Yellowtail Dam & Bighorn Lake
Potential Revisions to Draft Criteria Based on Comments and Operating Experience

Billings, MT
October 13, 2011
Potential Revisions

- Some Refinements to Lake Level Targets

- Refinement to procedure for forecasting Nov-Mar Gains

- Refinement to procedure for setting Nov-Mar Release Rate

- Continue review and adjust Rule Curve as needed to improve its effectiveness.

- Consideration for providing gradual reduction in release to minimize bank erosion
## REVISED RESERVOIR LEVEL TARGETS

<table>
<thead>
<tr>
<th>Date</th>
<th>Modified Target Elev.</th>
<th>Draft Criteria Target Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 31</td>
<td>3635-3640</td>
<td>3638-3640</td>
</tr>
<tr>
<td>Mar 31</td>
<td>3615-3619</td>
<td>3616.7-3620.6</td>
</tr>
<tr>
<td>RC Low Point</td>
<td>3603-3617</td>
<td>3603-3618</td>
</tr>
<tr>
<td>July 31</td>
<td>3640</td>
<td>3640</td>
</tr>
</tbody>
</table>

**Note:** During a prolonged drought minimum level can reach 3570 or lower.
Nov-Mar Release Procedure

- Revise Equation for Forecasting Gains
  - Use Linear Relationship for forecast equation
  - Add data through 2011
  - Adjust gains for 1967-1990 to allow correlation to be developed for full period of record

- Incorporate New End of March Target Elev.

- Revised Procedure expected to increase Nov-Mar release by up to 100 cfs as compared to current Procedure.
Comparison of Gain Correlation

Bighorn Lake Gains 1991-2011
Apr-Oct vs Nov-Mar.

\[ y = 0.1282x + 219288 \]
\[ R^2 = 0.5457 \]

Apr-Oct vs Nov-Mar.

\[ y = 0.145x + 222402 \]
\[ R^2 = 0.6756 \]
Nov-Mar Gain Forecasts

Forecasts Curve Comparison

1991-2011 Forecast

1968-2011 Forecast
## Procedure to Setting Nov-Mar Release

End of Mar Target Adjusted based on release range

<table>
<thead>
<tr>
<th>River Release</th>
<th>March 31 Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 2500 cfs</td>
<td>3619</td>
</tr>
<tr>
<td>2000-2500 cfs</td>
<td>3617</td>
</tr>
<tr>
<td>Less than 2000 cfs</td>
<td>3615</td>
</tr>
</tbody>
</table>
### Effect on 2012 Nov-Mar Release

- **Calculated Nov-Mar River Release Rate**

<table>
<thead>
<tr>
<th>Proposed Changes</th>
<th>Current Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3170 cfs</td>
<td>3070 cfs</td>
</tr>
</tbody>
</table>

**End of March Target elevation**

| 3619                   | 3620.6           |

Note: The 100 cfs increase is provided by a 30 cfs increase from lowering the March target by 1.6 feet and a 70 cfs increase due to the revised gain forecasting method.
Refinements to Rule curve

• Lower starting elev. to 3617. Some minor adjustments were made early in 2011 to the medium to high rule curves to provide a better distribution of water in April and May.

• Continuing to review curves to see if they can be improved. 2011 will be added to data base for the curves and refinements will be made accordingly.

• For 2011 the curves worked well in defining the timing for the low point for the lake a day ahead of the rain flood event.
<table>
<thead>
<tr>
<th>A-J Forecast</th>
<th>% of Ave.</th>
<th>Min Elev.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>500,000 af</td>
<td>44%</td>
<td>3617.0</td>
<td>4/1</td>
</tr>
<tr>
<td>700,000 af</td>
<td>62%</td>
<td>3617.0</td>
<td>4/1</td>
</tr>
<tr>
<td>1,000,000 af</td>
<td>88%</td>
<td>3616.1</td>
<td>4/29</td>
</tr>
<tr>
<td>1,150,000 af</td>
<td>100%</td>
<td>3614.5</td>
<td>5/5</td>
</tr>
<tr>
<td>1,300,000 af</td>
<td>115%</td>
<td>3612.9</td>
<td>5/16</td>
</tr>
<tr>
<td>1,500,000 af</td>
<td>132%</td>
<td>3608.9</td>
<td>5/21</td>
</tr>
<tr>
<td>1,700,000 af</td>
<td>150%</td>
<td>3606.2</td>
<td>5/22</td>
</tr>
<tr>
<td>1,900,000 af</td>
<td>168%</td>
<td>3604.2</td>
<td>5/22</td>
</tr>
<tr>
<td>2,000,000 af</td>
<td>176%</td>
<td>3602.7</td>
<td>5/23</td>
</tr>
</tbody>
</table>
Integration of Daily Reservoir Spreadsheets by GPRO

• A new Integrated Spreadsheet was developed to allow better review of the system operations: Buffalo Bill, Boysen and Bighorn Lake

• Travel time between reservoirs carefully tracked by Integrated Spreadsheet

• Additional graphs and tables have been developed to assist with review of system for flood control.
Percent of Total Useable Storage Space Filled
Conservation, Joint Use and Exclusive Flood Pools

Percent of Total Useable Storage Space Filled
Conservation, Joint Use and Exclusive Flood Pools

Percent

<table>
<thead>
<tr>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/1</td>
<td>5/1</td>
<td>6/1</td>
<td>7/1</td>
<td>8/1</td>
<td>9/1</td>
<td>10/1</td>
<td>11/1</td>
<td>12/1</td>
<td>13/1</td>
<td>14/1</td>
</tr>
</tbody>
</table>

Percent

4/1 5/1 6/1 7/1

Boysen Buffalo Bill Yellowtail

RECLAMATION
Percent of Flood Control Space Filled

Boysen

Yellowtail

RECLAMATION
2011 Bighorn River Basin System Operations (Composite Reservoir)

Exclusive Flood Pool: 408,955 af
Joint Use Pool: 376,594 af

Flow cfs

4/1 5/1 6/1 7/1

Unregulated Regulated Flow Composite Storage Top of Joint Use Top of Exclusive Flood Pool Top of Active Conservation

RECLAMATION
Draft Criteria Report

• Plan to revise report to provide more clarity

• Additional Table and graphs will be added

• Potential Revisions to Criteria will be discussed.
Questions or Comments