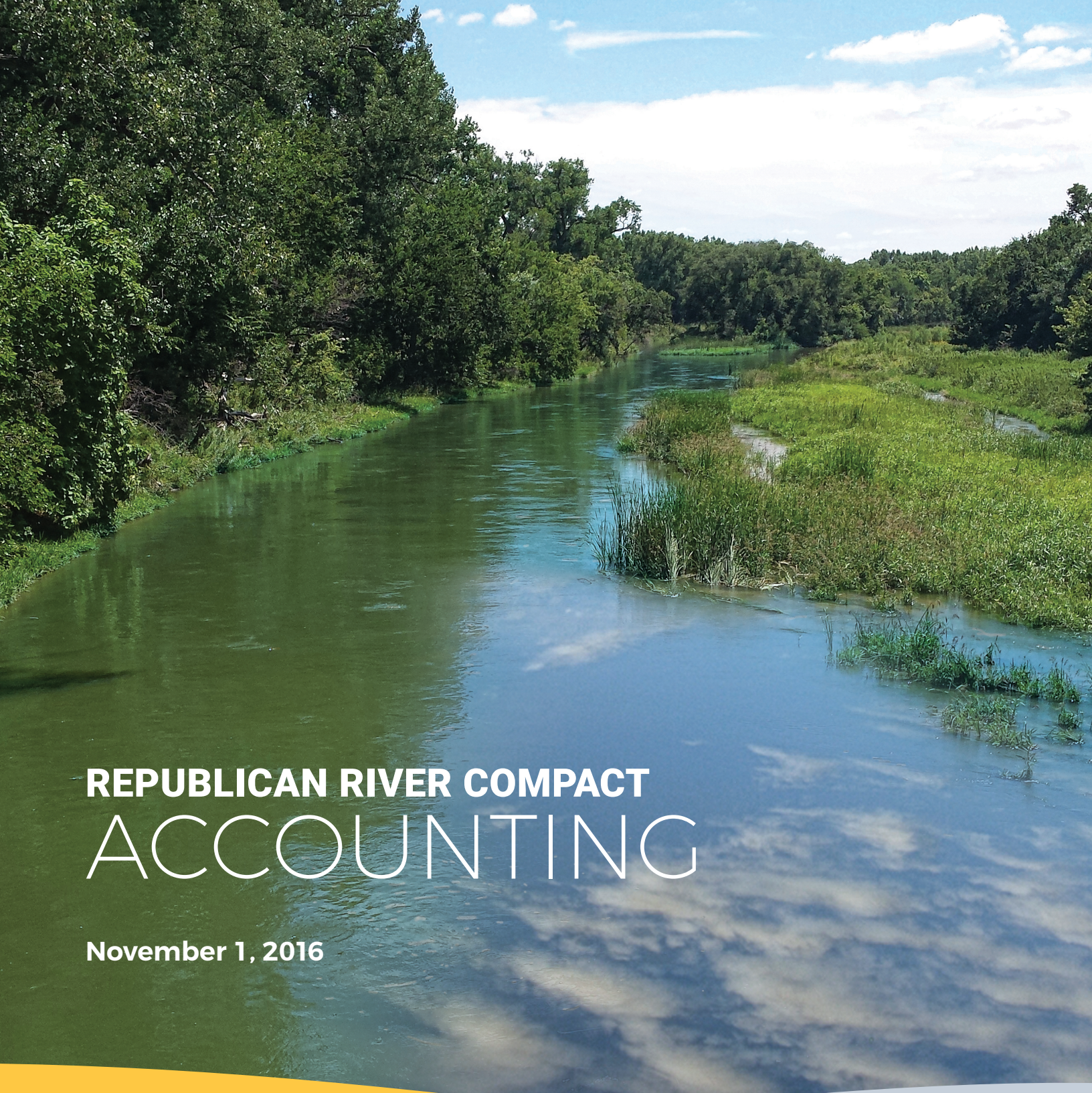

REPUBLICAN RIVER COMPACT ACCOUNTING

November 1, 2016

NEBRASKA

DEPT. OF NATURAL RESOURCES


REPUBLICAN
RIVER
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WHY DO WE HAVE A COMPACT?

The Republican River Compact (Compact) was signed by the three states of Nebraska, Kansas, and Colorado and approved by the U.S. Congress in 1943. Negotiations between the states, and with the federal government, took several years, and involved many people representing different interests.

Why did the states invest in a compact to direct the management of the Republican River? There are several reasons—two of which are outlined here:

FEDERAL RESERVOIR DEVELOPMENT AND FLOOD CONTROL

After the 1935 floods on the Republican River, which killed dozens of people and caused tremendous damage, there was a strong push for new dams to help contain future flood waters. Before allowing for this development, however, the federal government directed the states to write a compact, to justify federal expenditures and new responsibilities that would result.

PROTECTION AGAINST UPSTREAM WATER USERS

Before the Compact, there was little protection for water users downstream of upstream states on the river. Since the Republican River and its tributaries start in western Colorado and Kansas, flow downstream to Nebraska, and then end in eastern Kansas, even the State of Nebraska was at risk from upstream users using more than their portion of the water supplies of the Republican River Basin (Basin).

WHY DOES THE COMPACT HAVE ACCOUNTING PROCEDURES?

The Republican River Compact is a consumptive water use allocation compact. This means that while river flows are important for the Compact, they are only a part of a more complex method used for determining if a state is in compliance.

In order to know whether each state is using only the portion of supply that it was entitled to (a quantity referred to as an "allocation"), it is important to have a consistent way to calculate the different forms of supply and use. That's why the Accounting Procedures were created, updated, and adopted by the Republican River Compact Administration (RRCA). The Accounting Procedures provide directions for calculating the total water supply and how much of that total supply each state can beneficially use (allocation). Additionally, the procedures provide a consistent means for each state to estimate water used for irrigation and other demands. It is the difference between a state's allocation (supply) a nd water used that determines the accounting balance for each state in a given year and over a series of years.

Accounting Procedures help to provide certainty to water users and help protect each state's ability to maximize its beneficial use of its allocation. With accounting agreed to by all three states, it is a way for water users and the states to know how much water would be available for them to use or whether a state had exceeded its allocation.

The Accounting Procedures can also be updated over time, as better information and new technology provide better ways to account for water supplies and uses.

WHAT IS INCLUDED IN THE ACCOUNTING?

The inputs to the Accounting Procedures generally fall into four categories: 1) streamflow; 2) groundwater depletions estimates; 3) surface water use estimates; and 4) Imported Water Supply, each of which is further described below.

Streamflow—gaged streamflow values are measured at Compact gages located throughout the Basin (Figure 1). These gages provide important information as to the amount of water exiting portions of the river basin (subbasins), including the mainstem of the Republican River.

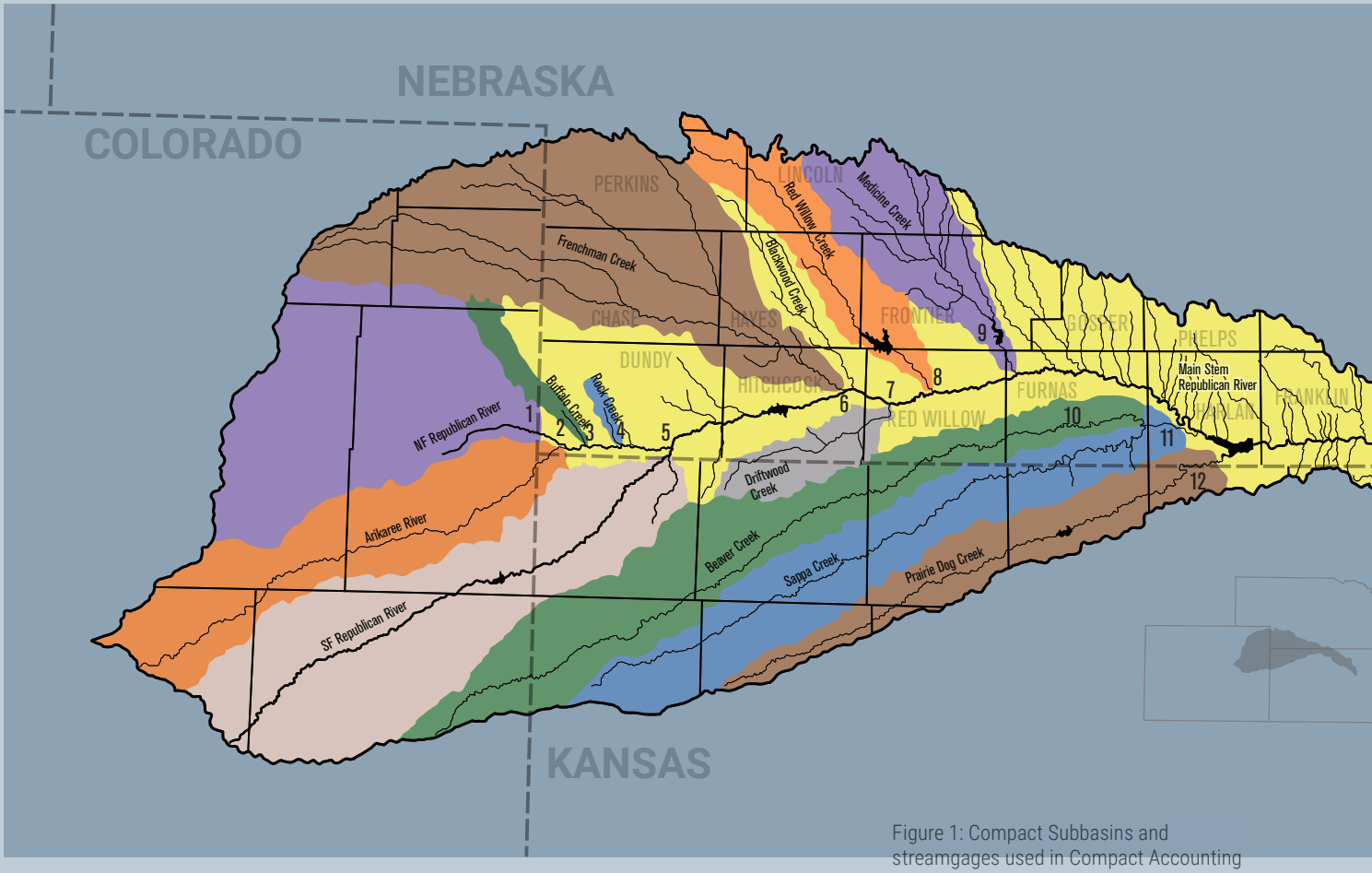


Figure 1: Compact Subbasins and streamgages used in Compact Accounting

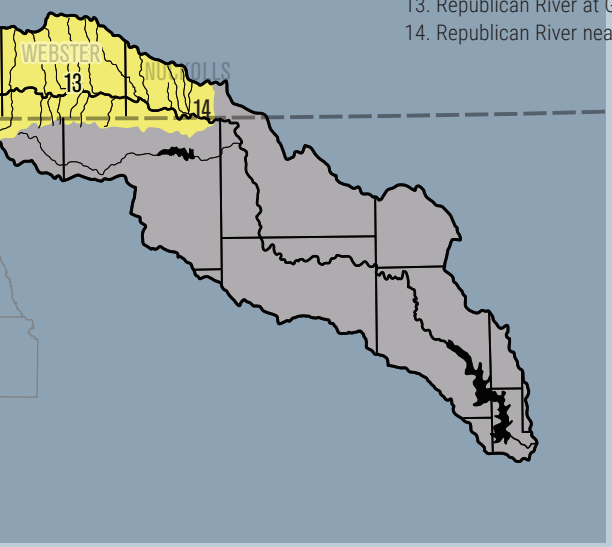
Groundwater depletions estimates– surface water and groundwater are connected, so groundwater pumping can result in decreases to streamflow, depending on the properties of the underground aquifer between the well and the river. Groundwater depletions (i.e., the impacts of groundwater pumping on streamflow) in the Basin are estimated using a groundwater model. The area analyzed by the model extends outside of the surface water basin boundary in order to capture the full extent of the impact of groundwater pumping on streamflow, meaning some wells outside of the surface water basin are included in estimating depletions. Within the Basin, all irrigation wells are metered, and these meter data are used within the model to estimate the impacts from pumping.

Surface water use estimates– this component of the accounting estimates the amount of surface water that is consumptively used in the Basin. This includes several different sources, including evapotranspiration from crops serviced by canals and small individual pumpers. It also includes water lost as evaporation from reservoirs that hold more than 15 acre-feet of water.

Imported Water Supply (IWS)– this volume of water results from human activities that occur outside of the Basin. It originates from canal seepage in the Platte River Basin, which seeps underground into the water table, and then moves south into the Republican River Basin (Figure 2).

COMPACT STREAMGAGES

1. North Fork Republican River at Colorado-Nebraska State Line
2. Arikaree River at Haigler
3. Buffalo Creek near Haigler
4. Rock Creek at Parks
5. South Fork Republican River near Benkelman
6. Frenchman Creek at Culbertson
7. Driftwood Creek near Red Willow
8. Red Willow Creek near McCook
9. Medicine Creek below Harry Strunk
10. Beaver Creek near Beaver City
11. Sappa Creek near Stamford
12. Prairie Dog Creek near Woodruff
13. Republican River at Guide Rock
14. Republican River near Hardy



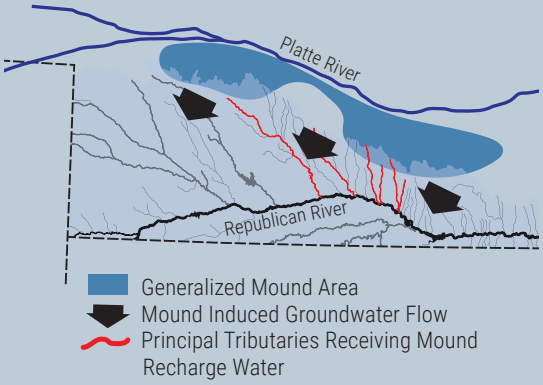


Figure 2. Illustration of sources for Republican River Basin imported water supplies.

HOW ARE ALLOCATIONS AND WATER USES DETERMINED?

Water supplies under the Compact are based on how much streamflow might have been available in the Republican River without certain human activities. In other words, if people were not using water from the river or hydrologically connected groundwater, we would expect the current river flows to equal the water supply.

Each year, the total water supply available for all three states combined is estimated for each of the twelve subbasins and the mainstem (Figure 1 and Table 1) by adding the following volumes:

- Streamflow
- Groundwater depletions (GWCBCU)
- Surface water use (SWCBCU)

and then subtracting

- Imported Water Supply credit (IWS).

3-state water supply =
streamflow + GWCBCU + SWCBCU – IWS

Subbasin	Colorado Allocation Percentage	Kansas Allocation Percentage	Nebraska Allocation Percentage
North Fork	22.4%	27.1%	50.5%
Arikaree	78.5%	4.9%	16.6%
Buffalo		34.2%	65.8%
Rock		30.7%	69.3%
South Fork	44.4%	47.4%	8.2%
Frenchman		23.7%	76.3%
Driftwood		46.1%	53.9%
Red Willow		41.3%	58.7%
Medicine		46.4%	53.6%
Beaver	20.0%	39.1%	40.9%
Sappa		50.2%	49.8%
Prairie Dog		69.6%	30.4%
Main Stem		51.1%	48.9%
Overall Percentage	~10.0%	~40.0%	~50.0%

Table 1. The percentage of allocation from each subbasin that is dedicated to each state.

To determine how much of the water supply in each subbasin is available for each state, the Accounting Procedures define a percentage for each state in each subbasin. On average, across the entire Basin, Nebraska generally receives more than 50 percent of the Basin's water supplies, with Kansas receiving approximately 40 percent and Colorado receiving approximately 10 percent. Table 1 illustrates the specific distributions of the subbasin allocations and the typical overall percentage of allocation to each state after the water supplies calculated for each subbasin are aggregated. The specific volume of water that each state is allocated varies from year-to-year depending on climate conditions, as illustrated in Figure 3.

In addition to Nebraska's allocation of these water supplies, Nebraska also receives a credit from imported water supplies, as described on page 4. Because of this, Nebraska's water supply is calculated as:

Nebraska water supply =
Nebraska's portion of 3-state water supply + IWS

Each state's water use is determined each year by adding together its groundwater depletions estimates and surface water use estimates. The difference between a state's water supply and water use creates an annual "Compact balance" that is used in measuring compliance. The next section provides an overview of how the compliance tests are applied.

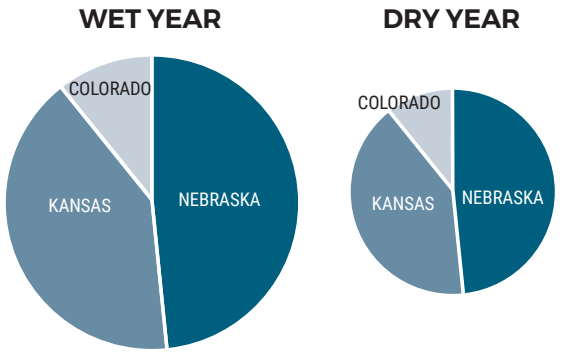


Figure 3. Illustration of the effects of wet and dry conditions on allocations.

HOW IS COMPACT COMPLIANCE MEASURED?

Large variations in weather, hydrology, and management conditions can occur from year to year in the Basin. In order to provide greater flexibility for water management, Compact compliance is determined by considering the average of multiple years, instead of evaluating only a single year. Averaging helps the states to respond to changing conditions and is beneficial because adaptive management decisions and fluctuations in hydrology can have impacts that span multiple years.

Compliance with the Compact is generally evaluated based on the average balance between Nebraska's allocation and use for all areas upstream of the Hardy gage over a five year period (Figure 4A); however, during certain periods an additional compliance test is also applied. This additional compliance test reduces the averaging period to two years and evaluates the balance of allocation and water use for only those areas upstream of Guide Rock, Nebraska (Figure 4B). This additional compliance test (two-year averaging upstream of Guide Rock) is required when the irrigation water supplies stored in Harlan County Lake are less than 119,000 acre-feet. A recent agreement by the three states provides additional flexibility with this requirement. The periods when water supplies are less than 119,000 acre-feet are referred to as Water-Short Years. The United States Bureau of Reclamation is responsible for performing calculations related to determining the irrigation water supplies available in Harlan County Lake. These calculations are finalized on June 30th of each year.

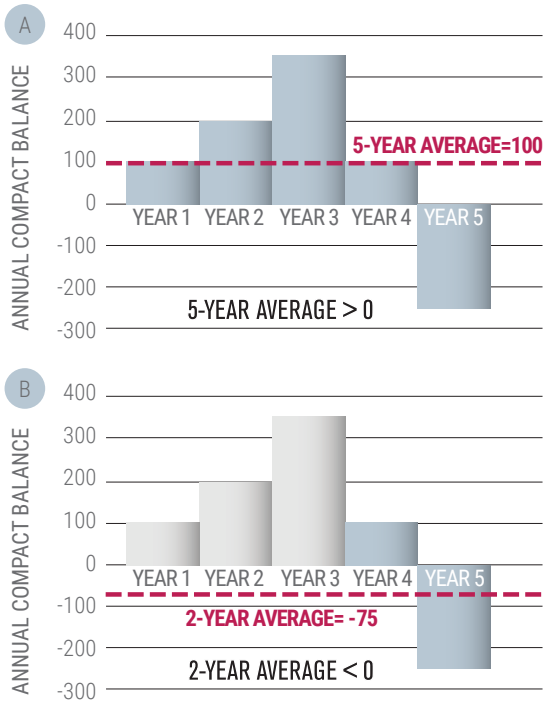


Figure 4. Illustration of the effects of the averaging period on Compact compliance calculations.

Figure A indicates that the five-year averaging period applies and the resulting average is positive.

Figure B indicates that for the same annual Compact balances, the average would be negative under the shorter two-year averaging.

In reality, the annual values for the two- and five-year tests would differ slightly, since they are measured at different gages (Guide Rock and Hardy, respectively). See Figure 1 for the location of these gages.

THE NEED FOR A FORECAST

The retrospective nature of Compact accounting (calculations performed after the end of the year) creates the need to predict Nebraska's allocation and use, especially during periods subject to the two-year average. The forecast calculations are performed by the Nebraska Department of Natural Resources (NeDNR) in consultation with the Natural Resources Districts (NRDs) in the Basin. The methods used in the forecast are outlined in each of the three Basin NRDs' integrated management plans. This forecast attempts to conservatively estimate Nebraska's accounting balance for the upcoming year and combines that projection with the preliminary accounting balances from previous years to assess whether Nebraska will remain in compliance if no additional management actions, such as use curtailments or augmentation, are implemented.

Once Nebraska has projected the allocation that will likely be available for its use, it must determine how that projected allocation will be shared among various users. The integrated management plans of the Basin's NRDs contain the full details of how the allocation is shared, but generally, the allocation is shared by totaling the water use from sources within the Basin and, after projecting surface water use, distributing what is left to the three NRDs within the Basin. The next section will explore what occurs when Nebraska's allocation is projected to be insufficient to support all of Nebraska's uses in the Basin.

WHY ARE MANAGEMENT ACTIONS NECESSARY AND WHO BENEFITS FROM THOSE ACTIONS?

Simply put, management actions become necessary when Nebraska's supply (allocation) is projected to be less than its use, over the appropriate averaging period (Figure 5). Management actions assist by either creating a larger supply (e.g., augmentation) or by reducing use (e.g., retirement of acres and allocations).

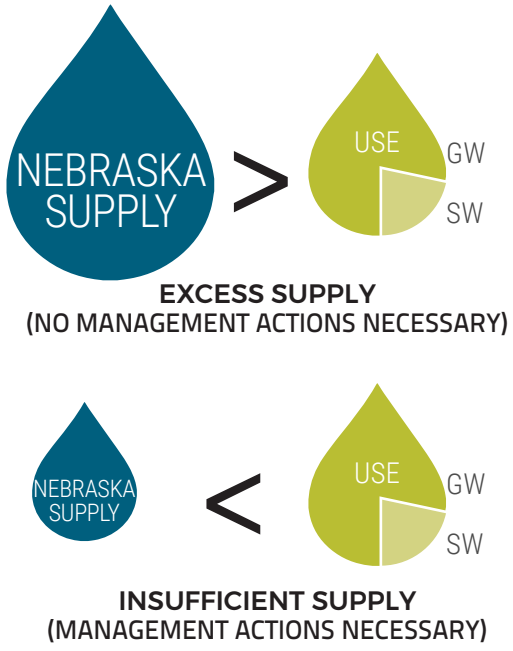


Figure 5. Illustration of the balance of supply and use. When supplies exceed use, the result is a positive annual balance, but when supplies are less than use, the annual balance is negative. Nebraska's use consists of groundwater depletions (GW) and surface water use (SW).

As described in the previous section, the need for management actions is determined annually by NeDNR through its forecast. When management actions are necessary, the individual NRDs in the Basin determine which specific actions to implement. Once NeDNR determines that sufficient actions are being taken to provide the required water, NeDNR protects the water resulting from those management actions.

The implementation of management actions, such as augmentation, pumping limits, acreage reduction, and others, benefits all water users in the Basin. This is because actions such as augmentation increase Nebraska's allocation (Figure 6). With this increased allocation, the need to restrict water use is reduced or eliminated.

Figure 6. Illustration of the effect of increasing Nebraska's water supplies through augmentation. This figure shows that when water supplies are insufficient, water uses cannot be fully met and thus create unmet demand. However, when water supplies are increased via augmentation this new water supply can accommodate all groundwater depletions (GW) and surface water uses (SW).

SUMMARY

This publication has provided a broad review of the Compact, Accounting Procedures, how Nebraska's compliance is measured, and how management actions assist in meeting Compact obligations. A separate NeDNR publication, *A Deeper Understanding of Republican River Compact Accounting*, will explore how changes to various inputs can affect the annual Compact accounting results and ultimately the magnitude of Nebraska's management actions to ensure Compact compliance.

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