                     |               |                                    | 928      | JUL 23, 2006                  |          |  |
| DAILY FLOW AT BARRETTS W/O<br>CLARK CANYON RESERVOIR (CFS) |            |                     |               |                                    | 758      | JUN 09, 2006                  |          |  |
| PEAK SPILL (CFS)                                           |            |                     |               |                                    | 0        | NONE                          |          |  |
| TOTAL SPILL (AF)                                           |            |                     |               |                                    | 0        | NONE                          |          |  |
|                                                            | MONTH      | INFLOW              |               | OUTFLOW*                           |          | CONTENT                       |          |  |
|                                                            |            | KAF                 | % OF AVG      | KAF                                | % OF AVG | KAF                           | % OF AVG |  |
|                                                            | OCTOBER    | 14.3                | 61            | 1.8                                | 11       | 56.5                          | 45       |  |
|                                                            | NOVEMBER   | 14.2                | 64            | 1.6                                | 11       | 69.0                          | 52       |  |
|                                                            | DECEMBER   | 12.2                | 64            | 1.6                                | 13       | 80.0                          | 58       |  |
|                                                            | JANUARY    | 12.2                | 76            | 1.6                                | 15       | 90.2                          | 65       |  |
|                                                            | FEBRUARY   | 9.3                 | 64            | 1.5                                | 15       | 98.0                          | 69       |  |
|                                                            | MARCH      | 10.6                | 56            | 1.7                                | 15       | 106.8                         | 72       |  |
|                                                            | APRIL      | 16.1                | 74            | 1.8                                | 11       | 121.1                         | 76       |  |
|                                                            | MAY        | 13.2                | 48            | 23.5                               | 15       | 110.8                         | 67       |  |
|                                                            | JUNE       | 14.8                | 41            | 29.4                               | 33       | 96.3                          | 58       |  |
|                                                            | JULY       | 19.9                | 72            | 42.9                               | 71       | 73.2                          | 49       |  |
|                                                            | AUGUST     | 13.0                | 67            | 27.0                               | 52       | 59.3                          | 46       |  |
|                                                            | SEPTEMBER  | 16.1                | 80            | 11.0                               | 55       | 64.4                          | 52       |  |
|                                                            | ANNUAL     | 165.9               | 62            | 145.5                              | 57       |                               |          |  |
|                                                            | APRIL-JULY | 64.0                | 57            |                                    |          |                               |          |  |

\* Average for the 1965-2006 period.

# FIGURE MTG3

## CLARK CANYON RESERVOIR



WATER YEAR 2006

## **Canyon Ferry Lake and Powerplant**

Canyon Ferry Lake (P-S MBP), formed by Canyon Ferry Dam, is located on the Missouri River near Helena, Montana. It has a total capacity of 1,992,977 acre-feet. The top 3 feet were allocated to exclusive flood control in February 1966. The next 27 feet are allocated to joint conservation and flood control purposes. The joint-use space will be evacuated for flood control purposes only to the extent that refill during the spring runoff is reasonably assured. The conservation space was constructed mainly for power generation and to provide replacement storage for several new irrigation developments



located on the Missouri River and its tributaries above Great Falls, Montana. To date, however, the conservation storage has been used primarily for power production. The only new areas under irrigation are 5,000 acres being irrigated on the Crow Creek Unit (P-S MBP), 13,900 acres on the Helena Valley Unit (P-S MBP), and 20,300 acres on the East Bench Unit (P-S MBP). In addition, about 5,200 acres in the Helena Valley Unit that were once irrigated by pumping from Lake Helena and from other streams, are now irrigated by pumping from Canyon Ferry Reservoir. About 28,000 acres on the East Bench Unit also receives a supplemental water supply. A small amount of municipal water is also furnished to the city of Helena, Montana, through facilities for the Helena Valley Unit.

In 1997, a hydrographic and a topographic survey was conducted and a new elevation-area-capacity table and curve was developed. The 1997 survey determined that Canyon Ferry Lake has a storage capacity of 1,992,977 acre-feet and a surface area of 34,048 acres at reservoir elevation 3800. Since closure in 1953, the reservoir has accumulated a sediment volume of 59,746 acre-feet below reservoir elevation 3800. This volume represents a 2.91 percent loss in capacity and an average annual loss of 1,345.6 acre-feet. The revised area-capacity table was put into effect on October 1, 1998, reflecting the new storage levels.

The persistent drought since 2001 has had lingering effects on streamflows into Canyon Ferry Lake over the past several years. The National Weather Service reported the valley precipitation during September 2005 was 78 percent of average while the mountain precipitation was 84 percent of average. This contributed to the well below normal inflows into Canyon Ferry during August and September. With inflows to Canyon Ferry Lake at only 60 percent of average during these months, conservative releases were maintained at rates that provided river flows downstream of Holter Dam at 4,100 cfs. As a result, Canyon Ferry Lake slowly declined and entered water year 2006 with a storage content of 1,550,596 acre-feet at elevation 3786.42. This was 91 percent of average and 151,646 acre-feet and 5.03 feet higher than at the beginning of water-year 2005.

Precipitation in the Missouri River Basin above Canyon Ferry Lake was well above average during October through January. Valley precipitation during October and November was 185 and 172 percent of average, respectively, while the mountain precipitation was 95 and 136 percent of average, respectively. During December and January the valley precipitation dropped to 98 and

138 percent of average, respectively, while the mountain precipitation was 98 and 117 percent of average, respectively. Even though the precipitation during the fall and early winter was above normal, the lingering effects of the persistent drought continued to affect the inflow to Canyon Ferry Lake. During October through December the inflow averaged 75 percent of normal and improved to 102 percent of average during January. At the beginning of the year with storage 5 feet higher than a year ago, plans were made to maintain river flows downstream of Holter Dam no lower than 4,100 cfs to protect the downstream river fishery. Maintaining releases at or above this rate allowed storage in Canyon Ferry Lake to slowly decrease to 1,429,716 acre-feet at elevation 3782.44 by the end of December. This was 24,354 acre-feet or 0.83 feet higher than on December 31, 2004.

On January 1, the Natural Resources Conservation Service (NRCS) measured the mountain snowpack in the Missouri River Basin above Canyon Ferry to be 110 percent of average, about 29 percent higher than a year ago. Snowpack in the Jefferson, Madison, and Gallatin River Basins, major tributaries of the Missouri River Basin was 109, 112 and 124 percent of normal, respectively. As the winter proceeded, snow continued to accumulate in the mountains, but at slightly below normal rates. By April 1, mountain snowpack in the Missouri River Basin had declined to 98 percent of average. This was 32 percent higher than that experienced a year ago. Snowpack in the tributaries of the Jefferson, Madison, and Gallatin River Basins reported 103, 105, and 105 percent of normal respectively, as compared to 61, 72, and 75 percent of normal a year ago.

The water supply forecast prepared on April 1, indicated the April-July runoff into Canyon Ferry Lake was expected to be 99 percent of average, totaling 2,012,000 acre-feet. With storage at 87 percent of average, projected operations indicated the release out of Canyon Ferry to the Missouri River could continue to be maintained at rates that would provide flows in the Missouri River downstream of Holter Dam at or above 4,100 cfs during April through June and still allow Canyon Ferry Lake to fill to the top of the joint-use pool at elevation 3797 near the end of June.

Precipitation in Montana varied considerably during April through June. Valley precipitation above Canyon Ferry Lake during April, May, and June was respectively 177, 55, and 110 percent of average while the mountain precipitation was 119, 48, and 107 percent of average, respectively. The lingering effects of the persistent drought kept the inflow to Canyon Ferry Lake well below normal during February and March. However, with the generous rains received during April, inflow to Canyon Ferry slowly recovered and increased to 110 and 105 percent of average during April and May. Unseasonably warm temperatures were experienced during April through June. The warmer temperatures quickly melted the high elevation snow, but it was not until about the middle of May that the snowmelt runoff actually began to flow into Canyon Ferry Lake. Inflows to Canyon Ferry gradually increased from near 6,000 cfs about the middle of May to 16,066 cfs by May 28. To control the rate of fill in Canyon Ferry Lake, a peak discharge from Canyon Ferry Lake to the Missouri River for the year was recorded on May 16 at 6,147 cfs. With most of the high elevation snow above Canyon Ferry Lake melted out by early June, inflow to Canyon Ferry Lake quickly receded.

In early June, another major storm system moved into Montana, bringing significant precipitation with it. Inflow to Canyon Ferry Lake once again increased significantly, reaching a peak for the

year of 16,829 cfs on June 11. Immediately following the generous rains, inflow quickly and dramatically declined to near 3,650 cfs by the end of June. Total inflow during June was 71 percent of average and continued to decline to only 46 percent of average during July.

Reservoir operations were closely monitored and plans were prepared to best assure storage in Canyon Ferry would fill and reach the top of the joint-use pool at elevation 3797 by the end of June.

With strict conservative releases maintained out of Canyon Ferry Lake, storage in Canyon Ferry Lake slowly filled from a content of 1,323,217 acre-feet at elevation 3778.73 on May 15 to a peak content for the year of 1,870,599 acre-feet at elevation 3796.36 on June 28, about 21,289 acre-feet or 0.64 feet below the top of the joint-use pool.

Valley precipitation in the Missouri River Basin during July, August, and September was 75, 54, and 72 percent of average, respectively, while the mountain precipitation was 64, 45, and 91 percent of average, respectively. Because of the well below normal precipitation in the Missouri River Basin, the July-September inflow to Canyon Ferry Lake was only 51 percent of average, totaling 365,326 acre-feet. With releases continuing to be maintained at rates that would maintain river flows downstream of Holter Dam at or above 4,100 cfs, storage in Canyon Ferry Lake was quickly receding. By August 1, Canyon Ferry Lake had reached a storage content of 1,777,868 acre-feet at elevation 3793.54 and was declining at a rate of about 2 inches per day. In closely monitoring the situation, plans were being made to maintain river flows downstream of Holter Dam at or above 3,500 cfs to slow the rate of decline in storage. By the end of the year, Canyon Ferry Lake reached a storage content of 1,526,128 acre-feet at elevation 3785.63. This was 89 percent of average and about 24,468 acre-feet or 0.79 feet lower than at the end of water year 2005.

Since March 2000 through December 2006, the inflow to Canyon Ferry has been below average for 70 consecutive months. This marks the longest period of record that the monthly inflows to Canyon Ferry Lake were below average. The April-July runoff into Canyon Ferry totaled 1,687,292 acre-feet. This was 83 percent of average and 323,119 acre-feet higher than the inflow experienced in 2005.

The annual inflow to Canyon Ferry Lake was 79 percent of average, totaling 3,136,600 acre-feet. This was 435,196 acre-feet greater than the total annual inflow experienced in water-year 2005.

During 2006, Canyon Ferry powerplant generated 346,280,000 kilowatt-hours. This was 69 percent of the long-term average and 66,802,000 kilowatt-hours more than generated in 2005. The plant used 93 percent of the water released from the dam in 2006 (2,936,389 acre-feet). The remainder of the water was released to meet the irrigation needs of the Helena Valley Irrigation District (215,316 acre-feet) and spilled through the river outlet gates (9,363 acre-feet) to allow for scheduled maintenance outages at Canyon Ferry Dam and Powerplant.

The Corps of Engineers estimated that during 2006, Canyon Ferry prevented \$1,847,500 in local flood damages and also prevented \$108,400 in flood damages downstream on the Missouri River below Fort Peck Reservoir. Since construction of the Canyon Ferry Dam in 1954, Canyon Ferry Reservoir has reduced flood damages by a total of \$150,774,200.



### **Important Events - Water Year 2006**

October 3: All irrigation deliveries to the Helena Valley Unit were discontinued for the 2005 irrigation season. To continue conserving storage in Canyon Ferry, turbine releases were maintained above 4,100 cfs downstream of Holter Dam, the desired minimum flow required to protect the downstream river fishery.

September 30-October 6: PPL-MT completed maintenance work around Hauser and Holter Reservoirs. To assist them in refilling the reservoirs, total release from Canyon Ferry was increased to 5,115 cfs ( $\approx$  4,530 cfs through the powerplant and 585 cfs for the Helena Valley Project) on September 30. On October 6, normal operations resumed with the total release from Canyon Ferry being reduced to 4,115 cfs ( $\approx$  3,530 cfs through the powerplant and 585 cfs for the Helena Valley Project).

October 13: To allow for maintenance work on the hydraulic cylinder of Unit No. 1's fixed wheel gate, turbine releases were reduced and restricted to 2-unit capacity (3,745 cfs) for approximately 10 hours. After maintenance was completed, turbine releases were increased to maintain minimum flows of 4,100 cfs downstream of Holter Dam.

October 28: Flow measurements indicated actual river flows below Holter Dam were less than anticipated. Turbine releases from Canyon Ferry were adjusted to maintain river flows downstream of Holter Dam at or near 4,100 cfs.

November 16: PPL-MT reported difficulty in maintaining stable levels in Hauser and Holter Reservoirs while maintaining river flows below Holter Dam at or above 4,100 cfs. At the request of PPL-MT, the turbine releases out of Canyon Ferry were increased to 4,035 cfs.

January 23: Emergency maintenance was required on Unit No. 1 of the powerplant. In response, turbine releases were reduced 2-unit capacity and after the maintenance was completed, the turbine releases were increased to 4,055 cfs.

February 7: Snowpack in the basin was 120 percent of average. Based on the February water supply outlook, turbine releases were increased to 4,500 cfs to evacuate storage as projected.

February 21-March 23: Triennial maintenance was scheduled on Unit No. 2 of the powerplant. To allow for the maintenance and continue evacuating storage from Canyon Ferry Lake as projected, turbine releases were restricted to 2-unit capacity and releases through the river outlet gates were initiated. The total release from Canyon Ferry was maintained at 4,500 cfs ( $\approx$  4,000 cfs through the powerplant and 500 cfs through the river outlet gates).

March 8: Triennial maintenance was completed on Unit No. 2 of the powerplant. All releases through the river outlet gates were discontinued and releases through the powerplant were increased to 4,500 cfs.

March 16: Snowpack in the basin was 106 percent of average. Based on the March water supply outlook, turbine releases were increased to 4,800 cfs to evacuate storage as projected.

March 21: Irrigation deliveries to Helena Valley Unit were initiated on March 21 and adjusted periodically throughout the irrigation season to meet the irrigation demands. Based on the revised water supply outlook, turbine releases from Canyon Ferry powerplant were also adjusted proportionately to maintain the total release from Canyon Ferry at 5,100 cfs ( $\approx$  4,800 cfs through the powerplant and 300 cfs for the Helena Valley Project).

March 29-30: Helena Valley Reservoir was approaching full pool. In response, total release from Canyon Ferry was gradually decreased to 4,800 cfs ( $\approx$  4,800 cfs through the powerplant and 0 cfs for the Helena Valley Project).

April 5: Helena Valley Irrigation District increased irrigation deliveries. In response, total release from Canyon Ferry was increased to 5,020 cfs ( $\approx$  4,800 cfs through the powerplant and 220 cfs for the Helena Valley Project).

April 13: Reclamation attended and participated in the Upper Missouri River Advisory Group meeting held in the Department of Water Quality Building in Helena, Montana. Tim Felchle, Chief of Reservoir and River Operations, presented the water supply outlook for the upper Missouri River Basin and the proposed operations for Canyon Ferry for 2006.

April 13: Construction work is proceeding on at Goose Bay and Broadwater Bay recreation areas. As inflow to Canyon Ferry gradually increased, total release from Canyon Ferry was increased to 5,800 cfs ( $\approx$  5,540 cfs through the powerplant and 260 cfs for the Helena Valley Project), to prevent the level of Canyon Ferry from increasing.

April 14: Helena Valley Irrigation District increased irrigation deliveries. In response, total release from Canyon Ferry was increased to 5,930 cfs ( $\approx$  5,540 cfs through the powerplant and 390 cfs for the Helena Valley Project).

April 19: Rains caused inflow to Canyon Ferry to increase. To slow the rate of rise of storage in Canyon Ferry, total release from Canyon Ferry was increased to 6,120 cfs ( $\approx$  5,800 cfs through the powerplant and 320 cfs for the Helena Valley Project).

April 28-May1: Helena Valley Irrigation District increased irrigation deliveries. In response, total release from Canyon Ferry was gradually increased to 6,310 cfs ( $\approx$  5,810 cfs through the powerplant and 500 cfs for the Helena Valley Project).

May 15-19: Cool temperatures delayed the normal high elevation snowmelt. To accelerate refilling Canyon Ferry prior to Memorial Day weekend, total release from Canyon Ferry was gradually decreased to 5,120 cfs ( $\approx$  4,300 cfs through the powerplant and 820 cfs for the Helena Valley Project).

May 24: The snowmelt runoff into Canyon Ferry appears to be reaching a peak flow rate. To better assure Canyon Ferry Reservoir of filling to the top of the joint-use pool, total release from Canyon Ferry was decreased to 4,640 cfs ( $\approx$  3,800 cfs through the powerplant and 840 cfs for the Helena Valley Project).

June 5: The snowmelt runoff into Canyon Ferry continues to quickly recede. To better assure Canyon Ferry Reservoir of filling to the top of the joint-use pool, total release from Canyon Ferry was decreased to 4,045 cfs ( $\approx$  3,300 cfs through the powerplant and 745 cfs for the Helena Valley Project).

June 13-14: Recent rains and record high temperatures quickly melted the remaining high elevation snow, has caused streamflows into Canyon Ferry to increase dramatically. To control and slow the rate of fill of storage in Canyon Ferry Reservoir, total release from Canyon Ferry was gradually increased to 4,915 cfs ( $\approx$  4,500 cfs through the powerplant and 415 cfs for the Helena Valley Project).

June 15-21: Streamflows upstream of Canyon Ferry are receding more quickly than anticipated. To better assure Canyon Ferry Reservoir of filling to the top of the joint-use pool, total release from Canyon Ferry was gradually decreased to 3,550 cfs ( $\approx$  3,100 cfs through the powerplant and 450 cfs for the Helena Valley Project).

June 24: PPL-MT reported difficulty in maintaining stable levels in Hauser and Holter Reservoirs while maintaining river flows below Holter Dam no lower than 4,100 cfs. In response, the total release out of Canyon Ferry was increased to 3,750 cfs ( $\approx$  3,300 cfs through the powerplant and 450 cfs for the Helena Valley Project).

June 27-30: Helena Valley Irrigation District increased irrigation deliveries. In response, total release from Canyon Ferry was gradually increased to 3,830 cfs ( $\approx$  3,205 cfs through the powerplant and 625 cfs for the Helena Valley Project).

July 1: PPL-MT reported difficulty in maintaining stable levels in Hauser and Holter Reservoirs while maintaining river flows below Holter Dam no lower than 4,100 cfs. In response, the total release out of Canyon Ferry was increased to 3,870 cfs ( $\approx$  3,205 cfs through the powerplant and 665 cfs for the Helena Valley Project).

July 12: PPL-MT reported difficulty in maintaining stable levels in Hauser and Holter Reservoirs while maintaining river flows below Holter Dam no lower than 4,100 cfs. In response, the total release out of Canyon Ferry was increased to 3,965 cfs ( $\approx$  3,300 cfs through the powerplant and 665 cfs for the Helena Valley Project).

July 18: PPL-MT reported difficulty in maintaining stable levels in Hauser and Holter Reservoirs while maintaining river flows below Holter Dam no lower than 4,100 cfs. In response, the total release out of Canyon Ferry was increased to 4,065 cfs ( $\approx$  3,400 cfs through the powerplant and 665 cfs for the Helena Valley Project).

July 18: Helena Valley Irrigation District increased irrigation deliveries. In response, total release from Canyon Ferry was increased to 4,110 cfs ( $\approx$  3,400 cfs through the powerplant and 710 cfs for the Helena Valley Project).

July 24: PPL-MT reported recent streamflow measurements indicated actual river flows below Holter Dam are lower than anticipated. To adjust for the variation in river flows, total release from Canyon Ferry were increased to 4,315 cfs ( $\approx$  3,600 cfs through the powerplant and 715 cfs for the Helena Valley Project).

August 7: PPL-MT reported recent streamflow measurements indicated actual river flows below Holter Dam are higher than anticipated. To adjust for the variation in river flows, total release from Canyon Ferry were decreased to 3,810 cfs ( $\approx$  3,100 cfs through the powerplant and 710 cfs for the Helena Valley Project).

August 31: Helena Valley Irrigation District decreased irrigation deliveries. In response, total release from Canyon Ferry was decreased to 3,730 cfs ( $\approx$  3,090 cfs through the powerplant and 640 cfs for the Helena Valley Project).

September 6: Helena Valley Irrigation District decreased irrigation deliveries. In response, total release from Canyon Ferry was decreased to 3,685 cfs ( $\approx$  3,170 cfs through the powerplant and 515 cfs for the Helena Valley Project).

September 27-28: Helena Valley Irrigation District planned to discontinue all irrigation deliveries on September 28. In response, total release from Canyon Ferry was gradually decreased to 3,440 cfs ( $\approx$  3,440 cfs through the powerplant and 0 cfs for the Helena Valley Project).

Additional statistical information of Canyon Ferry Reservoir and its operations during 2006 can be found on Table MTT6 and Figure MTG4.

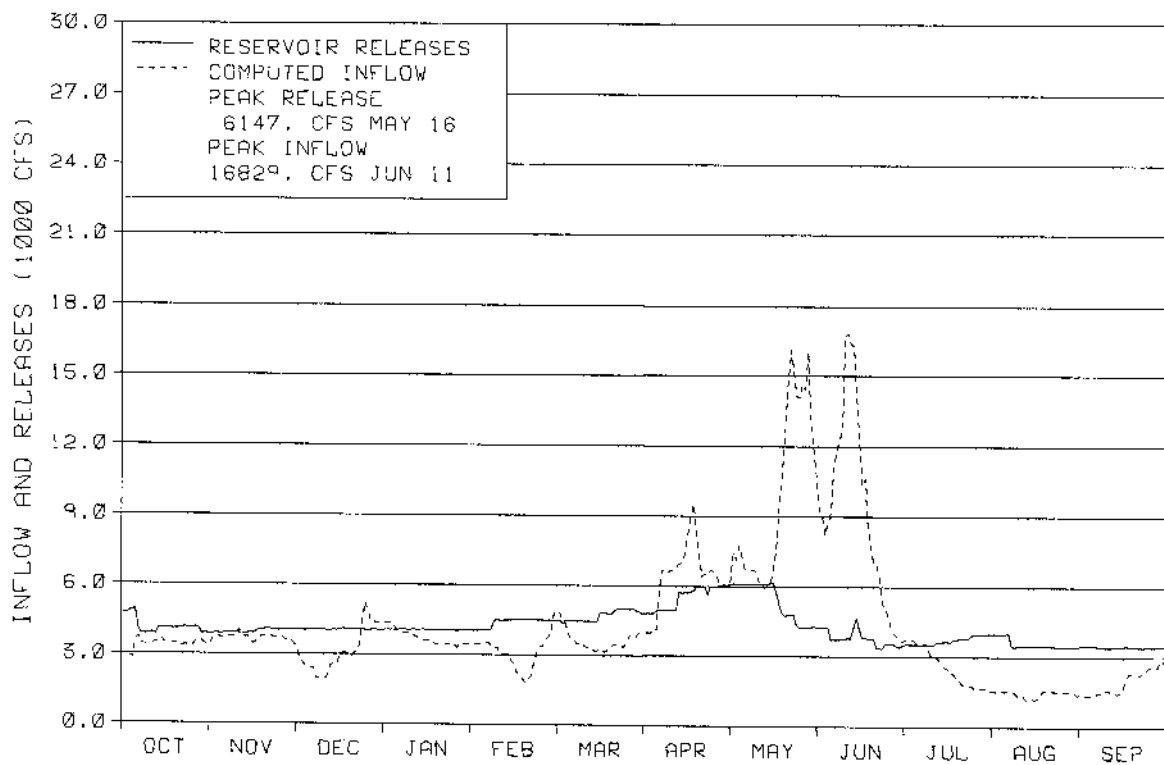
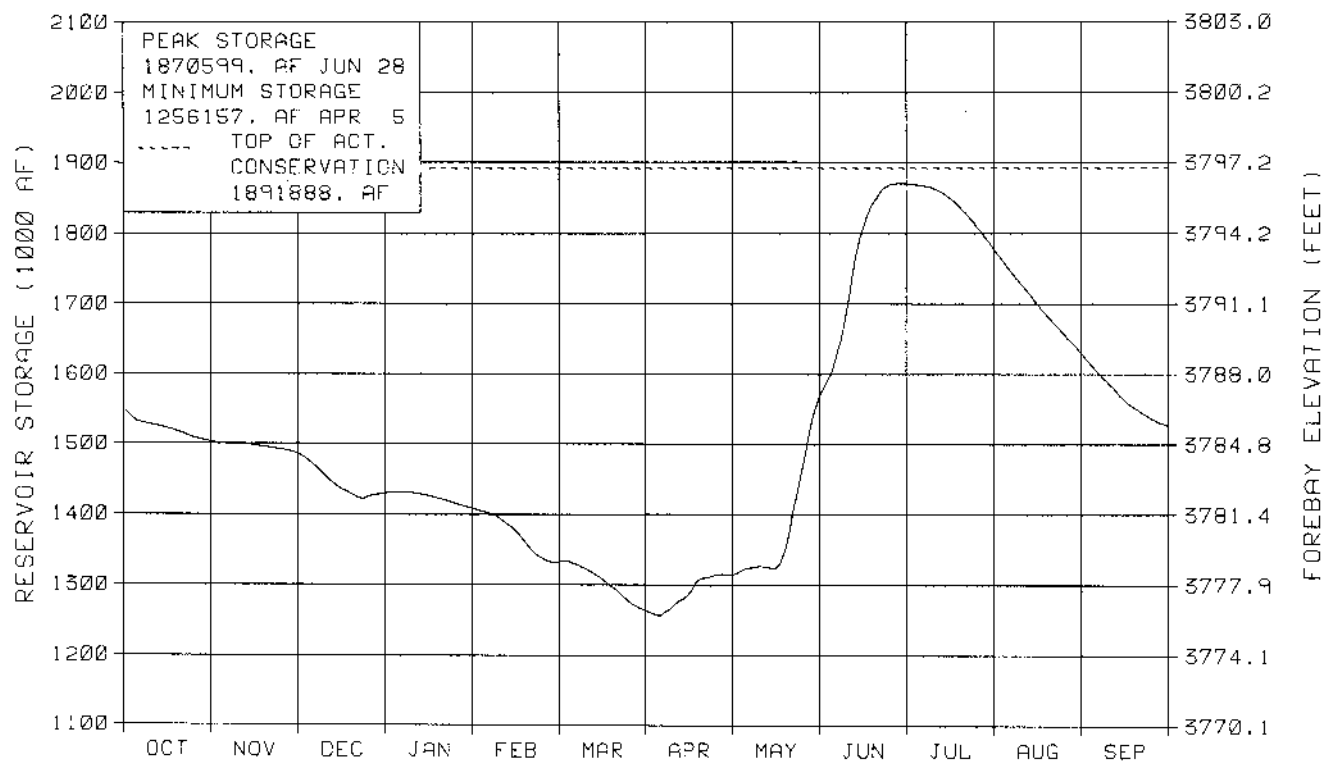
TABLE MTT6  
HYDROLOGIC DATA FOR 2006  
CANYON FERRY RESERVOIR

| RESERVOIR ALLOCATIONS          |         |             | ELEVATION<br>(FEET)                    | TOTAL<br>RESERVOIR<br>STORAGE (AF) |              | STORAGE<br>ALLOCATION<br>(AF) |         |                |
|--------------------------------|---------|-------------|----------------------------------------|------------------------------------|--------------|-------------------------------|---------|----------------|
| TOP OF INACTIVE AND DEAD       |         |             | 3728.00                                | 396,031                            |              | 396,031                       |         |                |
| TOP OF ACTIVE CONSERVATION     |         |             | 3770.00                                | 1,097,599                          |              | 701,568                       |         |                |
| TOP OF JOINT USE               |         |             | 3797.00                                | 1,891,888                          |              | 794,289                       |         |                |
| TOP OF EXCLUSIVE FLOOD CONTROL |         |             | 3800.00                                | 1,992,977                          |              | 101,089                       |         |                |
|                                |         |             |                                        |                                    |              |                               |         |                |
| STORAGE-ELEVATION DATA         |         |             | ELEVATION (FT)                         | STORAGE (AF)                       |              | DATE                          |         |                |
| BEGINNING OF YEAR              |         |             | 3786.42                                | 1,550,596                          |              | OCT 01, 2005                  |         |                |
| END OF YEAR                    |         |             | 3785.63                                | 1,526,128                          |              | SEP 30, 2006                  |         |                |
| ANNUAL LOW                     |         |             | 3776.27                                | 1,256,157                          |              | APR 05, 2006                  |         |                |
| ANNUAL HIGH                    |         |             | 3796.36                                | 1,870,599                          |              | JUN 28, 2006                  |         |                |
| HISTORIC HIGH                  |         |             | 3800.00                                | 2,050,900                          |              | JUN 23, 1964                  |         |                |
|                                |         |             |                                        |                                    |              |                               |         |                |
| INFLOW-OUTFLOW DATA            |         |             | INFLOW                                 | DATE                               |              | OUTFLOW                       |         | DATE           |
| ANNUAL TOTAL (AF)              |         |             | 3,136,598                              | OCT 05-SEP 06                      |              | 3,058,452                     |         | OCT 05-SEP 06  |
| DAILY PEAK (CFS)               |         |             | 16,829                                 | JUN 11, 2006                       |              | 6,147                         |         | MAY 16, 2006   |
| DAILY MINIMUM (CFS)            |         |             | 1,213                                  | AUG 15, 2006                       |              | 3,339                         |         | JUN 23, 2006   |
| PEAK SPILL (CFS)               |         |             |                                        |                                    |              | 358                           |         | FEB 22, 2006   |
| TOTAL SPILL (AF)               |         |             |                                        |                                    |              | 9,363                         |         | 2/21-4/24/2006 |
| MONTH                          | INFLOW  |             | OUTFLOW*                               |                                    |              |                               | CONTENT |                |
|                                | KAF     | % OF<br>AVG | PUMPED TO<br>HELENA<br>VALLEY<br>(KAF) | % OF<br>AVG                        | RIVER<br>KAF | % OF<br>AVG                   | KAF     | % OF<br>AVG    |
| OCTOBER                        | 207.7   | 73          | 1.3                                    | 146                                | 255.1        | 97                            | 1,501.9 | 87             |
| NOVEMBER                       | 219.7   | 74          | 0                                      | ---                                | 236.1        | 87                            | 1,485.4 | 85             |
| DECEMBER                       | 193.8   | 80          | 0                                      | ---                                | 249.5        | 84                            | 1,429.7 | 85             |
| JANUARY                        | 226.0   | 102         | 0                                      | ---                                | 249.5        | 84                            | 1,406.2 | 88             |
| FEBRUARY                       | 170.2   | 77          | 0                                      | ---                                | 244.8        | 91                            | 1,331.6 | 88             |
| MARCH                          | 223.7   | 83          | 2.6                                    | 889                                | 288.3        | 96                            | 1,264.4 | 87             |
| APRIL                          | 382.6   | 110         | 6.9                                    | 125                                | 326.6        | 107                           | 1,313.5 | 90             |
| MAY                            | 598.8   | 105         | 18.3                                   | 144                                | 330.3        | 91                            | 1,563.7 | 96             |
| JUNE                           | 548.9   | 71          | 17.1                                   | 112                                | 225.2        | 47                            | 1,870.3 | 99             |
| JULY                           | 157.1   | 46          | 21.5                                   | 129                                | 228.0        | 64                            | 1,777.9 | 97             |
| AUGUST                         | 90.2    | 53          | 21.4                                   | 138                                | 219.2        | 87                            | 1,627.3 | 94             |
| SEPTEMBER                      | 118.1   | 55          | 13.5                                   | 174                                | 205.8        | 88                            | 1,526.1 | 89             |
| ANNUAL                         | 3,136.6 | 79          | 102.6                                  | 136                                | 3,058.5      | 83                            |         |                |
| APRIL-JULY                     | 1,687.4 | 83          |                                        |                                    |              |                               |         |                |

\* Average for the 1955-2006 period.

# FIGURE MTG4

## CANYON FERRY LAKE



WATER YEAR 2006

## **Helena Valley Reservoir**

Helena Valley Reservoir is a regulating offstream reservoir for Helena Valley Unit (P-S MBP), located west of Canyon Ferry. It has a total capacity of 10,451 acre-feet, which is used for irrigation and for furnishing a supplemental municipal supply to the city of Helena, Montana. Helena Valley Reservoir receives its entire water supply by pumping from Canyon Ferry Reservoir. When fully developed, Helena Valley Unit will irrigate about 14,100 acres of full-service land plus 3,500 acres of supplemental-service lands. Present development is about 13,867 full-service acres, including 5,200 acres previously irrigated by pumping from Lake Helena or from other streams.



At the beginning of the year, storage in Helena Valley Reservoir was 10,270 acre-feet at an elevation of 3819.72 feet. Helena Valley Reservoir reached a low for the year of 7,165 acre-feet at an elevation of 3812.86 feet on August 4, 2006. With new operating criteria in place, goals were to fill Helena Valley Reservoir by April 1 and maintain it nearly full through June. In response, diversions to the Helena Valley Unit from Canyon Ferry Reservoir were started on March 21. Storage in Helena Valley Reservoir then steadily increased to a peak for the year of 10,399 acre-feet at an elevation of 3819.97 feet on May 4, 2006. By the end of water year 2006, Helena Valley reservoir ended with a storage content of 10,209 acre-feet at elevation 3819.60. During 2006, 102,615 acre-feet of water was pumped to Helena Valley from Canyon Ferry Reservoir. Helena Valley Irrigation District released 87,981 acre-feet for irrigation. All irrigation deliveries were discontinued for the 2006 season on September 28.

The reservoir provided an adequate water supply to satisfy all irrigation requirements for the Helena Valley Unit in 2006 and supplement the City of Helena's municipal water supply.

Statistical information pertaining to Helena Valley Reservoir is shown on Table MTT7.

TABLE MTT7  
HYDROLOGIC DATA FOR 2006

| RESERVOIR ALLOCATIONS                             | ELEVATION<br>(FEET) | RESERVOIR<br>STORAGE<br>(AF) | STORAGE<br>ALLOCATION<br>(AF) |
|---------------------------------------------------|---------------------|------------------------------|-------------------------------|
| Top of Inactive Storage                           | 3805.00             | 4,554                        | 4,554                         |
| Top of Active Conservation Storage                | 3820.07             | 10,451                       | 5,897                         |
| STORAGE ELEVATION DATA                            | ELEVATION<br>(FEET) | STORAGE<br>(AF)              | DATE                          |
| Beginning of Year                                 | 3819.72             | 10,270                       | 10/01/05                      |
| End of Year                                       | 3819.60             | 10,209                       | 09/30/06                      |
| Annual Low                                        | 3812.86             | 7,615                        | 08/04/06                      |
| Annual High                                       | 3819.97             | 10,399                       | 05/04/06                      |
| Historic High                                     | 3820.60             | 10,738                       | 6/02/75                       |
| INFLOW-OUTFLOW DATA                               |                     |                              | ANNUAL                        |
| Pumped from Canyon Ferry to Helena Valley Unit    |                     |                              | 102,615 AC-FT                 |
| Inflow to Helena Valley Reservoir                 |                     |                              | 90,114 AC-FT                  |
| Released from reservoir for irrigation            |                     |                              | 87,981 AC-FT                  |
| Delivered to the City of Helena for municipal use |                     |                              | 2,193 AC-FT                   |

| MONTH     | RESERVOIR                      |                             | PUMPED TO<br>HELENA<br>VALLEY<br>(KAF) |
|-----------|--------------------------------|-----------------------------|----------------------------------------|
|           | FOREBAY<br>ELEVATION<br>(FEET) | STORAGE<br>CONTENT<br>(KAF) |                                        |
| OCTOBER   | 3818.65                        | 9.7                         | 1.3                                    |
| NOVEMBER  | 3817.72                        | 9.3                         | 0                                      |
| DECEMBER  | 3816.92                        | 8.9                         | 0                                      |
| JANUARY   | 3816.08                        | 8.5                         | 0                                      |
| FEBRUARY  | 3815.33                        | 8.2                         | 0                                      |
| MARCH     | 3819.30                        | 10.1                        | 2.6                                    |
| APRIL     | 3819.75                        | 10.3                        | 6.9                                    |
| MAY       | 3816.18                        | 8.6                         | 18.3                                   |
| JUNE      | 3818.68                        | 9.7                         | 17.1                                   |
| JULY      | 3813.18                        | 7.3                         | 21.5                                   |
| AUGUST    | 3818.54                        | 9.7                         | 21.5                                   |
| SEPTEMBER | 3819.60                        | 10.2                        | 13.5                                   |
| ANNUAL    |                                |                             | 102.6                                  |



## **Sun River Project**

Storage for the Sun River Project is provided by Gibson, Willow Creek, and Pishkun Reservoirs, which are all single-purpose irrigation structures. The project serves 95,000 acres on the Greenfields and Fort Shaw Irrigation Districts. A diversion dam is located on the Sun River about 3 miles below Gibson Reservoir to allow flows to be diverted down the Pishkun Supply Canal to Pishkun Reservoir, or down the Willow Creek Feeder Canal to Willow Creek Reservoir. Releases are made from Pishkun Reservoir to supply the canals of the Greenfields Irrigation District. Releases from Willow Creek Reservoir re-enter the Sun River where they can be diverted at the Fort Shaw Diversion Dam to supply the canals of the Fort Shaw Irrigation District.

**Gibson Reservoir** is located on the Sun River above Augusta, Montana, and has a total capacity of 96,477 acre-feet. In 1996, a hydrographic and topographic survey was conducted to measure the reservoir volume lost due to sediment accumulations that occurred in the drainage basin since the major forest fires that occurred in 1988. As a result of the survey, a new elevation-area-capacity table and curve was developed.



The 1996 survey determined that Gibson Reservoir has a storage capacity of 96,477 acre-feet and a surface area of 1,296 acres at reservoir elevation 4724. Since closure in 1929, the reservoir has accumulated a sediment volume of 8,383 acre-feet below reservoir elevation 4724. This volume represents a 7.99 percent loss in capacity and an average annual loss of 125.7 acre-feet. The 1996 survey also showed the average annual rate of sediment deposition since 1973 was 113.1 acre-feet per year and that most of the sediment contribution came after the 1988 fires. The revised area-capacity table was developed and put into effect on October 1, 1997, reflecting the new storage levels.

The spillway crest is at elevation 4712.0 (81,255 acre-feet). Depending on the runoff conditions and reservoir levels, the spillway gates remain open during the spring until the inflows and remaining snow cover indicate that the runoff is receding. Once it is apparent that the runoff has peaked and begun to recede, the spillway gates are progressively closed to allow the reservoir to fill to the top of the conservation pool at elevation 4724.0 (96,477 acre-feet).

The dry conditions in 2005 provided below average water supply storage in the Sun River basin, heading into water year 2006. The July through September inflow to Gibson Reservoir was 55 percent of average, totaling 62,919 acre-feet. With the inflows averaging 174 cfs and releases averaging 73 cfs during September, storage in Gibson Reservoir remained fairly constant and entered water year 2006 with a storage content of 5,080 acre-feet at elevation 4609.22. This was 18 percent of average and only 5 percent of full capacity. This was also 91,397 acre-feet or 114.78 feet below the top of the conservation pool and was 17,416 acre-feet or 37.22 feet less than at the beginning of water year 2005.

At the conclusion of the 2005 irrigation season, fall and winter releases from Gibson Reservoir to the Sun River were reduced in mid-September and maintained between 50-60 cfs with the expectation that with normal snowpack they could be increased later. By early December, snowpack was near normal and releases were increased to about 100 cfs. Storage in Gibson Reservoir had slowly but steadily increased to 8,761 acre-feet at elevation 4619.39 by the end of December.

Precipitation in the Sun River basin varied from much above average to much below average during water year 2006. Cumulative precipitation for October through December was near average for valley areas and much below average for mountain areas in the Sun River basin. By January 1, the Natural Resources and Conservation Service (NRCS) measured the mountain snowpack in the Sun-Teton River Basins at 68 percent of average, which was a 12 percent increase from a year ago. During January, precipitation was above average in the valley areas and was near normal in the mountain areas. Snowpack accumulated at above normal rates during February and by March 1 snowpack had improved to 94 percent of average. March precipitation was near average in valley areas, while much below average in the mountains. The cumulative precipitation through the end of March was 111 and 78 percent of average for the valley and mountain areas, respectively.

On April 1, the NRCS measured the snowpack at 83 percent of average. In 2006 the snowpack in the Sun River basin reached its peak accumulation in early April and was near average. Snowmelt runoff began entering Gibson Reservoir in early April and storage began to increase dramatically. However, releases to the Sun River were not increased until April 27. By May 1, storage in Gibson Reservoir had reached 57,600 acre-feet at elevation 4690.92, 38,877 acre-feet or 33.08 feet below the top of the conservation pool. As the temperatures increased in early May, streamflows increased to the peak inflow for the year of 5,361 cfs on May 19.

During April, precipitation in both the valley and mountain areas was above average to much above average. However, precipitation in May was again below average, signaling the drought was not essentially over. Valley and mountain precipitation during June was 124 and 74 percent of average, respectively. Even with the above average valley precipitation during June, the spring runoff into Gibson Reservoir remained below average, indicating the dry soils were quickly absorbing the much welcomed moisture.

As the inflow to Gibson Reservoir and the storage in Gibson steadily increased, the releases from Gibson Reservoir to the Sun River were gradually increased to control the rate of fill. The peak inflow into Gibson Reservoir was recorded at 5,361 cfs on May 19. On June 2, Gibson Reservoir reached a peak storage content for the year of 96,387 acre-feet at elevation 4723.93, 90 acre-feet or 0.07 feet below the top of the active conservation pool. The peak discharge to the Sun River over the Sun River Diversion Dam was recorded on May 19 at 4,179 cfs, while the peak discharge from Gibson Reservoir was recorded on May 24 at 4,981 cfs. The snowmelt runoff peaked quickly and began to recede by the end of May.

Inflow to Gibson Reservoir during May was 96 percent of average but quickly declined to only 59 and 49 percent of average respectively for June and July. The actual April-July inflow totaled 359,923 acre-feet, which is approximately 117,700 acre-feet or 25 percent below average.

July precipitation in both the valley and mountain areas was much below average. The cumulative water year precipitation through August for valley and mountain areas was 108 and 79 percent of average, respectively. Concluding the water year, September valley and mountain precipitation were 113 and 85 percent of average respectively. The August-September inflow to Gibson Reservoir was 65 percent of average totaling 29,741 acre-feet. Beginning in August, releases from Gibson Dam were gradually reduced from approximately 1,450 cfs to about 120 cfs by the end of September. During September the average inflow was approximately 189 cfs, allowing storage in Gibson Reservoir to gradually increase. During late September, releases from Gibson Reservoir were reduced to rates adequate to provide a minimum fishery flow below the Sun River Diversion Dam. Gibson Reservoir slowly increased and ended the water year with a content of 10,545 acre-feet of storage at elevation 4623.56 on September 30. This was 38 percent of average and 11 percent of normal full capacity or 85,932 acre-feet or 100.44 feet below the top of the conservation pool. This was 5,465 acre-feet or 14.34 feet more than at the end of water year 2005.

Total annual inflow for water year 2006 was 72 percent of average, totaling 444,008 acre-feet. This was 63,391 acre-feet or 10 percent more than the inflow experienced during water year 2005.

Diversions to the Pishkun Supply Canal were started on April 12 and May 4 for Willow Creek and Pishkun Reservoirs, respectively. They were adjusted periodically throughout the year to meet the downstream irrigation demands on the Sun River Project. Diversions to Pishkun Reservoir were discontinued August 12 so that all storage could be evacuated from the reservoir to perform maintenance on the outlet works. The total net inflow to Pishkun Reservoir during water year 2006 was 209,761 acre-feet, 92 percent of average. Diversions to Willow Creek Reservoir were discontinued on May 15. Diversions to Willow Creek Reservoir were reinitiated on September 6 and continued through December 1 totaling approximately 12,815 acre-feet. The net inflow for the water year to Willow Creek Reservoir was 15,494 acre-feet. All diversions for the season were discontinued on December 1, 2006.

Greenfields Irrigation District discontinued water delivery on August 30. Supplemental water contracts served by Greenfields were satisfied May 22 through June 24 while Gibson Reservoir releases were in excess of senior irrigation demands. Based on average diversions to Pishkun Reservoir and supplemental water delivered, Greenfields delivered approximately 75 percent of normal allotment to their water users. The total diversion for Fort Shaw Irrigation District was above average during 2006. The total water diverted during May 1 through October 15 was approximately 48,070 acre-feet, which is 114 percent of average.

Even though there is no space allocated to flood control, the Corps of Engineers still estimates flood damages that may be prevented by Gibson Reservoir. During 2006 Gibson Reservoir did not contribute to the reduction of flood damages locally or downstream on the Missouri River below Fort Peck Reservoir.

Additional hydrologic and statistical data pertaining to the operation of Gibson Reservoir can be found in Table MTT8-A and Figure MTG5.

**Pishkun Reservoir**, near Augusta, Montana, is an off-stream reservoir supplied by a feeder canal which diverts water from the Sun River below Gibson Reservoir. The reservoir serves the 81,000-acre Greenfields Division. The total capacity of the reservoir is 46,670 acre-feet at elevation 4370.0.



All canal diversions from the Sun River to Pishkun during the 2005 irrigation season were discontinued on August 19, 2005. Reservoir content in Pishkun at the beginning of water year 2006 was 35,674 acre-feet at elevation 4362.20. This was 108 percent of average and 76 percent of normal full capacity and 1,717 acre-feet or 1.33 feet less than at the beginning of water year 2005.

Storage began to decrease because of normal reservoir losses throughout the winter and early spring of 2006. By May 4, storage had declined to 32,995 acre-feet at elevation 4360.21 at which time diversions from the Sun River began to reach Pishkun Reservoir. Prior to the beginning of the irrigation season after diversions began, storage increased to 44,306 acre-feet at elevation 4368.41 on May 18. Once irrigation releases began, storage fluctuated based on meeting irrigation demands. Due to the above average precipitation in June, demands decreased significantly allowing storage to increase to a peak content for the year of 47,941 acre-feet at elevation 4370.81 on June 11. Irrigation releases from Pishkun Reservoir were started on May 12 with a maximum release of 1,780 cfs recorded on June 30. The maximum inflow was 1,526 cfs on June 26, 2006. All diversions from the Sun River to Pishkun Reservoir were discontinued on August 12. Irrigation demands were reduced in August. All irrigation releases from Pishkun Reservoir were discontinued on August 31. Approximately 229,426 acre-feet of water, 101 percent of average, was released from Pishkun Reservoir during May 12 through August 31 to help meet the irrigation demands on the Sun River Project. By the end of the water year, the reservoir storage was 16,008 acre-feet at elevation 4342.20. This was 49 percent of average and 34 percent of full capacity. This was also 19,666 acre-feet or 20.00 feet less than at the end of water year 2005.

Additional hydrologic and statistical data pertaining to Pishkun Reservoir can be found in Table MTT8-B and Figure MTG6.

**Willow Creek Reservoir** obtains its water supply from Willow Creek and the Sun River via the Willow Creek Feeder Canal. The total reservoir capacity is 32,300 acre-feet at elevation 4142.0 feet. Releases from Willow Creek Reservoir enter the Sun River and can be diverted for irrigation at the Fort Shaw Diversion Dam, the Floweree Canal of the Broken O Ranch, and other downstream senior water users.



All diversions from the Sun River to Willow Creek during the 2005 irrigation season were discontinued on December 3, 2005. Reservoir content in Willow Creek at the beginning of water year 2006 was 17,562 acre-feet at elevation 4131.19. This was 101 percent of average and 56 percent of full capacity and 1,592 acre-feet or 0.89 feet less than at the beginning of water year 2005.

Storage in Willow Creek Reservoir remained fairly stable throughout the winter. Diversions from the Sun River to Willow Creek Reservoir during 2006 were initiated on April 12 at a rate of approximately 25 cfs and were eventually increased to 100 cfs on April 27. The diversions began to reach Willow Creek Reservoir on April 16 and storage increased to a peak storage content for the year of 32,375 acre-feet at elevation 4142.36 on June 24. This storage level was 113 percent of average and was at 102 percent of full capacity. Due to the reservoir approaching normal full pool, diversions from the Sun River to Willow Creek were discontinued on May 16, with the total inflow during this period approximately equal to 3,635 acre-feet.

To help meet irrigation demands within the Sun River Irrigation Projects a release of 100 cfs was initiated from Willow Creek Reservoir on July 5 and steadily increased to 125 cfs by the end of the month. Releases were adjusted during July and August to meet downstream irrigation demands, until they were discontinued on August 26. Approximately 11,015 acre-feet of storage was released from Willow Creek Reservoir during July 5 through August 26 to help meet the irrigation demands in 2006. As a result, storage was drafted to a content of 19,465 acre-feet at elevation 4132.84 on August 25. Diversions to Willow Creek Reservoir were reinitiated on September 6, allowing storage to slowly increase through the remainder of the year. Willow Creek Reservoir ended the water year with a storage content of 22,035 acre-feet at elevation 4134.90. This was 126 percent of average and 69 percent of normal full capacity. This was also 4,473 acre-feet or 3.71 feet higher than at the end of water year 2005. Diversions to Willow Creek Reservoir continued through December 1 with an average diversion of 75 cfs per day. Approximately 12,818 acre-feet of water was diverted at the end of water year 2006 and beginning of water year 2007.

Additional hydrologic and statistical data pertaining to Willow Creek Reservoir can be found in Table MTT8-C and Figure MTG7.

### **Important Events – 2006**

December 3: Diversions to Willow Creek Feeder Canal were discontinued for the winter.

April 12: Diversions to the Willow Creek Feeder Canal were initiated.

May 4: Diversions to the Pishkun Supply Canal were initiated.

May 16: Diversions to Willow Creek Reservoir discontinued.

May 19: Inflows into Gibson Reservoir peak at approximately 5,361 cfs.

June 2: Gibson Reservoir reaches peak for year at elevation 4723.93.

June 11: Pishkun Reservoir reaches peak for year at elevation 4370.81.

June 24: Willow Creek Reservoir reaches peak for year at elevation 4142.36.

August 12: Diversions to Pishkun Reservoir discontinued for the year.

August 31: Greenfields Irrigation District discontinued water delivery from Pishkun Reservoir.

September 6: Diversion to Willow Creek Reservoir reinitiated to provide increased winter carry-over storage.

December 1: Diversions discontinued to the Willow Creek Feeder Canal.

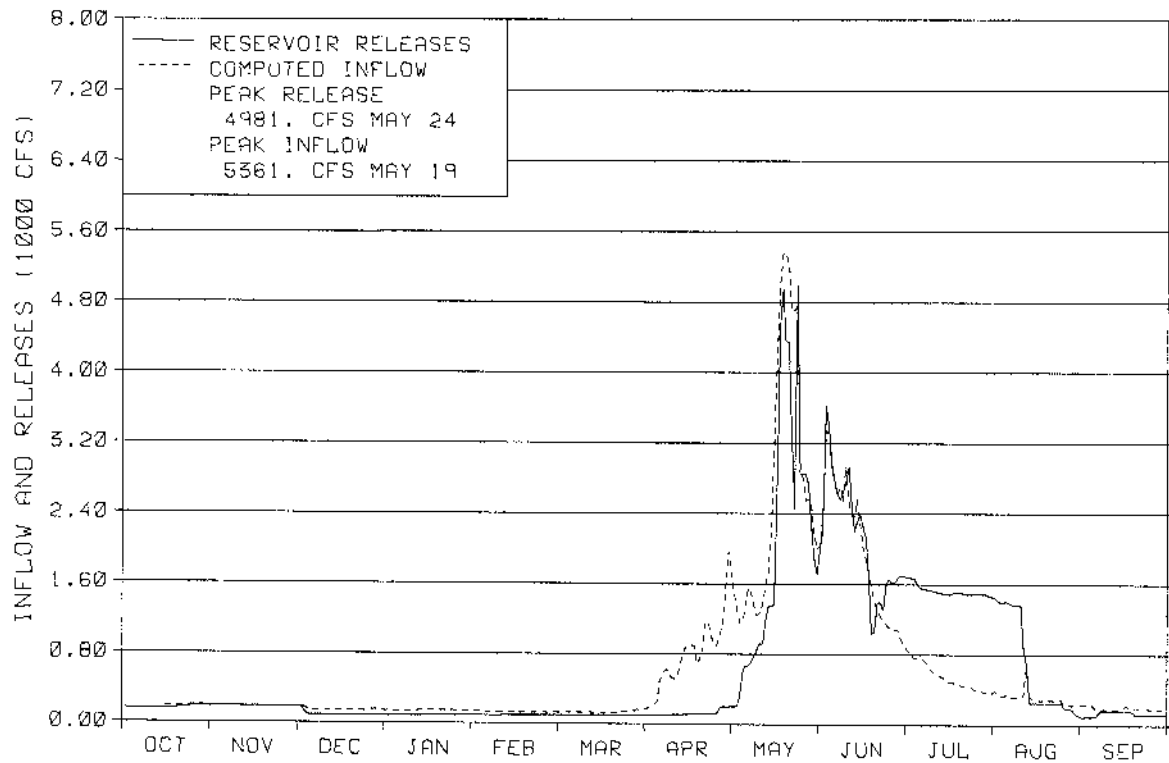
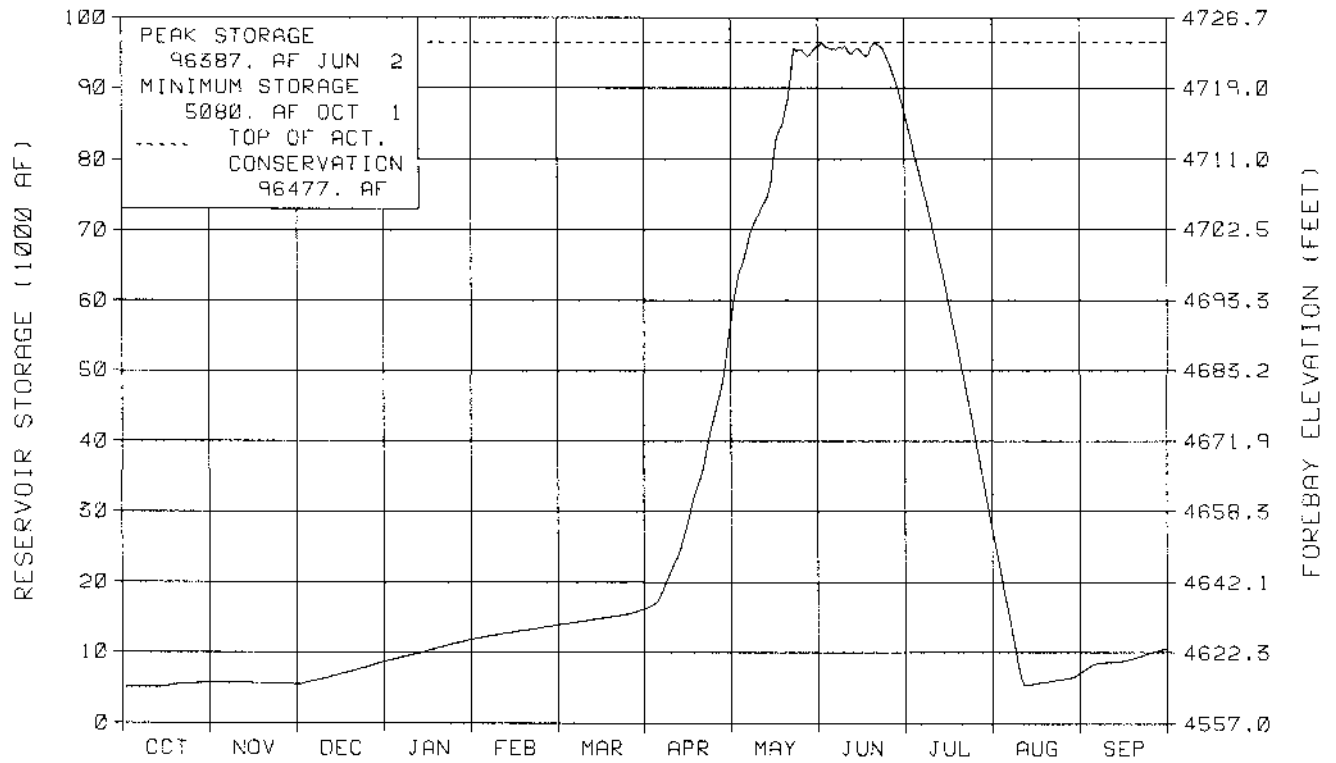
TABLE MTT8-A  
HYDROLOGIC DATA FOR 2006  
GIBSON RESERVOIR (SUN RIVER PROJECT)

| RESERVOIR ALLOCATIONS      |        | ELEVATION<br>(FEET) |                       | TOTAL<br>RESERVOIR<br>STORAGE (AF) |              | STORAGE<br>ALLOCATION<br>(AF) |              |               |  |
|----------------------------|--------|---------------------|-----------------------|------------------------------------|--------------|-------------------------------|--------------|---------------|--|
| TOP OF INACTIVE AND DEAD   |        | 4557.50             |                       | 0                                  |              | 0                             |              |               |  |
| TOP OF ACTIVE CONSERVATION |        | 4724.00             |                       | 96,477                             |              | 96,477                        |              |               |  |
|                            |        |                     |                       |                                    |              |                               |              |               |  |
| STORAGE-ELEVATION DATA     |        |                     | ELEVATION (FT)        |                                    | STORAGE (AF) |                               | DATE         |               |  |
| BEGINNING OF YEAR          |        |                     | 4609.22               |                                    | 5,080        |                               | OCT 01, 2005 |               |  |
| END OF YEAR                |        |                     | 4623.56               |                                    | 10,545       |                               | SEP 30, 2006 |               |  |
| ANNUAL LOW                 |        |                     | 4609.22               |                                    | 5,080        |                               | OCT 01, 2005 |               |  |
| ANNUAL HIGH                |        |                     | 4723.93               |                                    | 96,387       |                               | JUN 02, 2006 |               |  |
| HISTORIC HIGH              |        |                     | 4732.23               |                                    | 116,400      |                               | JUN 08, 1964 |               |  |
|                            |        |                     |                       |                                    |              |                               |              |               |  |
| INFLOW-OUTFLOW DATA        |        |                     | INFLOW                | DATE                               |              | OUTFLOW                       |              | DATE          |  |
| ANNUAL TOTAL (AF)          |        |                     | 444,008               | OCT 05-SEP 06                      |              | 438,542                       |              | OCT 05-SEP 06 |  |
| DAILY PEAK (CFS)           |        |                     | 5,361                 | MAY 19, 2006                       |              | 4,981                         |              | MAY 24, 2006  |  |
| DAILY MINIMUM (CFS)        |        |                     | 124                   | MAR 21, 2006                       |              | 85                            |              | DEC 04, 2005  |  |
|                            |        |                     |                       |                                    |              |                               |              |               |  |
| MONTH                      | INFLOW |                     | OUTFLOW*              |                                    |              |                               | CONTENT      |               |  |
|                            | KAF    | % OF<br>AVG         | TOTAL<br>CANAL<br>KAF | % OF<br>AVG                        | RIVER<br>KAF | % OF<br>AVG                   | KAF          | % OF<br>AVG   |  |
| OCTOBER                    | 10.7   | 57                  | 7.3                   | 221                                | 3.3          | 33                            | 5.7          | 19            |  |
| NOVEMBER                   | 11.0   | 64                  | 7.9                   | 669                                | 3.3          | 30                            | 5.5          | 16            |  |
| DECEMBER                   | 8.8    | 56                  | 1.3                   | 964                                | 5.2          | 46                            | 8.8          | 23            |  |
| JANUARY                    | 8.6    | 63                  | 0                     | -                                  | 5.5          | 55                            | 11.9         | 29            |  |
| FEBRUARY                   | 7.1    | 58                  |                       | --                                 | 4.7          | 58                            | 13.8         | 31            |  |
| MARCH                      | 8.2    | 56                  | 0                     | ---                                | 5.4          | 55                            | 16.1         | 34            |  |
| APRIL                      | 45.5   | 113                 | 2.7                   | 32                                 | 6.7          | 30                            | 54.6         | 102           |  |
| MAY                        | 162.7  | 96                  | 55.8                  | 143                                | 81.9         | 84                            | 96.0         | 113           |  |
| JUNE                       | 117.9  | 59                  | 57.7                  | 102                                | 90.6         | 68                            | 87.5         | 99            |  |
| JULY                       | 33.8   | 49                  | 84.4                  | 117                                | 11.6         | 44                            | 27.5         | 47            |  |
| AUGUST                     | 18.5   | 70                  | 36.1                  | 90                                 | 4.8          | 36                            | 7.2          | 22            |  |
| SEPTEMBER                  | 11.2   | 59                  | 3.7                   | 32                                 | 5.8          | 57                            | 10.5         | 38            |  |
| ANNUAL                     | 444.0  | 72                  | 256.9                 | 110                                | 228.8        | 63                            |              |               |  |
| APRIL-JULY                 | 359.9  | 75                  |                       |                                    |              |                               |              |               |  |

\* Average for the 1931-2006 period.

# FIGURE MTG5

## GIBSON RESERVOIR



WATER YEAR 2006



TABLE MTT8-B  
HYDROLOGIC DATA FOR 2006  
PISHKUN RESERVOIR (SUN RIVER PROJECT)  
NEW SEDIMENT SURVEY DATA EFFECTIVE 10/01/2005

| RESERVOIR ALLOCATIONS      | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |               |
|----------------------------|---------------------|------------------------------------|-------------------------------|---------------|
| TOP OF INACTIVE AND DEAD   | 4342.00             | 16,008                             | 16,008                        |               |
| TOP OF ACTIVE CONSERVATION | 4370.00             | 46,694                             | 30,686                        |               |
|                            |                     |                                    |                               |               |
| STORAGE-ELEVATION DATA     | ELEVATION (FT)      | STORAGE (AF)                       | DATE                          |               |
| BEGINNING OF YEAR          | 4362.20             | 35,674                             | OCT 01, 2005                  |               |
| END OF YEAR                | 4342.20             | 16,008                             | SEP 30, 2006                  |               |
| ANNUAL LOW                 | 4342.20             | 16,008                             | SEP 05, 2006                  |               |
| ANNUAL HIGH                | 4370.81             | 47,941                             | JUN 11, 2006                  |               |
| HISTORIC HIGH              | 4371.40             | 48,950                             | JUL 04, 1953                  |               |
|                            |                     |                                    |                               |               |
| INFLOW-OUTFLOW DATA        | INFLOW              | DATE                               | OUTFLOW                       | DATE          |
| ANNUAL TOTAL (AF)          | 209,761             | OCT 05-SEP 06                      | 229,427                       | OCT 05-SEP 06 |
| DAILY PEAK (CFS)           | 1,526               | JUN 26, 2006                       | 1,780                         | JUN 30, 2006  |
| DAILY MINIMUM (CFS)        | 0                   | *                                  | 0                             | *             |

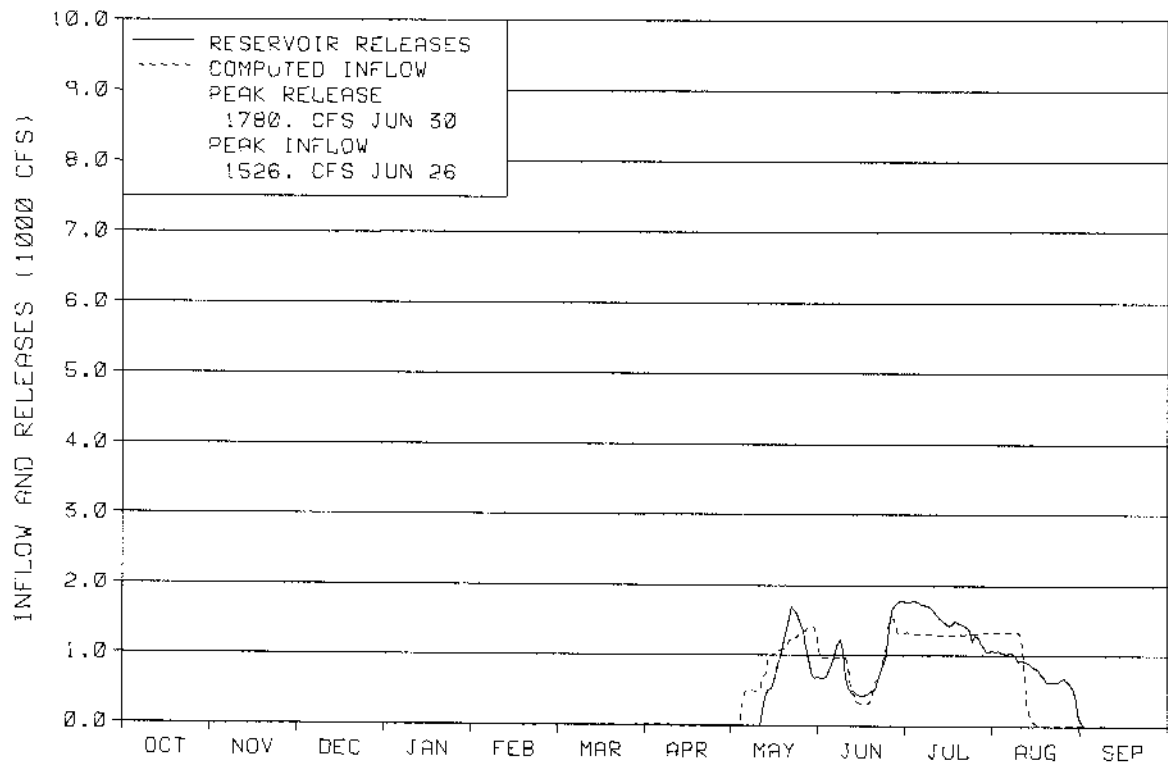
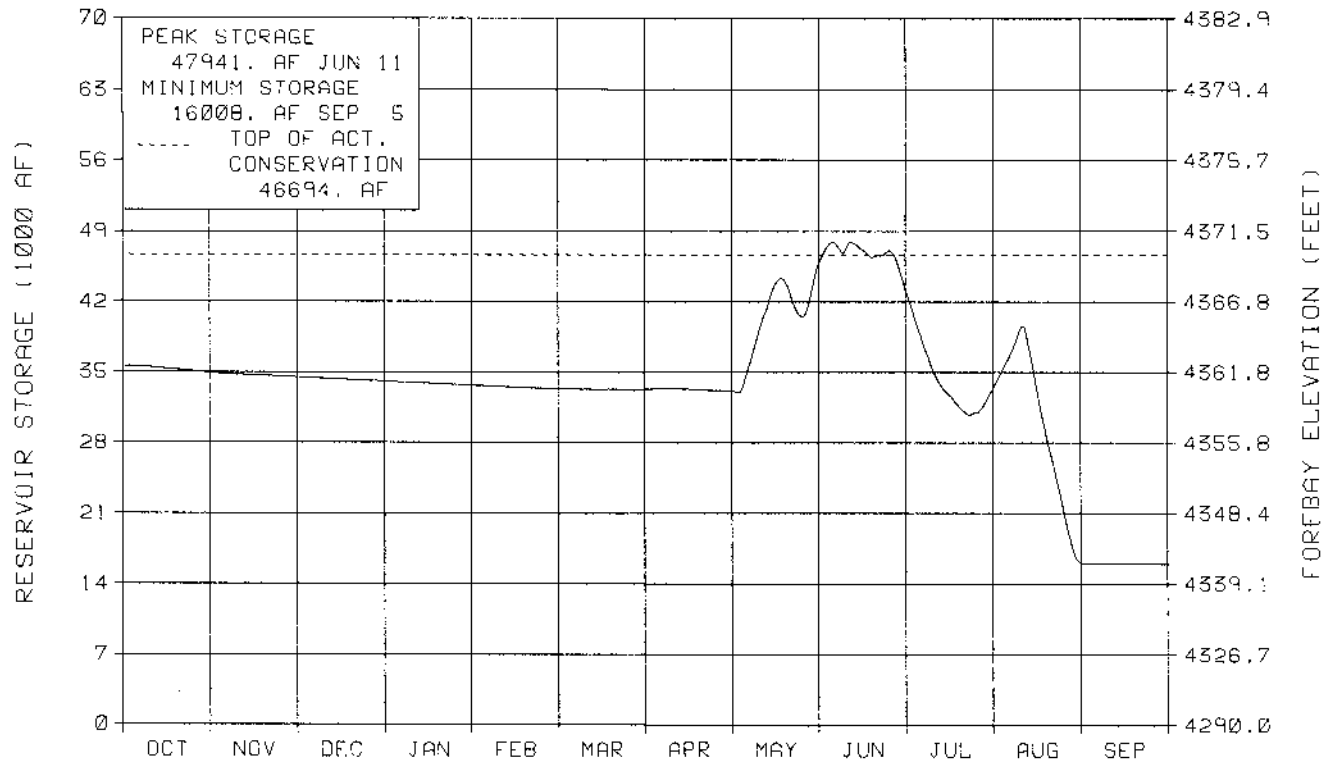
\* During nonirrigation season

| MONTH      | INFLOW* |          | OUTFLOW* |          | CONTENT |          |
|------------|---------|----------|----------|----------|---------|----------|
|            | KAF     | % OF AVG | KAF      | % OF AVG | KAF     | % OF AVG |
| OCTOBER    | -0.8    | ---      | 0        | ---      | 34.9    | 102      |
| NOVEMBER   | -0.4    | ---      | 0        | ---      | 34.5    | 100      |
| DECEMBER   | -0.4    | ---      | 0        | ---      | 34.1    | 99       |
| JANUARY    | -0.4    | ---      | 0        | ---      | 33.7    | 99       |
| FEBRUARY   | -0.3    | ---      | 0        | ---      | 33.4    | 98       |
| MARCH      | -0.1    | ---      | 0        | ---      | 33.3    | 97       |
| APRIL      | -0.2    | ---      | 0        | ---      | 33.1    | 81       |
| MAY        | 52.1    | 145      | 39.6     | 130      | 45.7    | 100      |
| JUNE       | 50.9    | 88       | 52.8     | 87       | 43.8    | 103      |
| JULY       | 80.0    | 116      | 90.4     | 122      | 33.3    | 90       |
| AUGUST     | 29.4    | 71       | 46.6     | 108      | 16.0    | 46       |
| SEPTEMBER  | 0.0     | ---      | 0        | ---      | 16.0    | 49       |
| ANNUAL     | 209.8   | 92       | 229.4    | 101      |         |          |
| APRIL-JULY | 182.8   | 108      |          |          |         |          |

\* Average for the 1947-2006 period.

# FIGURE MTG6

## PISHKUN RESERVOIR NEAR AUGUSTA



WATER YEAR 2006

TABLE MTT8-C  
HYDROLOGIC DATA FOR 2006  
WILLOW CREEK RESERVOIR (SUN RIVER PROJECT)  
NEW SEDIMENT SURVEY DATA EFFECTIVE 10/01/2005

| RESERVOIR ALLOCATIONS      | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |               |
|----------------------------|---------------------|------------------------------------|-------------------------------|---------------|
| TOP OF INACTIVE AND DEAD   | 4085.28             | 1                                  | 1                             |               |
| TOP OF ACTIVE CONSERVATION | 4142.00             | 31,848                             | 31,847                        |               |
|                            |                     |                                    |                               |               |
| STORAGE-ELEVATION DATA     | ELEVATION (FT)      | STORAGE (AF)                       | DATE                          |               |
| BEGINNING OF YEAR          | 4131.19             | 17,562                             | OCT 01, 2005                  |               |
| END OF YEAR                | 4134.90             | 22,035                             | SEP 30, 2006                  |               |
| ANNUAL LOW                 | 4131.19             | 17,562                             | OCT 01, 2005                  |               |
| ANNUAL HIGH                | 4142.36             | 32,375                             | JUN 24, 2006                  |               |
| HISTORIC HIGH              | 4144.00             | 35,300                             | JUN 22, 1975                  |               |
|                            |                     |                                    |                               |               |
| INFLOW-OUTFLOW DATA        | INFLOW              | DATE                               | OUTFLOW                       | DATE          |
| ANNUAL TOTAL (AF)          | 15,494              | OCT 05-SEP 06                      | 11,015                        | OCT 05-SEP 06 |
| DAILY PEAK (CFS)           | 95                  | MAY 04, 2006                       | 127                           | AUG 04, 2006  |
| DAILY MINIMUM (CFS)        | 0                   | *                                  | 0                             | *             |

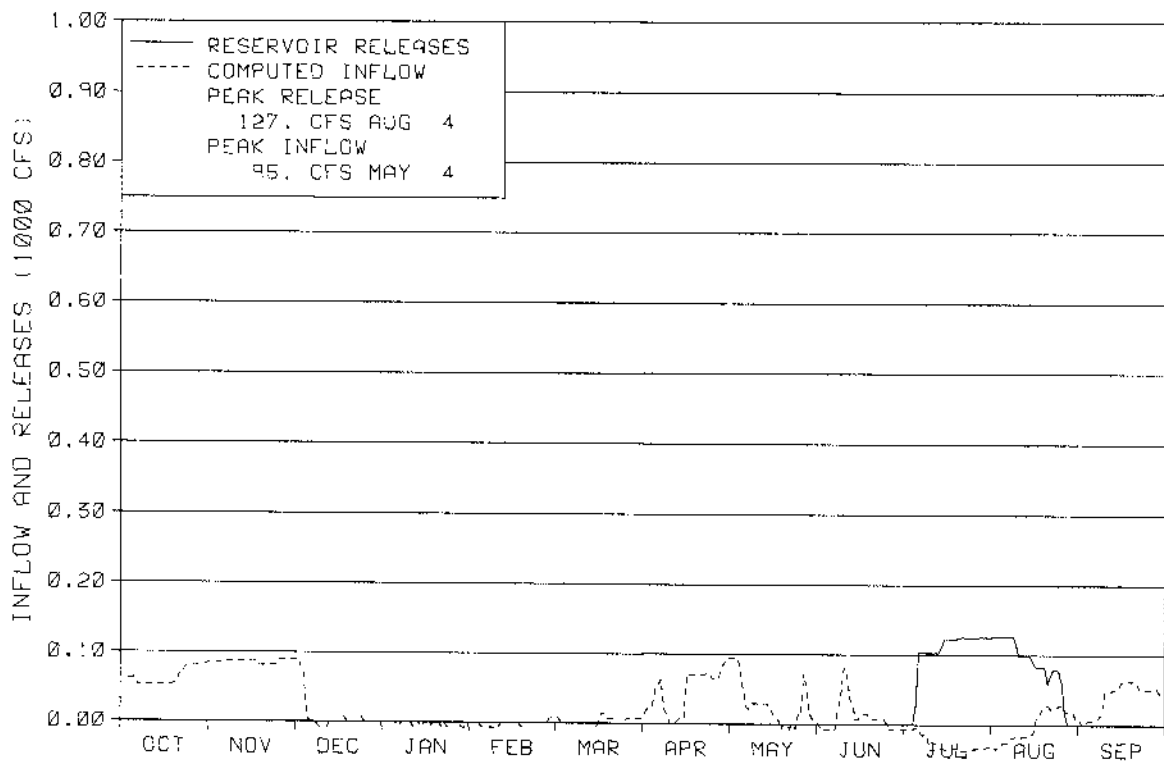
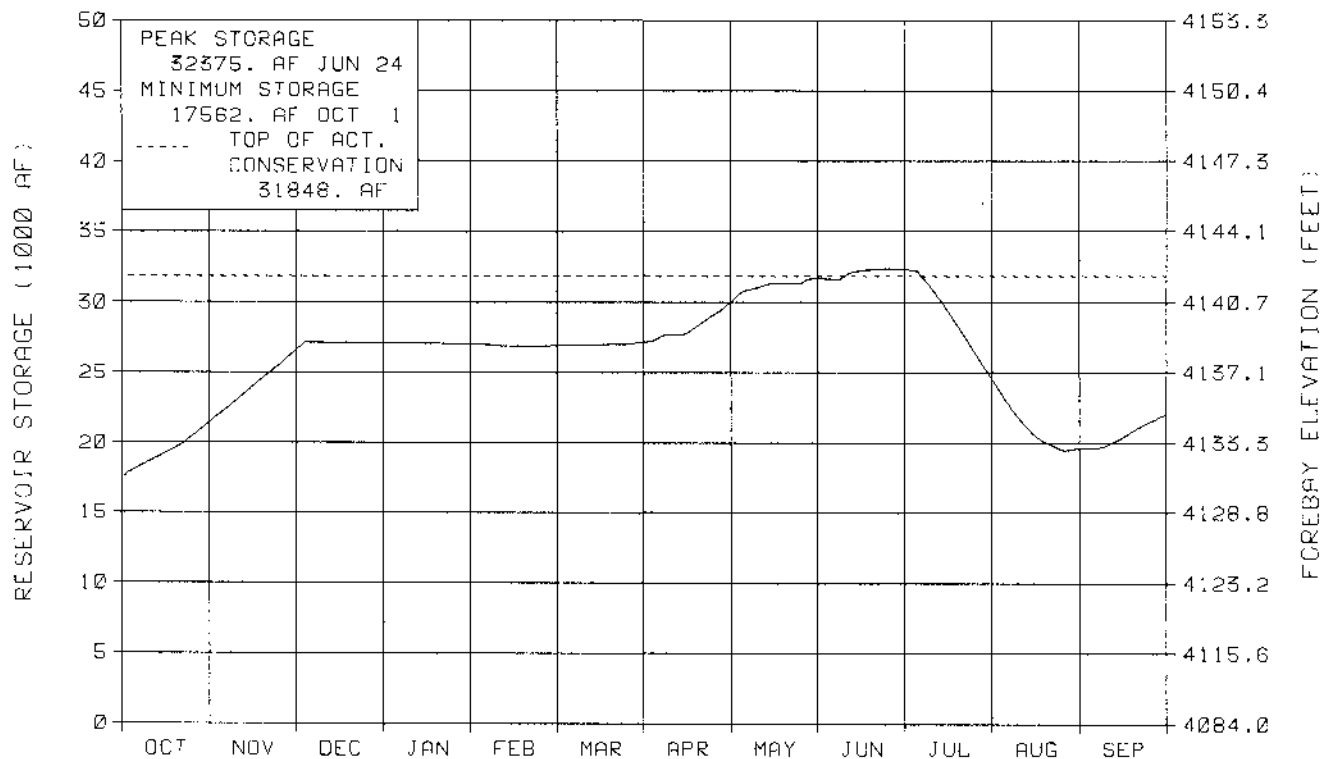
\* During nonirrigation season

| MONTH      | INFLOW* |          | OUTFLOW* |          | CONTENT |          |
|------------|---------|----------|----------|----------|---------|----------|
|            | KAF     | % OF AVG | KAF      | % OF AVG | KAF     | % OF AVG |
| OCTOBER    | 4.0     | 521      | 0        | ---      | 21.5    | 113      |
| NOVEMBER   | 5.1     | 752      | 0        | ---      | 26.6    | 136      |
| DECEMBER   | 0.5     | 111      | 0        | ---      | 27.1    | 136      |
| JANUARY    | -0.1    | ---      | 0        | ---      | 27.0    | 134      |
| FEBRUARY   | -0.1    | ---      | 0        | ---      | 26.9    | 130      |
| MARCH      | 0.2     | 21       | 0        | ---      | 27.1    | 124      |
| APRIL      | 2.8     | 136      | 0        | ---      | 29.9    | 120      |
| MAY        | 1.8     | 44       | 0        | ---      | 31.7    | 115      |
| JUNE       | 0.6     | 15       | 0        | ---      | 32.3    | 108      |
| JULY       | -1.7    | ---      | 6.1      | 113      | 24.5    | 105      |
| AUGUST     | 0.0     | ---      | 4.9      | 134      | 19.6    | 106      |
| SEPTEMBER  | 2.4     | 537      | 0        | ---      | 22.0    | 126      |
| ANNUAL     | 15.5    | 106      | 11.0     | 76       |         |          |
| APRIL-JULY | 3.5     | 33       |          |          |         |          |

\* Average for the 1952-2006 period.

# FIGURE MTG7

## WILLOW CREEK RESERVOIR



WATER YEAR 2006

## **Lake Elwell (Tiber Dam)**

Lake Elwell (Tiber Dam) (P-S M.B.P.) is located on the Marias River near Chester, Montana. It was built to provide an adequate water supply for 127,000 acres in the Lower Marias Unit and for flood control. The crest section of Tiber Dam spillway began settling in 1956, following initial filling of the reservoir. Restrictions were placed on reservoir operating levels in the late 1950s to safeguard the structure until repairs could be made. The settling continued despite attempts to halt it. The rate of settlement was alarming following the flood of 1964 and the heavy runoff of 1965. This settlement was attributed to a weakness of the underlying shale formation in which small lenses of gypsum were slowly being dissolved as water passed through the shale. Measures to protect the structure were approved by Congress, and construction was initiated in 1967. This work, completed in 1970, consisted of modifying the canal outlet works for use as an auxiliary outlet works and closing the entrance channel of the spillway by a temporary earthfill cofferdam. To accommodate these changed conditions, the reservoir operating criteria was further revised and the active capacity was eliminated. Work on modification of the spillway to restore active conservation capacity was begun in 1976. This work, completed in October 1981, consisted of replacing the upstream section of the spillway and raising the dam 5 feet. Since that time, all restrictions on operating levels were lifted and normal operations were restored at Lake Elwell.



Because the irrigation distribution works have not yet been constructed, the reservoir is operated primarily for flood control and for increased fishery and recreation benefits. However, the reservoir provides irrigation water to several individual operators by water service contracts and provides about 1,500 acre-feet to the Tiber County Water District for municipal, industrial, rural domestic, and livestock use. The city of Chester, Montana, receives a small amount of water from the reservoir annually for municipal use. Approximately 3,000 acres are irrigated by contract from Lake Elwell storage.

In 2002, Reclamation surveyed Lake Elwell to develop a topographic map and compute a present storage-elevation relationship (area-capacity tables). The data were used to calculate reservoir capacity lost due to sediment accumulation since dam closure in October of 1957. The 2002 survey determined that Lake Elwell has a storage capacity of 925,649 acre-feet and a surface area of 18,275 acres at a reservoir elevation of 2993.00. Since closure in 1957, the reservoir has accumulated a sediment volume of 42,179 acre-feet below elevation 2993.00. This volume represents a 4.4 percent change in total capacity at this elevation. The revised area-capacity table was put into effect on October 1, 2005, reflecting the new storage levels.

In September of 2003, construction of a Federal Energy Regulatory Commission (FERC) permitted powerplant began. The river outlet works underwent extensive modification to incorporate the addition of a 7.5 MW powerplant, privately owned by Tiber Montana, LLC. A bifurcation pipe was installed in the river outlet works tunnel at the downstream end to divert flow from the existing 72-inch outlet pipe through a bifurcation and 96-inch butterfly valve to the powerplant. Construction of the powerplant was completed and brought on-line in June 2004.

During July and August of 2005, precipitation in the Marias River Basin above Lake Elwell was well below normal. Valley precipitation was recorded at 12 and 97 percent of average, respectively, while mountain precipitation was 24 and 86 percent of average, respectively. Inflow into Lake Elwell during July-September totaled 27,806 acre-feet which was only 34 percent of normal and the eighth lowest inflow ever recorded during this time. The total annual runoff into Lake Elwell during 2005 was 339,111 acre-feet, 50 percent of normal and 35,054 acre-feet more than experienced in 2004. This was the ninth lowest annual inflow ever recorded into Lake Elwell.

By the end of water year 2005, normal operations Lake Elwell drafted storage to 789,477 acre-feet at an elevation of 2982.22 feet. This was 96 percent of normal and 0.33 feet lower than reported on September 30, 2004.

Water year 2006 started off very wet with valley precipitation in the Marias River Basin upstream of Lake Elwell during October being 203 percent of normal while mountain precipitation was only 74 percent of normal. By November it appeared the drought was once again returning. Precipitation dropped well below normal with the valley precipitation declining to 77 percent of average and the mountain precipitation declining to 72 percent of average. Inflow into Lake Elwell during October through December totaled 45,432 acre-feet and was only 72 percent of normal.

During the winter of 2005-2006, mountain snowpack in the Marias Basin above Lake Elwell began accumulating at below normal rates. On November 1, the Natural Resources and Conservation Service (NRCS) measured the mountain snowpack in the Marias River Basin above Lake Elwell to only be 38 percent of average. With streamflows at near record low levels, releases from Lake Elwell to the Marias River were decreased to 320 cfs on November 3 in an effort to conserve storage. From early November through early December, snowpack accumulated at near normal rates and improved to near 90 percent of average. During December snowpack once again accumulated at below normal rates and by January 1, the NRCS reported that snowpack in the Marias River Basin above Lake Elwell had deteriorated to 58 percent of average. The January 1 water supply forecast, based on mountain snowpack, indicated the April-July runoff into Lake Elwell would be 286,000 acre-feet, only 59 percent of normal.

As the winter progressed, mountain snowfall increased at near normal rates and by April 1, mountain snowpack in the Marias River Basin had improved to 89 percent of normal. Mountain snowpack peaked on April 7 at 96 percent of normal. The April 1 water supply forecast indicated the April-July runoff into Lake Elwell would be 373,000 acre-feet or 77 percent of normal. Storage in Lake Elwell slowly drafted to a low content for the year of 728,322 acre-feet at elevation 2980.61 on March 17.

Precipitation across much of Montana improved during January through April. Valley precipitation above Lake Elwell during February, March and April was 142, 156 and 117 percent of average, respectively, while the mountain precipitation 120, 61, and 98 percent of average, respectively.

From March 27 through April 3, Tiber Montana, LLC, performed scheduled maintenance on their turbine unit. Releases were discontinued through the powerplant and initiated through the auxiliary outlet works at the desired rate of 320 cfs. After completion of the maintenance, Tiber Montana, LLC, conducted efficiency tests of the powerplant by discontinuing flows through the auxiliary outlet works and initiating a flow of 320 cfs through the powerplant. Tiber Montana, LLC then increased flows by 50 cfs at 30 minutes intervals until reaching a maximum flow of 700 cfs. Flows

were then decreased on April 3 and maintained at 500 cfs. Due to near average precipitation during April, inflow into Lake Elwell during April was also near normal. Therefore, storage conditions also improved and releases to the Marias River were increased to 650 cfs on April 24.

The May 1 water supply forecast indicated the May-July runoff into Lake Elwell would be 297,000 acre-feet or 70 percent of normal. Inflow to Lake Elwell during May was only 62 percent of average, leaving lots of room for improvement. Heavy rains and warm temperatures in early June caused inflows to increase and it appeared the runoff into Lake Elwell would be adequate to support a natural runoff hydrograph. Beginning on June 9, releases to the Marias River were gradually increased from 650 cfs until reaching a peak for the year of 4,750 cfs on June 14. Beginning on June 16, flows were gradually decreased until reaching a flow rate of 650 cfs on June 22.

The June inflow to Lake Elwell continued to remain well below normal at only 62 percent of average. Storage steadily increased until reaching a peak content for the year of 852,365 acre-feet at elevation 2988.83 on June 12, 2006. Inflow into Lake Elwell steadily increased until reaching a peak for the year of 4,331 cfs on June 14, 2006. Actual April-July runoff into Lake Elwell totaled 297,654 acre-feet which was 61 percent of normal and 73,719 acre-feet more than in 2005.

Precipitation in the Marias River Basin above Lake Elwell was well below normal during July and August. Valley precipitation was recorded at 42 and 40 percent of average, respectively, while mountain precipitation was 33 and 57 percent of average, respectively. Inflow to Lake Elwell during July was only 24 percent of average and the tenth lowest July inflow ever recorded. To slow the rate of decline, releases from Lake Elwell to the Marias River were decreased and maintained at 525 cfs on August 3. Inflow to Lake Elwell during August was only 12 percent of average and the sixth lowest August inflow ever recorded. To conserve storage in Lake Elwell, releases from lake Elwell to the Marias River were decreased to 500 cfs on September 8.

Inflow into Lake Elwell during July-September totaled 22,955 acre-feet which was only 23 percent of normal and the eighth lowest inflow ever recorded during this time. The total annual runoff into Lake Elwell during 2006 was 406,655 acre-feet, 61 percent of normal and 67,543 acre-feet more than experienced in 2005. This was the 14th lowest annual inflow ever recorded into Lake Elwell.

By the end of the year, normal operations Lake Elwell drafted storage to 769,201 acre-feet at an elevation of 2983.47 feet. This was 98 percent of normal and 1.25 feet higher than reported on September 30, 2005.

The Corps of Engineers determined that during 2006, Lake Elwell did not prevent any local flood damages but did prevent \$11,500 in flood damages downstream on the Missouri River below Fort Peck Reservoir. Since closure of Tiber Dam in 1954, Lake Elwell has reduced flood damages by a total of \$60,900,400.00.

### **Important Events – 2006**

November 3, 2005: Streamflows continue to remain at near record low levels. In an effort to conserve storage, releases from Lake Elwell were decreased from 400 cfs to 320 cfs.

December 1, 2005: Natural Resources and Conservation Service measured snowpack conditions in the watershed above Lake Elwell to be about 82 percent of normal.

January 1, 2006: Natural Resources and Conservation Service reported snowpack conditions in the watershed above Lake Elwell had deteriorated to about 58 percent of normal.

March 30-27, 2006: Tiber Montana LLC scheduled maintenance on their turbine unit to modify the draft tube to determine if a new runner installation was necessary. Flows were switched from the powerplant to the auxiliary outlet works and maintained at a rate of 320 cfs. After completion of the maintenance, Tiber Montana LLC conducted efficiency tests of the powerplant by increasing flows by 50 cfs at 30 minute increments until reaching a maximum flow of approximately 700 cfs when flows were decreased and maintained at a rate of 500 cfs.

April 1, 2006: Natural Resources and Conservation Service reported snowpack conditions in the watershed above Lake Elwell had improved and were 89 percent of normal. Water supply forecast indicated the April-July runoff into Lake Elwell would be 373,000 acre-feet or 77 percent of normal.

April 12, 2006: Personnel from the Reservoir and River Operations Branch met with the Marias Management Committee to discuss the projected water supply for the Marias River Basin and proposed operations of Lake Elwell.

April 24, 2006: Recent rains and snowmelt runoff increased inflow into Lake Elwell. In response, releases to the Marias River were increased to 650 cfs.

June 09-22, 2006: To control the rate of rise in Lake Elwell and assimilate a more natural hydrograph, releases to the Marias River were increased from 650 cfs to a peak for the year of 4,750 cfs on June 14.

June 12, 2006: Lake Elwell reaches a peak elevation for the year of 2988.83 feet, 4.17 feet below the top of the joint use pool.

August 3, 2006: To slow the rate of decline. Releases from Lake Elwell to the Marias River were decreased to 525 cfs.

August 29, 2006: To complete the installation of a guard gate limit switches on the river outlet works, flows were discontinued from the powerplant and switched to the auxiliary outlet works.

September 8, 2006: Inflow into Lake Elwell during August was the sixth lowest on record. To conserve storage, releases from Lake Elwell to the Marias River were decreased to 500 cfs.

Additional hydrologic and statistical information pertaining to the operation of Lake Elwell during 2006 can be found in Table MTT9 and Figure MTG8.



TABLE MTT9  
HYDROLOGIC DATA FOR 2006  
LAKE ELWELL (TIBER DAM)  
NEW SEDIMENT SURVEY DATA EFFECTIVE 10/01/2005

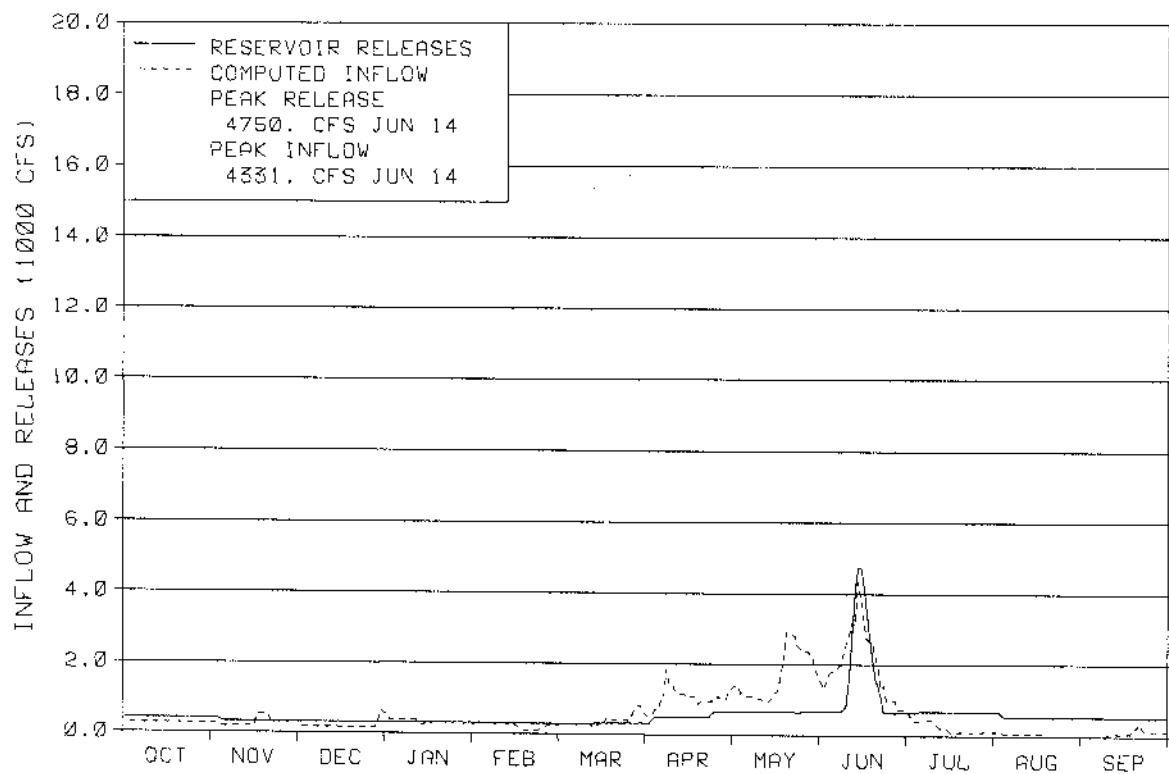
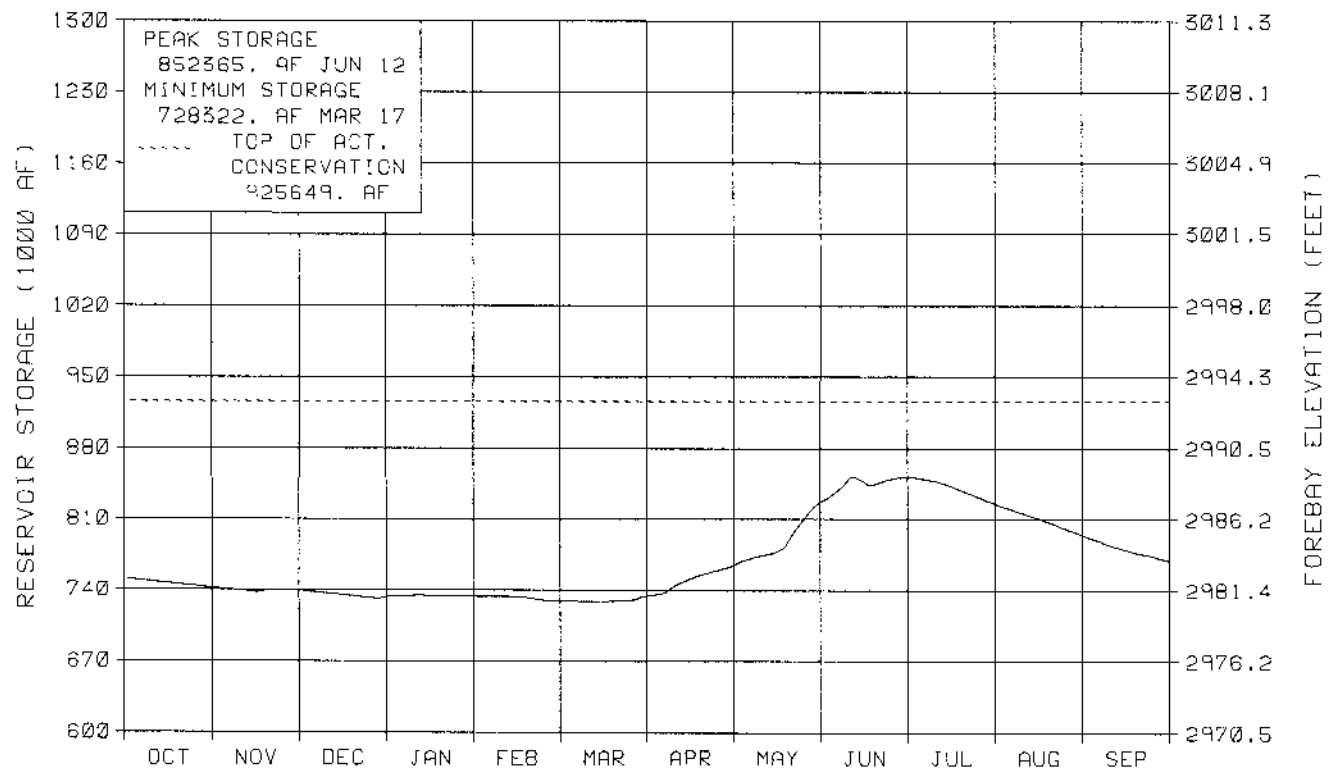
| RESERVOIR ALLOCATIONS          | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |               |
|--------------------------------|---------------------|------------------------------------|-------------------------------|---------------|
| TOP OF INACTIVE AND DEAD       | 2966.40             | 554,330                            | 554,330                       |               |
| TOP OF ACTIVE CONSERVATION     | 2976.00             | 667,213                            | 112,883                       |               |
| TOP OF JOINT USE               | 2993.00             | 925,649                            | 258,436                       |               |
| TOP OF EXCLUSIVE FLOOD CONTROL | 3012.50             | 1,328,723                          | 403,074                       |               |
|                                |                     |                                    |                               |               |
| STORAGE-ELEVATION DATA         | ELEVATION (FT)      | STORAGE (AF)                       | DATE                          |               |
| BEGINNING OF YEAR              | 2982.22             | 751,102                            | OCT 01, 2005                  |               |
| END OF YEAR                    | 2983.47             | 769,201                            | SEP 30, 2006                  |               |
| ANNUAL LOW                     | 2980.61             | 728,322                            | MAR 17, 2006                  |               |
| ANNUAL HIGH                    | 2988.83             | 852,365                            | JUN 12, 2006                  |               |
| HISTORIC HIGH                  | 3005.59             | 1,214,417                          | JUL 12, 1965                  |               |
|                                |                     |                                    |                               |               |
| INFLOW-OUTFLOW DATA            | INFLOW              | DATE                               | OUTFLOW                       | DATE          |
| ANNUAL TOTAL (AF)              | 406,655             | OCT 05-SEP 06                      | 388,154                       | OCT 05-SEP 06 |
| DAILY PEAK (CFS)               | 4,331               | JUN 14, 2006                       | 4,750                         | JUN 14, 2006  |
| DAILY MINIMUM (CFS)            | -15                 | AUG 21, 2006                       | 291                           | MAR 09, 2006  |
| PEAK SPILL (CFS)               |                     |                                    | 0                             | NONE          |
| TOTAL SPILL (AF)               |                     |                                    | 0                             | NONE          |

| MONTH      | INFLOW |          | OUTFLOW* |          | CONTENT |          |
|------------|--------|----------|----------|----------|---------|----------|
|            | KAF    | % OF AVG | KAF      | % OF AVG | KAF     | % OF AVG |
| OCTOBER    | 16.0   | 71       | 25.0     | 55       | 741.7   | 99       |
| NOVEMBER   | 16.5   | 75       | 19.2     | 54       | 739.0   | 101      |
| DECEMBER   | 13.0   | 69       | 18.9     | 68       | 733.1   | 104      |
| JANUARY    | 19.8   | 122      | 19.1     | 75       | 733.8   | 107      |
| FEBRUARY   | 12.2   | 56       | 17.0     | 69       | 729.0   | 109      |
| MARCH      | 23.4   | 47       | 18.7     | 54       | 733.6   | 109      |
| APRIL      | 60.3   | 95       | 30.5     | 67       | 763.5   | 109      |
| MAY        | 103.4  | 62       | 40.3     | 59       | 826.6   | 104      |
| JUNE       | 119.1  | 62       | 93.8     | 95       | 851.9   | 91       |
| JULY       | 14.8   | 24       | 41.2     | 54       | 825.5   | 90       |
| AUGUST     | 2.3    | 12       | 33.5     | 57       | 794.2   | 94       |
| SEPTEMBER  | 5.9    | 37       | 30.9     | 60       | 769.2   | 98       |
| ANNUAL     | 406.7  | 61       | 388.2    | 65       |         |          |
| APRIL-JULY | 297.6  | 61       |          |          |         |          |

\* Average for the 1957-2006 period.

# FIGURE MTG8

## LAKE ELWELL



WATER YEAR 2006

## **Milk River Project**

The 120,000-acre Milk River Project, located in north-central Montana, is served by Sherburne, Fresno, and Nelson Reservoirs. Sherburne and Nelson Reservoirs are single-purpose irrigation structures. Fresno Reservoir has joint-use flood control space, provides a municipal water supply to several municipalities on or near the project, and serves as the primary irrigation storage structure for the Milk River Project. Approximately 101,500 acres are presently served by irrigation districts, 9,500 acres are served by private facilities; and between 5,000 and 6,000 acres are served supplemental water by the Ft. Belknap Indian Irrigation Project.

**Sherburne Reservoir** is located in Glacier National Park on Swiftcurrent Creek, a tributary of the St. Mary River in the Hudson Bay Drainage Basin. Lake Sherburne has a total capacity of 66,147 acre-feet at elevation 4788.0. The use of boundary waters of the St. Mary and Milk Rivers are divided between Canada and the United States by the 1909 Boundary Waters Treaty. The United States utilizes its entitlement to St. Mary River water by regulating flows through storage in Lake Sherburne and diverting St. Mary River flows through the St. Mary Canal



to the Milk River basin. The river outlet works have a capacity of 2,100 cfs at elevation 4788.0 feet. The maximum combined discharge of the spillway and river outlet works is 4,000 cfs at a maximum water surface elevation of 4810.0 feet.

In 2002, Reclamation surveyed Lake Sherburne to develop a topographic map and compute a present storage-elevation relationship (area-capacity tables). The data were used to calculate reservoir capacity lost due to sediment accumulation since dam closure in 1919. The 2002 survey determined that Lake Sherburne has a storage capacity of 66,147 acre-feet and a surface area of 1,719 acres at a reservoir elevation of 4788.00. Since Lake Sherburne closure in 1919, the measured total volume change at reservoir elevation 4788.00 was estimated to be 343 acre-feet between the 1948 and 2002 surveys and 1,707 acre-feet between the 1983 and 2002 surveys. Due to the upstream lakes, the loss due to sediment deposition in Lake Sherburne should be minimal so it is assumed the volume differences between the surveys are due to the different survey methods and the differences in the vertical datum. The revised area-capacity table was put into effect on October 1, 2005, reflecting the new storage levels.

Water year 2005 provided precipitation extremes in both valley and mountain areas of the St. Mary River basin. The latter part of the year produced much above average precipitation in both the mountain and valley areas. Valley areas for August and September were 164 and 163 percent of average respectively, while mountain areas were 102 and 178 percent of average respectively. However, even with good precipitation, inflow to Lake Sherburne was 5,436 acre-feet, only 85 percent of average during September. This resulted in storage in Lake Sherburne being increased to 12,180 acre-feet, 120 percent of average and 18 percent of normal full capacity, at elevation 4742.29 by the beginning of water year 2006. The St. Mary Canal was shutdown on September 12, 2005 and subsequently releases from Lake Sherburne were discontinued on September 13 until spring of 2006.

Although October precipitation in the mountain areas was above normal, the overall fall precipitation in both mountain and valley areas was below average. Cumulative valley precipitation from October to the end of December was 63 percent of average. During the same period cumulative mountain precipitation was 78 percent of average. Inflows during October through December varied from much above to average; the inflows were 268, 110, and 100 percent of average, respectively. This resulted in storage at the end of December of 38,484 acre-feet, 220 percent of average.

On January 1, the Natural Resource and Conservation Service reported that mountain snowpack in the St. Mary basin was 56 percent of normal. This was mainly because of the below average November and December precipitation. The February 1 snowpack for the St. Mary basin had improved to 95 percent of average. Storm patterns improved in February with above normal precipitation in both the valley and mountain areas. The March 1 snowpack for the St. Mary basin was reported at 103 percent of average. Total inflow during January through March was 10,658 acre-feet, 129 percent of normal and the 12<sup>th</sup> highest inflow since 1930.

Generally, diversions into the St. Mary Canal in the spring began as soon as weather permits, which in mild years can be as early as March. In 2006, the prospect of continued drought in the Milk River basin indicated that irrigation water would possibly be needed very early in the season; therefore diversions to the St. Mary Canal were initiated on March 6. Releases from Lake Sherburne preceded the canal diversion on March 3. With normal mountain precipitation during March snowpack also accumulated at near average rates. The snow pack peaked on March 30, slightly earlier than the normal time. The April 1 water supply forecast for April through July runoff indicated that the runoff would be 96,600 acre-feet, 93 percent of normal

Once releases were started, storage decreased until May 15 when warm weather began to increase streamflows and thus beginning the snowmelt runoff season for 2006. Diversion to the St. Mary Canal averaged 498 cfs during April and 671 cfs during May. Releases from Lake Sherburne were increased during April and early May to maintain diversion rates for the St. Mary Canal. Releases were then reduced briefly to approximately 40 cfs on May 19 to increase storage as the flow of the St. Mary River appeared to be adequate to meet the canal diversions until June 14. Valley and mountain precipitation for April and May were both below average. Due to above normal precipitation in both the valley and mountain areas during June, releases from Lake Sherburne were once again reduced to approximately 40 cfs from June 23 through June 26.

The snowmelt runoff was essentially melted out by the end of June which is approximately three weeks earlier than normal. Lake Sherburne storage peaked on June 29 at 66,507 acre-feet, at elevation 4788.21, which was 360 acre-feet and 0.21 feet above the top of normal full capacity. The actual April through July runoff was approximately 109,700 acre-feet, 105 percent of normal.

Precipitation during July and August was much below average in both the valley and mountain areas. Consequently, the cumulative water year precipitation through the end of August for valley and mountain areas was 85 and 89 percent of average, respectively.

Consequently inflows decreased during August and September to 63 and 76 percent of average, respectively. Inflow for the water year totaled 157,562 acre-feet, 110 percent of average. This was 36,160 acre-feet or 30 percent more than the inflow experienced during water year 2005. Storage on September 30, 2006, was 7,652 acre-feet, 91 percent of normal.

According to preliminary data, diversions from the St. Mary River to the Milk River totaled 218,900 acre-feet, 145 percent of the long-term average. The long-term average annual diversion is 150,500 acre-feet and the 1972-2002 average is 168,900 acre-feet. The largest diversion previously recorded was 277,500 acre-feet during 1989. Canal diversions for water year 2006 were discontinued on September 25. The gates at Lake Sherburne were closed on September 23.

The Corps of Engineers recently completed the analysis on flood stages for Swiftcurrent Creek and the St. Mary River. From this analysis, flood benefits can be estimated for Lake Sherburne. During 2006, Lake Sherburne did not contribute to the reduction of flood damages locally or downstream on the Missouri River below Fort Peck reservoir. This is the second year flood damages prevented were estimated for Lake Sherburne.

Additional hydrologic and statistical information pertaining to the operation of Sherburne Reservoir during 2006 can be found in Table MTT10-A and Figure MTG9.

**Fresno Reservoir** is located above all project lands on the Milk River near Havre, Montana. A sediment re-survey done during 1999 and finalized during 2000 determined the normal full pool capacity was 92,880 acre-feet, a loss of 10,517 acre-feet from the previous capacity. The new revised elevation-area-capacity data was used beginning in water year 2001. The top 32,802 acre-feet is used jointly for flood control and conservation and is not filled until the start of the spring runoff. Fresno stores the natural flow of the Milk River along with water diverted into



the Milk River from the St. Mary River and Lake Sherburne. Stored water is used principally for irrigation, but Havre and Chinook, Montana, have contracted for a minimum flow in the river of 25 cfs during the winter to maintain a suitable water quality for municipal use. The city of Harlem and the Hill County Water District have also contracted for municipal use.

During water year 2005 there was little relief to the drought conditions in the Milk River basin. Cumulative precipitation was 90 percent of normal at the end of September. Inflow into Fresno Reservoir during September was 19,300 acre-feet, 74 percent of normal. Consequently, with reduced irrigation demands, Fresno Reservoir slowly filled to a storage content of 46,249 acre-feet, 116 percent of normal and 50 percent of full capacity to begin water year 2006. Releases were reduced to winter levels of approximately 40 cfs on September 23 near the end of water year 2005. No additional releases were made from Fresno Reservoir to transfer water to Nelson Reservoir during fall of 2005.

Weather conditions improved during the start of water year 2006; the accumulated precipitation from October through December was 149 percent of normal. Reservoir inflow was below average in October but improved during November and December and storage remained steady throughout the fall. The end of December storage was 47,173 acre-feet, 126 percent of average and 51 percent of normal full capacity.

By January 1, the Natural Resource and Conservation Service reported the snowpack in the Milk River basin was 128 percent of average because of the much above average precipitation during October and November. Snowpack on February 1 was 107 percent of average thus producing a March through July runoff forecast for Fresno Reservoir of 69,000 acre-feet, 83 percent of average.

Storage at the end of February was 49,355 acre-feet, 139 percent of average. In the Milk River basin the spring runoff season generally occurs from March through June. Therefore, the peak snowpack and most reliable water supply runoff forecast for the Milk River basin is generally at the beginning of March. During 2006, the precipitation in February remained much above average and snowpack in the Milk River basin on March 1 was reported at 117 percent of average. The March 1 water supply forecast indicated that 70,000 acre-feet of runoff could be expected, which was 84 percent of normal. Based upon this forecast, Fresno Reservoir was expected to fill to the top of the conservation pool. Also in March, Reclamation and the Milk River irrigation districts began to discuss water supply. Fortunately, the precipitation during February, March, and April was above average, which postponed any early irrigation demands.

When the runoff below Fresno Reservoir began in late March, diversions to Nelson Reservoir were initiated. Diversion into Dodson South Canal began on March 23. Approximately 5,700 acre-feet of runoff was delivered to Nelson Reservoir during March 25 through April 4, before releases were initiated from Fresno Reservoir. Releases were then increased to transfer storage to Nelson Reservoir. Inflows to Nelson were maintained at or above 150 cfs for the entire irrigation season except in late May irrigation demands on the Dodson South Canal exceeded capacity. Inflows to Nelson Reservoir during this time were approximately 60 cfs.

The initial meeting with the Milk River Joint Board of Control (MRJBC) regarding water supply was on March 21. The initial allotment was set at 1.5 acre-feet per acre. Then on June 18, there was a meeting with MRJBC to reassess allotments. Based on storage conditions the MRJBC elected to increase the irrigation allotment to 2.5 acre-feet per acre. In the latter part of the irrigation season, the MRJBC met on August 15 to discuss water supply and elected once again to increase allotments to 3.0 acre-feet per acre. At that time they also designated September 5 as the end of the irrigation season. Releases were continued from Fresno Reservoir after September 5 to satisfy the Ft. Belknap Indian Irrigation Project irrigation demand from their storage.

By May 1, cumulative valley precipitation was 137 percent of normal. The above average precipitation in March and April resulted in the reservoir storage increasing until May 9, when storage peaked at 95,200 acre-feet at elevation 2575.47 or 0.47 feet above the spillway crest. The average releases for June and July were 628 cfs and 1096 cfs, which were 77 and 121 percent of average, respectively. Releases from Fresno Reservoir peaked at 1,239 cfs on July 14. The actual March through July inflow for Fresno Reservoir, excluding St. Mary canal

water, was approximately 58,800 acre-feet, 61 percent of average. Inflow to Fresno Reservoir peaked during this time at 1,712 cfs, on June 16.

July through September precipitation was below average and by end of September, the cumulative water year precipitation was 93 percent of average. Total inflow for the year was 258,645 acre-feet, 96 percent of average. This was 42,493 acre-feet or 20 percent more than the inflow experienced during water year 2005. Diversions from the St. Mary River basin to the Milk River basin accounted for about 77 percent of the inflow to Fresno Reservoir during 2006. Storage on September 30, 2006 was 42,134 acre-feet, 106 percent of average and 45 percent of normal full capacity.

The Corps of Engineers estimated that during 2006 inflows to Fresno Reservoir were not large enough to have caused local flooding even if passed downstream undiminished. In addition, Fresno did not contribute to the reduction of flood damages downstream on the Missouri River below Fort Peck Reservoir. Since 1950 Fresno Dam and reservoir has reduced flood damages by a total of \$13,085,200.

Additional hydrologic and statistical information pertaining to the operation of Fresno Reservoir during 2006 can be found in Table MTT10-B and Figure MTG10.

**Nelson Reservoir**, located near Malta, Montana, is an off-stream reservoir which receives its water supply from the Milk River by diversion through the Dodson South Canal. Nelson Reservoir is the only source of supply for the lower portion of the Malta Irrigation District. Nelson Reservoir can also serve the Glasgow Irrigation District when water is not available from Fresno Reservoir. In 1999 a sediment re-survey was performed and then finalized during 2000-01. Since Nelson Reservoir operation began in 1916, the measured total volume loss due to sedimentation was 446 acre-feet. The new revised elevation-area capacity data was implemented at the beginning of water year 2002. Nelson Reservoir now has a total capacity of 78,950 acre-feet and an active capacity of 60,810 acre-feet.



Nelson Reservoir began the 2006 water year with a storage content of 58,308 acre-feet, at elevation 2216.41, 103 percent of average and 74 percent of normal full capacity. Storage slowly increased until October 19 when storage decreased through the winter until late March. Releases from Fresno Reservoir to transfer storage were necessary to ensure that Malta and Glasgow Irrigation Districts would have sufficient water for the beginning of the irrigation season. The total inflow prior to irrigation season, March 25 through April 30, was approximately 21,300 acre-feet. Irrigation releases from Nelson Reservoir began on April 25 and continued through September 8. From the middle of May, storage steadily decreased until late May when irrigation demands were satisfied. Beginning in June, storage oscillated until early July when once again irrigation demands increased and storage decreased through the end of the irrigation season. Storage in Nelson Reservoir peaked at 73,539 acre-feet at elevation 2220.32 on May 17. No piping plovers were observed during 2006 nesting on the shores of Nelson Reservoir. Inflows to Nelson Reservoir during May through July totaled

35,000 acre-feet. Releases to the Milk River were made for use by Glasgow Irrigation District during May through August. The total storage released for Glasgow was approximately 24,200 acre-feet. Storage was drafted until early September when irrigation demands were decreased. In September demands decreased significantly and inflows to the reservoir increased thus allowing storage to be recovered through the end of the water year. Water that was diverted into Nelson Reservoir during August through October totaled 22,000 acre-feet. Total inflow to Nelson Reservoir during water year 2006 was 70,391 acre-feet. Storage on September 30, 2006 was 48,814 acre-feet at elevation 2213.68, 86 percent of average and 62 percent of normal full capacity.

Additional hydrologic and statistical information pertaining to the operation of Nelson Reservoir during 2006 can be found in Table MTT10-C and Figure MTG11.

### **Important Events - 2006**

March 1: Milk River runoff forecast indicates 84 percent of normal runoff.

March 3: Releases begin from Lake Sherburne.

March 6: St. Mary Canal begins to divert.

March 21: MRJBC sets the irrigation allotment to 1.5 acre-feet per acre

April 4: Irrigation release are initiated from Fresno Reservoir

April 25: Irrigation releases are initiated from Nelson Reservoir

May 9: Fresno Reservoir storage peaks for the year at 95,200 acre-feet at elevation 2575.47, 0.47 feet above normal full pool.

May 17: Nelson Reservoir storage peaks for the year at 73,539 acre-feet at elevation 2220.32, 1.28 feet below normal full pool.

June 16: Inflow to Lake Sherburne peaked for the year at 1,786 cfs.

June 16: Inflow to Fresno Reservoir peaked at 1,712 cfs.

June 18: The MRJBC increases the irrigation allotment to 2.5 acre-feet per acre

June 29: Lake Sherburne storage peaks for the year at 66,507 acre-feet, at elevation 4788.21, which is 0.21 feet above normal full pool.

August 15: The MRJBC increases irrigation allotment to 3.0 acre-feet per acre and sets September 5 as the end of irrigation season.

September 7-23: Additional water from what was needed to maintain the St. Mary Canal diversion was released from Lake Sherburne to satisfy requirements under the Boundary Waters Treaty.



September 8: Releases from Nelson Reservoir are discontinued.

September 23: Lake Sherburne releases are discontinued.

September 25: St. Mary Canal diversions are discontinued.

September 28: Releases from Fresno Reservoir are set at approximately 40 cfs for the duration of the winter.

TABLE MTT10-A  
HYDROLOGIC DATA FOR 2006  
SHERBURNE RESERVOIR (MILK RIVER PROJECT)  
NEW SEDIMENT SURVEY DATA EFFECTIVE 10/01/2005

| RESERVOIR ALLOCATIONS      | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |               |
|----------------------------|---------------------|------------------------------------|-------------------------------|---------------|
| TOP OF INACTIVE AND DEAD   | 4729.30             | 1,899                              | 1,899                         |               |
| TOP OF ACTIVE CONSERVATION | 4788.00             | 66,147                             | 64,248                        |               |
|                            |                     |                                    |                               |               |
| STORAGE-ELEVATION DATA     | ELEVATION (FT)      | STORAGE (AF)                       | DATE                          |               |
| BEGINNING OF YEAR          | 4742.29             | 10,242                             | OCT 01, 2005                  |               |
| END OF YEAR                | 4738.85             | 7,652                              | SEP 30, 2005                  |               |
| ANNUAL LOW                 | 4737.42             | 6,640                              | SEP 22, 2006                  |               |
| ANNUAL HIGH                | 4788.21             | 66,507                             | JUN 29, 2006                  |               |
| HISTORIC HIGH              | 4788.30             | 68,371                             | JUN 30, 1986                  |               |
|                            |                     |                                    |                               |               |
| INFLOW-OUTFLOW DATA        | INFLOW              | DATE                               | OUTFLOW                       | DATE          |
| ANNUAL TOTAL (AF)          | 157,562             | OCT 05-SEP 06                      | 162,090                       | OCT 05-SEP 06 |
| DAILY PEAK (CFS)           | 1,786               | JUN 16, 2006                       | 1,054                         | JUN 18, 2006  |
| DAILY MINIMUM (CFS)        | 28                  | MAR 15, 2006                       | 0                             | *             |

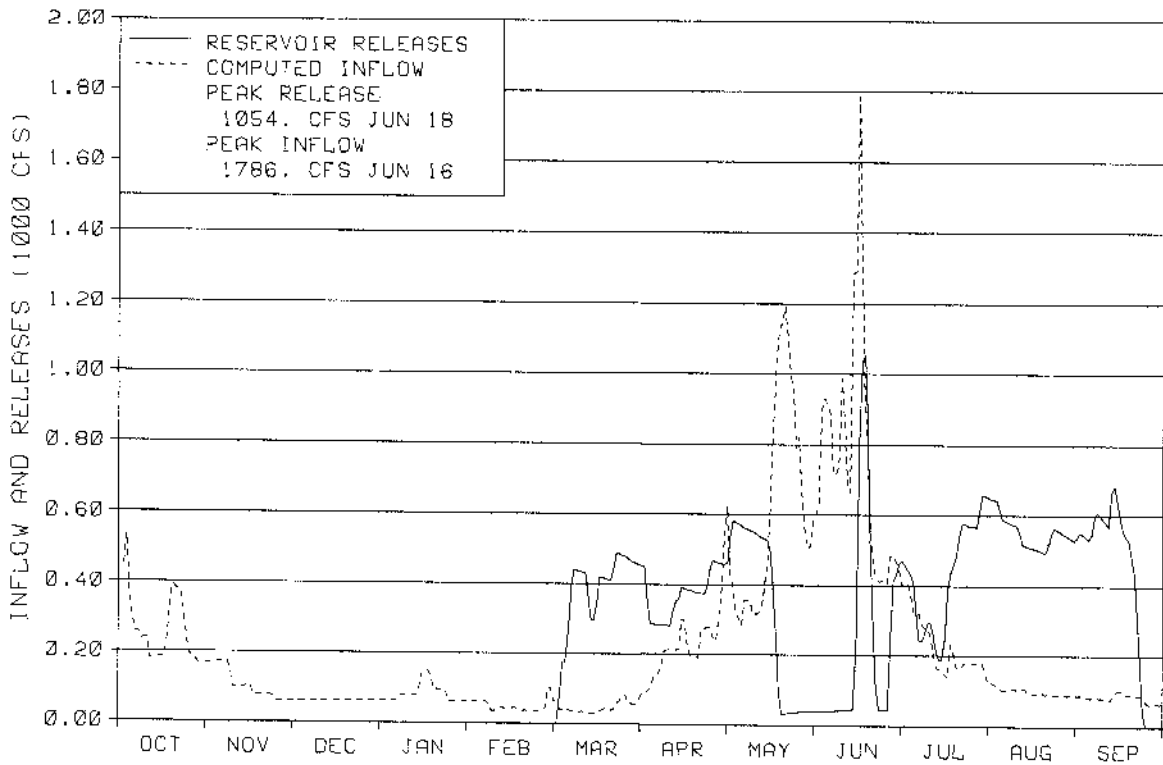
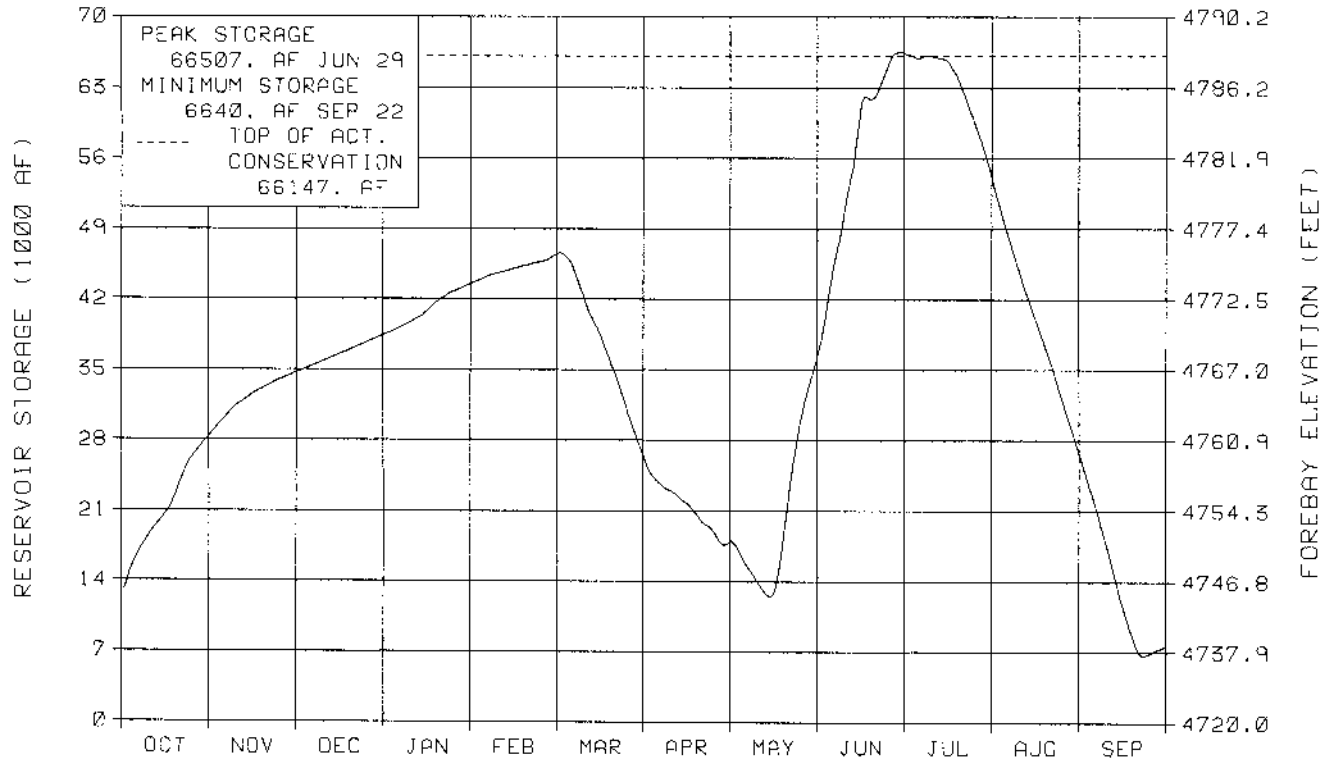
\* During nonirrigation season

| MONTH      | INFLOW |          | OUTFLOW* |          | CONTENT |          |
|------------|--------|----------|----------|----------|---------|----------|
|            | KAF    | % OF AVG | KAF      | % OF AVG | KAF     | % OF AVG |
| OCTOBER    | 16.3   | 268      | 0.0      | ---      | 28.5    | 303      |
| NOVEMBER   | 6.1    | 110      | 0.0      | ---      | 34.7    | 255      |
| DECEMBER   | 3.8    | 100      | 0.0      | ---      | 38.5    | 220      |
| JANUARY    | 5.1    | 184      | 0.0      | ---      | 43.6    | 216      |
| FEBRUARY   | 2.7    | 112      | 0.0      | ---      | 46.3    | 205      |
| MARCH      | 2.8    | 94       | 22.4     | 533      | 26.7    | 119      |
| APRIL      | 13.1   | 146      | 22.1     | 157      | 17.7    | 94       |
| MAY        | 37.7   | 117      | 19.6     | 98       | 35.8    | 123      |
| JUNE       | 44.8   | 108      | 14.2     | 74       | 66.5    | 126      |
| JULY       | 14.1   | 67       | 26.3     | 106      | 54.3    | 113      |
| AUGUST     | 6.0    | 63       | 33.9     | 105      | 26.4    | 112      |
| SEPTEMBER  | 4.9    | 76       | 23.6     | 106      | 7.7     | 91       |
| ANNUAL     | 157.6  | 110      | 162.1    | 114      |         |          |
| APRIL-JULY | 109.7  | 105      |          |          |         |          |

\* Average for the 1955-2006 period.

# FIGURE MTG9

## LAKE SHERBURNE



WATER YEAR 2006

TABLE MTT10-B  
HYDROLOGIC DATA FOR 2006  
FRESNO RESERVOIR (MILK RIVER PROJECT)  
NEW SEDIMENT SURVEY DATA EFFECTIVE 10/1/2000

| RESERVOIR ALLOCATIONS      | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |
|----------------------------|---------------------|------------------------------------|-------------------------------|
| TOP OF INACTIVE AND DEAD   | 2530.00             | 448                                | 448                           |
| TOP OF ACTIVE CONSERVATION | 2567.00             | 60,346                             | 59,898                        |
| TOP OF JOINT USE           | 2575.00             | 92,880                             | 32,534                        |

| STORAGE-ELEVATION DATA | ELEVATION (FT) | STORAGE (AF) | DATE         |
|------------------------|----------------|--------------|--------------|
| BEGINNING OF YEAR      | 2562.04        | 46,249       | OCT 01, 2005 |
| END OF YEAR            | 2560.37        | 42,134       | SEP 30, 2006 |
| ANNUAL LOW             | 2553.90        | 28,238       | SEP 01, 2006 |
| ANNUAL HIGH            | 2575.47        | 95,200       | MAY 09, 2006 |
| HISTORIC HIGH          | 2579.35        | 154,023      | APR 03, 1952 |

| INFLOW-OUTFLOW DATA | INFLOW  | DATE          | OUTFLOW | DATE          |
|---------------------|---------|---------------|---------|---------------|
| ANNUAL TOTAL (AF)   | 258,645 | OCT 05-SEP 06 | 262,760 | OCT 05-SEP 06 |
| DAILY PEAK (CFS)    | 1,712   | JUN 16, 2006  | 1,239   | JUL 14, 2006  |
| DAILY MINIMUM (CFS) | 0       | *             | 13      | NOV 08, 2005  |

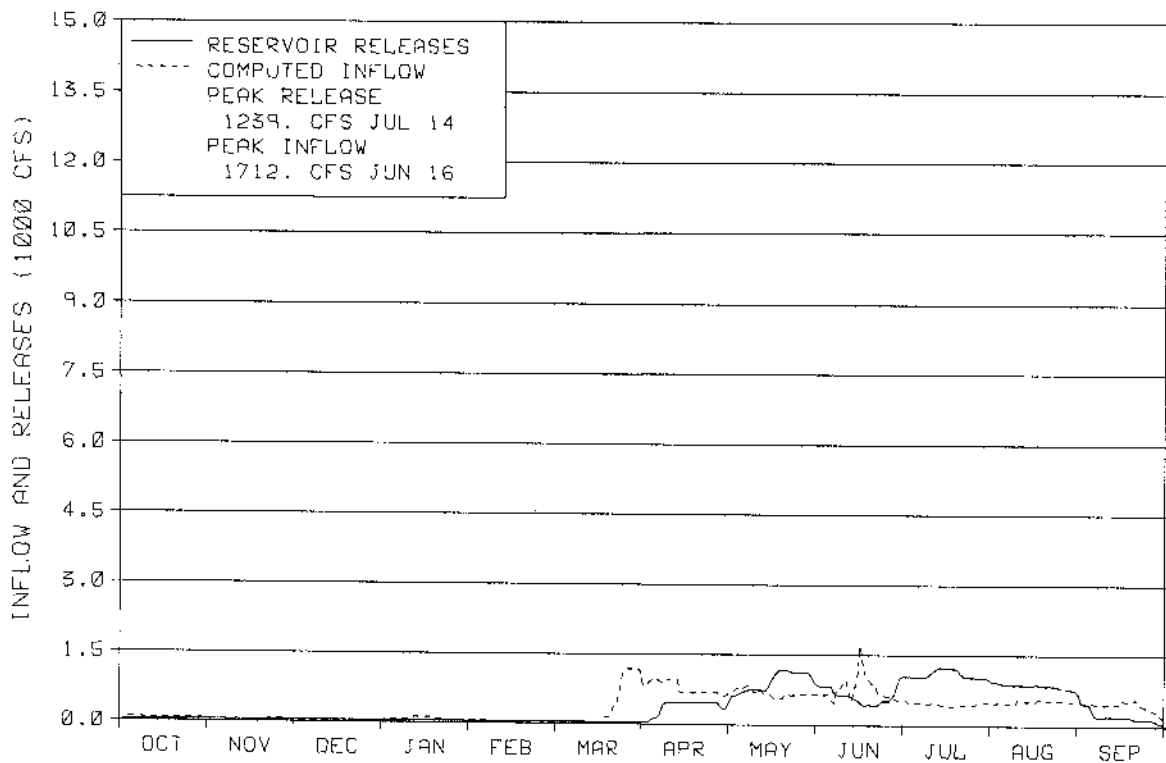
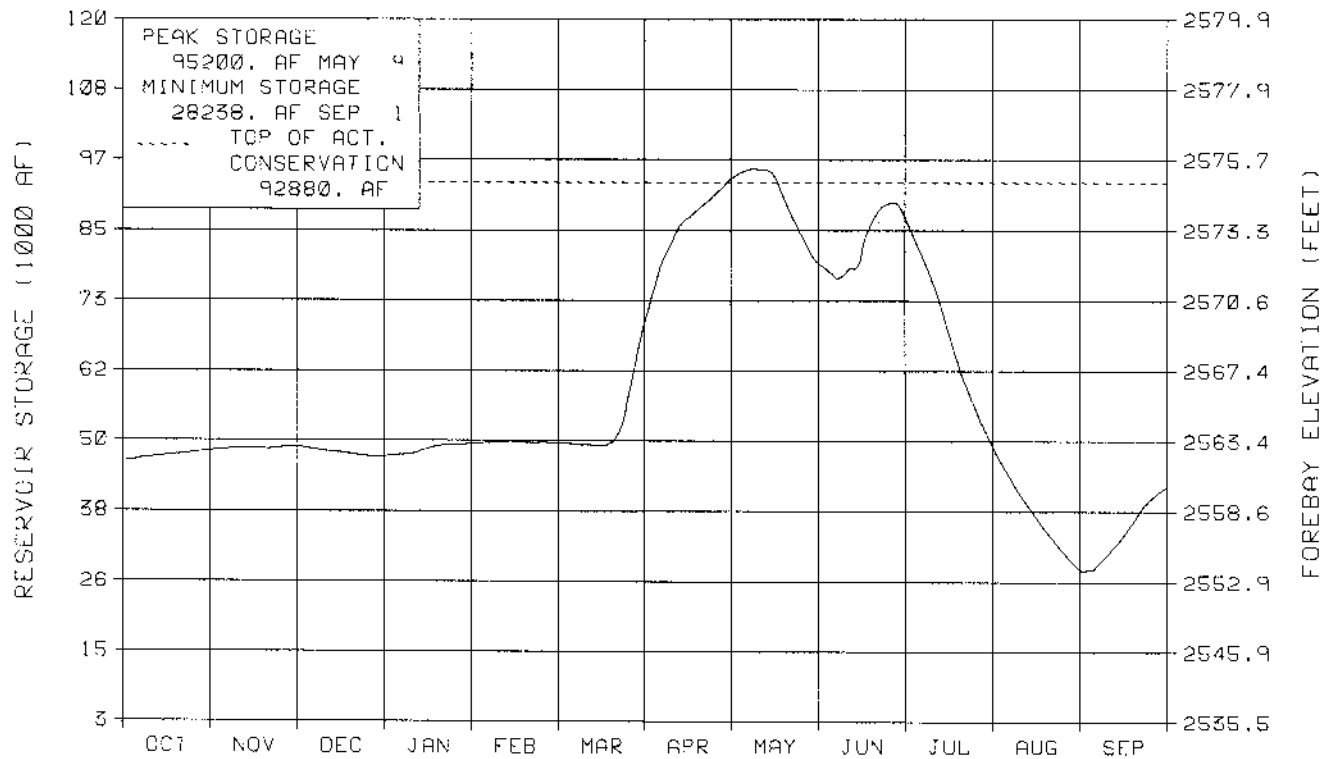
\* During nonirrigation season

| MONTH      | INFLOW |          | OUTFLOW* |          | CONTENT |          |
|------------|--------|----------|----------|----------|---------|----------|
|            | KAF    | % OF AVG | KAF      | % OF AVG | KAF     | % OF AVG |
| OCTOBER    | 4.4    | 59       | 2.6      | 34       | 48.1    | 123      |
| NOVEMBER   | 3.1    | 148      | 2.4      | 78       | 48.7    | 126      |
| DECEMBER   | 1.1    | 109      | 2.6      | 101      | 47.2    | 126      |
| JANUARY    | 4.8    | 953      | 2.6      | 103      | 49.3    | 138      |
| FEBRUARY   | 2.4    | 72       | 2.4      | 99       | 49.4    | 139      |
| MARCH      | 21.9   | 72       | 2.7      | 40       | 68.6    | 131      |
| APRIL      | 46.8   | 118      | 22.2     | 109      | 93.2    | 132      |
| MAY        | 42.0   | 96       | 55.6     | 115      | 79.5    | 122      |
| JUNE       | 45.4   | 99       | 37.3     | 77       | 87.7    | 141      |
| JULY       | 28.7   | 81       | 67.4     | 121      | 49.0    | 110      |
| AUGUST     | 31.9   | 97       | 52.5     | 116      | 28.3    | 76       |
| SEPTEMBER  | 26.2   | 100      | 12.3     | 55       | 42.1    | 106      |
| ANNUAL     | 258.6  | 96       | 262.8    | 99       |         |          |
| APRIL-JULY | 162.9  | 99       |          |          |         |          |

verage for the 1949-2006 period.

# FIGURE MTG10

## FRESNO RESERVOIR



WATER YEAR 2006

TABLE MTT10-C  
HYDROLOGIC DATA FOR 2006  
NELSON RESERVOIR (MILK RIVER PROJECT)  
NEW SEDIMENT SURVEY DATA EFFECTIVE 10/1/2001

| RESERVOIR ALLOCATIONS      | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |
|----------------------------|---------------------|------------------------------------|-------------------------------|
| TOP OF INACTIVE AND DEAD   | 2200.00             | 18,140                             | 18,140                        |
| TOP OF ACTIVE CONSERVATION | 2221.60             | 78,950                             | 60,810                        |

| STORAGE-ELEVATION DATA | ELEVATION (FT) | STORAGE (AF) | DATE         |
|------------------------|----------------|--------------|--------------|
| BEGINNING OF YEAR      | 2216.41        | 58,308       | OCT 01, 2005 |
| END OF YEAR            | 2213.68        | 48,814       | SEP 30, 2006 |
| ANNUAL LOW             | 2210.70        | 40,092       | SEP 04, 2006 |
| ANNUAL HIGH            | 2220.32        | 73,539       | MAY 17, 2006 |
| HISTORIC HIGH          | 2221.60        | 79,224       | JUL 12, 1965 |

| INFLOW-OUTFLOW DATA | INFLOW | DATE          | OUTFLOW | DATE          |
|---------------------|--------|---------------|---------|---------------|
| ANNUAL TOTAL (AF)   | 70,391 | OCT 05-SEP 06 | 79,885  | OCT 05-SEP 06 |
| DAILY PEAK (CFS)    | 382    | MAY 10, 2006  | 656     | JUL 18, 2006  |
| DAILY MINIMUM (CFS) | 0      | *             | 0       | *             |

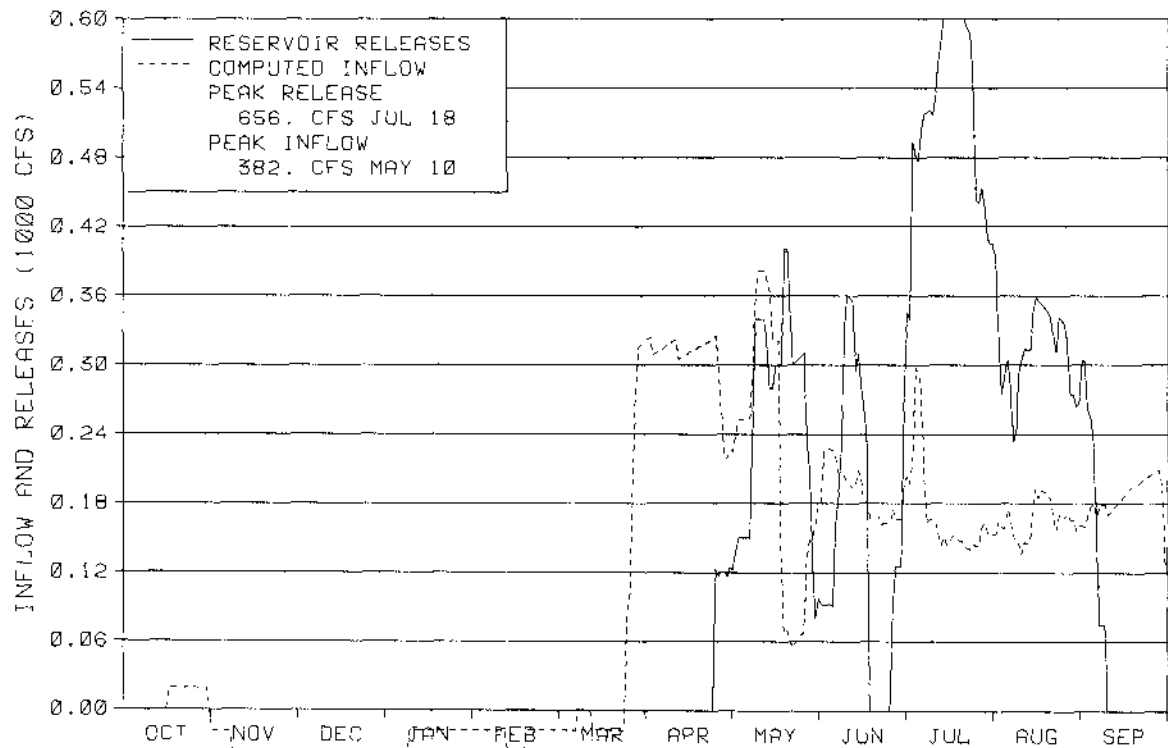
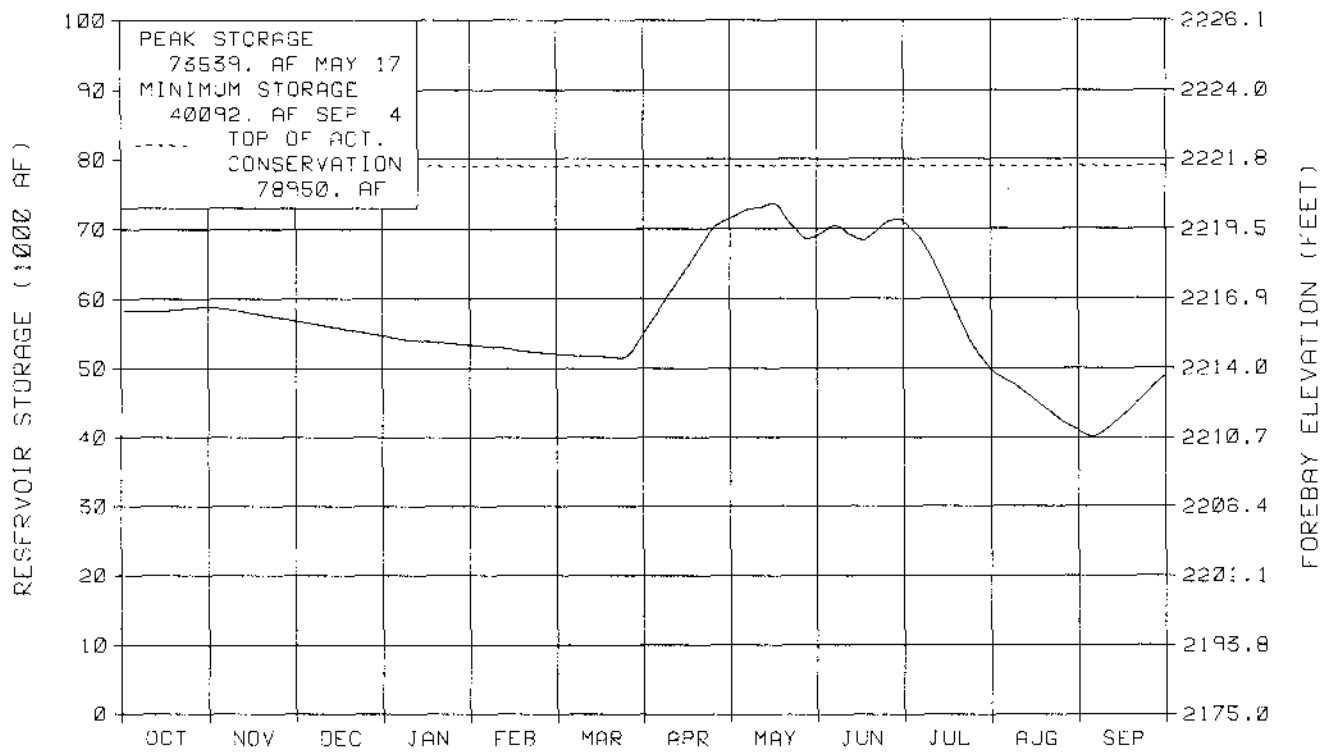
\* During nonirrigation season

| MONTH      | INFLOW* |          | OUTFLOW* |          | CONTENT |          |
|------------|---------|----------|----------|----------|---------|----------|
|            | KAF     | % OF AVG | KAF      | % OF AVG | KAF     | % OF AVG |
| OCTOBER    | 0.5     | 12       | 0.0      | ---      | 58.8    | 99       |
| NOVEMBER   | -2.0    | ---      | 0.0      | ---      | 56.8    | 97       |
| DECEMBER   | -2.2    | ---      | 0.0      | ---      | 54.6    | 96       |
| JANUARY    | -1.3    | ---      | 0.0      | ---      | 53.3    | 97       |
| FEBRUARY   | -1.2    | ---      | 0.0      | ---      | 52.1    | 97       |
| MARCH      | 2.6     | 195      | 0.0      | ---      | 54.6    | 100      |
| APRIL      | 18.1    | 254      | 1.4      | 253      | 71.3    | 118      |
| MAY        | 13.2    | 197      | 15.5     | 206      | 69.0    | 114      |
| JUNE       | 11.2    | 146      | 9.0      | 123      | 71.2    | 119      |
| JULY       | 10.6    | 214      | 31.9     | 313      | 49.8    | 91       |
| AUGUST     | 10.2    | 145      | 19.1     | 245      | 40.8    | 75       |
| SEPTEMBER  | 10.9    | 182      | 2.8      | 80       | 48.8    | 86       |
| ANNUAL     | 70.4    | 176      | 79.9     | 202      |         |          |
| APRIL-JULY | 53.1    | 201      |          |          |         |          |

\* Average for the 1947-2006 period.

# FIGURE MTG11

## NELSON RESERVOIR



WATER YEAR 2006

## **Bighorn Lake and Yellowtail Powerplant**

Bighorn Lake (P-S, MBP) is located on the Bighorn River about 45 miles southwest of Hardin, Montana. It has a total capacity of 1,328,360 acre-feet. The dam and reservoir were built for power generation, irrigation, flood control, fish and wildlife and recreation. The nameplate capacity of Yellowtail Powerplant is 250,000 kilowatts. Provisions have been made for gravity diversions from the reservoir to the proposed Hardin Unit which contains 42,600 acres of irrigable lands needing a full water supply and 950 acres to receive a supplemental supply. Stored water can also be used to irrigate additional lands along the Yellowstone River. Reclamation has negotiated an



industrial water service contract with Pennsylvania Power & Light, MT (PPL-MT), formerly known as Montana Power Company (MPC) for 6,000 acre-feet. All other industrial water service contracts with different entities expired as of May 1982, and none were renewed. Bull Lake, Boysen and Buffalo Bill Reservoirs are three major tributary reservoirs located in Wyoming upstream of Bighorn Lake. Because these reservoirs are operated and managed by the Wyoming Area Office (WYAO), all reservoir and river operations in the Bighorn River Basin are closely coordinated between the Montana Area Office (MTAO) and WYAO.

In 1982, a hydrographic and a topographic survey was conducted and a new elevation-area-capacity table and curve was developed. The 1982 survey determined that Bighorn Lake has a storage capacity of 1,328,360 acre-feet and a surface area of 17,279 acres at reservoir elevation 3657.0 (the top of the spillway gates). Since closure in 1965, the reservoir has accumulated a sediment volume of 53,950 acre-feet below reservoir elevation 3657. This volume represents a 3.9 percent loss in capacity and an average annual loss of 3,224 acre-feet from November 1965 through July 1982. Sediment was deposited at the annual rate of 0.314 acre-feet per square mile during that period. The revised area-capacity table was put into effect on August 1, 1986, reflecting the new storage levels.

During the fall of 2005, precipitation in the Bighorn Basin upstream of Bighorn Lake was above average during August but dropped to well below average during September. The generous precipitation that was received during August, helped reduce upstream irrigation demands and by September, the irrigation was winding down. This attributed to an increase in streamflows to Bighorn Lake during August and September. The August-September inflow during 2005 was 90 percent of average, totaling 314,673 acre-feet. As a result, by maintaining releases from Bighorn Lake to the Bighorn River at 1,500 cfs, storage in Bighorn Lake gradually increased. By the beginning of water year 2006, storage in Bighorn Lake had increased to 1,000,506 acre-feet at elevation 3634.03. This was only 69,523 acre-feet or 5.97 feet below the top of the joint-use pool and 290,164 acre-feet or 40.40 feet higher than at the beginning of water year 2005.

At the end of water year 2005, storages in Boysen and Buffalo Bill Reservoirs located on the Wind and Shoshone Rivers were drafted to 112 and 104 percent of average, respectively, to meet irrigation demands. With year-end reservoir levels much improved over a year ago, the WYAO established the minimum winter releases out of these reservoirs at flow rates of 1,000 and 200 cfs. During the fall of 2005, precipitation in the Bighorn River Basin was generally near to well above normal. During October, valley precipitation was 172 percent of average while the mountain precipitation was 97



percent of average. The generous fall precipitation, caused the tributary flow between Boysen and Buffalo Bill Reservoirs to Bighorn Lake to be 116 percent of average during October. However, the releases out of Boysen and Buffalo Bill Reservoirs had a bigger effect on the inflow to Bighorn Lake. The lower than normal releases coupled with the dry soil conditions caused the inflow to Bighorn Lake to be only 85 percent of average during October. As inflows to Bighorn Lake averaged slightly over 2,600 cfs and releases to the Bighorn River maintained at 2,500, Bighorn Lake rose to elevation 3636.25 feet with a storage content of 1,025,038 acre-feet on October 16. There was little known, this would eventually be recorded as the peak storage for the year, about 3.75 feet or 44,991 acre-feet below the top of the joint-use pool.

The November-February inflow totaled 407,510 acre-feet and was only 68 percent of average, the tenth lowest of record since the construction of Yellowtail Dam. With daily inflows averaging slightly over 1,700 cfs and releases to the Bighorn River maintained at 2,500 cfs, storage in Bighorn Lake gradually declined throughout the winter. By March 1, the level of Bighorn Lake had declined to an elevation of 3616.26 with a storage content of 845,680 acre-feet.

The fall and winter of 2005-2006 for the Bighorn River Basin started out cooler and wetter than normal but quickly changed. Snows accumulated in the higher elevations at above normal rates in early October but quickly dropped to well below normal rates during late October through the middle of November. From about the middle of November through early January, winter storms were more frequent over the Bighorn Basin. Valley precipitation during November was 115 percent of average while the mountain precipitation was average. but mountain snowpack continued to accumulate at below normal rates.

By December, weather conditions turned warm and mild. Precipitation varied widely throughout the Bighorn River Basin. Valley precipitation declined to 61 and 23 percent of average, respectively, during December and January while the mountain precipitation dropped to 94 and 82 percent of average, respectively.

On January 1, the Natural Resources Conservation Service (NRCS) measured mountain snowpack in the Bighorn Basin at about 89 percent of normal. The Wind and Shoshone River Basins, major tributaries of the Bighorn River, were measured at 91 and 86 percent of average, respectively. This was 9 percent lower in the Wind River Basin and 20 percent and 3 percent higher in the Shoshone and Bighorn River Basins, respectively, than reported on January 1, 2005. By February 1, snowpack in the Wind River Basin declined by 8 percent to 83 percent of average while the snowpack in Shoshone River Basin essentially remained the same at 87 percent of average.

During February, valley precipitation improved to 96 percent of average while the mountain precipitation improved to 89 percent of average. But then weather conditions changed, signaling the return of the drought. Valley precipitation during March and April had dropped significantly to 64 and 67 percent of average, respectively while the mountain precipitation dropped to 70 and 57 percent of average, respectively. By April 1, the mountain snowpack in the Bighorn River Basin had decline to 83 percent of average, an increase of 8 percent above that on April 1, 2005. Snowpack in the Wind and Shoshone River Basins, major tributaries of the Bighorn River, was measured at 81 and 79 percent of normal, respectively. On April 1, 2005, the mountain snowpack in these basins reported snowpack at 82 and 59 percent of average, respectively.

On April 1, Bighorn Lake had a storage content of 823,388 acre-feet at elevation 3613.08. This was a decline of 3.18 feet from March 1. Water supply forecasts of April-July snowmelt runoff are prepared at the beginning of each month beginning in January and continuing through June. During January through March, the water supply forecasts indicated the spring runoff would be adequate to allow Bighorn Lake to fill to the top of the joint-use pool at elevation 3640 by the end of June or early July while maintaining river releases at the desired minimum fishery flow rate of 2,500 cfs. The water supply forecast prepared on April 1, indicated the spring runoff into Bighorn Lake was still adequate to maintain a minimum river release of 2,500 cfs, but was not sufficient to fill Bighorn Lake to the top of the conservation pool at elevation 3640. However, the water supply was adequate to maintain the storage level of Bighorn Lake above elevation 3615 (minimum elevation for safe launching of boats at Horseshoe Bend) throughout the recreation season. The operation plans prepared on April 1, indicated Bighorn Lake would reach a peak storage content of 997,700 acre-feet at elevation 3633.77 near the end of May. This would be 6.23 feet below the top of the joint-use pool.

Normally mountain snowpack continues to accumulate through the middle of April, reaching a peak snow water content of generally around 14.75 inches on April 15. After that time, the snowmelt runoff begins and streamflows begin to increase. However, in 2006 the wintry storms essentially ended in early April and the snowpack reached a peak snow water content for the year was recorded at 11.5 inches on April 3.

Since April precipitation was well below normal, heavy irrigation demands occurred much earlier than normal. The extremely mild winter experienced in 2006 resulted in little to no low elevation snow remaining in the mountains by mid April. April inflows to Bighorn Lake quickly dropped to only 60 percent of average. During May and June, climatic and hydrologic conditions did not change significantly. Valley precipitation was only 35 percent of average during May and June, while the mountain precipitation was 50 percent of average.

Normally the level of Bighorn Lake begins to increase during late March to mid-April. However, in 2006 this did not occur until late May. Record high temperatures about the middle of May finally began to melt the little remaining higher elevation mountain snow. Accompanied by a minor storm disturbance about the middle of May, inflows to Bighorn Lake increased from about 1,500 cfs in early May to a peak for the year of 6,756 cfs on May 24. After that time, the inflows began to quickly recede. The May inflow to Bighorn Lake was 71 percent of average, improving by 10 percent from that experienced a month earlier.

With releases to the Bighorn River maintained at 2,500 cfs, storage in Bighorn Lake steadily declined during April and May. On May 16, Bighorn Lake reached a low elevation for the year of 3603.33 with a storage content of 763,270 acre-feet. This storage level was 90 percent of average and 36.67 feet or 306,759 acre-feet below the top of the joint-use pool. Inflows to Bighorn Lake were now exceeding the total release. However, this lasted only briefly until about the middle of June when storage in Bighorn Lake reached a peak content for the year of 1,025,039 acre-feet at elevation 3615.02 on June 17. During the spring runoff season, storage had only increased 11.69 feet from May 16 to June 17. With storage quickly receding, the decision was made to gradually reduce the releases to the Bighorn River to 2,250 cfs during June 25-26 to conserve storage. This was done in close coordination with Montana Fish, Wildlife, and Parks and the National Park Service.

By early June, the high elevation mountain snow was essentially melted out. This was about a month earlier than normal. As precipitation in the Bighorn River Basin continued to remain well below normal throughout the remainder of the summer, irrigation demands in the Bighorn River Basin remained high, causing inflow to Bighorn Lake to quickly recede. Inflows to Bighorn Lake were only 37 percent of average during June and 23 percent of average during July, making them the 8<sup>th</sup> and 2<sup>nd</sup> lowest June and July inflow of records, respectively. As a result of the near record low inflow, storage in Bighorn Lake was quickly dropping. By the end of June, storage had dropped to an elevation as low as 3613, about 27 feet below the top of the joint-use pool. As storage in Bighorn Lake continued to drop, the releases to the Bighorn River were once again reduced to 2,000 cfs on June 30 and gradually to 1,500 cfs during July 10-13 in an effort to conserve storage in Bighorn Lake.

Valley precipitation in the Bighorn River Basin was 46 percent of average during July and 32 percent of average during August while the mountain precipitation was 50 and 64 percent of average, respectively. This kept irrigation demands high, causing inflows to Bighorn Lake to remain at near record low rates of only 23 and 48 percent of average, respectively. Even with releases maintained at 1,500 cfs, Bighorn Lake continued to drop to a low elevation for the year at 3598.43 with a storage content of 735,982 acre-feet on September 2. This was 73 percent of average and 41.57 feet or 334,047 acre-feet below the top of the joint-use pool. Since June 17, when storage in Bighorn Lake had reached a peak content, storage steadily dropped 16.59 feet by September 2.

Weather conditions improved considerably during September. Valley precipitation increased to 110 percent of average while the mountain precipitation improved to 130 percent of average. This caused inflows to Bighorn Lake to increase to 77 percent of average. In response, storage in Bighorn Lake to gradually increased over 4.6 feet during September to a content of 761,787 acre-feet at elevation 3603.07 on September 30. This was 75 percent of average and 308,242 acre-feet or 36.93 feet below the top of the joint-use pool and also 238,719 acre-feet or 30.96 feet lower than the level experienced at the end of water year 2005.

The April-July runoff into Bighorn Lake during 2006 was 44 percent of average and totaled 528,199 acre-feet, 536,842 acre-feet or about half as much of the inflow experienced in 2005. This made it the 4<sup>th</sup> lowest April-July inflow of record since construction of Yellowtail Dam. The annual runoff into Bighorn Lake totaled 1,432,634 acre-feet and will be recorded as the 6<sup>th</sup> lowest annual runoff of record. This was 57 percent of average and 17 percent or 415,350 acre-feet lower than the total runoff experienced during water year 2005. The total amount of water released to the Bighorn River during 2006 was 1,617,847 acre-feet, 70 percent of normal.

The persistent extended drought severely impacted the operations of Bighorn Lake and the Bighorn River Basin. There was difficulty in managing the critically low water supply in the Bighorn Basin and balancing it among the various competing interest groups. However with strict conservative measures implemented early in the year, it was possible to provide limited opportunities for lake recreation on Bighorn Lake, protect the lake fishery interests, and provide habitat for the renowned trout fishery downstream of Yellowtail Afterbay Dam. Throughout the winter and early spring, releases to the Bighorn River were maintained at 2,500 cfs the desired minimum flow required to support a healthy river fishery. Because of the record low precipitation received during 2006, these releases had to eventually be reduced to the absolute minimum level of 1,500 cfs by early July, in an effort to conserve storage in Bighorn Lake. Even though the low water levels of Bighorn Lake did

not allow for the National Park Service to open Horseshoe Bend Marina, there were always opportunities to launch boats at Ok-A-Beh and Barry's Landing around Bighorn Lake all year.

The Corps of Engineers estimated that during 2006, Bighorn Lake did not prevent any local flood damages but did prevent \$13,300 in flood damages downstream on the Missouri River below Fort Peck Reservoir. Since construction of Yellowtail Dam in 1965, Bighorn Lake has reduced flood damages by a total of \$111,745,900.

Total generation produced at Yellowtail Powerplant during 2006 was 575,096,000 kilowatt-hours, 65 percent of the long term average since construction of the powerplant in 1967. This was 261,369 kilowatt-hours more than generated during the record low year of 2003 and 61,419 kilowatt-hours more than generated in 2005. All of the water released from the dam was released through the powerplant.

### **Important Events - Water Year 2006**

September 26-29: With the 2005 irrigation season essentially over, the BIA requested gradual reductions in diversions to the Bighorn Canal until being completely shut off on September 29. Turbine releases were gradually reduced to maintain a total release of 2,500 cfs (2,500 cfs to the Bighorn River and 0 cfs to the Bighorn Canal).

October 27: Power generation indicated actual flows in the Bighorn River were higher than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

November 3: Recent flow measurements indicated actual flows in the Bighorn River were higher than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

November 8: Power generation indicated actual flows in the Bighorn River were higher than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

November 17: Power generation indicated actual flows in the Bighorn River were higher than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

December 1: Power generation indicated actual flows in the Bighorn River were higher than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

December 15: Power generation indicated actual flows in the Bighorn River were higher than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

February 15: Power generation indicated actual flows in the Bighorn River were higher than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

March 8: Recent flow measurements indicated actual flows in the Bighorn River were lower than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

March 28: Reclamation hosted and participated in the Bighorn Interagency Coordination Meeting at the Montana Area Office's 1<sup>st</sup> Floor Conference Room to discuss the operations of Bighorn Lake

and Bighorn River. Tim Felchle, Chief of Reservoir and River Operations, presented the water supply outlook and the proposed operations of Bighorn Lake and Bighorn River for the 2006 season.

April 5: Recent flow measurements indicated actual flows in the Bighorn River were lower than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

April 20-May 1: A 12-day maintenance outage was scheduled on the Afterbay Dam sluice gates. During this outage, the level of the Afterbay was maintained between elevations 3183 and 3190 to allow for the required river discharge to be released through the Afterbay spillway gates.

April 26: Maintenance outages were scheduled on Units No. 1 & 2 to allow for the 3-hour annual black start test. Turbine generation during these outages were restricted to 2-unit capacity.

May 3: To allow for inspection of the Yellowtail Dam spillway tunnel, the tailwater elevation was maintained no higher than elevation 3183 to allow boats to safely enter the spillway stilling basin.

May 10: Recent flow measurements indicated actual flows in the Bighorn River were lower than anticipated. Turbine releases were adjusted to maintain river releases at 2,500 cfs.

May 16-23: The BIA requested irrigation diversions to the Bighorn Canal be initiated and gradually increased to 500 cfs.

May 25: Actual inflow to Bighorn Lake was lower than previously forecasted. To conserve storage and better assure the reservoir of filling to the top of the joint-use pool, total release from Yellowtail Dam to the Bighorn River was decreased to 2,250 cfs.

May 26: The BIA reported a leak on the Bighorn Canal and requested all diversions to be decreased to 200 cfs until repairs on the canal can be completed. In response, the total release was decreased to 2,450 cfs (2,250 cfs to the Bighorn River and 200 cfs to the Bighorn Canal).

May 29-June 1: The BIA reported maintenance work on the Bighorn Canal was completed and requested diversions to be gradually increased. In response, diversions to the Bighorn Canal were gradually increased to 450 cfs by June 1, resulting in a total release of 2,700 cfs (2,250 cfs to the Bighorn River and 450 cfs to the Bighorn Canal).

May 31: Western Area Power Administration performed maintenance in the switchyard. In response, Units No. 3 & 4 were taken off line and turbine releases were restricted to 2-unit capacity.

June 7-12: To assist the BIA in de-mossing the Bighorn Canal, a special operation was conducted to gradually reduce diversions to the Bighorn Canal to 265 cfs and gradually increase them to 400 cfs later.

June 27-29: To assist the BIA in de-mossing the Bighorn Canal, a special operation was conducted to gradually reduce diversions to the Bighorn Canal to 350 cfs and gradually increase them to 450 cfs later.

June 29: The persistent drought is severely impacting runoff into Bighorn Lake, causing storage in Bighorn Lake to continually decline. To slow the rate of decline, total release was reduced to 2,450 cfs (2,000 cfs to the Bighorn River and 450 cfs to the Bighorn Canal).

July 10-July 13: The persistent drought continues to severely impact the runoff into Bighorn Lake. To slow the rate of decline, total release was gradually reduced to 1,950 cfs (1,500 cfs to the Bighorn River and 450 cfs to the Bighorn Canal).

July 18: To allow for inspection of the Yellowtail Dam spillway tunnel, the tailwater elevation was maintained no higher than elevation 3183 to allow boats to safely enter the spillway stilling basin.

July 20: The BIA requested a reduction in diversions to the Bighorn Canal. In response, the total release was reduced to 1,900 cfs (1,500 cfs to the Bighorn River and 400 cfs to the Bighorn Canal).

July 27: The BIA requested an increase in diversions to the Bighorn Canal. In response, the total release was reduced to 1,950 cfs (1,500 cfs to the Bighorn River and 450 cfs to the Bighorn Canal).

August 14: Recent flow measurements indicated actual flows in the Bighorn River and Bighorn Canal were lower than anticipated. Turbine releases were adjusted to the total release at 1,935 cfs (1,500 cfs to the Bighorn River and 435 cfs to the Bighorn Canal).

August 21-September 1: A 12-day maintenance outage was scheduled on the Afterbay Dam sluice gates. During this outage, the level of the Afterbay was maintained between elevations 3183 and 3190 to allow for the required river discharge to be released through the Afterbay spillway gates.

August 24: The BIA requested an increase in diversions to the Bighorn Canal. In response, the total release was reduced to 1,970 cfs (1,500 cfs to the Bighorn River and 470 cfs to the Bighorn Canal).

August 28-31: The BIA requested reductions in diversions to the Bighorn Canal. In response, the total release was gradually reduced to 1,900 cfs (1,500 cfs to the Bighorn River and 400 cfs to the Bighorn Canal).

September 7: The BIA requested a reduction in diversions to the Bighorn Canal. In response, the total release was reduced to 1,800 cfs (1,500 cfs to the Bighorn River and 300 cfs to the Bighorn Canal).

September 11: Recent flow measurements indicated actual flows in the Bighorn River and Bighorn Canal were lower than anticipated. The BIA also requested gradual increase in diversions to the Bighorn Canal. In response, the total release was adjusted to provide 1,785 cfs (1,500 cfs to the Bighorn River and 285 cfs to the Bighorn Canal).

September 18-21: Due to recent rains, the BIA requested gradual reductions in diversions to the Bighorn Canal. In response, the total release was gradually reduced to 1,685 cfs (1,500 cfs to the Bighorn River and 185 cfs to the Bighorn Canal).

October 2-3: With the 2006 irrigation season essentially over, the BIA requested all diversions to the Bighorn Canal be gradually discontinued by October 3. In response, the total release was gradually reduced to 1,500 cfs (1,500 cfs to the Bighorn River and 0 cfs to the Bighorn Canal).

Additional hydrologic and statistical information pertaining to the operations of Bighorn Lake during 2006 can be found on Table MTT11 and MTG12.

For more detailed information on the operations of Boysen and Buffalo Bill Reservoirs during 2006, refer to the narratives for Boysen Reservoir and Powerplant and Shoshone Project under the responsibility of the Wyoming Area Office.

TABLE MTT11  
HYDROLOGIC DATA FOR 2006  
BIGHORN LAKE (YELLOWTAIL DAM)

| RESERVOIR ALLOCATIONS          | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |
|--------------------------------|---------------------|------------------------------------|-------------------------------|
| TOP OF INACTIVE AND DEAD       | 3547.00             | 493,584                            | 493,584                       |
| TOP OF ACTIVE CONSERVATION     | 3614.00             | 829,687                            | 336,103                       |
| TOP OF JOINT USE               | 3640.00             | 1,070,029                          | 240,342                       |
| TOP OF EXCLUSIVE FLOOD CONTROL | 3657.00             | 1,328,360                          | 258,331                       |

| STORAGE-ELEVATION DATA | ELEVATION (FT) | STORAGE (AF) | DATE         |
|------------------------|----------------|--------------|--------------|
| BEGINNING OF YEAR      | 3634.03        | 1,000,506    | OCT 01, 2005 |
| END OF YEAR            | 3603.07        | 761,787      | SEP 30, 2006 |
| ANNUAL LOW             | 3598.43        | 735,982      | SEP 02, 2006 |
| ANNUAL HIGH            | 3636.25        | 1,025,038    | OCT 16, 2005 |
| HISTORIC HIGH          | 3656.43        | 1,365,198    | JUL 06, 1967 |

| INFLOW-OUTFLOW DATA | INFLOW    | DATE          | OUTFLOW*  | DATE          |
|---------------------|-----------|---------------|-----------|---------------|
| ANNUAL TOTAL (AF)   | 1,432,860 | OCT 05-SEP 06 | 1,617,847 | OCT 05-SEP 06 |
| DAILY PEAK (CFS)    | 6,756     | MAY 24, 2006  | 2,531     | APR 06, 2006  |
| DAILY MINIMUM (CFS) | 910       | AUG 11, 2006  | 1,492     | SEP 11, 2006  |
| PEAK SPILL (CFS)    |           |               | 0         | NONE          |
| TOTAL SPILL (AF)    |           |               | 0         | NONE          |

\*Discharge to the Bighorn River

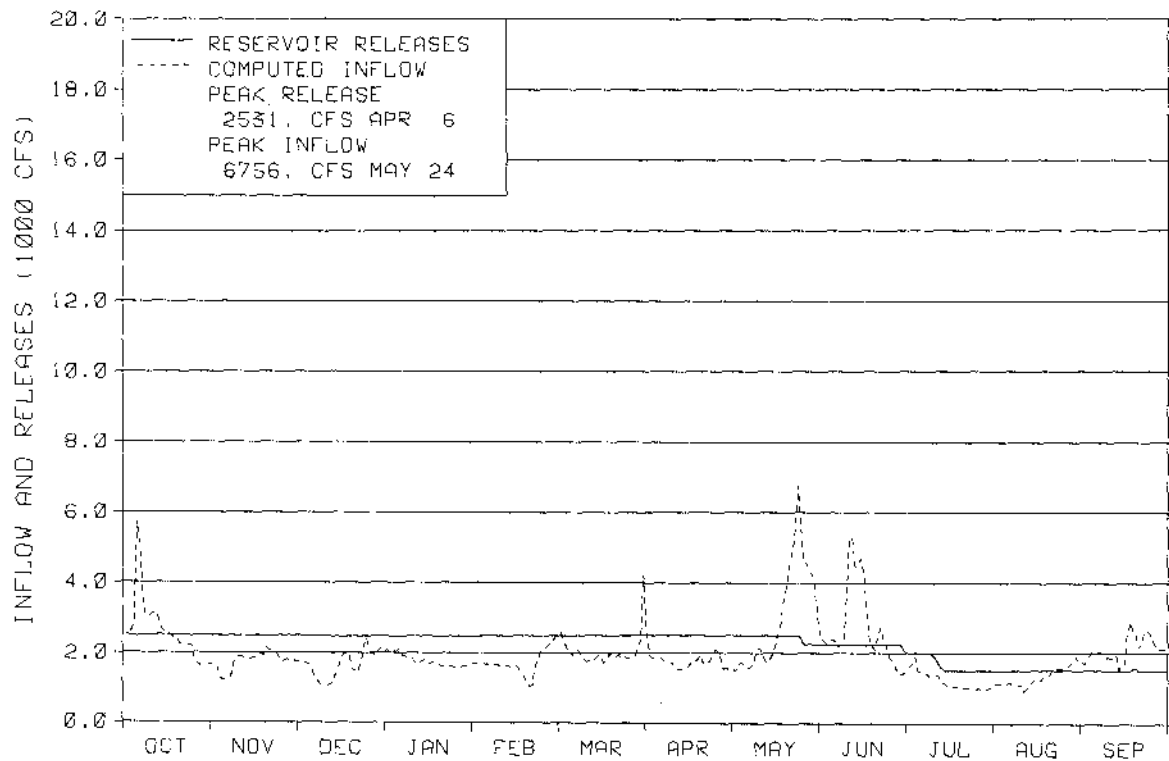
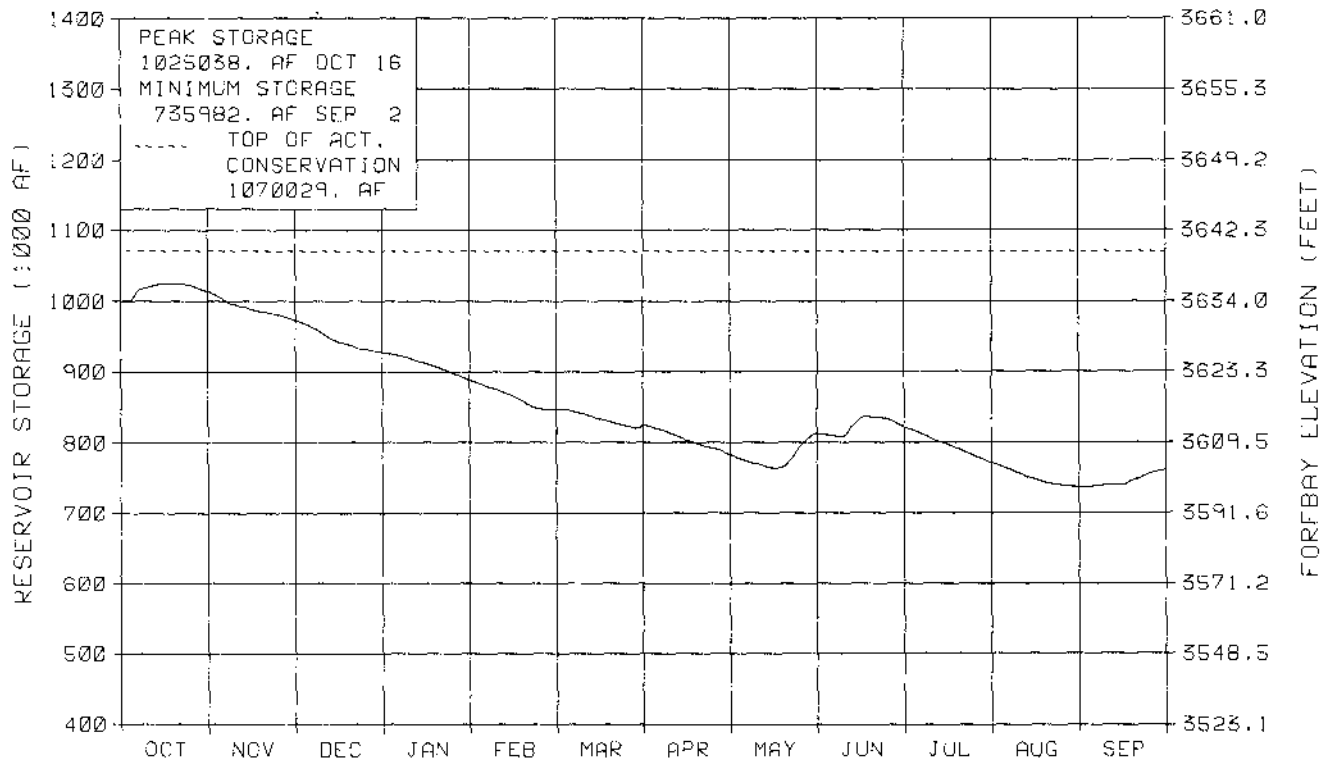
| MONTH      | INFLOW  |             | OUTFLOW*     |             |              |             | CONTENT |             |
|------------|---------|-------------|--------------|-------------|--------------|-------------|---------|-------------|
|            | KAF     | % OF<br>AVG | CANAL<br>KAF | % OF<br>AVG | RIVER<br>KAF | % OF<br>AVG | KAF     | % OF<br>AVG |
| OCTOBER    | 160.9   | 85          | 0.0          | ---         | 153.5        | 88          | 1,012.3 | 100         |
| NOVEMBER   | 104.3   | 64          | 0.0          | ---         | 148.0        | 82          | 972.7   | 100         |
| DECEMBER   | 102.1   | 69          | 0.0          | ---         | 152.3        | 82          | 926.4   | 101         |
| JANUARY    | 107.2   | 76          | 0.0          | ---         | 152.1        | 83          | 886.0   | 102         |
| FEBRUARY   | 93.8    | 65          | 0.0          | ---         | 138.0        | 83          | 845.7   | 101         |
| MARCH      | 126.9   | 71          | 0.0          | ---         | 153.6        | 82          | 823.4   | 99          |
| APRIL      | 106.0   | 61          | 0.0          | ---         | 149.4        | 82          | 784.1   | 96          |
| MAY        | 184.0   | 71          | 9.6          | 86          | 151.0        | 81          | 812.1   | 93          |
| JUNE       | 163.6   | 37          | 23.8         | 109         | 133.6        | 51          | 822.5   | 80          |
| JULY       | 74.7    | 23          | 26.8         | 97          | 103.6        | 38          | 770.9   | 74          |
| AUGUST     | 82.2    | 48          | 27.5         | 103         | 93.0         | 54          | 736.4   | 73          |
| SEPTEMBER  | 127.2   | 71          | 16.2         | 86          | 89.8         | 59          | 761.8   | 75          |
| ANNUAL     | 1,432.9 | 57          | 104.0        | 93          | 1,617.8      | 70          |         |             |
| APRIL-JULY | 528.3   | 44          |              |             |              |             |         |             |

\* Average for the 1967-2006 period.



# FIGURE MTG12

## BIGHORN LAKE



WATER YEAR 2006

## **CLIMATE SUMMARY**

After limited relief from the drought in water year 2005, the Bighorn basin of Wyoming saw a return to well below average precipitation combined with one of the warmest summers on record. Conditions looked pretty good through the winter months as the snowpack accumulated at a rate that ranged from ten to fifteen percent below average with frequent storms passing through the basin. Very little precipitation fell from March through September and basin reservoirs were heavily relied upon to provide an adequate water supply through the irrigation season. At the end of the water year almost the entire Bighorn basin was considered to be in the extreme drought category.

The water year got off to a promising start with one to two inches of rain falling on the Bighorn basin during the first week of October. Little rain fell during the remainder of the month but the monthly totals were still well above average in the river valleys. The mountains also began to build snowpack with the early October storm but the lack of precipitation through the remainder of the month resulted in less than average mountain precipitation for October. Temperatures in both the Shoshone and Wind River basins were about two degrees above average for the month. Precipitation remained above average in the Shoshone drainage in November while the Boysen watershed received less than average rainfall. Storms around the 7<sup>th</sup> and 14<sup>th</sup> of the month added to the accumulation of snow in the mountains of both the Shoshone and Wind River basins. November remained mild with temperatures about five degrees above average in both the Wind and Shoshone basins. On December 1<sup>st</sup>, the early winter snowpack stood at 69 percent of average in the basin above Boysen and 82 percent of average in the Buffalo Bill watershed. A strong winter storm moved through western Wyoming on December 1<sup>st</sup> and 2<sup>nd</sup> adding significant snow to the upper reaches of both the Wind and Shoshone basins. Additional snow fell as a second storm hit the western mountains between the 4<sup>th</sup> and 6<sup>th</sup>. As high pressure moved into the state following the winter storms, skies cleared and nighttime temperatures plummeted, with many stations reporting lows in the -25° to -30° degree range on December 7<sup>th</sup> and 8<sup>th</sup>. Snowfall returned to the Bighorn basin during the last week of December as one storm after another blanketed the basin between December 28<sup>th</sup> and January 4<sup>th</sup>. For the month, precipitation was above average in the Shoshone drainage and just slightly below average in the Boysen watershed. The extreme cold of the early part of the month weighed in on what was otherwise a fairly mild month, resulting in the monthly average temperature for December being slightly below normal.

By January 1<sup>st</sup> the snowpack in the Wind River basin had increased to 89 percent of average and the Shoshone basin had improved to 87 percent of average. The mild winter continued into the new year with January temperatures in the Shoshone and Wind River basins about eleven and nine degrees warmer than normal, respectively. Storms continued to track over western Wyoming during January, dropping enough snow in the mountains to maintain the snowpack at about 90 percent of average through the month in both the Shoshone and Wind River basins. Precipitation at the lower elevation weather stations was below average for January, especially in

the Boysen watershed which received about half the normal for January. During the month of February, the snowpack in the Shoshone basin slowly fell further from average. The storms that did pass through Wyoming during the month had their greatest effect on the central part of the state and helped prevent the snowpack in the Wind River mountains from dropping. The major moisture producing storms occurred on the 14<sup>th</sup> and 28<sup>th</sup> of the month. Temperatures were below normal for the month of February, due primarily to an arctic air mass that settled over the state near the middle of the month. For the month, temperatures in the Shoshone basin were about one degree below average while the Wind River basin was about three degrees colder than normal. On February 17<sup>th</sup> and 18<sup>th</sup>, temperatures of -25 degrees and colder were common over the entire Bighorn basin with Lander reporting a low of -38 degrees on the 18<sup>th</sup>. On the first of March, the snowpack in the Shoshone watershed had fallen five percent from the February 1 level and stood at 83 percent of average. The snowpack in the drainage upstream of Boysen only lost two percent over the month, reporting 88 percent of average on March 1. Precipitation during March was about 75 percent of average in the mountains and river valleys of both the Buffalo Bill and Boysen drainages with the only notable snowfall occurring on the 19<sup>th</sup> and 20<sup>th</sup>. Temperatures in the Shoshone basin were right at the monthly average while the Wind River basin was about two degrees colder than normal. Snowpack in both basins continued to slowly fall further below average and on April 1, the snowpack above Boysen and Buffalo Bill was 86 and 79 percent of average, respectively.

The condition of the snowpack and the weather patterns of the months through February indicated the snowmelt runoff would be near average in both the Wind and Shoshone River drainages. While the snowpack had only small losses compared to average during March, a shift to drier conditions was returning to the Bighorn basin and especially to the watershed above Boysen. April precipitation was above average at the lower elevation sites in the Shoshone drainage but the mountains above Buffalo Bill only received about 70 percent of average precipitation. In the Boysen watershed precipitation was about 50 percent of average in the Wind River valley as well as in the mountains. With April temperatures about four degrees above average for the month and below average precipitation, the heavy, wet spring snows that normally occur in March and early April did not materialize and the snowpack began a steady fall from average. By May 1, the snowpack in the Wind River mountains was down to 65 percent of average, a loss of more than 20 percent during April. In the mountains above Buffalo Bill, the snowpack dropped 12 percent during April to 67 percent of average on May 1<sup>st</sup>.

The month of May is normally the wettest month of the year in the Bighorn basin, but May of 2006 was extremely dry. In the drainage above Boysen the 30 year average for May is 1.86 inches of precipitation, but the drainage only received 0.21 inches, or 11 percent of average in 2006. The weather station at Lander recorded 0.06 inches of rain, which was the lowest total precipitation for the month of May since record-keeping began in 1892. Conditions in the Shoshone watershed were somewhat better, with 56 percent of average precipitation falling during the month. Inflow to Buffalo Bill Reservoir from snowmelt runoff began to increase in early May and peaked at 6,652 cfs on May 20<sup>th</sup>. Much of the runoff in the basin above Boysen was diverted for irrigation upstream of the reservoir, resulting in a peak inflow to Boysen of 2,688 cfs on May 22<sup>nd</sup>. On June 1<sup>st</sup>, the snowpack was essentially gone at all but the highest elevation SNOTEL sites in both the Shoshone and Wind River basins and the snowpack in both areas had fallen to 29 percent of average. The lack of rain continued into September and was most notable in the Boysen watershed, which received only 18 percent of average in June; 29 percent of average in July; and 54 percent of average in August. Temperatures in June were

fairly moderate but extreme heat entered the Wind River basin in the middle of July and remained through the end of the month. Temperatures in excess of 100 degrees were common throughout the Basin between July 15<sup>th</sup> and 20<sup>th</sup>, with Lander and Riverton both setting new records during the period. The July heat wave also hit the Shoshone basin but precipitation was not quite as scarce through the summer above Buffalo Bill. In June, the Shoshone basin received 67 percent of average precipitation and July rainfall was 107 percent of the 30 year average. August and September precipitation returned to below average at 46 and 67 percent of average, respectively. The weather changed abruptly in mid-September as the first winter storm of the season dropped close to a foot of snow in the mountains and almost an inch of rain at many lower elevation weather stations. A second storm the next week brought another 12 to 16 inches of snow to mountain locations above 7000 feet with rainfall totals in excess of one inch in the river valley below Boysen, which brought an end to the need for irrigation water.

The 2006 mountain snow water content for the drainage basins in Wyoming is shown on Table WYT1. The 2006 water supply forecasts are shown on Table WYT2 and the 2006 precipitation in inches and the percent of average is shown on Table WYT3.

**TABLE WYT1**  
**2006 MOUNTAIN SNOW WATER CONTENT <sup>1</sup>**  
**AS A PERCENT OF THE 1971-2000 AVERAGE**

| DRAINAGE BASIN | JAN 1  |    | FEB 1  |    | MAR 1  |    | APR 1  |    | MAY 1  |    |
|----------------|--------|----|--------|----|--------|----|--------|----|--------|----|
|                | INCHES | %  | INCHES | %  | INCHES | %  | INCHES | %  | INCHES | %  |
| BULL LAKE      | 3.80   | 68 | 5.58   | 76 | 7.03   | 78 | 8.78   | 78 | 5.80   | 56 |
| BOYSEN         | 5.81   | 89 | 8.41   | 90 | 10.13  | 88 | 12.08  | 86 | 9.22   | 65 |
| BUFFALO BILL   | 7.63   | 87 | 10.74  | 88 | 12.60  | 83 | 14.56  | 79 | 13.13  | 67 |

<sup>1</sup> A composite of the following Natural Resources Conservation Service SNOTEL sites was used to determine snow water content and percent of average for the basins:

Bull Lake.....Cold Springs, Elkhart Park, Hobbs Park, and St. Lawrence Alt;

Boysen.....Burroughs Creek, Cold Springs, Hobbs Park, Kirwin, Little Warm, St. Lawrence Alt, South Pass, Togwotee Pass, Townsend Creek, and Younts Peak;

Buffalo Bill.....Blackwater, Evening Star, Kirwin, Marquette, Sylvan Lake, Sylvan Road, and Younts Peak

**TABLE WYT2**  
**2006 WATER SUPPLY FORECASTS OF APRIL - JULY SNOWMELT RUNOFF**

|              | JAN 1 |             | FEB 1 |             | MAR 1 |             | APR 1 |             | MAY 1 |             | JUN 1 |             | ACTUAL | APR-JULY    | % OF APRIL<br>FORECAST<br>RECEIVED |
|--------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|--------|-------------|------------------------------------|
|              | KAF   | % OF<br>AVG | KAF   | % OF<br>AVG | KAF   | % OF<br>AVG | KAF   | % OF<br>AVG | KAF   | % OF<br>AVG | KAF   | % OF<br>AVG | KAF    | % OF<br>AVG |                                    |
| BULL LAKE    | 115   | 82          | 130   | 93          | 130   | 93          | 130   | 93          | 110   | 79          | 90    | 65          | 120.8  | 87          | 93                                 |
| BOYSEN       | 400   | 71          | 500   | 89          | 500   | 89          | 450   | 80          | 350   | 62          | 300   | 53          | 200.5  | 36          | 45                                 |
| BUFFALO BILL | 600   | 92          | 650   | 100         | 650   | 100         | 600   | 92          | 500   | 77          | 470   | 72          | 545.9  | 84          | 91                                 |

Averages are based on the 1976-2005 period

TABLE WYT3  
PRECIPITATION IN INCHES AND PERCENT OF AVERAGE

| BASIN                                      | OCT  |     | NOV  |     | DEC  |     | JAN   |     | FEB   |     | MAR   |     | APR   |     | MAY   |     | JUN   |    | JUL   |     | AUG   |    | SEP   |     |
|--------------------------------------------|------|-----|------|-----|------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|----|-------|-----|-------|----|-------|-----|
|                                            | IN.  | %   | IN.  | %   | IN.  | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %   | IN.   | %  | IN.   | %   | IN.   | %  | IN.   | %   |
| <b>VALLEY PRECIPITATION <sup>1</sup></b>   |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |    |       |     |       |    |       |     |
| BUFFALO BILL                               |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |    |       |     |       |    |       |     |
| MONTHLY PRECIP AND % OF AVERAGE            | 1.35 | 124 | 1.94 | 178 | 1.29 | 127 | 0.90  | 80  | 0.87  | 99  | 0.76  | 70  | 1.57  | 123 | 1.19  | 56  | 1.35  | 67 | 1.54  | 107 | 0.60  | 46 | 0.89  | 67  |
| YEAR-TO-DATE PRECIP AND % OF AVERAGE       | 1.35 | 124 | 3.29 | 151 | 4.58 | 143 | 5.48  | 127 | 6.35  | 122 | 7.11  | 113 | 8.68  | 115 | 9.87  | 102 | 11.22 | 96 | 12.76 | 97  | 13.36 | 92 | 14.25 | 90  |
| BOYSEN                                     |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |    |       |     |       |    |       |     |
| MONTHLY PRECIP AND % OF AVERAGE            | 1.49 | 202 | 0.28 | 56  | 0.27 | 95  | 0.14  | 53  | 0.42  | 124 | 0.44  | 73  | 0.58  | 48  | 0.21  | 11  | 0.21  | 18 | 0.26  | 29  | 0.36  | 54 | 0.88  | 89  |
| YEAR-TO-DATE PRECIP AND % OF AVERAGE       | 1.49 | 202 | 1.77 | 142 | 2.04 | 132 | 2.18  | 120 | 2.60  | 121 | 3.04  | 111 | 3.62  | 91  | 3.83  | 66  | 4.04  | 58 | 4.30  | 54  | 4.66  | 54 | 5.54  | 58  |
| BULL LAKE                                  |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |    |       |     |       |    |       |     |
| MONTHLY PRECIP AND % OF AVERAGE            | 1.49 | 256 | 0.11 | 26  | 0.07 | 31  | 0.09  | 47  | 0.31  | 115 | 0.40  | 86  | 0.23  | 20  | 0.14  | 7   | 0.32  | 26 | 0.37  | 38  | 0.43  | 55 | 0.56  | 53  |
| YEAR-TO-DATE PRECIP AND % OF AVERAGE       | 1.49 | 256 | 1.60 | 157 | 1.67 | 134 | 1.76  | 121 | 2.07  | 120 | 2.47  | 113 | 2.70  | 81  | 2.84  | 55  | 3.16  | 49 | 3.53  | 48  | 3.96  | 49 | 4.52  | 49  |
| <b>MOUNTAIN PRECIPITATION <sup>2</sup></b> |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |    |       |     |       |    |       |     |
| BUFFALO BILL                               |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |    |       |     |       |    |       |     |
| MONTHLY PRECIP AND % OF AVERAGE            | 2.10 | 88  | 4.30 | 116 | 3.20 | 103 | 3.40  | 113 | 2.00  | 80  | 2.10  | 75  | 2.30  | 68  | 2.30  | 61  | 1.10  | 37 | 1.30  | 59  | 0.80  | 50 | 2.30  | 105 |
| YEAR-TO-DATE PRECIP AND % OF AVERAGE       | 2.10 | 88  | 6.40 | 105 | 9.60 | 104 | 13.00 | 107 | 15.00 | 102 | 17.10 | 98  | 19.40 | 93  | 21.70 | 88  | 22.80 | 82 | 24.10 | 81  | 24.90 | 79 | 27.20 | 81  |
| BOYSEN                                     |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |    |       |     |       |    |       |     |
| MONTHLY PRECIP AND % OF AVERAGE            | 2.00 | 95  | 2.90 | 97  | 2.50 | 100 | 3.00  | 120 | 1.50  | 68  | 2.10  | 72  | 1.80  | 51  | 1.10  | 32  | 0.50  | 21 | 0.60  | 35  | 1.10  | 79 | 2.50  | 125 |
| YEAR-TO-DATE PRECIP AND % OF AVERAGE       | 2.00 | 95  | 4.90 | 96  | 7.40 | 97  | 10.40 | 103 | 11.90 | 97  | 14.00 | 92  | 15.80 | 84  | 16.90 | 76  | 17.40 | 71 | 18.00 | 69  | 19.10 | 69 | 21.60 | 73  |
| BULL LAKE                                  |      |     |      |     |      |     |       |     |       |     |       |     |       |     |       |     |       |    |       |     |       |    |       |     |
| MONTHLY PRECIP AND % OF AVERAGE            | 1.90 | 95  | 1.80 | 82  | 1.50 | 88  | 2.00  | 125 | 1.20  | 75  | 2.00  | 83  | 1.80  | 56  | 0.50  | 15  | 0.40  | 17 | 0.50  | 33  | 0.90  | 64 | 2.10  | 111 |
| YEAR-TO-DATE PRECIP AND % OF AVERAGE       | 1.90 | 95  | 3.70 | 88  | 5.20 | 88  | 7.20  | 96  | 8.40  | 92  | 10.40 | 90  | 12.20 | 83  | 12.70 | 70  | 13.10 | 64 | 13.60 | 62  | 14.50 | 62 | 16.60 | 66  |

<sup>1</sup> A composite of the following National Weather Service stations was used to determine monthly valley precipitation and percent of average for the drainage basins:

Bull Lake.....Burris, Diversion Dam, and Dubois;  
Boysen.....Boysen Dam, Burris, Diversion Dam, Dubois, Lander, and Riverton;  
Buffalo Bill.....Buffalo Bill Dam, Lake Yellowstone, and Tower Falls

<sup>2</sup> A composite of the following Natural Resources Conservation Service SNOTEL sites was used to determine monthly mountain precipitation and percent of average for the drainage basins:

Bull Lake.....Cold Springs, Elkhart Park, Hobbs Park, and St. Lawrence Alt;  
Boysen.....Burroughs Creek, Cold Springs, Hobbs Park, Kirwin, Little Warm, St. Lawrence Alt, South Pass, Togwotee Pass, Townsend Creek, and Younts Peak;  
Buffalo Bill.....Blackwater, Evening Star, Kirwin, Marquette, Sylvan Lake, Sylvan Road, and Younts Peak

Averages for Valley Precipitation are based on the 1976-2005 period

Averages for Mountain Precipitation are based on the 1971-2000 period

## FLOOD BENEFITS

| Flood Damage Prevented<br>in the Wind/Bighorn and Shoshone River Systems <sup>1</sup> |       |           |            |                       |                                |
|---------------------------------------------------------------------------------------|-------|-----------|------------|-----------------------|--------------------------------|
| Reservoir                                                                             | Local | Main Stem | 2006 Total | Previous Accumulation | 1950 - 2006 Accumulation Total |
| Bull Lake <sup>2</sup>                                                                | \$ 0  | \$ 0      | \$ 0       | \$ 2,690,300          | \$ 2,690,300                   |
| Boysen                                                                                | \$ 0  | \$ 4,400  | \$ 4,400   | \$88,251,900          | \$88,256,300                   |
| Buffalo Bill <sup>2</sup>                                                             | \$ 0  | \$ 0      | \$ 0       | \$10,989,400          | \$10,989,400                   |

1/ This data is received from the Army Corps of Engineers Omaha District Office and is revised every October. The period of assessment is 1950 through 2006.

2/ No space is allocated to flood control, but some flood protection is provided by operation for other purposes.

## **Riverton Unit**

The Riverton Project was reauthorized as the Riverton Unit Pick-Sloan Missouri Basin Program (P-S MBP) on September 25, 1970. Major facilities of this unit are Bull Lake Reservoir, Wind River Diversion Dam, Wyoming Canal, Pilot Butte Powerplant, Pilot Butte Reservoir, and Pilot Butte Canal. The major facilities provide water for irrigation of about 76,000 acres on the Midvale Irrigation District (Midvale). The water supply comes partly from the natural flow of the Wind River and partly from water stored in Bull Lake and Pilot Butte Reservoirs.

**Bull Lake Reservoir** is located on Bull Lake Creek, a tributary of the Wind River near Crowheart, Wyoming. Bull Lake has an active capacity of 151,737 acre-feet (AF), and is above all unit land. It is the principal storage facility for the unit and is operated by Midvale under contract with Reclamation. A small amount of incidental flood control benefit is provided by normal operation for other purposes. Bull Lake also provides a water resource for enhancing fish, wildlife, and recreation.

Bull Lake held 66,804 AF of water at the start of water year 2006, which was 86 percent of the normal end of September content and 44 percent of capacity. Irrigation diversions into the Wyoming Canal ended in early October and releases from Bull Lake were reduced at that time to conserve the remaining storage in Bull Lake.

During water year 2005, Midvale entered into an agreement with Reclamation that allowed the storage of Boysen water in Bull Lake by exchange. Because of this agreement, Bull Lake ended the water year at a higher content. Once irrigation season ended, the Boysen water in Bull Lake was transferred back to Boysen at a rate of approximately 20 cfs to provide a winter flow in Bull Lake Creek. Inflow during October, November, and December exceeded the release and the content of Bull Lake began to increase as soon as irrigation releases ended. By the end of December, storage in Bull Lake had increased to 72,094 AF, which was 94 percent of average. On January 1, snowpack in the basin above Bull Lake was 68 percent of average. Water supply forecasts were prepared each month, beginning in January and continuing through June, for the April-July snowmelt runoff period. The January forecast indicated the April-July snowmelt runoff would be approximately 115,000 AF, which was 82 percent of average. Precipitation in the mountains above Bull Lake was above average during January and the snowpack increased to 76 percent of average on February 1<sup>st</sup>. The April-July snowmelt runoff forecast was increased to 130,000 AF. Inflow during January, February, and March was slightly more than the release from the dam and by the end of March the reservoir held 73,037 AF. The snowpack held fairly constant, compared to average, through the period with precipitation in the mountains about 80 percent of average. On April 1<sup>st</sup> the snowpack above Bull Lake was 78 percent of average. Forecasts prepared on March 1<sup>st</sup> and April 1<sup>st</sup> both indicated the April-July inflow to Bull Lake would be the same as was forecasted on February 1<sup>st</sup>, about 130,000 AF.

Midvale began diverting water into Wyoming Canal on April 9<sup>th</sup>, utilizing the natural flow in the Wind River to flush the canal system and irrigation deliveries began on April 24<sup>th</sup>. Releases from Bull Lake were increased as irrigation water was needed to supplement diversions from the Wind River. April precipitation was well below average on the irrigated lands of the district and precipitation in the mountains above Bull Lake was about half of normal. The snowpack remained at about 75 percent of average through the first half of April. The second half of the month saw little snowfall and the snowpack began to fall further below average. By May 1<sup>st</sup> the snowpack in the



Bull Lake drainage was down to 56 percent of average, resulting in a reduction in the May 1 forecast to 110,000 AF, 79 percent of average. As Wind River flows increased in mid-May, project demands were met with natural flow from the river and Bull Lake releases were cut back. Flows in Bull Lake Creek above Bull Lake were also increasing at this time and the reservoir level rose about ten feet in the last half of May, to 5784.01 feet on May 31<sup>st</sup>. Demand for Bull Lake water increased for a period in late May and early June but for most of June much of Midvale's irrigation requirement was met from natural flow and storage in Bull Lake continued to increase. As temperatures increased in June, a second period of higher runoff was under way with inflow to Bull Lake peaking on June 10<sup>th</sup> at 1,584 cfs. Inflow continued to exceed the release from Bull Lake through the end of June and the reservoir held 128,770 AF of water at the end of the month with a corresponding elevation of 5797.27 feet. The reservoir level continued a slow rise into July, reaching a maximum content of 132,472 AF on July 11<sup>th</sup> at elevation of 5798.51 feet. This was 19,987 AF and 6.49 feet below the top of the active conservation pool. Inflow to Bull Lake was 69 percent of average during July and the flow of the Wind River above Bull Lake Creek was 56 percent of average. As the flow in the Wind River declined, more Bull Lake storage water was needed to satisfy the irrigation demand and reservoir storage fell to 115,299 AF of water by July 31<sup>st</sup>. August and September inflows continued to be below average and little of the natural flow in the Wind River was available for diversion by Midvale. Irrigation releases from Bull Lake in excess of 1,000 cfs occurred for periods in July and August, with the highest release of 1,069 cfs on August 25<sup>th</sup>. Irrigation on the Riverton Unit ended on September 15<sup>th</sup> and Bull Lake storage for water year 2006 reached a low of 50,595 AF of water at elevation 5766.80 feet on September 18<sup>th</sup>. As the release from the dam was reduced, the lake level began to slowly increase and on September 30<sup>th</sup> the water surface elevation of Bull Lake was 5767.11 feet. The content of Bull Lake on September 30<sup>th</sup> was 51,258 AF of water.

Actual April-July inflows totaled 120,838 AF, 87 percent of average. Total inflow to Bull Lake for the water year was 154,385 AF, which was 83 percent of average. The flow of the Wind River above the mouth of Bull Lake Creek was estimated to be 71 percent of average, totaling 290,288 AF during the April-July period. The total diversion into the Wyoming Canal for the April-September period was 319,317 AF, 94 percent of average.

Additional hydrologic and statistical information pertaining to Bull Lake operations during 2006 can be found in Table WYT4 and Figure WYG1.

**Pilot Butte Reservoir**, an off-stream reservoir near Kinnear, Wyoming, receives its water supply from the Wind River through the Wyoming Canal. Pilot Butte Reservoir has a total capacity of 33,721 AF. Of this amount, 3,803 AF is allocated for inactive and dead storage and 29,918 AF for active conservation storage. Pilot Butte Dam and the Wyoming Canal which supplies the reservoir are operated by Midvale under contract with Reclamation.

Pilot Butte Reservoir began water year 2006 with a total storage content of approximately 15,435 AF at elevation 5436.17 feet. Irrigation releases to Pilot Canal continued until October 7, 2006. Diversions into the Wyoming Canal continued after the Pilot Canal gate was closed in order to refill Pilot Butte Reservoir. Diversions continued through October 19<sup>th</sup> with storage in the reservoir reaching 28,451 AF at elevation 5453.93 feet. After diversions into the lake were terminated for the year, the reservoir level slowly fell through the winter as evaporation reduced the content. Storage on March 31<sup>st</sup> was 27,853 AF at elevation 5453.21 feet. Diversions into Pilot Butte began on April 12<sup>th</sup> and the reservoir reached its maximum storage content for the irrigation season of 28,518 AF at elevation 5454.01 feet on June 16, 2006. Releases from Pilot Butte began on April 10<sup>th</sup> to flush the canal and irrigation deliveries were initiated on April 24<sup>th</sup>. Water year 2006 was very hot and dry

and Pilot Butte storage was drawn upon through the irrigation season, with releases to Pilot Canal ending on September 17<sup>th</sup>. Because of work on the outlet works scheduled at Pilot Butte for the fall of 2006, the reservoir was drained to as low a level as possible. At the end of water year 2006, Pilot Butte held 4,158 AF of water at elevation 5411.25 feet.

Total generation at the Pilot Butte Powerplant in water year 2006 was 4,636,000 kilowatt-hours (kWh). During water year 2006, 50,406 AF or 32 percent of the water that entered the reservoir was used to generate power at Pilot Butte Powerplant.

Additional hydrologic and statistical information pertaining to Pilot Butte Reservoir during 2006 can be found in Table WYT5 and Figure WYG2.

# TABLE WYT4

## HYDROLOGIC DATA FOR WATER YEAR 2006

### BULL LAKE RESERVOIR

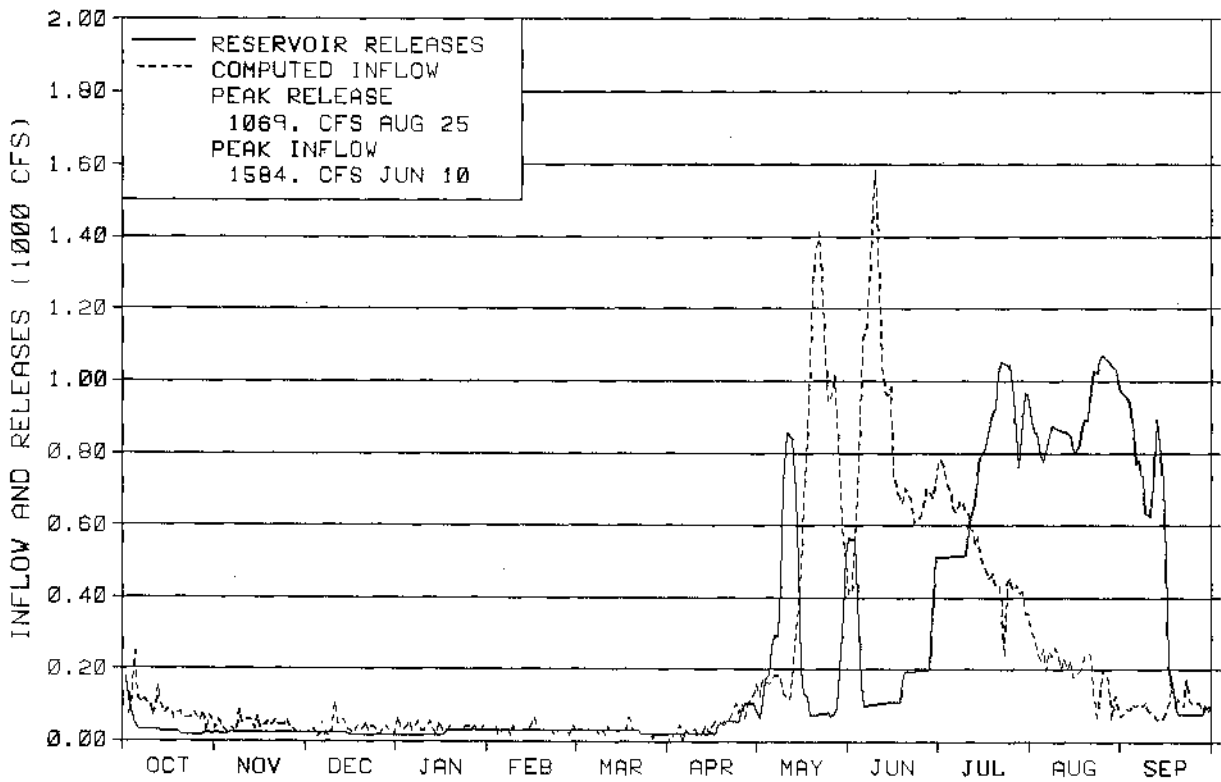
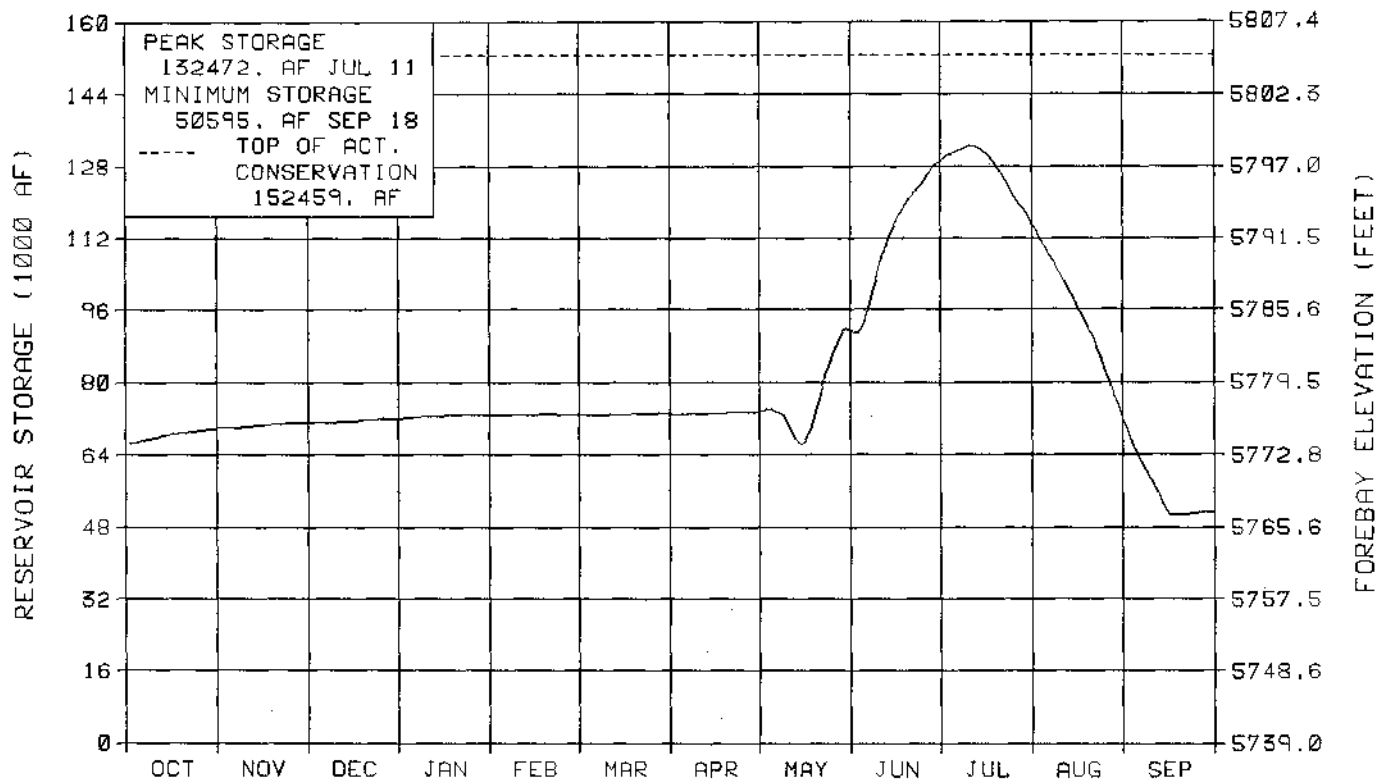
| RESERVOIR ALLOCATIONS                                                                                      | ELEVATION<br>(FEET) | TOTAL RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION (AF) |               |
|------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------|----------------------------|---------------|
| TOP OF INACTIVE AND DEAD                                                                                   | 5739.00             | 722                             | 722                        |               |
| TOP OF ACTIVE CONSERVATION                                                                                 | 5805.00             | 152,459                         | 151,737                    |               |
|                                                                                                            |                     |                                 |                            |               |
| STORAGE-ELEVATION DATA                                                                                     | ELEVATION<br>(FEET) | STORAGE<br>(AF)                 | DATE                       |               |
| BEGINNING OF YEAR                                                                                          | 5774.02             | 66,804                          | OCT 01, 2005               |               |
| END OF YEAR                                                                                                | 5767.11             | 51,258                          | SEP 30, 2006               |               |
| ANNUAL LOW                                                                                                 | 5766.80             | 50,595                          | SEP 18, 2006               |               |
| HISTORIC LOW*                                                                                              | 5743.03             | 6,228                           | MAR 31, 1950               |               |
| ANNUAL HIGH                                                                                                | 5798.51             | 132,472                         | JUL 11, 2006               |               |
| HISTORIC HIGH •                                                                                            | 5805.70             | 154,677                         | AUG 10, 1965               |               |
| * Prior to 1952 daily records are not available. End of month data was used to determine the historic low. |                     |                                 |                            |               |
| INFLOW-OUTFLOW DATA                                                                                        | INFLOW              | DATE                            | OUTFLOW                    | DATE          |
| ANNUAL TOTAL (AF)                                                                                          | 154,385             | OCT 05-SEP 06                   | 170,343                    | OCT 05-SEP 06 |
| DAILY PEAK (cfs)                                                                                           | 1,584               | JUNE 10, 2006                   | 1,069                      | AUG 25, 2006  |
| DAILY MINIMUM (cfs)                                                                                        | 6                   | MAR 27, 2006                    | 15                         | OCT 20, 2005  |
| PEAK SPILLWAY FLOW (cfs)                                                                                   |                     |                                 | 0                          |               |
| TOTAL SPILLWAY FLOW (AF)                                                                                   |                     |                                 | 0                          |               |

|                          | INFLOW |           | OUTFLOW |           | CONTENT |           |
|--------------------------|--------|-----------|---------|-----------|---------|-----------|
| MONTH                    | KAF    | % of Avg* | KAF     | % of Avg* | KAF     | % of Avg* |
| OCTOBER                  | 5.2    | 100       | 2.1     | 31        | 69.9    | 92        |
| NOVEMBER                 | 2.6    | 90        | 1.3     | 52        | 71.2    | 93        |
| DECEMBER                 | 2.2    | 88        | 1.2     | 60        | 72.1    | 94        |
| JANUARY                  | 2.2    | 105       | 1.5     | 75        | 72.9    | 95        |
| FEBRUARY                 | 1.7    | 106       | 1.6     | 100       | 73.0    | 95        |
| MARCH                    | 1.7    | 94        | 1.6     | 89        | 73.0    | 95        |
| APRIL                    | 3.0    | 83        | 2.5     | 74        | 73.5    | 95        |
| MAY                      | 35.3   | 128       | 17.2    | 119       | 91.7    | 102       |
| JUNE                     | 49.8   | 81        | 12.7    | 51        | 128.8   | 102       |
| JULY                     | 32.7   | 69        | 46.6    | 102       | 115.3   | 90        |
| AUGUST                   | 12.1   | 56        | 56.1    | 122       | 71.3    | 68        |
| SEPTEMBER                | 5.9    | 61        | 25.9    | 71        | 51.3    | 66        |
| ANNUAL                   | 154.4  | 83        | 170.3   | 91        |         |           |
|                          |        |           |         |           |         |           |
| APRIL - JULY INFLOW (AF) |        |           |         |           |         |           |
| ACTUAL                   |        |           |         |           |         |           |
| 120,838                  |        |           |         |           |         |           |
| AVERAGE                  |        |           |         |           |         |           |
| 139,500                  |        |           |         |           |         |           |

\* Average for the 1976-2005 period

FIGURE WYG1

BULL LAKE RESERVOIR NEAR LENORE



WATER YEAR 2006

# TABLE WYT5

## HYDROLOGIC DATA FOR WATER YEAR 2006

### PILOT BUTTE RESERVOIR

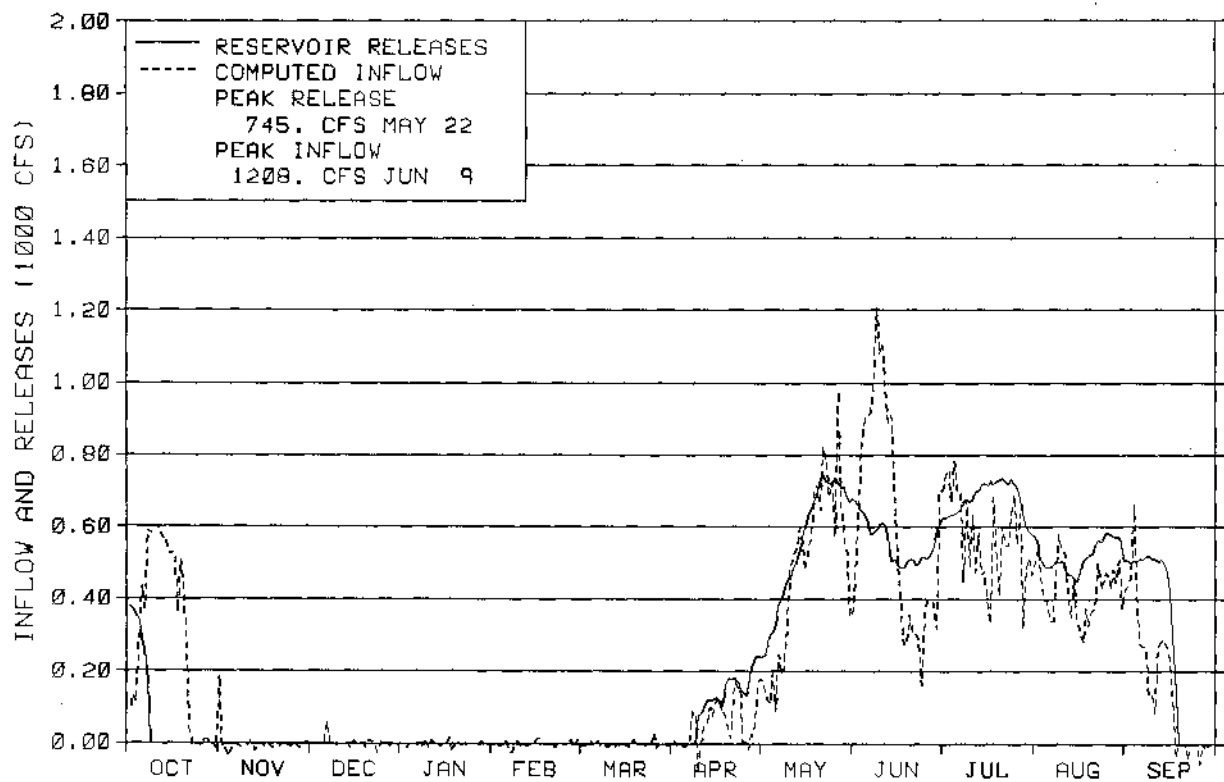
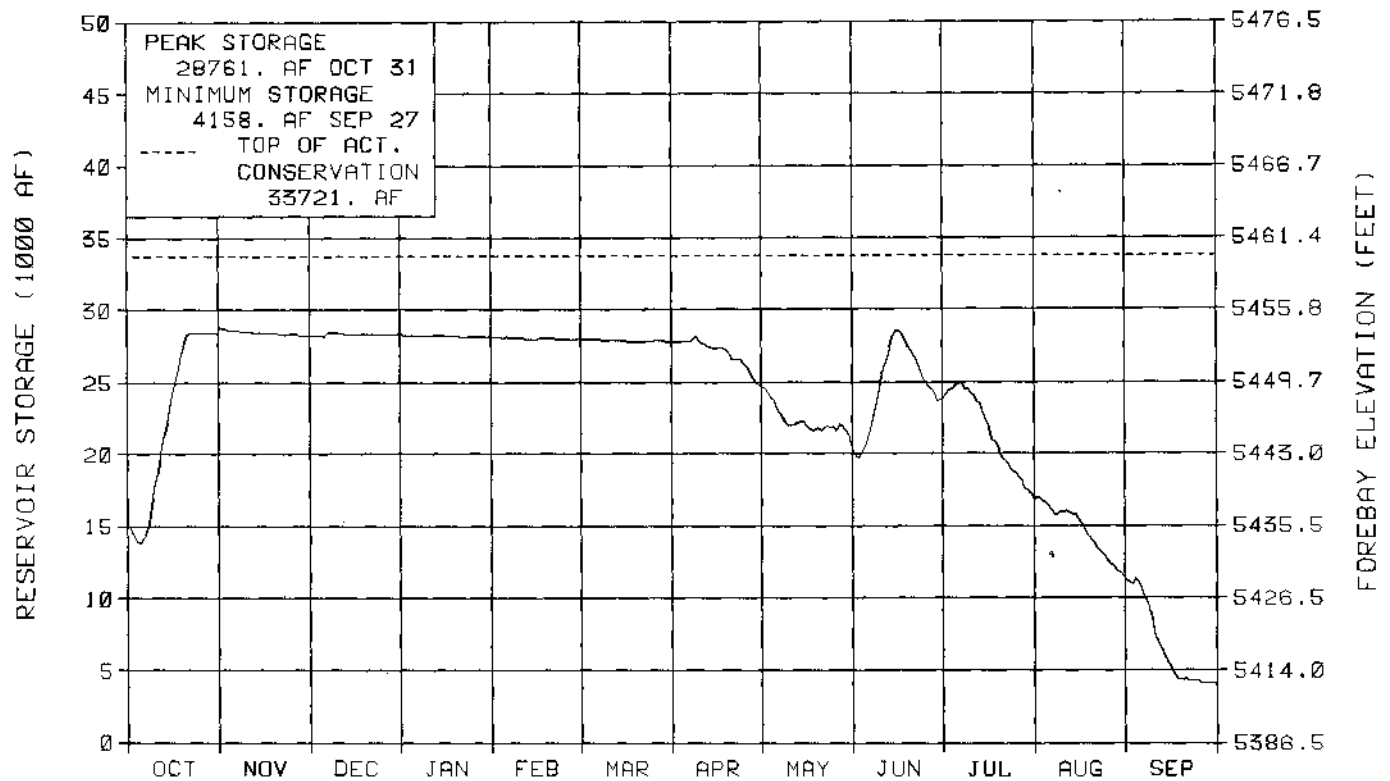
| RESERVOIR ALLOCATIONS      |  | ELEVATION<br>(FEET) | TOTAL RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION (AF) |               |
|----------------------------|--|---------------------|---------------------------------|----------------------------|---------------|
| TOP OF INACTIVE AND DEAD   |  | 5410.00             | 3,803                           | 3,803                      |               |
| TOP OF ACTIVE CONSERVATION |  | 5460.00             | 33,721                          | 29,918                     |               |
|                            |  |                     |                                 |                            |               |
| STORAGE-ELEVATION DATA     |  | ELEVATION<br>(FEET) | STORAGE<br>(AF)                 | DATE                       |               |
| BEGINNING OF YEAR          |  | 5436.17             | 15,435                          | OCT 01, 2005               |               |
| END OF YEAR                |  | 5411.25             | 4,158                           | SEP 30, 2006               |               |
| ANNUAL LOW                 |  | 5411.25             | 4,158                           | SEP 30, 2006               |               |
| HISTORIC LOW               |  | 5409.96             | 3,792                           | SEP 19, 2001               |               |
| ANNUAL HIGH                |  | 5454.30             | 28,761                          | OCT 31, 2005               |               |
| HISTORIC HIGH              |  | 5460.00             | 36,910                          | 7/7/73 & 6/24/89           |               |
|                            |  |                     |                                 |                            |               |
| INFLOW-OUTFLOW DATA        |  | INFLOW              | DATE                            | OUTFLOW                    | DATE          |
| ANNUAL TOTAL (AF)          |  | 155,675             | OCT 05-SEP 06                   | 166,952                    | OCT 05-SEP 06 |
| DAILY PEAK (cfs)           |  | 1,208               | JUNE 09, 2006                   | 745                        | MAY 22, 2006  |
| DAILY MINIMUM (cfs)        |  | 0                   | WINTER MONTHS                   | 0                          | WINTER MONTHS |
| PEAK SPILLWAY FLOW (cfs)   |  |                     |                                 | 0                          |               |
| TOTAL SPILLWAY FLOW (AF)   |  |                     |                                 | 0                          |               |
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\* Negative values are the result of calculated inflow based on reservoir release and change in reservoir content.

\*\* Average for the 1976-2005 period.

FIGURE WYG2

# PILOT BUTTE RESERVOIR



WATER YEAR 2006

## **Boysen Reservoir and Powerplant**

Boysen Reservoir (P-S MBP) is located on the Wind River above Thermopolis, Wyoming. The dam and reservoir were built for flood control, power generation, irrigation, recreation, and fish and wildlife. Boysen Reservoir has a total capacity of 892,226 AF. Of this amount, 219,181 AF is allocated for inactive and dead storage, 522,413 AF for active conservation storage, and 150,632 AF for exclusive flood control storage. Of the amount allocated for active conservation, 144,229 AF is specifically allocated for joint-use flood control storage. All of the joint-use space is located between elevation 4717.00 feet and elevation 4725.00 feet, which is the top of the spillway gates when closed. The exclusive flood control space is located between elevation 4725.00 feet and elevation 4732.20 feet. When the reservoir rises above elevation 4724.50 feet, the spillway gates must be partially opened to maintain ½ foot of the gates above the water to prevent over-topping of the gates. When all flood control space is filled, releases cannot be controlled to less than 14,000 cfs.

Irrigation water is provided from the reservoir for several units, both upstream and downstream of Boysen Dam. Water is furnished downstream to about 7,500 acres in the Hanover-Bluff Unit (P-S MBP) and 3,400 acres on the Lucerne Canal in the Owl Creek Unit (P-S MBP). Supplemental water is also furnished to other irrigation districts and to a number of individual water users below the Dam. The Bighorn Canal Irrigation District and Hanover Irrigation District receive water under long term contracts with Reclamation. Depending on availability, water is also provided to Bluff Irrigation District, Kirby Ditch Company, Lower Hanover Canal Association, Bighorn Canal Irrigation District, and Hanover Irrigation District utilizing temporary water service contracts. In addition, water is provided on a demand basis, by exchange, to Midvale, Riverton Valley, and LeClair Irrigation Districts located on the Wind River upstream of the reservoir. Riverton Valley and LeClair Irrigation Districts hold long term contracts with Reclamation.

Water year 2006 began with 631,932 AF of water stored in Boysen Reservoir, which was 112 percent of the 30 year average. The corresponding reservoir elevation of 4719.06 feet was 5.94 feet below the top of the joint use pool. On October 1, 2005, releases were reduced to the planned fall and winter release of 950 cfs. In order to accommodate a request from the Town of Thermopolis while their contractor placed a pipeline across the river, the release from Boysen Dam was reduced to 600 cfs from October 23<sup>rd</sup> through November 4<sup>th</sup>. October precipitation in the Boysen watershed was about twice the thirty year average but the reservoir inflow was only 77 percent of average during the month and the reservoir level dropped slightly to 4718.80 feet at the end of October. Upon completion of the work in the river, the release from the dam was increased to 1,000 cfs until December 5<sup>th</sup> when the outflow was reduced to 900 cfs. November precipitation was 56 percent of average and the snowpack stood at 69 percent of average on December 1<sup>st</sup>. Reservoir inflow was near normal during November but with releases of 1,000 cfs for most of the month, the reservoir level fell to 4718.27 feet on November 30. In December, a storm early in the month gave a boost to the snowpack but little additional moisture fell until the last week of the month. Total precipitation for December was near average with inflow that was 86 percent of average. Storage in the reservoir

continued to decline through December and at the end of the month, Boysen held 595,902 AF at elevation 4716.91 feet.

Forecasts of April-July snowmelt runoff were prepared at the beginning of each month beginning in January and continuing through June. On January 1<sup>st</sup> the snowpack in the mountains above Boysen was 89 percent of average and the forecast indicated approximately 400,000 AF of water, 71 percent of average, would enter Boysen Reservoir during the April-July snowmelt runoff period. The mild conditions that had been prevalent through most of December helped keep the river channel open. With the below average snowmelt runoff forecast and the opportunity to adjust the release with no ice in the river, the flow from the dam was reduced to 800 cfs on January 6<sup>th</sup>. Precipitation during January was below average at lower elevations but precipitation in the mountains was above average, with temperatures that were well above normal. The snowpack remained fairly constant through the month and was 90 percent of average on February 1<sup>st</sup>. With the snowpack seeming to level out at about 90 percent of average, the February and March forecasts both indicated that about 500,000 AF of runoff could be expected to enter Boysen during the April-July runoff period. At the end of February, Boysen held 570,317 AF of water at elevation 4715.30 feet and with the forecasted runoff, the reservoir was expected to fill. The Wyoming Game and Fish Department requested a flushing flow release from Boysen in March. Flushing flows are designed to simulate high runoff events that occurred in the river prior to flows being controlled by the dam. The rapidly increasing flows flush the fine sediment from the spawning gravels in the river, improving the spawning habitat for trout. After evaluating the request, Reclamation determined that based on reservoir conditions and anticipated inflow to Boysen Reservoir, a flushing flow could be provided without increasing the amount of water scheduled to be released between March 1 and June 30, 2006. The flushing flow began early on the morning of March 29<sup>th</sup> when releases were increased from 800 cfs to 2,400 cfs, with another increase to 5,000 cfs occurring five hours later. The 5,000 cfs release was maintained for ten hours and then gradually reduced back to 800 cfs. During the flushing flow, approximately 6,000 AF of water was released above the 800 cfs winter release. Storage in Boysen continued to fall during March and at the end of the month the reservoir held 556,819 AF of water. Precipitation during March was 73 percent of average and the snowpack changed little over the month, standing at 86 percent of average on April 1<sup>st</sup>. Based on conditions in the basin, the April 1 forecast was reduced by 50,000 AF to 450,000 AF of runoff for the April-July period.

Irrigators began diverting water into the canals early in the month but the 800 cfs winter release was adequate to satisfy demands for most of April. Releases were increased on April 20<sup>th</sup> and again on April 30<sup>th</sup> in accordance with the April operating plan to evacuate the volume of water scheduled to be released during the month. By the end of April the Boysen release was 900 cfs and with April inflow averaging about 680 cfs the reservoir level dropped 0.84 feet over the month to elevation 4713.58 feet. April precipitation was about half of what normally falls in the basin during the month and temperatures were above average, resulting in a significant loss of snowpack. Even though the snowpack fell 21 percent compared to average during April, there was not a corresponding increase in streamflow during the month and the inflow to Boysen was 74 percent of average. With the snowpack on May 1<sup>st</sup> at 65 percent of average and falling, the May forecast of April-July snowmelt runoff was reduced to 350,000 AF, which was 62 percent of average. May was extremely dry in the



basin above Boysen, receiving only 11 percent of average moisture. The irrigated lands below the dam were also suffering from the lack of rain and releases above what was planned for May were required to meet demands. As releases increased above the May target release of 1,100 cfs, Boysen storage use accounting was initiated and continued through the remainder of the irrigation season. The Boysen release was limited to the amount needed to meet the demands of downstream contractors, with changes coordinated by the Wyoming State Engineer's Office in Riverton.

Irrigation demands upstream of Boysen were also increasing due to the dry spring weather and a good part of the snowmelt runoff that normally flows into Boysen was diverted out of the river by upstream users. The peak inflow during May was only 2,688 cfs and there were just five days during the month with inflow greater than 2,000 cfs, resulting in a total monthly inflow that was 55 percent of average. By the end of May the snow was gone from most of the SNOTEL sites in the Wind River mountains and one of the driest months of May was in the record book. At month end, the content of Boysen Reservoir was 549,113 AF at elevation 4713.91 feet. The first week of June saw warmer temperatures move into the basin, which brought down the remaining snow in the high country and caused inflows to peak at 2,706 cfs on June 11<sup>th</sup>. Following the peak, inflows dropped rapidly and the total inflow for June was just 26 percent of average. The maximum content of the irrigation season of 557,584 AF occurred on June 16<sup>th</sup> at elevation 4714.47 feet before falling to 544,166 AF by the end of the month. Releases of approximately 1,200 cfs were required through mid-August to meet irrigation demands and the reservoir level fell until September 17<sup>th</sup> when rainfall in the basin lessened demand for irrigation water. A second storm the next week brought an inch or more of precipitation to the valley below Boysen, bringing irrigation demands below the 500 cfs planned winter release from Boysen on September 22<sup>nd</sup> and ending the storage use accounting.

Actual inflow for the April-July period totaled 200,508 AF, which was 36 percent of average. Total inflow to Boysen during water year 2006 was 500,640 AF, 52 percent of average. The reservoir ended the water year at 4706.63 feet with a content of 447,786 AF. This was 80 percent of the average end of September content. During water year 2006, Boysen Powerplant generated 57,556,000 kWh of electricity, about 95 percent of average and 1,013,000 kWh more than was generated in 2005. Of the 684,785 AF of water released from Boysen in water year 2006, 673,559 AF was discharged through the powerplant and 11,226 AF bypassed the powerplant.

### **Important Events - 2006**

October 1, 2005: The release from Boysen Reservoir was reduced to the planned winter release of 950 cfs.

October 23, 2005: The release from Boysen Reservoir was reduced to 600 cfs to accommodate work in the river near Thermopolis.

November 5, 2005: The release from Boysen Reservoir was increased to 1,000 cfs following the completion of work in the river.

December 5, 2005: The release from Boysen Reservoir was decreased to 900 cfs.

January 6, 2006: The release from Boysen Reservoir was decreased to 800 cfs.

March 21, 2006: Boysen Reservoir spring water information meeting was held in Worland to discuss the water supply and proposed operation of Boysen Reservoir in 2006.

March 29-30, 2006: Reservoir releases were adjusted as requested by Wyoming Game and Fish to provide a flushing flow in the river below Boysen Dam.

May 17, 2006: Boysen storage water use accounting was initiated after releases for irrigation exceeded the May target release of 1,100 cfs.

September 22, 2006: Irrigation demand fell below the planned winter release of 500 cfs, ending storage use accounting for the year.

Additional hydrologic and statistical information pertaining to the operation of Boysen Reservoir can be found in Table WYT6 and Figure WYG3.

# TABLE WYT6

## HYDROLOGIC DATA FOR WATER YEAR 2006

### BOYSEN RESERVOIR

| RESERVOIR ALLOCATIONS                                                                                                                                                                                                                                                                                                                 | ELEVATION<br>(FEET) | TOTAL RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION (AF) |               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------|----------------------------|---------------|
| TOP OF INACTIVE AND DEAD                                                                                                                                                                                                                                                                                                              | 4685.00             | 219,181                         | 219,181                    |               |
| TOP OF ACTIVE CONSERVATION                                                                                                                                                                                                                                                                                                            | 4717.00             | 597,365                         | 378,184                    |               |
| TOP OF JOINT USE                                                                                                                                                                                                                                                                                                                      | 4725.00             | 741,594                         | 144,229                    |               |
| TOP OF EXCLUSIVE FLOOD CONTROL                                                                                                                                                                                                                                                                                                        | 4732.20             | 892,226                         | 150,632                    |               |
| STORAGE-ELEVATION DATA                                                                                                                                                                                                                                                                                                                | ELEVATION<br>(FEET) | STORAGE<br>(AF)                 | DATE                       |               |
| BEGINNING OF YEAR                                                                                                                                                                                                                                                                                                                     | 4719.06             | 631,932                         | OCT 01, 2005               |               |
| END OF YEAR                                                                                                                                                                                                                                                                                                                           | 4706.63             | 447,786                         | SEP 30, 2006               |               |
| ANNUAL LOW                                                                                                                                                                                                                                                                                                                            | 4706.22             | 442,553                         | SEP 17, 2006               |               |
| HISTORIC LOW ELEVATION *                                                                                                                                                                                                                                                                                                              | 4684.18             |                                 | MAR 18, 1956               |               |
| HISTORIC LOW CONTENT *                                                                                                                                                                                                                                                                                                                |                     | 235,737                         | SEP 24, 2002               |               |
| ANNUAL HIGH                                                                                                                                                                                                                                                                                                                           | 4719.03             | 631,410                         | SEP 06, 2005               |               |
| HISTORIC HIGH                                                                                                                                                                                                                                                                                                                         | 4730.83             | 922,406                         | JUL 06, 1967               |               |
| * Because storage space in a reservoir is lost as sediment is trapped behind the dam, reservoirs are resurveyed periodically to determine actual capacity. Based on the 1994 resurvey of Boysen Reservoir, the historic low content of 235,737 AF occurred at an elevation that was 2.69 feet higher than the historic low elevation. |                     |                                 |                            |               |
| INFLOW-OUTFLOW DATA                                                                                                                                                                                                                                                                                                                   | INFLOW              | DATE                            | OUTFLOW                    | DATE          |
| ANNUAL TOTAL (AF)                                                                                                                                                                                                                                                                                                                     | 500,640             | OCT 05-SEP 06                   | 684,785*                   | OCT 05-SEP 06 |
| DAILY PEAK (cfs)                                                                                                                                                                                                                                                                                                                      | 2,706               | JUN 11, 2006                    | 3,130                      | MAR 29, 2006  |
| DAILY MINIMUM (cfs)                                                                                                                                                                                                                                                                                                                   | 16                  | JUN 20, 2006                    | 496                        | SEP 24, 2006  |
| PEAK SPILLWAY FLOW (cfs)**                                                                                                                                                                                                                                                                                                            |                     |                                 | 1,687                      | MAR 29, 2006  |
| TOTAL SPILLWAY FLOW (AF)**                                                                                                                                                                                                                                                                                                            |                     |                                 | 3,345                      | MAR 29, 2006  |
|                                                                                                                                                                                                                                                                                                                                       |                     |                                 |                            |               |

\* Of the 684,785 AF of water released from Boysen Reservoir, 11,226 AF bypassed the powerplant.

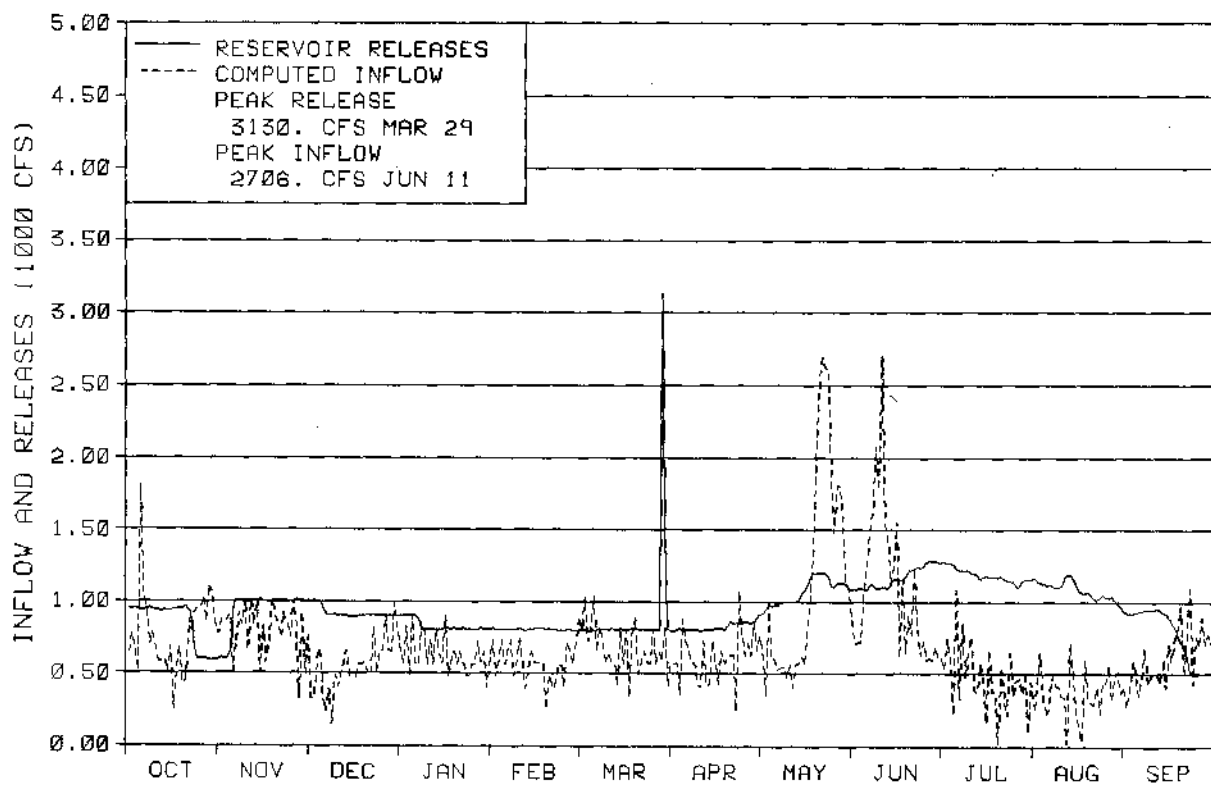
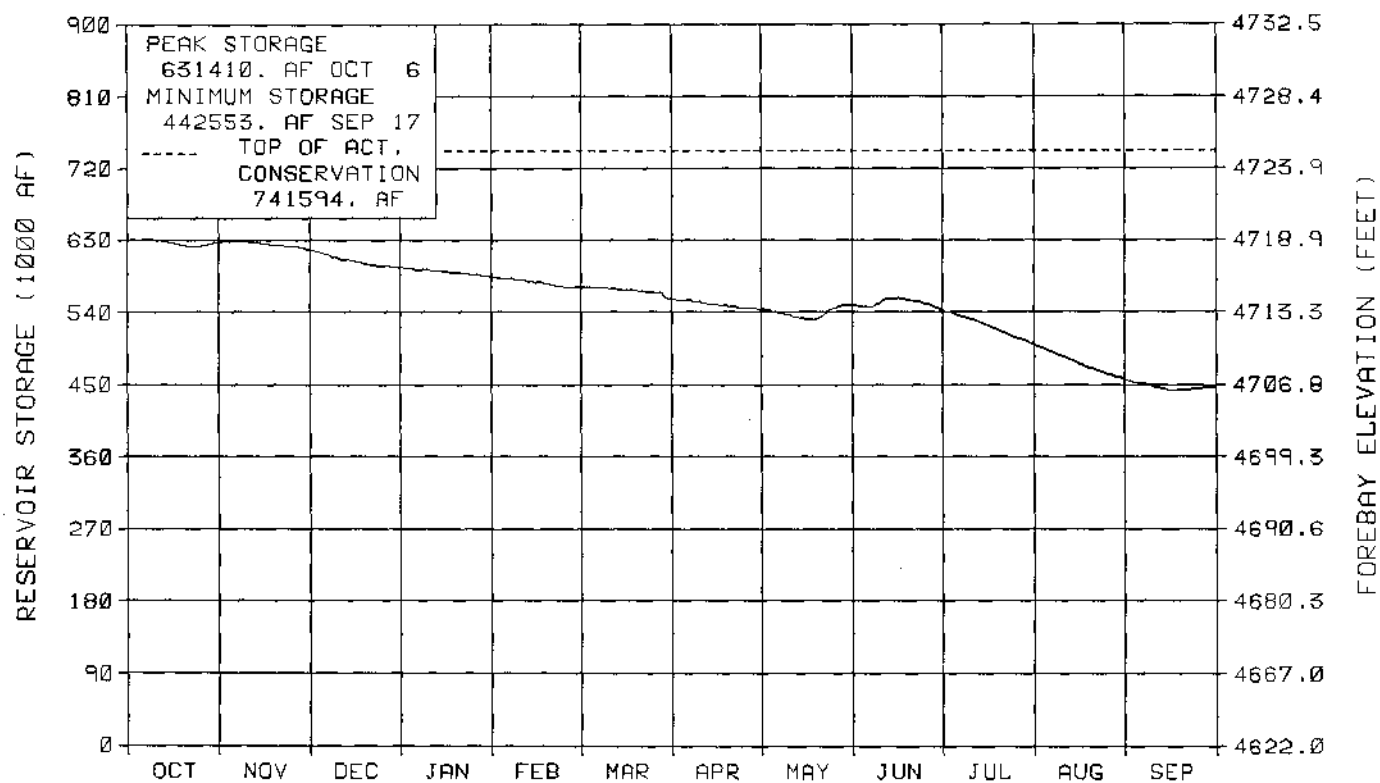
\*\*In 2006, the only time water was released through the spillway was during the flushing flow when releases in excess of Powerplant capacity were made in order to provide a total flow in the river of 5,000 cfs.

|           | INFLOW                   |           | OUTFLOW |           | CONTENT |           |
|-----------|--------------------------|-----------|---------|-----------|---------|-----------|
| MONTH     | KAF                      | % of Avg* | KAF     | % of Avg* | KAF     | % of Avg* |
| OCTOBER   | 47.4                     | 77        | 51.9    | 79        | 627.5   | 112       |
| NOVEMBER  | 47.5                     | 97        | 56.6    | 98        | 618.4   | 112       |
| DECEMBER  | 33.8                     | 86        | 56.3    | 94        | 595.9   | 111       |
| JANUARY   | 38.6                     | 105       | 50.6    | 88        | 583.8   | 112       |
| FEBRUARY  | 31.1                     | 82        | 44.6    | 88        | 570.3   | 112       |
| MARCH     | 42.0                     | 79        | 55.5    | 90        | 556.8   | 111       |
| APRIL     | 36.2                     | 74        | 48.9    | 69        | 544.2   | 113       |
| MAY       | 70.6                     | 55        | 65.7    | 70        | 549.1   | 108       |
| JUNE      | 64.6                     | 26        | 69.5    | 51        | 544.2   | 89        |
| JULY      | 29.1                     | 21        | 73.2    | 52        | 500.1   | 82        |
| AUGUST    | 22.9                     | 36        | 66.5    | 73        | 456.5   | 79        |
| SEPTEMBER | 36.9                     | 67        | 45.5    | 62        | 447.8   | 80        |
| ANNUAL    | 500.6                    | 52        | 684.8   | 71        |         |           |
|           | APRIL - JULY INFLOW (AF) |           |         |           |         |           |
|           | ACTUAL                   |           | AVERAGE |           |         |           |
|           | 200,508                  |           | 564,500 |           |         |           |

\* Average for the 1976 - 2005 period

FIGURE WYG3

BOYSEN RESERVOIR



WATER YEAR 2006

## **Anchor Reservoir**

Anchor Reservoir (P-S MBP) is located on the South Fork of Owl Creek, a tributary of the Bighorn River near Thermopolis, Wyoming. It has a total storage capacity of 17,228 AF, of which 17,160 AF is active storage. It was constructed to furnish a supplemental irrigation supply for the Owl Creek Unit (P-S MBP). The dam was completed in November 1960. However, several major sinkholes developed in the lower portion of the reservoir after it began to fill, and corrective work to plug the sinkholes has not been successful. There have also been substantial water losses through a rock waste area just upstream from the dam. Two dikes, in service since 1979, partition off the portions of the reservoir with high seepage losses. The top of the dikes are at elevation 6415.00 feet, however, when the reservoir rises above elevation 6412.80 feet, water flows through a notch in one of the dikes into the sinkhole area. The reservoir is operated not to exceed elevation 6412.80 feet. Operation and maintenance of Anchor Dam is performed by contract with Owl Creek Irrigation District. To prevent damage to the dikes and minimize the chance of creating new sinkholes, a reservoir restriction is in place at Anchor Reservoir. Reclamation requires notification from the irrigation district any time the reservoir level is expected to exceed elevation 6400.00 feet. Operation above 6400.00 feet will be directed by Wyoming Area Office (WYAO) staff to avoid overtopping of the dikes.

Storage in Anchor Reservoir at the beginning of water year 2006 was 269 AF at elevation 6355.50 feet. The reservoir level increased through October, reaching 433 AF by the end of the month. From that point storage slowly fell through the winter. By the end of January, storage in the reservoir had fallen to 254 AF at elevation 6355.00 feet. Inflows began to increase in April as did releases for irrigation and at the end of April, Anchor held 263 AF of water. The snowpack at the Owl Creek Snotel above Anchor reached a peak around the first of April but by April 12<sup>th</sup> the site reported no snow. As temperatures warmed in mid-May, inflow began to exceed the release and the reservoir reached its maximum content for the year of 628 AF on May 19<sup>th</sup>. A second, smaller runoff event occurred in early June but irrigation releases were greater than the inflow and the reservoir level continued to fall. By mid-July the reservoir was down to 212 AF of water and it remained at about that content for the remainder of the water year. The maximum daily inflow for the year of 74 cfs occurred on May 21<sup>st</sup> and the maximum release of 81 cfs was on May 19<sup>th</sup>.

Hydrologic and statistical data pertaining to Anchor Reservoir operations during 2006 can be found in Table WYT7 and Figure WYG4. The negative inflows displayed in Figure WYG4 are the result of calculated inflow based on reservoir release and change in reservoir content. During some periods, evaporation and seepage from the reservoir could exceed inflow.

# TABLE WYT7 HYDROLOGIC DATA FOR WATER YEAR 2006 ANCHOR RESERVOIR

| RESERVOIR ALLOCATIONS                                                                                                                                                                                                                |  | ELEVATION<br>(FEET) | TOTAL RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION (AF) |               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------|---------------------------------|----------------------------|---------------|
| TOP OF INACTIVE AND DEAD                                                                                                                                                                                                             |  | 6343.75             | 68                              | 68                         |               |
| TOP OF ACTIVE CONSERVATION*                                                                                                                                                                                                          |  | 6441.00             | 17,228                          | 17,160                     |               |
| * District operation has been restricted to elevation 6400.00 feet or less to prevent damage to the dikes and to minimize the chance of creating new sinkholes. Operations above elevation 6400.00 feet are directed by Reclamation. |  |                     |                                 |                            |               |
| STORAGE-ELEVATION DATA                                                                                                                                                                                                               |  | ELEVATION<br>(FEET) | STORAGE<br>(AF)                 | DATE                       |               |
| BEGINNING OF YEAR                                                                                                                                                                                                                    |  | 6355.50             | 269                             | OCT 01,2005                |               |
| END OF YEAR                                                                                                                                                                                                                          |  | 6354.00             | 233                             | SEP 30, 2006               |               |
| ANNUAL LOW                                                                                                                                                                                                                           |  | 6353.00             | 212                             | JUL 14, 2006               |               |
| HISTORIC LOW                                                                                                                                                                                                                         |  |                     |                                 |                            |               |
| ANNUAL HIGH                                                                                                                                                                                                                          |  | 6365.00             | 628                             | MAY 18, 2006               |               |
| HISTORIC HIGH                                                                                                                                                                                                                        |  | 6418.52             | 9,252                           | JUL 03, 1967               |               |
|                                                                                                                                                                                                                                      |  |                     |                                 |                            |               |
| INFLOW-OUTFLOW DATA                                                                                                                                                                                                                  |  | INFLOW              | DATE                            | OUTFLOW*                   | DATE          |
| ANNUAL TOTAL (AF)                                                                                                                                                                                                                    |  | 4,635               | OCT 05-SEP 06                   | 4,668                      | OCT 05-SEP 06 |
| DAILY PEAK (cfs)                                                                                                                                                                                                                     |  | 74                  | MAY 21, 2006                    | 81                         | MAY 19, 2006  |
| DAILY MINIMUM (cfs)                                                                                                                                                                                                                  |  | 0                   | WINTER MONTHS                   | 0                          | WINTER MONTHS |
| PEAK SPILLWAY FLOW (cfs)                                                                                                                                                                                                             |  |                     |                                 | 0                          |               |
| TOTAL SPILLWAY FLOW (AF)                                                                                                                                                                                                             |  |                     |                                 | 0                          |               |

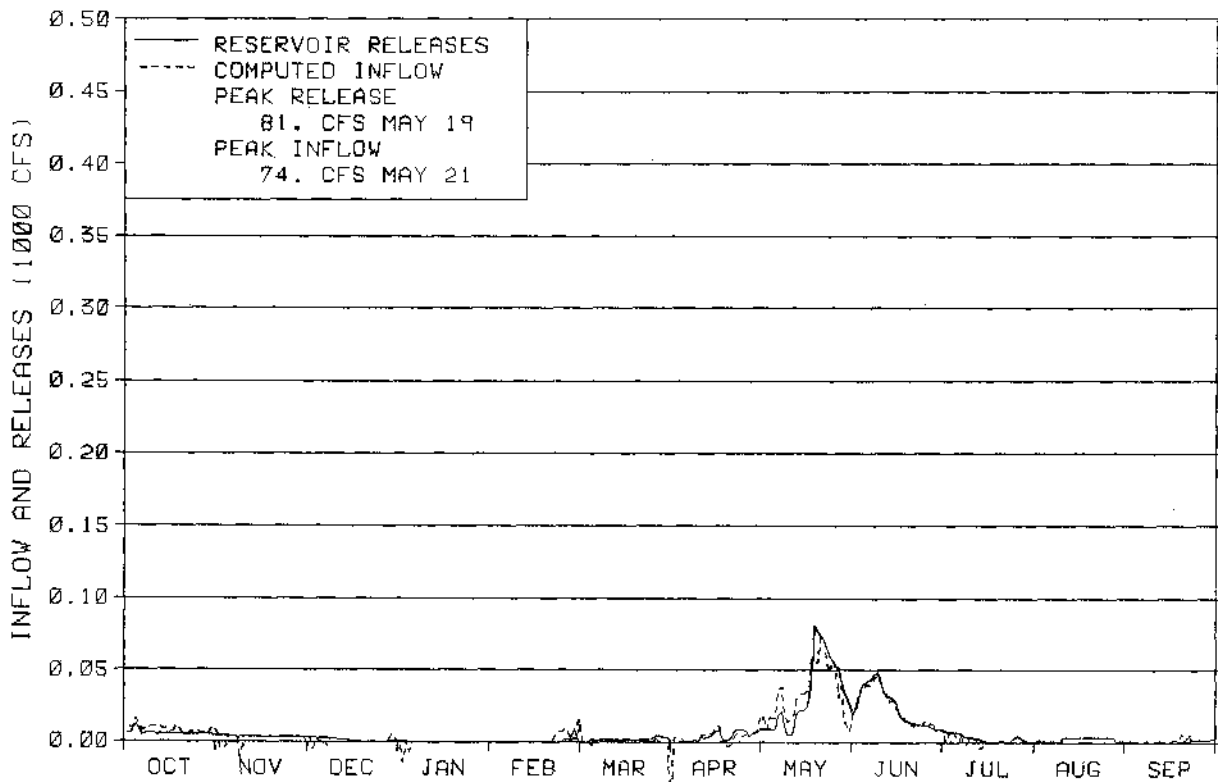
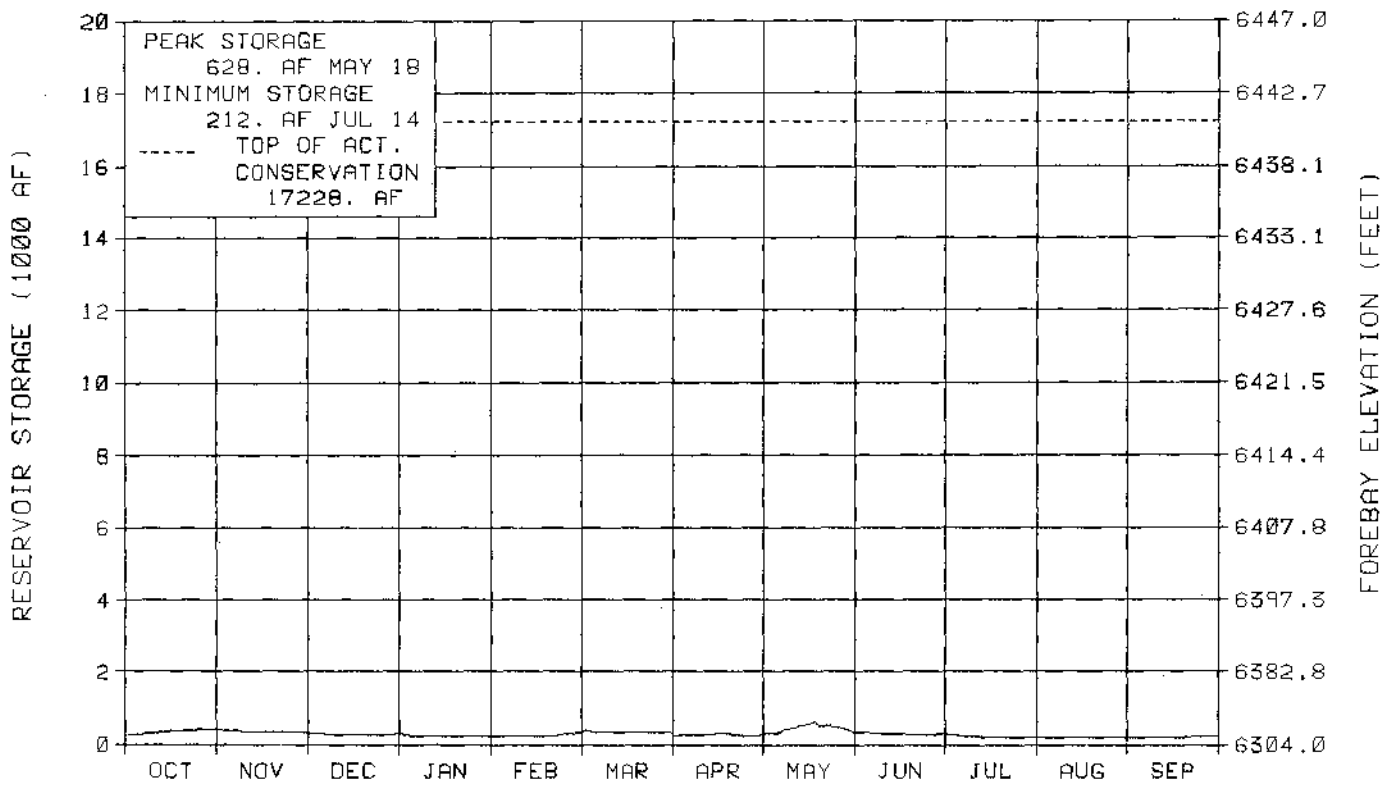
\* Outflow is water released from the Dam to Owl Creek. When the reservoir level rises above approximately 6412.80 feet, water flows through a notch in one of the dikes into the sinkhole area. This water is neither measured nor accounted for. In 2006, no water flowed over the notch in the dike.

|           | INFLOW |           | OUTFLOW* |           | CONTENT |           |
|-----------|--------|-----------|----------|-----------|---------|-----------|
| MONTH     | KAF    | % of Avg* | KAF      | % of Avg* | KAF     | % of Avg* |
| OCTOBER   | 0.5    | 77        | 0.3      | 48        | 0.4     | 169       |
| NOVEMBER  | 0.1    | 26        | 0.2      | 49        | 0.3     | 159       |
| DECEMBER  | 0.0    | 0         | 0.1      | 32        | 0.3     | 150       |
| JANUARY   | 0.0    | 0         | 0.0      | 0         | 0.3     | 135       |
| FEBRUARY  | 0.1    | 76        | 0.0      | 0         | 0.3     | 162       |
| MARCH     | 0.1    | 27        | 0.1      | 38        | 0.3     | 113       |
| APRIL     | 0.1    | 19        | 0.2      | 43        | 0.3     | 53        |
| MAY       | 2.1    | 47        | 2.0      | 62        | 0.3     | 20        |
| JUNE      | 1.4    | 20        | 1.5      | 27        | 0.3     | 9         |
| JULY      | 0.1    | 4         | 0.2      | 4         | 0.2     | 10        |
| AUGUST    | 0.1    | 51        | 0.1      | 7         | 0.2     | 32        |
| SEPTEMBER | 0.1    | 10        | 0.0      | 0         | 0.2     | 70        |
| ANNUAL    | 4.6    | 27        | 4.7      | 28        |         |           |

\* Average is for the 1991-2006 period. This period was used because of the availability of data at Anchor Reservoir.

FIGURE WYG4

# ANCHOR RESERVOIR



WATER YEAR 2006

## **Shoshone Project & Buffalo Bill Unit**

The primary features of the original Shoshone Project included Buffalo Bill Dam and Reservoir, Shoshone and Heart Mountain Powerplants, and the canal and lateral systems for the Willwood, Frannie, Garland, and Heart Mountain Divisions. In 1982, The Buffalo Bill Dam and Reservoir Modifications, Shoshone Project, Wyoming, was authorized as the Buffalo Bill Unit (P-S MBP). The principal modifications to Buffalo Bill Dam included raising the height of the Dam by 25 feet, reconstructing the Shoshone Powerplant, construction of the Buffalo Bill Powerplant, construction of the Spirit Mountain Energy Dissipation Structure, pressurizing a portion of the Shoshone Canyon Conduit, enlarging and gating the spillway, constructing a visitor's center, and constructing the North Fork, South Fork, and Diamond Creek Dikes. The North and South Fork dust abatement dikes were designed to impound water in areas of the enlarged reservoir that would be dry during periods when the reservoir elevation is low, thereby reducing the dust producing area of the reservoir. The Diamond Creek protective dike prevents the enlarged reservoir from inundating Irma Flats.

Controlled releases are made from Buffalo Bill Reservoir at four points: (1) Shoshone Canyon Conduit, (2) Shoshone Powerplant, (3) the gated spillway, and (4) two river outlets (jetflow valve and 4X5 high pressure gates). Water for the Willwood, Frannie, and Garland Divisions of the Shoshone Project is diverted from the Shoshone River below Buffalo Bill Reservoir. The Heart Mountain Division is irrigated by water released at the dam through a high-level outlet to the Shoshone Canyon Conduit and Heart Mountain Canal. Irrigation releases for the project land along the Shoshone River are made through the Shoshone Powerplant, the river outlets, or through the Shoshone Canyon Conduit and Buffalo Bill or Heart Mountain Powerplants. Project works presently serve about 93,000 acres in the four divisions.

**The Heart Mountain Powerplant**, Shoshone Project, with a nameplate capability of 6,000 kilowatts (kW) and maximum discharge capacity of 360 cfs, is located at the end of the Shoshone Canyon Conduit, which obtains its water from a high-level outlet, elevation 5233.00 feet, at Buffalo Bill Dam. The powerplant is located 3.5 miles below the dam and discharges into the Shoshone River. During the summer months, the water released through the powerplant is used to satisfy a portion of the irrigation demand of lands diverting directly from the river.

**The Shoshone Powerplant**, reconstructed as part of the Buffalo Bill Unit (P-S MBP), is located on the left bank of the Shoshone River at the toe of Buffalo Bill Dam and releases water directly into the Shoshone River. After 56 years of continuous use, the Shoshone Powerplant became obsolete because of safety problems beyond economical repair. On March 21, 1980, the original plant was taken out of service. In 1992 one of the three generating units was replaced with a new unit having a nameplate capability of 3,000 kW. In accordance with the Buffalo Bill Reservoir Enlargement Winter Release Operation Agreement, a flow of at least 100 cfs is released to the Shoshone River at the base of the dam at all times. This is normally achieved by the use of the Shoshone Powerplant. A maximum release of approximately 200 cfs can be made through the Shoshone Powerplant.



**The Buffalo Bill Powerplant**, Buffalo Bill Unit (P-S MBP), with a nameplate capability of 18,000 kW, is located about one mile downstream of Buffalo Bill Dam on the right bank of the Shoshone River. Water for generation at this powerplant is supplied through a portion of the Shoshone Canyon Conduit, which was pressurized as part of the Buffalo Bill modification. The maximum discharge capacity of the three units at the Buffalo Bill Powerplant is 930 cfs. The powerplant first generated power on July 15, 1992.

**Spirit Mountain Powerplant**, Buffalo Bill Unit (P-S MBP), with a nameplate capability of 4,500 kW and discharge capacity of 560 cfs, is a newly constructed energy dissipator powerplant located about one mile downstream of Buffalo Bill Dam on the right side of the Shoshone River. Water released through the Shoshone Canyon Conduit for Heart Mountain Canal or Heart Mountain Powerplant must be routed through the Spirit Mountain Powerplant or through associated sleeve valves to dissipate energy in the transition from the pressurized portion of the Shoshone Canyon Conduit to the free flow portion of the conduit. The discharge from the powerplant must be carried away from the plant by use of the free-flow conduit and operation of the powerplant depends on the availability of the conduit to carry discharged water.

**Buffalo Bill Dam and Reservoir**, located on the Shoshone River above Cody, Wyoming, is a multipurpose facility that provides water for domestic, irrigation, municipal, fish and wildlife, power, and recreational use. It also provides a small amount of incidental flood control, although no storage space is specifically reserved for this purpose. The total storage capacity of the reservoir is 646,565 AF at elevation 5393.50 feet, the top of the active conservation pool.

Storage in Buffalo Bill Reservoir at the beginning of water year 2006 was 450,274 AF of water at elevation 5367.60 feet. The reservoir level continued to slowly fall during the first half of October as releases for irrigation continued to exceed inflow. By October 15<sup>th</sup> releases to the Shoshone River for irrigation were no longer required and the release to the Shoshone River was reduced to 200 cfs in accordance with the Buffalo Bill Reservoir Enlargement Winter Release Operation Agreement. Irrigation deliveries to the Heart Mountain Canal were discontinued on October 18<sup>th</sup>. The release of 200 cfs was maintained until April 17<sup>th</sup>, when increases were required to meet the irrigation demands of the downstream districts.

Once releases to the canal and river for irrigation ended, the reservoir began to recover and at the end of October there were 451,259 AF of water in storage at elevation 5367.63 feet. Inflows during October, November, and December were above average each month and by the end of December storage in the reservoir had increased to 471,060 AF. Precipitation was also above average during each of the first three months of the water year and the snowpack in the Buffalo Bill watershed stood at 87 percent of average on January 1<sup>st</sup>.

Forecasts of the April-July snowmelt runoff are made each month beginning in January and

continuing through June for Buffalo Bill Reservoir. Conditions on January 1<sup>st</sup> indicated that 600,000 AF of runoff could be expected to flow into Buffalo Bill Reservoir during the April through July period, which was 92 percent of the 30 year average. January inflow to Buffalo Bill was slightly below average and at the end of the month the reservoir held 472,505 AF of water. Precipitation in the mountains of the Buffalo Bill watershed continued to be above average during January but the snowpack fell to 88 percent of average on February 1<sup>st</sup>. The February forecast was increased to 650,000 AF, which was right at the 30 year average April-July runoff. The snowpack continued to build at a below average rate during February, falling five percent to 83 percent of average on March 1. Reservoir inflow dropped to 89 percent of average during February but overall conditions still indicated a near average runoff and the March 1 forecast remained at 650,000 AF. March precipitation was about 70 percent of average and the snowpack continued to slowly fall further below average. At the end of the month the reservoir content was 474,963 AF of water at elevation 5371.01 feet. With no major snowfall events during the month, the snowpack dropped another four percent to 79 percent of average on April 1. As the spring progressed and the trend was toward drier conditions, the April forecast was reduced by 50,000 AF to 600,000 AF of inflow expected to enter Buffalo Bill during the April-July snowmelt runoff period.

Releases from the Dam were increased on April 17<sup>th</sup> to meet downstream irrigation needs and Heart Mountain Canal deliveries were also initiated on April 17<sup>th</sup>. Mountain precipitation was below average for the third consecutive month, with above average temperatures. While precipitation was above average at lower elevation sites in the basin, irrigation demand was also above average for April. When the snowpack in the Buffalo Bill watershed peaked on April 20<sup>th</sup>, it was at 78 percent of average. By May 1<sup>st</sup>, the snowpack had fallen to 67 percent of average and was dropping rapidly. Inflows did not begin to respond to the melting snowpack until the very end of April and as releases were increased to meet irrigation demands the reservoir level began to decline. By the end of April, the content in Buffalo Bill had dropped to 472,593 AF. The May 1 forecast was reduced to 500,000 AF, which was 77 percent of the average April-July inflow to Buffalo Bill Reservoir. Temperatures remained fairly warm during the first half of May and reservoir inflow continued to increase. As temperatures reached into the 80's, the runoff was in full swing and inflows climbed above 6,000 cfs from May 19<sup>th</sup> through the 22<sup>nd</sup>. As temperatures moderated, the inflow to Buffalo Bill decreased but the total inflow for May was 128 percent of average and the reservoir rose about twelve feet during the month to 5382.14 feet. Temperatures returned to the 80's during the first week of June and a second round of runoff was under way. The peak average daily inflow to Buffalo Bill of 6,722 cfs occurred on June 8<sup>th</sup> with the reservoir rising about one foot per day. Provisional data from the U S Geological Survey shows that the inflow on the North Fork of the Shoshone River peaked at 4,820 cfs on June 8<sup>th</sup> and the peak on the South Fork of 2,150 cfs occurred on May 20<sup>th</sup>. Releases from the dam were increased above irrigation demand beginning on June 9<sup>th</sup> to slow the rate at which the reservoir was filling. The maximum release to the river occurred on June 11<sup>th</sup>, with an average for the day of 3,530 cfs. As the reservoir level approached the top of the active conservation pool at 5393.50 feet, releases were adjusted as necessary to maintain adequate freeboard on the dam. June inflow was only 79 percent of average but the reservoir still essentially filled, reaching a maximum elevation of 5392.35 feet on July 6<sup>th</sup>. This was 1.15 feet below the top of the active conservation pool and 2.85 feet below the top of the dam. As inflows continued to fall during July, the release

from the dam was reduced accordingly and on July 11<sup>th</sup> the release was back to the amount required to meet irrigation demand. For the most part, the remainder of the summer was hotter and drier than normal, which in turn required above average irrigation releases.

Inflow during July, August, and September was well below average and the reservoir level fell through the end of the water year. On September 30, the reservoir held 441,121 AF of water at elevation 5366.19 feet. The end of September content was 101 percent of the 1994-2005 average for the enlarged reservoir. The total inflow to Buffalo Bill during the April through July runoff period was 545,897 AF, which was 84 percent of average. The total water year inflow of 701,688 AF was 84 percent of average.

Total energy generated at all powerplants that directly receive water out of Buffalo Bill Reservoir totaled 105,035,000 kWh in 2006. Of this total amount, Heart Mountain Powerplant generated 15,824,000 kWh, Buffalo Bill Powerplant generated 54,451,000 kWh, Shoshone Powerplant generated 18,923,000 kWh and Spirit Mountain Powerplant generated 15,837,000 kWh. The powerplants used 578,238 AF of water to generate this amount of energy, or 81 percent of the total water released from Buffalo Bill Reservoir during water year 2006. About 34 percent, or 239,697 AF of the total water released from Buffalo Bill Reservoir, was released to the Heart Mountain Canal for irrigation purposes.

### **Important Events - 2006**

October 15, 2005: Irrigation releases to the Shoshone River were discontinued for the 2005 irrigation season, control of releases was returned to the Bureau of Reclamation, and a river release of 200 cfs was established for the winter.

October 18, 2005: Irrigation diversions to the Heart Mountain Canal were discontinued for the 2005 irrigation season.

March 22, 2006: Buffalo Bill Reservoir Public Information meeting was held in Powell to discuss water year 2005 operation and expected 2006 operation.

April 17, 2006: Releases from Buffalo Bill Reservoir were increased to meet downstream irrigation demand.

April 17, 2006: Irrigation releases to the Heart Mountain Canal were initiated for the 2006 irrigation season.

July 6, 2006: Buffalo Bill Reservoir reached a maximum elevation for the water year of 5392.35 feet.

Additional hydrologic and statistical information pertaining to the operations of Buffalo Bill Reservoir during water year 2006 can be found in Table WYT8 and Figure WYG5.

# TABLE WYT8

## HYDROLOGIC DATA FOR WATER YEAR 2006

### BUFFALO BILL RESERVOIR

| RESERVOIR ALLOCATIONS                                                                                      | ELEVATION<br>(FEET) | TOTAL RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION (AF) |               |
|------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------|----------------------------|---------------|
| TOP OF INACTIVE AND DEAD                                                                                   | 5259.60             | 41,748                          | 41,748                     |               |
| TOP OF ACTIVE CONSERVATION                                                                                 | 5393.50             | 646,565                         | 604,817                    |               |
|                                                                                                            |                     |                                 |                            |               |
| STORAGE-ELEVATION DATA                                                                                     | ELEVATION<br>(FEET) | STORAGE<br>(AF)                 | DATE                       |               |
| BEGINNING OF YEAR                                                                                          | 5367.60             | 450,274                         | OCT 01,2005                |               |
| END OF YEAR                                                                                                | 5366.19             | 441,121                         | SEP 30, 2006               |               |
| ANNUAL LOW                                                                                                 | 5366.19             | 441,121                         | SEP 30, 2006               |               |
| HISTORIC LOW*                                                                                              |                     | 19,080                          | JAN 31, 1941               |               |
| ANNUAL HIGH                                                                                                | 5392.35             | 637,356                         | JUL 06, 2006               |               |
| HISTORIC HIGH                                                                                              | 5393.51             | 646,647                         | JUL 30, 1996               |               |
| * Prior to 1952 daily records are not available. End of month data was used to determine the historic low. |                     |                                 |                            |               |
| INFLOW-OUTFLOW DATA                                                                                        | INFLOW              | DATE                            | OUTFLOW*                   | DATE          |
| ANNUAL TOTAL (AF)                                                                                          | 701,688             | OCT 05-SEP 06                   | 710,227                    | OCT 05-SEP 06 |
| DAILY PEAK (cfs)                                                                                           | 6,722               | JUN 08, 2006                    | 4,307                      | JUN 11, 2006  |
| DAILY MINIMUM (cfs)                                                                                        | 17                  | APR 02, 2006                    | 157                        | FEB 22, 2006  |
| PEAK SPILLWAY FLOW (cfs)                                                                                   |                     |                                 |                            |               |
| TOTAL SPILLWAY FLOW (AF)                                                                                   |                     |                                 |                            |               |

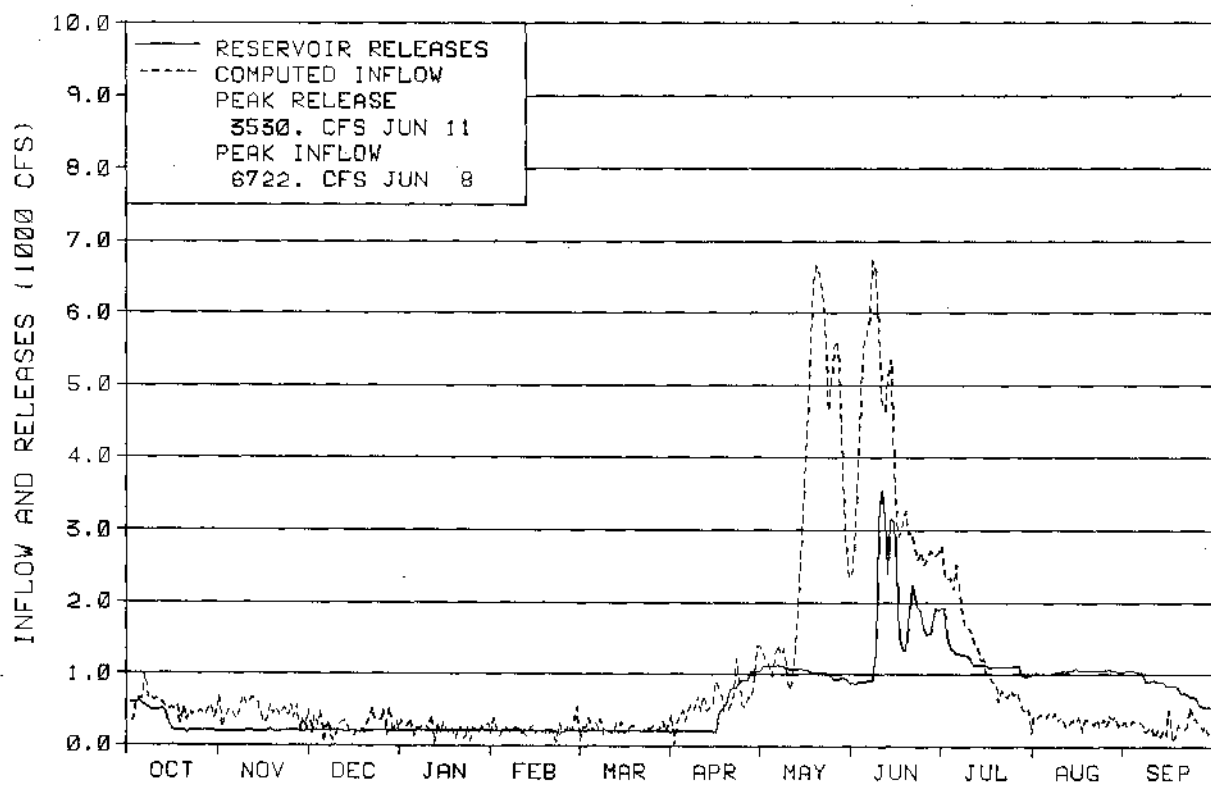
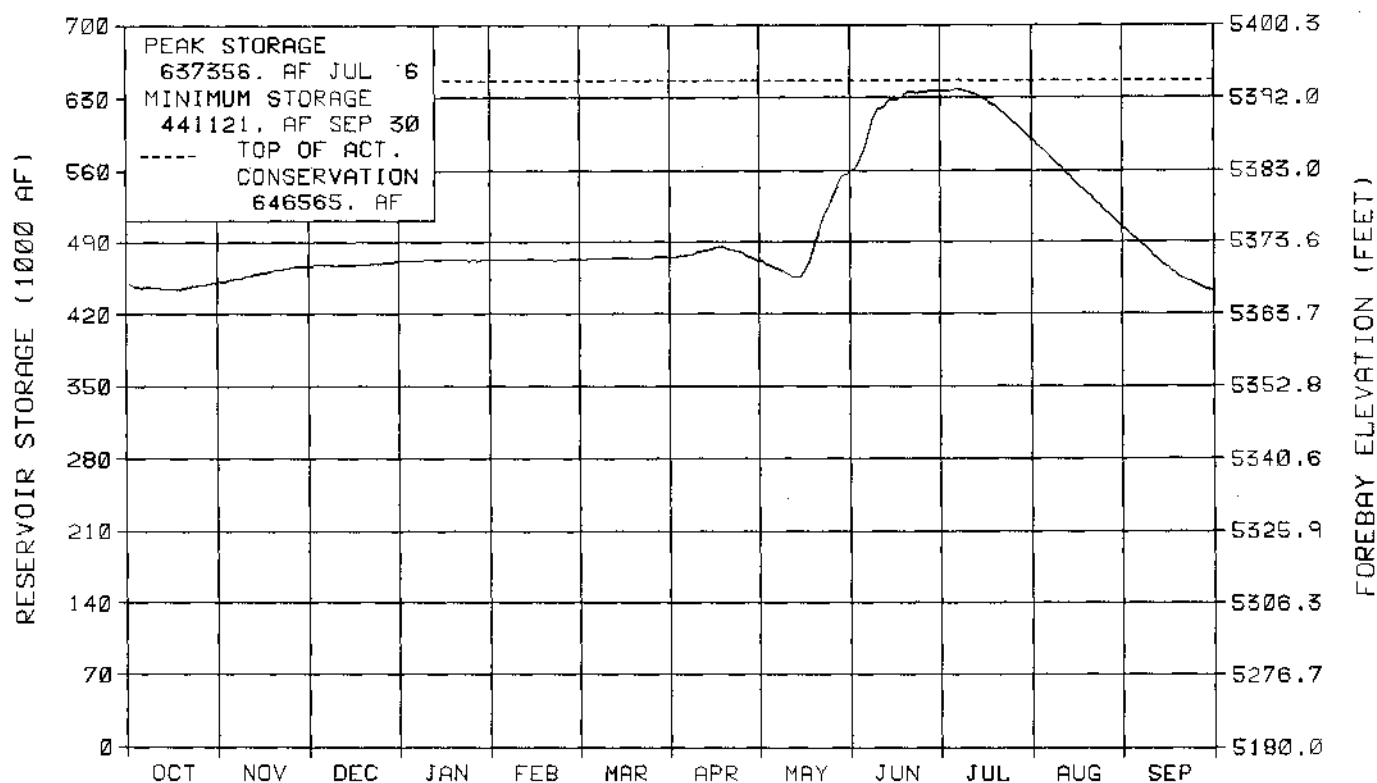
\*Daily peak and minimum are releases to the river

|                                                                                                                                          | INFLOW |           | OUTFLOW |           | CONTENT |           |
|------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------|---------|-----------|---------|-----------|
| MONTH                                                                                                                                    | KAF    | % of Avg* | KAF     | % of Avg* | KAF     | % of Avg* |
| OCTOBER                                                                                                                                  | 32.3   | 133       | 31.3    | 86        | 451.3   | 110       |
| NOVEMBER                                                                                                                                 | 27.5   | 133       | 12.0    | 63        | 466.8   | 114       |
| DECEMBER                                                                                                                                 | 17.4   | 108       | 12.6    | 64        | 471.1   | 115       |
| JANUARY                                                                                                                                  | 14.2   | 95        | 12.8    | 70        | 472.5   | 116       |
| FEBRUARY                                                                                                                                 | 11.8   | 89        | 11.4    | 67        | 473.0   | 117       |
| MARCH                                                                                                                                    | 14.7   | 77        | 12.7    | 58        | 475.0   | 120       |
| APRIL                                                                                                                                    | 37.0   | 88        | 39.3    | 70        | 472.6   | 127       |
| MAY                                                                                                                                      | 198.8  | 128       | 113.9   | 105       | 557.5   | 134       |
| JUNE                                                                                                                                     | 231.2  | 79        | 152.3   | 90        | 636.4   | 115       |
| JULY                                                                                                                                     | 78.9   | 49        | 125.1   | 71        | 590.1   | 105       |
| AUGUST                                                                                                                                   | 22.1   | 47        | 108.8   | 99        | 503.4   | 102       |
| SEPTEMBER                                                                                                                                | 15.7   | 59        | 78.0    | 101       | 441.1   | 101       |
| ANNUAL                                                                                                                                   | 701.7  | 84        | 710.2   | 81        |         |           |
| <div> <div>APRIL - JULY INFLOW (AF)</div> <div> <div>ACTUAL</div> <div>545,897</div> </div> <div>AVERAGE</div> <div>653,100</div> </div> |        |           |         |           |         |           |

\* Average for inflow and outflow is the 1976-2005 period. Because of the enlargement of Buffalo Bill Reservoir in 1992, the period of record on which average content is based is 1993-2005.

FIGURE WYG5

BUFFALO BILL RESERVOIR



WATER YEAR 2006

**Table WYT9**

**WATER YEAR 2006 ACTUAL OUTAGES FOR WYOMING  
POWERPLANTS**

| <u>Facilities</u>          | <u>Description of Work</u>                       | <u>Outage Dates</u> |
|----------------------------|--------------------------------------------------|---------------------|
| <b><u>BOYSEN</u></b>       |                                                  |                     |
| Unit 1                     | Transformer K1A Work                             | 10/24/05 - 10/28/05 |
| Unit 1                     | Annual Maintenance                               | 10/31/05 - 12/16/05 |
| Unit 1                     | Generator Cooler Replacement                     | 12/17/05 - 04/05/06 |
| Unit 2                     | Transformer K1A Work                             | 10/24/05 - 10/28/05 |
| Unit 2                     | Annual Maintenance                               | 04/10/06 - 05/01/06 |
| <b><u>PILOT BUTTE</u></b>  |                                                  |                     |
| Unit 1                     | Annual Maintenance & Turbine Bearing Repair      | 01/03/06 - 02/09/06 |
| Unit 1                     | Replace Plant Vent Fan                           | 03/13/06 - 03/20/06 |
| Unit 2                     | Annual Maintenance                               | 01/03/06 - 02/09/06 |
| Unit 2                     | Replace Plant Vent Fan                           | 03/13/06 - 03/20/06 |
| <b><u>BUFFALO BILL</u></b> |                                                  |                     |
| Buffalo Bill Powerplant    |                                                  |                     |
| Unit 1                     | Conduit Inspection & Butterfly Valve Seal Repair | 10/24/05 - 11/07/05 |
| Unit 1                     | Annual Maintenance & Grounding Ball Stud Install | 11/14/05 - 11/23/05 |
| Unit 2                     | Conduit Inspection                               | 10/24/05 - 11/07/05 |
| Unit 2                     | Grounding Ball Stud Installation                 | 11/14/05 - 11/23/05 |
| Unit 2                     | Annual Maintenance                               | 12/05/05 - 01/18/06 |
| Unit 3                     | Conduit Inspection                               | 10/24/05 - 11/07/05 |
| Unit 3                     | Annual Maintenance                               | 01/17/06 - 01/31/06 |

|                            |                                          |                     |
|----------------------------|------------------------------------------|---------------------|
| Unit 3                     | Grounding Ball Stud Installation         | 02/06/06 - 02/11/06 |
| Shoshone Powerplant        |                                          |                     |
| Unit 3                     | Annual Maintenance                       | 11/09/04 - 11/20/04 |
| Heart Mountain Powerplant  |                                          |                     |
| Unit 1                     | Conduit Inspection                       | 10/24/05 - 11/07/05 |
| Unit 1                     | Annual Maintenance & Grounding Ball Stud | 03/20/06 - 03/30/06 |
| Spirit Mountain Powerplant |                                          |                     |
| Unit 1                     | Annual Maintenance & Conduit Inspection  | 10/24/05 - 11/07/05 |
| Unit 1                     | Packing Box Repair                       | 04/03/06 - 04/17/06 |

## **SUMMARY OF RESERVOIR OPERATIONS FOR BENEFIT OF FISH AND WILDLIFE, ENVIRONMENT AND RECREATION**

### **Bull Lake Reservoir**

During water year 2005, Midvale and Reclamation entered into an agreement whereby Reclamation could store Boysen water in Bull Lake under any combination of four conditions set forth in the agreement. The Boysen water stored in Bull Lake allows Bull Lake to be maintained at a higher content and also provides a flow of 20 to 25 cfs in Bull Lake Creek below the dam as the Boysen water is released from Bull Lake through the winter months. On October 4<sup>th</sup>, 2005, when Midvale began transferring the Boysen water held in Bull Lake back to Boysen, Bull Lake Reservoir held 66,969 AF of water. Of the 66,969 AF held in Bull Lake, 11,345 AF was Boysen water in Bull Lake. Inflow to Bull Lake was slightly greater than the release and the reservoir slowly rose through the winter. Inflow began to increase in late April as snowmelt runoff began. During the April-July period the inflow was 87 percent of average and the reservoir reached a maximum elevation of 5798.51 feet on July 11. As inflows receded and irrigation demands increased, the reservoir fell to a minimum elevation of 5766.80 feet on September 18, or a range of 31.71 feet of fluctuation from maximum to minimum elevation. At the end of water year 2006, the content of Bull Lake was 51,258 AF, with 20,000 AF of the total being Boysen storage water in Bull Lake. This water will be transferred back to Boysen during the winter months of water year 2007 to provide a winter flow in Bull Lake Creek.

### **Boysen Reservoir**

Boysen Reservoir storage at the beginning of water year 2006 was 112 percent of average and 85 percent of capacity. Following the 2005 irrigation season, the release from Boysen Dam was set at approximately 950 cfs but was reduced to 800 cfs in January as snowmelt runoff forecasts indicated below average April – July inflow could be expected. In 2006 the Wyoming Game and Fish Department made a request for a flushing flow in the river below Boysen Dam. Based on the amount of water in the reservoir and the expected reservoir inflow, it was determined that the flushing flow could be provided. On March 29<sup>th</sup>, the release from Boysen Dam was increased in two increments from 800 cfs to 2,400 cfs and then from 2,400 cfs to 5,000 cfs. The 5,000 cfs release was maintained for ten hours and then gradually lowered over the next day back to 800 cfs. Flushing flows are a means of simulating high runoff events that, prior to the closure of the dam, occurred naturally in the river and improved spawning habitat for trout by removing sediment from the spawning gravels in the river. To accomplish the flushing flow, approximately 6,000 AF of water was released from Boysen Dam above the 800 cfs winter release.

The month of April is normally when many species of fish spawn in the upper few feet of the reservoir. To insure a successful spawn, it is important to limit the amount of drawdown on the reservoir during April. With April inflow averaging about 200 cfs less than the outflow, the reservoir level declined slowly through the month and on April 30 was 0.84 feet lower than it was on March 31. The reservoir level fell another 0.94 feet during the first half of May before it began to fill



and ended the month 0.33 feet higher than at the end of April. The reservoir level was at 4713.68 feet going into the Memorial Day weekend, which was 8.82 feet lower than at the beginning of the holiday weekend in 2005.

### **Buffalo Bill Reservoir**

Following the 2005 irrigation season the release from Buffalo Bill Reservoir was set at approximately 200 cfs, based on winter release criteria contained in the Buffalo Bill Reservoir Enlargement Winter Release Operation Agreement. A winter release of 100 cfs, 150 cfs, 200 cfs, or 350 cfs will be provided below Buffalo Bill Powerplant based on the total inflow to Buffalo Bill Reservoir during the previous water year and the amount of storage in the reservoir and in the State account on September 30<sup>th</sup>. A release of 100 cfs will be maintained in the river at the Shoshone Powerplant at all times.

Reclamation continues to support the WGF Reservoir Research Branch in its efforts to assess fish population and species distribution in the enlarged reservoir through the use of hydro-acoustic technology and by providing WGF river access and an aluminum tube for planting fish in the Shoshone River off the deck of Buffalo Bill Powerplant.

At Buffalo Bill Reservoir, as the reservoir is drawn down, the lake bed is exposed to wind erosion which creates dust in the reservoir area and in the Town of Cody, Wyoming. As a part of the enlargement of Buffalo Bill Reservoir, dust abatement dikes were built on the upper ends of the North and South Fork arms of the reservoir to hold water in areas that would become dry as the reservoir level decreased, thus reducing the area of dry lake bed. During the periods from October 1, 2005, through December 19, 2005, the water surface elevation of Buffalo Bill Reservoir was below the top of the North Fork Dike (elevation 5370.00 feet). The maximum elevation of the pool behind the South Fork Dike of 5394.11 feet occurred on June 28, 2006, and the minimum elevation of 5388.67 feet occurred on October 1, 2005. At the maximum elevation, the pool behind the South Fork Dike covered 208 surface acres. On October 14, 2005, when the water surface elevation of Buffalo Bill Reservoir was at its low for the year of 5366.59 feet, the water surface elevation of the pool behind the North Fork Dike was approximately the same as the main reservoir and the water surface elevation of the pool behind the South Fork Dike was 5392.95 feet. At the minimum reported elevation of Buffalo Bill Reservoir, 187 more acres of land would have been exposed without the ability to store water behind the South Fork Dike.

The number of stoplogs at the outlet control structure on the South Fork Dike has been set to maintain the static water level of the pond behind the dike at approximately 5391.00 feet at the end of the water year. The increased elevation provides a larger impoundment behind the dike, benefiting waterfowl as well as the fishery.

The Diamond Creek Dike was constructed to prevent Diamond Creek and the Irma Flats area from being inundated by the enlarged reservoir. Inflows from the Diamond Creek drainage enter

Diamond Creek Reservoir which lies at the base of the dike. This water is then pumped into Buffalo Bill Reservoir in order to maintain the elevation of Diamond Creek Reservoir between a maximum of 5340.40 feet and a minimum of 5339.50 feet with the normal water surface elevation being 5340.00 feet. In water year 2006, 6,750 AF of water was pumped from Diamond Creek Reservoir into Buffalo Bill Reservoir.

Reservoir levels during all of water year 2006 were adequate for recreational activities on Buffalo Bill Reservoir.

## WEATHER SUMMARY FOR NORTH AND SOUTH DAKOTA

October precipitation was slightly above normal at Heart Butte, near normal at Dickinson, Angostura, Belle Fourche, and Shadehill Reservoirs and below normal at the remaining reservoirs.

November precipitation was much above normal at Dickinson and slightly above normal at Heart Butte and below normal at all remaining reservoirs.

December precipitation was much above normal at Heart Butte, slightly above normal at Belle Fourche, Deerfield, and Shadehill reservoirs and below to much below normal at the remaining reservoirs.

January precipitation was slightly below to much below normal at all reservoirs.

February precipitation was much below to below normal at all reservoirs, with Dickinson recording no precipitation.

March precipitation was much above normal at Angostura and Pactola reservoirs, normal at Dickinson and Heart Butte, and below normal at the remaining reservoirs.

April precipitation was below normal at Jamestown, Heart Butte, Deerfield and Pactola Reservoirs and above to much above normal at all remaining reservoirs.

May precipitation was slightly above normal for Jamestown and below normal at all remaining reservoirs.

June precipitation was below to much below normal at all reservoirs.

July precipitation was below to much below normal at all reservoirs.

August precipitation was above normal at Jamestown, Angostura, Pactola and Shadehill, normal at Heart Butte and below normal at all remaining reservoirs.

September precipitation was below normal at Angostura Reservoir, normal at Dickinson, and above to much above normal at all remaining reservoirs.

Total annual precipitation for Reclamation facilities in North Dakota, South Dakota, and Northeastern Wyoming are shown on Table DKT1.

| <b>TABLE DKT1</b><br><b>Total Annual Precipitation for Reclamation Reservoirs</b><br><b>in North Dakota, South Dakota, and Northeastern Wyoming in Inches</b> |                   |                      |                |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------|----------------|
| <b>Reservoir</b>                                                                                                                                              | <b>2006 Total</b> | <b>Average Total</b> | <b>Percent</b> |
| Angostura 1/                                                                                                                                                  | 56.53             | 64.99                | 87             |
| Belle Fourche 2/                                                                                                                                              | 56.09             | 60.60                | 93             |
| Deerfield                                                                                                                                                     | 13.69             | 20.87                | 66             |
| Keyhole 3/                                                                                                                                                    | 22.12             | 35.72                | 62             |
| Pactola                                                                                                                                                       | 18.16             | 21.10                | 86             |
| Shadehill 4/                                                                                                                                                  | 27.04             | 32.61                | 83             |
| Dickinson                                                                                                                                                     | 12.47             | 16.35                | 76             |
| Lake Tschida                                                                                                                                                  | 10.09             | 15.75                | 64             |
| Jamestown                                                                                                                                                     | 14.93             | 18.49                | 81             |

1/ Angostura Reservoir's annual precipitation includes data from Oelrichs, SD, Hot Springs, SD, Newcastle, WY, and Red Bird, WY climate stations.

2/ Belle Fourche Reservoir's annual precipitation includes data from Newell, SD, Spearfish, SD, and Sundance, WY climate stations.

3/ Keyhole Reservoir's annual precipitation includes data from Dillinger, WY and Sundance, WY climate stations.

4/ Shadehill Reservoir's annual precipitation includes data from Camp Crook and Lemmon, SD climate stations.

Table DKT2 displays the changes in storage content between September 30, 2005, and September 30, 2006, at reservoirs in North and South Dakota and eastern Wyoming.

| <b>TABLE DKT2</b><br><b>Comparison of End-of-Month Storage Content for Reservoirs</b><br><b>in North Dakota, South Dakota, and Northeastern Wyoming</b><br><b>in Acre-Feet</b> |                                       |                                       |                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------|--------------------------|
| <b>Reservoir</b>                                                                                                                                                               | <b>Storage<br/>September 30, 2005</b> | <b>Storage<br/>September 30, 2006</b> | <b>Change in Storage</b> |
| Angostura                                                                                                                                                                      | 57,779                                | 43,815                                | -13,964                  |
| Belle Fourche                                                                                                                                                                  | 19,352                                | 29,002                                | 9,650                    |
| Deerfield                                                                                                                                                                      | 13,115                                | 12,028                                | -1,087                   |
| Keyhole                                                                                                                                                                        | 77,138                                | 54,170                                | -22,968                  |
| Pactola                                                                                                                                                                        | 36,131                                | 32,296                                | -3,835                   |
| Shadehill                                                                                                                                                                      | 81,365                                | 81,099                                | -266                     |
| Dickinson                                                                                                                                                                      | 2,228                                 | 4,897                                 | 2,669                    |
| Lake Tschida                                                                                                                                                                   | 57,391                                | 49,032                                | -8,359                   |
| Jamestown                                                                                                                                                                      | 29,114                                | 28,133                                | -981                     |

## FLOOD BENEFITS FOR RESERVOIRS IN NORTH AND SOUTH DAKOTA AND NORTHEASTERN WYOMING

Several Bureau of Reclamation reservoirs in northeastern Wyoming, South Dakota, and North Dakota provided flood relief during Water Year (WY) 2006. They are: Lake Tschida on the Heart River near Glen Ullin, North Dakota; Shadehill on the Grand River near Shadehill, South Dakota; Angostura on the Cheyenne River near Hot Springs, South Dakota; Pactola on Rapid Creek near Rapid City, South Dakota; Keyhole on the Belle Fourche River near Moorcroft, Wyoming; and Jamestown on the James River near Jamestown, North Dakota.

The information on the distribution of flood damages prevented is provided by the Corps of Engineers. The distributions of flood damages prevented for each reservoir are as follows:

### FLOOD DAMAGE PREVENTED IN 2006 ACCUMULATED TOTAL 1950-2006

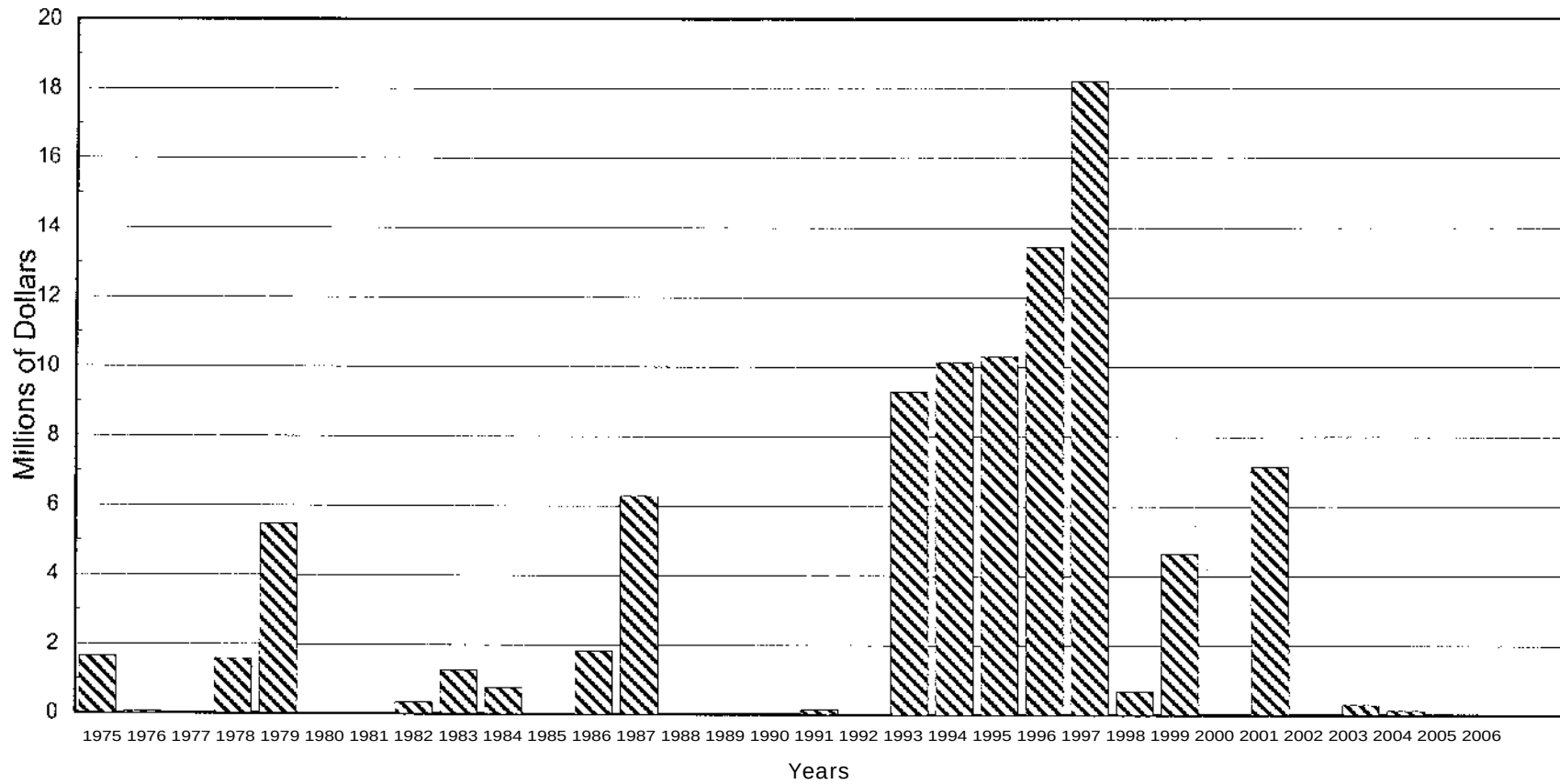
|              | Local | Main-Stem | 2006<br>Total | Previous<br>Accumulations | 1950-2006<br>Accum Totals |
|--------------|-------|-----------|---------------|---------------------------|---------------------------|
| Lake Tschida | \$0   | \$100     | \$100         | \$13,305,500              | \$13,305,600              |
| Shadehill    | \$0   | \$100     | \$100         | \$9,032,500               | \$9,032,600               |
| Angostura    | \$0   | \$0       | \$0           | \$21,100                  | \$21,100                  |
| Pactola      | \$0   | \$0       | \$0           | \$3,116,500               | \$3,116,500               |
| Keyhole      | \$0   | \$0       | \$0           | \$3,762,700               | \$3,762,700               |
| Jamestown    | \$0   | \$0       | \$0           | \$86,807,300              | \$86,807,300              |
| Total        | \$0   | \$200     | \$200         | \$116,045,600             | \$116,045,800             |

Flood damages prevented by Dakotas Area Office between Garrison and Gavins Point Dams are shown on Figure DKG1.

FIGURE DKG1

## FLOOD DAMAGES PREVENTED

By Dakota Area Projects Between Garrison and Gavins Point Dams



# **UNIT OPERATIONAL SUMMERIES FOR WATER YEAR 2006**

## **EDWARD ARTHUR PATTERSON LAKE**

### **BACKGROUND**

Edward Arthur Patterson Lake (Dickinson Reservoir) is located on the Heart River near Dickinson, North Dakota. The reservoir has a dead capacity of 356 acre-feet, an inactive capacity of 100 acre-feet and an active conservation capacity of 8,156 acre-feet (for a total storage capacity of 8,612 acre-feet at the top of conservation elevation 2420.00). Reservoir water is utilized for irrigating approximately 230 acres along the Heart River downstream of the dam and for municipal use by the Dickinson parks and Recreation District.

### **WATER YEAR 2006 OPERATIONS SUMMARY**

The water surface elevation of Dickinson Reservoir at the beginning of water year 2006 was 2411.91 feet with storage of 2,178 acre-feet, which is 8.09 feet, and 6,434 acre-feet below the top of the conservation pool (elevation 2420.0). Dickinson Reservoir peaked at elevation 2419.10 feet on May 2<sup>nd</sup> with 7,581 acre-feet of storage. Water was released through the river bypass valve to lower the reservoir elevation to facilitate coating of the Bascule gate. The reservoir elevation on September 30, 2006 was 2416.28 feet with storage of 4,897 acre-feet, which is 3.72 feet, and 3,715 acre-feet below the top of conservation pool.

The maximum daily discharge of 44 cfs occurred from January to February. Reservoir net inflows for water year 2006 totaled 6,378 acre-feet, 33 percent of average. Precipitation for the water year totaled 12.47 inches, which is 76 percent of average.

### **MONTHLY STATISTICS FOR WY 2006**

Record and near record monthly inflows in 55 years of record keeping were recorded in the following months:

October had its 6<sup>th</sup> highest inflow, November had its 6<sup>th</sup> highest inflow, December had its 9<sup>th</sup> lowest inflow, January had its 4<sup>th</sup> highest inflow, June had its 3<sup>rd</sup> lowest inflow, July had its 4<sup>th</sup> lowest inflow and August had its 4<sup>th</sup> lowest inflow.

Record and near record monthly end of month content in 55 years of record keeping were recorded in the following months:

October had its lowest EOM ever recorded in October, November had its 2<sup>nd</sup> lowest EOM, December had its 2<sup>nd</sup> lowest EOM, January had its 2<sup>nd</sup> lowest EOM, February had its lowest EOM ever recorded in February, and March had its lowest EOM ever recorded in March.



Additional statistical information on E.A. Patterson Lake and its operations during 2006 can be found on Table DKT3 and Figure DKG2.

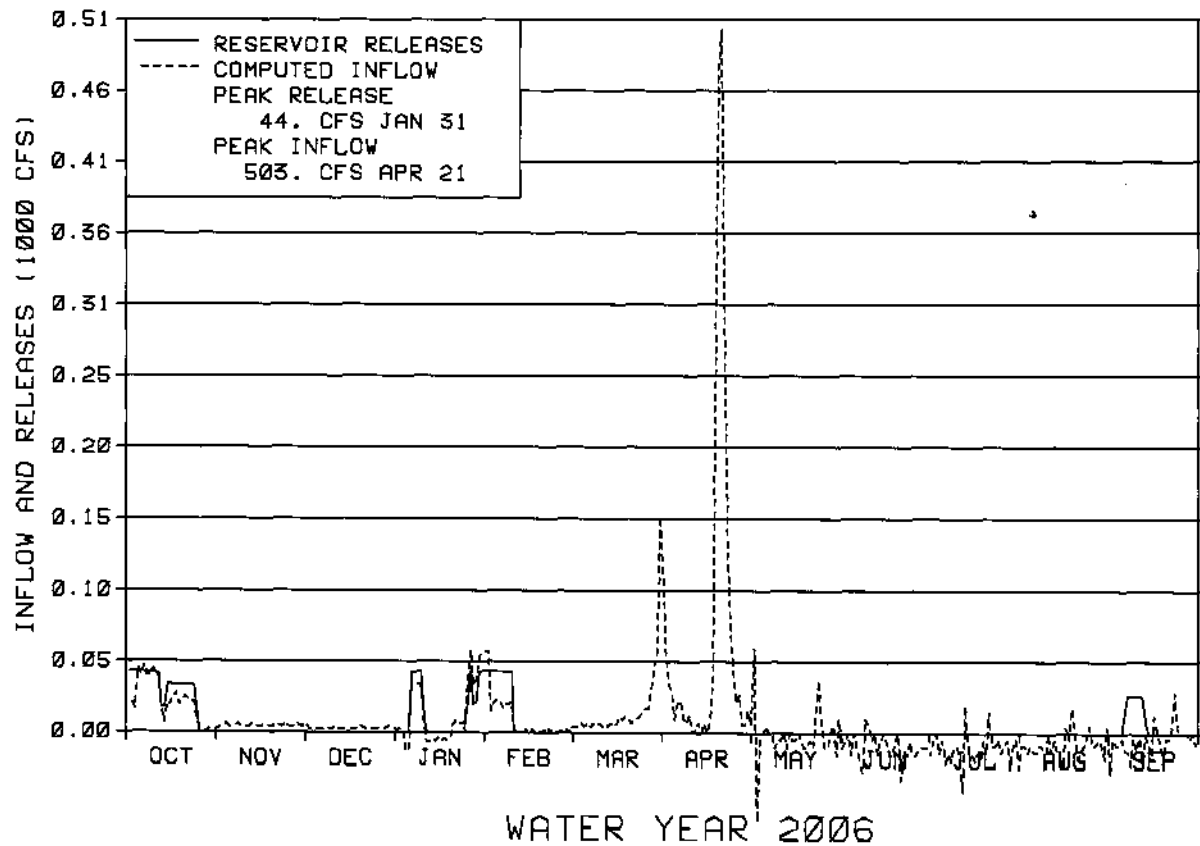
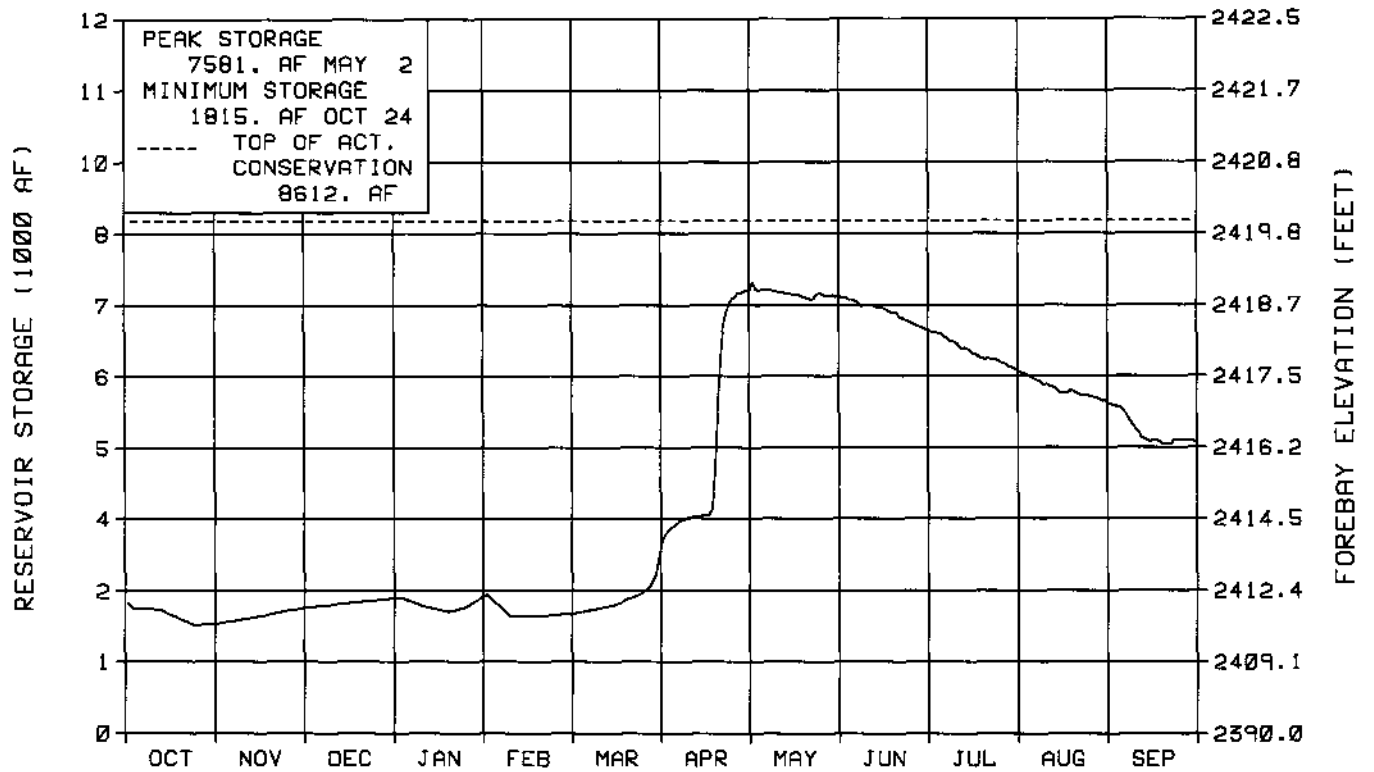
TABLE DKT3  
HYDROLOGIC DATA FOR 2006  
E.A. PATTERSON DAM AND LAKE

| RESERVOIR ALLOCATIONS          |           |        | ELEVATION<br>(FEET) |         | TOTAL<br>RESERVOIR<br>STORAGE (AF) |         | STORAGE<br>ALLOCATION<br>(AF) |  |               |  |
|--------------------------------|-----------|--------|---------------------|---------|------------------------------------|---------|-------------------------------|--|---------------|--|
| TOP OF INACTIVE AND DEAD       |           |        | 2,405.00            |         | 456                                |         | 456                           |  |               |  |
| TOP OF ACTIVE CONSERVATION     |           |        | 2,420.00            |         | 8,612                              |         | 8,156                         |  |               |  |
| TOP OF JOINT USE               |           |        |                     |         |                                    |         |                               |  |               |  |
| TOP OF EXCLUSIVE FLOOD CONTROL |           |        |                     |         |                                    |         |                               |  |               |  |
|                                |           |        |                     |         |                                    |         |                               |  |               |  |
| STORAGE-ELEVATION DATA         |           |        | ELEVATION (FT)      |         | STORAGE (AF)                       |         | DATE                          |  |               |  |
| BEGINNING OF YEAR              |           |        | 2,411.91            |         | 2,178                              |         | OCT 01, 2005                  |  |               |  |
| END OF YEAR                    |           |        | 2,416.28            |         | 4,897                              |         | SEP 30, 2006                  |  |               |  |
| ANNUAL LOW                     |           |        | 2,411.04            |         | 1,815                              |         | OCT 24, 2005                  |  |               |  |
| ANNUAL HIGH                    |           |        | 2,419.10            |         | 7,581                              |         | MAY 02, 2006                  |  |               |  |
| HISTORIC HIGH                  |           |        | 2,422.19            |         | **9,348                            |         | MAR 21, 1997                  |  |               |  |
| INFLOW-OUTFLOW DATA            |           |        | INFLOW              |         | DATE                               |         | OUTFLOW                       |  | DATE          |  |
| ANNUAL TOTAL (AF)              |           |        | 6,378               |         | OCT 05-SEP 06                      |         | 3,718                         |  | OCT 05-SEP 06 |  |
| DAILY PEAK (CFS)               |           |        | 503                 |         | APR 21, 2006                       |         | 44                            |  | JAN- FEB 06   |  |
| DAILY MINIMUM (CFS)            |           |        | 0                   |         | *                                  |         | 0                             |  | *             |  |
|                                | MONTH     | INFLOW |                     | OUTFLOW |                                    | CONTENT |                               |  |               |  |
|                                |           | AF     | % OF AVG            | AF      | % OF AVG                           | AF      | % OF AVG                      |  |               |  |
|                                | OCTOBER   | 1,330  | 545                 | 1,720   | 524                                | 1,838   | 33                            |  |               |  |
|                                | NOVEMBER  | 282    | 210                 | 0       | NA                                 | 2,120   | 38                            |  |               |  |
|                                | DECEMBER  | 154    | 127                 | 0       | NA                                 | 2,274   | 41                            |  |               |  |
|                                | JANUARY   | 1,001  | 579                 | 944     | 665                                | 2,331   | 42                            |  |               |  |
|                                | FEBRUARY  | 362    | 32                  | 693     | 94                                 | 2,000   | 34                            |  |               |  |
|                                | MARCH     | 1,003  | 14                  | 0       | NA                                 | 3,003   | 43                            |  |               |  |
|                                | APRIL     | 4,447  | 107                 | 0       | NA                                 | 7,450   | 106                           |  |               |  |
|                                | MAY       | -97    | NA                  | 0       | NA                                 | 7,353   | 106                           |  |               |  |
|                                | JUNE      | -564   | NA                  | 0       | NA                                 | 6,789   | 97                            |  |               |  |
|                                | JULY      | -714   | NA                  | 0       | NA                                 | 6,084   | 93                            |  |               |  |
|                                | AUGUST    | -549   | NA                  | 0       | NA                                 | 5,535   | 91                            |  |               |  |
|                                | SEPTEMBER | -276   | NA                  | 362     | 108                                | 4,897   | 85                            |  |               |  |
|                                | ANNUAL    |        | 6,378               | 33      | 3,718                              | 19      |                               |  |               |  |
| APRIL-JULY                     |           | 3,072  | 31                  |         |                                    |         |                               |  |               |  |

\* Frequently observed during fall and winter months

\*\* Due to new area-capacity table, the capacity that corresponds to the new historic high elevation is less than a previous historic high capacity amount (11,520 AF @ Elevation 2421.08 on June 9, 1982)

FIGURE DKG2  
E. A. PATTERSON LAKE



# LAKE TSCHIDA

## BACKGROUND

Heart Butte Dam and Lake Tschida (Heart Butte Reservoir) is located on the Heart River near Glen Ullin, North Dakota. The reservoir has a dead storage capacity of 5,227 acre-feet, an active conservation capacity of 61,915 acre-feet (for a total storage capacity of 67,142 acre-feet at the top of active conservation elevation 2064.50), and an exclusive flood control space of 147,027 acre-feet. Flood control storage is located above the crest of an ungated glory-hole spillway. Lake Tschida is primarily used for flood control and the authorized irrigation of up to 13,100 acres of which about 7,320 acres are now being irrigated.

## WATER YEAR 2006 OPERATIONS SUMMARY

The water surface elevation of Heart Butte Reservoir at the beginning of water year 2006 was 2061.38 feet with storage of 57,270 acre-feet, which is 3.12 feet, and 9,872 acre-feet below the top of conservation pool (elevation 2064.50). Heart Butte Reservoir peaked at elevation 2065.16 on May 2<sup>nd</sup> with 69,338 acre-feet of storage. The reservoir elevation on September 30<sup>th</sup> 2006 was 2058.54 feet with storage of 49,032 acre-feet, which is 5.96 feet and 18,110 acre-feet below the top of conservation pool.

The maximum discharge of 132 cfs occurred on July 6<sup>th</sup>. Reservoir net inflows for water year 2006 totaled 12,869 acre-feet, 15 percent of average. Precipitation for the water year totaled 10.09 inches, which is 64 percent of average.

## MONTHLY STATISTICS FOR WY 2006

Record and near record monthly inflows in 57 years of record keeping were recorded in the following months:

October had its 8<sup>th</sup> highest inflow, May had its 3<sup>rd</sup> lowest inflow, June had its 2<sup>nd</sup> lowest inflow, July had its 2<sup>nd</sup> lowest inflow, and August had its 6<sup>th</sup> lowest inflow.

Record and near record monthly end of month content in 57 years of record keeping were recorded in the following months:

June had its 7<sup>th</sup> lowest EOM, July had its 6<sup>th</sup> lowest EOM, August had its 7<sup>th</sup> lowest EOM, and September had its 7<sup>th</sup> lowest EOM.

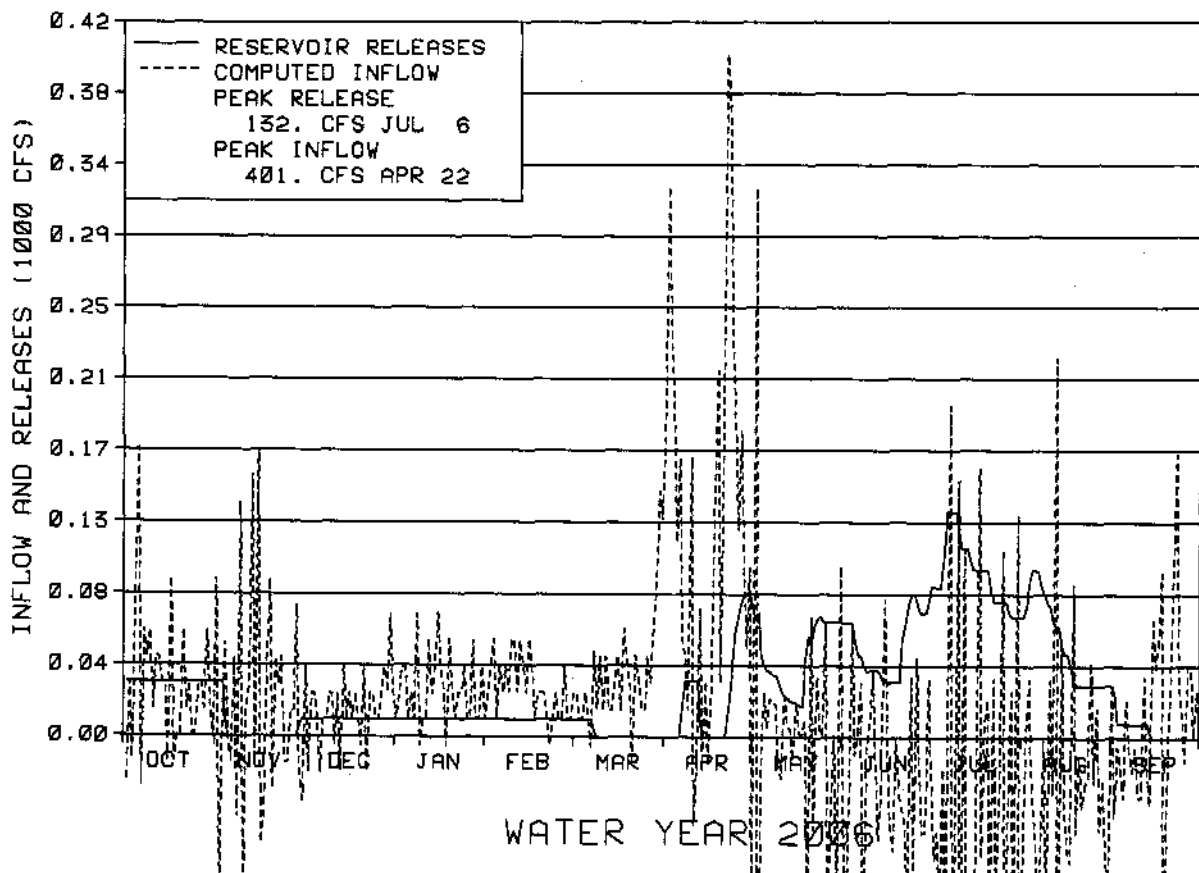
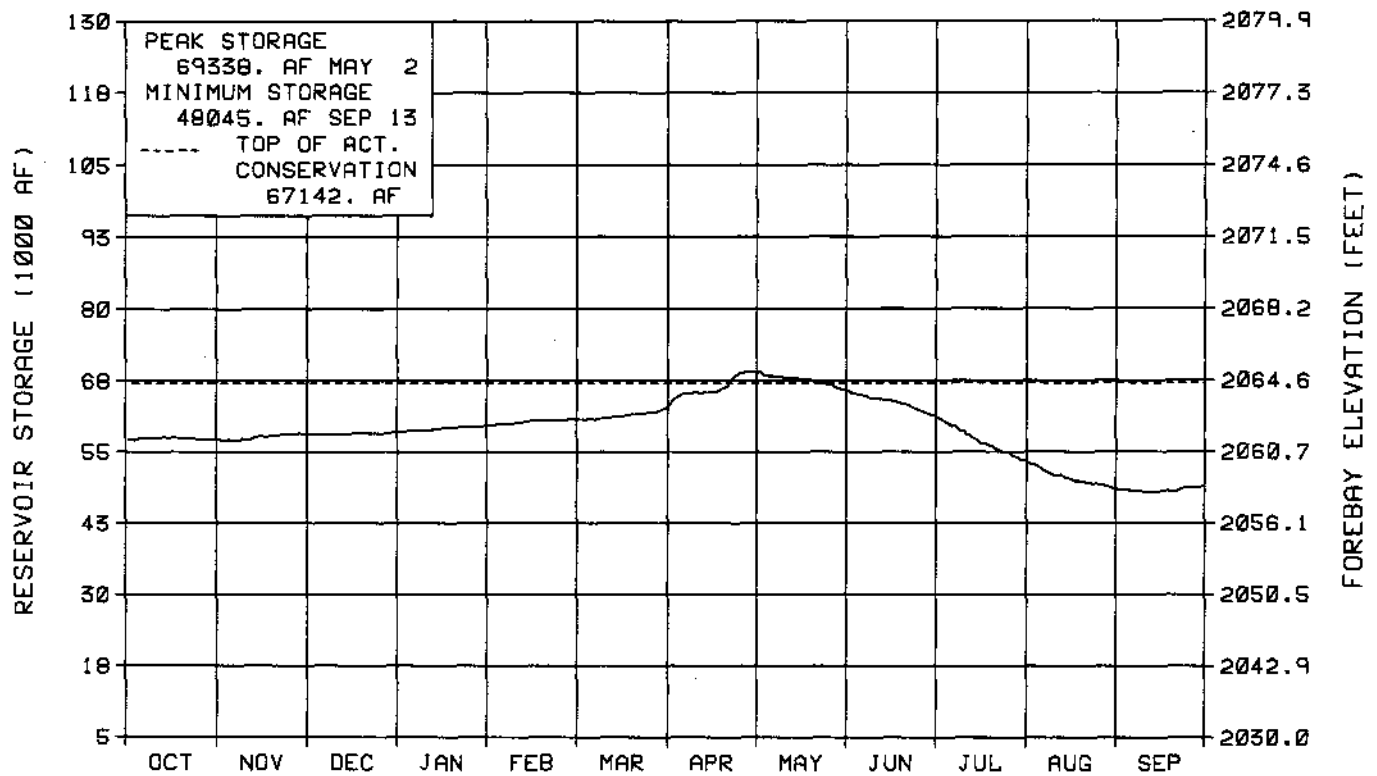
Additional statistical information on Lake Tschida and its operations during 2006 can be found on Table DKT4 and Figure DKG3.

TABLE DKT4  
HYDROLOGIC DATA FOR 2006  
LAKE TSCHIDA

| RESERVOIR ALLOCATIONS          | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |               |          |         |          |
|--------------------------------|---------------------|------------------------------------|-------------------------------|---------------|----------|---------|----------|
| TOP OF INACTIVE AND DEAD       | 2,030.00            | 5,227                              | 5,227                         |               |          |         |          |
| TOP OF ACTIVE CONSERVATION     | 2,064.50            | 67,142                             | 61,915                        |               |          |         |          |
| TOP OF JOINT USE               |                     |                                    |                               |               |          |         |          |
| TOP OF EXCLUSIVE FLOOD CONTROL | 2,094.50            | 214,169                            | 147,027                       |               |          |         |          |
|                                |                     |                                    |                               |               |          |         |          |
| STORAGE-ELEVATION DATA         | ELEVATION (FT)      | STORAGE (AF)                       | DATE                          |               |          |         |          |
| BEGINNING OF YEAR              | 2,061.38            | 57,270                             | OCT 01, 2005                  |               |          |         |          |
| END OF YEAR                    | 2,058.54            | 49,032                             | SEP 30, 2006                  |               |          |         |          |
| ANNUAL LOW                     | 2,058.18            | 48,045                             | SEP 13, 2006                  |               |          |         |          |
| ANNUAL HIGH                    | 2,065.16            | 69,338                             | MAY 02, 2006                  |               |          |         |          |
| HISTORIC HIGH                  | 2,086.23            | 173,203                            | APR 09, 1952                  |               |          |         |          |
|                                |                     |                                    |                               |               |          |         |          |
| INFLOW-OUTFLOW DATA            | INFLOW              | DATE                               | OUTFLOW                       | DATE          |          |         |          |
| ANNUAL TOTAL (AF)              | 12,869              | OCT 05-SEP 06                      | 21,198                        | OCT 05-SEP 06 |          |         |          |
| DAILY PEAK (CFS)               | 401                 | APR 22, 2006                       | 132                           | JUL 06, 2006  |          |         |          |
| DAILY MINIMUM (CFS)            | 0                   | *                                  | 0                             | *             |          |         |          |
|                                |                     |                                    |                               |               |          |         |          |
|                                |                     |                                    |                               |               |          |         |          |
|                                | MONTH               | INFLOW                             |                               | OUTFLOW       |          | CONTENT |          |
|                                |                     | AF                                 | % OF AVG                      | AF            | % OF AVG | AF      | % OF AVG |
|                                | OCTOBER             | 1,980                              | 204                           | 1,950         | 106      | 57,421  | 98       |
|                                | NOVEMBER            | 1,049                              | 88                            | 196           | 13       | 58,274  | 100      |
|                                | DECEMBER            | 986                                | 123                           | 618           | 47       | 58,642  | 101      |
|                                | JANUARY             | 1,699                              | 194                           | 620           | 54       | 59,721  | 104      |
|                                | FEBRUARY            | 1,621                              | 44                            | 562           | 29       | 60,780  | 103      |
|                                | MARCH               | 2,294                              | 8                             | 148           | 1        | 62,926  | 89       |
|                                | APRIL               | 7,699                              | 33                            | 1,421         | 6        | 69,204  | 98       |
|                                | MAY                 | -212                               | NA                            | 2,967         | 27       | 66,025  | 95       |
|                                | JUNE                | -1,279                             | NA                            | 3,245         | 36       | 61,501  | 87       |
|                                | JULY                | -2,110                             | NA                            | 5,897         | 72       | 53,464  | 80       |
|                                | AUGUST              | -1,446                             | NA                            | 3,344         | 64       | 48,674  | 77       |
|                                | SEPTEMBER           | 588                                | 245                           | 230           | 9        | 49,032  | 81       |
| ANNUAL                         | 12,869              | 15                                 | 21,198                        | 25            |          |         |          |
| APRIL-JULY                     | 4,098               | 9                                  |                               |               |          |         |          |

\* Frequently observed during fall and winter months

FIGURE DKG3  
LAKE TSCHIDA



## JAMESTOWN RESERVOIR

### BACKGROUND

Jamestown Reservoir is located on the James River above Jamestown, North Dakota. The reservoir has a dead capacity of 822 acre-feet, an active conservation capacity of 24,535 acre-feet (for a total top of active conservation capacity of 25,357 acre-feet at elevation 1428.00), a joint-use capacity of 6,153 acre-feet, and an exclusive flood control space of 189,468 acre-feet. The exclusive flood control storage is below the crest of an ungated glory-hole spillway, and flood control releases are controlled by the gated outlets. The joint-use space is available for flood control at the beginning of spring runoff and is used for conservation purposes during the summer months.

### WATER YEAR 2006 OPERATIONS SUMMARY

The water surface elevation of Jamestown Reservoir at the beginning of water year 2006 was 1429.61 feet with storage of 28,521 acre-feet, which is 1.61 feet, and 3,164 acre-feet above the top of the conservation pool (elevation 1428.00). Jamestown Reservoir peaked at elevation 1431.12 feet on July 7<sup>th</sup> with 31,791 acre-feet of storage. The reservoir elevation on September 30, 2006 was 1429.42 with storage of 28,133 acre-feet, which is 1.42 feet, and 2,776 acre-feet above the top of active conservation pool.

The maximum discharge of 199 cfs occurred on October 1<sup>st</sup>, 2005. Reservoir net inflows for water year 2006 totaled 10,059 acre-feet, 23 percent of average. Precipitation for the water year totaled 14.93 inches at 81 percent of average.

### MONTHLY STATISTICS FOR WY 2006

Record and near record monthly inflows in 53 years of record keeping were recorded in the following months:

October had its 10<sup>th</sup> highest inflow; July had its 2<sup>nd</sup> lowest inflow.

Record and near record monthly end of month content in 53 years of record keeping were recorded in the following months:

No record end of month content was recorded at Jamestown Reservoir

Additional statistical information on Jamestown Reservoir and its operations during 2006 can be found on Table DKT5 and Figure DKG4.

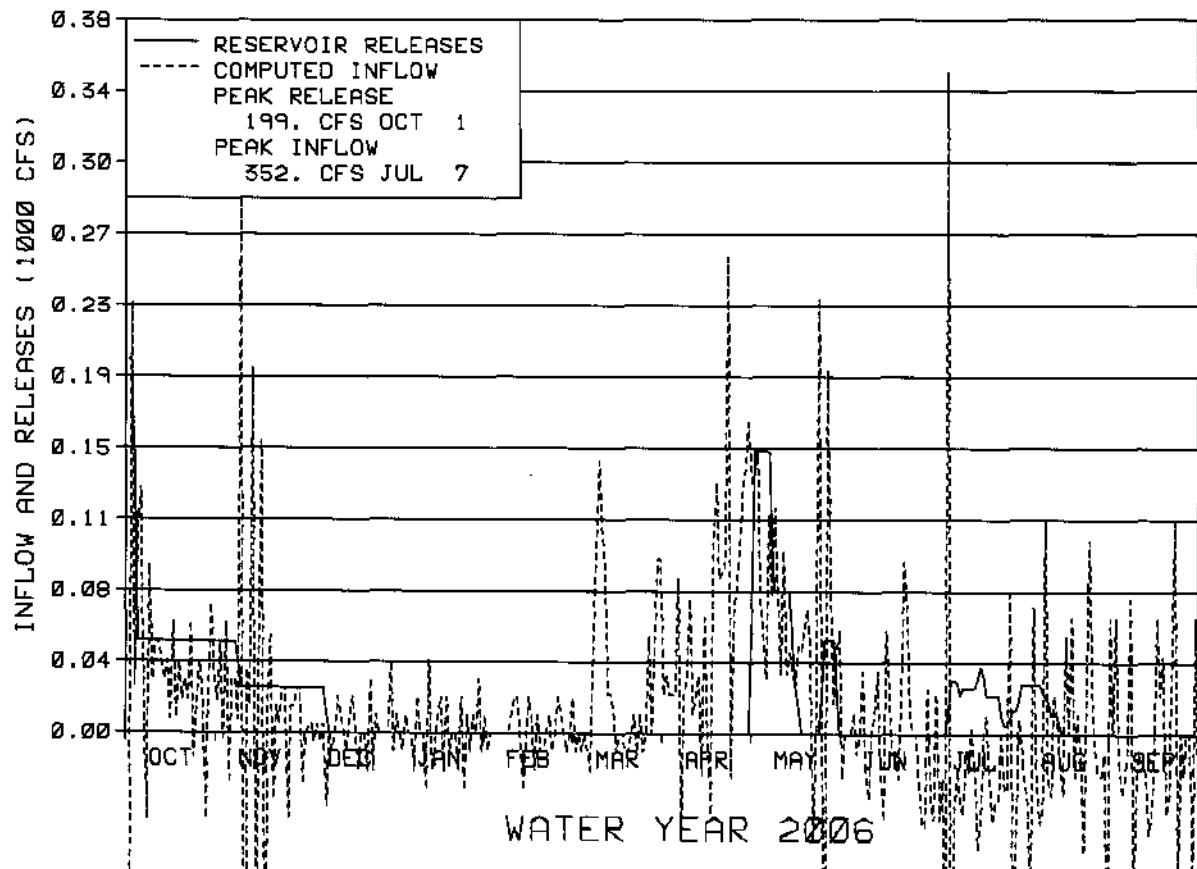
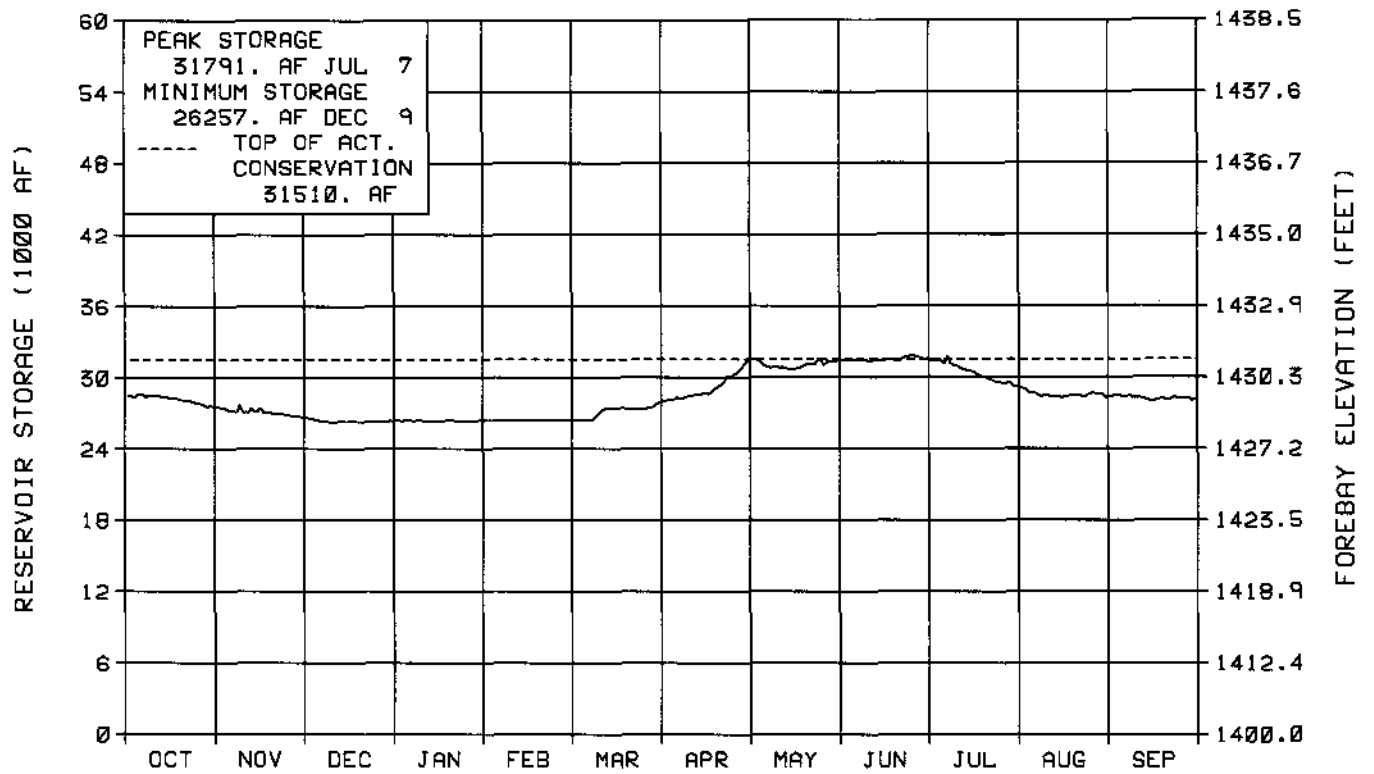
TABLE DKT5  
HYDROLOGIC DATA FOR 2006  
JAMESTOWN RESERVOIR

| RESERVOIR ALLOCATIONS          |  | ELEVATION<br>(FEET) |               | TOTAL<br>RESERVOIR<br>STORAGE (AF) |         | STORAGE<br>ALLOCATION<br>(AF) |  |
|--------------------------------|--|---------------------|---------------|------------------------------------|---------|-------------------------------|--|
| TOP OF INACTIVE AND DEAD       |  | 1,400.00            |               | 822                                |         | 822                           |  |
| TOP OF ACTIVE CONSERVATION     |  | 1,428.00            |               | 25,357                             |         | 24,535                        |  |
| TOP OF JOINT USE               |  | 1,431.00            |               | 31,510                             |         | 6,153                         |  |
| TOP OF EXCLUSIVE FLOOD CONTROL |  | 1,454.00            |               | 220,978                            |         | 189,468                       |  |
|                                |  |                     |               |                                    |         |                               |  |
| STORAGE-ELEVATION DATA         |  | ELEVATION (FT)      |               | STORAGE (AF)                       |         | DATE                          |  |
| BEGINNING OF YEAR              |  | 1,429.61            |               | 28,521                             |         | OCT 01, 2005                  |  |
| END OF YEAR                    |  | 1,429.42            |               | 28,133                             |         | SEP 30, 2006                  |  |
| ANNUAL LOW                     |  | 1,428.47            |               | 26,257                             |         | DEC 09, 2005                  |  |
| ANNUAL HIGH                    |  | 1,431.12            |               | 31,791                             |         | JUL 07, 2006                  |  |
| HISTORIC HIGH                  |  | 1,445.91            |               | 126,067                            |         | MAY 05, 1997                  |  |
|                                |  |                     |               |                                    |         |                               |  |
| INFLOW-OUTFLOW DATA            |  | INFLOW              | DATE          |                                    | OUTFLOW | DATE                          |  |
| ANNUAL TOTAL (AF)              |  | 10,059              | OCT 05-SEP 06 |                                    | 11,062  | OCT 05-SEP 06                 |  |
| DAILY PEAK (CFS)               |  | 352                 | JUL 07, 2006  |                                    | 199     | OCT 01, 2005                  |  |
| DAILY MINIMUM (CFS)            |  | 0                   | *             |                                    | 0       | *                             |  |
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\* Frequently observed during fall and winter months



FIGURE DKG4  
JAMESTOWN RESERVOIR



## **DEERFIELD RESERVOIR**

### **BACKGROUND**

Deerfield Reservoir is located on Castle Creek, a tributary of Rapid Creek above Rapid City. Deerfield Reservoir (Rapid Valley Project) and Pactola Reservoir (Rapid Valley Unit, P-S MBP), furnish a supplemental irrigation supply to about 8,900 acres in the Rapid Valley Water Conservancy District and furnish replacement water for a portion of the water used from Rapid Creek by Rapid City. The majority of prior rights to the flows of Rapid Creek during the irrigation season are held by individuals and ditch companies in the Rapid Valley Water Conservancy District.

In 1985, Deerfield Dam was modified to accommodate a larger flood as determined from the results of the Probable Maximum Flood analysis. These modifications consisted of raising the crest of the dam 38 feet, excavating an unlined auxiliary spillway, removing and filling in the old spillway, and extending the existing emergency gate passageway to the new control house at the higher crest elevation. The reservoir has a total capacity of 15,655 acre-feet with an additional 26,655 acre-feet of surcharge capacity.

During the winter of 1995-96 the hollow jet valves were removed to allow the installation of the jet flow valves as part of the outlet works modification contract. The work was done to improve fish habitat in 1.5 miles of the creek immediately downstream of the dam. The stream improvement project was a cooperative effort accomplished by the City of Rapid City, Rapid Valley Water Conservancy District, Black Hills Fly Fishers, Bureau of Reclamation, US Forest Service, and SD Game Fish and Parks. The project modified the outlet works of Deerfield Dam by installing Jet Flow Gates to allow greater minimum winter releases than the 6-in bypass is capable of providing.

### **WY 2006 OPERATIONS SUMMARY**

Inflows to Deerfield Reservoir for WY 2006 totaled 5,525 acre-feet (57% of the average). The water year began with 13,115 acre-feet of storage, at elevation 5901.69. WY 2006 ended with Deerfield at elevation 5898.79 and storage content of 12,028 acre-feet. The peak reservoir elevation for the year was 5901.68 on October 4 with 13,111 acre-feet of storage.

Rapid Valley Water Conservancy District ordered 4,459 acre feet of water from Deerfield for the 2006 irrigation season.

A mechanical Comprehensive Facility Review (CFR) was conducted March 29, 2006 and a civil CFR on May 4, 2006 by personnel from the Denver Technical Service Center (TSC), Great Plains Regional Office (GPRO), Dakotas Area Office (DKAO), and the Rapid City Field Office (RCFO).

An Emergency Management/Security orientation was conducted on April 6, 2006.

## MONTHLY STATISTICS FOR WY 2006

October EOM elevation, at Deerfield Reservoir, was above average. October inflow was much below average. Winter release is 10 cfs. Deerfield finished the month 7.0 feet from full.

November EOM elevation, at Deerfield Reservoir, was above average. November inflow was 3rd lowest in 53 years of record. Winter release is 10 cfs. Deerfield finished the month 7.9 feet from full.

December EOM elevation, at Deerfield Reservoir, was below average. December inflow was 4th lowest in 53 years of record. Winter release is 10 cfs. Deerfield finished the month 8.7 feet from full.

January EOM elevation, at Deerfield Reservoir, was below average. January inflow was much below average. Winter release is 10 cfs. Deerfield finished the month 9.4 feet from full.

February EOM elevation, at Deerfield Reservoir, was below average. February inflow was the 4th lowest in 43 years of record. Winter release is 10 cfs. Deerfield finished the month 10.0 feet from full.

March EOM elevation and March inflow, at Deerfield Reservoir, were below average. Winter release is 10 cfs. Deerfield finished the month 10.2 feet from full. Mechanical CFR completed on March 29th.

April EOM elevation, at Deerfield Reservoir, was much below average. April inflow was below average. Emergency Management/Security orientation was completed on April 6th. Release changed from 10 cfs to 8 cfs. Deerfield finished the month 9.1 feet from full.

May EOM elevation and May inflow, at Deerfield Reservoir, were below average. Civil CFR completed May 4th. Release is 8 cfs. Deerfield finished the month 7.8 feet from full.

June EOM elevation, at Deerfield Reservoir, was below average. June inflow was much below average. Release is 8 cfs. Deerfield finished the month 7.9 feet from full.

July EOM elevation, at Deerfield Reservoir, was below average. July inflow was 4th lowest in 53 years of record. Release is 8 cfs. Deerfield finished the month 8.4 feet from full.

August EOM elevation, at Deerfield Reservoir, was below average. August inflow was 5th lowest in 53 years of record. Release is 8 cfs. Deerfield finished the month 9.0 feet from full.

September EOM elevation and September inflow, at Deerfield Reservoir, were below average. Release is 8 cfs. Deerfield finished the month 9.2 feet from full.

Additional statistical information on Deerfield Reservoir and its operations during 2006 can be found on Table DKT6 and Figure DKG5.

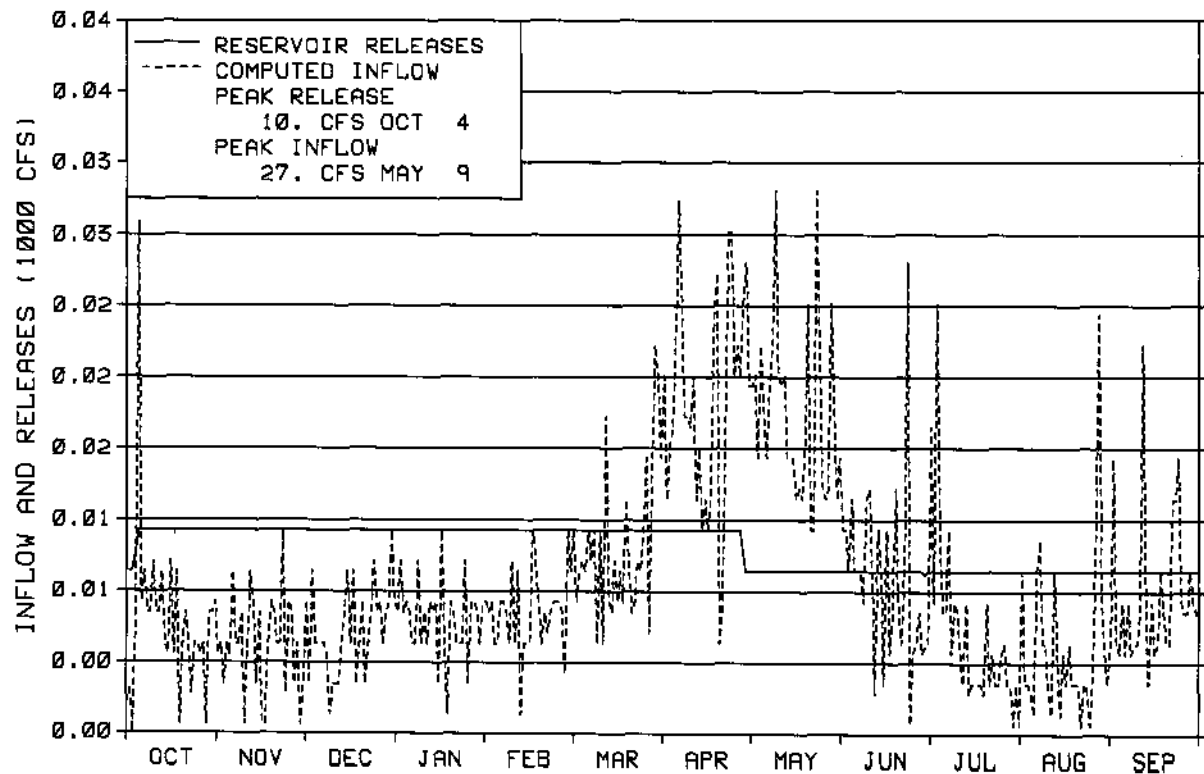
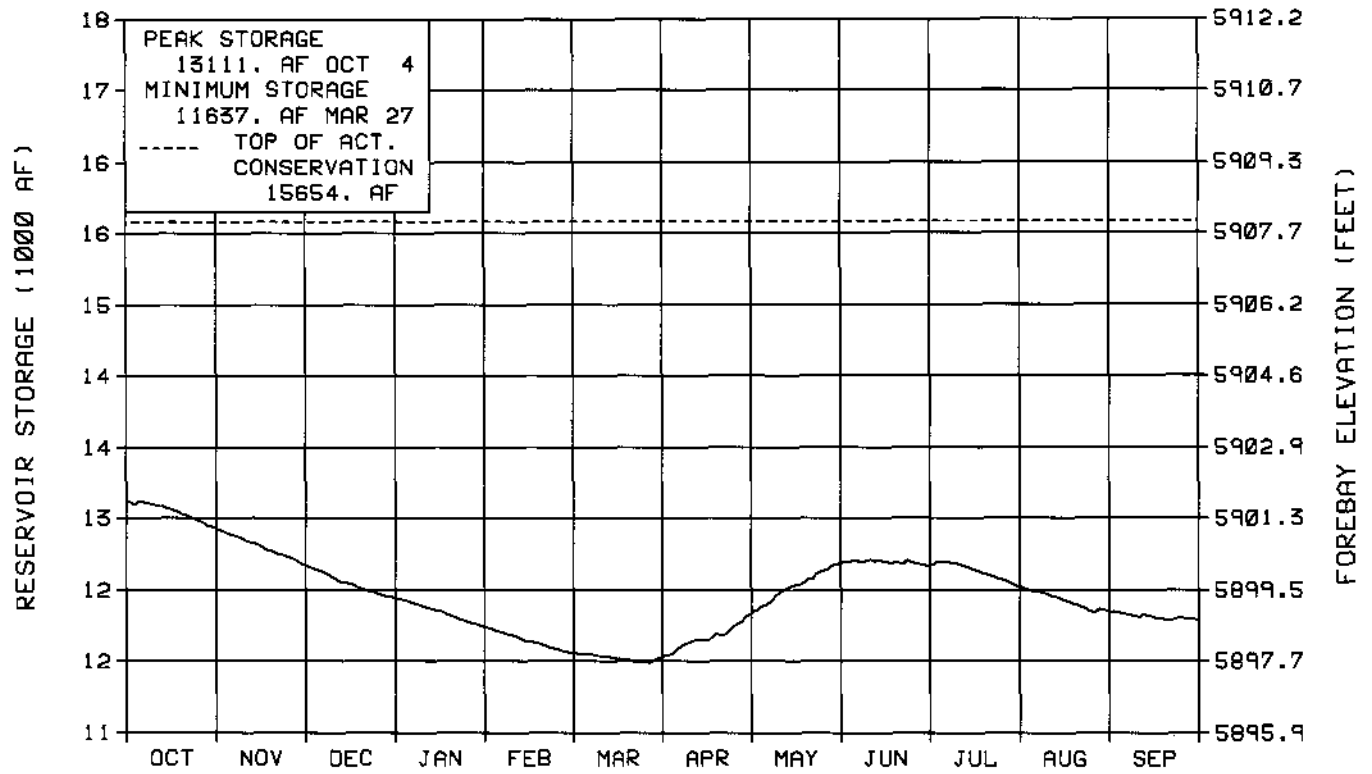
TABLE DKT6  
HYDROLOGIC DATA FOR 2006  
DEERFIELD RESERVOIR

| RESERVOIR ALLOCATIONS          | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |               |
|--------------------------------|---------------------|------------------------------------|-------------------------------|---------------|
| TOP OF INACTIVE AND DEAD       | 5,839.00            | 151                                | 151                           |               |
| TOP OF ACTIVE CONSERVATION     | 5,908.00            | 15,654                             | 15,503                        |               |
| TOP OF JOINT USE               |                     |                                    |                               |               |
| TOP OF EXCLUSIVE FLOOD CONTROL |                     |                                    |                               |               |
|                                |                     |                                    |                               |               |
| STORAGE-ELEVATION DATA         | ELEVATION (FT)      | STORAGE (AF)                       | DATE                          |               |
| BEGINNING OF YEAR              | 5,901.69            | 13,115                             | OCT 01, 2005                  |               |
| END OF YEAR                    | 5,898.79            | 12,028                             | SEP 30, 2006                  |               |
| ANNUAL LOW                     | 5,897.71            | 11,637                             | MAR 27, 2006                  |               |
| ANNUAL HIGH                    | 5,901.68            | 13,111                             | OCT 04, 2005                  |               |
| HISTORIC HIGH                  | 5,909.05            | 16,157                             | FEB 25, 1985                  |               |
|                                |                     |                                    |                               |               |
| INFLOW-OUTFLOW DATA            | INFLOW              | DATE                               | OUTFLOW                       | DATE          |
| ANNUAL TOTAL (AF)              | 5,525               | OCT 05-SEP 06                      | 6,612                         | OCT 05-SEP06  |
| DAILY PEAK (CFS)               | 27                  | MAY 09, 2006                       | 10                            | OCT 05-APR 06 |
| DAILY MINIMUM (CFS)            | 0                   | *                                  | 8                             | APR-SEPT 06   |

| MONTH      | INFLOW |          | OUTFLOW |          | CONTENT |          |
|------------|--------|----------|---------|----------|---------|----------|
|            | AF     | % OF AVG | AF      | % OF AVG | AF      | % OF AVG |
| OCTOBER    | 345    | 52       | 605     | 79       | 12,855  | 104      |
| NOVEMBER   | 264    | 44       | 595     | 178      | 12,524  | 100      |
| DECEMBER   | 314    | 50       | 615     | 214      | 12,223  | 95       |
| JANUARY    | 347    | 56       | 615     | 214      | 11,955  | 90       |
| FEBRUARY   | 330    | 57       | 555     | 184      | 11,730  | 87       |
| MARCH      | 568    | 65       | 615     | 105      | 11,683  | 85       |
| APRIL      | 978    | 82       | 585     | 55       | 12,076  | 86       |
| MAY        | 962    | 72       | 492     | 113      | 12,546  | 90       |
| JUNE       | 447    | 37       | 476     | 38       | 12,517  | 90       |
| JULY       | 302    | 36       | 492     | 43       | 12,327  | 90       |
| AUGUST     | 263    | 39       | 492     | 39       | 12,098  | 93       |
| SEPTEMBER  | 406    | 67       | 476     | 39       | 12,028  | 97       |
| ANNUAL     | 5,525  | 57       | 6,612   | 68       |         |          |
| APRIL-JULY | 2,689  | 59       |         |          |         |          |

\* Frequently observed during fall and winter months

FIGURE DKG5  
DEERFIELD RESERVOIR



WATER YEAR 2006

# **PACTOLA RESERVOIR**

## **BACKGROUND**

Pactola Reservoir, Rapid Valley Unit (P-S MBP), located on Rapid Creek above Rapid City, South Dakota, acts in conjunction with Deerfield Reservoir, Rapid Valley Project, to furnish a supplemental irrigation supply to about 8,900 acres in the Rapid Valley Water Conservancy District, replacement water for Rapid City, and a supply of domestic water for private water systems both above and below the city. The reservoir is also operated to provide flood control. It has a conservation capacity of 55,972 acre-feet (54,955 acre-feet active) and 43,057 acre-feet of exclusive flood control space. The flood control space is all below the ungated spillway crest, and releases in this pool are controlled by the river outlet works. Rapid City has contracts for Pactola and Deerfield Reservoir water. The Rapid Valley Sanitation District and C&J Sanders Water Company also have contracts for water service from Pactola Reservoir. Operation of the two reservoirs is integrated to maintain as much water as possible in the upstream facility, Deerfield Reservoir, and at the same time maintain a uniform outflow from Deerfield to maximize fishery benefits in the stream between the reservoirs. Since no inflow forecasts are available, the reservoir is normally operated as full as possible. Two Snowtel (North Rapid Creek and Blind Park) sites were installed in the Pactola and Deerfield drainage basin in May of 1990.

As part of the Safety Examination of Existing Structures (Safety of Dams) Program, a study was made in the early 1980's to determine the adequacy of Pactola Dam, Spillway, and Reservoir to safely pass the new Inflow Design Flood (IDF) determined on the basis of present day hydrologic technology. The studies showed that the facility was not able to safely handle the new IDF. Modification work was completed in 1987 and provided sufficient surcharge storage and spillway capacity to pass the IDF. Modification work consisted of raising the crest of the dam 15 feet, widening the existing rock-cut spillway chute and stilling basin from 240 feet to 425 feet, relocating Highway 385 to the new dam crest, extending the existing gate access shaft to the higher crest elevation, and reconstructing a new two-level gate control house at the higher crest elevation.

## **WY 2006 OPERATIONS SUMMARY**

Storage in Pactola Reservoir at the beginning of the year was 36,131 acre-feet at elevation 4553.28, which is 19,841 acre-feet and 26.92 feet below the top of the conservation pool. The inflows for WY 2006 totaled 18,755 acre-feet (53 % of average).

The water year maximum storage of 41,463 acre-feet occurred on June 2, 2006 and the annual minimum storage of 32,155 acre-feet occurred on September 21, 2006. At the end of WY 2006, storage was 32,296 acre-feet at elevation 4546.97 ft, 23,676 acre-feet and 33.23 ft below the top of the conservation pool.

The City of Rapid City ordered 3,451 acre-feet from Pactola to meet needs over and above natural flow releases required to meet prior rights in Rapid Creek during the summer of 2006. The operation of Pactola Reservoir provided minimal local and mainstream flood relief during WY 2006.

The flood plain through Rapid City is designed to pass 6,500 cfs without major property damage, but some areas of the bicycle path near Canyon Lake will inundate at 350 to 400 cfs. Spring releases from Pactola Dam peaked at 107 cfs on July 1.

An Emergency Management/Security orientation was conducted on April 6, 2006.

A mechanical Comprehensive Facility Review (CFR) was conducted March 29, 2006 and a civil CFR on May 3, 2006 by personnel from the TSC, GPRO, DKAO, and the RCFO.

## MONTHLY STATISTICS FOR WY 2006

October EOM elevation and October inflow, at Pactola Reservoir, were below average. Winter release is 18 cfs. Pactola ended the month 27.0 feet from full.

November EOM elevation and November inflow, at Pactola Reservoir, were below average. Winter release is 18 cfs. Pactola ended the month 26.9 feet from full.

December EOM elevation and December inflow, at Pactola Reservoir, were below average. Winter release is 18 cfs. Pactola ended the month 26.9 feet from full.

January EOM elevation and January inflow, at Pactola Reservoir, were below average. Winter release is 18 cfs. Pactola ended the month 26.6 feet from full.

February EOM elevation, at Pactola Reservoir, was much below average. February inflow was below average. Winter release is 18 cfs. Pactola ended the month 26.3 feet from full.

March EOM elevation and March inflow, at Pactola Reservoir, were below average. Winter release is 18 cfs. Pactola ended the month 24.9 feet from full. Mechanical CFR completed on March 29th.

April EOM elevation and April inflow, at Pactola Reservoir, were below average. Emergency Management/Security orientation was completed on April 6<sup>th</sup>. Winter release is 18 cfs. Pactola ended the month 21.4 feet from full.

May EOM elevation and May inflow, at Pactola Reservoir, were below average. Civil CFR completed May 3<sup>rd</sup>. Release is 47 cfs. Pactola ended the month 18.9 feet from full.

June EOM elevation and June inflow, at Pactola Reservoir, were much below average. Release is 101 cfs. Pactola ended the month 21.5 feet from full.

July EOM elevation, at Pactola Reservoir, was much below average. July inflow was the lowest since the reservoir was constructed in 1956. Release is 69 cfs. Pactola ended the month 28.5 feet from full.

August EOM elevation, at Pactola Reservoir, was much below average. August inflow was lowest August inflow since reservoir was constructed in 1956. Release is 69 cfs. Pactola ended the month 32.9 feet from full.

September EOM elevation and September inflow, at Pactola Reservoir, were much below average. Winter release set at 16cfs. Pactola ended the month 33.2 feet from full.

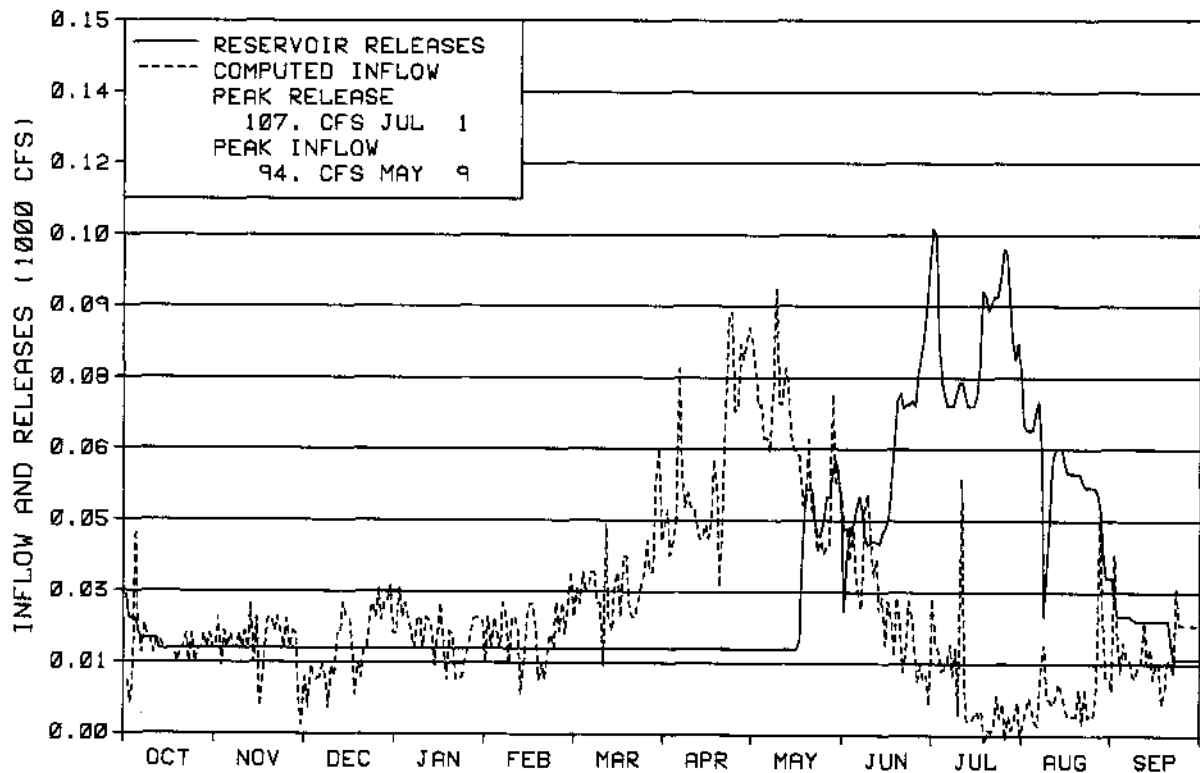
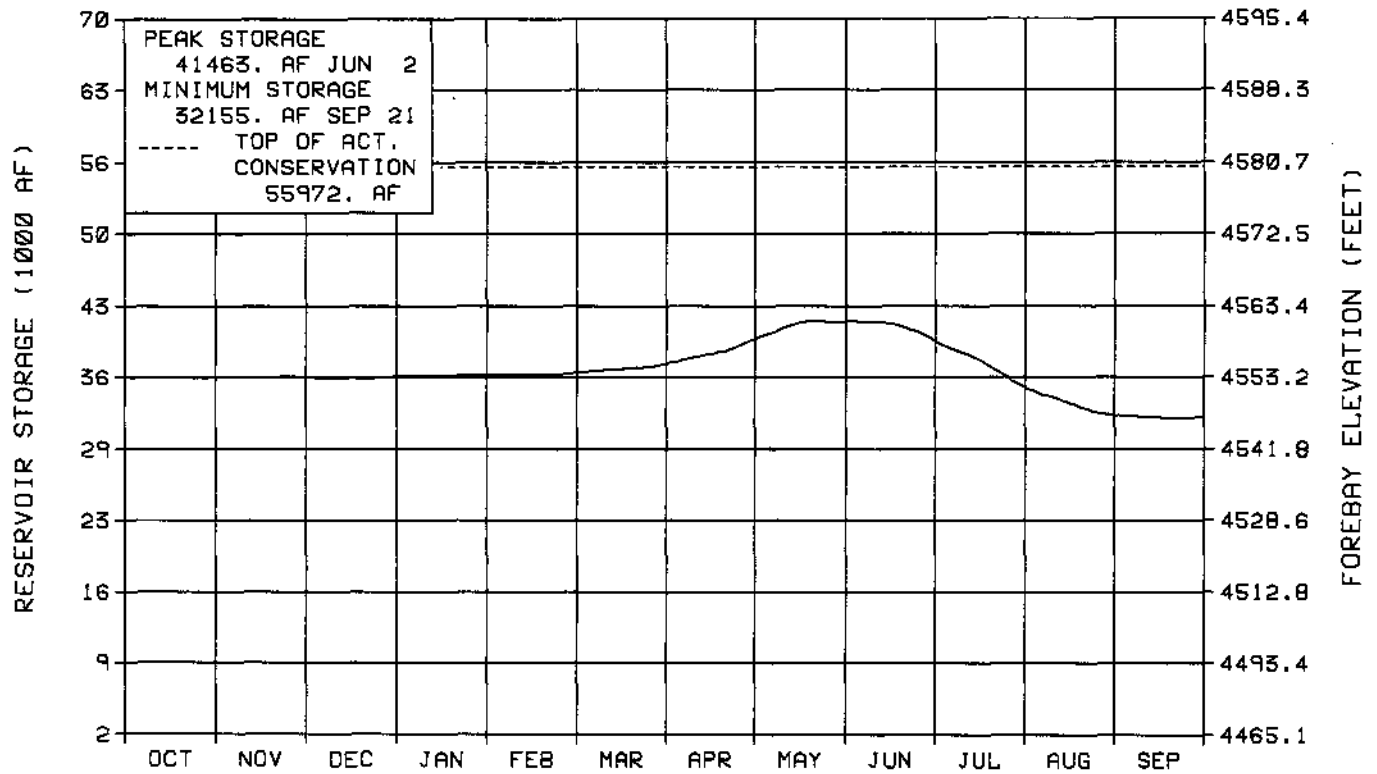
Additional statistical information on Pactola Reservoir and its operations during 2006 can be found on Table DKT7 and Figure DKG6.



TABLE DKT7  
HYDROLOGIC DATA FOR 2006  
PACTOLA RESERVOIR

| RESERVOIR ALLOCATIONS          |           | ELEVATION<br>(FEET) |               | TOTAL<br>RESERVOIR<br>STORAGE (AF) |          | STORAGE<br>ALLOCATION<br>(AF) |          |
|--------------------------------|-----------|---------------------|---------------|------------------------------------|----------|-------------------------------|----------|
| TOP OF INACTIVE AND DEAD       |           | 4,456.10            |               | 1,017                              |          | 1,017                         |          |
| TOP OF ACTIVE CONSERVATION     |           | 4,580.20            |               | 55,972                             |          | 54,955                        |          |
| TOP OF JOINT USE               |           |                     |               |                                    |          |                               |          |
| TOP OF EXCLUSIVE FLOOD CONTROL |           | 4,621.50            |               | 99,029                             |          | 43,057                        |          |
|                                |           |                     |               |                                    |          |                               |          |
| STORAGE-ELEVATION DATA         |           | ELEVATION (FT)      |               | STORAGE (AF)                       |          | DATE                          |          |
| BEGINNING OF YEAR              |           | 4,553.28            |               | 36,131                             |          | OCT 01, 2005                  |          |
| END OF YEAR                    |           | 4,546.97            |               | 32,296                             |          | SEP 30, 2006                  |          |
| ANNUAL LOW                     |           | 4,546.73            |               | 32,155                             |          | SEP 21, 2006                  |          |
| ANNUAL HIGH                    |           | 4,561.34            |               | 41,463                             |          | JUN 02, 2006                  |          |
| HISTORIC HIGH                  |           | 4,585.87            |               | 61,105                             |          | MAY 19, 1965                  |          |
|                                |           |                     |               |                                    |          |                               |          |
| INFLOW-OUTFLOW DATA            |           | INFLOW              | DATE          |                                    | OUTFLOW  | DATE                          |          |
| ANNUAL TOTAL (AF)              |           | 18,755              | OCT 05-SEP 06 |                                    | 22,593   | OCT 05-SEP 06                 |          |
| DAILY PEAK (CFS)               |           | 94                  | MAY 09, 2006  |                                    | 107      | JUL 01, 2006                  |          |
| DAILY MINIMUM (CFS)            |           | 0                   | JUL-SEP, 2006 |                                    | 16       | OCT 06                        |          |
|                                |           |                     |               |                                    |          |                               |          |
|                                | MONTH     | INFLOW              |               | OUTFLOW                            |          | CONTENT                       |          |
|                                |           | AF                  | % OF AVG      | AF                                 | % OF AVG | AF                            | % OF AVG |
|                                | OCTOBER   | 1,141               | 55            | 1,193                              | 72       | 36,081                        | 81       |
|                                | NOVEMBER  | 1,109               | 74            | 1,071                              | 79       | 36,119                        | 80       |
|                                | DECEMBER  | 1,151               | 91            | 1,107                              | 80       | 36,163                        | 81       |
|                                | JANUARY   | 1,278               | 97            | 1,107                              | 84       | 36,334                        | 81       |
|                                | FEBRUARY  | 1,183               | 88            | 1,000                              | 83       | 36,518                        | 81       |
|                                | MARCH     | 1,991               | 84            | 1,107                              | 64       | 37,402                        | 82       |
|                                | APRIL     | 3,372               | 80            | 1,071                              | 38       | 39,703                        | 85       |
|                                | MAY       | 3,679               | 57            | 1,967                              | 36       | 41,415                        | 86       |
|                                | JUNE      | 1,629               | 24            | 3,381                              | 56       | 39,663                        | 82       |
|                                | JULY      | 570                 | 16            | 5,070                              | 97       | 35,163                        | 75       |
|                                | AUGUST    | 559                 | 21            | 3,238                              | 80       | 32,484                        | 73       |
|                                | SEPTEMBER | 1,093               | 49            | 1,281                              | 48       | 32,296                        | 73       |
| ANNUAL                         | 18,755    | 53                  | 22,593        | 66                                 |          |                               |          |
| APRIL-JULY                     | 9,250     | 45                  |               |                                    |          |                               |          |

FIGURE DKG6  
PACTOLA RESERVOIR



WATER YEAR 2006

# ANGOSTURA RESERVOIR

## BACKGROUND

Angostura Reservoir (P-S MBP), located on the Cheyenne River above Hot Springs, South Dakota, was built to service about 12,200 acres in the Angostura Unit (P-S MBP) and for power generation. It has a total capacity of 123,048 acre-feet with an additional surcharge capacity of 57,308 acre-feet.

Its principle use is for irrigation of the Angostura Unit, which diverts its water from a high-level outlet at the dam. In the early years, water surplus to irrigation needs was released to the river through a small power plant with a nameplate capacity of 1,200 kilowatts. Because of the low runoff, and because actual irrigation diversions were higher than previously anticipated, it was concluded that continued operation of the power plant was economically infeasible. Except for a few operations of less than 24 hours each, the plant was last operated in February 1959. In 1966, the plant was officially closed and the equipment was declared surplus in March 1968. Disposal of this equipment was completed in 1971. Releases for irrigation are made through the canal outlet works into the Angostura Main Canal having a design capacity of 290 cfs. Releases to the Cheyenne River are only made when the reservoir is assured of filling.

## WY 2006 OPERATIONS SUMMARY

Angostura began WY 2006 at an elevation of 3166.70 ft. and storage of 51,215 acre-feet. Total inflows for the water year were 15,803 acre-feet (20 % of average). Peak inflows occurred in March, totaling 3,814 acre-feet for the month.

Water users were allocated 45% of their full allotments of project water. Releases for irrigation began May 24 and reached a peak of 198 cfs on June 29. The irrigation release was terminated on August 25, with 43,275 acre-feet in total storage and 1,070 acre-feet in active storage. Total irrigation releases were 23,264 acre-feet. Storage on September 30, 2006 was 43,815 acre-feet at elevation 3163.69, which is 79,233 acre-feet and 23.51 ft below the top of conservation pool.

Reclamation's Sedimentation and River Hydraulics Group of the Technical Service Center in Denver conducted a sedimentation survey of Angostura Reservoir in 2004 and provided a survey report and new Area and Capacity Tables in August of 2005. The last survey was done in 1979. Angostura Reservoir accumulated 7,716 acre-feet of sediment since the last survey. Since construction in 1949, Angostura has accumulated 36,867 acre-feet of sediment. The sedimentation rate from 1949 through 2004 has averaged 670 acre-feet per year. The new Area and Capacity Tables were used, beginning, in WY 2006 and all 2006 numbers reflect the change in capacity.

Annual Emergency Management/Security orientation was conducted on April 4, 2006.

A mechanical Comprehensive Facility Review (CFR) was conducted April 11, 2006 and a civil CFR on May 9, 2006 by personnel from the TSC, GPRO, DKAO and RCFO.

## MONTHLY STATISTICS FOR WATER YEAR 2006

October end-of-month (EOM) elevation, at Angostura Reservoir, was 4<sup>th</sup> lowest in 54 years of record. October inflow was below average. Angostura ended the month 19.9 feet from full.

November end-of-month (EOM) elevation, at Angostura Reservoir, was 4<sup>th</sup> lowest in 54 years of record. November inflow was below average. Angostura ended the month 19.5 feet from full.

December end-of-month (EOM) elevation, at Angostura Reservoir, was 4<sup>th</sup> lowest in 54 years of record. December inflow was slightly below average. Angostura ended the month 18.8 feet from full.

January end-of-month (EOM) elevation, at Angostura Reservoir, was 5<sup>th</sup> lowest in 54 years of record. January inflow was slightly above average. Angostura ended the month 17.9 feet from full.

February end-of-month (EOM) elevation, at Angostura Reservoir, was 5<sup>th</sup> lowest in 54 years of record. February inflow was below average. Angostura ended the month 17.2 feet from full.

March end-of-month (EOM) elevation, at Angostura Reservoir, was 5<sup>th</sup> lowest in 54 years of record. March inflow was below average. Angostura ended the month 15.9 feet from full.

April end-of-month (EOM) elevation, at Angostura Reservoir, was 5<sup>th</sup> lowest in 54 years of record. April inflow was below average. Emergency Management/Security orientation was completed on April 4<sup>th</sup>. Mechanical CFR completed on April 11<sup>th</sup>. Angostura ended the month 15.3 feet from full.

May end-of-month (EOM) elevation, at Angostura Reservoir, was 3<sup>rd</sup> lowest in 54 years of record. May inflow was much below average. Civil CFR completed on May 9<sup>th</sup>. Began filling the canal on May 24<sup>th</sup>. Angostura ended the month 15.6 feet from full.

June end-of-month (EOM) elevation, at Angostura Reservoir, was 2<sup>nd</sup> lowest in 54 years of record. June inflow was below average. Angostura ended the month 18.3 feet from full.

July end-of-month (EOM) elevation, at Angostura Reservoir, was 2<sup>nd</sup> lowest in 54 years of record. July inflow was much below average. Angostura ended the month 21.8 feet from full.

August end-of-month (EOM) elevation, at Angostura Reservoir, was lowest August elevation since the reservoir was constructed in 1952. August inflow was below average. Irrigation releases ended on August 25<sup>th</sup>. Angostura ended the month 23.6 feet from full.

September end-of-month (EOM) elevation, at Angostura Reservoir, was 3<sup>rd</sup> lowest in 54 years of record. September inflow was below average. Angostura ended the month 23.5 feet from full.

Additional statistical information on Angostura Reservoir and its operations during 2006 can be found on Table DKT8 and Figure DKG7.

TABLE DKT8  
HYDROLOGIC DATA FOR 2006  
ANGOSTURA RESERVOIR

| RESERVOIR ALLOCATIONS          | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |
|--------------------------------|---------------------|------------------------------------|-------------------------------|
| TOP OF INACTIVE AND DEAD       | 3,163.00            | 42,205                             | 42,205                        |
| TOP OF ACTIVE CONSERVATION     | 3,187.20            | 123,048                            | 80,843                        |
| TOP OF JOINT USE               |                     |                                    |                               |
| TOP OF EXCLUSIVE FLOOD CONTROL |                     |                                    |                               |

| STORAGE-ELEVATION DATA | ELEVATION (FT) | STORAGE (AF) | DATE         |
|------------------------|----------------|--------------|--------------|
| BEGINNING OF YEAR      | 3,166.70       | 57,779       | OCT 01, 2005 |
| END OF YEAR            | 3,163.69       | 43,815       | SEP 30, 2006 |
| ANNUAL LOW             | 3,163.46       | 43,275       | AUG 25, 2006 |
| ANNUAL HIGH            | 3,172.07       | 66,011       | MAY 22, 2006 |
| HISTORIC HIGH          | 3,189.37       | **152,228    | MAY 20, 1978 |

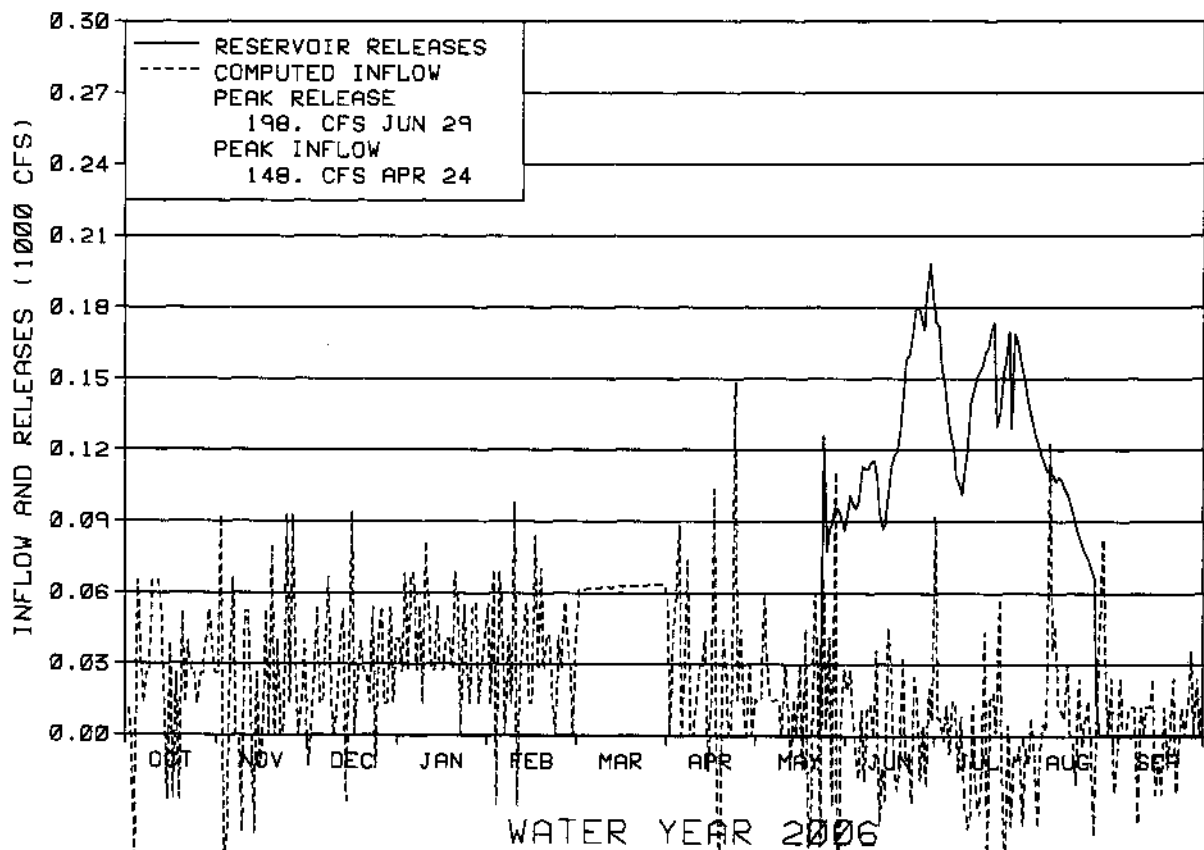
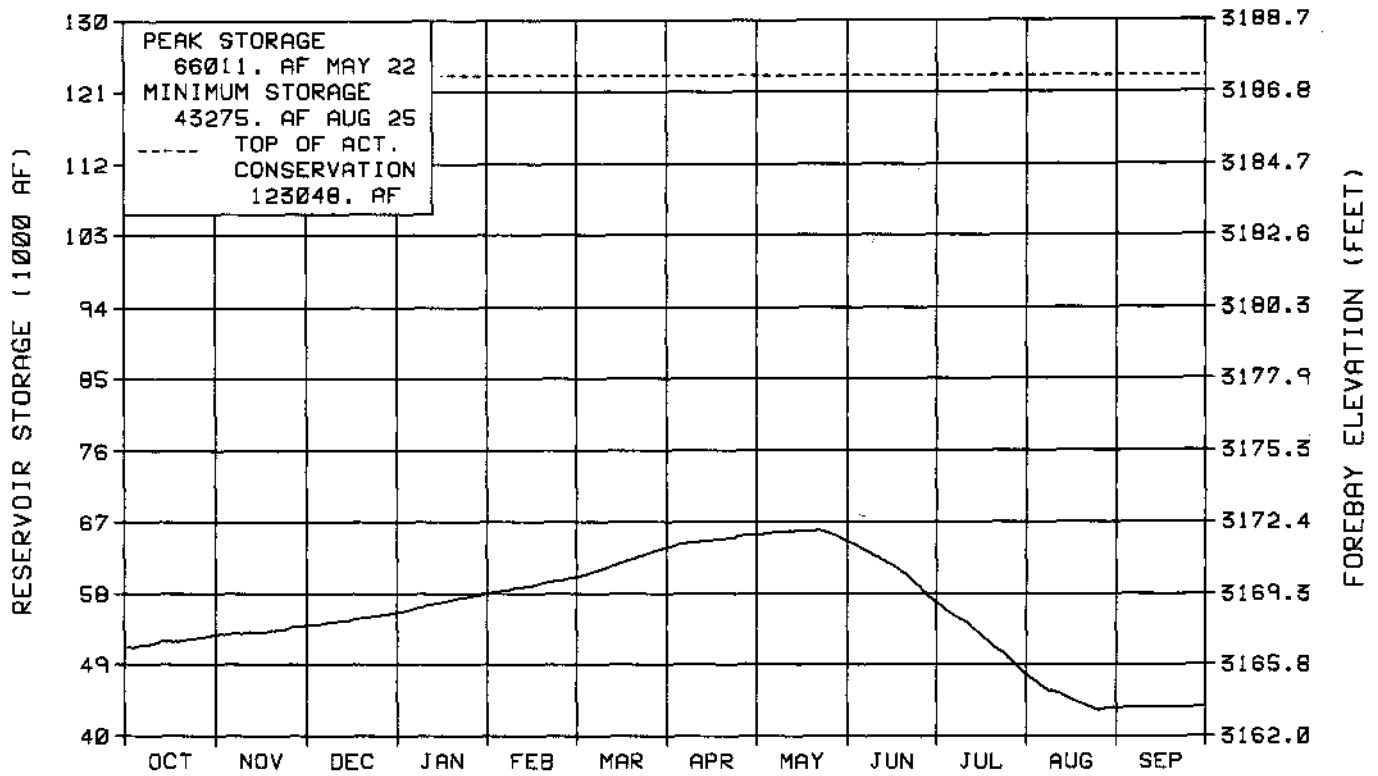
| INFLOW-OUTFLOW DATA | INFLOW | DATE          | OUTFLOW | DATE          |
|---------------------|--------|---------------|---------|---------------|
| ANNUAL TOTAL (AF)   | 15,803 | OCT 05-SEP 06 | 23,202  | OCT 05-SEP 06 |
| DAILY PEAK (CFS)    | 148    | APR 24, 2006  | 198     | JUN 29, 2006  |
| DAILY MINIMUM (CFS) | 0      | *             | 0       | *             |

| MONTH      | INFLOW |          | OUTFLOW |          | CONTENT |          |
|------------|--------|----------|---------|----------|---------|----------|
|            | AF     | % OF AVG | AF      | % OF AVG | AF      | % OF AVG |
| OCTOBER    | 1,553  | 94       | 0       | NA       | 52,767  | 52       |
| NOVEMBER   | 1,155  | 51       | 0       | NA       | 53,922  | 53       |
| DECEMBER   | 1,733  | 97       | 3       | 1        | 55,652  | 54       |
| JANUARY    | 2,473  | 119      | 4       | 1        | 58,121  | 55       |
| FEBRUARY   | 1,856  | 41       | 3       | 0        | 59,974  | 55       |
| MARCH      | 3,814  | 33       | 4       | 0        | 63,784  | 55       |
| APRIL      | 1,613  | 20       | 6       | 0        | 65,391  | 54       |
| MAY        | 786    | 4        | 1,490   | 11       | 64,687  | 52       |
| JUNE       | 91     | 0        | 7,776   | 39       | 57,002  | 46       |
| JULY       | -211   | NA       | 8,951   | 55       | 47,840  | 41       |
| AUGUST     | 686    | 21       | 4,946   | 37       | 43,580  | 41       |
| SEPTEMBER  | 254    | 23       | 19      | 0        | 43,815  | 44       |
| ANNUAL     | 15,803 | 20       | 23,202  | 29       |         |          |
| APRIL-JULY | 2,965  | 54       |         |          |         |          |

\* Frequently observed during fall and winter months

\*\* Due to new area-capacity table, the capacity that corresponds to the new historic high elevation is less than a previous high capacity amount (169,020 AF @ Elevation 3189.0 on June 18, 1962)

FIGURE DKG7  
ANGOSTURA RESERVOIR



## KEYHOLE RESERVOIR

### BACKGROUND

Keyhole Reservoir (P-S MBP) located on the Belle Fourche River below Moorcroft, Wyoming, has a conservation capacity of 188,671 acre-feet (182,079 acre-feet active) and 140,463 acre-feet of exclusive flood control space. It was constructed to furnish a supplemental irrigation supply to 57,000 acres in the Belle Fourche Project and for flood control. Keyhole Reservoir is subject to the Belle Fourche River Compact, and the inflows and storage in the reservoir are allocated 10 percent to Wyoming users and 90 percent to South Dakota users, subject to prior rights. On January 3, 1963, the Belle Fourche Irrigation District executed a long-term contract for the use of 7.7 percent of active storage space in the reservoir. This space will be used to store water belonging to the irrigation district under its prior water right along with the District's pro rata share of storable inflows to Keyhole Reservoir. On January 1, 1985, the Crook County Irrigation District's contract for 18,080 acre-feet of space in Keyhole Reservoir became effective. The allocated space is used by each organization to store its pro rata share of inflows to Keyhole Reservoir. The flood control space at Keyhole Reservoir is all located above an ungated spillway. The spillway capacity is 11,000 cfs at maximum water surface elevation. The downstream safe channel capacity is 3,000 cfs. Formulas for forecasting inflows have not been developed. Research by the Soil Conservation Service during water years 1992 through 1994 show that inflow forecasting to Keyhole Reservoir is not reliable since there is no consistent snow pack and precipitation is highly cyclical. No further efforts to develop forecast models are planned.

### WY 2006 OPERATIONS SUMMARY

Keyhole reservoir started WY 2006 with an elevation of 4081.75 and storage of 72,613 acre feet. Inflows for WY 2006 totaled a negative 953 acre-feet. Average inflows for a water year are 16,171 acre-feet. On May 30, 2006, Keyhole reached its peak elevation for WY 2006 at elevation 4082.58, 16.72 feet below top of conservation.

Keyhole ended WY 2006 at an elevation of 4076.99 ft, with storage of 54,170 acre-feet, which is 22.31 feet and 134,501 acre-feet below top of conservation.

Irrigation releases began in June and continued through September with Crook County Irrigation District taking 432 acre-feet and the Belle Fourche Irrigation District ordering 16,809 acre-feet.

Reclamation's Sedimentation and River Hydraulics Group of the Technical Service Center in Denver conducted a sedimentation survey of Keyhole Reservoir in 2003 and provided a survey report and new area and capacity tables in July of 2005. The last survey was done in 1978. Keyhole Reservoir accumulated 5,082 acre-feet of sediment since the last survey. Since construction in 1952, Keyhole has accumulated 12,495 acre-feet of sediment. The sedimentation rate from 1952 through 2003 has averaged 240 acre-feet per year. The new Area and Capacity Tables were used, beginning, in WY 2006 and all 2006 numbers reflect the change in capacity.

An Emergency Management Tabletop exercise was held on May 11, 2006.

The Annual Facility Review was done on May 31, 2006 by personnel from the Rapid City Field Office.

## MONTHLY STATISTICS FOR WATER YEAR 2006

October EOM elevation, at Keyhole Reservoir, was above average. October inflow was above average. Keyhole finished the month 17.6 feet from full.

November EOM elevation, at Keyhole Reservoir, was above average. November inflow was above average. Keyhole finished the month 17.7 feet from full.

December EOM elevation, at Keyhole Reservoir, was above average. December inflow was above average. Keyhole finished the month 17.6 feet from full.

January EOM elevation, at Keyhole Reservoir, was above average. January inflow was below average. Keyhole finished the month 17.6 feet from full.

February EOM elevation, at Keyhole Reservoir, was above average. February inflow was below average. Keyhole finished the month 17.5 feet from full.

March EOM elevation, at Keyhole Reservoir, was above average. March inflow was much below average. Keyhole finished the month 17.4 feet from full.

April EOM elevation, at Keyhole Reservoir, was above average. April inflow was below average. Keyhole finished the month 17.1 feet from full.

May EOM elevation, at Keyhole Reservoir, was above average. May inflow was below average. Emergency Management Tabletop exercise held May 11<sup>th</sup>. Annual inspection was done on May 31<sup>st</sup>. Keyhole finished the month 16.8 feet from full.

June EOM elevation, at Keyhole Reservoir, was below average. June inflow was much below average. Began 75 cfs irrigation release to Belle Fourche Irrigation District on June 19<sup>th</sup>, increasing to 125 cfs on June 27<sup>th</sup>. Keyhole finished the month 17.6 feet from full.

July EOM elevation, at Keyhole Reservoir, was below average. July inflow was below average. Keyhole finished the month 19.9 feet from full.

August EOM elevation, at Keyhole Reservoir, was below average. August inflow was above average. Keyhole finished the month 22.1 feet from full. Irrigation release was set at 52 cfs.

September EOM elevation, at Keyhole Reservoir, was below average. September inflow was much above average. Keyhole finished the month 22.3 feet from full. Irrigation release ended September 5<sup>th</sup>.

Additional statistical information on Keyhole Reservoir and its operations during 2006 can be found on Table DKT9 and Figure DKG8.



Additional statistical information on Keyhole Reservoir and its operations during 2006 can be found on Table DKT9 and Figure DKG8.

TABLE DKT9  
HYDROLOGIC DATA FOR 2006  
KEYHOLE RESERVOIR

| RESERVOIR ALLOCATIONS          | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |
|--------------------------------|---------------------|------------------------------------|-------------------------------|
| TOP OF INACTIVE AND DEAD       | 4,051.00            | 6,592                              | 6,592                         |
| TOP OF ACTIVE CONSERVATION     | 4,099.30            | 188,671                            | 182,079                       |
| TOP OF JOINT USE               |                     |                                    |                               |
| TOP OF EXCLUSIVE FLOOD CONTROL | 4,111.50            | 329,134                            | 140,463                       |

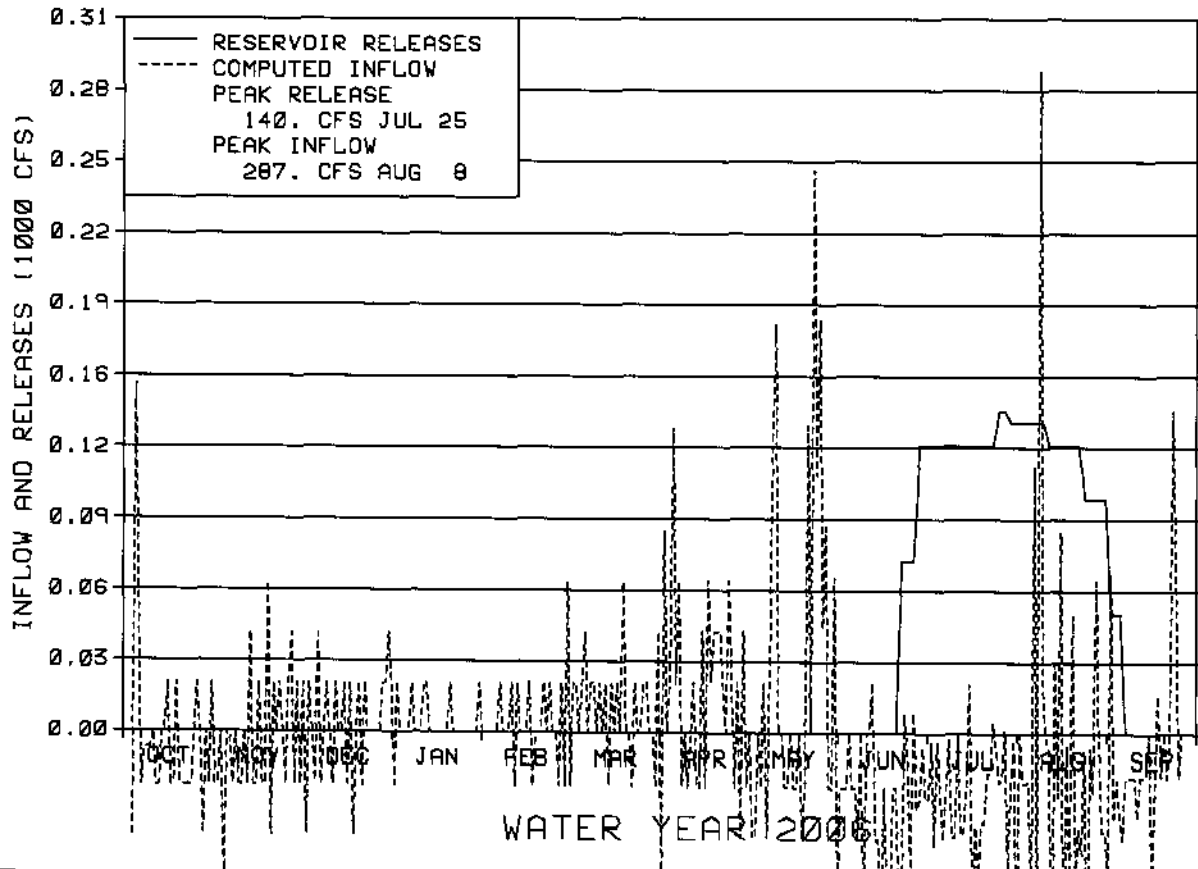
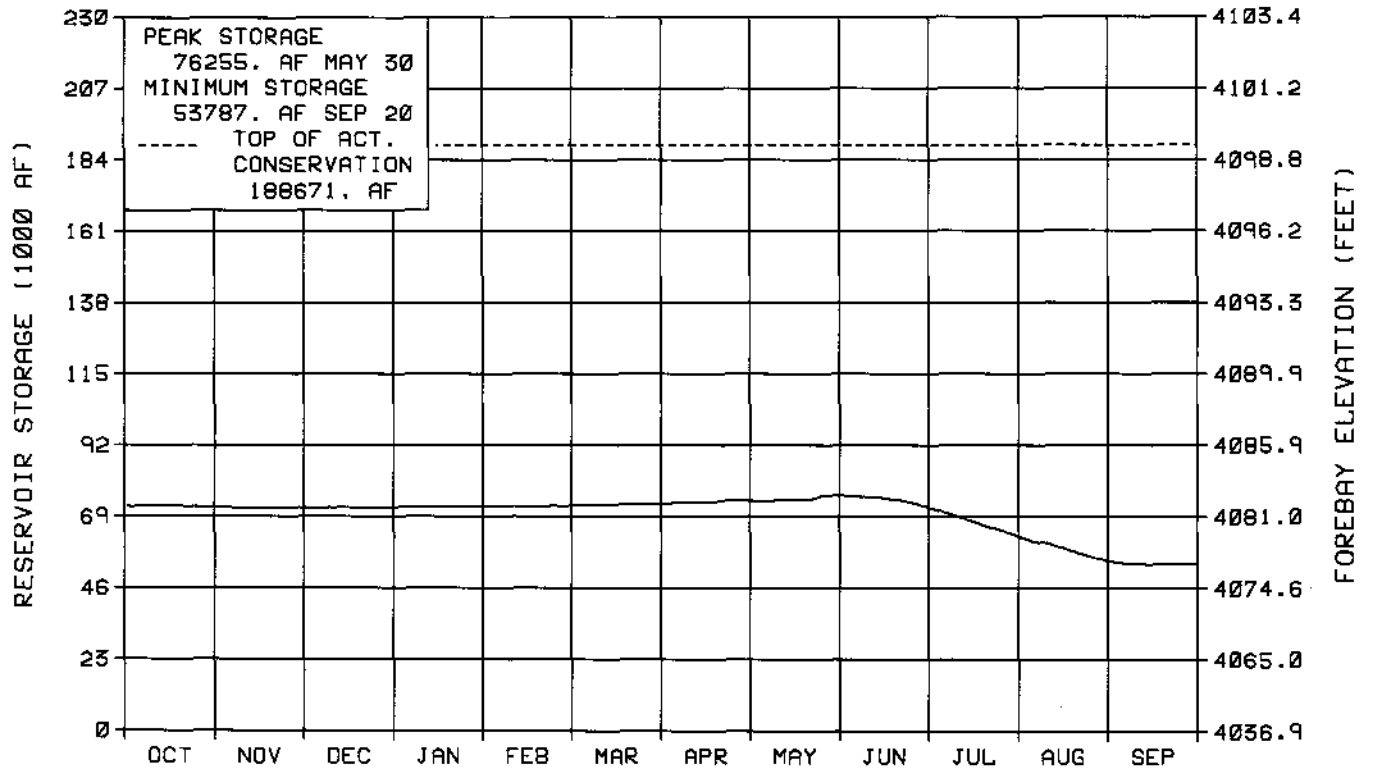
| STORAGE-ELEVATION DATA | ELEVATION (FT) | STORAGE (AF) | DATE         |
|------------------------|----------------|--------------|--------------|
| BEGINNING OF YEAR      | 4,081.75       | 77,138       | OCT 01, 2005 |
| END OF YEAR            | 4,076.99       | 54,170       | SEP 30, 2006 |
| ANNUAL LOW             | 4,076.88       | 53,787       | SEP 20, 2006 |
| ANNUAL HIGH            | 4,082.58       | 76,255       | MAY 30, 2006 |
| HISTORIC HIGH          | 4,100.38       | 210,222      | MAY 21, 1978 |

| INFLOW-OUTFLOW DATA | INFLOW | DATE          | OUTFLOW | DATE          |
|---------------------|--------|---------------|---------|---------------|
| ANNUAL TOTAL (AF)   | -953   | OCT 05-SEP 06 | 17,490  | OCT 05-SEP 06 |
| DAILY PEAK (CFS)    | 287    | AUG 08, 2006  | 140     | JUL 25, 2006  |
| DAILY MINIMUM (CFS) | 0      | *             | 0       | *             |

| MONTH      | INFLOW |          | OUTFLOW |          | CONTENT |          |
|------------|--------|----------|---------|----------|---------|----------|
|            | AF     | % OF AVG | AF      | % OF AVG | AF      | % OF AVG |
| OCTOBER    | -301   | NA       | 0       | NA       | 72,312  | 82       |
| NOVEMBER   | -171   | NA       | 0       | NA       | 72,141  | 82       |
| DECEMBER   | 171    | 144      | 0       | NA       | 72,312  | 82       |
| JANUARY    | 258    | 57       | 0       | NA       | 72,570  | 82       |
| FEBRUARY   | 259    | 9        | 0       | NA       | 72,829  | 80       |
| MARCH      | 649    | 9        | 0       | NA       | 73,478  | 75       |
| APRIL      | 1,048  | 41       | 0       | NA       | 74,526  | 76       |
| MAY        | 1,595  | 35       | 0       | NA       | 76,121  | 76       |
| JUNE       | -1,791 | NA       | 1,760   | 85       | 72,570  | 71       |
| JULY       | -1,699 | NA       | 7,874   | 188      | 62,997  | 65       |
| AUGUST     | -700   | NA       | 7,391   | 190      | 54,906  | 60       |
| SEPTEMBER  | -272   | NA       | 464     | 59       | 54,170  | 61       |
| ANNUAL     | -953   | NA       | 17,490  | 118      |         |          |
| APRIL-JULY | -847   | NA       |         |          |         |          |

Frequently observed during fall and winter months

FIGURE DKG8  
KEYHOLE RESERVOIR



## SHADEHILL RESERVOIR

### BACKGROUND

Shadehill Reservoir, a feature of the Shadehill Unit (P-S MBP), is located on the Grand River near Shadehill, South Dakota, and was constructed for irrigation of 9,700 acres, and for flood control, recreation, and fish and wildlife purposes. The reservoir has a dead and conservation capacity totaling 120,172 acre-feet with an additional exclusive flood control capacity of 230,004 acre-feet and a surcharge capacity of 119,560 acre-feet. Flood control space is all located above the crest of an un-gated glory-hole spillway. Because of the questionable quality of water, it was decided to postpone construction of distribution works for irrigation.

After further study, it was concluded that water from Shadehill Reservoir can be used for sustained irrigation if certain limitations of soils, leaching water, soil amendments, and drainage are met. A definite plan report covering 6,700 acres which meets these limitations has been completed, approved by the Commissioner, and released for distribution. On December 17, 1963, landowners within the area voted 24 to 21 against formation of an irrigation district. Further action on development of the area was deferred until the attitude of the landowners was more favorable. Pending more extensive irrigation development, an additional 51,500 acre-feet of space between elevations 2260 and 2272 was allocated to flood control. Allocations and evacuation of this space was made possible by modification of the outlet works in 1969 to permit a discharge of 600 cfs to the river. In June of 1975, the West River Conservancy Sub-District was formed combining all but one of the old individual contracts for water supply from the reservoir into one. Acreage contracted for by the District was 5,000 acres; however, only 3,064 acres were developed. On March 18, 1986, the contract between Reclamation and the West River Conservancy Sub-District was assigned to the Shadehill Water User District, an organization, which succeeded the Sub-District under South Dakota law. This contract has expired and presently conservation releases are meeting irrigation demands. Should irrigation releases be required a temporary water service contract will need to be executed with the Shadehill Water User District.

Because certain release criteria reduced the effectiveness of flood control operations in the zone between elevation 2260 and 2272, and because the Corps of Engineers has constructed Bowman Haley Reservoir upstream from Shadehill Reservoir with 53,800 acre-feet of flood control space, the Corps requested that the interim flood control agreement be terminated and that responsibility for the operations of Shadehill Reservoir when the pool is between elevations 2260 and 2272 revert to Reclamation. By a revised field working agreement dated May 15, 1972, it was agreed that the space between elevation 2260 and 2272 (51,500 acre-feet) be reallocated to conservation use. However, space below elevation 2272 will continue to be evacuated before the start of the spring runoff, but to a lesser extent than in the past.

## WY 2006 OPERATIONS SUMMARY

Shadehill reservoir began WY 2006 at elevation 2263.23 ft with storage of 81,365 acre-feet. The peak reservoir water elevation occurred on May 15, with an elevation of 2265.84 ft.

Inflows for the water year were 15,257 acre-feet, which was 22% of average. Shadehill ended the water year at elevation 2263.16 ft with storage of 81,099 acre-feet.

All project irrigation demands were met from river maintenance releases. There were no storage releases for irrigation needed during water year 2006.

An Emergency Management/Security orientation was conducted on May 3, 2006.

Annual inspection was done on June 15, 2006 by personnel from the Rapid City Field Office.

## MONTHLY STATISTICS FOR WATER YEAR 2006

October EOM elevation and October inflow, at Shadehill Reservoir, were below average. Controlled release at 21 cfs. Shadehill finished the month 9.0 feet below top of conservation.

November EOM elevation and November inflow, at Shadehill Reservoir, were much below average. Controlled release at 21 cfs. Shadehill finished the month 9.4 feet below top of conservation.

December EOM elevation and December inflow, at Shadehill Reservoir, were much below average. Controlled release at 20 cfs. Shadehill finished the month 9.8 feet below top of conservation.

January EOM elevation, at Shadehill Reservoir, was much below average. January inflow was much above average. Controlled release at 20 cfs. Shadehill finished the month 9.7 feet below top of conservation.

February EOM elevation, at Shadehill Reservoir, was below average. February inflow was below average. Controlled release at 20 cfs. Shadehill finished the month 9.7 feet below top of conservation.

March EOM elevation, at Shadehill Reservoir, was much below average. March inflow was below average. Controlled release at 20 cfs. Shadehill finished the month 9.0 feet below top of conservation.

April EOM elevation, at Shadehill Reservoir, was much below average. April inflow was below average. Controlled release at 23 cfs. Shadehill finished the month 6.5 feet below top of conservation.

May EOM elevation, at Shadehill Reservoir, was much below average. May inflow was below average. Emergency Management/Security orientation held May 3<sup>rd</sup>. Controlled release at 23 cfs. Shadehill finished the month 6.3 feet below top of conservation.

June EOM elevation and June inflow, at Shadehill Reservoir, were much below average. Annual facility inspection was done on June 15<sup>th</sup>. Controlled release at 23 cfs. Shadehill finished the month 6.6 feet below top of conservation.

July EOM elevation, at Shadehill Reservoir, was much below average. Inflow was 2<sup>nd</sup> lowest in 54 years of record. Controlled release at 22 cfs. Shadehill finished the month 7.6 feet below top of conservation.

August EOM elevation, at Shadehill Reservoir, was much below average. August inflow was below average. Controlled release at 22 cfs. Shadehill finished the month 8.4 feet below top of conservation.

September EOM elevation, at Shadehill Reservoir, was much below average. September inflow was above average. Controlled release at 22 cfs. Shadehill finished the month 8.8 feet below top of conservation.

Additional statistical information on Shadehill Reservoir and its operations during 2006 can be found on Table DKT10 and Figure DKG9.

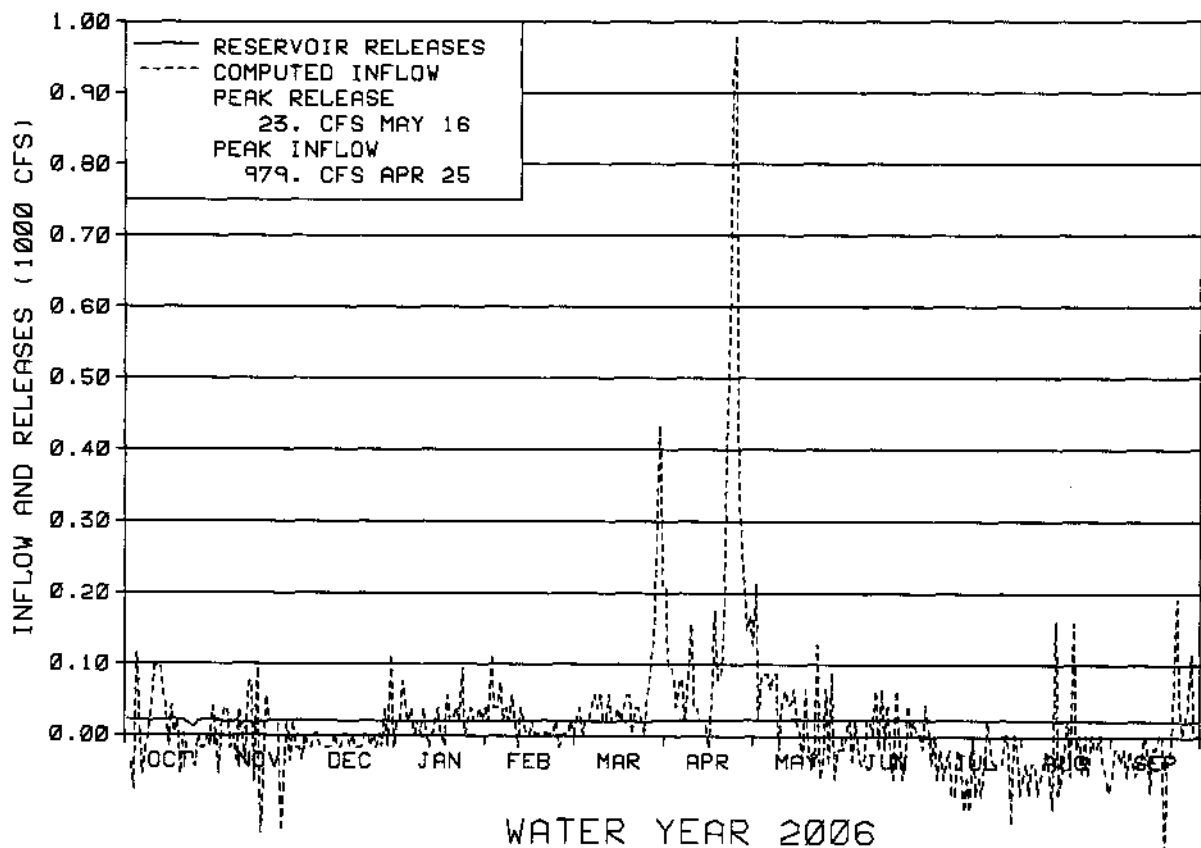
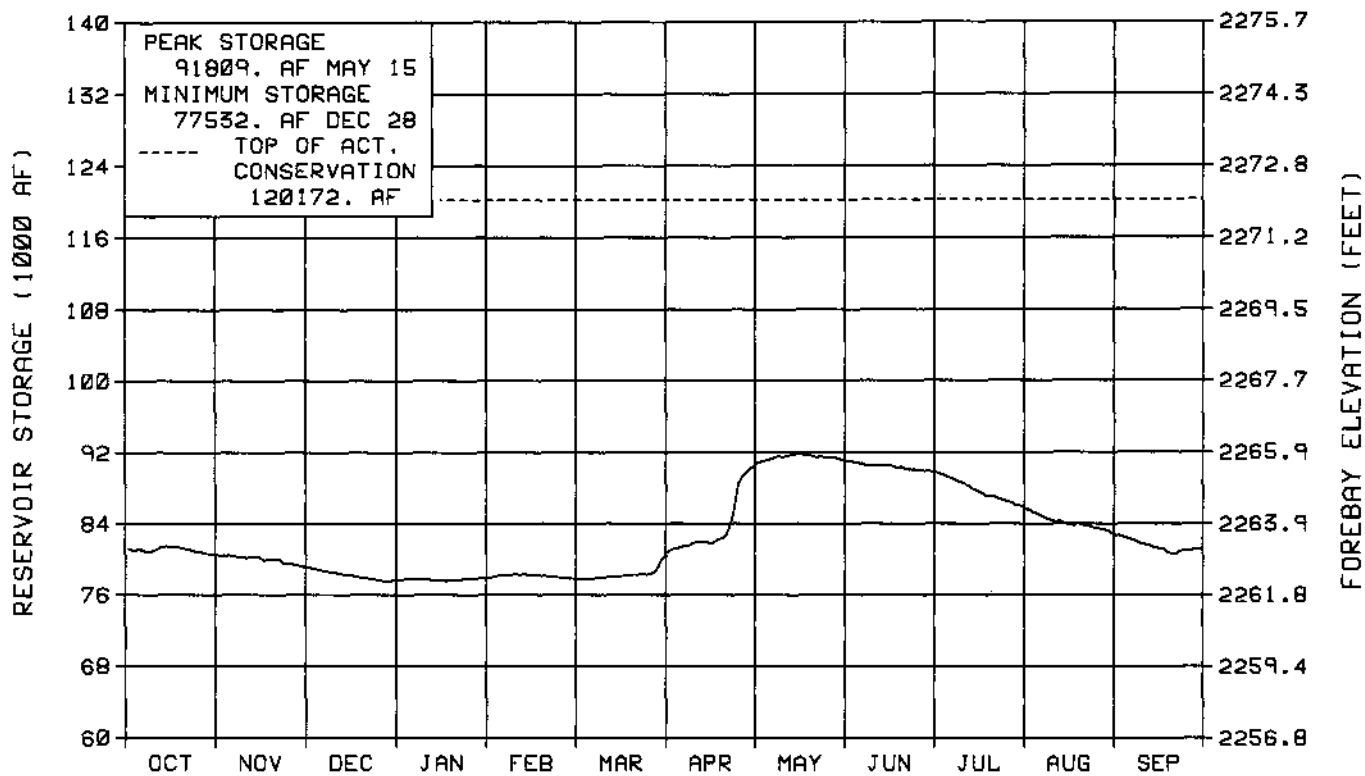
TABLE DKT10  
HYDROLOGIC DATA FOR 2006  
SHADEHILL RESERVOIR

| RESERVOIR ALLOCATIONS          | ELEVATION<br>(FEET) | TOTAL<br>RESERVOIR<br>STORAGE (AF) | STORAGE<br>ALLOCATION<br>(AF) |               |
|--------------------------------|---------------------|------------------------------------|-------------------------------|---------------|
| TOP OF INACTIVE AND DEAD       | 2,250.80            | 43,869                             | 43,869                        |               |
| TOP OF ACTIVE CONSERVATION     | 2,272.00            | 120,172                            | 76,303                        |               |
| TOP OF JOINT USE               |                     |                                    |                               |               |
| TOP OF EXCLUSIVE FLOOD CONTROL | 2,302.00            | 350,176                            | 230,004                       |               |
|                                |                     |                                    |                               |               |
| STORAGE-ELEVATION DATA         | ELEVATION (FT)      | STORAGE (AF)                       | DATE                          |               |
| BEGINNING OF YEAR              | 2,263.23            | 81,365                             | OCT 01, 2005                  |               |
| END OF YEAR                    | 2,263.16            | 81,099                             | SEP 30, 2006                  |               |
| ANNUAL LOW                     | 2,262.20            | 77,532                             | DEC 28, 2005                  |               |
| ANNUAL HIGH                    | 2,265.84            | 91,809                             | MAY 15, 2006                  |               |
| HISTORIC HIGH                  | 2,297.90            | 318,438                            | APR 10, 1952                  |               |
|                                |                     |                                    |                               |               |
| INFLOW-OUTFLOW DATA            | INFLOW              | DATE                               | OUTFLOW                       | DATE          |
| ANNUAL TOTAL (AF)              | 15,257              | OCT 05-SEP 06                      | 15,523                        | OCT 05-SEP 06 |
| DAILY PEAK (CFS)               | 979                 | APR 25, 2006                       | 23                            | APR -JUL 06   |
| DAILY MINIMUM (CFS)            | 0                   | *                                  | 12                            | NOV 13, 2006  |

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|            | MONTH    | INFLOW |          | OUTFLOW |          | CONTENT |  |          |
|            |          | AF     | % OF AVG | AF      | % OF AVG | AF      |  | % OF AVG |
|            | OCTOBER  | 464    | 89       | 1,259   | 39       | 80,570  |  | 71       |
|            | NOVEMBER | -292   | NA       | 1,166   | 44       | 79,112  |  | 71       |
|            | DECEMBER | -201   | NA       | 1,270   | 51       | 77,641  |  | 71       |
|            | JANUARY  | 1,511  | 156      | 1,255   | 52       | 77,897  |  | 72       |
|            | FEBRUARY | 1,073  | 33       | 1,146   | 54       | 77,824  |  | 71       |
|            | MARCH    | 3,893  | 19       | 1,260   | 15       | 80,457  |  | 66       |
|            | APRIL    | 11,156 | 60       | 1,304   | 9        | 90,309  |  | 72       |
|            | MAY      | 2,225  | 20       | 1,436   | 15       | 91,098  |  | 72       |
|            | JUNE     | 144    | 2        | 1,387   | 17       | 89,855  |  | 71       |
|            | JULY     | -2,651 | NA       | 1,404   | 26       | 85,800  |  | 69       |
| AUGUST     | -1,658   | NA     | 1,360    | 31      | 82,782   | 69      |  |          |
| SEPTEMBER  | -408     | NA     | 1,275    | 35      | 81,099   | 70      |  |          |
| ANNUAL     | 15,257   | 22     | 15,523   | 23      |          |         |  |          |
| APRIL-JULY | 10,874   | 26     |          |         |          |         |  |          |

\* Frequently observed during fall and winter months

# FIGURE DKG9 SHADEHILL RESERVOIR



WATER YEAR 2006



## **BELLE FOURCHE RESERVOIR**

### **BACKGROUND**

Belle Fourche Reservoir, located near Belle Fourche, South Dakota, is formed by Belle Fourche Dam on Owl Creek, a tributary of the Belle Fourche River. It has a total capacity of 192,077 acre-feet (185,277 acre-feet active). The reservoir is filled by diverting water from the Belle Fourche River through the Inlet Canal, which has a capacity of 1,300 cfs. The reservoir is used for irrigation of 57,000 acres in the Belle Fourche Project, which also receives a supplemental supply from Keyhole Reservoir. From November 1965 through May 1977, the active capacity of the reservoir was temporarily limited to 160,300 acre-feet at elevation 2981.8 feet until the damaged spillway was replaced.

When the Belle Fourche Reservoir storage right is satisfied by the reservoir filling, the South Dakota Department of Environment and Natural Resources provide guidelines for complying with water rights on the Belle Fourche River. The District is required to continue to bypass 5 cfs for domestic use prior to diverting the Johnson Lateral water right for up to 40 cfs. If flows into the diversion dam are greater than 45 cfs, the District is required to bypass up to 60 cfs for downstream irrigation rights. Any flows in excess of these amounts can be diverted into the reservoir and stored. If all of these rights are not needed, the District can divert flows into the reservoir.

### **WATER YEAR 2006 OPERATIONS SUMMARY**

Belle Fourche Reservoir began WY 2006 at elevation 2937.72 and storage of 19,352 acre-feet.

Water users were allocated 12 inches of water for the 2006 irrigation season which is 67 % of a full allotment of project water.

The Inlet Canal remained open all winter. Both North Canal and South Canal were turned on June 7. South Canal was shut off on September 12 and North Canal on September 20. Irrigation releases for the 2006 season were South Canal 41,464 acre-feet, North Canal 57,622 acre-feet, and Inlet Canal-Johnson Lateral 3,750 acre-feet for a total of 102,836 acre-feet.

Inflows peaked in April with a total of 30,253 acre-feet for the month which is 221% of average. Inflows for WY 2006 were 109,405 acre-feet, which was 95% of average.

The reservoir ended the water year at elevation 2942.88 ft with storage of 29,002 acre-feet. The reservoir finished the year 32.12 feet from full.

Annual Emergency Management/Security orientation was conducted on April 18, 2006.

The annual settlement survey was completed. This survey is done approximately one month after the peak elevation for the year has occurred in the reservoir. Inclinator readings were

taken quarterly as required by the periodic monitoring schedule.

Annual inspection was April 26, 2006 by personnel from the Rapid City Field Office.

## MONTHLY STATISTICS FOR WATER YEAR 2006

October EOM elevation, at Belle Fourche Reservoir, was much below average and October inflow was slightly below average. Belle Fourche ended the month 31.9 feet from full.

November EOM elevation, at Belle Fourche Reservoir, was much below average and November inflow was 4<sup>th</sup> lowest in 54 years of record. Belle Fourche ended the month 29.8 feet from full.

December EOM elevation, at Belle Fourche Reservoir, was much below average and December inflow was highest in 54 years of record. Belle Fourche ended the month 25.1 feet from full.

January EOM elevation, at Belle Fourche Reservoir, was much below average and January inflow was above average. Belle Fourche ended the month 22.3 feet from full.

February EOM elevation, at Belle Fourche Reservoir, was much below average and February inflow was below average. Belle Fourche ended the month 20.4 feet from full.

March EOM elevation, at Belle Fourche Reservoir, was much below average and March inflow was below average. Belle Fourche ended the month 18.2 feet from full.

April EOM elevation, at Belle Fourche Reservoir, was much below average. April inflow was 4<sup>th</sup> highest in 54 years of record. Emergency Management/Security orientation was completed on April 18<sup>th</sup>. Annual dam inspection completed on April 26<sup>th</sup>. Belle Fourche ended the month 12.4 feet from full.

May EOM elevation, at Belle Fourche Reservoir, was below average. May inflow was above average. Belle Fourche ended the month 9.1 feet from full.

June EOM elevation, at Belle Fourche Reservoir, was much below average. June inflow was 4<sup>th</sup> lowest in 54 years of record. Began irrigation releases on June 7<sup>th</sup>. Belle Fourche ended the month 12.4 feet from full.

July EOM elevation, at Belle Fourche Reservoir, was much below average. July inflow was 2<sup>nd</sup> lowest in 54 years of record. Belle Fourche ended the month 22.0 feet from full.

August EOM elevation, at Belle Fourche Reservoir, was much below average. August inflow was below average. Belle Fourche ended the month 31.4 feet from full.

September EOM elevation, at Belle Fourche Reservoir, was below average. September inflow was above average. South Canal turned off on September 12<sup>th</sup>, North Canal on September 20<sup>th</sup>. Belle Fourche ended the month 32.1 feet from full.

Additional statistical information on Belle Fourche Reservoir and its operations during 2006 can

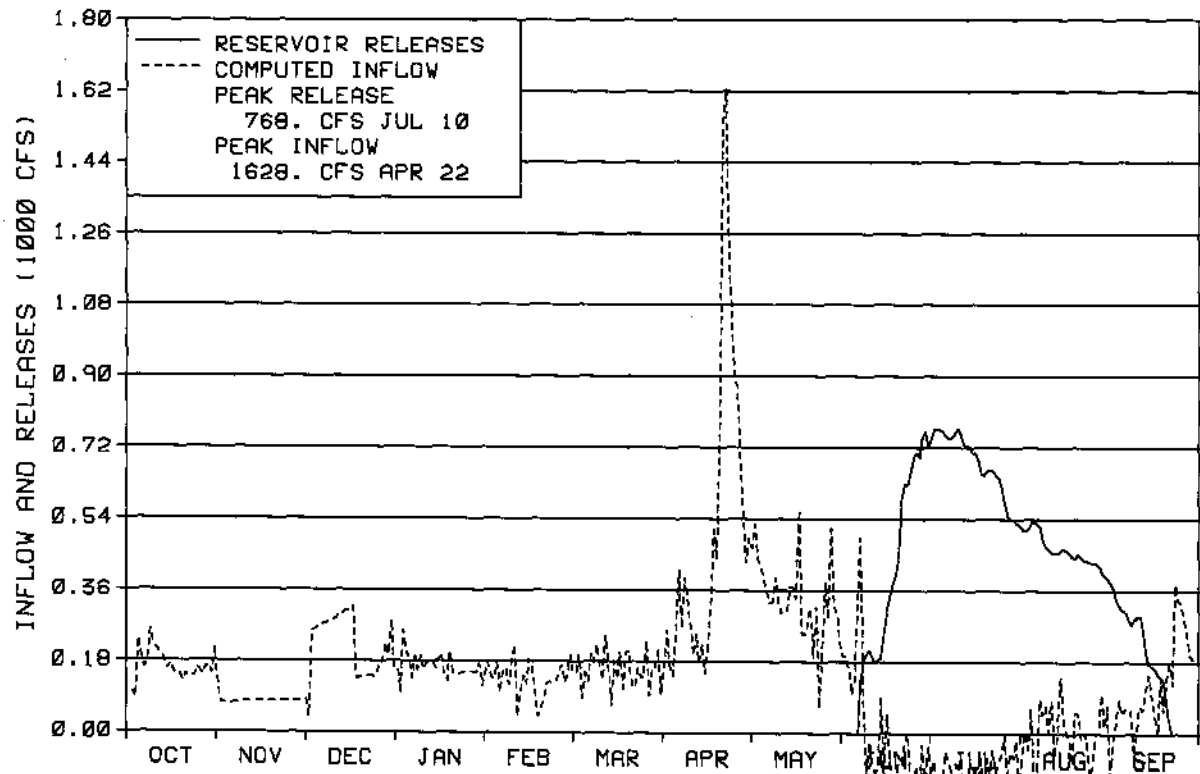
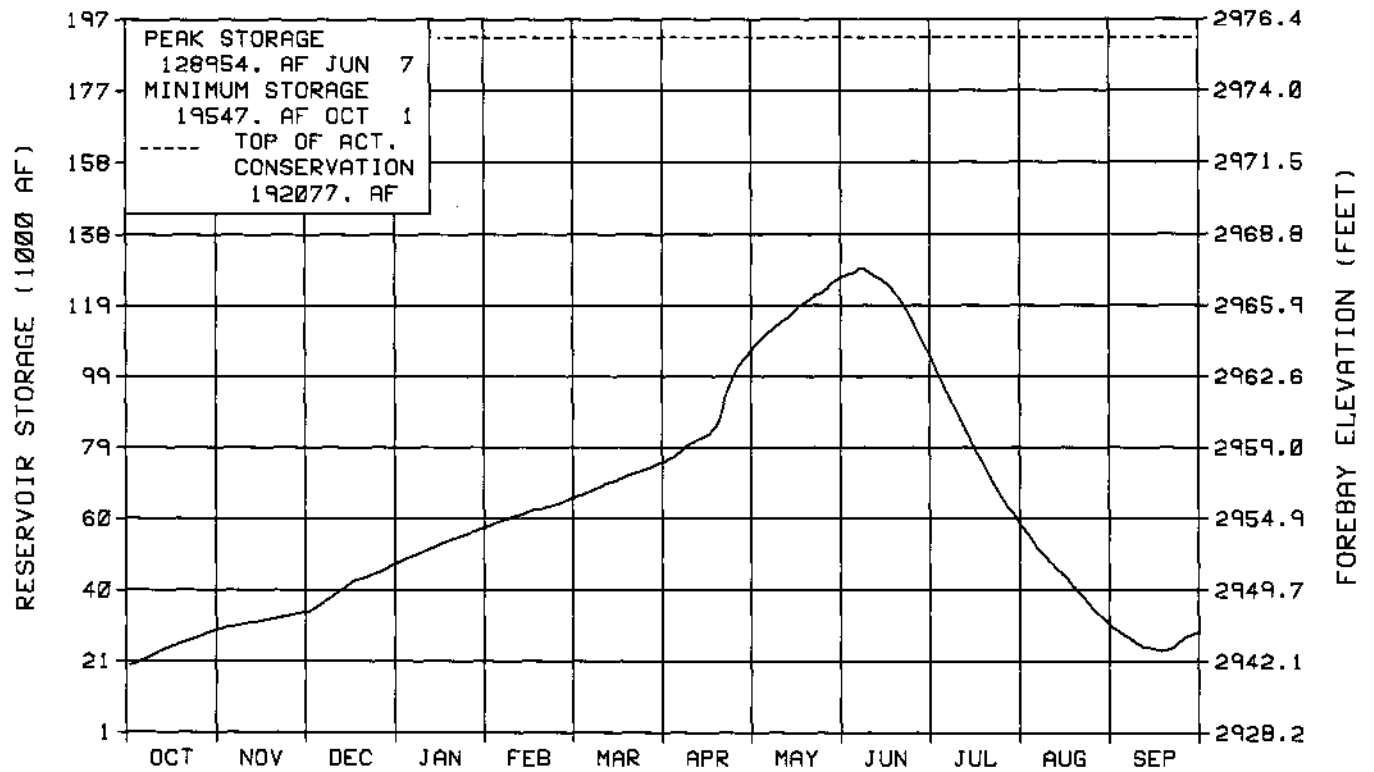
be found on Table DKT11 and Figure DKG10.

TABLE DKT11  
HYDROLOGIC DATA FOR 2006  
BELLE FOURCHE RESERVOIR

| RESERVOIR ALLOCATIONS          |  | ELEVATION<br>(FEET) |               | TOTAL<br>RESERVOIR<br>STORAGE (AF) |         | STORAGE<br>ALLOCATION<br>(AF) |  |
|--------------------------------|--|---------------------|---------------|------------------------------------|---------|-------------------------------|--|
| TOP OF INACTIVE AND DEAD       |  | 2,927.00            |               | 6,800                              |         | 6,800                         |  |
| TOP OF ACTIVE CONSERVATION     |  | 2,975.00            |               | 192,077                            |         | 185,277                       |  |
| TOP OF JOINT USE               |  |                     |               |                                    |         |                               |  |
| TOP OF EXCLUSIVE FLOOD CONTROL |  |                     |               |                                    |         |                               |  |
|                                |  |                     |               |                                    |         |                               |  |
| STORAGE-ELEVATION DATA         |  | ELEVATION (FT)      |               | STORAGE (AF)                       |         | DATE                          |  |
| BEGINNING OF YEAR              |  | 2,937.84            |               | 19,547                             |         | OCT 01, 2005                  |  |
| END OF YEAR                    |  | 2,942.88            |               | 29,002                             |         | SEP 30, 2006                  |  |
| ANNUAL LOW                     |  | 2,937.84            |               | 19,547                             |         | OCT 01, 2005                  |  |
| ANNUAL HIGH                    |  | 2,966.40            |               | 128,954                            |         | JUN 07, 2006                  |  |
| HISTORIC HIGH                  |  | 2,975.80            |               | 198,455                            |         | MAY 12, 1978                  |  |
|                                |  |                     |               |                                    |         |                               |  |
| INFLOW-OUTFLOW DATA            |  | INFLOW              | DATE          |                                    | OUTFLOW | DATE                          |  |
| ANNUAL TOTAL (AF)              |  | 109,405             | OCT 05-SEP 06 |                                    | 99,755  | OCT 05-SEP 06                 |  |
| DAILY PEAK (CFS)               |  | 1,628               | APR 22, 2006  |                                    | 768     | JUL 10, 2006                  |  |
| DAILY MINIMUM (CFS)            |  | 0                   | *             |                                    | 0       | *                             |  |
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\* Frequently observed during fall and winter months

FIGURE DKG10  
BELLE FOURCHE RESERVOIR



WATER YEAR 2006

## CORPS OF ENGINEERS MAIN STEM RESERVOIRS

The Missouri River main stem reservoir system consists of six reservoirs located on the Missouri River in Montana, North Dakota, South Dakota, and Nebraska. This reservoir system serves flood control, irrigation, navigation, power, municipal and industrial water supply, water quality control, fish and wildlife, and recreation. Based on information from the Corps' 2006 AOP, the capacity and storage allocations of the main stem system were updated to current values and are shown in downstream order as follows:

### Reservoir Storage Allocation (1,000 Acre-Feet)

| <u>Dam</u>   | <u>Permanent</u> | <u>Carryover<br/>Multiple Use</u> | <u>Annual<br/>Flood Control<br/>and<br/>Multiple Use</u> | <u>Exclusive<br/>Flood<br/>Control</u> | <u>Total<br/>Storage</u> |
|--------------|------------------|-----------------------------------|----------------------------------------------------------|----------------------------------------|--------------------------|
| Fort Peck    | 4,211            | 10,785                            | 2,717                                                    | 975                                    | 18,688                   |
| Garrison     | 4,980            | 13,130                            | 4,222                                                    | 1,489                                  | 23,821                   |
| Oahe         | 5,373            | 13,461                            | 3,201                                                    | 1,102                                  | 23,137                   |
| Big Bend     | 1,682            | 0                                 | 117                                                      | 60                                     | 1,859                    |
| Fort Randall | 1,517            | 1,607                             | 1,309                                                    | 985                                    | 5,418                    |
| Gavins Point | <u>321</u>       | <u>0</u>                          | <u>90</u>                                                | <u>59</u>                              | <u>470</u>               |
| Totals       | 18,084           | 38,983                            | 11,656                                                   | 4,670                                  | 73,393                   |

Each main stem facility serves a powerplant. The number of generating units and total nameplate capabilities are shown below:

| <u>Powerplant</u> | <u>Units</u> | <u>Capacity<br/>(Kilowatts)</u> |
|-------------------|--------------|---------------------------------|
| Fort Peck         | 5            | 185,250                         |
| Garrison          | 5            | 517,750                         |
| Oahe              | 7            | 786,030                         |
| Big Bend          | 8            | 494,320                         |
| Fort Randall      | 8            | 320,000                         |
| Gavins Point      | <u>3</u>     | <u>132,300</u>                  |
| Totals            | 36           | 2,435,650                       |

Main stem system releases are regulated to support the multiple use purposes of the reservoirs. The navigation season on the Missouri River below the dams normally is from late March to late November. Generally, releases from the system for navigation are higher during late summer and fall lowering the system storage. During that time, much of the system's hydropower is generated from the lower most projects. During closure of the navigation season, higher releases are made and more power is generated from the upstream Fort Peck and Garrison Reservoirs. This offsets the reduced release and generation from the downstream projects during winter closure of the river for navigation. The desired annual target system storage level is 57.0 million acre-feet on the first of March.

The regulation of Missouri River flows by the main stem storage provided benefits to nine water resource-related functions, including flood control, irrigation, navigation, power, municipal and industrial water supply, water quality control, fish and wildlife, and recreation. Table CET1 presents the regulation benefit for most of those functions as recorded in 2005-2006, 2004-2005, and the average. Benefits are defined as the tons of produce shipped, dollars of damages prevented, kilowatt hours of electricity produced, and reservoir elevation and river stages maintained. For the shipping information, estimates also were provided this year which included the sand, gravel, and waterway material shipped.

**TABLE CET1**  
**Main Stem Reservoir Water Regulation**  
**Comparison with Past Regulations**

| Use of Regulated Water  | Period of Use or Season  | Totals                            | Totals                            | Long-Term                      |
|-------------------------|--------------------------|-----------------------------------|-----------------------------------|--------------------------------|
| Navigation*             | Apr. - Dec. <sup>4</sup> | 0.19 million tons (2006)          | 0.28 million tons (2005)          | 2.01 million tons <sup>1</sup> |
| Flood Damages Prevented | Oct. – Sept.             | \$0.45 million (2006)             | \$109 million (2005)              | \$18.3 billion <sup>2</sup>    |
| Energy                  | Aug. - Jul.              | 6.0 billion KWH (Aug. 05-July 06) | 5.6 billion KWH (Aug. 04-July 05) | 9.9 billion KWH <sup>3</sup>   |

\* Excludes sand, gravel, and waterway material (2006 estimated and 2005 preliminary)  
2006 – 7.50 million tons sand, gravel, and waterway material  
Total Tonnage including sand, gravel, and waterway material  
7.69 million tons (2006)  
7.94 million tons (2005)  
7.09 million tons (40-year long-term average through 2006)

The main stem reservoirs also provide supplemental water for irrigation and municipal uses and improves water quality in the river system.

<sup>1</sup> Average for 40 years 1967-2006 with the peak shipments in 1977 (3.35 million tons)

<sup>2</sup> Total damages prevented (1937-2006)

<sup>3</sup> Average Annual 1968-2006

<sup>4</sup> End of navigation season shortened 48 days in 2005 and 44 days in 2006

A detailed description of the main stem system operations during 2006 is presented in annual operating reports prepared by and available for distribution from the U.S. Missouri River Basin

Water Management Division, U.S. Army Corps of Engineers, Northwestern Division, Omaha, Nebraska.

## ENERGY GENERATION

There are 14 Federal powerplants located in the Upper Missouri River Basin that are currently operating. Eight of the powerplants are operated and maintained by Reclamation and have a total capacity of 348,100 kilowatts. The other six have a total capacity of 2,435,650 kilowatts and are operated and maintained by the Corps. The Corps' powerplants are located on the main stem of the Missouri River. Generation from the 14 powerplants is marketed by the Department of Energy.

Total generation in the combined system in WY 2006 was 7288.567 million kilowatt hours, 780.775 million kilowatt hours more than in WY 2005. A summary of the past 10 years of energy generation within the Upper Missouri River Basin is shown below.

| USBR and COE Energy Generation<br>Million KiloWatt Hours |          |           |           |
|----------------------------------------------------------|----------|-----------|-----------|
| Year                                                     | USBR     | COE       | TOTAL     |
| 2006                                                     | 1088.603 | 6199.964  | 7288.567  |
| 2005                                                     | 953.992  | 5553.800  | 6507.792  |
| 2004                                                     | 688.367  | 7046.084  | 7734.451  |
| 2003                                                     | 757.118  | 7783.378  | 8540.496  |
| 2002                                                     | 708.594  | 7271.994  | 7980.588  |
| 2001                                                     | 905.528  | 6521.944  | 7427.472  |
| 2000                                                     | 1240.802 | 10363.931 | 11604.733 |
| 1999                                                     | 2017.536 | 11073.228 | 13090.764 |
| 1998                                                     | 1822.698 | 11435.586 | 13258.284 |
| 1997                                                     | 2016.989 | 13942.025 | 15959.014 |

A comparison of 2005 and 2006 generation and other data from Missouri Basin Region powerplants is shown on Table CET2. Tables CET3, 4, and 5 show the monthly generation, power releases, and total downstream releases, respectively, for all Federal plants in the Missouri Basin Region. The annual energy generation for each of the last several years for all Reclamation, Corps, and combined plants is shown graphically on Figures CEG1, 3, and 5, respectively. Monthly generation for each month during the past several years is shown graphically on Figures CEG2, 4, and 6.



For a more detailed account of powerplants operation at Reclamation facilities during the year, refer to the 2006 operation summaries. Information on the Corps' powerplants operations can be obtained from the annual operating reports prepared by and available for distribution from the Reservoir Control Center, U.S. Army Corps of Engineers, Omaha, Nebraska.

TABLE CET2  
ANNUAL ENERGY PRODUCTION DATA  
WATER YEAR 2006

| POWERPLANT                          | INSTALLED<br>NAMEPLATE<br>CAPACITY (KW) | MILLION KILOWATT-HOURS<br>GENERATED |         | WATER USED FOR GENERATION |                             |                    | RIVER<br>RELEASE<br>1,000 AF | TOTAL<br>RELEASE<br>1,000 AF |
|-------------------------------------|-----------------------------------------|-------------------------------------|---------|---------------------------|-----------------------------|--------------------|------------------------------|------------------------------|
|                                     |                                         |                                     |         | 1,000 AF                  | PERCENT OF<br>TOTAL RELEASE | KW-HOURS<br>PER AF |                              |                              |
|                                     |                                         | 2005                                | 2006    |                           |                             |                    |                              |                              |
| PILOT BUTTE <sup>1</sup>            | 1,600                                   | 4.482                               | 4.636   | 50.406                    | 32                          | 91.973             | 156.583                      | 156.583                      |
| BOYSEN                              | 15,000                                  | 56.523                              | 57.556  | 673.559                   | 98                          | 85.451             | 684.785                      | 684.785                      |
|                                     |                                         |                                     |         |                           |                             |                    |                              |                              |
| SHOSHONE                            | 3,000                                   | 21.846                              | 18.923  | 103.351                   | 15                          | 183.095            | See Below for Total          |                              |
| BUFFALO BILL                        | 18,000                                  | 56.632                              | 54.451  | 241.246                   | 34                          | 225.707            | See Below for Total          |                              |
| HEART MOUNTAIN                      | 6,000                                   | 6.966                               | 15.824  | 72.400                    | 10                          | 218.564            | See Below for Total          |                              |
| SPIRIT MOUNTAIN <sup>2</sup>        | 4,500                                   | 14.388                              | 15.837  | 161.241                   | 23                          | 98.219             | See Below for Total          |                              |
| TOTAL FOR BUFFALO BILL <sup>3</sup> | 31,500                                  | 99.832                              | 105.035 | 578.238                   | 81                          | 181.647            | 467.388                      | 710.227                      |
| TOTAL                               | 48,100                                  | 160.837                             | 167.227 | 1302.203                  | 84                          | 128.419            | 1308.756                     | 1551.595                     |

<sup>1</sup> River Release and Total Release at Pilot Butte Reservoir is Computed Inflow to Pilot Butte due to the location of the powerplant at inlet of supply canal.

<sup>2</sup> Spirit Mountain Powerplant is used to dissipate energy in the transition from the pressurized portion of the Shoshone Canyon Conduit to the free flow section of the conduit. Water used for generation at Spirit Mountain Powerplant is then routed to Heart Mountain Canal or used for generation at Heart Mountain Powerplant.

<sup>3</sup> This represents the total for the four separate powerplants at Buffalo Bill Dam.

TABLE CET3  
MONTHLY ENERGY GENERATION (MILLION KILOWATT-HOURS)  
WATER YEAR 2006

| MONTH     | PILOT BUTTE | BOYSEN | SHOSHONE | BUFFALO BILL | HEART MTN. | SPIRIT MTN. |
|-----------|-------------|--------|----------|--------------|------------|-------------|
| OCTOBER   | 0.409       | 4.256  | 1.776    | 1.883        | 0.000      | 0.383       |
| NOVEMBER  | 0.000       | 5.045  | 1.375    | 0.534        | 0.000      | 0.000       |
| DECEMBER  | 0.000       | 5.203  | 1.289    | 0.816        | 0.000      | 0.000       |
| JANUARY   | 0.000       | 4.645  | 1.304    | 0.951        | 0.000      | 0.000       |
| FEBRUARY  | 0.000       | 3.995  | 0.203    | 0.747        | 0.000      | 0.000       |
| MARCH     | 0.000       | 4.479  | 0.880    | 0.491        | 0.000      | 0.000       |
| APRIL     | 0.000       | 4.318  | 1.630    | 4.887        | 0.367      | 0.297       |
| MAY       | 0.854       | 5.402  | 2.162    | 9.478        | 3.160      | 2.822       |
| JUNE      | 0.957       | 5.738  | 2.110    | 11.134       | 3.095      | 3.147       |
| JULY      | 1.085       | 5.879  | 2.165    | 10.648       | 3.184      | 3.193       |
| AUGUST    | 1.100       | 5.090  | 2.085    | 8.312        | 3.010      | 3.068       |
| SEPTEMBER | 0.231       | 3.506  | 1.944    | 4.570        | 3.008      | 2.927       |
| TOTAL     | 4.636       | 57.556 | 18.923   | 54.451       | 15.824     | 15.837      |

TABLE CET4  
WATER USED FOR POWER GENERATION (KAF)  
WATER YEAR 2006

| MONTH     | PILOT BUTTE | BOYSEN  | SHOSHONE | BUFFALO BILL | HEART MTN. | SPIRIT MTN. <sup>1</sup> |
|-----------|-------------|---------|----------|--------------|------------|--------------------------|
| OCTOBER   | 4.431       | 46.879  | 10.220   | 10.980       | 0.000      | 4.111                    |
| NOVEMBER  | 0.000       | 56.553  | 8.028    | 3.789        | 0.000      | 0.000                    |
| DECEMBER  | 0.000       | 56.341  | 7.491    | 4.710        | 0.000      | 0.000                    |
| JANUARY   | 0.000       | 50.633  | 7.560    | 5.011        | 0.000      | 0.000                    |
| FEBRUARY  | 0.000       | 44.592  | 1.180    | 4.535        | 0.000      | 0.000                    |
| MARCH     | 0.000       | 49.437  | 4.666    | 5.705        | 0.000      | 0.000                    |
| APRIL     | 0.000       | 48.851  | 8.652    | 18.087       | 1.916      | 2.816                    |
| MAY       | 9.384       | 65.660  | 11.476   | 37.558       | 14.925     | 28.178                   |
| JUNE      | 10.443      | 69.441  | 11.200   | 42.090       | 14.394     | 31.635                   |
| JULY      | 11.744      | 73.125  | 11.492   | 44.005       | 14.943     | 32.469                   |
| AUGUST    | 11.893      | 66.519  | 11.067   | 39.016       | 14.064     | 31.964                   |
| SEPTEMBER | 2.511       | 45.528  | 10.319   | 25.760       | 12.158     | 30.068                   |
| TOTAL     | 50.406      | 673.559 | 103.351  | 241.246      | 72.400     | 161.241                  |

<sup>1</sup> Spirit Mountain Powerplant is used to dissipate energy in the transition from the pressurized portion of the Shoshone Canyon Conduit to the free flow section of the conduit. Water used for generation at Spirit Mountain Powerplant is then routed to Heart Mountain Canal or used for generation at Heart Mountain Powerplant.

TABLE CET5  
TOTAL RELEASE (KAF)  
WATER YEAR 2006

| MONTH     | BOYSEN  | BUFFALO BILL | BULL LAKE | PILOT BUTTE | ANCHOR |
|-----------|---------|--------------|-----------|-------------|--------|
| OCTOBER   | 51.861  | 31.316       | 2.124     | 4.281       | 0.339  |
| NOVEMBER  | 56.553  | 11.969       | 1.317     | 0.000       | 0.192  |
| DECEMBER  | 56.341  | 12.554       | 1.244     | 0.000       | 0.066  |
| JANUARY   | 50.633  | 12.787       | 1.464     | 0.000       | 0.002  |
| FEBRUARY  | 44.592  | 11.367       | 1.611     | 0.000       | 0.014  |
| MARCH     | 55.492  | 12.730       | 1.607     | 0.000       | 0.085  |
| APRIL     | 48.851  | 39.329       | 2.525     | 6.146       | 0.214  |
| MAY       | 65.660  | 113.896      | 17.159    | 33.709      | 1.978  |
| JUNE      | 69.533  | 152.332      | 12.687    | 33.356      | 1.455  |
| JULY      | 73.222  | 125.123      | 46.616    | 41.704      | 0.165  |
| AUGUST    | 66.519  | 108.832      | 56.098    | 31.979      | 0.114  |
| SEPTEMBER | 45.528  | 77.992       | 25.891    | 15.777      | 0.044  |
| TOTAL     | 684.785 | 710.227      | 170.343   | 166.952     | 4.668  |

TABLE CET6  
TOTAL RESERVOIR STORAGE CONTENTS (KAF)  
WATER YEARS 2005 AND 2006

| RESERVOIR                 | TOP OF<br>CONSERVATION<br>CAPACITY | DEAD AND<br>INACTIVE<br>STORAGE | TOTAL STORAGE<br>SEPTEMBER 30 |       | END OF SEPTEMBER<br>PERCENT OF AVG |      |
|---------------------------|------------------------------------|---------------------------------|-------------------------------|-------|------------------------------------|------|
|                           |                                    |                                 | 2005                          | 2006  | 2005                               | 2006 |
| PILOT BUTTE               | 33.7                               | 3.8                             | 15.4                          | 4.2   | 95                                 | 26   |
| BULL LAKE                 | 152.5                              | 0.7                             | 66.8                          | 51.3  | 86                                 | 66   |
| BOYSEN                    | 741.6                              | 219.2                           | 631.9                         | 447.8 | 112                                | 80   |
| ANCHOR <sup>1</sup>       | 17.2                               | 0.1                             | 0.3                           | 0.2   | 80                                 | 70   |
| BUFFALO BILL <sup>2</sup> | 646.6                              | 41.7                            | 450.3                         | 441.1 | 104                                | 101  |

<sup>1</sup> Percent of average content of Anchor Reservoir is based on a fourteen year average, 1991-2005.

<sup>2</sup> Percent of average content of Buffalo Bill Reservoir is based on a thirteen year average, 1993-2005; to reflect the operation of the reservoir since 1992 when the dam was raised and the capacity of the reservoir was increased to 646,565 acre-feet.

TABLE CET7  
END OF MONTH CONTENTS (KAF)  
WATER YEAR 2006

| RESERVOIR                 | OCT   | NOV   | DEC   | JAN   | FEB   | MAR   | APR   | MAY   | JUNE  | JULY  | AUG   | SEP   |
|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| BOYSEN                    | 627.5 | 618.4 | 595.9 | 583.8 | 570.3 | 556.8 | 544.2 | 549.1 | 544.2 | 500.1 | 456.5 | 447.8 |
| % OF AVERAGE              | 112   | 112   | 111   | 112   | 112   | 111   | 113   | 108   | 89    | 82    | 79    | 80    |
| BUFFALO BILL              | 451.3 | 466.8 | 471.1 | 472.5 | 473.0 | 475.0 | 472.6 | 557.5 | 636.4 | 590.1 | 503.4 | 441.1 |
| % OF AVERAGE <sup>1</sup> | 110   | 114   | 115   | 116   | 117   | 120   | 127   | 134   | 115   | 105   | 102   | 101   |
| BULL LAKE                 | 69.9  | 71.2  | 72.1  | 72.9  | 73.0  | 73.0  | 73.5  | 91.7  | 128.8 | 115.3 | 71.3  | 51.3  |
| % OF AVERAGE              | 92    | 93    | 94    | 95    | 95    | 95    | 95    | 102   | 102   | 90    | 68    | 66    |
| PILOT BUTTE               | 28.8  | 28.3  | 28.3  | 28.2  | 28.0  | 27.9  | 24.8  | 20.7  | 23.8  | 17.0  | 11.2  | 4.2   |
| % OF AVERAGE              | 125   | 117   | 118   | 118   | 118   | 108   | 86    | 81    | 86    | 73    | 58    | 26    |
| ANCHOR                    | 0.4   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.2   | 0.2   | 0.2   |
| % OF AVERAGE <sup>2</sup> | 169   | 159   | 150   | 135   | 162   | 113   | 53    | 20    | 9     | 10    | 32    | 70    |

<sup>1</sup> Percent of average content of Buffalo Bill Reservoir is based on a thirteen year average, 1993-2005; to reflect the operation of the reservoir since 1992 when the dam was raised and the capacity of the reservoir was increased to 646,565 acre-feet.

<sup>2</sup> Percent of average content of Anchor Reservoir is based on a fifteen year average, 1991-2005; this is due to the availability of data for Anchor Reservoir.

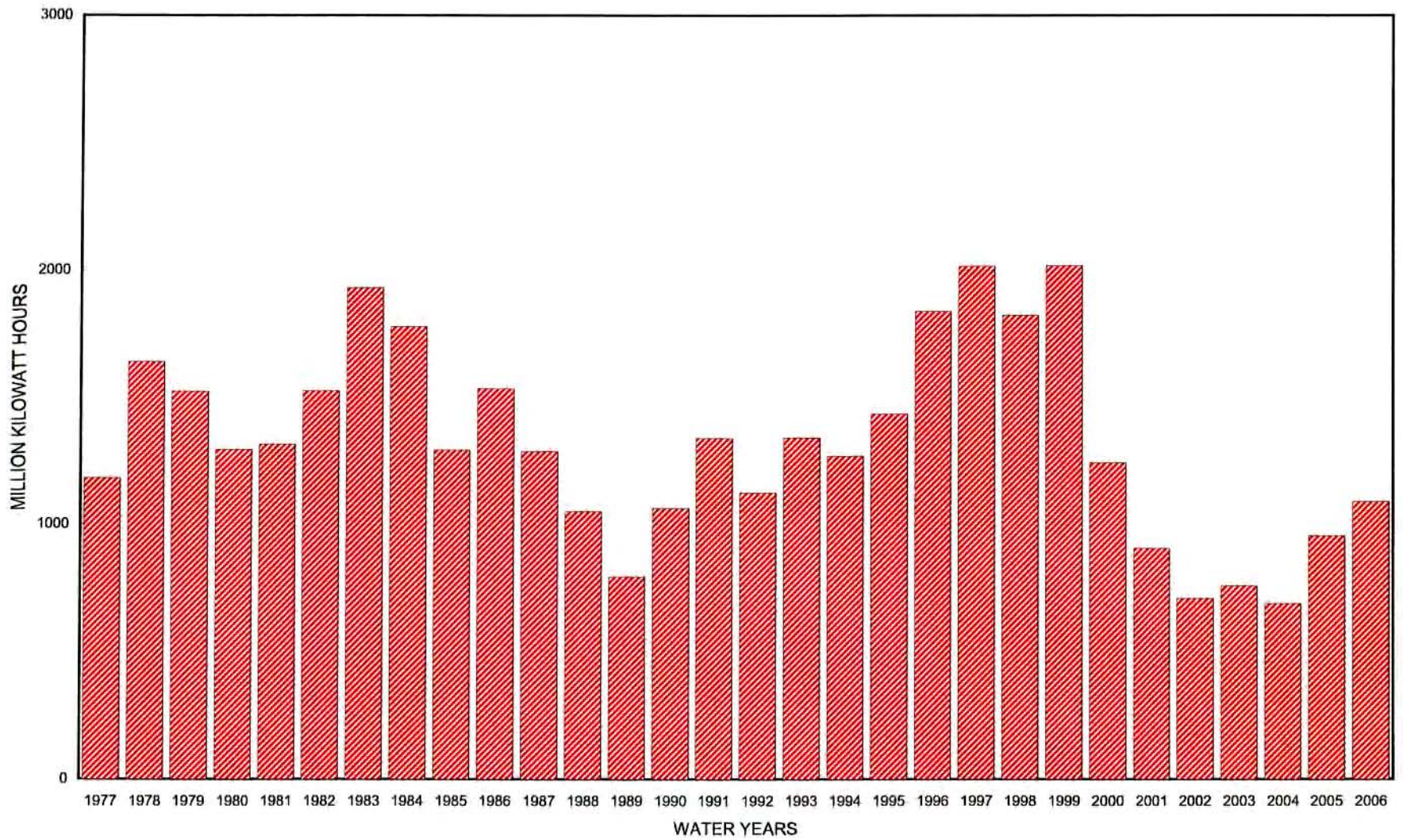
TABLE CET8  
MONTHLY INFLOW AMOUNTS (KAF)  
WATER YEAR 2006

| RESERVOIR                 | OCT  | NOV  | DEC  | JAN  | FEB  | MAR  | APR  | MAY   | JUNE  | JULY | AUG  | SEP  |
|---------------------------|------|------|------|------|------|------|------|-------|-------|------|------|------|
| BOYSEN                    | 47.4 | 47.5 | 33.8 | 38.6 | 31.1 | 42.0 | 36.2 | 70.6  | 64.6  | 29.1 | 22.9 | 36.9 |
| % OF AVERAGE              | 77   | 97   | 86   | 105  | 82   | 79   | 74   | 55    | 26    | 21   | 36   | 67   |
| BUFFALO BILL              | 32.3 | 27.5 | 17.4 | 14.2 | 11.8 | 14.7 | 37.0 | 198.8 | 231.2 | 78.9 | 22.1 | 15.7 |
| % OF AVERAGE              | 133  | 133  | 108  | 95   | 89   | 77   | 88   | 128   | 79    | 49   | 47   | 59   |
| BULL LAKE                 | 5.2  | 2.6  | 2.2  | 2.2  | 1.7  | 1.7  | 3.0  | 35.3  | 49.8  | 32.7 | 12.1 | 5.9  |
| % OF AVERAGE              | 100  | 90   | 88   | 105  | 106  | 94   | 83   | 128   | 81    | 69   | 56   | 61   |
| PILOT BUTTE <sup>1</sup>  | 17.6 | -0.5 | 0.0  | -0.2 | -0.1 | -0.2 | 3.1  | 29.6  | 36.4  | 35.0 | 26.2 | 8.7  |
| % OF AVERAGE              | 198  | 0    | 0    | 0    | 0    | 0    | 38   | 129   | 95    | 83   | 81   | 36   |
| ANCHOR                    | 0.5  | 0.1  | 0.0  | 0.0  | 0.1  | 0.1  | 0.1  | 2.1   | 1.4   | 0.1  | 0.1  | 0.1  |
| % OF AVERAGE <sup>2</sup> | 77   | 26   | 17   | 0    | 76   | 27   | 19   | 47    | 20    | 4    | 51   | 10   |

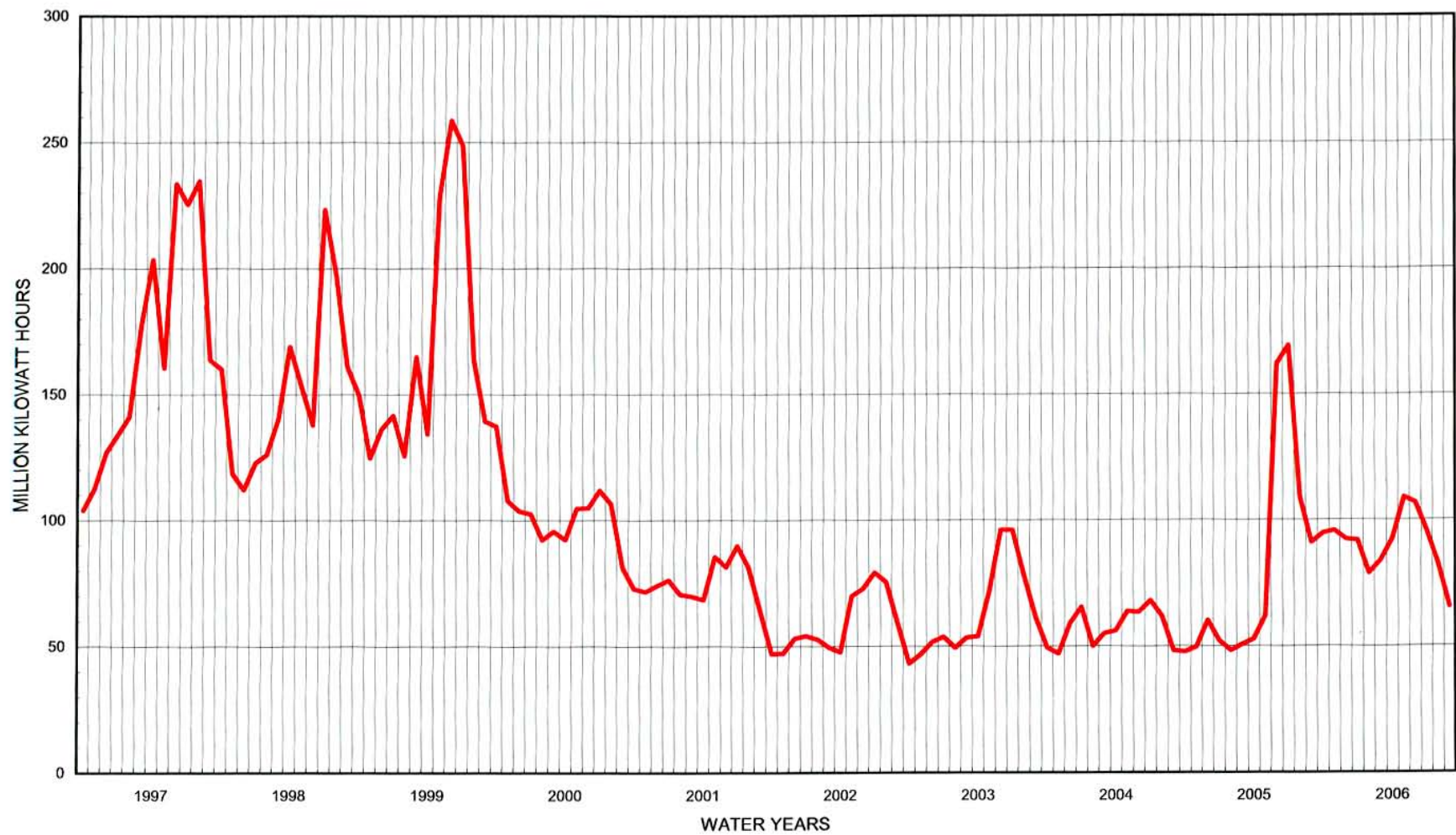
<sup>1</sup> Negative values are the result of calculated inflow based on reservoir release and change in reservoir content.

<sup>2</sup> Percent of average inflow for Anchor Reservoir is based on a fifteen year average, 1991-2005; this is due to the availability of data for Anchor Reservoir.

**FIGURE CEG1**  
**ANNUAL GENERATION AT USBR PLANTS**

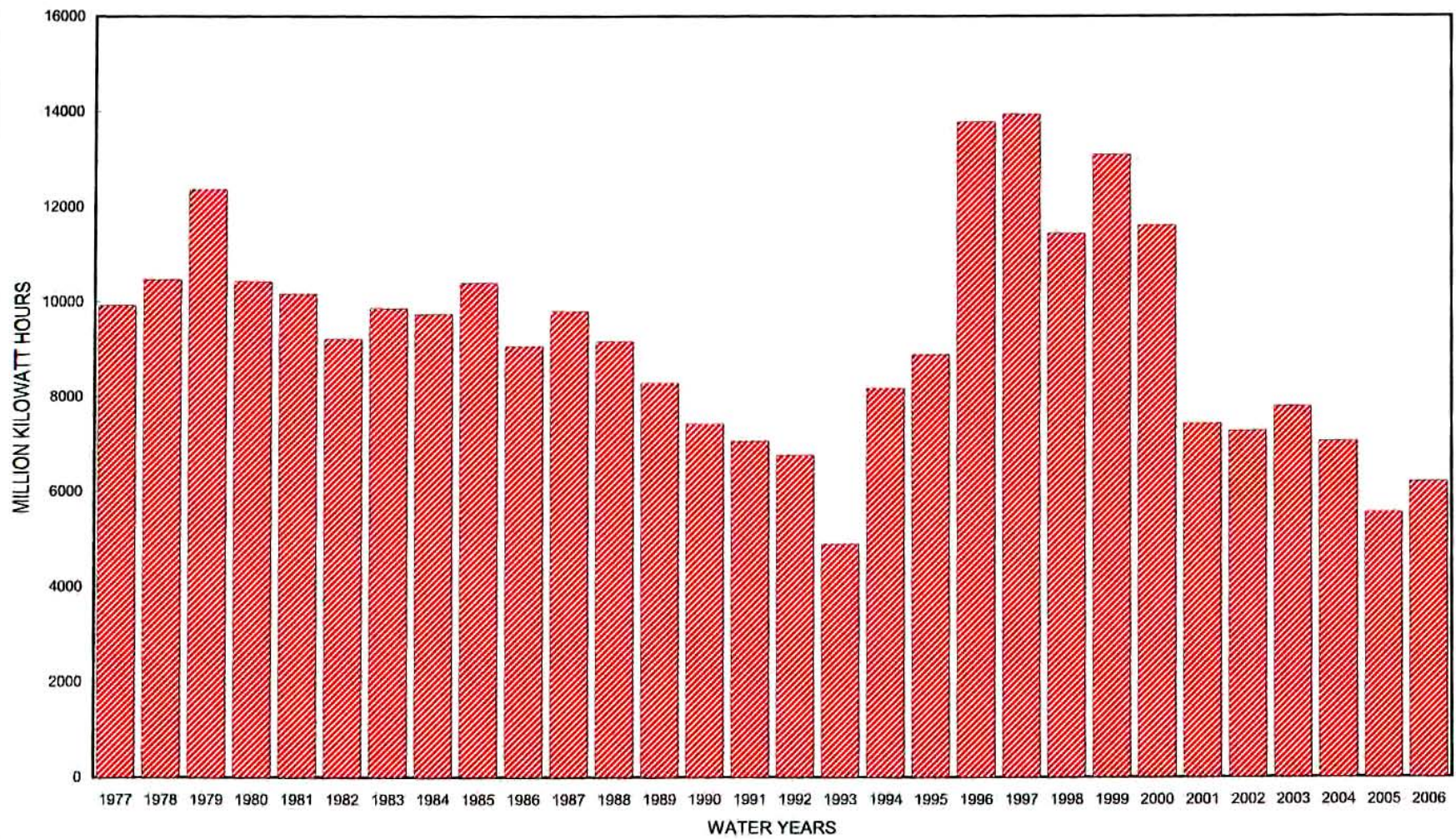


**FIGURE CEG2**  
**MONTHLY GENERATION AT USBR PLANTS**



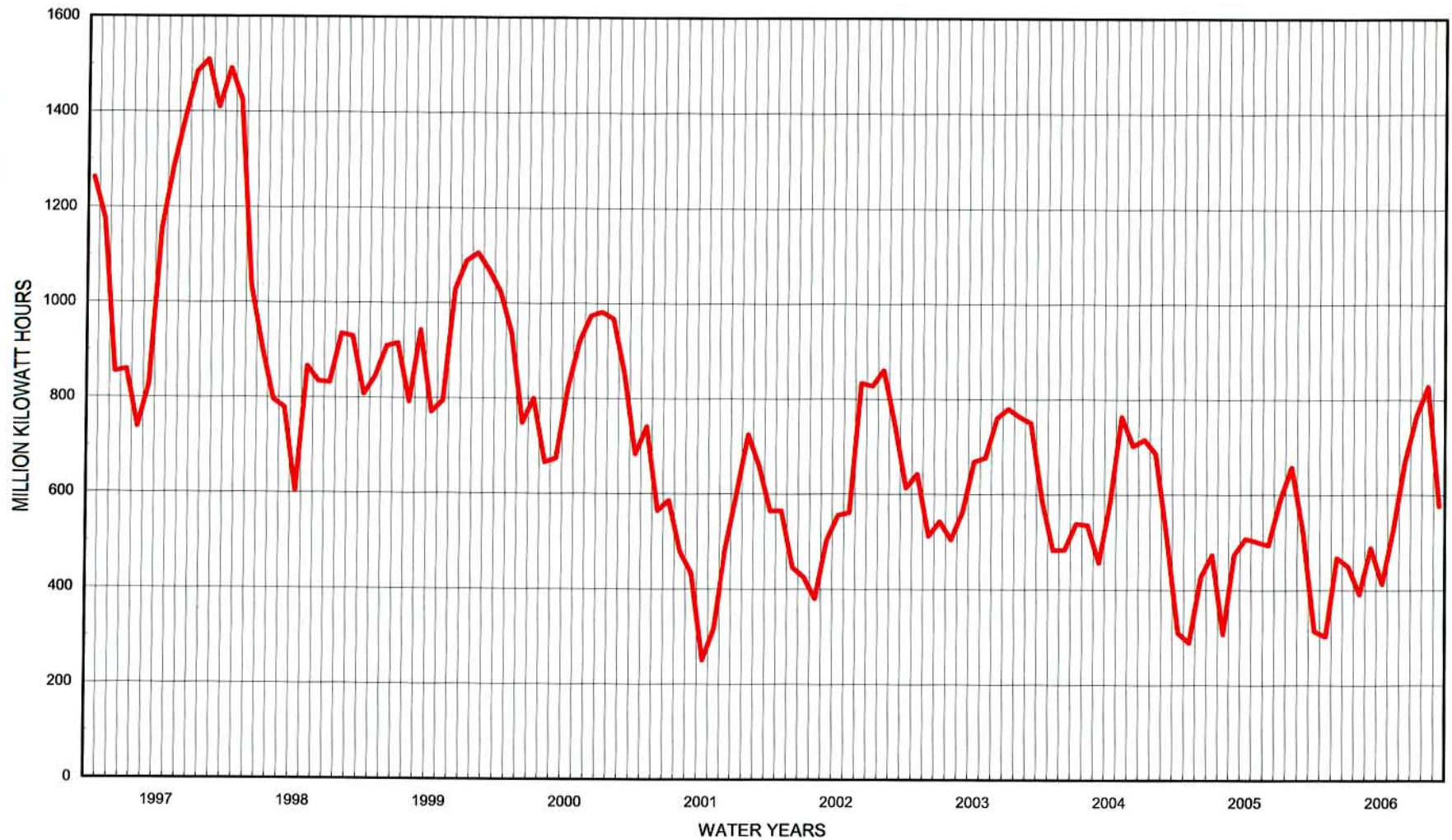


**FIGURE CEG3**  
**ANNUAL GENERATION AT COE PLANTS**

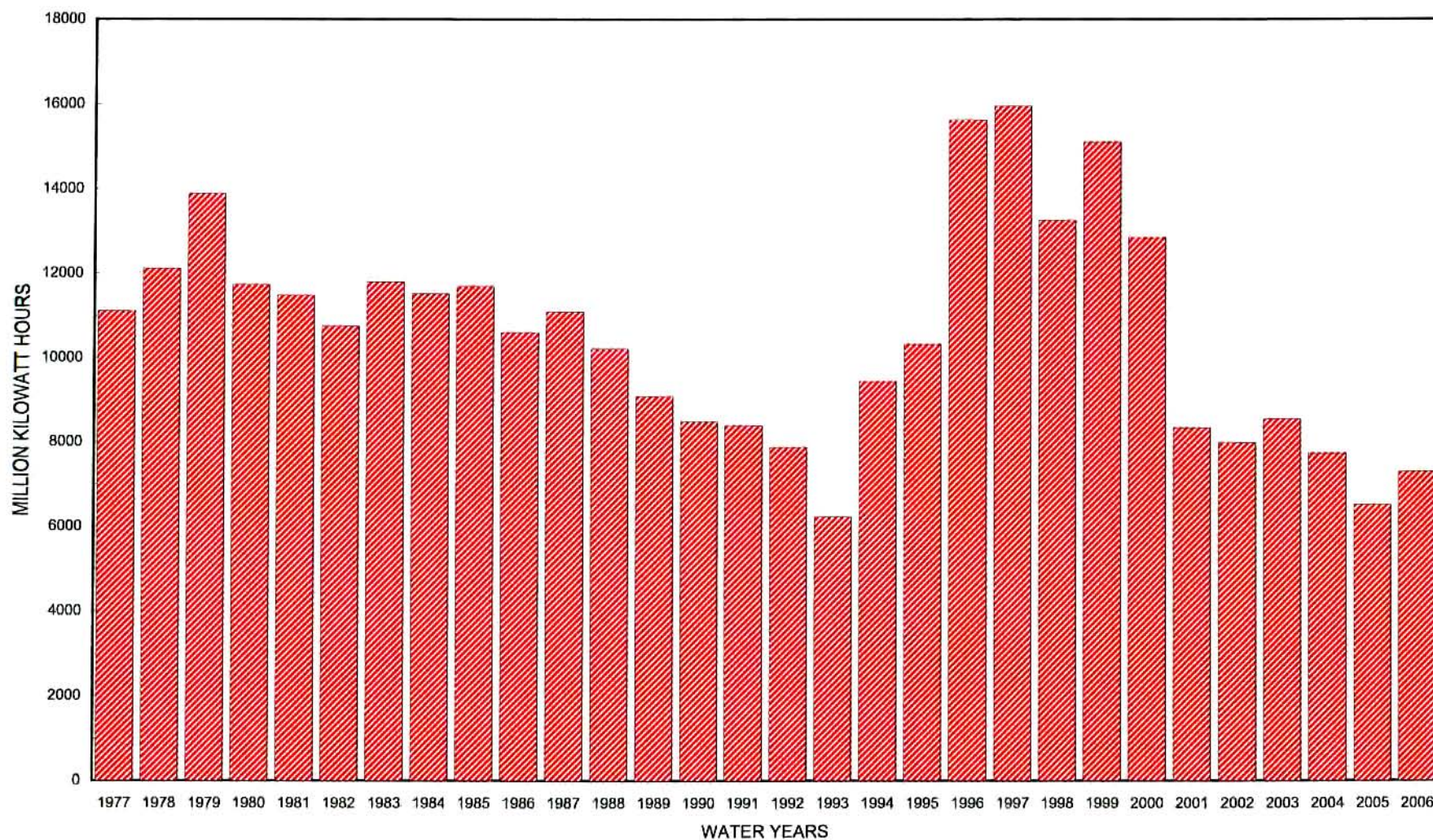




**FIGURE CEG4**  
**MONTHLY GENERATION AT COE PLANTS**



**FIGURE CEG5**  
**ANNUAL GENERATION - USBR & COE PLANTS**





**FIGURE CEG6**  
**MONTHLY GENERATION - USBR & COE PLANTS**

