



# Ecological Resource Consultants, Inc.

Streams~Wetlands~Water Resources

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## Memorandum

Date: May 26, 2009

To: Manuel Montoya, FRICO  
Laurie Rink, Mile High Wetlands Group

From: Heather Thompson

Re: **Review of Milton Reservoir Water Balance for Water Quality Evaluations**

A water quality assessment was completed for Milton Reservoir by AMEC Earth & Environmental (AMEC, 2008). At the request of Manuel Montoya and Laurie Rink, the hydrologic data and water balance that was conducted to support the water quality assessment was reviewed. The following sections summarize that review.

### **MILTON RESERVOIR LAKE**

Table 4 of the AMEC report presents a summary of average annual inflow to Milton Reservoir from the Platte Valley Canal and Beebe Canal and releases to the Gilmore Canal for the period from 1969 through 2004. Data for Table 4 was provided to Laurie Rink by Duane Helton in the Excel file, Milton Water Balance 1-08.xls. The data provided by Duane Helton was already in units of acre-feet, however, AMEC assumed the data was in units of CFS. Therefore, it appears the values in Table 4 are off by a factor of 1.9835.

Tables 9 through 12 of the AMEC report present hydrologic data for a Milton Reservoir water balance, which was developed by Duane Helton from FRICO records. A water balance was conducted for Milton Reservoir for irrigation years 2000 through 2004. Each of the following terms of the water balance were reviewed.

#### Inflows

1. Platte Valley Canal
2. Beebe Canal/Subsurface Inflow
3. Precipitation

#### Outflows

1. Gilmore Canal Releases
2. Outflow Seepage
3. Evaporation

## **Inflow Terms**

Table 10 in the AMEC report shows the average annual inflow to Milton Reservoir from the Platte Valley Canal was 16,553 AF for the period from 2000 through 2004. The average annual inflow from the Beebe Canal and subsurface inflow was 11,081 AF. These values reflect adjustments that were made when conducting the water balance, because there were unaccounted for gains in some months. These gains were typically greatest during the summer months (May through July). AMEC distributed these gains to the Platte Valley Canal and the combined Beebe Canal/subsurface inflow terms by volume. The Evans No. 2 Ditch and Platte Valley Canal share a common headgate on the South Platte River. The Evans No. 2 Ditch and Platte Valley Canal bifurcate approximately 2 miles northeast of Platteville, however, no measurement is made of the water in the Platte Valley Canal that is delivered to Milton Reservoir. As a result, it is difficult to estimate how much of the water diverted from the South Platte River was delivered to Milton Reservoir versus the Evan #2 Canal. It is more likely that the bulk of these unaccounted for gains are attributable to water that was diverted into the Platte Valley Canal and delivered to Milton Reservoir as opposed to inflow from the Beebe Canal. For example, in May 2000, the unaccounted for gain to Milton Reservoir is 5,183 AF. During that month, the total diversion into the Platte Valley Canal is 8,535 AF, while the delivery to Milton Reservoir is estimated to be 0 AF. It is more likely that a significant portion of the unaccounted gain of 5,183 AF was actually water diverted into the Platte Valley Canal and delivered to Milton as opposed to inflow from the Beebe Canal. The method for apportioning unaccounted gains should be revised as follows. The unaccounted gain should be apportioned to the Platte Valley Canal up to the difference between the total amount diverted from the Platte Valley Canal less water delivered to Milton Reservoir. Any remaining unaccounted gain can be apportioned as described in the AMEC report. This results in an average annual inflow from the Platte Valley Canal and Beebe Canal/subsurface inflow of 21,600 AF and 6,000 AF, respectively. Manuel Montoya with FRICO concurs with this method of apportioning unaccounted gains. The inflow to Milton from the Platte Valley Canal and Beebe Canal should be presented as a range because of the high level of uncertainty regarding the split of water to the Evan #2 Canal versus Milton Reservoir.

Table 10 in the AMEC report shows the average annual inflow to Milton Reservoir from precipitation was 2,722 AF based on precipitation records for Denver International Airport (DIA). This value appears slightly high. Average annual precipitation recorded at DIA from 2000-2004 was approximately 13.3 in. Based on an average reservoir surface area of about 1,200 acres during that period, average inflow from precipitation would be about 1,300 AF/yr. Even at the full pool surface area of 2,082 acres shown in Table 3 of the AMEC Report, the average annual inflow from precipitation would be approximately 2,300 AF, which is still less than AMEC's estimate of 2,722 AF.

## **Outflow Terms**

Table 11 in the AMEC report shows the average annual release from Milton Reservoir to the Gilmore Canal was 18,211 AF. These releases are measured and reflect the best available information.

Table 11 in the AMEC report shows the average annual subsurface loss from Barr Lake was 7,398 AF. Note that the values for 2000 through 2004 do not correspond exactly with the data provided in the Excel file, Milton Water Balance 1-08.xls. The values in Table 11 are typically within a few hundred acre-feet of the values shown in Excel spreadsheet. The estimate of subsurface loss may be high by about 3,000 based on previous a previous water balance conducted for Milton Reservoir by Hydro-Triad, which is discussed in more detail below.

Table 11 in the AMEC report shows the average annual evaporation loss from the reservoir was 5,964 AF. Assuming an average reservoir surface area of approximately 1,200 acres, and an average annual gross evaporation rate of 41 inches, the annual evaporation from Barr Lake would be approximately 4,100 AF. The estimate for evaporation used in the water balance may be high by about 2,000 AF.

**Previous Milton Reservoir Water Balance Analyses**

A similar water balance was conducted for Milton Reservoir by Hydro-Triad for the Beebe Draw Diversion and Augmentation Program (Hydro-Triad, 1984). The water balance for the AMEC study was completed for the period from 2000 through 2004 while the water balance completed by Hydro-Triad was for the period from 1927 through 1981. The following table compares the two water balances.

<b>Water Balance Terms</b>	<b>AMEC Study</b>	<b>Hydro-Triad</b>
Inflows	(AF/yr)	(AF/yr)
Platte Valley Canal	16,533	12,350
Beebe Canal/Subsurface Inflow	11,081	6,960
Precipitation	2,722	1,090
<b>Total Inflow</b>	<b>30,356</b>	<b>20,400</b>
Outflows		
Release to Gilmore Canal	18,211	13,170
Outflow Seepage	7,398	4,000
Evaporation	5,964	3,230
<b>Total Outflow</b>	<b>31,573</b>	<b>20,400</b>

It is difficult to compare these water balances since they cover different study periods. However, estimates of precipitation, evaporation, Beebe Canal/subsurface inflow and outflow seepage were compared since these terms tend to vary less on a year-to-year basis than diversions to the reservoir via the Platte Valley Canal and releases to the Gilmore Canal.

Estimates of precipitation and evaporation included in the AMEC study are approximately 1,630 AF and 2,730 AF higher, respectively, than similar estimates made by Hydro-Triad. Additional information is needed from AMEC to review the methodology and data they relied on to estimate

precipitation and evaporation. As discussed in the previous section, AMEC's estimates of precipitation and evaporation appear high based on calculations using an average reservoir surface area of 1,200 acres for the period from 2000 through 2004.

Beebe Canal/subsurface inflow was estimated to be 11,081 AF in the AMEC study, which is approximately 4,120 AF higher than the estimate of 6,960 AF in the Hydro-Triad study. As discussed in the previous section, it is possible that too much of the unaccounted for gain to Milton Reservoir may be attributed to the Beebe Canal/subsurface inflow. A significant portion of the unaccounted gain may have been diverted into the Platte Valley Canal and delivered to Milton as opposed to inflow from the Beebe Canal/subsurface inflow.

Outflow seepage was estimated to be 7,398 AF in the AMEC study, which is approximately 3,400 AF higher than the estimate of 4,000 AF in the Hydro-Triad study. Duane Helton estimated outflow seepage to be approximately 6,700 AF/yr on average for the period from 1977 through 2004 based on a water balance he performed for Milton Reservoir. The estimate in the AMEC study is reasonably consistent with Duane Helton's estimate of outflow seepage. The estimate provided in the Hydro-Triad report was based on a groundwater model of the Milton Reservoir area that was constructed to define seepage and groundwater movement. The estimate of seepage in the Hydro-Triad report was based on historic average reservoir levels, well pumping and groundwater aquifer parameters. It is possible that seepage loss from the reservoir has increased based on current data and reservoir operations, however, this difference should be reviewed by Duane Helton or DeWayne Shroeder.

## **Summary**

Table 4 of the AMEC report presents a summary of average annual inflow to Milton Reservoir from the Platte Valley Canal and Beebe Canal and releases to the Gilmore Canal for the period from 1969 through 2004. It appears the values in Table 4 are off by a factor of 1.9835.

The data used for the Milton water balance presented in the AMEC report was reviewed and compared with a previous water balance conducted by Hydro-Triad. The average subsurface loss from Milton Reservoir of 7,398 AF/yr in the AMEC study is approximately 3,400 AF higher than a similar estimate made by Hydro-Triad. This difference may be accounted for due to different study periods. Estimates of precipitation and evaporation included in the AMEC study are approximately 1,630 AF and 2,730 AF higher, respectively, than similar estimates made by Hydro-Triad. The methodology and data AMEC relied on to estimate precipitation and evaporation should be reviewed. Beebe Canal/subsurface inflow was estimated to be 11,081 AF in the AMEC study, which is approximately 4,120 AF higher than the estimate of 6,960 AF in the Hydro-Triad study. It is possible that too much of the unaccounted for gain to Milton Reservoir may be attributed to the Beebe Canal/subsurface inflow. It is possible that a significant portion of the unaccounted gain was actually water diverted into the Platte Valley Canal and delivered to Milton as opposed to inflow from the Beebe Canal/subsurface inflow. AMEC should consider revising the method for apportioning unaccounted gains in a manner which would apportion more of the unaccounted gain to the Platte Valley Canal as opposed to the Beebe Canal/subsurface

inflow. In addition, it may be appropriate to present the inflow to Milton from these two sources as a range due to the high level of uncertainty regarding the split of water to the Evan #2 Canal versus Milton Reservoir. If the inflow and outflow terms change as a result of this review, the Phosphorus and Nitrogen balances conducted for Milton Reservoir should be reevaluated.

### **References**

AMEC Earth and Environmental. May 2008. Milton Reservoir Water Quality Assessment Weld County, Colorado.

Hydro-Triad. 1984. Beebe Draw Diversion and Augmentation Program Report No. 1 The Water Resources of Beebe Draw.