No. 126, Original

IN THE SUPREME COURT OF THE UNITED STATES
October Term, 1998

STATE OF KANSAS,

Plaintiff,

vs.

STATE OF NEBRASKA and STATE OF COLORADO,

Defendants.

COLORADO'S RESPONSE TO NEBRASKA'S MOTION TO DISMISS

KEN SALAZAR
Attorney General
BARBARA McDONNELL
Chief Deputy Attorney General
MICHAEL E. McLACHLAN
Solicitor General
FELICITY HANNAY
Deputy Attorney General
WENDY WEISS
First Assistant Attorney General

ALEXANDRA L. DAVIS*
Assistant Attorney General
Natural Resources and
Environment Section
Attorneys for State of Colorado
1525 Sherman Street, 5th Fl.
Denver, Colorado 80203
Telephone: (303) 866-5041
FAX: (303) 866-3558
Counsel of Record

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INTRODUCTION

This is an action by the State of Kansas against the State of Nebraska and the State of Colorado. Kansas alleges that Nebraska's unregulated pumping of ground water in the Republican River basin violates the Republican River Compact ("Compact"). Upon an order from this Court, Nebraska filed a motion to dismiss on the grounds that the Compact does not apportion or allocate ground water in the Republican River basin. The question presented to this Court is: "Does the Republican River Compact restrict a State's consumption of ground water?" (Court's Order, June 21, 1999.)

As Nebraska's brief recognizes, there are two types of ground water within the geographic boundaries of the Republican River basin: alluvial ground water and Ogallala Aquifer ground water. Nebraska's Brief in Support of

Motion to Dismiss ("Nebraska Brief") at 18-19. Nebraska argues that Ogallala ground water was not included in the Compact, but virtually concedes that alluvial ground water was. *Id.* Colorado concurs, believing that those who drafted and ratified the Compact intended to include alluvial, but not Ogallala, ground water.

STATEMENT OF FACTS

Colorado, Kansas, and Nebraska determined that a compact was necessary to equitably allocate the waters of the Republican River and designated commissioners for the purpose of drafting a compact. The commissioners (M.C. Hinderlider for Colorado, George S. Knapp for Kansas, and A.C. Tilley and later Wardner G. Scott for Nebraska) met eight times between May 26, 1940 and March 19, 1941. The first Republican River Compact was signed by each of the participating states and consented to by Congress in 1941, but vetoed by President Roosevelt because of the lack of federal representation in the negotiations.

After the veto, Glenn Parker, Chief Hydrologist U.S. Geological Survey, was appointed to the commission as the federal representative. The second draft compact, with provisions intended to correlate federal and state interests without impairing the underlying federal jurisdiction, was signed by the commissioners on December 31, 1942, and subsequently ratified by the compacting states. Congress consented to the Compact and President Roosevelt approved it on May 26, 1943. Pub. Law 60, 78th Congress, 57 Stat. 86. The major change between the two compacts was language addressing rights of the federal government. The allocations of water and much of the original language were unchanged between the 1941 and the 1943 versions.

SUMMARY OF ARGUMENT

Nebraska argues that, as a matter of law, the Compact does not restrict ground water consumption for three reasons:

> (1) the Compact, by its plain and unambiguous terms, does not apportion or allocate consumption of any ground water; (2) this Court and the Compact states have previously interpreted the Compact as an agreement regarding rights to only surface water as distinguished from ground water; and (3) the parties did not intend to apportion any ground water under the Compact.

Nebraska Brief at 5-6. Nebraska is wrong on each count.

First, the water supply allocated by the Compact is not clearly limited to surface water and does not specifically exclude ground water. Thus, the Compact is ambiguous and the Court must look at the extrinsic evidence contained in the historical documents surrounding the formation of the Compact to determine the states' intent.

As to the second and third points, the historical documents show that the Compact commissioners intended to apportion alluvial ground water and the states have consistently administered the Compact to include the beneficial consumptive use of alluvial ground water in each state's allocation. This Court has not contradicted the states' interpretation.

While the Republican River Compact allocates the surface water and alluvial ground water of the Republican River Basin, it does not allocate or address water in the enormous, multi-state Ogallala Aquifer. The Compact sets forth the precise geographical boundaries of the Republican River basin. The Ogallala Aquifer boundaries extend far beyond the area covered by the Compact. The Compact specifically defines the full amount of water allocated, yet the Ogallala Aquifer contains vastly more water than the amount allocated by the Compact. Finally, Ogallala water has been

specifically excluded from the computations used to administer the Compact.

ARGUMENT

I. THE REPUBLICAN RIVER COMPACT ALLOCATES GROUND WATER

A. The language of the Compact is ambiguous.

A compact approved by Congress becomes a law of the United States, but is, after all, a contract, and remains a legal document that must be construed and applied in accordance with its terms. *Texas v. New Mexico*, 482 U.S. 124, 128 (1987). Ambiguity exists where the terms of the contract are reasonably susceptible to more than one interpretation. *Papago Tribal Utility Authority v. Federal Energy Regulatory Comm.*, 723 F.2d 950 (D.C. 1983) *cert. denied*, 467 U.S. 1241 (1984). The United States Supreme Court has the final power to pass upon the meaning and validity of compacts. U.S.C. Const. art. 1, § 10, cl. 3., *State ex rel. Dyer et al. v. Sims*, 341 U.S. 22, 28 (1951). This Court has previously determined the meaning of ambiguous words in interstate compacts. In *Oklahoma v. New Mexico*, 501 U.S. 221, 232-236 (1991), the Court found the word "originating" ambiguous. The Court determined the meaning of the word by reviewing numerous historical documents concerning the formation of the compact and the intent of the states. *Id.* at 234.

The plain language of the Compact neither specifically excludes nor includes ground water. The Compact allocates the "Virgin Water Supply," defined as "the water supply within the Basin undepleted by the activities of man." Art. II. The Compact states, "[t]he specific allocations in acre-feet hereinafter made to each

State are derived from the computed average annual Virgin Water Supply originating in the following designated drainage basins or parts thereof in the amounts shown." Art. III. The Compact then lists specific acre-feet amounts for specific drainage basins, rather than specific surface streams.

Article IV contains the specific allocations of beneficial consumptive use for each state, in acre-feet amounts, "derived from the sources . . . specified." The Compact's definition of "Beneficial Consumptive Use" refers to "the water supply of the basin," again without distinguishing between surface water and ground water. Art. II.

Nebraska's argument implies that "water supply" has universally been understood to mean **only** surface water, which is simply not supportable. As early as 1907, this Court recognized:

> If the bed of a stream is not solid rock, but earth, through which water will percolate, . . . undoubtedly water will be found many feet below the surface, and the lighter the soil the more easily will it find its way downward and the more water will be discoverable by wells or other modes of exploring the subsurface.

Kansas v. Colorado, 206 U.S. 46, 114 (1907). Contrary to Nebraska's assertion that the Compact's failure to use the term ground water does not create an ambiguity, the language of the Compact is ambiguous, and further information is necessary to interpret it.

B. The commissioners intended to include alluvial ground water in the original allocation of the waters of the Republican River basin.

When the meaning of a term within a Compact is ambiguous, it is appropriate to look to extrinsic evidence of the negotiation history in order to interpret the term. *See, e.g., Oklahoma, v. New Mexico*, 501 U.S. 221, 232-36 (1991).

The Republican River Compact does not explicitly include or exclude ground water in determining the virgin water supply of the basin or each state's allocation of the water supply based on beneficial consumptive use. The historical evidence shows that alluvial ground water was included in both of these determinations. Three documents conclusively demonstrate that such ground water was included in the Compact: (1) the Explanatory Statement and Report to the Thirty-fourth General Assembly by M.C. Hinderlider, the Republican River Compact Commissioner for Colorado, signed December 31, 1942; (2) the March 20, 1941 transmittal letter from M.C. Hinderlider, accompanying the transmission of the first compact to the governor of Colorado; and (3) the January 9, 1943 transmittal letter from M.C. Hinderlider to Governor Carr of Colorado, accompanying the transmission of the second compact (appendix A-1, A-11, and A-14).

In Commissioner Hinderlider's report to Colorado's general assembly in support of ratification of the Compact, he stated:

> It is believed that this Compact equitably apportions the total available average annual virgin water supplies of the Basin, **both surface and underground**, among the three signatory States, in such manner and in such

> amounts as will not only protect all existing uses within the Basin, but will insure, insofar as possible that the available water supplies when regulated by storage works, will adequately meet future requirements for domestic, irrigation, industrial and recreational purposes, and that it affords ample opportunity for multiple use development and flood control.

Explanatory Statement and Report to the Thirty-fourth General Assembly, Colorado, by M.C. Hinderlider, (1942) (appendix A-1) (emphasis added). Hinderlider sent his report to both commissioners and Glenn Parker, the federal representative, and requested observations or criticisms on his explanatory statement. Letter from M.C. Hinderlider to Glenn L. Parker, Chief Engineer, USGS (February 5, 1943) (appendix A-18). The commissioners would have objected to the inclusion of ground water had that been contrary to their intent.

In his March 20, 1941 transmittal letter to the governor, Commissioner Hinderlider again stated that the Compact allocations included such ground water:

> In its deliberations, the Commission gave careful consideration to the report of the Division Engineer, . . . also to a voluminous report of the Bureau of Agricultural Economics of the U.S. Department of Agriculture on the underground water resources of the Republican River basin and their availability for beneficial application to the future development of the basin. . . . **The compact allocates to Colorado, . . . all of the surface and underground water supplies** originating in Colorado within the Frenchmen and Red Willow Creek drainage basins; . . ..

Letter from M.C. Hinderlider, to Governor Carr of Colorado (March 20, 1941) (appendix A-11) (emphasis added).

Commissioner Hinderlider's transmittal letter of January 9, 1943, was equally clear, stating, "The Compact allocates for beneficial consumptive use in Colorado, annually, a total of 54,100 acre feet of water . . .. **These allocations include not only surface, but also sub-surface, or underground water supplies.**" Letter from M.C. Hinderlider to Governor Carr (January 9, 1943) (appendix A-14) (emphasis added).

Commissioner Hinderlider's explicit statements in these public documents were never contradicted or disputed. These documents demonstrate that the states intended to include ground water in the allocations made by the Compact.

The minutes of the Compact negotiation meetings also show that the commissioners intended to include ground water within the Compact. The commissioners considered ground water an important issue and discussed it extensively. On January 27, 1941, at the fourth meeting of the Republican River compact commission at Topeka, Kansas, the commissioners heard from U.S. Bureau of Agricultural Economics representatives Harry P. Burleigh and Robert M. Barkley. They explained in great detail the scope of the Bureau's work to determine the extent and usability of the underground waters of the Republican River basin:

> Mr. Burleigh explained at considerable length the nature of these investigations . . . . He also presented the Commission with a tabular statement showing estimated amounts of underground water available in the various basins in the Republican River Basin in the three states and amounts of land to which such water supplies could be applied within the economic limits he had assumed.

> Mr. Burleigh advised the Commission that, in view of the fact that numerous applications had been made to his department by land owners thruout (sic) the basin, **he was desirous of obtaining a statement from the Commission as to whether the amounts of underground waters he had determined would be feasibly possible of use, would, in the opinion of the Commission, exceed the allotments of water to each state which the Commission may have agreed upon; that his department did not want to recommend developments of underground water supplies in excess of the allocations of water to each state. . . .**
>
> **Mr. Burleigh advised the Commission that all of the underground waters of the basin above Scandia, Kansas, are included in the total water supplies of the basin**, as reflected in measurements of stream flow at Scandia and other points in the basin, and that any underground water developments must be considered as reducing to that extent the amount of surface water available for use within the basin.

Minutes of the Fourth Meeting of the Republican River Compact Commission, January 27, 1941, Topeka, Kansas, Brief for the United States in Opposition to the Motion to Dismiss, appendix 27a (emphasis added).

Thus, the commissioners were informed of the amount of alluvial ground water available in the Republican River basin and specifically asked to determine whether the federal estimates were consistent with the proposed Compact allocations. The commissioners complied with the request. Following Mr. Burleigh's report, Commissioner Hinderlider

wrote to Commissioners Scott (Nebraska) and Knapp (Kansas):

> It is my understanding that Mr. Knapp will address a letter to Engineer Burleigh of the Bureau of Agricultural Economics, advising him that **the commissioners are in agreement that the estimated amount of ground water which may be developed in each of the tributary basins of the Republican River basin are [sic] within the allocations which the commission has tentatively made.**

Letter from Commissioner Hinderlider to Wardner G. Scott, Republican River Compact Commissioner for Nebraska, and George S. Knapp, Republican River Compact Commissioner for Kansas, (January 31, 1941) (appendix A-20) (emphasis added).

Commissioner Knapp sent an official letter to Mr. Burleigh to the same effect:

> We, the Republican River Compact Commissioners on the Republican River, meeting at Topeka on January 28, examined the tables which you submitted to us on the 27th indicating the approximate recommendations for consumptive use of water by basins in the three states, and **find that the total estimated annual consumptive use of water is within the amount of the water supply available in the basin above Hardy, and that the proposed allocations in each of the several states fall within the amounts which the commission may see fit to allocate to each state.**

Letter from George S. Knapp to Harry P. Burleigh, U.S. Bureau of Agricultural Economics (January 30, 1941) (appendix A-23) (emphasis added).

Mr. Burleigh's detailed presentation on alluvial ground water to the commission, followed by the commissioners' correspondence indicating their agreement with the estimates by the Bureau of Agricultural Economics, are compelling evidence that the commissioners intended to include alluvial ground water in the Compact's allocations of the water supply.

Nebraska argues that "[f]urther evidence of the intentional omission of ground water from the Compact" is that the water supply figures contained in the Compact are too small to include Ogallala ground water." Nebraska Brief at 9-10. While this statement is true, its reasoning does not apply to alluvial ground water. To the contrary, alluvial ground water was in fact included in the water supply figures. *See e.g.* First Annual Report, Republican River Compact Administration for the Year 1960, Lincoln, Nebraska, April 4, 1961, Formulas for the Computation of Annual Virgin Water Supply (appendix A-24).

Nebraska also argues that the Compact's failure to expressly mention ground water and its use of different language than several other compacts show that the parties did not intend to include ground water. [1] This argument

[1] Nebraska's argument that ground water was intentionally omitted from the Compact is based, in large part, on the assertion that, prior to 1943, Kansas had engaged in lengthy litigation with Colorado over the Arkansas River that involved an explicit distinction between surface water and ground water. (Nebraska Brief at 9.) Therefore, Nebraska argues, the states would have made such a distinction in the Republican River Compact had they intended to include

sharply contradicts Nebraska's position in another ongoing interstate water dispute.

This is what counsel for Nebraska said about ground water depletions in oral argument before the Special Master in *Nebraska v. Wyoming*, No. 108, Original:

> It doesn't make any difference whether the ultimate provision in the Arkansas River compact was against the depletions of usable state line flows. It doesn't make any difference whether the ultimate provision in the Pecos River compact related to a diminution of the 1947 condition. **It really doesn't make any difference what kind of apportionment provision you have.**
>
> If post compact or post decree wells physically take unapportioned water that happens as a result of changed conditions but if they take water destined pursuant to the document that we're talking about, to a downstream state, they are violating that document, pure and simple, as everybody seems to be fond of using that phrase.

Transcript at 70-71 (emphasis added), *Nebraska v. Wyoming*, No. 108, Original (June 4, 1998).

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ground water. This disregards the fact that Kansas then entered into a compact with Colorado on the Arkansas River that did not specifically allocate ground water, yet, in the opinion of a special master, confirmed by this Court, has been held to apply to alluvial ground water. First Special Master's Report at 107-08, *Kansas v. Colorado*, 514 U.S. 673 (1995). In any case, Nebraska's argument is based on inferences that are contradicted by the history of the compact negotiations.

In that same case, Nebraska stated in a brief:

> As the Court has held, it is impossible to separate surface water from hydrologically connected ground water. In most river systems, surface water and ground water are one in the same, separated only in time. Typically, the surface flow of an interstate river consists of tributary inflow and ground water accretions, with the latter most often providing the most significant contribution. Wyoming's argument that the ground water portion of the North Platte River was not apportioned is, in a word, absurd.

Nebraska's Reply to Wyoming's, Colorado's, and the United States' Responses to Nebraska's Motion for Leave to File an Amended Petition at 8 (footnote omitted), *Nebraska v. Wyoming*, No. 108, Original (May 16, 1994). Nebraska repeated that language as recently as December 1998. Nebraska's Response to State of Wyoming's Motion to Dismiss Pursuant to Fed. R. Civ. P. 12(b)(1) and 12(b)(6) and Motion for Summary Judgment Pursuant to Fed. R. Civ. P. 56(c) at 51, *Nebraska v. Wyoming*, No. 108, Original (Dec. 5, 1998).

Although the language of the Compact may be ambiguous, the express statements of the original Compact commissioners and the minutes of their meetings show that alluvial ground water was intended to be included in the apportionment of the Republican River basin water supply. As discussed below, this conclusion is reinforced by decades of consistent Compact administration.

II. THE STATES AND THE COURT HAVE NOT INTERPRETED THE COMPACT TO APPLY ONLY TO SURFACE WATER.

A. The states have administered the Compact to include alluvial ground water.

Nebraska concedes that, from 1961 to 1996, the Compact Administration[2] calculated the annual surface water supply of the basin and the annual consumptive use of each state using formulas that it adopted, which "defined the surface water to include water flowing in the stream as well as water found in the adjacent alluvium." Nebraska Brief at 18-19 (footnote defining "alluvium" omitted).

The Compact has consistently been administered to include alluvial ground water in the allocations of Republican River water to each state. From the first, the

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[2] The three commissioners in their role of administering the Compact are called the "Administration." "The State Engineer of the State of Colorado; the Director of Water Resources of the State of Nebraska; and the Chief Engineer, Division of Water Resources, State Board of Agriculture of the State of Kansas, being the officials in their respective states charged with the duty of administering public water supplies, shall be the official members of and together they shall constitute an administrative body hereby designated, 'The Republican River Compact Administration.'" Rules and Regulations of the Republican River Compact Commission, adopted July 15, 1959, Rule 1 (appendix A-159). "The Republican River Compact, hereinafter referred to as the "Compact", shall be administered by the Republican River Compact Administration, hereinafter referred to as the 'Administration.'" *Id.*, Rule 2.

Administration has included alluvial ground water in computing both annual virgin water supply and annual beneficial consumptive use.

The annual reports of the Compact Administration meetings from 1960 forward show that the Administration has consistently included alluvial ground water. In 1962, the Committee on Procedure for Computation of Annual Virgin Water Supply was formed to compute the virgin flow of the Republican River and its tributaries. The May 3, 1963 Progress Report of that committee reports that the data to be used in the computation included "records of pumping from wells" to be collected from irrigators using "wells pumping from the valley floor . . . ." Report of the Third Annual Meeting, May 3, 1963, Exhibit A (appendix A-27). At the fifth annual meeting, the Administration discussed the computed virgin water supply for the previous year and noted that "any errors in assumed factors for return flow or **well diversion** could make a considerable difference in total computed annual virgin water supply." Report of the Fifth Annual Meeting, April 27, 1964 (appendix A-32) (emphasis added). At that meeting, the Administration discussed at some length the consumption of alluvial ground water by wells and inclusion of that information in the virgin water supply computations. Progress Report of the Engineering Committee, April 27, 1964 (appendix A-33).

In 1969, the engineering committee revised the formulas for computing the virgin water supply in the Republican River basin. The subsequent report, dated May 26, 1970,[3] stated: "Computations of virgin water supply by

[3] The revised formulas were discussed at the May 26, 1970 Compact Administration meeting and unanimously adopted by the Administration. *See*, Minutes of the Eleventh Annual Meeting, Republican River Compact Administration for the year 1969, Topeka, Kansas May 26, 1970 (appendix A-153).

the formulas are based upon the following factors: 1. The irrigation diversions by canals, stream pumps and **wells** for which recorded diversions are not available shall be computed by each State based upon the best information available . . . ." Minutes of the Eleventh Annual Meeting, Republican River Compact Administration, Topeka, Kansas May 26, 1970 (appendix A-153) (emphasis added). The report stated further that "irrigation diversions from ground water shall be limited to those by wells pumping from the alluvium along the stream channels." *Id.*

The yearly reports of the Compact Administration meetings uniformly show that alluvial ground water has been included in Compact allocation determinations. Annual consumptive use has consistently been computed using diversions from both surface and ground water sources and both ground water and surface water diversions have been included in computing the virgin water supply, except where the wells were considered to be upland (Ogallala) wells. *See, e.g.*, Progress Report of the Engineering Committee, June 19, 1967 (appendix A-39); Report of the Engineering Committee, June 3, 1968 (appendix A-45); Report of the Engineering Committee, June 30, 1969 (appendix A-51); Report of the Engineering Committee, May 26, 1970 (appendix A-58); Report of the Engineering Committee, June 4, 1971 (appendix A-64); Report of the Engineering Committee, June 9, 1972 (appendix A-71); Report of the Engineering Committee, June 18, 1973 (appendix A-77); Report of the Engineering Committee, June 13, 1974 (appendix A-84); Report of the Engineering Committee, July 30, 1975 (appendix A-91); Report of the Engineering Committee, July 20, 1976 (appendix A-99); Report of the Engineering Committee, June 30, 1977 (appendix A-106); Report of the Engineering Committee, July 7, 1978 (appendix A-115); Report of the Engineering Committee, 1979 Water Year (appendix A-124); Report of the Engineering Committee, 1980 Water Year (appendix A-129); Report of the Engineering Committee, 1981 Water

Year (appendix A-134); Report of the Engineering Committee, 1987 Water Year (appendix A-138); The Thirty –First Annual Report, for the year 1990, July 19, 1991 (appendix A-142); Report of the Engineering Committee, 1991 Water Year (appendix A-146); Report of the Engineering Committee, 1992 Water Year, exhibit 1(appendix A-148); Report of the Engineering Committee, 1993 Water Year, exhibit 2 (appendix A-150).[4]

The Administration's consistent inclusion of alluvial ground water in its calculations of the allocations to each State reinforces the conclusion that alluvial ground water was intended to be included in the apportionment of the Republican River basin water supply.

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[4] Alluvial ground water has been included in the computations since administration began; however, this does not mean the issue is without its disputes. As Administration meeting reports show, in the last decade, disputes have arisen concerning ground water pumping and its effects on surface water. The Minutes of the Thirty–Second Annual Meeting, July 19, 1991, notes that the Administration had asked the Bureau of Reclamation to explore the role of ground water in the Compact. Further, each state computed consumptive use of alluvial ground water differently. Colorado and Kansas included wells constructed into and diverting water from the alluvium of the streams in the basins. Nebraska initially included wells in a band within a mile from either side of a stream, but, in 1990, was in the process of revising its procedure to also include only wells constructed in the alluvium. Minutes of the Thirty–Second Annual Meeting, July 19, 1991 (appendix A-156).

B. The *Sporhase* decision is consistent with the Compact's inclusion of alluvial ground water.

Sporhase v. Nebraska ex rel. Douglas, 458 U.S. 941 (1982), did not consider whether the Republican River Compact includes alluvial ground water. Nebraska misrepresents *Sporhase* by saying that "[t]his Court found the Compact addressed only surface water" and "this court concluded the Compact was limited to surface water . . . ." Nebraska Brief at 11. This Court did no such thing. *Sporhase* was a Commerce Clause challenge to a Nebraska statute that restricted the export of ground water to another state. Nebraska pointed to 37 federal statutes and 23 interstate water compacts, including the Republican River Compact and the South Platte River Compact, to demonstrate Congress' deference to state water law. This Court held that Congress' historical deference to state water law and its willingness to let states settle their differences over water through compacts did not constitute persuasive evidence that Congress consented to the unilateral imposition of unreasonable burdens on commerce. 458 U.S. at 959. In that context, the Court explained that "[t]he interstate compacts to which appellee refers are agreements among States regarding rights to surface water." 458 U.S. 959. That statement can hardly be taken as a specific determination that all interstate compacts, or any particular interstate compact, apply only to surface water.

Moreover, *Sporhase* involved Ogallala ground water, not alluvial ground water. Nebraska Brief at 4. To the extent that *Sporhase* recognized that the Ogallala ground water at issue was not included in any interstate compact, the decision supports Colorado's contention that the Republican River Compact does not include Ogallala ground water.

Nebraska also mischaracterizes *Pioneer Irrigation Districts v. Danielson*, 658 P.2d 842 (Colo. 1983), in stating that "the Colorado Supreme Court concluded that the Compact regulates surface water only and does not affect the actions of Colorado's Ground Water Commission in the Basin." Nebraska Brief at 15. The Pioneer Irrigation Districts are surface water appropriators on the North Fork of the Republican River that alleged that ground water pumping by wells located within the Northern High Plains Designated Ground Water Basin[5] was affecting Republican River surface flows and interfering with their water right. The districts filed a complaint in the water court seeking to require the State Engineer to curtail the wells. The sole question was one of jurisdiction. The Colorado Ground Water Commission has jurisdiction over designated ground water, while the water courts have jurisdiction over surface water rights and other ground water, which is part of the "waters of the state." The water court dismissed the complaint and the Colorado Supreme Court affirmed on the narrow ground that the Ground Water Commission is the forum having initial jurisdiction to make a determination of whether a ground water matter involves designated ground water. The Colorado Supreme Court stated:

> The primary issue is whether the wells which Pioneer seeks to curtail are pumping "designated ground water" or "waters of the state." The Ground Water Commission must make that initial factual determination. **If the Commission finds that the ground water is not designated ground water, then the**

[5] The Northern High Plains Designated Ground Water Basin includes the entire drainage of the North Fork of the Republican River and encompasses the ground water found in the Ogallala Aquifer. 658 P.2d at 844.

matter must be transferred to the water court.

658 P.2d at 846 (emphasis added) (footnote omitted). Thus, the Colorado Supreme Court (1) did not even consider whether the Republican River Compact includes any ground water and (2) concluded that if the Ground Water Commission were to find that wells were pumping waters of the state, rather than designated ground water, the water court would have jurisdiction. If any inference concerning the Compact can be drawn from *Pioneer*, it is that ground water that is classified as "waters of the state" (as opposed to designated Ogallala ground water) would be accounted for under the Compact.

The states have consistently interpreted the Compact to include alluvial ground water and the courts have not held otherwise.

III. THE COMPACT DOES NOT RESTRICT A STATE'S CONSUMPTION OF OGALLALA AQUIFER GROUND WATER.

In its brief, Nebraska fails to distinguish between alluvial ground water and ground water in the Ogallala Aquifer. The Ogallala Aquifer is a huge multi-state aquifer that lies beneath an area known as the High Plains Region. Pub. L. 99-662, Title X, § 1121, Nov. 17, 1986 100 Stat. 4239. The Ogallala is a physically distinct underground structure of the high plains containing billions of acre feet of ground water.[6] The High Plains Region spreads across eight

[6] *A Summary of Results of The Ogallala Aquifer Regional Study, with Recommendations to the Secretary of Commerce and Congress*, High Plains Study Council, December 13, 1982, at 3.

states: Colorado, Wyoming, South Dakota, Nebraska, Kansas, Texas, Oklahoma, and New Mexico.[7] Only three of these states are parties to the Republican River Compact.[8]

The same factors that show that alluvial ground water was allocated by the Compact also show that Ogallala ground water was **not** allocated: the language of the Compact, the history of Compact negotiations, and the states' subsequent administration of the Compact over the past decades.

The Compact applies solely to the Republican River Basin, *see* Arts. I, II, III, IV, and specifically provides that: "The Basin is all the area in Colorado, Kansas, and Nebraska, which is naturally drained by the Republican River, and its tributaries, to its junction with the Smoky Hill River in Kansas." Art. II. The Compact allocates a total of less than 500,000 acre feet of water. A compact of expressly limited geographic scope and precisely defined amounts of water cannot be read to allocate an interstate aquifer that covers 180,000 square miles and contains over 3 billion acre-feet of water. *See* Nebraska Brief, Appendix A.

Historical documents confirm the limited geographical area and the limited amounts of water addressed by the Compact. In his March 29, 1943, Report and Recommendation, Glenn Parker, the United States Representative to the Republican River Compact negotiations, stated:

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[7] Lukey, Gutentag and Weeks, Hydrologic Investigations Atlas HA-652 (sheet 1 of 2), U.S.G.S. 1981.

[8] This Court has previously refused to interpret a compact in such a manner that the compact would include water arising in a state not party to that compact and foreclose claims by the state to such water. *Oklahoma v. New Mexico*, 501 U.S. 221, 232 (1991).

> The drainage basin involved in the proposed compact comprises an area of 24,960 square miles in northeastern Colorado, northwestern Kansas, and southwestern Nebraska, which is naturally drained by the Republican River, and tributaries, above Junction City, Kansas.

George W. Norris, the U.S. Senator from the State of Nebraska, stated:

> [T]hese experts . . . were men who were able to go into all the technicalities of the stream for irrigation and reclamation. They had used 500,000 acre-feet not as being anything necessarily definite but as covering the entire amount of water that was going to be controlled.

The Republican River Compact, 1941: Hearings on H.R. 4647 and H.R. 5945 Before the Comm. on Irrigation and Reclamation, 77th Cong. (1941) (Statement of Hon. George W. Norris, U.S. Senator from Nebraska).

In addition, the States have consistently administered and interpreted the Compact to exclude Ogallala Aquifer ground water. *See, e.g*, Progress Report of the Engineering Committee April, 27, 1964 (appendix A-38), (ground water diversions in Colorado assumed to be table land [Ogallala] diversions and considered to have no effect on flow of streams); Progress Report of the Engineering Committee, June 19, 1967 (appendix A-39) (including both ground water and surface water diversions in computation of virgin water supply, except where wells were considered to be up-land [Ogallala] wells); *See also*, Reports of Engineering Committee, cited above, 1967-1991.

In their *amici* brief in *Sporhase*, Colorado and Kansas stated that there was only a "*de facto* equitable apportionment" of Ogallala ground water, that "each state overlying the aquifer allocates for beneficial use only that

quantity of ground water which can be diverted within the state," and that this Court's decision could force the states to seek a formal equitable apportionment of the Ogallala through compact or decree. Nebraska Brief, at 12-13. These statements are inconsistent with the notion that the Republican River Compact had already apportioned any part of the Ogallala.

It does not make technical, legal, or common sense to interpret the Compact to include the Ogallala Aquifer, in whole or in part. The Compact was intended "to remove all causes, present and future, which might lead to controversies [and] to promote interstate comity . . .." Art. I. It follows that, almost sixty years ago, states compacting to remove causes of controversy did not intend to include a poorly understood, separate aquifer in the Compact, subjecting water users to decades of uncertainty.

By its terms, the Compact allocates rights in the interstate waters of the Republican River drainage basin to the three compacting states. Water from the Ogallala aquifer was never meant to be included in, and was not allocated under, the Compact.

CONCLUSION

Colorado respectfully requests the Court to find, as a matter of law, that the Republican River Compact allocates alluvial ground water to each of the three compacting states and that the Compact does not include Ogallala Aquifer ground water.

KEN SALAZAR
Attorney General

BARBARA McDONNELL
Chief Deputy Attorney General

Solicitor General

FELICITY HANNAY
Deputy Attorney General

WENDY WEISS
First Assistant Attorney General

ALEXANDRA L. DAVIS*
Assistant Attorney General
Natural Resources and Environment Section
Attorneys for State of Colorado
1525 Sherman Street, 5th Floor
Denver, Colorado 80203
Telephone: (303) 866-5041
FAX: (303) 866-3558
*Counsel of Record

APPENDIX
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Explanatory Statement and
Report on Republican River Compact

There is herewith submitted to the General Assembly of the State of Colorado, with recommendation for favorable consideration, a new Republican River Compact. After two conferences by the Republican River Compact Commissioners and their legal advisers, this Compact was signed by the Commissioners for the States of Colorado, Kansas and Nebraska, at Lincoln, Nebraska, on the 31st day of December, 1942. The major purposes of this Compact are set forth in Article I which reads, in part, as follows:

> "The major purposes of this compact are to provide for the most efficient use of the waters of the Republican River Basin (hereinafter referred to as the "Basin") for multiple purposes; to provide for an equitable division of such waters; to remove all causes, present and future, which might lead to controversies; to promote interstate comity; to recognize that the most efficient utilization of the waters within the Basin is for beneficial consumptive use; and to promote joint action by the States and the United States in the efficient use of water and the control of destructive floods".

The negotiation of this Compact by the States of Colorado, Kansas and Nebraska was authorized by an Act of the Congress of the United States, approved August 4, 1942 (Public No. 696-77th Congress, Chapter 545-2nd Session) which authorized these states "to negotiate and enter into a compact not later than June 1, 1945, providing for an equitable division and apportionment among the said states of the waters of the Republican and also of its tributaries above its junction with the Smoke Hill River in Kansas, under condition that a suitable person, who shall be

appointed by the President of the United States, shall participate in said negotiations as the representative of the United States and shall make report to the Congress of the proceedings and of any compact entered into: ***"

Thereafter and pursuant to their several authorities, the Governors of each of the signatory States named the same Commissioners who had been designated to negotiate a former Compact, and the President appointed as the representative of the United States, Glenn L. Parker, Chief Hydraulic Engineer of the United States Geological Survey.

The Commission held its first meeting in Denver, Colorado on December 2-3, 1942, when, by unanimous action of the Commission, Mr. Parker was designated Chairman thereof. Another, and the final meeting was held in Lincoln, Nebraska, on December 29, 30, 31, 1942, following which this Compact was signed by the Commissioners and the Federal representative endorsed upon the Compact the following:

> "I have participated in the negotiations leading to this proposed compact and propose to report to the Congress of the United States favorably thereon.
>
> Glenn L. Parker,
> Representative of the United States"

Throughout these two conferences the Commissioner for Colorado was advised on all matters by Attorney General Gail L. Ireland and Judge Clifford H. Stone, Director of the Colorado Water Conservation Board, whose services in this connection were most valuable. During the negotiations the Commissioners for Kansas and Nebraska were advised by representatives of the Attorneys General of those two states. Prior to the attachment of the signatures of the

Commissioners to this Compact, the Governors of each of the signatory states were fully advised of the conclusions reached by the Commissioners, and approved the same.

The Legislatures of Colorado, Kansas and Nebraska, in 1941, ratified a former compact allocating the waters of the Republican river basin. That Compact was later approved by the Congress of the United States. The Act providing for Congressional approval, however, was vetoed by the President. The veto message of the President set forth, in substance, that the Compact failed to adequately protect the interests of the United States. This situation arose out of the inclusion in Article I of the former Compact the following language:

> "The Republican River and tributaries thereof within the basin, as hereinabove defined, are not navigable, and all uses of water of a consumptive nature, as hereinafter defined, wherever such uses may occur within the basin, shall constitute paramount uses". (sic)

The Federal Power Commission with support, in varying degree, from other Federal agencies, strenuously opposed within the Congress, the last mentioned provision.

Numerous amendments to the approving legislation were proposed in Congress. The adoption of these amendments, however, would have constituted material modifications of that Compact, and would have required a re-reference of the Compact to the Legislatures of the signatory states. They were finally defeated, and Congress approved the former Compact without modifying provisions, but, as stated, the approving legislation was vetoed by the President.

In general, it should be stated that representatives of certain Federal agencies contended that the provisions of Article I of the first Compact, above quoted, created a dangerous precedent, and were contrary to federal jurisdiction and to the public interest, unless interpreted, limited and modified by appropriate amendments to be incorporated in the approving legislation.

Following the abortive effort to obtain final approval of the former Compact by the Congress, it was believed by the Commissioners that the uses of the waters of the Republican river and its tributaries and the inherent Federal and States' interests could be correlated in such way as to permit of (sic) the most beneficial use of the waters of the Basin.

Congressional authorization to make a new Compact having been obtained, further negotiations followed, as above outlined.

During these negotiations for a new Compact, representatives of the Departments of Agriculture and Interior, the Corps of U. S. Engineers and the National Resources Planning Board, were in attendance and contributed materially in the negotiations of the Commissioners.

This Compact eliminates the objectional provision in the former Compact, hereinabove quoted.

Article XI of this Compact, however, is designed to protect the States' interests in these waters by a recognition that the most efficient utilization of the waters within the Basin is for beneficial consumptive use, and also to promote joint action by the States and the Federal Government in effectuating such use and for the control of destructive floods.

It will be noted that this Compact provides that, unless the Congress of the United States in its approving legislation includes the provisions set forth in Article XI for the protection of the interests of the States, then the approval would be ineffectual. These protective measures may be summarized as follows:

1. Any beneficial consumptive uses by the United States, or those acting by or under its authority, within a State, of the waters allocated by this Compact, shall be made within the allocations of water for use within such State.

2. That the united States, or those acting by or under its authority, in the exercise of rights or powers arising from whatever jurisdiction the United States has in, over, and to the waters of the Basin, shall recognize, to the extent consistent with the best utilization of the waters for multiple purposes, that the beneficial consumptive use of the waters within the Basin, is of paramount importance to the development of the Basin.

3. That no exercise of Federal jurisdiction over such waters, that would interfere with the full beneficial consumptive use of the waters within the Basin, shall be made except upon a determination, giving due consideration to the objectives of this Compact and after consultation with all interested Federal agencies and State officials charged with the administration of this Compact, that such exercise is in the interest of the best utilization of such waters for multiple purposes.

4. That the United States or those acting by or under its authority, will recognize any established use, for domestic and irrigation purposes, of the waters allocated by this Compact which may be impaired by

> the exercise of Federal jurisdiction in, over, and to such waters; provided, that such use is being exercised beneficially, is valid under the laws of the appropriate State and in conformity with this Compact at the time of the impairment thereof, and was validly initiated under state law prior to the initiation or authorization of the Federal program or project which causes such impairment.

In considering this compact it should be noted that beneficial consumptive use is the basis and the principle upon which the allocations of water are made and predicated. Beneficial consumptive use is defined by the Compact in these words:

> "The term 'Beneficial Consumptive Use' is herein defined to be that use by which the water supply of the Basin is consumed thru the activities of man, and shall include water consumed by evaporation from any reservoir, canal, ditch, or irrigated area". (sic)

This definition of "Beneficial Consumptive Use" must be considered in connection with Article XI of the Compact. "Beneficial Consumptive Use", (sic) as above defined, includes the use of water for domestic, irrigation and industrial purposes. The use of water for these purposes is regulated and controlled under State laws.

The Federal Government claims jurisdiction over the waters of the Basin for the production of hydro-electric energy, the maintenance of navigable capacity within and without the Basin, and in the interest of flood control, all of which in general, are of a non-consumptive character.

It is believed that the interests of the Federal Government and of the signatory States in the waters of the

Basin, are adequately protected and correlated by the provisions of Article X and XI, and by other provisions of this Compact.

In its deliberations resulting in the first draft of a Compact, the Commission gave careful consideration to the report of the Corps of U. S. Engineers dated February 27, 1940, covering its comprehensive study in 1939-1940 of the needs for flood control, including presently irrigated and arable areas, water conservation and related benefits to irrigation, domestic requirements, and power development. The Commission conferred from time to time with representatives of the U. S. Bureau of Reclamation which was then engaged in field investigations and studies of water supply, irrigated and arable areas within the Basin, the development of which would require the consumptive use of the waters of the Republican river (sic) and its tributaries. During its deliberations the Commission also conferred with representatives of the Bureau of Agricultural Economics of the U. S. Department of Agriculture which had just completed a field study and voluminous report on the underground water resources of the Basin and the availability of the same for future developments therein. While the absence of extensive development of the natural resources of the Basin tended to simplify the problem of allocating the waters thereof, the Commission was confronted with other difficult problems involving a multiplicity of primary and secondary tributary stream systems which are largely disassociated in their possibilities for use, and which, due to their erratic character, will require the construction of extensive regulatory works throughout the Basin. A careful evaluation by the Commission, of the total available water supplies of the Basin, based upon the preceding eleven years during which period fairly reliable records of stream flow are available, and of the results of the studies by the Corps of U.S. Engineers, U. S. Bureau of Reclamation and Bureau of Agricultural Economics, with respect to irrigated and arable areas, disclosed that the virgin

water supplies of the Basin when regulated by storage reservoirs are, in general, ample to meet all present and future requirements for domestic, irrigation and industrial uses within the Basin, with periodic surpluses which, when regulated, could be made to serve navigation needs, if any, outside the Basin.

The Compact allocates for beneficial consumptive use in Colorado, annually, a total of 54,100 acre-feet derived from the following sources:

North Fork of the Republican River	10,000	acre-feet
Arikaree River	15,400	"
South Fork of the Republican River	25,400	"
Beaver Creek	3,300	"
	54,100	

and, in addition, the entire water supply of the Frenchman and Red Willow Creek drainage basins in Colorado.

It is specifically pointed out that the above allocations of water are identical with the allocations made by the former Compact heretofore approved by the Legislatures of the signatory states; and that such are in no manner or detail changed by this Compact. In the interest of clarity, however, it was considered desirable, in this Compact, to transpose the order in which the determined basic water supplies of the Basin, and the specific allocations to each of the three States, was set out in the former Compact. The only material changes in this Compact, were made to meet the conflicts between the various uses of water, and between Federal and State interests in these waters. These latter changes, as hereinabove explained, are all of a legal nature.

The foregoing allocations constitute about 23 percent of the total water supply of the North Fork of the Republican; 79 percent of that of the Arikaree; 44 percent of

that of the South Fork of the Republican; and 100 percent of that of the Beaver, Frenchman and Red Willow Creek drainage basins in Colorado. It should be borne in mind that these allocations of water do not limit the right of Colorado or any of its agencies to divert and apply much larger quantities of water than the amounts allocated by the Compact

.

Particular attention is called to Article I of this Compact which provides in part as follows:

> "The physical and other conditions peculiar to the Basin constitute the basis for this compact, and none of the States hereby, nor the Congress of the United States by its consent, concedes that this compact establishes any general principle or precedent with respect to any other interstate stream."

It is believed that this Compact equitably apportions the total available average annual virgin water supplies of the Basin, both surface and underground, among the three signatory States, in such manner and in such amounts as will not only protect all existing uses within the Basin, but will insure, insofar as possible, that the available water supplies when regulated by storage works, will adequately meet future requirements for domestic, irrigation, industrial and recreational purposes, and that it affords ample opportunity for multiple use development and for flood control. It provides for the collaboration by the U. S. Geological Survey with the Compact Commissioners of the three States, in the collection, correlation and publication of water facts necessary for the proper administration of the Compact.

It is also believed that this Compact, by its recognition and correlation of the inherent rights of the signatory States and their entities, and those of the Federal

Government, provides the sound and constructive basis dictated by the physical and other conditions peculiar to the Basin, as mentioned in Article I of this Compact, for the regulation, control and most beneficial uses of the waters of the Basin, which uses are of such vital importance to that arid and semi-arid region.

As Commissioner for the State of Colorado, I, therefore, submit this Compact to the 34th General Assembly of the State of Colorado, for its consideration, and recommend the ratification of the same by your Honorable body.

M. C. HINDERLIDER
Republican River Compact Commissioner for Colorado

March 20, 1941

His Excellency, Ralph L. Carr
Governor of Colorado
Denver, Colorado

My dear Governor Carr:

I have the honor to transmit herewith for your consideration and further disposition two original drafts of a compact, which it is believed equitably apportions the waters of the Republican River basin between the States of Colorado, Kansas, and Nebraska. This compact, the result of several months of investigations, study, and eight conferences between the commissioners, their legal advisers, and water users of the three states, was signed at Denver on March 19, 1941, by the three compact commissioners appointed by the Governors of the signatory states.

Since it appears that no interest of the federal government, by virtue of ownership of property or of any responsibility as a result of interstate or international treaties, or obligations to Indian tribes, is involved, no representative of the government was invited to participate in the deliberations of the Commission, nor to approve its findings and conclusions.

In its deliberations, the Commission gave careful consideration to the report of the Division Engineer, Corps of U.S. Engineers, dated February 27, 1940, to the Chief of Engineers, covering the comprehensive study by the Corps on flood control in the Republican River basin and related matters, and to preliminary and progress reports by the U.S. Bureau of Reclamation, which is conducting a comprehensive and detailed investigation of the land and

water resources of this basin; also to a voluminous report of the Bureau of Agricultural Economics of the U.S. Department of Agriculture on the underground water resources of the Republican River basin and their availability for beneficial application to the future development of the basin.

While the absence of extensive development of the natural resources of the Republican River basin tended to simplify the problem of allocations of the waters therein, the Commission was confronted with other difficult problems involving a multiplicity of primary and secondary tributary streams, which are largely dissociated in their possibilities for use, and which, due to their erratic character, will require extensive regulatory works throughout the basin.

The compact allocates to Colorado, its citizens, agencies, associations and corporations all of the surface and underground water supplies originating in Colorado within the Frenchman and Red Willow Creek drainage basins; about 25 percent of those of the North Fork of the Republican; 80 per cent of those of the Arikaree River; 77 per cent of those of the South Fork of the Republican; and an estimated 100 per cent of those of the Beaver Creek basin, which it is believed is the limit of consumptive use which it is practicable to make in Colorado of the waters from these stream basins.

It should be borne in mind that these allocations of water are for beneficial consumptive use and do not limit the right of Colorado, or any of its agencies, to divert and apply much greater quantities of water than the amounts allocated by the compact.

The compact, when ratified by the Legislatures of the signatory states and consented to by the Congress of the United States, provides the basis for an orderly planning of the regulation, conservation and efficient use of the waters of

the basin, unhampered by uncertainties arising out of interstate conflicts or misunderstandings.

As hereinabove stated, it is believed that the compact equitably apportions between the signatory states all the waters of the Republican River basin. As commissioner for the State of Colorado, I therefore respectfully recommend that this compact be transmitted with a special message to the present General Assembly of our state for ratification.

In conclusion, I desire to express to you my deep sense of appreciation for the confidence reposed in me as the official representative of our state to carry out these important negotiations, and for the invaluable assistance from you as a result of your ripe experience in these interstate matters. I also desire to acknowledge the loyal support and valuable aid received from Attorney General Gail L. Ireland, who was my legal adviser during the final preparation of the compact, to Clifford H. Stone, Esquire, for valued suggestions; to Mr. A. C. Etiefel, assistance chief engineer of the Colorado Water Conservation Board, who prepared the map of the Republican River basin which is made a part of the compact, and to Senators Burt Ragan and Harry M. McKinney, and Representatives C.J. Buchanan and Harold A. Tabor, who have at all times given me sympathetic and loyal support.

Titles for Senate Bill No. 42, by Sentors (sic) Ragan and McKinney, and House Bill No. 188, by Representatives Buchanan and Tabor, have heretofore been introduced in the present Legislature, under which the compact, if approved by you, may be properly presented to the Legislature for final disposition.

Respectfully,
Republican River
Compact Com'r for
Colorado

MCH:EP

January 9, 1943

Honorable Ralph L. Carr
Governor of Colorado
State Capitol Building
Denver, Colorado

My dear Governor Carr:

I have the honor to transmit herewith, for your consideration and further disposition, an original draft of a Compact apportioning the waters of the Republican River Basin between the States of Colorado, Kansas and Nebraska, which was consummated at Lincoln, Nebraska, on December 31, 1942, by the Commissioners appointed by the Governors of the signatory States, pursuant to authority from the Legislatures of these States to negotiate an Interstate Compact to equitably apportion the waters of the Republican River Basin.

This Compact replaces the Compact which was ratified by the Legislatures of Colorado, Kansas and Nebraska, in 1941, and which, by appropriate Act, received the approval of the Congress of the United States, but which Act was vetoed by the President for the reason that he felt the Compact did not adequately recognize and protect the interests of the United States.

The compact herewith transmitted, was negotiated pursuant to not only the aforementioned authority of the Legislatures and Governors of the signatory States, but also to Pub. 396-77th Congress, Chapter 545, 2nd Session (Senate 2604) granting authority to the States to enter into a Compact, which Act also provided for the appointment by the President of a representative of the United States to participate in said negotiations, and to make report to the

Congress of the proceedings, and of any Compact entered into.

Pursuant to this authorization by Congress the President designated Mr. Glen L. Parker, Chief Hydraulic Engineer of the United States Geological Survey, as the Federal representative, who, later by unanimous action of the three State Commissioners, was made Chairman of the Republican River Compact Commission.

The Commission held two meetings, one at Denver, Colorado, on December 2nd and 3rd, and one at Lincoln, Nebraska on December 29, 30, 31, 1942, at the conclusion of which this Compact was signed.

These two meetings of the Commission, presided over by the Federal representative, were participated in by Honorable Gail L. Ireland, Attorney General of Colorado, and Clifford H. Stone, Director of the Colorado Water Conservation Board; by representatives of the Attorneys General of Kansas and Nebraska, and also by representatives of the U.S. Departments of Agriculture, Interior and War. Also present was a representative of the National Resources Planning Board.

The draft of the Compact, herewith transmitted, does not in any way change the allocations of water to the signatory States provided for in the former Compact. The only material changes in the new draft are of a legal nature, and were made in an attempt to compose conflicts between the fundamental rights and powers of the Federal Government arising out of the navigation clause of the Constitution of the United States as interpreted by decisions of the United States Supreme Court, and the rights and vital interests of the signatory States in the consumptive use of the waters of the Republican River and its tributaries essential to the full development of the Basin.

It is believed that the Compact as signed equitably apportions between the signatory States the waters of the Basin for beneficial multiple use purposes, recognizes and protects existing uses of waters therein, and recognizes that

the most efficient utilization of the waters within the Basin is for beneficial consumptive purposes.

It is believed that this Compact, when operative, will promote the orderly development of the land and water resources of the Basin, including the regulations of destructive floods, and will protect any agency of the Federal Government in the acquirement of water rights under the laws of the signatory States, and also the authority of the Federal Government to regulate the waters of the Basin in the interest of navigation, should such need arise in the future.

The Compact allocates for beneficial consumptive use in Colorado, annually, a total of 54,100 acre feet of water from the following sources and in the following amounts:

From the North Fork of the Republican river Drainage Basin, 10,000 acre feet

From Arickaree River Drainage Basin, 15,400 acre feet

From the South Fork of the Republican River Drainage Basin, 25,400 acre feet

From Beaver Creek Drainage Basin, 3,300 acre feet, and, in addition, the entire water supply of the drainage basins of Frenchman and Red Willow Creeks in Colorado.

This allocation constitutes about 23 percent of the entire average annual water supply of the North fork of the Republican River; 80 percent of that of the Arickaree River, 77 percent of that of the South Fork of the Republican River, and an estimated 100 percent of the waters of Beaver Creek Basin in Colorado, which it is believed is the limit of ultimate consumptive use which it is possible to make in Colorado of the waters of these stream basins.

These allocations include not only surface, but also sub-surface, or underground water supplies.

It should be borne in mind that these allocations of waters are for beneficial consumptive use, and do not limit the right of Colorado or any of its people or entities to divert and apply much greater quantities of water than the amounts allocated by the Compact.

It will be noted that Article XI of the Compact includes the specific language to be used by the Congress in giving its consent to and approval of the actions of the signatory States, which constitutes a definite recognition on the part of the Congress, of the paramount importance of the use of the waters of the Basin in the development of multiple purpose projects which will involve the consumptive use of the waters therein, and also constitutes a recognition on the part of the Congress of any established use for domestic and irrigation purposes of the waters allocated by the Compact when such use is a valid one under the laws of the appropriate State.

A more detailed report will be presented later for the information of the Legislature.

In conclusion, I desire to express to you my deep sense of appreciation for the confidence reposed in me as the official representative of our State to carry out these important negotiations, and for the invaluable assistance from you, as Governor, and from Attorney General Ireland and Judge Clifford H. Stone.

Respectfully submitted,
/s/ M. C. Hinderlider
Republican River Compact Commissioner
for Colorado

MCH J

February 5, 1943

Mr. Glen L. Parker
Chief Hydraulic Engineer
U.S. Geological Survey
North Interior Building
Washington, D.C.

Dear Mr. Parker:

For your information, I am enclosing two mimmeograph (sic) copies of the Republican River Compact, to which is attached my explanatory statement and report on the Compact to our General Assembly, which I thought you might be interested in reading.

Plans have been made for the publication of the Compact, and my explanatory statement and report, in pamphlet form, similar to that of the Rio Grande Compact, for distribution among those who may be interested in the Compact.

I would be pleased to have your observations, criticisms, etc., on my explanatory article.

I furnished a copy of the same to Mr. Knapp and Mr. Scott. Mr. Scott has just sent me a copy of a Bill introduced in his Legislature for the ratification of the Compact, but as yet I have had no word from Mr. Knapp concerning the progress in his Legislature.

I note from last night's press reports that Senator Burke of Nebraska and Congressman Curtis, have introduced

Bills in the Congress for the purpose of obtaining approval by the Congress of the Compact.

I am interested in hearing from you what progress, if any, has been made by you with interested Federal agencies in this connection.

I might state also that I furnished Colonel Pick two copies of the enclosure, and have been advised by both Colonel Pick and Major Freeman that there is no disposition on their parts to place any obstructions in the way of obtaining the consent of the Congress. It is clearly understood, of course, that Colonel Pick is in no way obligated, as you have heretofore advised me.

We are asking the present Legislature to appropriate at least the amount of money appropriated last ~~year~~ session for our cooperative stream gaging work, and I hope that you will be successful in obtaining your usual appropriations at least for carrying on this important work.

With best regards, I am

Sincerely yours,

State Engineer

MCH J
encls

January 31, 1941

Mr. George S. Knapp
Republican River Compact Commissioner
Topeka, Kansas

Mr. Wardner G. Scott
Republican River Compact Commissioner
Lincoln, Nebraska

Gentlemen:

I am enclosing draft of the minutes of the third and fourth meetings of the Republican River Compact Commission at Lincoln and Topeka, respectively.

I have included suggested changes by Mr. Knapp in the minutes covering the Lincoln meeting. As will be noted, I have signed the copies of the minutes of these two meetings and, if you approve the same, I will request that you advise me accordingly, - otherwise approval can await our next meeting on the 15th of February.

I am also enclosing some additions to the preliminary draft for a compact as suggested by Governor Carr and Attorney General Ireland.

It is my understanding that Mr. Knapp will address a letter to Engineer Burleigh of the Bureau of Agricultural Economics, advising him that the commissioners are in agreement that the estimated amount of ground water which may be developed in each of the tributary basins of the Republican River basin (sic) are within the allocations which the Commission has tentatively made.

Very truly yours,

/s/_____
M.C. Hinderlider
Republican River Commissioner

MCH:EP
CC: R. H. Willis

Page 6 of tentative draft for compact:

Following the word "made" at the end of the paragraph near the center of the page, add this sentence:

> "No state shall have the right to dictate the method of distribution of the waters herein allocated to any other state".

Page 8

Insert this sentence after the first paragraph:

> "Such payment to the counties in Colorado shall be in addition to the amounts required to be paid to the owners of said lands upon their purchase or condemnation under the power of eminent domain."

January 30, 1941

Mr. Harry P. Burleigh,
Hydraulic Engineer,
Bureau of Agricultural Economics,
Amarillo, Texas.

Dear Mr. Burleigh:

We, the Republican River Compact Commissioners on the Republican River, meeting at Topeka on January 28, examined the tables which you submitted to us on the 27th indicating the approximate recommendations for consumptive use of water by basins in the three states, and find that the total estimated annual consumptive use of water is within the amount of the water supply available in the basin above Hardy, and that the proposed allocations in each of the several states fall within the amounts which the Commission may see fit to allocate to each state.

Please accept our thanks for meeting with us and supplying us with these figures.

Sincerely yours,

Geo. S. Knapp
Commissioner for Kansas
For the Commission

GEK:MM
CC to M. C. Hinderlider
Wardner Scott

REPORT

to the

REPUBLICAN RIVER COMPACT ADMINISTRATION

FORMULAS FOR THE COMPUTATION OF ANNUAL VIRGIN WATER SUPPLY

REPUBLICAN RIVER BASIN

Committee on Procedure for Computation of
Annual Virgin Water Supply

April 4, 1961

Computation of Virgin Water Supply
Republican River Compact Administration

INTRODUCTION

Article III of the Republican River Compact designates the drainage basins, or parts therof, from which specific allocations are made to the states of Colorado, Kansas and Nebraska.

The annual virgin water supply for each of those designated drainage basins shall be computed by the formulas given herein.

. . . .

GENERAL PROCEDURES

Reservoir evaporation shall be the total evaporation corrected for the precipitation upon the reservoir surface area.

Average monthly reservoir surface areas shall be computed by applying the average of the mean daily reservoir elevations to the most recent area-capacity tables.

Depletions of stream flows due to erosion control practices and stockwater ponds have not been included in the present virgin water supply formulas. Representatives of the U.S. Department of Agriculture have indicated there has been no success in isolating the effect of such practices on stream flow.

Irrigation diversions from ground water shall be limited to those by wells pumping from the alluvium along the stream channels. The determination of the effect of pumping by "table-land" wells on the flows of the streams in the Republican River Basin must await considerably more research and data regarding the character of the ground-water aquifers and the behavior of ground-water flow before even approximate information is available as to the monthly or annual effects on stream flows. The ground-water representatives of the Geological Survey and the University of Nebraska reported that the effect of pumping by "table-land" wells is not subject to an exact determination and that it is possible those wells may not appreciably deplete stream flows. The wells in the Frenchman Creek drainage basin in Colorado have been considered as "table-land" wells.

Irrigation diversions by canals, stream pumps and wells for which recorded diversions are not available shall be computed by applying an average annual diversion rate to the irrigated acreages.

Return flows from the lands irrigated by major project developments flowing into two or more designated drainage basins shall be divided in the ratio of the irrigated lands from which the water returns to each drainage basin.

Return flows are considered to be reflected in stream discharge records during the same year the irrigation diversions are made.

. . . .

"EXHIBIT A"

Progress Report
of the
Committee on Procedure
for
Computation of Annual
Virgin Water Supply
to the
Republican River Compact Administration
May 3, 1963

The Republican River Compact Administration at its March 23rd meeting, 1962, assigned the subject committee the task to compute the virgin flow of the Republican River and its tributaries for the water year 1962 and to make computations of the consumptive uses within each of the sub-basins for the years 1961 and 1962. Presented herewith is a summary of the computed annual virgin water supply of the Republican River Basin dated March 15, 1963. This is the virgin water supply for the water year 1962. The annual report of the administration of March 23, 1962 contains the computations for the virgin water supply for the water years of 1959, 1960 and 1961.

The committee met on just one occasion during the past year at its 7th meeting of the committee held March 14th and 15th, 1963. The minutes of that meeting have been approved by the committee and furnished to members of the administration. Steps have been taken during the past year to continue to improve the data for use in the formula for the computations of virgin water supply. Following the example set by Kansas for obtaining records, the Nebraska Department of Water Resources prepared an "Irrigation Pumping Record Book" which has been designed for either keeping the records of pumping from streams or for keeping the records of pumping from wells. These record books were furnished to the irrigators pumping from streams in the

Frenchman, Red Willow, and Medicine Creek Basins and to irrigators with wells pumping from the valley floor in all of the Republican River Basin in Nebraska.

In view of the fact that the Nebraska law does not require the keeping of records of pumping from wells, the information obtained in Nebraska for wells was furnished on a voluntary basis. Approximately 750 record books were mailed to land owners and we received a reply from approximately 35% of this number. The irrigation season was an unusual one with a dry spring with low rainfall in April and May, but with a greater than normal rainfall during June, July, August and September. As a consequence, many of the irrigation wells were not used. Also as a consequence, of the unusually high rainfall the indicated amount of water pumped from wells varied considerably depending upon the amount of rainfall. The results of this sampling indicated an average pumping rate of 0.32 acre-feet per acre as compared to the average rate used last year of 1.6 acre-feet per acre for the wells. The Nebraska Department of Water Resources has again initiated this program of obtaining information from wells for the 1963 irrigation season, and we hope to continue to receive the cooperation from the land owners in providing us with such information so that we may be able to determine the variation in this use of ground water for different types of years.

Much valuable information was obtained from the information returned to the Nebraska Department of Water Resources in the pumping record booklets, such as many reported that they did not use their irrigation well because they received adequate water from their surface canal systems. This information indicates that in many cases wells are used to supplement pumping or diversion from a stream source. This explains in part the reason for a lower average diversion rate in Nebraska as compared to Kansas.

The Virgin Flow Committee indicated in its 1962 report that it was desirable to obtain better information for the Haigler canal diversion from the North Fork of the Republican River. In 1963 two records were obtained, one by the headgate keeper furnishing information to Colorado and one computed by Nebraska from information obtained from data furnished by the same headgate keeper to Nebraska. Colorado reported a total of 6,730 acre-feet diverted, while Nebraska reported 9,950 acre-feet diverted. After further investigation, it was found that the Nebraska records probably do not reflect the spills wasted to the North Fork of the Republican River immediately below the headgate, and it was agreed that the Colorado records of diversions would be used in the virgin flow study. This situation points up the necessity previously mentioned by the committee of requiring that suitable measuring devices be installed on the Haigler canal. We recommend that measuring devices be installed both at the headgate and at the point where the canal crosses the state line. Due to the fact that one irrigation district operates the entire system, it may be undesirable to request the district to place a measuring device at both points the same year. We recommend that Colorado continue to impress upon the district the necessity for the measuring device at the diversion point and that we delay requesting the measuring device at the state line until a later date.

The U. S. Geological Survey presented a study with certain recommendations for return flow investigations in the Republican Basin at the 1962 meeting of the administration. Nothing was done in the field during the 1962 irrigation season to obtain return flow data due to the unusually wet irrigation season. Floyd LeFever, District Engineer of the Surface Water Branch of the U. S. Geological Survey has compared the records for the 1962 irrigation season with those presented in the report which Herman Brice described to the administration at the 1962 meeting. Mr. LeFever may, at this meeting, wish to comment further on the comparison of the 1962 records with the previous data.

The Bureau of Reclamation on April 3, 1963, presented its annual operating plan for the year 1963 at a public meeting held in Lincoln. That report indicated that the Bureau of Reclamation is concerned with the return flow from the projects along the Republican River, and representatives of the Virgin Flow Committee made the recommendation that the committee would like to cooperate with the Bureau of Reclamation in any studies made by that organization concerning return flow. It developed, however, that the Bureau of Reclamation is more interested in channel carriage losses than in the details of the return flow studies. Therefore, it would appear that nothing would be gained by a cooperative venture by the committee and the Bureau of Reclamation concerning the return flow studies.

The committee has not fulfilled its assignment concerning the computation of consumptive uses within each of the sub-basins of the Republican River Basin for the years 1961 and 1962. It became apparent during the meeting of the committee on March 14th and 15th that work needs to be done by the committee with the approval of the administration in the development of a formula for the computation of consumptive use. The problem of determining the consumptive use in Kansas and the proration of the Harlan County losses between the two states is a matter that will require confirmation by the administration. This point was not recognized until we approached the subject as a committee. Another point which should be resolved by the administration is the method of handling the return flow in the computation of consumptive use where return flow from a particular sub-basin does not return to the same sub-basin, but enters the main Republican River or another tributary basin. The matter of handling the return flow could affect the computation of consumptive use in a particular basin under the formulas provided in the compact.

Respectfully submitted,

/s/

M. E. Ball, Chairman
Virgin Flow Committee

Minutes of the
Fifth Annual Meeting

Topeka, Kansas – April 27, 1964

The meeting was called to order by the Chairman, R.V. Smrha, at 10:00 a.m., in Room 1031-S, State Office Building, Topeka, Kansas . . . .

Accompanying the report of the Engineering Committee was a tabulation of the computed virgin water supply for 1963 water year and revised computations for 1959 through 1962 water years. It was pointed out that any errors in assumed factors for return flow or well diversions could make considerable difference in total computed annual virgin water supply. On motion of Mr. Smrha the Administration accepted the tabulation of computed virgin water supplies for 1959 through 1963 water years which is made a part of these minutes as Exhibit "B". Detailed computations are in the files of each Official Member.

Formulas to compute annual consumptive use in the Republican River Basin were next presented to the Administration. These formulas were adopted by the Administration and are attached as Exhibit "C".

The Fifth Annual Meeting of the Administration adjourned at 3:00 p.m.

/s/_____
R. V. Smrha, Chairman

"EXHIBIT A"

Progress Report of the Engineering Committee

Republican River Compact Administration

April 27, 1964

The Republican River Compact Administration at its annual meeting held May 3, 1963, assigned the subject committee the following tasks:

(1) Virgin flow computations for 1963;

(2) Establish formulas and make computations of consumptive use for 1961, 1962 and 1963;

(3) In cooperation with representatives of the Bureau of Reclamation and Corps of Engineers arrive at a method of computing inflow to Lovewell Reservoir from White Rock Creek;

(4) Establish a method of proration of evaporation losses from Harlan County Reservoir between Nebraska and Kansas and proration of evaporation losses from Lovewell Reservoir between White Rock Creek and Republican River waters.

Submitted herewith in accordance with the above assigned tasks are the following:

(1) Tabulation of the computed annual virgin water supply Republican River

Basin for the water years 1959 through 1963, inclusive;

(2) Tabulation of the formulas for computation of the annual consumptive use - Republican River Basin;

(3) Computed annual consumptive use by states for the water years 1959 through 1963, inclusive.

The Engineering Committee met on three occasions during the past year. The committee held its eighth meeting on November 5-6, 1963, in Denver, Colorado, at which meeting formulas were developed for the computation of consumptive use of each of the states in the Republican River Basin. The committee held its ninth meeting January 16-17, 1964, with Mr. E.C. Balke of the Corps of Engineers and Mr. R.E. Aldrich and Mr. B.C. Filkin of the U. S. Bureau of Reclamation in attendance, for the primary purpose of discussing the evaporation data for Lovewell Reservoir. As a result of the discussions concerning this subject Mr. Balke agreed to submit a memorandum concerning the method of computation preferred by the Corps of Engineers and such memorandum was transmitted to the department dated February 7, 1964, and received February 17, 1964. Mr. Balke's memorandum provides a formula for the computation of the inflow to Lovewell Reservoir, which computation is basic in determining the respective quantities of White Rock Creek water and Republican River water in Lovewell Reservoir. The Bureau of Reclamation also summarized its views in a memorandum dated January 29, 1964.

The Engineering Committee met in its tenth meeting March 24-25, 1964, and after review of the Corps and Bureau memorandums, the Engineering Committee agreed on a formula for the computation of inflow to Lovewell Reservoir.

The discussions concerning whether to accept the measured inflows to Lovewell Reservoir from White Rock Creek or to compute the inflow cannot be described in detail in this report, but the decision to compute the inflow from White Rock Creek rather than accept the measured inflow data is appropriately summarized by the conclusion in paragraph 5 of Mr. Balke's statement where he states, "fundamentally then because of the many imponderables along with our sometimes seeming inept methods, we must arrive at a reasonable total. We must also always recognize that the cost of getting the final answer each month and year should not get out of hand in comparison with the benefits."

In short, it would be too expensive to obtain sufficient data to correct the measured inflows at the Burr Oak Gaging Station on White Rock Creek to determine actual reservoir inflows.

The committee agreed further at its tenth meeting that the evaporation losses from Lovewell Reservoir should be prorated between the Republican River water and the White Rock Creek water stored in Lovewell Reservoir, and that it will be necessary to continue a running account by months of the storage of two kinds of water in the reservoir to prorate the evaporation loss. The committee agreed to accept the evaporation loss by months as furnished by the Corps of Engineers.

The Compact Commissioners met with the Bureau of Reclamation in the fall of 1949 at Indianola, Nebraska, and at that time agreed that the consumptive use by evaporation from Harlan County should be divided on the basis of the benefits received. The Engineering Committee, together with the Corps and Bureau representatives, at their ninth meeting considered whether it should be necessary to keep a running account of the Harlan County Reservoir storage in the same manner as for the Lovewell Reservoir, thereby keeping a record of the water stored for Kansas and Nebraska in the reservoir in order to arrive at a proper allocation of the net

evaporation between the two states. All parties agreed that it would not be desirable to keep a running account of the division of storage in Harlan County Reservoir between the two states because the inflow to Harlan County Reservoir was primarily all Republican River water, and that the conditions were not similar to those at the Lovewell Reservoir where the White Rock Creek water was a significantly large portion of the total water used from Lovewell Reservoir. It was, therefore, agreed that it would be more appropriate to prorate the evaporation loss in Harlan County Reservoir on some other basis. Kansas presented a study of the Lovewell Reservoir operations since water was first stored in Lovewell Reservoir. The computed inflow from White Rock Creek was used in this study. This study showed that White Rock Creek water was a major portion of the water storable in Lovewell Reservoir and that at the end of the 1962 irrigation season only White Rock Creek water remained in the reservoir. There was a carry-over of 7,835 acre-feet of Republican River water in Lovewell Reservoir at the end of the 1963 irrigation season.

The Committee agreed, after considerable study, that the best interpretation of the benefits of Harlan County Reservoir to Nebraska and Kansas would be obtained for the past years up to the present time by prorating the net evaporation in Harlan County Reservoir on the ratio of the annual diversions by the Nebraska-Bostwick Irrigation District below Harlan County Reservoir, and the state line flows of the Courtland Canal, plus the diversions by the individual irrigators in Kansas above the Hardy Gaging Station. Since stored water in Harlan County Reservoir is carried over from year to year, it may be desirable in the future to divide the net evaporation on the basis of the acreage in each state for which irrigation service is available. The percent of the net evaporation from Harlan County Reservoir charged to Nebraska and Kansas, based on the diversions as stated above, is as follows for the years 1959 through 1963.

PER CENT OF HARLAN COUNTY NET EVAPORATION

	1959	1960	1961	1962	1963
Kansas	36	41	49	41	57
Nebraska	64	59	51	59	43

The Committee considered that the Compact Administration should make the decision as to the meaning of the words "benefits received" from Harlan County and that the Administration should adopt one of the two formulas for the proration of Harlan County losses. It is the opinion of the Committee that the matter is not critical for past usage of Harlan County Reservoir, and that the method could be changed in the future if the Administration considered the conditions warranted such change.

The procedure adopted by the Engineering Committee for the determination of the use of water by small stream pumps and by the ground-water wells was very much the same as adopted in 1962. Kansas based its use on the results of the reported data under Kansas law for the various streams and wells. The average of all diversion rates in the Republican River Basin in Kansas gave 1.9 acre-feet per acre for diversions from ground water alluvium and 0.7 acre-feet per acre from surface water.

Nebraska continued its procedure of obtaining pumping data from wells whose owners reported on a voluntary basis, which procedure was established in 1962. The voluntary response in Nebraska for 780 well users was 24% in the Republican River Valley, indicating a pumping rate of 1.70 acre-feet per acre for 1963, and this rate was applied to all acres irrigated from wells in Nebraska. Nebraska obtained actual records of diversions from surface water by small pumps on Frenchman, Medicine and Red Willow Creeks. The actual diversion records were used for these streams. No diversion records were obtained for the pumps diverting from the main stem of the Republican River and other small tributaries, and a figure of one acre-foot per acre diversion was adopted for these pumps.

Colorado had records of all surface water diversions for 1963, but no information was available on ground water diversions. The ground water diversions in Colorado were assumed to be table land diversions and were considered to have no effect on the flow of the streams. Groundwater diversions from the alluvium along the streams in Colorado are minor in that state and were considered to be zero in the 1963 computations of virgin water supply.

Respectfully submitted,
/s/
M.E. Ball, Chairman
Engineering Committee

Report of Engineering Committee
Republican River Compact Administration
June 19, 1967

The Republican River Compact Administration in its 7th annual meeting held April 7, 1966, agreed that the assignments to the Engineering Committee would include the following:

1. Compute annual virgin water supply for 1966;
2. Compute annual consumptive use for 1966;
3. Continue studies of method of computing inflow to Lovewell Reservoir;
4. Continue study of the proration of reservoir evaporation losses;
5. Compute adjusted allocations on annual, 5-year and average annual basis;
6. Continue investigation of depletions by wells in the alluvium and the effect of well distance from a stream on those depletions.
7. Explore the need for modifying Annual Virgin Water Supply and Consumptive Use Formulas to include municipal and industrial diversions from ground water and surface water.

The Engineering Committee held one meeting during the year, March 29 and 30, 1967, the 13th meeting of the committee, to study these assignments. The Secretary of the Committee, by letter of April 7, 1967, submitted the following exhibits to the members of the Compact Administration for review prior to the annual meeting.

1. Virgin water supply computations, 1966 water year;
2. Summary Computed annual virgin water supply, Republican River Basin, 1966;
3. Computed annual consumptive use, Republican River Basin, 1966 water year;
4. Computation of inflow to Lovewell Reservoir, 1966 water year;
5. Computed operations of Lovewell Reservoir, 1966 water year;
6. Consumptive use computations -- Kansas-Main Stem Republican River;
7. Computation of adjusted allocations, 1966 water year;
8. Adjusted allocations on a 5-year average basis, 1962 thru 1966.

The virgin flow and consumptive use formulas, presented in previous reports of the Committee, were used without change in the preparation of the above data. All exhibits are presented for discussion without recommendations.

The 13th meeting of the Engineering Committee was attended only by members of the Committee. Mr. C. E. Schnurr passed away due to an illness during the past year and Mr. Glenn Brees, appointed by Colorado to replace Mr. Schnurr, was present at the meeting.

No new investigations were made by the Committee concerning assignment Number 6 concerning depletion by wells and consequently no new data is furnished in this report. Assignment Number 7 suggested that the Committee explore the need for modifying the annual virgin water supply and consumptive use formulas to include municipal and industrial diversions.

The Committee decided since such diversions for which the Committee had records were relatively small that they would not be included in the 1966 computations. Listed below are the diversions available to the Committee:

1966

	Water Year	Calendar Year
City of Norton	732 Ac. Ft.	743 Ac. Ft.
Midwest Oil Co.	0 Ac. Ft.	66.2 Ac. Ft.
Livingston Oil Co.	5.4 Ac. Ft.	10.6 Ac. Ft.

The Committee decided to include the bank storage loss in Hugh Butler Lake on Red Willow Creek and in Norton Reservoir on Prairie Dog Creek. Other reservoirs in the basin had filled and the bank storage losses were negligible by the time the water supply computations were initiated for the 1959 water year. The bank storage losses in High Butler Lake for the 1962 to 1966 period were substantial, therefore, it was decided to include the bank storage losses for both of these reservoirs.

Water Year	Hugh Butler Lake Bank Storage Loss Ac. Ft.	Bank Storage Loss Norton Reservoir Ac. Ft.
1962	5,290	- - -
1963	8,600	- - -
1964	4,850	- - -
1965	2,430	2,600
1966	4,770	1,690

The Committee agreed to ask the Administration whether the 1962 through 1965 computations of virgin water supply should be revised to include bank storage water losses.

An error was found in the 1965 record of diversion for the Hale Ditch but the Committee decided to defer revising the 1965 computations until after discussing the matter with the

members of the Administration concerning this and other corrections which should be made.

The Committee agreed to compute the diversions by the three states using the same formulas as were used in 1965.

The ground water diversions in Nebraska were based on the data obtained from 22% of well users in the Republican Valley, which indicated a rate of 1.0 acre-feet per acre diversion. The diversion rate of 1.4 acre-feet per acre obtained from records in Kansas was used for diversions by stream pumps. Recorded diversions in Colorado from surface water were 2,540 acre-feet from the South Fork Republican River and 2,088 acre-feet from the North Fork Republican River. There were no recorded diversions from surface water from Arikaree River and Beaver Creek in Colorado. All ground water diversions in Colorado were assumed, as in previous years, to be up-land wells and were not involved in these computations.

Records for the Haigler Canal presented by Colorado for the canal diversions at the headgate and gauging station at the state line showed more water at the state line than at the headgate.

New Parshall flumes were installed prior to this past irrigation season near the headgate and at the state line. Apparently these flumes were not correctly installed and submerge under high flow conditions.

Due to the apparent error in the records, the Committee agreed to use the record for the headgate diversion only and to divide the water used in Colorado and Nebraska in the same manner as in 1965.

The diversion of flow was as follows:

Colorado	1,080 Ac. = 3/8 = 2,040 Ac. Ft.
Nebraska	2,020 Ac. = 5/8 = 3,390 Ac. Ft.

Total	3,100 Ac.	5,430 Ac. Ft.

The Bureau of Reclamation furnished the Committee a report entitled "Use of Water in Federal Irrigation Projects" 1966. This report contained consumptive use studies for the Meeker-Driftwood Project which was commenced in 1965 and discussed by Mr. Hedges of the Bureau of Reclamation before the Administration in 1965. The results of this consumptive use study to date were not considered to be conclusive for changing any of the return flow figures used in virgin flow computations for the principal canals in the Republican River Basin.

The Chairman of the Engineering Committee, with Mr. Kenneth MacKichan of the U.S.G.S., together with several members of his organization made a field investigation of the "Return-Flow" study section between the Trenton dam and Cambridge, during the summer of 1966. A member of the United States Geological Survey will discuss the field report of this investigation briefly for the Administration at the 1967 Annual Meeting.

The Committee has no new recommendations concerning the formulas for computation of the virgin water supply and consumptive use. In addition, the Committee has not discovered any new information for changing its policies for computing the consumptive use by irrigation wells.

A member of the Bureau of Reclamation will be called upon at the annual meeting to discuss the plans of that organization in the Republican River Valley.

Respectfully submitted,
/s/
M.E. Ball, Chairman
Nebraska

/s/
Harris L. Mackey

Kansas

/s/
Glen E. Brees
Colorado

Report of Engineering Committee
Republican River Compact Administration
June 3, 1968

The Republican River Compact Administration in its 8th annual meeting held June 19, 1967, agreed that the assignments to the Engineering Committee would include the following:

1. Compute annual virgin water supply for 1967;
2. Compute annual consumptive use for 1967;
3. Continue studies of method of computing inflow to Lovewell Reservoir;
4. Continue study of the proration of reservoir evaporation losses;
5. Compute adjusted allocations on annual, 5-year and average annual basis;
6. Continue investigation of depletions by wells in the alluvium and the effect of well distance from a stream on those depletions.
7. Explore the need for modifying Annual Virgin Water Supply and Consumptive Use Formulas to include municipal and industrial diversions from ground water and surface water.

The Engineering Committee held one meeting during the year; April 25-26, 1968, the 14th meeting of the Committee, to study these assignments. Submitted herewith and made a part of this report.

1. Computed Annual Virgin Water Supply, Republican River Basin, 1967
2. Computed Annual Consumptive Use, Republican River Basin, 1967.

The virgin flow and consumptive use formulas, presented in previous reports of the Committee, were used

without change in the preparation of the above data. The following exhibits are presented for discussions without recommendations.

1. Virgin water supply computations, 1967 water year;
2. Computations of inflow to Lovewell Reservoir, 1967 water year;
3. Computed operations of Lovewell Reservoir, 1967 water year;
4. Consumptive use computations, Main Stem Republican River;
5. Computations of adjusted allocations, 1967 water year;
6. Adjusted allocations on a 5-year average basis, 1962 through 1967.

The 14th meeting of the Engineering Committee was attended only by members of the Committee.

No new investigations were made by the Committee concerning assignment Number 6 concerning depletion by wells and consequently no new data is furnished in this report. Assignment Number 7 suggested that the Committee explore the need for modifying the annual virgin water supply and consumptive use formulas to include municipal and industrial diversions.

The Committee decided since such diversions for which the Committee had records were relatively small that they would not be included in the 1967 computations. Listed below are the diversions available to the Committee:

	Calendar Year
City of Norton	609.0 Acre-Feet
Midwest Oil Co.	945.5 Acre-Feet
Livingston Oil Co.	30.5 Acre-Feet

Last year, bank storage loss studies in Hugh-Butler Lake on Red Willow Creek and in Norton Reservoir on Prairie Dog Creek showed substantial losses in each of these reservoirs which were included in the consumptive use studies in 1966.

Continued bank storage computations revealed a gain of 3540 acre-feet at Hugh-Butler Reservoir and a gain of 2730 acre-feet at Norton Reservoir. These gains will be reflected in the change in reservoir storage so no further accounting of this factor is necessary for 1967.

The Committee agreed to compute the diversions by the three States using the same formulas as have been used in the past.

Diversions from wells and individual irrigators in Kansas were estimated on the basis of water use reports from about 44% of the water users. The average of all reported diversions in Kansas was 1.5 acre-feet/acre overall; 1.6 acre-feet/acre for ground water alluvium and 1.25 acre-feet/acre for surface water diversions. Diversions in Nebraska by small stream pumps were assumed equal to the diversions from surface water in Kansas, or 1.25 acre-feet/ acre with the following exception. The diversions in acre-feet were available for the following Nebraska streams:

Frenchman Creek	3770 Acre-Feet
Medicine Creek	750 Acre-Feet
Red Willow Creek	260 Acre-Feet

Records of diversions from surface water by the irrigation districts were available and the return flow for each of the canal systems was computed independently.

The diversions in Nebraska from ground water were computed as 0.9 acre-feet/acre for all irrigated acres irrigated in the valley alluvium, based on a sampling of use of water

from irrigation wells made by Nebraska. Recorded diversions from surface water in Colorado were 2210 acre-feet from the South Fork of the Republican River and 3400 acre-feet from the North Fork of the Republican River. There were no recorded surface water diversions for the Arikaree and Beaver Creeks in Colorado. Again all ground water diversions in Colorado were assumed to be from upland wells.

Last year's report pointed out a difficulty in the measurements of water for the Haigler Canal at the headgate and at the gaging Station at the State Line. Numerous measurements were made during the year at the State Line Station of the Haigler Canal and there allowed a reasonable determination of the diversions.

Colorado	3,810 Acre-Feet
Nebraska	7,330 Acre-Feet
Total	11,140 Acre Feet

The return flow percentage for the Hale Ditch and the Haigler Canal were held at 38% and from other diversions at 25%.

Consumptive use in each State was computed and the results tabulated. Based on total diversions for the canals below Harlan County Reservoir, Kansas was charged with 61% and Nebraska 39% of that reservoir's only evaporation.

Consumptive use of the Courtland Canal transportation loss through Nebraska was divided between Nebraska and Kansas on the basis of the diversions.

Courtland Canal	Acre-Feet
Transportation Loss	5,510
Return to river	4 130
Transportation Consumptive Use	1,380

Since state line flows were 92% of total headgate diversions

Kansas Transportation
consumptive use = 92% x 1380
= 1,270 acre-feet
Nebraska Transportation
consumptive use = 1,380 -1,270
= 110 acre-feet

Consumptive use by Nebraska from the Courtland Canal as computed from the monthly distribution form was used rather than data shown on the virgin water supply computation form. For 1967 this consumptive use was 1240 acre-feet, making a total of 1350 acre-feet including transportation loss.

It was noted that the consumptive use formulas should be revised on this basis some time in the future.

The U.S. Geological Survey supervised two seepage run studies during the past winter season to determine the pickup in the Republican River between Culbertson and Cambridge, Nebraska. These studies were made in November, 1967 and March, 1968. The discharge data has been tabulated and will be presented by the Chairman of the Engineering Committee at this meeting on behalf of the U.S. Geological Survey.

A concluding report summarizing the results of these two seepage runs has been prepared by the U.S. Geological Survey and it is intended that additional runs will probably be made next fall. The Chairman of the Engineering Committee will present the tabular data to the administration at this meeting for observation and discussion. The Engineering Committee has not had an opportunity to study or draw any conclusions from this data.

Respectfully submitted,
/s/
M.E. Ball
Nebraska

/s/
Harris L. Mackey
Kansas

/s/
Glen E. Brees
Colorado

EXHIBIT D

Report of Engineering Committee
Republican River Compact Administration
June 30, 1969

The Republican River Compact Administration at its 9th annual meeting held June 3, 1968, agreed the assignments to the Engineering Committee would include the following:

1. Compute annual virgin water supply for 1968;

2. Compute annual consumptive use for 1968;

3. Continue studies of method of computing inflow to Lovewell Reservoir;

4. Continue study of proration of reservoir evaporation losses;

5. Compute adjusted allocations on annual, 5-year and 10-year average annual basis;

6. Continue investigation of depletions by wells in the alluvium and the effect of well distance from a stream on those depletions;

7. Explore the need for modifying Annual Virgin Water Supply and Consumptive Use Formulas to include municipal and industrial diversions from ground water and surface water;

8. Review procedures and formulas used by Engineering Committee and present such recommendations as are in order to the next meeting of the Administration.

The Engineering Committee held two meetings during the year; October 29, 1968 the 15th meeting of the Committee to study assignment number 6 and May 19-20, 1969, to study the other assignments. Submitted herewith and made a part of this report are the following:

1. Computed annual virgin water supply, Republican River Basin, 1968.

2. Computed annual consumptive use, Republican River Basin, 1968.

The virgin flow and consumptive use formulas presented in the previous reports of the Committee were used with only minor changes in the preparation of the above data. The following exhibits are presented for discussion without recommendations:

1. Virgin water supply computations, 1968 water year.

2. Computed annual computations of flow to Lovewell Reservoir, 1968 water year.

3. Computed operations of Lovewell Reservoir.

4. Consumptive use computations-Kansas, main stem of the Republican River.

5. Computations of adjusted allocations, 1968 water year.

6. Adjusted allocations on a 5-year average basis, 1962-1968.

7. Adjusted allocations on a 10-year average basis, 1959-1968.

8A. Computed annual virgin water supply, 1959-1968.

8B. Allocations in acre-feet, 1959-1968, adjusted per annual virgin water supply.

8C. Average-annual virgin water supply, 5-year average and 10-year average.

8D. Allocations in acre-feet adjusted by 5-year averages and by 10-year average, 1959-1968.

8E. Computed annual consumptive use by states, 1959-1968.

The 15th meeting of the Engineering Committee was attended by Jesse Honnold, Charles Huntly, Ray Aldrich of the Bureau of Reclamation, Harland Erker of the Colorado Division of Water Resources and by members of the Engineering Committee. As heretofore stated, the purpose of the meeting was to "continue investigations of depletions by wells in the alluvium and the effects of well distance from a stream on those depletions.

It was the consensus of the group that improvement of present computation procedures or additional studies by use of analog or computer models would require the collection of more accurate basic data on pumping rates, annual quantities and return flows. While theoretical studies possibly could give a range of values, they could not give a true answer for any one year. It was questioned whether the cost to improve present methods by collecting all the data needed could be Justified. It was also questioned whether the results of a research project on a relatively small area could be applied to the entire basin due to differences in geology, concentration of wells and aquifer characteristics.

These conclusions are presented to the Administration for consideration without recommendations by the Engineering Committee.

No progress has been made by the Engineering Committee on assignment numbers 7 and 8. The Committee's conclusion was the same as for last year concerning the modification of the virgin water supply and consumptive use formulas to not include municipal and industrial diversions.

Listed below are the diversions available to the Committee.

	1968 Calendar year
City of Norton	686 acre-feet
Midwest Oil Co.	664 acre-feet
Livingston Oil Co.	36 acre-feet

Information was available for the diversions for the Haigler Canal between Colorado and Nebraska for 1968 as follows:

Colorado	3,390 acre-feet
Nebraska	7,560 acre-feet

The Committee agreed to compute the diversions for the three states using the same formulas as had been used in the past, with exceptions as noted.

Diversion by individual irrigators from alluvial wells or streams in Kansas were estimated on the basis of water use reports from 51 percent of the water users. The average of all reported diversion in the Republican Basin in Kansas was 1.58 acre-feet per acre overall. 1.63 acre-feet per acre

per groundwater alluvium and 1.39 acre-feet per acre for surface water diversions.

In Nebraska surface water diversions were computed at 1.4 acre-feet per acre shown as intended to be irrigated. Groundwater diversion rates used for 1968, based on a sample of use of water from irrigation wells by Nebraska was 1.6 acre-feet per acre. The diversions of surface water by stream pumps in the north side tributaries were:

Frenchman Creek	4,510 acre feet
Medicine Creek	910 acre-feet
Red Willow Creek	490 acre-feet

Recorded diversions from surface water in Colorado were 2,830 acre feet from the North Fork Republican River. There were no recorded surface water diversions from the Arikaree River and Beaver Creek in Colorado. All groundwater diversions in Colorado were assumed to be from upland wells and so were not included in the computations.

Consumptive use in each state was computed and the results tabulated. Return flow percentages were computed for the major canals from data supplied by the U.S. Bureau of Reclamation. The return flow percentages for the Hale Ditch and Haigler Canal were held at 38 percent and from other diversions at 25 percent. For the first time, two canals, Champion and Riverside, which divert from the Frenchman River, had recorded diversions to be included in the computations of canals. Return flow percentages were assumed the same as for the Culbertson Canal or 38 percent, and for both the return flows were a Tributary to Frenchman River.

The annual virgin water supply and the consumptive use in each state was computed and the results are shown in attached Exhibits. Based on water diversions by canals

below Harlan County Reservoir, Kansas was charged 57 percent (18,800 acre-feet) and Nebraska 43 percent (14,240 acre-feet) of that reservoirs net evaporation.

Except for Harlan County, the Engineering Committee has done nothing toward the proration of net evaporation losses from reservoirs from the Republican River Basin. Since this has been an assignment of the Engineering Committee (assignment number 4) the Committee decided to report these to the Administration for further instructions. As a matter of information, there is given below computed total net evaporation from all reservoirs as compared with that from Harlan County Reservoir, which, on the average, accounts for about 48 percent of the total.

Annual Net Evaporation in Basin in Acre-Feet

Year	Total	Harlan County
1959	60,130	30,070
1960	47,320	20,550
1961	41,870	18,100
1962	36,390	18,010
1963	64,340	32,020
1964	76,080	38,870
1965	25,000	7,660
1966	68,110	36,160
1967	53,580	26,670
1968	75,180	33,120
Average	54,800	26,220

The U.S. Geological Survey supervised two additional seepage runs during the past water year to determine the pickup in the Republican River between Culbertson and Cambridge, Nebraska. These seepage runs were made in November 1968 and March 1969. The discharge data has been tabulated and will be presented by the chairman of the Engineering Committee at this meeting

on behalf of the U.S. Geological Survey. The Engineering Committee has not had an opportunity to study or draw any conclusions from this data.

Respectfully submitted,
/s/
M.E. Ball
Nebraska

/s/
Harris L. Mackey
Kansas

/s/
Glen E. Brees
Colorado

Report of Engineering Committee
Republican River Compact Administration
May 26, 1970

The Republican River Compact Administration at its 10th annual meeting held June 30, 1969, agreed the assignments to the Engineering Committee would include the following:

1. Compute annual virgin water supply, 1969 water year;

2. Compute annual consumptive use, 1969 water year;

3. Compute inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1969 water year;

4. Continue study of proration of net evaporation losses from all reservoirs in the basin and possible effect upon consumptive use by each State;

5. Compute adjusted allocations on annual, five-year average and ten-year average basis;

6. Continue investigations of depletions by wells in the alluvium;

7. Bring up to date in form for publication the procedures and formulas used by the Engineering Committee for the computation of annual virgin water supply and annual consumptive use.

The Engineering Committee held one meeting during the year, April 8th to 10th, 1970, the 17th meeting, to study

the virgin water supply and consumptive use of the water year 1969 and to revise the formulas for these computations. Submitted herewith and made a part of this report are the following:

1. Computed annual virgin water supply Republican River Basin 1969;

2. Computed annual consumptive use Republican River Basin, 1969;

3. Draft of revisions of formulas for the computation of virgin water supply Republican River Basin;

4. Draft of revisions of the formulas for the computation of annual consumptive use, Republican River Basin.

The following exhibits are presented for discussion without recommendation:

1. Virgin water supply computation, 1969 water year;

2. Computation, annual inflow to Lovewell Reservoir, 1969 water year;

3. Computed operations of Lovewell Reservoir, 1969 water year;

4. Consumptive use computation-Kansas, main stem of the Republican River;

5. Computation of adjusted allocations on an annual basis, 1969 water year;

6. Adjusted allocations on a 5-year average basis, 1962-1969;

7. Adjusted allocations on a 10-year average basis, 1959-1969.

The municipal and industrial uses which have not been included in the virgin water supply or consumptive use formulas are given below:

	1969 Calendar Year
City of Norton	645 Ac. Ft.
Midwest Oil Co.	644 Ac. Ft.
Livingston Oil Co.	336 Ac. Ft.

Recorded division of diversions by the Haigler Canal between Colorado and Nebraska for 1969 were:

Colorado	3,140 Ac. Ft.
Nebraska	8,080 Ac. Ft.
Total	11,220 Ac. Ft.

Diversions by individual irrigators from alluvial wells or streams in Kansas were estimated on the basis of water use reports from 48% of the water users. Average of all reported diversions in the Republican River Basin in Kansas was 1.5 Ac. Ft./Ac. Average of diversions from groundwater alluvium was 1.6 Ac. Ft./Ac. and from surface water was 1.3 Ac. Ft./Ac.

Nebraska records of diversions from surface water by other than major canals were:

Frenchman Creek	3,480 Ac. Ft.
Medicine Creek	780 Ac. Ft.
Red Willow Creek	800 Ac. Ft.

In other basins in Nebraska surface water diversions are computed as 1.3 Ac. Ft./Ac. shown as intended to be irrigated. Groundwater diversion rate used for 1969 was 1.2 Ac. Ft./Ac. as determined from a 14% sample of water use reports.

Recorded diversions from surface water in Colorado were:

S. Fork Republican River	2,330 Ac. Ft.
N. Fork Republican River	3,810 Ac. Ft.
Arikaree River	0 Ac. Ft.
Beaver Creek	0 Ac. Ft.

All groundwater diversions in Colorado were assumed to be from upland wells and are not included in the computations.

Return flow percentages were computed for the major canals from data by the U.S. Bureau of Reclamation with the following results:

Canal	Return as Per Cent of Total Diversions	Canal	Return as Per Cent Total Diversions
Culbertson	41%	Franklin	56%
Culbertson Ext.	45%	Franklin Pump	41%
Meeker-Driftwood	41%	Naponee	41%
Red Willow	46%	Superior	55%
Cambridge	41%	Courtland-Nebr.	25%
Bartley	39%	Courtland-Kansas	
Almena	36%	Above Lovewell	54%
		Below Lovewell	47%

Return flow percentages for other canals and diversions were estimated as given below:

Hale Ditch	38%	Groundwater diversions	25%
Haigler Canal	38%	Surface wate diversions	25%
Champion Canal	41%		
Riverside Canal	41%		

The annual virgin water supply and the consumptive use in each state was computed and the results are shown on the attached exhibits. Based on diversions by canals below Harlan County Reservoir, the net evaporation from Harlan County was divided (55%), 8,750 Ac. Ft. to Kansas and (45%), 7,160 Ac. Ft. to Nebraska.

The committee reviewed and revised the formulas for computation of annual virgin water supply and annual consumptive use. These revised formulas are presented in draft form for action by the Administration at this meeting.

No action was taken on the prorating of the net evaporation from reservoirs other than in the Harlan County Reservoir.

The committee studied a detailed computation of the annual losses and gains in the Trenton-Palisade to Cambridge reach of the Republican River. This study indicates that prior to the operation of Irrigation Districts the reach was a losing stream but return flows from districts have now made a gaining river through the reach. The results of this table explain why the original studies made by Floyd LeFever indicated no definite show of return flow as

his studies were made at the time of transition of the river from a losing stream to a gaining stream.

The U.S. Geological Survey has supervised two additional seepage runs during the past year to determine the pickup in the Republican River in this same river section. The U.S. Geological Survey will present the results of these studies at this meeting.

Respectfully submitted,

/s/
M.E. Ball
Nebraska

/s/
Harris L. Mackey
Kansas

/s/
Glen E. Brees
Colorado

Report of Engineering Committee
Republican River Compact Administration
June 4, 1971

The Republican River Compact Administration at its 11th annual meeting held May 26, 1970, agreed the assignments to the Engineering Committee would include the following:

1. Compute annual virgin water supply, 1970 water year;

2. Compute annual consumptive use, 1970 water year;

3. Compute inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1970 water year.

4. Compute adjusted allocations on annual, five-year average and ten-year average basis;

5. Continue investigations of depletions by wells in the alluvium;

6. Make a water-budget study, in cooperation with the U.S. Geological Survey, of the Trenton-Palisades to Cambridge reach of the Republican River.

The Engineering Committee held one meeting during the year, May 6-7, 1971, the 18th meeting, to study the virgin water supply and consumptive use of the water year 1970. Submitted herewith and made a part of this report are the following:

1. Computed annual virgin water supply Republican River Basin 1970;

2. Computed annual consumptive use Republican River Basin, 1970;

The following exhibits are presented for discussion without recommendation:

1. Virgin water supply computation, 1970 water year;

2. Computation, annual inflow to Lovewell Reservoir, 1970 water year;

3. Computed operations of Lovewell Reservoir, 1970 water year;

4. Consumptive use computation-Kansas, main stem of the Republican River;

5. Computation of adjusted allocations on an annual basis, 1970 water year;

6. Adjusted allocations on a 5-year average basis, 1966-1970;

7. Adjusted allocations on a 10-year average basis, 1961-1970.

The municipal and industrial uses which have not been included in the virgin water supply or consumptive use formulas are given below:

	1970 Calendar Year
City of Norton	824 Ac. Ft.
Midwest Oil Co.	574 Ac. Ft.
L.V.O. Oil Co. (formerly Livingston Oil Co.)	17 Ac. Ft.
Hahn Petroleum Co.	3 Ac. Ft.

Recorded division of diversions from the North Fork Republican River by the Haigler Canal between Colorado and Nebraska for 1970 were:

Colorado	3,120 Ac. Ft.
Nebraska	6,720 Ac. Ft.
Total	9,840 Ac. Ft.

Recorded diversions from surface water in Colorado other than by the Hale Ditch were:

S. Fk. Republican River	1,940 Ac. Ft.
N Fk. Republican River	4,090 Ac. Ft.
Arikaree River	0 Ac. Ft.
Beaver Creek	0 Ac. Ft.

All groundwater diversions in Colorado have been considered to be from upland wells and have not been included in the computations. It was agreed that Colorado for 1971 should try to determine the acreage irrigated by wells, if any, in the alluvium so that groundwater diversions may be estimated.

Diversions by individual irrigators from alluvial wells or streams in Kansas were estimated on the basis of water use reports from 50% of the water users. Average of all reported diversions in the Republican River Basin in Kansas was 1.8 Ac. Ft./Ac. Average rate of diversion from groundwater alluvium was 1.8 Ac. Ft./Ac., and from surface water was 1.3 Ac. Ft./Ac.

Estimated diversions by individuals in Kansas for 1970 are given below in acre-feet:

Sub-basin	Groundwater	Surface Water
Arikaree River	200	0
S. Fk. Republican River	4,860	550
Beaver Creek	7,060	830
Sappa Creek	7,660	300
Prairie Dog Creek	10,140	1,950

Republican River above Hardy	160	680

The Nebraska records of diversion for surface water by other than major canals for the principal tributaries were:

Frenchman Creek	3,700 Ac. Ft.
Medicine Creek	1,080 Ac. Ft. (above gaging station)
Medicine Creek	60 Ac. Ft. (below gaging station)
Red Willow Creek	450 Ac. Ft.

In other basins in Nebraska including the main stem of the Republican River surface water diversions by stream pumps were computed as 1.3 Ac. Ft. per acre. Groundwater diversion rate used for 1970 was 1.6 acre-feet per acre as determined from a 10 percent sample by water use reports.

Return flow percentages were computed for the major canals from data provided by the U. S. Bureau of Reclamation as follows:

Canal	Return as Per Cent of Total Diversions	Canal	Return as Per Cent of Total Diversions
Culbertson	43%	Franklin	51%
Culbertson Ext.	46%	Franklin Pump	42%
Meeker-Driftwood	41%	Naponee	41%
Red Willow	46%	Superior	45%
Cambridge	40%	Courtland-Nebr.	25%
Bartley	38%	Courtland-Kans.	
Athena	35%	above Lovewell	42%
		below Lovewell	38%

Return flow percentages for other canals and diversions were estimated as given below:

Hale Ditch	38%	Groundwater Diversions	25%
Haigler Canal	38%	Surface Water Diversions	25%

The 1970 annual virgin water supply was computed using the above data together with pertinent stream-flow diversion and reservoir records. Based on canal diversions below Harlan County Reservoir the net evaporation from this reservoir was divided (58%) 16,070 Ac. Ft. to Kansas and (42%) 11,630 Ac. Ft. to Nebraska.

In past years the committee had thrown the water consumed in Prairie Dog Creek, Sappa Creek, Beaver Creek, and Medicine Creek Basin below the gaging stations near the mouths of these streams into the water consumed in the main stem of the Republican River. This was in accordance with the formulas for determining consumptive use as originally drafted and as presented in the corrected formulas in the meeting of the Administration last year. The committee decided to make additional computations for these streams to show the water consumed above the mouth of those streams with the water consumed in the streams above the gaging stations. This was done for comparative purposes to permit the Administration to study the matter and to determine whether the consumptive use from these streams below the gaging stations should be included with water consumed in the balance of the streams or should be left a part of consumptive use at the Main Stem of the Republican River. The following is a consumptive use table for these streams showing the water consumed above the gaging stations and above the mouth.

Consumptive Use in Nebraska - 1970

	Above Gaging Sta. Ac. Ft.	Above Mouth Ac. Ft.
Prairie Dog Creek	0	0
Beaver Creek	7,050	9,840
Sappa Creek	8,690	9,350
Medicine Creek	8,820	8,860

The consumptive use of Nebraska in the Main Stem of the Republican for 1970 was 182,750 Ac. Ft. which would be reduced to 178,690 Ac. Ft. by the change of the formula.

No material advancement has been made in the results desired in Assignment No. 6 to the Engineering Committee for a water budget study. The committee agreed further study was needed in the future on the assignment to attempt to isolate the depletions by wells. No specific assignment was made by the committee to the U. S. Geological Survey to assist in these studies during the past year. The USGS will provide consultations to the committee in any future studies.

The results of the seepage runs in c.f.s. for the years 1967 to April of 1970 were summarized in a report from the U. S. Geological Survey provided information for the May 26, 1970, meeting of the administration. A conclusion was made that as a result of the data furnished that the seepage runs be discontinued. One additional seepage run was made November 5, 1970, as a final check. This run showed an inflow to the river reach studied of 2.5 c.f.s.

This confirmed the April 1970 result of 1.33 c.f.s. which was a drop of about 40 second-feet as shown in the two seepage runs during 1969.

Respectfully submitted,

/s/
M.E. Ball
Nebraska

/s/
Harris L. Mackey
Kansas

/s/
Glen E. Brees
Colorado

Report of Engineering Committee
Republican River Compact Administration
June 9, 1972

The Republican River Compact Administration at its 12th annual meeting held June 4, 1971, agreed the assignments to the Engineering Committee would include the following:

1. Compute annual virgin water supply, 1971 water year;
2. Compute annual consumptive use, 1971 water year;
3. Compute inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1971 water year;
4. Compute adjusted allocations on annual, five-year average and ten-year average basis;
5. Continue investigations of depletions by wells in the alluvium;
6. Make a water-budget study, in cooperation with the U.S. Geological Survey, of the Trenton-Palisade to Cambridge reach of the Republican River.

The Engineering Committee held one meeting during the year, April 25-26, 1972, the 19th meeting, to study the virgin water supply and consumptive use of the water year 1971. Submitted herewith and made a part of this report are the following:

1. Computed annual virgin water supply Republican River Basin 1971;
2. Computed annual consumptive use Republican River Basin, 1971;

The following exhibits are presented for discussion without recommendation:

1. Virgin water supply computation, 1971 water year;
2. Computation, annual inflow to Lovewell Reservoir 1971 water year;
3. Computed operations of Lovewell Reservoir, 1971 water year;
4. Consumptive use computation-Kansas, main stem of the Republican River;
5. Computation of adjusted allocations on an annual basis, 1971 water year;
6. Adjusted allocations on a 5-year average basis, 1967-1971;
7. Adjusted allocations on a 10-year average basis, 1962-1971.
8. Computed Annual Virgin Water Supply, 1959-1971;
9. Computed Adjusted Allocations. Annual Basis, 1959-1971;
10. Computed Average Annual Virgin Water Supply 5-year and 10-year Averages;
11. Computed Adjusted Allocations based on 5-year and 10-year Averages;
12. Computed Annual Consumptive Use, 1959-1971.

Municipal and industrial uses are not included in the virgin water supply formulas; but, for the record, those available to the Committee are given below:

	1971 Calendar Year
City of Norton	816 Ac. Ft.
Midwest Oil Co.	454 Ac. Ft.
L. V. O. Oil Co.	19 Ac. Ft.

Recorded division of diversions from the North Fork Republican River by the Haigler canal for 1971 was:

Colorado	2,990 Ac. Ft.
Nebraska	6,410 Ac. Ft.
Total	9,400 Ac. Ft.

Other recorded diversions from surface water in Colorado with the exception of the Hale Ditch were:

S. Fk. Republican River	1,720 Ac. Ft.
N. Fk. Republican River	3,930 Ac. Ft.
Arikaree River	0 Ac. Ft.
Beaver Creek	0 Ac. Ft.

Colorado was unable to present reasonable estimates of diversions by wells in the alluvium due to the difficult problem of separating those diverting from alluvium from those diverting from the Ogallala. Since there were no reports of actual diversions in 1971, only the rates and quantities shown on the permits are available. It was thought that wells in the S. Fk. Republican River and Arikaree River Basins would be metered in the near future.

The Committee agreed to recommend to the Administration that further efforts be made to provide reasonable estimates of diversions from alluvial wells in Colorado.

Nebraska records of diversions from surface water by other than major canals were:

Frenchman Creek	2,720 Ac. Ft.
Medicine Creek	1,090 Ac. Ft.
Red Willow Creek	380 Ac. Ft.

In other basins in Nebraska surface water diversions were computed as 1.7 Ac, Ft. per acre intended to be irrigated. Ground-water diversion rate used for 1971 was 1.3 Ac. Ft. per acre intended to be irrigated as determined from a 10% sample of reports from irrigators.

Diversions by individual irrigators from alluvial wells or streams in Kansas were estimated on the basis of water use reports from 43% of the water users. Average of all reported diversions in the Republican River Basin in Kansas was 1.9 Ac. Ft./Ac. Average rate of diversion from alluvium was 1.9 Ac. Ft./Ac. And from surface water was 1.7 Ac. Ft./Ac.

Estimated diversions by individuals in Kansas for 1971 are given below in acre-feet:

Sub-Basin	Groundwater	Surface Water
Arikaree River	330	0
S. Fk. Republican River	7,880	160
Beaver Creek	9,190	760
Sappa Creek	8,170	310
Prairie Dog Creek	12,610	2,220
Republican River above Hardy	200	630

Return flow percentages were computed for the major canals from data by the U.S. Bureau of Reclamation as follows:

Canal	Return as Per Cent of Total Diversions	Canal	Return as Per Cent of Total Diversions
Culbertson	44%	Franklin	53%
Culbertson Ext.	48%	Franklin Pump	47%
Meeker-Driftwood	42%	Naponee	38%
Red Willow	41%	Superior	47%
Cambridge	42%	Courtland -Nebr.	23%
Bartley	36%	Courtland -Kans.	
Athena	37%	Above Lovewell	43%
		Below Lovewell	46%

Return flow percentages for other canals and diversions were estimated as given below:

Hale Ditch and Haigler Canal	38%
Champion and Riverside Canal	44%
Groundwater and surface water Diversions	25%

Computations of consumptive use to mouths of tributaries in Nebraska are shown below:

	By Formula Ac. Ft.	Above Mouth Ac. Ft.
Prairie Dog Creek	0	580
Beaver Creek	6,200	8,830
Sappa Creek	8,180	8,120
Medicine Creek	7,570	8,070

Net evaporation from Harlan County Reservoir was divided (51%) 10,030 Ac. Ft./Ac. to Kansas and (49%) 9,640 Ac. Ft. to Nebraska based on total diversions by the canals in each state below Harlan County Reservoir.

No further studies were made during the past year on the assignment regarding the stream depletions by wells in the alluvium. The annual water budget computations were brought up-to-date by Nebraska and the results of these studies to determine return flows will be described to the administration as a part of the engineering report at the annual meeting of the administration.

Respectfully submitted,

/s/
M.E. Ball
Nebraska
/s/
Harris L. Mackey
Kansas
/s/
Glen E. Brees
Colorado

Report of Engineering Committee
Republican River Compact Administration
June 18, 1973

The Republican River Compact Administration at its 13th Annual Meeting held June 9, 1972, agreed the assignments to the Engineering Committee would be as follows:

1. Compute annual virgin water supply, 1972 water year;

2. Compute annual consumptive use, 1972 water year;

3. Compute inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1972 water year;

4. Compute adjusted allocations on annual, five-year average and ten-year average basis;

5. Continue investigations of depletions by wells in the alluvium;

6. Make a water-budget study, in cooperation with the U.S. Geological Survey, of the Trenton-Palisade to Cambridge reach of the Republican River.

The Engineering Committee held one meeting during the year, May 10 through 11, 1973, to study the virgin water supply and consumptive use of the water supply 1972. Submitted here and made a part of this report are the following:

1. Computed annual virgin water supply Republican River Basin 1972; and,

2. Computed annual consumptive use Republican River Basin, 1972.

The detailed computations of the virgin water supply and consumptive use, the adjusted allocations on an annual basis for 1972, and a five-year and ten-year average basis are available for inspection here at this meeting. Tables are also available for inspection identified as attachments 10A through 10E showing the following. These tables have been made available previously to the Compact Administrators.

10A. 1959-1972, Computed Annual Virgin Water Supply;

10B. 1959-1972, Allocations Adjusted on Basis of Annual Virgin Water Supply;

10C. 1959-1972, Average Annual Virgin Water Supply for Five-Year and Ten-Year Running Averages;

10D. 1959-1972, Adjusted Allocations by Five-Year and Ten-Year Running Averages;

10E. 1959-1972, Computed Annual Consumptive Use by Years.

These attachments are not made a part of the engineering report.

Municipal and industrial uses are not included in the virgin water supply formulas, but, for the record, those available to the Committee are given below:

	1972 Calendar Year
City of Norton	600 Ac.-Ft.
Midwest Oil Company	429 Ac.-Ft.
L. V. O. Oil Company	11 Ac.-Ft.

Recorded division of diversions from the North Fork Republican River by the Haigler canal for 1972 was:

Colorado	3, 620 Ac.-Ft.
Nebraska	8,740 Ac.-Ft.
Total	12, 360 Ac.-Ft.

Other recorded diversions from surface water in Colorado with the exception of the Hale Ditch were:

S. Fork Republican River	1, 280 Ac.-Ft.
N. Fork Republican River	5, 040 Ac.-Ft.
Arikaree River	0 Ac.-Ft.
Beaver Creek	0 Ac.-Ft.

Colorado's diversions from groundwater, based on information and data compiled by the U.S. Geological Survey, were estimated by applying an average diversion of 169 Ac.-Ft. per well to the number of wells in the alluvium and are shown below:

Sub-Basin	Acre-Feet
S. Fork Republican River	1,010
N. Fork Republican River	510
Arikaree River	3,720
Beaver Creek	0

Nebraska recorded diversions from surface water by other than major canals were:

Frenchman Creek	1,780 Ac.-Ft.
Medicine Creek	1,140 Ac.-Ft.
Red Willow Creek	330 Ac.-Ft.

In other basins in Nebraska surface water diversions were computed as 1.35 ac.-ft. per acre intended to be irrigated. Groundwater diversion rate used for 1972 was 1.4

ac.-ft. per acre irrigated as determined from reports of irrigators for 12% of wells pumping from the valley alluvium.

Diversions by individual irrigators from alluvial wells or streams in Kansas were estimated on the basis of water use reports from 37% of the water users. Average of all reported diversions in the Republican River Basin in Kansas was 1.7 ac.-ft./ac. Average rate of diversion from alluvium was 1.8 ac.-ft./ac. and from surface water was 1.35 ac.-ft./ac.

Estimated diversions by individuals in Kansas for 1972 are given below in acre-feet:

Sub-basin	Groundwater	Surface Water
Arikaree River	260	0
S. Fork	8,520	210
Republican River		
Beaver Creek	7,790	520
Sappa Creek	8,650	
		280
Prairie Dog Creek	12,750	1,870
Republican River above Hardy	90	910

Return flow percentages were computed for the major canals from data provided by the U.S. Bureau of Reclamation as follows:

Canal	Return as % of Total Diversions	Canal	Return as % of Total Diversions
Culbertson	43%	Franklin	56%
Culbertson Ext.	50%	Franklin Pump	42%
Meeker-Driftwood	46%	Naponee	43%
Red Willow	44%	Superior	53%
Cambridge	43%	Courtland-Nebr.	26%
Bartley	36%	Courtland-Kansas	
Almena	52%	Above Lovewell	47%
		Below Lovewell	48%

Return flow percentages for other canals and diversions were estimated as given below:

Hale Ditch and Haigler Canal	38%
Champion and Riverside Canals	43%
Groundwater and surface water Diversions	25%

Computation of the return flow from the Courtland Canal in Nebraska is shown to be 6,720 acre-feet.

In Kansas 67% of the irrigable land above Lovewell was irrigated in 1972 with an average diversion rate of 1.83 ac.-ft./ac. Based on this data it was established that 1,390 ac.-ft. were diverted on 762 acres above Hardy and the return flows were 650 ac.-ft.

Net evaporation from Harlan County Reservoir was divided (51%) 5, 800 acre-feet to Kansas and (49%) 5, 580 acre-feet to Nebraska based on total diversions by the canals in each state below Harlan County Reservoir.

Computations of inflow to Lovewell Reservoir gave a 1972 total inflow of 40,420 acre-feet of which 29,940 acre-feet was diverted from the Republican River. Computed operations of Lovewell Reservoir for 1972 gave a net evaporation loss of 510 acre-feet from Republican River water. Storage in Lovewell at the beginning of the water year was 30,970 acre-feet of which 9,620 acre-feet was water from the Republican River. At the close of the water year, storage in Lovewell was 38,980 acre-feet of which 6.700 acre-feet was water from the Republican River.

Computation of consumptive use in Kansas of water diverted from the main stem Republican River, including prorated shares of net evaporation from Harlan County Reservoir and Courtland Canal transportation loss through Nebraska was 36,170 acre-feet in 1971-72 water year.

Consumptive use to mouths of tributaries in Nebraska are shown below:

Consumptive Use in Nebraska - 1972

	By Formula Ac.-Ft.	Above Mouth Ac.-Ft.
Prairie Dog Creek	0	460
Beaver Creek	9,120	11,480
Sappa Creek	7,780	8,200
Medicine Creek	9,310	9,840
S. Fork Republican River	0	180
Buffalo Creek	680	870

The Twelfth Annual Report of the Administration does show that the Chairman of the Engineering Committee produced a tabulation entitled "Republican River Return Flow Study for the Years 1954-1971," and recommended to the Administration that the U.S. Geological Survey be requested to review this tabulation and to comment whether or not the study should be continued in the river reach from Trenton to Cambridge. The Administration accepted the recommendation and Mr. Butler Shaffer of the U.S. Geological Survey stated that they would be glad to make this study.

A report of the study by the U.S. Geological Survey was submitted to the Engineering Committee and this report will be discussed later. This report is not submitted as a part of the engineering report.

Respectfully
submitted,

/s/

Nebraska

/s/
Gerald E. Holmes
Kansas

/s/
Glen E. Brees
Colorado

Report of Engineering Committee
Republican River Compact Administration
June 13, 1974

The Republican River Compact Administration at its 14th Annual Meeting held June 18, 1973, agreed the assignments to the Engineering Committee would be as follows:

1. Compute annual virgin water supply, 1973 water year;

2. Compute annual consumptive use, 1973 water year;

3. Compute inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1973 water year;

4. Compute adjusted allocations on annual, five-year average and ten-year average basis;

5. Continue investigations of depletions by wells in the alluvium.

The Engineering Committee held one meeting during the year, May 13-14, 1974, to study the virgin water supply and consumptive use of the water supply 1973. Submitted here and made a part of this report are the following:

1. (Exhibit A) Computed annual virgin water supply Republican River Basin, 1973 water year;

2. (Exhibit B) Computed annual consumptive use Republican River Basin, 1973 water year;

3. Computed inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1973 water year;

4. Computed adjusted allocations on annual, five-year average and ten-year average basis;

5. Continued investigations of depletions by wells in the alluvium.

It is the recommendation of the Engineering Committee that the computed annual virgin water supply and computed annual consumptive use for the 1973 water year be published in the 14th annual report of the Republican River Compact Administration.

Computations of inflow to Lovewell Reservoir gave a 1973 total inflow of 112,040 Ac. ft. of which 20,650 Ac. Ft. was diverted from the Republican River. Computed operations of Lovewell Reservoir for 1973 gave a net evaporation loss of 600 Ac. Ft. from the Republican River water. Storage in Lovewell Reservoir at the beginning of the water year was 38,980 Ac. Ft. of which 6,700 Ac. Ft. was water from the Republican River. At the close of the water year, storage in Lovewell was 71,200 Ac. ft. of which 0.0 Ac. Ft. was water from the Republican River.

The detailed computations of the virgin water supply and consumptive use, the adjusted allocations on an annual basis for 1973, and a five-year and ten-year average basis are available for inspection here at the Fifteenth Annual meeting.

No progress was made on Assignment 5 because of the lack of adequate basic data with respect to stream flow data, ground water levels and ground water extractions.

The following exhibits have been made available to the members of the Compact Administration with the

recommendation that they not be published in the Fourteenth Annual Report.

10A. Computed Annual Virgin Water Supply, for the 1972 water year and 1973 water year;

10B. Adjusted allocations computed on the Basis of Annual Virgin Water Supply, for 1972 water year and 1973 water year;

10C. Average Annual Virgin Water Supply, for Five-Year Running Averages for 1968-1972 and 1969-1973, and Ten-Year Running Averages for 1963-1972 and 1963-1973;

10D. Adjusted Allocations by Five-year and Ten-year Running Averages for same years as 10C.

10E. Computed Annual Consumptive Use by Years, by States for 1972 water year and 1973 water year.

The above computations made by the Engineering Committee followed the procedures of previous years.

Municipal and industrial uses are not included in the virgin water supply computations but, for the record, those available to the Committee are given below:

	1973 Calendar Year
City of Norton	540 Ac.-Ft.
Midwest Oil Company	370 Ac.-Ft.
L. V. O. Oil Company	110 Ac.-Ft.

Recorded diversions from the North Fork Republican River by the Haigler Canal for 1973 were:

Colorado	1,940 Ac.-Ft.
Nebraska	6,000 Ac. -Ft.
Total	7,940 Ac.-Ft .

Return flow percentages for other canals and diversions were estimated as given below:

Hale Ditch and Haigler Canal	38%
Champion and Riverside Canals	42%
Groundwater and surface water diversions	25%

Computation of return flow from the Courtland Canal in Nebraska is shown below:

Item	Acre-Feet
Courtland Canal -Headgate	50,040
Courtland Canal –Stateline	-43,970
Total loss in Nebraska	6,070
Direct Supply to Nebraska Lands	-1,310
Courtland Canal Transportation Loss in Nebraska	4,760
Return Flow Percentage	x75%
Transportation Loss Returned to River	3 ,570
Direct Supply Returned to River (1,310 x 28%)	+ 370
Total Return Flow in Nebraska	3,940

In Kansas 61% of the irrigable land above Lovewell was irrigated in 1973 with an average diversion rate of 2.31 Ac. Ft. per acre. Based on this data it was estimated that 1,600 Ac. Ft. were diverted on 694 acres above Hardy and the return flows were 750 Ac. Ft.

Diversion of return flows between tributaries and main stem Republican remain the same percentages as for the 1972 computations and the results are given below:

	Return Flows			Division of Return Flows	
Canal	Diversions	%	Ac. Ft.	Frenchman	Main stem
Champion	2,770	42	1,160	1,160 (100%)	
Riverside	1,610	42	680	680 (100%)	
Culbertson	22,060	42	9,270	7,690 (83%)	1,580 (17%)
Culbertson	26,600	46	12,240	____	12,240 (100%)
Totals	53,040		23,350	9,530	13,820

	Return Flows			Division of Return Flows	
Canal	Diversions	%	Ac. Ft.	Frenchman	Main stem
Meeker-Driftwood	37,300	41	15,290	3,670 (24%)	11,620 (76%)
Red Willow	10,680	42	4,490	450 (10%)	4,040 (90%)

The 1973 annual virgin water supply was computed using the above together with stream-flow, diversion and reservoir records.

Net evaporation from Harlan County Reservoir was divided (45%) 2,520 Ac. Ft. to Kansas and (55%) 3,090 Ac. Ft. to Nebraska based on total diversions by the canals in each state below Harlan County Reservoir.

Computation of consumptive use in Kansas of water diverted from the main stem Republican River, including prorated shares of net evaporation from Harlan County Reservoir and Courtland Canal transportation loss thru Nebraska was 33,430 Ac. Ft. in the 1973 water year.

Consumptive use to mouths of tributaries in Nebraska were computed The results are shown below:

Consumptive Use in Nebraska - 1973

	By Formula Ac. Ft.	Above Mouth Ac. Ft.
Prairie Dog Creek	0	480
Beaver Creek	7,230	9,470
Sappa Creek	7,840	8,040
Medicine Creek	8,990	9,840
S. Fk. Republican River	200	200
Buffalo Creek	1,240	1,240

The Committee computed adjusted allocations for each state based on the computed annual virgin water supply for the 1973 water year, the 1969-73 five-year average and the 1964-73 ten-year average.

The Engineering Committee discussed the matters of derived virgin water supplies and allocations within the Compact Basin and if given Compact allocations need be adjusted on basis of past computations. No recommendations were made by the Engineering Committee concerning the matter at hand.

Respectfully submitted,

/s/
M.E. Ball
Nebraska

/s/
Harris L. Mackey
Kansas

/s/
Glen E. Brees
Colorado

Report of Engineering Committee
Republican River Compact Administration
July 30, 1975

The Republican River Compact Administration at its 15th annual meeting held June 13, 1974, agreed the assignments to the Engineering Committee would be as follows:

1. Compute annual virgin water supply, 1974 water year;

2. Compute annual consumptive use, 1974 water year;

3. Compute adjusted allocations on annual, five-year average and ten-year average basis;

4. Any other special assignment that might be assigned to the Committee by the Compact Administration during the coming year.

The Engineering Committee held one regular meeting during the year, June 24-25, 1975, to study the virgin water supply and consumptive use of the water supply for 1974. The Special Engineering Committee, appointed during the year by the Compact Administration, held two meetings, one on January 21, 1975, and on June 25, 1975, to begin study of administration procedures in the event of a water shortage and to provide recommendations to the Compact Administration. Submitted here and made a part of this report are the following:

1. (Exhibit A) Computed annual virgin water supply Republican River Basin, 1974 water year;

2. (Exhibit B) Computed annual consumptive use Republican River Basin, 1974 water year;

3. Computed inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1974 water year;

4. Computed adjusted allocations on annual five-year average and ten-year average basis.

It is the recommendation of the Engineering Committee that the computed annual virgin water supply and computed annual consumptive use for the 1974 water year be published in the 15th annual report of the Republican River Compact Administration.

Computations of inflow to Lovewell Reservoir gave a 1974 total inflow of 137,700 acre-feet of which 41,850 acre-feet was diverted from the Republican River. Computed operations of Lovewell Reservoir for 1974 gave a net evaporation loss of 1 410 acre-feet from the Republican River water. Storage in Lovewell Reservoir at the beginning of the water year was 71,200 acre-feet of which 0.0 acre-feet was water from the Republican River. At the close of the water year, storage in Lovewell was 30,560 acre-feet of which 7,400 acre-feet was water from the Republican River.

The detailed computations of the virgin water supply and consumptive use, the adjusted allocations on an annual basis for 1974, and a five-year and ten-year average basis are available for inspection here at the Sixteenth Annual Meeting.

The following exhibits are available to the members of the Compact Administration with the recommendation that they not be published in detail in the Fifteenth Annual Report.

10A. Computed Annual Virgin Water Supply for the 1974 water year;

10B. Adjusted allocations computed on the Basis of Annual Virgin Water Supply, for 1974 water year;

10C. Average Annual Virgin Water Supply for Five-year Running Averages for 1970-74 and Ten-year Running Averages for 1965-1974;

10D. Adjusted Allocations by Five-year and Ten-year Running Averages for same years as 10C;

10E. Computed Annual Consumptive Use by States for 1974 water year.

The above computations made by the Engineering Committee followed the procedures of previous years.

Municipal and industrial uses are not included in the virgin water supply computations; but, for the record, those available to the Committee are as follows:

		1974 Calendar Year
	City of Norton	850 Ac. Ft.
(Amoco)	Midwest Oil Co.	320 Ac. Ft.
(Ladd)	L.V.O. Oil Co.	20 Ac. Ft.

Recorded diversions from the North Fork Republican River by the Haigler Canal for 1974 were:

Colorado	2,540 Ac. Ft.
Nebraska	6 840 Ac. Ft.
Total	9,380 Ac. Ft.

Other recorded diversions from surface water in Colorado with the exception of the Hale Ditch were:

S. Fk. Republican River	2,420 Ac. Ft.
N. Fk. Republican River	3,060 Ac. Ft.
Arikaree River	0 Ac. Ft.
Beaver Creek	0 Ac. Ft.

Colorado diversions from groundwater were based on an average diversion of 169 acre-feet per well producing from valley alluvium and are shown below in acre-feet:

S. Fk. Republican River	1,180
N. Fk. Republican River	510
Arikaree River	4,220
Beaver Creek	0

Nebraska recorded diversions from surface water by other than major canals are given below in acre-feet:

Frenchman Creek	690
Medicine Creek	1,210
Red Willow Creek	340

In other basins in Nebraska, surface water diversions were computed as 1.7 acre-feet per acre intended to be irrigated. Groundwater diversion rate used for 1974 in Nebraska was 1.7 acre-feet per acre irrigated as determined from reports of irrigators for 10%. of wells pumping from the valley alluvium.

Diversions by individual irrigators from alluvial wells and streams in Kansas were estimated on the basis of water use reports from 41% of the water users. Average of all reported diversions in the Republican River Basin in Kansas was 2.2 Ac. Ft. Ac. Average rate of diversion from groundwater was 2.3 Ac. Ft./Ac. and from surface water was 1.7 Ac. Ft./Ac.

Estimated diversions by individuals in Kansas for 1974 are given below in acre-feet:

Sub-basin	Groundwater	Surface Water
Arikaree River	800	0
S. Fk. Republican River	9,120	930
Beaver Creek	9,050	1,670
Sappa Creek	16,090	70
Prairie Dog Creek	23,100	1,580
Republican River above Hardy	200	1,250

Return flow percentages were computed for the major canals from data provided by the U. S. Bureau of Reclamation as follows:

Canal	Return as Percent of Total Diversions	Canal	Return as Percent of Total Diversions
Culbertson	41%	Franklin	49%
Culbertson Ext.	49%	Franklin Pump	38%
Meeker-Driftwood	41%	Naponee	42%
Red Willow	38%	Superior	44%
Cambridge	39%	Courtland-Nebr.	23%
Bartley	35%	Courtland-Kansas	
Almena	49%	Above Lovewell	37%
		Below Lovewell	39%

Return flow percentages for other canals and diversions were estimated as given below:

Hale Ditch and Haigler Canal	38%
Champion and Riverside Canals	41%
Groundwater and surface water diversions	25%

Computation of return flow from the Courtland Canal in Nebraska is shown below:

Item	Acre-Feet
Courtland Canal-Headgate	79,740
Courtland Canal-Stateline	-70,140
Total loss in Nebraska	9,600
Direct Supply to Nebraska Lands	-2,440
Courtland Canal Transportation Loss in Nebraska	7,160
Return Flow Percentage	x 75%
Transportation Loss Returned to River	5,370
Direct Supply Returned to River (2,440 x 23%)	+ 560
Total Return Flow in Nebraska	5,930

In Kansas 59% of the irrigatable land above Lovewell was irrigated in 1974 with an average diversion rate of 3.16 acre-feet per acre. Based on this data it was estimated that 2,120 acre-feet were diverted on 670 acres above Hardy and the return flows were 780 acre feet.

Diversion of return flows between tributaries and main stem Republican are given below:

Canal	Diversions	Return Flows %	Ac. Ft.	Division of Return Flows Frenchman	Main stem
Champion	2,480	41	1,020	1,020 (100%)	
Riverside	2,200	41	900	900 (100%)	
Culbertson	17,080	41	7,000	5,810 (83%)	1,190 (17%)
Culbertson Ext.	24,410	49	11,960		11,960 (100%
Totals	46,170		20,880	7,730	13,150
				Main Stem Driftwood	Main Stem
Meeker-Driftwood	39,710	41	16,280	3,910 (24%)	12,370 (76%)
				Red Willow	Main Stem
Red Willow	11,470	38	4,360	440 (10%)	3,920 (90%)

The 1974 annual virgin water supply was computed using the above together with stream-flow, diversion and reservoir records.

Net evaporation from Harlan County Reservoir was divided (56%) 12,490 acre-feet to Kansas and (44%) 9,820 acre-feet to Nebraska based on total diversions by the canals in each state below Harlan County Reservoir.

Computation of consumptive use in Kansas of water diverted from the main stem Republican River, including prorated shares of net evaporation from Harlan County Reservoir and Courtland Canal transportation loss thru Nebraska was 65,790 acre-feet in the 1974 water year.

Consumptive use to mouths of tributaries in Nebraska were computed. The results are shown below:

Consumptive Use in Nebraska - 1974

	By Ac. Ft.	Above Ac. Ft.
Prairie Dog Creek	0	590
Beaver Creek	9,860	12,770
Sappa Creek	8,920	9,190
Medicine Creek	12,270	13,380
S. Fk. Republican River	340	340
Buffalo Creek	1,130	1,130

The Committee computed adjusted allocations for each state based on the computed annual virgin water supply for the 1974 water year, the 1970-74 five-year average and the 1965-74 ten-year average.

Respectfully submitted,

/s/
Robert F. Bishop
Nebraska

/s/
Gerald L. Hilmer
Kansas

/s/
Glen E. Brees
Colorado

Report of Engineering Committee
Republican River Compact Administration
July 20, 1976

The Republican River Compact Administration at its 16th annual meeting held July 30, 1975, agreed the assignments to the Engineering Committee would be as follows:

1. Compute annual virgin water supply, 1975 water year;

2. Compute annual consumptive use, 1975 water year;

3. Compute adjusted allocations on annual, five-year average and ten-year average basis;

4. Any other special assignment that might be assigned to the Committee by the Compact Administration during the coming year.

The Engineering Committee held one regular meeting during the year, June 2-3, 1976, to study the virgin water supply and consumptive use of the water supply for 1975. Submitted here and made a part of this report are the following:

1. (Exhibit A) Computed annual virgin water supply Republican River Basin, 1975 water year;

2. (Exhibit B) Computed annual consumptive use Republican River Basin, 1975 water year;

3. Computed inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1975 water year;

4. Computed adjusted allocations on annual five-year average and ten-year average basis.

It is the recommendation of the Engineering Committee that the computed annual virgin water supply and computed annual consumptive use for the 1975 water year be published in the 16th annual report of the Republican River Compact Administration.

The detailed computations of the virgin water supply and consumptive use, the adjusted allocations on an annual basis for 1975, and a five-year and ten-year average basis are available for inspection by members of the Compact Administration.

The following exhibits are available to the members of the Compact Administration with the recommendation that they not be published in detail in the Sixteenth Annual Report.

10A. Computed Annual Virgin Water Supply for the 1975 water year;

10B. Adjusted allocations computed on the Basis of Annual Virgin Water Supply, for 1975 water year;

10C. Average Annual Virgin Water Supply for Five-year Running Averages for 1971-1975 and Ten-year Running Averages for 1966-1975;

10D. Adjusted Allocations by Five-year and Ten-year Running Averages for same years as 10C.

10E. Computed Annual Consumptive Use by States for 1975 water year.

The above computations made by the Engineering Committee followed the procedures of previous years.

Municipal and industrial uses are not included in the virgin water supply computations; but, for the record, those available to the Committee are as follows:

		1975 Calendar Year
	City of Norton	883 Ac. Ft.
(Amoco)	Midwest Oil Co.	278 Ac. Ft.
(Ladd)	L.V.O. Oil Co.	41 Ac. Ft.

Recorded diversions from the North Fork Republican River by the Haigler Canal for 1975 were:

Colorado	3,880 Ac. Ft.
Nebraska	7 890 Ac. Ft.
Total	11,770 Ac. Ft.

Other recorded diversions from surface water in Colorado with the exception of the Hale Ditch were:

S. Fk. Republican River	1,980 Ac. Ft.
N. Fk. Republican River	3,410 Ac. Ft.
Arikaree River	0 Ac. Ft.
Beaver Creek	0 Ac. Ft.

Colorado diversions from groundwater were based on an average diversion of 169 acre-feet per well producing from valley alluvium and are shown below in acre-feet:

S. Fk. Republican River	1,350
N. Fk. Republican River	510
Arikaree River	4,900
Beaver Creek	0

Nebraska recorded diversions from surface water by other than major canals are given below in acre-feet:

Frenchman Creek	650	Buffalo Creek	1,170
Medicine Creek	1,170	Beaver Creek	1,410
Red Willow Creek	440	Sappa Creek	2,450
Republican River	20,940		

In other basins in Nebraska, surface water diversions were computed as 1.8 acre-feet per acre intended to be irrigated. Groundwater diversion rate used for 1975 in Nebraska was 1.6 acre-feet per acre irrigated as determined from reports of irrigators for 10% sample of wells pumping from the valley alluvium.

Diversions by individual irrigators from alluvial wells and streams in Kansas were estimated on the basis of water use reports from 42% of the water users. Average of all reported diversions in the Republican River Basin in Kansas was 1.8 Ac. Ft./Ac. Average rate of diversion from groundwater was 1.8 Ac. Ft./Ac. and from surface water was 1.8 Ac. Ft./Ac.

Estimated diversions by individuals in Kansas for 1975 are given below in acre-feet:

Sub-basin	Groundwater	Surface Water
Arikaree River	420	0
S. Fk. Republican River	6,840	1,040
Beaver Creek	11,470	460
Sappa Creek	11,210	180
Prairie Dog Creek	13,720	1,060
Republican River above Hardy	140	1,590

Return flow percentages were computed for the major canals from data provided by the U. S. Bureau of Reclamation as follows:

Canal	Return as Percent of Total Diversions	Canal	Return as Per Cent of Total Diversions
Culbertson	42%	Franklin	54%
Culbertson Ext.	50%	Franklin Pump	52%
Meeker-Driftwood	38%	Naponee	43%
Red Willow	40%	Superior	48%
Cambridge	38%	Courtland-Nebr.	25%
Bartley	38%	Courtland-Kansas	
Almena	42%	Above Lovewell	40%
		Below Lovewell	39%

Net evaporation from Harlan County Reservoir was divided (57%) 8,450 acre-feet to Kansas and (43%) 6,380 acre-feet to Nebraska based on total diversions by the canals in each state below Harlan County Reservoir,

Division of consumptive use of the Courtland Canal transportation lose thru Nebraska is given below:

Courtland Canal	Acre-feet
Transportation Loss	8,630
Return flow to river of transportation loss	-6,470
Consumptive use-Transportation Loss	2,160

$$\text{Kansas Share} = \frac{\text{Stateline Flow}}{\text{Headgate Diversions}} = \frac{70,910}{81,100} = 87\%$$

Kansas Share of Loss C.U. = 2,160 x 87% = 1,880 Ac, Ft.
Nebraska Share of Loss C.U. = 2,160 - 1880 = 280 Ac. Ft.

Consumptive use in Nebraska by the Courtland Canal was computed from the return flow computation rather than using the virgin water supply data, as follows:

Courtland Canal in Nebraska	Acre-feet
Net supply	1,560
Return flow (1,560 x 25%)	- 390
Consumptive use-irrigated lands in Nebraska	1,170
Consumptive use-transportation loss	+ 280
Total consumptive use in Nebraska	1,450

Computations of inflow to Lovewell Reservoir show a 1975 total inflow of 73,570 Ac. Ft. of which 42,480 Ac. Ft. was diverted from the Republican River. Computed operations of Lovewell Reservoir for 1975 gave a net evaporation lose of 1,560 Ac. Ft. from Republican River Water. Storage in Lovewell Reservoir at the beginning of the water year was 30,560 Ac. Ft. of which 7,400 Ac. Ft. was water from the Republican River. At the close of the water year, storage in Lovewell was 36,560 Ac. Ft. of which 4,610 Ac. Ft. was water from the Republican River.

Computation of consumptive use in Kansas of water diverted from the main stem Republican River, including prorated shares of net evaporation from Harlan County Reservoir and Courtland Canal transportation loss thru Nebraska was 56,920 acre-feet in the 1975 water year. Consumptive use to mouths of tributaries in Nebraska were computed. The results are shown below:

Consumptive Use in Nebraska - 1975

	By Formula Ac. Ft.	Above Mouth Ac. Ft.
Prairie Dog Creek	0	800
Beaver Creek	14,920	18,510

Sappa Creek	10,540	10,610
Medicine Creek	10,840	11,550
S. Fk. Republican River	540	540
Buffalo Creek	1,100	1,100

This report of the Engineering Committee was not prepared in time for presentation at the annual meeting of the Compact Administration at Topeka, Kansas, on July 20, 1976. Therefore, provision is made at the end of this report for acceptance by signature of the Compact Administration Members.

Respectfully submitted,
/s/
Robert F. Bishop 8/6/76
Nebraska
/s/
Gerald L. Hilmer 8/31/76
Kansas
/s/
Jeris A. Danielson 8/13/76
Colorado

Report of Engineering Committee
Republican River Compact Administration
June 30, 1977

The Republican River Compact Administration at its 17th Annual meeting held July 20, 1976, agreed the assignments to the Engineering Committee would be as follows:

1. Compute annual virgin water supply, 1976 water year;

2. Compute annual consumptive use, 1976 water year;

3. Compute adjusted allocations on annual five-year average and ten-year average basis;

4. Any other special assignment that might be assigned to the Committee by the Compact Administration during the coming year.

The Engineering Committee held one regular meeting during the year, June 7-8, 1977, to study the virgin water supply and consumptive use of the water supply for 1976. Submitted here and made a part of this report are the following:

1. (Exhibit A) Computed annual virgin water supply Republican River Basin, 1976 water year;

2. (Exhibit B) Computed annual consumptive use Republican River Basin, 1976 water year;

3. Computed inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1976 water year;

4. Computed adjusted allocations on annual five-year average and ten-year average basis.

It is the recommendation of the Engineering Committee that the computed annual virgin water supply and computed annual consumptive use for the 1976 water year be published in the 17th annual report of the Republican River Compact Administration.

The detailed computations of the virgin water supply and consumptive use, the adjusted allocations on an annual basis for 1976 and a five-year and ten-year average basis are available for inspection by members of the Compact Administration.

The following exhibits are available to the members of the Compact Administration with the recommendation that they not be published in detail in the Seventeenth Annual Report

10A. Computed Annual Virgin Water Supply for the 1976 water year;

10B. Adjusted allocations computed on the Basis of Annual Virgin Water Supply, for 1976 water year;

10C. Average Annual Virgin Water Supply for Five-year Running Averages for 1972-1976 and Ten-year Running Averages for 1967-1976;

10D. Adjusted Allocations by Five-year and Ten-year Running Averages for same years as 10C.

10E. Computed Annual Consumptive Use by States for 1976 water year.

The above computations made by the Engineering Committee followed the procedures of previous years.

Municipal and industrial uses are not included in the virgin water supply computations but, for the record, those available to the Committee are as follows:

	1976 Calendar Year	1975 Calendar Year
	City of Norton	832 Ac. Ft.
(Amoco)	Midwest Oil Co.	329 Ac. Ft.
(Ladd)	L.V.O. Oil Co.	63 Ac. Ft.

Recorded diversions from the North Fork Republican River by the Haigler Canal for 1976 were:

Colorado	3,740 Ac. Ft.
Nebraska	8,560 Ac Ft.
Total	12,300 Ac Ft.

Other recorded diversions from surface water in Colorado with the exception of the Hale Ditch were:

S. Fk. Republican River	3,110 Ac. Ft.
N. Fk. Republican River	4,810 Ac. Ft.
Arikaree River	0 Ac. Ft.
Beaver Creek	0 Ac. Ft.

Colorado diversions from groundwater were based on an average diversion of 169 acre-feet per well producing from valley alluvium and are shown below in acre-feet:

S. Fk. Republican River	1,860
N. Fk. Republican River	510
Arikaree River	4,900
Beaver Creek	0

Nebraska recorded diversions from surface water by other than major canals are given below in acre-feet:

Frenchman Creek	900	Buffalo Creek	1,340
Medicine Creek	1,400	Beaver Creek	350
Red Willow Creek	690	Sappa Creek	2,220
Republican River	23,270		

In other basins in Nebraska, surface water diversions were computed as 1.9 acre-feet per acre intended to be irrigated. Groundwater diversion rate used for 1976 in Nebraska was 2.0 acre-feet per acre irrigated as determined from reports of irrigators for 10% sample of wells pumping from the valley alluvium.

Estimated diversions by individuals in Nebraska for 1976 are given below in acre-feet:

Frenchman Creek	58,890	Buffalo Creek	360
Medicine Creek	14,840	Beaver Creek	24,420
Red Willow Creel	5,040	Sappa Creek	15,220
Republican River	1,260	Driftwood Cree	1,190

Diversions by individual irrigators from alluvial wells and streams in Kansas were estimated on the basis of water use reports from 47% of the water users. Average of all reported diversions in the Republican River Basin in Kansas was 2.0 Ac. Ft./Ac. Average rate diversion from groundwater was 2.0 Ac. Ft/Ac. and from surface water was 1.9 Ac. Ft./Ac.

Estimated diversions by individuals in Kansas for 1976 are given below in acre-feet:

Sub-basin	Groundwater	Surface Water
Arikaree River	400	0
S. Fk. Republican River	9,500	170
Beaver Creek	12,080	1,440
Sappa Creek	12,660	220
Prairie Dog Creek	16,750	1,250
Republican River above Hardy	360	1,720

Return flow percentages were computed for the major canals from data provided by the U. S. Bureau of Reclamation as follows:

Canal	Return as % of Total Diversions	Canal	Return as % of Total Diversions
Culbertson	42%	Franklin	49%
Culbertson Ext.	50%	Franklin Pump	41%
Meeker-Driftwood	38%	Naponee	43%
Red Willow	39%	Superior	44%
Cambridge	38%	Courtland-Nebr.	24%
Bartley	34%	Courtland-Kansas	
Almena	42%	Above Lovewell	39%
		Below Lovewell	40%

Return flow percentages for other canals and diversions were estimated as given below

Hale Ditch and Haigler Canal	38%
Champion and Riverside Canals	42%
Groundwater and surface water diversions	25%

Computation of return flow from the Courtland Canal in Nebraska is shown below:

Item	Acre-Feet
Courtland Canal-Headgate	112,160
Courtland Canal-Stateline	-100.030
Total lose in Nebraska	12,130
Direct Supply to Nebraska Lands	-2.890
Courtland Canal Transportation Loss in Nebraska	9,240
Return Flow Percentage	X 75%
Transportation Loss Returned to River	6,930
Direct Supply Returned to River (2,890 x 25%)	+ 720
Total Return Flow in Nebraska	6,210

In Kansas 63% of the irrigable land above Lovewell was irrigated in 1976 with an average diversion rate (based on net supply) of 4.25 acre-feet per acre. From this data it was estimated that 3,040 acre feet were diverted on 720 acres above Hardy and the return flows were 1,190 acre-feet. On the basis of "Farm Delivery" there wee an avers application of 2.63 acre-feet per acre.

Diversion of return flows between tributaries and main stem Republican are given below in acre-feet:

		Return Flows		Division of Return Flows	
Canal	Diversions	%	Ac. Ft.	Frenchman	Main stem:
Champion	3.040	42	1,280 (100%)		
Riverside	1,830	42	770	770 (100%)	
Culbertson	17,440	42	7,320	6,080 (83%)	1,240 (17%)
Culbertson Ex	23,680	50	11,840		11,840 (100%
Totals	45,990		21,210	8,130	13,080

		Return Flows		Division of Return Flows	
Canal	Diversions	%	Ac. Ft.	Frenchman	Main stem:
Meeker-Driftwood	42,180	42	15,610	3,750 (24%)	11,860 (76%)
Red Willow	12,040	39	4,700	470 (10%)	4,230 (90%)

The 1976 annual virgin water supply was computed using the above together with streamflow, diversion and reservoir records.

Net evaporation from Harlan County Reservoir was divided (60%) 15,850 acre-feet to Kansas and (40%) 10,560 acre-feet to Nebraska based on total diversions by the canals in each state below Harlan County Reservoir.

Division of consumptive use of the Courtland Canal transportation lose thou Nebraska is given below:

Courtland Canal	Acre-feet
Transportation Loss	9,240
Return flow to river of transportation lose	-6,930
Consumptive use-Transportation Loss	2,310

Kansas Share = Stateline Flow / Headgate Diversions = 100,030 / 112,160 = 89%

Kansas Share of Loss C.U. = 2,310 x 89% = 2,060 Ac, Ft.
Nebraska Share of Loss C.U. = 2,310 - 2,060 = 250 Ac. Ft.

Consumptive use in Nebraska by the Courtland Canal was computed from the return flow computation rather than using the virgin water supply data, as follows:

Courtland Canal in Nebraska	Acre-feet
Net supply	2,890
Return flow (1,560 x 25%)	- 720
Consumptive use-irrigated lands in Nebraska	2,170
Consumptive use-transportation loss	+ 250
Total consumptive use in Nebraska	2,420

Computations of inflow to Lovewell Reservoir show a 1976 total inflow of 70,320 Ac. Ft. of which 50,090 Ac. Ft. was diverted from the Republican River. Computed operations of Lovewell Reservoir for 1976 gave a net evaporation loss of 2,540 Ac. Ft. from Republican River Water. Storage in Lovewell Reservoir at the beginning of the water year was 36,560 Ac. Ft. of which 4,610 Ac. Ft. was water from the Republican River. At the close of the water year, storage in Lovewell was 27,160 Ac. Ft. of which 4,140 Ac. Ft. was water from the Republican River.

Computation of consumptive use in Kansas of water diverted from the main stem Republican River, including prorated shares of net evaporation from Harlan County Reservoir and Courtland Canal transportation loss thru Nebraska was 81,200 acre-feet in the 1976 water year.

Consumptive use to mouths of tributaries in Nebraska were computed. The results are shown below:

Consumptive Use in Nebraska - 1976

	By Formula Ac. Ft.	Above Mouth Ac. Ft.
Prairie Dog Creek	0	1,350
Beaver Creek	18,580	23,200
Sappa Creek	13,080	12,870
Medicine Creek	15,040	16,030
S. Fk. Republican River	940	940
Buffalo Creek	1,270	1,270

The Committee discussed the matter of modifying Annual Virgin Water Supply and Consumptive Use Formulae to include municipal and industrial diversions from Ground and surface water, It was noted that this assignment was given the Engineering Committee at the 8th Annual Meeting which was held on June 19, 1967 (7th Annual Report), The Report of Engineering Committee dated June 3, 1967 (8th Annual Report) shows the Committee decided that since Such diversions were relatively small they would not be included in the 1967 computations. No further action was taken on the assignment. The Engineering Committee at this 24th meeting unanimously agreed to refer said matter to the Administration for their consideration.

The meeting was adjourned at 12 o'clock noon on June 8, 1977.

Respectfully submitted,
/s/
Robert F. Bishop 6/23/77
Nebraska
/s/
Gerald L. Hilmer 6/29/77
Kansas
/s/
Jeris A. Danielson 28 Jun 77
Colorado

Report of Engineering Committee
Republican River Compact Administration
July 7, 1978

The Republican River Compact Administration at its 18th annual meeting held June 30, 1977, agreed the assignments to the Engineering Committee would be as follows:

1. Compute annual virgin water supply, 1977 water year;

2. Compute annual consumptive use, 1977 water year;

3. Compute adjusted allocations on annual five-year average and ten-year average basis;

4. Any other special assignment that might be assigned to the Committee by the Compact Administration during the coming year.

The Engineering Committee held one regular meeting during the year. April 26-27, 1978, to study the virgin water supply and consumptive use of the water supply for 1977. Submitted here and made a part of this report are the following:

1. (Exhibit A) Computed annual virgin water supply Republican River Basin, 1977 water year;

2. (Exhibit B) Computed annual consumptive use Republican River Basin, 1977 water year;

3. Computed inflow to Lovewell Reservoir and net evaporation of Republican River water stored in Lovewell, 1977 water year;

4. Computed adjusted allocations on annual five-year average and ten-year average basis.

It is the recommendation of the Engineering Committee that the computed annual virgin water supply and computed annual consumptive use for the 1977 water year be published in the 18th annual report of the Republican River Compact Administration.

The detailed computations of the virgin water supply and consumptive use, the adjusted allocations on an annual basis for 1977, and a five-year and ten-year average basis are available for inspection by members of the Compact Administration.

The following exhibits are available to the members of the Compact Administration with the recommendation that they not be published in detail in the Eighteenth Annual Report:

10A. Computed Annual Virgin Water Supply for the 1977 water year;

10B. Adjusted allocations computed on the Basis of Annual Virgin Water Supply, for 1977 water year;

10C. Average Annual Virgin Water Supply for Five-year Running Averages for 1973-1977 and Ten-year Running Averages for 1968-1977;

10D. Adjusted Allocations by Five-year and Ten-year Running Averages for same years as 10C.

10E. Computed Annual Consumptive Use by States for 1977 water year.

The above computations made by the Engineering Committee followed the procedures of previous years.

Municipal and industrial uses are not included in the virgin water supply computations; but, for the record, those available to the Committee are as follows:

		1977 Calendar Year
	City of Norton	660 Ac. Ft.
(Amoco)	Midwest Oil Co.	306 Ac. Ft.
(Ladd)	L.V.O. Oil Co.	15 Ac. Ft.

Recorded diversions from the North Fork Republican River by the Haigler Canal for 1977 were:

Colorado	3,370 Ac. Ft.
Nebraska	8,090 Ac. Ft.
Total	11,460 Ac. Ft.

Colorado diversions from ground water were based on an average diversion of 169 acre-feet per well producing from valley alluvium and are shown below in acre-feet along with other diversions from surface water with the exception of the Hale Ditch.

	Ground Water	Surface Water
S. Fk. Republican River	2,370	2,500
N Fk. Republican River	510	3,900
Arikaree River	5,240	0
Beaver Creek	0	0

Nebraska diversions in 1977 by individuals from surface water by other than major canals are given below in acre-feet along with diversions from

ground water by individuals. Surface water diversions were computed as 1.4 acre-feet per acre intended to be irrigated. The ground water diversion was computed from a 10% sampling applied to all registered wells in the valley alluvium as using 1.5 acre-feet per acre for lands irrigated from the wells.

	Ground Water	Surface Water
Republican River	121,030	19,500
Frenchman Creek	50,250	2,110
Medicine Creek	11,920	730
Red Willow Creek	5,030	420
So. Fork Republican River	950	0
Buffalo Creek	410	1,320
Beaver Creek	14,950	1,130
Sappa Creek	16,190	2,280
Driftwood Creek	1,490	0
Prairie Dog Creek	1,390	80

Diversions by individual irrigators from alluvial wells and streams in Kansas were estimated on the basis of water use reports from 41% of the water users. Average of all reported diversions in the Republican River Basin in Kansas was 1.8 acre-feet per acre. Average rate of diversion from ground water was 1.9 acre-feet per acre and from surface water was 1.4 acre-feet per acre.

Estimated diversions by individuals in Kansas for 1977 are given below in acre-feet:

Sub-Basin	Ground Water	Surface Water
Arikaree River	280	0
South Fk. Republican River	9,150	0
Beaver Creek	14,270	640
Sappa Creek	10,670	30
Prairie Dog Creek	15,950	820
Republican River above Hardy	320	1,420

Return flow percentages were computed for the major canals from data provided by the U. S. Bureau of Reclamation as follows:

Canal	Return as Per Cent of Total Diversions	Canal	Return as Per Cent of Total Diversions
Culbertson	45%	Franklin	55%
Culbertson Ext.	51%	Franklin Pump	42%
Meeker-Driftwood	43%	Naponee	48%
Red Willow	43%	Superior	48%
Cambridge	42%	Courtland-Nebr.	21%
Bartley	41%	Courtland-Kansas	
Almena	60%	Above Lovewell	46%
		Below Lovewell	46%

Return flow percentages for other canals and diversions were estimated as given below:

Hale Ditch and Haigler Canal	38%
Champion and Riverside Canals	45%
Ground water and surface water diversions	25%

Computation of return flow from the Courtland Canal in Nebraska is shown below:

Item	Acre-Feet
Courtland Canal-Headgate	86,360
Courtland Canal-Stateline	- 73,920
Total Loss in Nebraska	12,440
Direct Supply to Nebraska Lands	1,290
Courtland Canal Transportation Loss in Nebraska	11,150
Return Flow Percentage	x 75%
Transportation Loss Returned to River	8,360
Direct Supply Returned to River (2,890 x 25%)	+ 320
Total Return Flow in Nebraska	8,680

In Kansas 68% of the irrigable land above Lovewell was irrigated in 1977 with an average diversion

rate (based on net supply) of 2.1 acre-feet per acre. From this data it was estimated that 1,620 acre-feet were diverted on 780 acres above Hardy and the return flows were 745 acre-feet. The average diversion rate (based on farm delivery) was 1.3 acre-feet per acre.

Diversion of return flows between tributaries and main stem Republican are given below in acre-feet.

		Return Flows		Division of Return Flows	
Canal	Diversions	%	Ac. Ft.	Frenchman	Main stem:
Champion	2,570	45	1,160	1,160 (100%)	
Riverside	1,500	45	680	680 (100%)	
Culbertson	16,270	45	7,320	6,080 (83%)	1,240 (17%)
Culbertson Ext.	23,290	51	11,880	———	11,840 (100%)
Totals	43,630		21,040	7,920	13,080

		Return Flows		Division of Return Flows	
Canal	Diversions	%	Ac. Ft.	Frenchman	Main stem:
Meeker-Driftwood	28,420	43	12,200	2,930 (24%)	9,290 (76%)
Red Willow	7,500	43	3,250	330 (10%)	2,920 (90%)

The 1977 annual virgin water supply was computed using the above together with streamflow, diversion and reservoir records.

Net evaporation from Harlan County Reservoir was divided (65%) 9,070 acre-feet to Kansas and (35%) 4,890 acre-feet to Nebraska based on total diversions by the canals in each state below Harlan County Reservoir.

Division of consumptive use of the Courtland Canal transportation loss thru Nebraska is given below:

Courtland Canal	Acre-feet
Transportation Loss	11,150
Return flow to river of transportation loss	- 8 360
Consumptive use-transportation loss	2,790

Kansas Share = Stateline Flow = 73,920 = 86%
Headgate Diversions 83,360

Kansas Share of Loss C.U. = 2,790 x 86% = 2,400 Ac. Ft.
Nebraska Share of Loss C.U. = 2,790 - 2,400 = 390 Ac. Ft.

Consumptive use in Nebraska by the Courtland Canal was computed from the return flow computation rather than using the virgin water supply data, as follows:

Courtland Canal in Nebraska	Acre-feet
Net supply	1,290
Return flow (1,290 x 25%)	- 320
Consumptive use-irrigated lands in Nebraska	970
Consumptive use-transportation loss	+ 390
Total consumptive use in Nebraska	1,360

Computations of inflow to Lovewell Reservoir show a 1977 total inflow of 58,440 Ac.Ft. of which 51,760 Ac.Ft. was diverted from the Republican River. Computed operations of Lovewell Reservoir for 1977 show a net evaporation loss of 2,980 Ac.Ft. from Republican River Water. Storage in Lovewell Reservoir at the beginning of the water year was 27,160 Ac.Ft. of which 4,140 Ac.Ft. was water from the Republican River. At the close of the water year, storage in Lovewell was 41,870 Ac.Ft. of which 13,340 Ac.Ft. was water from the Republican River.

Computation of consumptive use in Kansas of water diverted from the main stem Republican River, including prorated shares of net evaporation from Harlan County Reservoir and Courtland Canal transportation loss thru Nebraska was 49,060 acre-feet in the 1977 water year.

Consumptive use to mouths of tributaries in Nebraska were computed. The results are shown below:

Consumptive Use in Nebraska - 1977

Sub-basin	By Formula Ac. Ft.	Above Mouth Ac. Ft.
Prairie Dog Creek	0	1,100
Beaver Creek	12,060	16,630
Sappa Creek	8,580	10,830
Medicine Creek	10,110	11,270
S. Fk. Republican River	710	710
Buffalo Creek	1,300	1,300

It was noted an error exists on Exhibit A, page 13, 17th Annual Report, Republican River Compact Administration. The ground water virgin water supply for the Main Stem of the Republican plus Blackwood Creek should read 110,530 rather than 11,530.

It was agreed the next annual meeting of the Engineering Committee would be held in Denver, Colorado.

The meeting was adjourned at 11 o'clock A.M. on April 27, 1978.

Respectfully submitted,

/s/
Robert F. Bishop June 19, 1978
Nebraska Date

/s/
Gerald L. Hilmer June 22, 1978
Kansas Date

/s/
Jeris A. Danielson June 26, 1978
Colorado Date

Report of Engineering Committee
Republican River Compact Administration
For the 1979 Water Year

The meeting of the Engineering Committee was held in the office of the Colorado Division of Water Resources on April 9 and 10, 1980.

Committee Members present were:

Michael Jess, Nebraska Department of Water Resources
Harold Simpson, Colorado State Engineer's Office
Gerald E. Hilmes, Kansas Division of Water Resources

Others in attendance were:

Glen E. Brees, Colorado State Engineer's Office
Robert F. Bishop, Nebraska Department of Water Resources

Computation of Virgin Water Supplies and Consumptive Uses

The Committee completed its annual assignment of computing the virgin water supply and consumptive uses by states. The procedures utilized were those used and discussed previously. They are explained in detail in the tenth Annual Report of the Compact Administration.

This year's Engineering Committee report is similar in format to last year's. It eliminates a detailed explanation of computations in the narrative. Instead, additional information within the tables of the report is provided for the convenience and reference of readers.

Municipal and industrial uses are not included in the computations, but for the record, those available to the Committee for the 1979 calendar year are:

City of Norton, Kansas	794 Ac. Ft.
Midwest (Amoco) Oil Company	335 Ac. Ft
Rex Monahan (Ladd) Petroleum Company	11 Ac. Ft.

Shown in Table 1 are the original allocations to each state by sub-basin along with the 1979 adjusted allocations. Adjusted allocations for each state were computed for each sub-basin. Briefly, a state's allocation is adjusted when the computed annual virgin water supply varies "more than ten per cent from the virgin water supply" as set forth originally in the Compact. The allocations made from such a source are "increased or decreased in the relative proportions that the future computed virgin water supply of such source bears to the computed virgin water supply" as set forth originally in the Compact.

Annual consumptive use estimates were made for each state and for each sub-basin. Table 2 summarizes those quantities. Annual consumptive use was computed for diversions from surface and ground water sources. Both measured and estimated data were utilized. Allowance was made for reservoir evaporation, return flow and other losses.

Other exhibits not included in this report, but available to the Administration are:

Form 10c. Average annual virgin water supply for five year running averages for 1975-1979 and ten year running averages for 1970-1979.

Form 10d. Adjusted allocations by five year and ten year running averages for same years as on Form 10c.

Uncertain utility and an apparent lack of interest on the part of the Administration has prompted the

Engineering Committee to re-evaluate the need for computation of five and ten year running averages displayed on Forms 10c and 10d. Unless directed otherwise, the Committee will discontinue making such computations in the future.

Additional Work Assignment

After making the computations discussed above, the Committee took up the additional assignment made by the Administration at its last meeting. That task consisted of evaluating three possible factors affecting virgin water supply estimates. Climate, basin facility operations and ground water reservoir storage were specifically identified by the Administration.

It is the Committee's opinion that both climate and basin facility operation are satisfactorily taken into consideration by the accounting procedure now followed. Stream gaging records are a practicable indicator of precipitation and reservoir operation. Reservoir inflow is proportionate to sub-basin precipitation. Gaged outflow is to some extent reflective of precipitation, but most indicative of facility operation. Reservoir evaporation and the estimation of return flows (based in part on previous research) add two additional constituents to the hydrologic budget.

The majority of the Committee's discussion focused upon treatment and definition of the ground water component within the accounting procedure. Members observe that "theoretically" if either surface water or ground water usage is held constant while the other is allowed to increase, an increase in virgin water supply will result. The corollary also holds.

Committee members also noted that computed virgin water supplies have not shown a trend (either increasing or

decreasing) with time. Annual computed virgin water supplies increase or decrease in proportion to consumption. Since computations were begun, the surface water component has tended to decrease while the ground water component has tended to increase.

The Committee concludes that the ground water component utilized in the present accounting system is in reality a portion of the surface water component. This notion is based upon recognition of two inherent limitations in the accounting system: (1) ground water consumption is tabulated only for wells tapping alluvial aquifers and located no further than one mile from perennial streams; and (2) the presence of, annual replenishment to and annual storage volume change in other aquifers is disregarded. Generally recognized, large-scale depletions within the Ogallala Formation, underlying much of the basin, are not disclosed by the accounting procedure. The same is true for other non-alluvial aquifer systems.

Does the accounting procedure adopted by the Compact Administration truly provide an estimate of the virgin water supply "defined to be the water supply within the Basin undepleted by the activities of man"? The Engineering Committee concludes that it does not. Due to considerable additional costs necessary for collection of greater numbers of input data, however, the Committee does not recommend a change in the accounting system.

Instead, it is urged that the Administration as well as other interested persons regard the consumptive water use and virgin water supply volumes in the limited context of surface water quantities.

/s/

Harold D. Simpson May 30, 1980
Colorado Date

Gerald E. Hilmes May 27, 1980
Kansas Date

Michael Jess June 4, 1980
Nebraska Date

EXHIBIT A

Report of Engineering Committee
Republican River Compact Administration
For the 1980 Water Year.

The meeting of the Engineering Committee held in the office of the Nebraska Department of Water Resources on May 20, 1981.

Committee Members present were:

Michael Jess, Nebraska Department of Water Resources Harold Simpson, Colorado State Engineer's Office Gerald E. Hilmes, Kansas Division of Water Resources

Others in attendance were:

Glen E. Brees, Colorado State Engineer's Office Robert Bishop, Nebraska Department of Water Resources

Computation of Virgin Water Supplies and Consumptive Uses

The Committee completed its annual assignment of computing the virgin water supply and consumptive uses by states. The procedures utilized were those used and discussed previously. They are explained in detail in the tenth Annual Report of the Compact Administration.

Municipal and industrial uses are not included in the computations, but for the record, those available to the Committee for the 1980 calendar year are:

City of Norton, Kansas	832 Ac Ft.
Midwest (Amoco) Oil Company	396 Ac. Ft

Rex Monahan (Ladd) Petroleum Company 1 Ac Ft.

Shown in Table 1 are the original computed virgin water supply and the original allocations to each state by sub-basin along with the 1980 adjusted allocations. Adjusted allocations for each state were computed for each sub-basin. Briefly, a state's allocation is adjusted when the computed annual virgin water supply varies "more than ten per cent from the virgin water supply" as set forth originally in the Compact. The allocations made from such a source are "increased or decreased in the relative proportions that the future computed virgin water supply of such source bears to the computed virgin water supply" as set forth originally in the Compact.

Annual consumptive use computations were made for each state and for each sub-basin. Table 2 summarizes those quantities. Annual consumptive use was computed for diversions from surface and ground water sources. Both measured and estimated data were utilized. Allowance was made for reservoir evaporation, return flow And other losses.

Other exhibits not included in this report, but available to the Administration are:

Form 10c: Average annual virgin water supply for five year running averages for 1976-1980 and ten year running averages for 1971-1980.

Form 10d: Adjusted allocations by five year and ten year running averages for same years as on Form 10c.

Additional Work Assignment

As directed by the Compact Officials the original computed virgin water supply amounts are now shown in the

first column of Table 1 opposite each sub-basin. These same amounts have been shown in the previous two years' reports in the second column from the right, however, the column was mistitled as "Compact Allocation." Table 1 in this report now correctly shows the total compact allocation by sub-basin in the second column from the right. Attention is called that the original computed virgin water supply was totally allocated to the three states, however, when the total supply of a sub-basin was not allocated the unallocated amounts were allocated out of the main stem supply of the Republican River.

In both Tables 1 and 2 the last two sub-basin descriptions are revised as instructed, by adding "in Colorado" to the "North Fork of the Republican River" and adding "North Fork Republican River in Nebraska" to "Main Stem of the Republican River plus Blackwood Creek.

"The Committee revised the formulas to include diversions of the Wilson No. 1 Ditch for irrigation of Nebraska lands and the return flows from Nebraska lands in the virgin water supply and consumptive use formulas. The new formulas will show the Wilson No. 1 Ditch diversions and return flows being handled similar to the computations used for the Haigler Canal, except that return flows would be 25% of the diversions. Copies of the revised formulas are accompanied with this report. The Committee suggests withholding the adoption of the revised formulas until after an application has been filed by Mr. Ashton Wilson with Nebraska Department of Water Resources to proceed to irrigate his lands in Nebraska.

The Committee discussed the matter of re-publication of the formulas if the revised formulas are adopted and it was generally agreed that it would be preferable in a special publication separate from the regular annual report.

Other Business

The Committee was requested by letter dated April 27, 1981, from Glenn Engel, Supervisory Hydrologist of the U. S. Geological Survey, to prioritize a list of gaging stations and ground water level observations as to their importance to the Compact Administration. The concern being that future Federal funding for their "Collection of Basic Records Program" may be insufficient to operate all of the data collection stations. The stations listed for prioritization were:

06835500	Frenchman Cr. at Culbertson
06852500	Courtland Canal at NE-KS line
06838000	Red Willow Cr. near Red Willow
06847500	Sappa Cr. near Stamford
06827500	S.F. Republican R. near Benkelman
06823000	N.F. Republican R. at CO-NE line
06824000	Rock Creek at Parks
06823500	Buffalo Cr. near Haigler
06836500	Driftwood Cr. near McCook
06821500	Arikaree R. at Haigler
06836000	Blackwood Cr. near Culbertson
	Haigler recording well and 8 nonrecording observation well

The consensus of the Committee was that all stations listed should have an equal No. 1 priority except for Blackwood Creek and the ground water level data; and informed Mr. Engel accordingly.

It was agreed that the next regular scheduled meeting of the Engineering Committee will be in the office of the Division of Water Resources at Topeka, Kansas, on the first Wednesday in May of 1982.

The Engineering Committee

/s/
Harold D. Simpson 6/22/81

Colorado
/s/
Gerald E. Hilmer 6/29/81
Kansas
/s/
Robert F. Bishop 6/19/81
Nebraska

Report of Engineering Committee
Republican River Compact Administration
For the 1981 Water Year

The meeting of the Engineering Committee was held in the office of the Kansas Division of Water Resources on May 5 and 6, 1982.

Committee members present were:

Robert F. Bishop, Nebraska Department of Water Resources Harold D. Simpson, Colorado State Engineers Office Gerald E. Hilmes, Kansas Division of Water Resources

Others in attendance were:

H. Lee Becker, Nebraska Department of Water Resources

Computation of Virgin Water Supplies and Consumptive Uses

The Committee completed its annual assignment of computing the virgin water supply and consumptive uses by states. The procedures utilized were similar to those used in previous years, however, in accordance with revised formulas which now include municipal and industrial uses.

Shown in Table 1 are the 1981 computed virgin water supply by ground water and surface water components shown together with the original computed virgin water supply and the original allocations to each state by sub-basin along with the 1981 adjusted allocations. Adjusted allocations for each state were computed for each sub-basin. A state's allocation is adjusted when the computed annual virgin water supply varies "more than ten percent from the virgin water supply" as set forth originally in the compact.

The allocations made from such a source are "increased or decreased in the relative proportions that the future computed virgin water supply of such source bears to the computed virgin water supply" as set forth originally in the Compact.

Annual consumptive use computations were made for each state and for each sub-basin. Table 2 summarizes those quantities. Annual consumptive use was computed for diversions from surface and ground water sources. Both measured and estimated data were utilized. Allowance was made for reservoir evaporation, return flow and other losses.

Other exhibits not included in this report, but available to the Administration are:

Form 10c: Average annual virgin water supply for five year running averages for 1977-1981 and ten year running averages for 1972-1981

Form 10d: Adjusted allocations by five year and ten year running averages for same years as on Form 10c.

Additional Assignment

Compact officials at their annual meeting on July 2, 1981 directed the Engineering Committee to revise the formulas for computing annual virgin water supply and annual consumptive use to include municipal and industrial uses in excess of 50 acre-feet. The formulas have been revised and are included with this report. Revisions are shown by lining through words to be deleted and underlining words to be added.

The committee has interpreted "in excess of 50 acre-feet" to mean the total gross diversion by each entity user.

Municipal and industrial diversions for Kansas and Colorado were obtained from 1981 reported uses. M and I uses in Nebraska were estimated on the basis of 1980 use reports. Return flows were computed as 505 for municipal and 75% for industrial diversions.

A summary of municipal and industrial diversions by sub-basin in 1981 is shown below in acre-feet:

Sub-basin	Kansas	Nebraska	Colorado
S.F. Rep. R.	510	0	0
Beaver Crk.	380	280	0
Sappa Crk.	430	0	0
Prairie Dog Crk.	850	0	0
Main Stem Rep. R.	0	8,010	0
Frenchman Crk.	0	500	0
Medicine Crk.	0	380	0
Total	2,170	9,170	0

Last year the committee revised certain formulas to account for use by a Wilson No. 1 Ditch which proposed a diversion from the North Fork of the Republican River in Colorado for irrigation of land in Nebraska. The committee was informed by Nebraska that Mr. Ashton Wilson did file an application with Nebraska for this project, however, he allowed his permit to be forfeited by reason of his failure to file a project map as required by Nebraska statutes.

The Engineering Committee agreed that their next annual meeting shall be held on the first Wednesday in May 1983 at Lincoln, Nebraska in the office of the Nebraska Department of Water Resources.

Respectfully submitted,

Engineering Committee, Republican River Compact

/s/
Robert F. Bishop

/s/
Harold D. Simpson

/s/
Gerald E. Hilmes

REPORT OF THE ENGINEERING COMMITTEE TO THE REPUBLICAN RIVER COMPACT ADMINISTRATION FOR THE 1987 WATER YEAR

The Engineering Committee met in McCook, Nebraska, on May 4, 1988, to address the work assigned by the Compact Administration at the July 9, 1987, annual meeting. Those in attendance at the meeting were as follows:

Bob Bishop, Nebraska Department of Water Resources

Russ Oaklund, Nebraska Department of Water Resources

Gerry Hilmes, Kansas Division of Water Resources

Alan Berryman, Colorado division (sic) of Water Resources

Hal Simpson, Colorado Division of Water Resources

At this meeting, the Committee agreed that the chairmanship of the Committee should follow the rotation of the Compact Administration chairmanship. The Chairman for 1989 and 1990 will be Bob Bishop from Nebraska.

The Committee also decided that it should have a rotating secretary to record the activities of the Committee. Hal Simpson will be the secretary for the next three years (1988-1990).

The Compact Administration gave five assignments to the Engineering Committee, one being the standard assignment of virgin flow computations, consumptive use

and adjustment of allocations. These assignments are shown on Exhibit A, attached.

Assignment 1

The Committee reviewed the computations of virgin water supply and consumptive use by basin for 1987 using the previously approved procedures. Exhibit B attached, includes Table 1, a summary of the results of the virgin water supply computations and adjusted allocation values. Table 2 is a summary of consumptive uses by each state from the main stem and sub-basins. Also attached and part of Exhibit B, are the computer prints of the detailed computations including five and ten-year averages. We recommend only Tables 1 and 2 be published in the annual report.

Assignment 2

Bishop provided a written report to the Committee evaluating allocations and usage when water diversions from a sub-basin are actually used on the lands in the valley of the main stem. His three-page report is attached and identified as Exhibit C.

The problem apparently arises from Nebraska's consistent overuse of allocations from Red Willow Creek and Medicine Creek. Bishop's report compares original virgin water supplies, original allocations, 28-year average consumptive uses by Nebraska re about ½ of its allocation from the Frenchman River largely because of an 8nsufficient supply at the major project diversion site. Nebraska's 28-year average uses from Re willow and Medicine Creeks are about twice the amounts allocated because much of the actual use is in the valley of the main stem Republican but charged by formula to sub-basin use.

The Committee does not recommend a formula change at this time. Compact officials should be aware of reasons of this pattern of use. Changing formula would merely transfer the use from sub-basin to the main stem. In reality, it makes little difference provided Nebraska's overuse of allocations does not interfere with another state's entitlement.

Assignment 3

Assignment 3 which dealt with the history of adjusting allocations was reviewed. Gerald Hilmes provided a written report of his review of the minutes of the annual meetings and the Engineering Committee reports. His report is attached and identified as Exhibit D.

Assignment 4

The committee was requested to provide the amount of consumptive use from the Republican River Basin in Kansas below the Hardy gaging station. Hilmes provided the value of 52,730 acre-feet for 1987. Details of his computation are provided in Exhibit E, attached.

Assignment 5

This assignment concerned the continued study of the Beaver Creek basin and the consideration of change in alluvial ground water storage upon virgin water supply. The number of observation wells in the Beaver Creek alluvium in Nebraska with a long-term record is about five with (sic) a 50-mile reach. This is not a sufficient density of wells to determine change in ground water storage. Likewise in Kansas, the number of observation wells with long-term records is not adequate. The Committee agreed that an observation well network with a well density of one well per square mile would be necessary to estimate the change in ground water storage. These wells would be existing

irrigation wells with measurements taken every year in January or February. The inclusion of change in ground water storage on the virgin water supply computation would improve the accuracy of the estimate of virgin water supply. This was discussed in detail in the Committee's report submitted to the Administration in 1987.

Hal Simpson reported that Colorado has been evaluating all wells near the alluvium to identify wells that are actually in alluvium. These wells will be field checked in the summer of 1988 to estimate the acres irrigated and crop types.

The next meeting will be the first Wednesday of May in 1989 (May 3) unless the Compact Administration assigns tasks that require additional meeting.

Respectfully Submitted,

Engineering Committee

_____
Robert F. Bishop, Chairman

/s/_____
Harold D. Simpson, Secretary

/s/_____
Gerald E. Hilmes

(For The Year 1990)

Report of the Engineering Committee

Mr. Hal Simpson, this year's chairman of the committee, gave the report. In order to save time and money the committee meet (sic) by conference telephone call on May 13, 1991. The only actions requiring attention were the normal computations of determining the virgin water supplies and consumptive uses for the water year 1990. The committee's computations were presented in Table 1 and Table 2 of the committee's report. Mr. Simpson stated that Colorado had discovered errors in reporting their amounts of surface diversions on the South Fork, which will require corrections to the tables as presently provided. Ann Bleed, who produces the tables, had been unable to provide corrected figures prior to the administration meeting. Corrected tables will be substituted in the report as soon as they are available. The corrected values for the south (sic) Fork Sub-basin were read to those present.

Due to below average precipitation and runoff, 8 of 13 sub-basins had their allocations of consumptive use reduced from the original allocations. Colorado used 71% of its total adjusted allocation, Kansas used 49% of its total adjusted allocation, and Nebraska used 112% of its total adjusted allocation. The total basin consumptive use for 1990 was 429,860 acre-feet which is an increase of 16,640 acre-feet over 1989. This increase is likely due to dryer conditions and increased ground water pumping in all 3 states.

The committee reviewed how each state computes consumptive use by ground water to determine if they are following consistent procedures. Colorado and Kansas are using wells constructed into and diverting water from the alluvium of the streams in the basins. Nebraska is using wells in a band two miles wide, one mile on either side of a

stream, but is in the process of revising its procedure to also use wells constructed in the alluvium. Nebraska stated that this revision will be complete for the 1991 year computations. Mr. Oaklund stated that 4 wells constructed during 1990 into the alluvium outside of the one mile limit were included in the computations for water year 1990.

Commissioner Pope commented that Kansas has a great concern that consumptive use is exceeding allocations in a number of sub-basins. He noted that Nebraska exceeded adjusted allocations in most of their sub-basins. Nebraska also exceeded its allocation for the state as whole by 112%; Kansas went over in a couple of sub-basins, and Colorado went over in one sub-basin. He believes a more serious problem exists than is first evident by looking at use of total state allocations.

Commissioner Pope moved that the report of the engineering advisors be accepted. Commissioner Danielson seconded and the report was accepted with the understanding that corrected table 1 and 2 will be provided.

Unfinished Business

Commissioner Pope reiterated Kansas' concerns as expressed over the past few years about the method of including ground water in the computations. He believes the views of Nebraska, such as were given in the recently distributed legal opinion of a member of the Nebraska staff, do not properly reflect the wording of the compact or reasonable hydrologic and engineering principles. Pope stated that pumping of wells which are hydraulically connected to the surface waters of the Republican River and its tributaries are the activities of man and should be counted somehow in the calculation of virgin water supply. Kansas desires to resolve this matter through the Compact Commission and still considers it a serous matter. Commissioner Danielson stated for the record that the 3

commissioners had a telephone conference during which Nebraska indicated they were preparing a report on the subject which was apparently not yet complete. Due to the absence of Commissioner Jess, Commissioners Danielson and Pope agreed that further discussion on the issue would not be appropriate until Commissioner Jess had a full opportunity to present his information. Commissioner Danielson noted this issue had been unresolved for three years and urged Nebraska to attempt to come to a resolution on the matter and offered the possibility of a special meeting to deal with the subject. Commissioner Pope requested instead that the matter be dealt with at next year's meeting.

Recognizing that this more properly belongs under new business, it was moved and adopted that a resolution honoring Bob Bishop for his years of service to the commission be completed. Nebraska is to prepare the resolution and provide it to the chairman for signature and mailing.

New Business

It was moved and seconded that the engineering committee be assigned their normal task of performing the standard computations. Commissioner Pope went on record as having objection to the methodology being used.

Commissioner Pope again expressed appreciation to Colorado for hosting this year's meeting in such a pleasant location.

A tentative date for next years meeting was set for Friday, July 10, 1992. Upon motion and second, the meeting was adjourned.

/s/
Jeris A. Danielson
Colorado Member (Chairman)

/s/_____
J. Michael Jess
Nebraska Member

/s/_____
David L. Pope
Kansas Member

REPORT OF THE ENGINEERING COMMITTEE TO THE REPUBLICAN RIVER COMPACT ADMINISTRATION FOR THE 1991 WATER YEAR

The engineering committee met via phone conference on June 5, 1992 to complete the work assignment made by the Compact Administration at the July 19, 1991 annual meeting. The phone conference included the following:

Ann Bleed	Nebraska Department of Water Resources
Jerry Hilmes	Kansas Division of Water Resources
Alan Berryman	Colorado Division of Water Resources
Keith Vander Horst	Colorado Division of Water Resources

No special assignments were required by the Compact Administration for the year. The Engineering Committee performed the normal computations for Virgin Water Supply, Original and Annual Adjusted Allocations, and 1991 Consumptive Use within the Republican River Basin. Computations were made using the computer program developed by the committee which incorporates the revised formulae published by the Compact Administration in 1990. Some minor changes in the data provided by each state were made during the meeting. Additionally, Nebraska changed its method of reporting ground water use by including only those wells constructed in the alluvial aquifer. Nebraska evaluated well depths, river valley changes and topographical maps to identify the wells considered as pumping compact water.

The results of the computations are presented on the attached tables. Table 1 is a summary of the results of the virgin water supply computations and adjusted allocations. Table 2 is a summary of consumptive uses by each state from the mainstem and sub-basins. The total annual

computed virgin water supply for the Republican River basin for 1991 is down from 1990 levels and is less than the original compact allocation. Eleven of the thirteen sub-basins had adjusted allocations lower than the original compact allocation. Consumptive use for 1991 is also reduced from 1990 levels. Table 2 indicates that Colorado did not exceed its allocation of consumptive use in any basin, Kansas exceeded its allocation in 2 basins, and Nebraska exceeded its consumptive use allocation in 9 sub-basins.

The next meeting of the Engineering Committee will be held in May of 1993 unless special assignments by the Compact Administration necessitate additional meetings.

Respectively submitted,

/s/_____
Ann Bleed, Nebraska

/s/_____
Gerald Hilmes, Kansas

/s/_____
Alan Berryman, Colorado

Report of the Engineering committee
to the
Republican River Compact Administration
for the
1992 Water Year

The Engineering Committee carried out its assignment to compute the virgin water supply, consumptive use and adjusted allocations by the exchange of data and checking the computations made by the computer program developed by the Engineering Committee. It is noted that Jerry Hilmes, Division of Water Resources, Kansas State Board of Agriculture, resigned his position effective May 27, 1993. As a consequence, James Bagley fulfilled Mr. Hilmes duties for the Engineering Committee for the State of Kansas.

The Engineering Committee completed its normal assignment of computing virgin water supply, consumptive use and adjusted allocations for the 1992 water year. The computations were made using the computer program developed by the Engineering Committee which utilizes the revised formulae approved by the administration in 1990. Data provided by each state for the diversion of water in 1992 were reviewed. Reported groundwater use was included for only those wells producing from the alluvial aquifers.

The results of the computations are shown in Tables 1 and 2 attached to this report. Table 1 is a summary of the 1992 computed annual virgin water supply and original adjusted allocations. Table 2 is a summary of the 1992 computed consumptive use.

According to the calculations resulting in Tables 1 and 2:

1. The computed annual virgin water for the basin for water year 1992 is 514,650 acre-feet. This is almost 100,000 acre-feet more than 1991 and nearly 36,000 acre-feet more than the original compact virgin water supply.

2 Adjusted allocations were less than or equal to original compact allocations in all sub-basins in each state except for the North Fork and Main Stem of the Republican River in Kansas and Nebraska where the adjusted allocations were larger than the original compact alloctions (sic). The adjusted allocation for Colorado was less than the original while the adjusted allocations for Kansas and Nebraska were larger than the original.

3. The computed consumptive use for the basin for water year 1992 was 292,090 acre-feet. This is almost 85,000 acre-feet less than in water year 1991. For calculated consumptive use by subbasin, and for each state, see Table 2.

Respectfully submitted:

Ann Salomon Bleed, Nebraska

James Bagley, Kansas

Alan Berryman, Colorado

Report of the Engineering Committee
To the
Republican River Compact Administration
For the 1993 Water Year

The Engineering Committee corresponded, exchanged data, and meet (sic) via phone conference on June 3, 1994 to complete the work assignments made by the Compact Administration at the June 10, 1993 annual meeting. Those assignments included the computation of the virgin water supply, consumptive use and adjusted allocations for the 1993 water year and a special assignment related to a compilation of studies regarding the Republican River basin. The phone conference included:

Ann Bleed,	Nebraska Department of Water Resources
Alan, Berryman,	Colorado Division of Water Resources
David Barfield,	Kansas Division of Water Resources
Jim Bagley,	Kansas Division of Water Resources

It is noted that David Barfield, Division of Water Resources, Kansas State Board of Agriculture, was appointed as Kansas Engineering Commission Representative through correspondence of Commissioner Pope of October 25, 1993 to the other Commissioners of the Administration.

COMMUPATION (sic) OF VIRGIN WATER SUPPLIES AND COMPUMPTIVE (sic) USES

The Engineering Committee completed its normal assignment of computing virgin water supply, consumptive use and adjusted allocations for the 1993 water year. The computations were made using the computer program developed by the Engineering Committee which utilizes the revised formulae approved by the administration in 1990. Data provided by each state for the diversion of water in

1993 was reviewed. Reported groundwater use was included for only those wells producing from the alluvial aquifers.

The results of the computations are shown in Tables 1 and 2 attached to this report. Table 1 is a summary of the 1993 computed annual virgin water supply and original and adjusted allocations. Table 2 is a summary of the 1993 computed consumptive use.

According to the calculations resulting in Tables 1 and 2:

The computed annual virgin water for the basin for water year 1993 is 1,035,820 acre-feet. This is more than 521,000 acre-feet more than 1992 and nearly 557,000 acre-feet more than the original compact virgin water supply. It represents the largest virgin water supply estimated by the Compact Administration. The unusually large water supply was produced by significant runoff from the flood of 1993 which dominated much of the summer, particularly in the main stem sub-basin. Storage in the basin's reservoir increased substantially during the water year.

Adjusted allocations in the main stem were particularly large. Other sub-basins with adjusted allocations greater than the original Compact were Prairie Dog Creek, Sappa Creek, Medicine Creek and Red Willow Creek. All other subbasins had adjusted allocations less than or equal to original compact allocations. The total adjusted allocation for Colorado was less than the original while the adjusted allocations for Kansas and Nebraska were larger than the original.

The computed consumptive use for the basin for water year 1993 was 156,170 acre-feet. This is almost 136,000 acre-feet less than in water year 1992 and the lowest consumptive use calculated by the Compact Administration. Unussually

(sic) low consumptive use was particularly evident in the main stem Republican due to the significant summer rains. For calculated consumptive use by subbasin, and for each state, see Table 2.

Special Assignment

The Engineering Committee carried out its assignment to compile a list of all technical reports (known to or easily discoverable by each state) which relate to the Republican River basin surface water hydrology, groundwater geology and hydrology, and interaction between groundwater and surface waters of the Republican River basin. The list of technical reports was to be compiled and provided to the Commissioners of the Republican River Compact Administration not later than November 1, 1993.

The final list comprising one-hundred thirty-nine (139) technical reports was mailed to the commissioners on January 26, 1994. Colorado provided a list of thirty (30) reports; Nebraska provided a list of seventy (70) reports; and Kansas provided a list of eighty-six (86) reports.

Respectfully submitted:

/s/
Ann Salomon Bleed, Nebraska

/s/
David Barfield, Kansas

/s/
Alan Berryman, Colorado

Minutes of the
Eleventh Annual Meeting

Republican River Compact Administration

Topeka, Kansas - May 26, 1970

The meeting was called to order by the Chairman, R.V. Smrha, at 10:00 a.m. in Room 1031-S, State Office Building, Topeka, Kansas.

. . . .

Mr. Mackey discussed the proposed changes in the Formulas for the Computation of Annual Virgin Water Supply, Republican River Basin and the Formulas for the Computation of Annual Consumptive Use, Republican River Basin. He pointed out that the proposed formulas gave the factors and procedures presently used in the annual computations. He stated the Engineering Committee recommended the adoption of the revised formulas with the understanding further revisions could be made in the future.

It was moved by Mr. Brees, seconded by Mr. Jones and passed unanimously that the Administration adopt the revised formulas and that they be published in the Tenth Annual Report. The revised formulas for the Computation of Annual Virgin Water Supply are given on page 19 of this report and for the Computation of Annual Consumptive use on page 33.

. . . .

Adjournment:

The Eleventh Annual Meeting of the Republican River Compact Administration was adjourned at 2:15 p.m., May 26, 1970.

/s/

R.V. Smrha, Chairman

. . . .

GENERAL PROCEDURES

Net reservoir evaporation shall be the total evaporation corrected for the precipitation upon the reservoir surface area.

Average monthly reservoir surface areas shall be computed by applying the average of the daily reservoir elevations to the most recent area table.

Depletions of stream flows due to erosion control practices and stockwater ponds have not been included in the present virgin water supply formulas. Representatives of the U.S. Department of Agriculture have indicated there has been no success in isolating the effect of such practices on stream flow.

Irrigation diversions from ground water shall be limited to those by wells pumping from the alluvium along the stream channels. The determination of the effect of pumping by "up-land" wells on the flows of the streams in the Republican River Basin must await considerably more research and data. The wells in the Frenchman Creek drainage basin in Colorado have been considered as "table-land" wells.

Return flows from the lands irrigated by major project developments flowing into two or more designated drainage basins shall be divided in the ratio of the irrigated lands from which the water returns to each drainage basin.

Return flows are considered to be reflected in stream discharge records during the same year the irrigation diversions are made.

. . . .

EVALUATION OF FACTORS

Computations of virgin water supply by the formulas are based upon the following factors:

1. The irrigation diversions by canals, stream pumps and wells for which recorded diversions are not available shall be computed by each State based upon the best information available.

2. Return flows from the lands irrigated by small canals, stream pumps and wells shall be computed as 25 percent of the annual diversions.

3. Return flows from the lands irrigated by major project development shall be computed as percent of annual diversions based on data furnished by the U. S. Bureau of Reclamation. Return flows from the lands irrigated by the Hale Ditch and the Haigler Canal shall be computed as 38 percent of annual diversions.

/s/_____
R.V. Smrha, Chairman

MINUTES
32ND ANNUAL MEETING
REPUBLICAN RIVER COMPACT ADMINISTRATION

The meeting was called to order by Chairman Danielson at 9:00 am, July 19, 1991 at the Sheraton Hotel in Steamboat Springs, Colorado.

. . . .

Per discussion from last year's meeting Commissioner Danielson asked if the Bureau had found anything further on the roll of ground water in the compact. Mr. Kutz stated they had not.

. . . .

The committee reviewed how each state computes consumptive use by ground water to determine if they are following consistent procedures. Colorado and Kansas are using wells constructed into and diverting water from the alluvium of the streams in the basins. Nebraska is using wells in a band two miles wide, one mile on either side of a stream, but is in the process of revising its procedure to also use wells constructed in the alluvium. Nebraska stated that this revision will be complete for the 1991 year computations. Mr. Oaklund stated that 4 wells constructed during 1990 into the alluvium outside of the one mile limit were included in the computations for water year 1990.

. . . .

A tentative date for next years (sic) meeting was set for Friday, July 10, 1992. Upon motion and second, the meeting was adjourned.

/s/
Jeris A. Danielson

Colorado Member (Chairman)

/s/_____
J. Michael Jess
Nebraska Member

/s/_____
David L. Pope
Kansas Member

REPUBLICAN RIVER COMPACT

Rules and Regulations

constituting

The Republican River Compact Administration

Pursuant to the responsibility and authority conferred upon them by the Republican River Compact, ... the officials in their respective states charged with the duty of administering public water supplies, assembled in meeting at Denver, Colorado, on July 15, 1959, and unanimously approved and adopted ... rules and regulations as follows:

1. The State Engineer of the State of Colorado; the Director of Water Resources of the State of Nebraska; and the Chief Engineer, Division of Water Resources, State Board of Agriculture of the State of Kansas, being the officials in their respective states charged with the duty of administering public water supplies, shall be the official members of and together they shall constitute an administrative body hereby designated, 'The Republican River Compact Administration.

2. The Republican River Compact, hereinafter referred to as the "Compact", shall be administered by the Republican River Compact Administration, hereinafter referred to as the 'Administration.