State of Idaho
322 East Front Street, P.O. Box 83720, Boise, Idaho 83720-0098
Phone: (208) 287-4800 FAX: (208) 287-6700 www.idwr.idaho.gov

MEMORANDUM

To: Gary Spackman, Director

From: Liz Cresto, Technical Hydrologist LC

Date: November 4, 2014

Subject: Accounting for the distribution of water to the federal on-stream reservoirs in Water District 63

Overview

This memorandum has been prepared in response to request for staff memorandum dated September 10, 2014 in the matter of accounting for distribution of water to the federal on-stream reservoirs within Water District 63. The Director requested a memorandum addressing: "(1) how and why water is counted or credited to the water rights for reservoirs in Basin 63 pursuant to the existing accounting methods and procedures; and (2) the origin, adoption, and development of the existing accounting methods and procedures in Water District 63.[1]"

Introduction

Idaho Code section § 42-602 authorizes watermasters to distribute water "in accordance with the prior appropriation doctrine" under the supervision of the Director. The watermaster on the Boise River is responsible for delivering water according to the elements of the water rights held by the water users in the water district.

[1] Order Lifting Stay and Notice of Status Conference, September 10, 2014.

The delivery of water stored in reservoirs through a river channel is also a responsibility of the watermaster authorized by Idaho Code § 42-801. Storage water is delivered according to contracts that the water users *(spaceholders)* have with the federal government.

Water Rights Accounting Definitions and Concepts

The term *water rights accounting,* in this document, is used to describe the set of computational tools the watermaster uses to quantify natural flow availability and use, and to track storage use, on a daily, after-the-fact basis. There are two types of flow in the water rights accounting: natural flow and stored flow. *Natural flow* is water that would be flowing in the river system absent reservoir operations and diversions. *Stored flow* is water in excess of the computed natural flow. The term *distribute* in this document refers to the use of the water rights accounting to apportion between natural flow and stored flow.

Water users' natural flow entitlements are defined by their licensed or decreed water rights; water users' storage entitlements are defined by their contracts with the Bureau or other water users. The amount of natural flow available for distribution under a water user's state water right is computed using the water rights accounting on the basis of streamflow, reservoir, and diversion measurements. The volume of storage water available for delivery to water users *(spaceholder allocations)* is quantified using a separate computer program (*storage program*) on the basis of the spaceholder contracts[2]. Storage water availability for delivery to water users is sometimes affected by federal reservoir operations that release stored water for purposes other than irrigation. The water rights accounting calculates how much natural flow would be available for delivery to water right holders absent reservoir operations, and distributes the natural flow in accordance with the elements of the water rights. Diversions in excess of natural flow entitlements are charged against water users' storage allocations or accounts.

[2] The storage program is discussed later in this document. The storage program determines the individual contract spaceholders' allocations and these are input into the water rights accounting program. The total storage use computed in the water rights accounting on October 31is input into the storage program and used to determine both the individual spaceholder carryover and the total reservoir carryover. The total reservoir carryover counts toward the "fill" or satisfaction of the reservoir rights for the following irrigation season.

The water rights accounting is run and maintained by Department staff. The watermaster provides the Department with diversion data. Department staff gathers the stream gaging and reservoir data needed to run the water rights accounting. While the Department executes the water rights accounting, it is ultimately reviewed and approved by the watermaster.

The following list comprises the major concepts and procedures contained in the water rights accounting currently relied upon by the Water District 63 watermaster to distribute water to diversion and reservoir water rights:

1. The river and reservoir system is broken into a series of river reaches for the purposes of determining natural flow. A river reach is a section of river between two flow measurement locations. The Boise River water rights accounting program has thirteen river reaches. The furthest upstream measurement locations are the Boise River near Twin Springs gage and the South Fork Boise near Featherville gage. The furthest downstream reach ends at the Boise River near Parma gage, however, the Boise River near Middleton is considered the end of the system. Natural flow that arises below Middleton has historically met demand in the lower reaches. Storage water released at Lucky Peak Dam that passes Middleton is consider storage water that has left the system.

2. Natural flow reach gains are calculated for each river reach in the water right accounting using the formula:

$$Reach\ gain = Outflow - Inflow + Diversions + Reservoir\ Change\ in\ Content + Reservoir\ Evaporation$$

Where:

Outflow is the river discharge at the end of the river reach;
Inflow is the river discharge at the beginning of the river reach;
Diversions is the sum of canal and pump diversions from the river reach;
Reservoir Change in Content is the daily increase (positive value) or decrease (negative value) in physical content of any reservoirs within the river reach;
Reservoir Evaporation is the calculated evaporative losses from the reservoir.

3. A positive reach gain indicates a gaining reach while a negative reach gain indicates a losing reach. The individual reach gains are summed from upstream to downstream to determine the total natural flow at each reach. Reach gains are averaged over multiple days in the water rights accounting to decrease variability of natural flow calculations caused by imprecise water travel times and inaccurate measurement data.

4. Natural flow is distributed to each water right based on water right priority, point-of-diversion, flow rate, volume, period-of-use, and any other limitations or conditions specified by the water right.

5. Natural flow distributed to diversions cannot exceed the following: (1) the amount of natural flow available to the diversion's water right(s) at the point of diversion, (2) the daily amount diverted by the pump or canal and (3) the annual volume limit of the water right.

6. Natural flow distributed to on-stream reservoir water rights are limited by the amount of natural flow that was available or that would have been available if not for impoundment by an upstream reservoir and by the reservoir's water right annual volume limitation. The on-stream reservoir water rights do not have a flow rate limits.

7. When the diversion rate at a point of diversion exceeds the computed natural flow available to the water right holder(s), the excess amount is charged as storage water use.

8. The remaining natural flow, if any, for each reach is calculated at the end of each day. The remaining natural flow is defined as the amount of natural flow at the end of each reach after all of the water rights within the reach and upstream reaches have been satisfied.

9. Water that is physically stored in the reservoir system but not accrued to a reservoir water

right is referred to as unallocated storage (UNACCT STOR)[3]. This situation can occur when there is natural flow in excess of demand, the reservoir right(s) has been satisfied, and there is space in the reservoir system. In the water rights accounting for Water District 63, unallocated storage has been captured in the system when the *remaining natural flow* (calculated) at the end of the system (the Boise River near Middleton gage) is greater than the actual measured discharge.

10. Storage released past Middleton is calculated by the water right accounting program and identified in the daily output report under the heading MIDDLETON STORED.

11. Physical reservoir system content is equal to the volume of natural flow accrued to reservoir water rights (STORED (AF)), plus unallocated storage (UNACCT STOR), minus reservoir evaporation, minus the storage delivered to diversions, minus the storage released past Middleton for each day in the water rights accounting. The discrepancies (AVERAGING ERROR) caused by the reach gain averaging are computed each day and must be added (positive value) or subtracted (negative value) to the water distributed to system diversions and reservoirs to balance the water distributed with system reservoir physical contents.

Technical Review

Responses to the request for analysis are presented below.

Director's Request - Item 1

- How and why water is counted or credited to the water rights for reservoirs in Basin 63 pursuant to the existing accounting methods and procedures.

Distribution of Natural Flow to On-stream Reservoir Water Rights

Any natural flow, that is available or would be available if not for upstream storage, and in priority at the point-of diversion (dam), is accrued toward the satisfaction of the on-stream

[3] The terms "unallocated" and "unaccounted" storage have been used historically to mean the same thing.

reservoir water right. Natural flow that arises below a reservoir may not be accrued to the reservoir's water right. For example, water entering Lucky Peak through Mores Creek can only be accrued to Lucky Peak's right (when it is available). Mores Creek water is not physically tributary to Anderson Ranch or Arrowrock and cannot be accrued to the upstream reservoir rights.

On-stream reservoir water rights in the water rights accounting do not have a flow rate limitation like a canal or pump water right, but the reservoir water rights do have an annual volume limitation. Any natural flow that is available and in priority at the point of diversion is accrued towards the reservoir right until the annual volume limit has been met. The amount of natural flow distributed to a reservoir water right is described as the amount *accrued* to the reservoir's account. This volume is computed on a daily basis by the water right accounting program and identified in the output report under the STORED (AF) heading. Natural flow distributed to canals and pumps in the water right accounting is described as the amount of natural flow *diverted* from the river.

For on-stream reservoirs "the entire flow of the natural stream has been diverted and stored and become subject to controlled releases.[4]" By contrast, canals and pumps divert only the amount needed for use. The water rights accounting accrues natural flow that is both available (or that would be available if not for upstream storage) and in priority at the point-of diversion toward the satisfaction of the reservoir water right.

Once the reservoir's cumulative accrual has reached the annual volume limit, the reservoir water right can no longer accrue additional natural flow to its water right in the water rights accounting and natural flow can begin to be distributed to junior water rights. The cumulative amount accrued to the reservoir water right in the water right accounting is not adjusted downwards as water users divert storage for irrigation purposes, nor is the cumulative amount reduced for storage that is released past Middleton. The water rights accounting does not track (a) where reservoir accrual is physically being held in the reservoir system, (b) which individual reservoir's

[4] *In the Matter of Accounting for Distribution of Water to the Federal On-stream Reservoirs in Water District 63. Notice of Contested Case and Formal Proceedings, and Notice of Status Conference.* October 24, 2013.

accrual is diverted by canals and pumps, and (c) which individual reservoir's accrual is released past Middleton.

The reservoir accrual annual volumes are reset in the water rights accounting after the day of allocation. After the reset, the reservoirs water rights may accrue water under their rights priority towards the annual volume for the following year's allocation.

The amount accrued to a reservoir's STORED (AF) account in the water right accounting is not reduced by the amount of water physically released from the dam, nor is the amount based on the change in the physical reservoir contents. Reservoir operations preclude basing the annual accrual volumes to on physical contents to the reservoir water right accrual for the following reasons:

- Natural flow accruing to a reservoir water right may physically be captured in another reservoir.
- Storage water may be moved from one reservoir to another.
- Storage water may be delivered to diversions at the same time natural flow is being accrued to the reservoir's water right.
- Stored water may be released from federal reservoirs for operational purposes at the same time natural flow is being accrued to the reservoir's water right.

The Bureau owns and operates Arrowrock and Anderson Ranch reservoirs. Lucky Peak is an Army Corps of Engineers (Corps) project and is operated in conjunction with Arrowrock and Anderson Ranch Reservoirs. Reservoir operations are outlined and governed by the procedures in the "Water Control Manual.[5]" The Boise River on-stream reservoirs (Arrowrock, Anderson Ranch and Lucky Peak) are operated as one system and water is often released from one reservoir to a downstream reservoir for reasons including but not limited to flood control, irrigation, power generation, recreation, and water quality. Reservoir operations in federal reservoirs are controlled by the federal government. If reservoir operations and physical contents determined the satisfaction of state water rights it could result in federal control of the

[5] *Water Control Manual for Boise River Reservoirs*. April 1985. U.S. Army Corps of Engineers Walla Walla District.

distribution of natural flow to state water rights. Some of the reservoir operations, such as flood control, are not authorized on a water right, and are not considered in distributing water to the reservoir water rights. Operational releases that are not authorized by a water right have no priority, flow rate, or volume that can be distributed. The water rights accounting determines the water available for storage under the water rights. The federal government determines how to allocate storage including how to account for operational decisions to release storage. Water right holders junior to the reservoir rights are not curtailed to make up for storage lost by operational decisions.

Paper Fill* versus *Physical Fill

The term *paper fill* has been used as a term of convenience to describe the cumulative amount of natural flow accrued to a reservoir water right in the water rights accounting. The term *physical fill* has been used to describe the water volume physically held in a reservoir or in the reservoir system. A common misconception is that *paper fill* represents imaginary water created by the water rights accounting. This incorrectly equates the physical fill of a reservoir with the accrual of the natural flow to on-stream reservoir rights. The natural flow accrual to reservoir water rights in the water rights accounting is calculated from actual flow measurements at real gages. Daily *paper fill* is the natural flow existing on a day of water rights accounting that was distributed or accrued to reservoir water rights.

The *paper fill* in each reservoir water right is frequently different than the *physical fill* in each reservoir because of the following occurrences: deliveries of previously accrued storage from reservoirs to diversions; previously accrued storage is sometimes released from the reservoir system past Middleton; storage moved from one reservoir to another; evaporative losses to the reservoir. The system's *paper fill* is equal to the system's *physical fill* adjusted for storage deliveries, water released past Middleton, and for reservoir evaporation. Any difference between the accounting accruals (*paper fill)* and the physical content of the reservoir system (*physical fill)* is a result of storage deliveries, and/or releases by the Bureau, and/or reservoir evaporation.

Unallocated Storage (UNACCT STOR)

Unallocated storage is the natural flow physically captured in a reservoir that could not be distributed to a water right. Unallocated storage occurs when there is water in excess of demand and there is space available in the reservoirs. This occurs in the water rights accounting when the observed (actual) discharge passing Middleton **is less than** the *remaining natural flow* at Middleton after system natural flow has been distributed to diversion and reservoir water rights upstream. This amount of surplus natural flow that could not be distributed to a water right (but now resides physically in the reservoir system) accrues to the unallocated storage (UNACCT STOR) in the water rights accounting. The physical reservoir contents is equal to the volume of natural flow accrued to the reservoir water rights adjusted for unallocated storage, reservoir evaporation, storage deliveries, and storage passing Middleton. The water rights accounting does not determine in which reservoir the unallocated storage was physically stored, nor does it determine how or when the storage should be distributed to water users.

Storage Passing Middleton

The Boise River near Middleton is considered the end of the system because natural flow that arises below Middleton has historically met the demand in the lower reaches. Any storage water that passes Middleton is considered to have left the system. Storage water passing Middleton can be the result of a variety of different reasons including:

- Storage delivery for flow augmentation by the Bureau,
- Storage released with the intent of meeting diversion demand but was not actually diverted (operational loss),
- Storage delivery for winter instream flow above Middleton resulting in storage passing Middleton,
- Storage delivery to Idaho Power from the rental pool for out of basin uses,
- Storage released as a result of reservoir operations, such as flood control.

The water rights accounting does not determine the purpose for the storage water passing Middleton. Distribution of natural flow is managed by the watermaster as supervised by the Director while reservoir operations are managed by the federal government. If reservoir operations result in storage passing Middleton and the releases lower the amount of water

physically available in the reservoirs, the Bureau must determine which reservoir account must be reduced before allocating storage to its spaceholders for use during the irrigation season.

Storage Allocations

Everything discussed in this memorandum up to the point has concentrated on the water rights accounting and the distribution of natural flow to diversion and reservoir rights. Although not explicitly requested by the Director, the following discussion is provided for informational purposes.

Storage Program

The storage program is a separate program from the water rights accounting. The purpose of the storage program is to allocate storage water to the individual spaceholders according to the federal contracts and Bureau instructions. The federal contracts are not water rights. The Department runs the storage program and the Bureau reviews and approves the output (storage report). The methodology and formulas for distributing storage water to the individual spaceholders were determined by the Bureau and are ultimately the responsibility of the Bureau. The storage report includes the following information:

- Total storage volume available for allocation and evaporation losses for each reservoir account;
- Reservoir space assigned to each spaceholder;
- Storage volume, evaporative, and operational loss allocated to each reservoir spaceholder;
- Storage used, rental pool, and other adjustments to each reservoir spaceholder;
- Total carryover and carryover in each reservoir account for each reservoir spaceholder;
- Total carryover in each reservoir account on October 31.

The storage program is generally run twice a year, on the day of allocation and after the end of the irrigation season (October 31). Spaceholders' annual storage allocations cannot be determined until the day of allocation has passed, which is after:

(1) the last day of reservoir accrual to reservoir rights has occurred in the water rights accounting,

(2) diversion demand is equal to or greater than the available natural flow, and

(3) the maximum physical total reservoir system contents has occurred.

Every year is different and the calendar date of the day of allocation varies based on water supply and demand. After the day of allocation has been determined, the storage program is run. The volume of storage water available for distribution is determined. If storage has been spilled past Middleton, the Bureau must decide how the storage allocations are reduced. If flood control operations result in a less than a full allocation, the first 60,000 acre-feet of shortage is deducted from the Bureau's Lucky Peak Reservoir streamflow maintenance account, and the irrigators are given a full storage allocation. Shortages in excess of 60,000 acre-feet are allocated proportionally to the Lucky Peak spaceholders. The Bureau must determine which reservoir account(s) must be reduced before allocating storage to its spaceholders for use during the irrigation season. The storage program is run to determine the total storage available to the individual spaceholders and the results are entered into the water rights accounting program.

The storage program is run again after October 31and subtracts each spaceholder's storage use volume from the spaceholder's storage allocation. The storage program then determines distribution of carryover among individual contract spaceholders and to the reservoirs. The distribution of carryover among the reservoirs becomes the November 1 volume of water credited towards the satisfaction or "fill" of the reservoir rights in the water rights accounting.

Storage Cancelling

In some years, the natural flow early in the irrigation season, typically in April, is insufficient to meet the irrigation demand and canals that divert in excess of their available natural flow are charged in the accounting for use of storage. After the spring runoff occurs, there may be water in excess of demand, and the reservoirs physically fill to 100%. The storage charged early in the season is "canceled" when this happens. This practice has been called "storage cancelling."

Winter Storage Releases

Storage water may be delivered during the non-irrigation season for authorized uses. Examples of winter storage releases include the Idaho Fish and Game and the Bureau storage releases from Lucky Peak for streamflow maintenance. The water released is deducted from Idaho Fish and

Game's and Bureau's storage carryover from the irrigation year, which ended on October 31. In the water rights accounting storage deliveries for these purposes reduces the reservoir rights accrual by the volume of storage delivered.

Director's Request -Item 2

- The origin, adoption, and development of the existing accounting methods and procedures in Water District 63.

Prior to implementation of the water rights accounting, the watermaster in Water District 63 used hand calculations to distribute water to water right holders in priority. In general, there was a reservoir accrual season (November 1 to April 1, non-regulation season) and an irrigation season (April 1 to October 31, regulation season). Water was distributed according to priorities on a daily basis only during the irrigation season. Accruals to reservoir water rights were not determined daily but rather on the date of maximum total reservoir fill[6]. The Bureau determined the fill of the reservoir rights. On the date of maximum fill, storage was assigned to the most senior reservoir right first. Arrowrock received the first allocation up to 100% of its right, the remainder was assigned to Anderson Ranch up to 100% of its right, and any remaining storage was assigned to the Lucky Peak right. Under this scenario, an upstream reservoir could have been credited for natural flow that arose below the reservoir.

In the early 1980's, the department considered the development and implementation of a computerized water right accounting system, comparable to the one implemented in the Water District 01 in 1978. It was not until 1986, in response to a request by the Water District 63 watermaster, that computerized accounting was implemented in Water District 63.[7] The computerized accounting program initiated in 1986 has been used every year since by the watermaster for the distribution of natural flow on the Boise River.

While many of the core algorithms used in the Water District 01 and Water District 63 accounting programs are the same, each water district accounting program has its own unique

[6] Memorandum May 3, 1977 To: RO 100, 700, 760 Project Superintendent, SCPO, Boise, Idaho From:761 Subject: New Method Adopted for Allocation of Boise System Storage.
[7] *Water Distribution of Boise River District 63 1986.* Page 1.

code. Bob Sutter, former Department staff, developed the water rights accounting programs for Water District 01 and Water District 63.

A 1987 document titled "Water Delivery Accounting Boise River WD-63" described the procedures used in the accounting program[8]. The computerized accounting program changed the method of computing the reservoir right accrual. The computerized accounting program filled reservoir rights based on the natural flow available to the water rights on a year round basis as opposed to previous method of assigning reservoir right accrual on the date of maximum fill to the most senior reservoir first. Natural flow arising below a reservoir would no longer be credited to upstream reservoirs. The report compared reservoir right allocations between the new and old methods of accounting for years 1973 and 1977.

Summary and Conclusions

In 1986, the Boise water rights accounting was initiated and began the first year-round water rights regulation of the Boise River. The water rights accounting has been used by the watermaster for every year since 1986. The methodology for distributing natural flow to water rights in the water rights accounting is determined using the physical water available each day. Distribution of natural flow is managed by the watermaster as supervised by the Director while reservoir operations are managed by the federal government. Natural flow distributed to on-stream reservoir water right(s) is limited by the amount of natural flow available or would have been available if not for impoundment by an upstream reservoir to the reservoir water right at the point of diversion, not to exceed the reservoir's water right(s) annual volume limit. During times when there is natural flow in excess of demand and there is space in the reservoirs, water may physically be stored in a reservoir, but not accrued to a reservoir right because the right has been satisfied.

[8] *Water Delivery Accounting Boise River WD-63.* February 4, 1987.