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TWELFTH ANNUAL REPORT

Republican River
Compact
Administration

For the Year 1971

LINCOLN, NEBRASKA
June 9, 1972

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Twelfth Annual Report

REPUBLICAN RIVER COMPACT ADMINISTRATION

In conformity with the Rules and Regulations of the Republican River Compact Administration, the Twelfth Annual Report is submitted as follows:

1. Pursuant to Rule 12, as amended, this report covers the period from June 4, 1971, to June 9, 1972.
2. Members of the Republican River Compact Administration are the officials of each of the States who are charged with the duty of administering the public water supplies, as follows:
Dan S. Jones, Jr., Director, Department of Water Resources, Nebraska
C. J. Kuiper, State Engineer of Colorado
Guy E. Gibson, Chief Engineer, Division of Water Resources, State Board of Agriculture, Kansas
3. The Thirteenth Annual Meeting of the Administration was held on June 9, 1972, in Room 2414 of the State Capitol Building, Lincoln, Nebraska. Minutes of the meeting are included in this report.
4. During the period covered by this report, one meeting of the Engineering Committee was held. A report from that Committee together with summary tabulations of the computed annual virgin water supply and consumptive use for the 1971 water year in the Republican River Basin were presented to and accepted by the Administration at the Thirteenth Annual Meeting. Copies of these presentations are included elsewhere in this report.
5. On June 9, 1972, Mr. C. J. Kuiper, Colorado member of the Administration, was elected Chairman to serve until the next annual meeting of the Administration.

Respectfully submitted,

REPUBLICAN RIVER COMPACT ADMINISTRATION

By: Dan S. Jones, Jr. Nebraska Member
(Chairman)

C. J. Kuiper Colorado Member

Guy E. Gibson Kansas Member

Minutes of the
Thirteenth Annual Meeting
Republican River Compact Administration
Lincoln, Nebraska - June 9, 1972

The meeting was called to order by Dan S. Jones, Jr., Chairman, at 11:15 A.M., Room 2414, State Capitol Building, Lincoln, Nebraska.

The following were in attendance:

| <u>Name</u> | <u>Agency</u> | <u>Location</u> |
|----------------------|--|---------------------|
| Dan S. Jones, Jr. | Official Member | Lincoln, Nebraska |
| Guy E. Gibson | Official Member | Topeka, Kansas |
| C. J. Kuiper | Official Member | Denver, Colorado |
| M. E. Ball | Chairman, Engineering Committee | Lincoln, Nebraska |
| Harris L. Mackey | Division of Water Resources | Topeka, Kansas |
| Gerald E. Hilmes | Division of Water Resources | Topeka, Kansas |
| Jeris A. Danielson | Division of Water Resources | Denver, Colorado |
| Glen E. Brees | Division of Water Resources | Denver, Colorado |
| W. O. Brown | U. S. Bureau of Reclamation | McCook, Nebraska |
| Burton Filkin | U. S. Bureau of Reclamation | McCook, Nebraska |
| Butler Shaffer | U. S. Geological Survey | Lincoln, Nebraska |
| Don Thompson | Republican Valley Conservation Ass'n. | McCook, Nebraska |
| Robert Bishop | Department of Water Resources | Lincoln, Nebraska |
| A. C. Splattstoesser | Bostwick Irrigation District | Red Cloud, Nebraska |

Mr. Harris Mackey presented a letter to the Chairman from Mr. Roy Freeland, Secretary of the Kansas State Board of Agriculture, announcing Mr. Guy Gibson as Chief Engineer of the Division of Water Resources, and charging him with the duty of representing the State of Kansas as the official member of the Republican River Compact Administration. It was moved by Mr. C. J. Kuiper that Mr. Gibson be recognized as the Kansas member, and it was so ordered by the Chairman. This letter is attached to these minutes on page 10.

Approval of the Minutes of Previous Meeting:

Motion was made by Mr. Gibson and seconded by Mr. Kuiper that the minutes of the Twelfth Annual Meeting as published in the Eleventh Annual Report be approved as published. The motion was passed unanimously.

Report of the Chairman:

The Chairman referred to a letter that he had received from Mr. James Smith, Assistant Secretary of Interior, regarding membership of a representative of the Republican River Compact Administration on the Missouri River Basin Commission. It was decided to discuss this further in connection with new business.

Report of Official Members:

Mr. Kuiper stated that Colorado had little to report except that they have started certain ground water studies in an attempt to determine which wells are affecting river flows. They have made some preliminary computations, and may be able to report some firm figures by next year.

Mr. Gibson stated that he had nothing to report.

On a motion by Mr. Gibson, seconded by Mr. Kuiper, the meeting was adjourned for lunch.

The meeting was reconvened at 1:00 P.M.

New Business:

A motion was made by Mr. C. J. Kuiper that the members of the Administration attend the organizational meetings of the Missouri River Basin Commission on June 13, 1972, to attempt to determine how much participation would be desirable, and then correspond and exchange views to determine whether or not a common position could be reached as to whether the Republican River Compact Administration would want to be a member or not. The motion was seconded by Mr. Guy Gibson and carried unanimously.

Mr. M. E. Ball, Engineering Committee Chairman, asked the members how they wished the engineering report to be presented. The Chairman suggested that only the high lights be presented. Copies of the report were distributed, and Mr. Mackey and Mr. Ball summarized and interpreted the results of the computations contained in the report. It was moved by Mr. Gibson that the report of the engineering committee as presented, both orally and in writing, be accepted and that the committee be commended for the report. The motion was seconded by Mr. Kuiper and carried unanimously.

A copy of the Engineering Report is included in the record. It was moved by Mr. Kuiper that Mr. Ball's report, "Republican River Return Flow Study," dated June, 1972, be accepted and also included in the record. Second was by Mr. Gibson. A motion was made by Mr. Kuiper that the Administration accept Mr. Ball's recommendation for the U. S. Geological Survey to accept and review this tabulation and comment whether or not they think the study should be continued in the reach from Trenton to Cambridge. The motion was seconded by Mr. Gibson. Mr. Butler Shaffer of the U. S. Geological Survey stated they would be glad to continue this study. The motion carried unanimously.

Motion was made by Mr. Gibson and seconded by Mr. Kuiper that the Engineering Committee be authorized to continue their study and assignment the same as during the past years. Motion carried unanimously.

Mr. Harris Mackey read a resolution commending Mr. R. V. Smrha for his service to the Administration and asking that it be made a part of the record, a copy of which should be sent to Mr. Smrha. A motion was made by Mr. Guy Gibson that the Resolution for R. V. Smrha be adopted. The motion was seconded by Mr. C. J. Kuiper and carried unanimously. A copy of the Resolution is attached on page 11.

A motion was made by Mr. Guy Gibson that the name of Mr. C. J. Kuiper, official member from Colorado, be placed in nomination for Chairman for the coming year. The motion was seconded by Mr. Jones and carried unanimously. Mr. Kuiper accepted the Chairmanship for the coming year.

Adjournment:

The Thirteenth Annual Meeting of the Republican River Compact Administration was adjourned at 2:45 P. M., June 9, 1972.



KANSAS STATE BOARD OF AGRICULTURE

ROY FREELAND
Secretary

STATE OFFICE BUILDING
TOPEKA, KANSAS 66612

PAUL IJAMS
Assistant Secretary

June 1, 1972

Mr. Dan S. Jones, Jr., Chairman
Republican River Compact Administration
P. O. Box 94607
Lincoln, Nebraska 68509

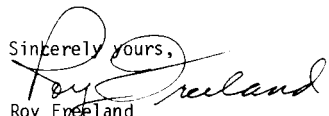
Dear Mr. Jones:

The Kansas State Board of Agriculture appointed Mr. Guy E. Gibson as Chief Engineer, Division of Water Resources, effective May 1, 1972.

Article IX of the Republican River Compact, entered into by the States of Colorado, Kansas and Nebraska, states in part "It shall be the duty of the three States to administer this compact through the official in each State who is now or may hereafter be charged with the duty of administering the public water supplies, ---".

Under his appointment, Mr. Gibson is charged with this duty and, therefore, will be the Official Member for Kansas on the Republican River Compact Administration.

Sincerely yours,


Roy Freeland
Secretary

RF:HLM:nc

RESOLUTION

WHEREAS, R. V. Smrha, Chief Engineer, Division of Water Resources, Kansas State Board of Agriculture, has been the Official Member for Kansas on the Republican River Compact Administration since its organization on July 15, 1959; and

WHEREAS, Mr. Smrha has voluntarily elected to retire from his duties as Chief Engineer, Division of Water Resources, and as Official Member of the Republican River Compact Administration; and

WHEREAS, Mr. Smrha, through the years, has contributed his knowledge, professional skill and services to the fulfillment of the purposes of the Republican River Compact and to the organization and performance of the Republican River Compact Administration;

NOW, THEREFORE, BE IT RESOLVED, that the Republican River Compact Administration does hereby acknowledge the outstanding contribution of R. V. Smrha to the States of Colorado, Kansas and Nebraska, express on behalf of the people of these States their sincere appreciation and commendation for his services and extend to him best wishes for the future.

BE IT FURTHER RESOLVED, that this resolution be entered into the records of this Administration and that the Chairman be instructed to send a copy to Mr. Smrha.

Adopted at the Thirteenth Annual Meeting of the Republican River Compact Administration at Lincoln, Nebraska, on the 9th day of June 1972.

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:

| | <u>1971 Calendar Year</u> |
|------------------|---------------------------|
| 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 | <u>6,410</u> 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:

| <u>Sub-Basin</u> | <u>Groundwater</u> | <u>Surface Water</u> |
|------------------------------|--------------------|----------------------|
| 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:

| <u>Canal</u> | <u>Return as Per Cent of Total Diversions</u> | <u>Canal</u> | <u>Return as Per Cent of Total Diversions</u> |
|------------------|---|-----------------|---|
| 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. | |
| Almena | 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 Canals | 44% |
| Groundwater and surface water diversions | 25% |

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

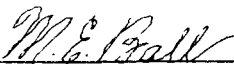
Consumptive Use in Nebraska - 1971

| | <u>By Formula</u> <u>Ac. Ft.</u> | <u>Above Mouth</u> <u>Ac. Ft.</u> |
|-------------------|-------------------------------------|--------------------------------------|
| 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,



Nebraska



Kansas



Colorado

Computed Annual Virgin Water Supply
 Republican River Basin

| <u>Drainage Basin</u> | <u>Compact Ac. Ft.</u> | <u>1971 W. Y. Ac. Ft.</u> |
|--|----------------------------|-------------------------------|
| Prairie Dog Creek | 27,600 | 16,770 |
| Sappa Creek | 21,400 | 20,830 |
| Beaver Creek | 16,500 | 16,060 |
| Medicine Creek | 50,800 | 44,550 |
| Red Willow Creek | 21,900 | 23,170 |
| Driftwood Creek | 7,300 | 2,170 |
| Frenchman Creek | 98,500 | 117,470 |
| South Fork of the Republican River | 57,200 | 30,910 |
| Rock Creek | 11,000 | 10,190 |
| Buffalo Creek | 7,890 | 5,480 |
| Arikaree River | 19,610 | 7,350 |
| North Fork of the Republican River | 44,700 | 42,950 |
| Main Stem of the Republican plus Blackwood Creek | *94,500 | 160,850 |
| TOTALS | 478,900 | 498,750 |
| *Main Stem Blackwood Creek | 87,700 6,800 | |

4/25/72

Computed Annual Consumptive Use
Republican River Basin

1971 Water Year

| <u>Drainage Basin</u> | <u>Colorado</u> | <u>Kansas</u> | <u>Nebraska</u> | <u>Total</u> |
|---------------------------------------|-----------------|---------------|-----------------|----------------|
| Prairie Dog Creek | - | 17,290 | 580 | 17,870 |
| Sappa Creek | - | 6,360 | 8,120 | 14,480 |
| Beaver Creek | 0 | 7,460 | 8,830 | 16,290 |
| Medicine Creek | - | - | 8,070 | 8,070 |
| Red Willow | - | - | 10,000 | 10,000 |
| Driftwood | - | 0 | 520 | 520 |
| Frenchman Creek | - | - | 52,730 | 52,730 |
| South Fork of the Republican River | 6,930 | 6,030 | 160 | 13,120 |
| Rock Creek | - | - | 100 | 100 |
| Buffalo Creek | - | - | 530 | 530 |
| Arikaree River | 0 | 250 | 0 | 250 |
| North Fork of the Republican River | 4,800 | - | 3,970 | 8,770 |
| Main Stem of the Republican River | - | 54,790 | 159,910 | 214,700 |
| TOTALS | 11,730 | 92,180 | 253,520 | 357,430 |

4/25/72

REPUBLICAN RIVER RETURN FLOW STUDY

M. E. Ball, June, 1972

Introduction

The attached table presents data determining the return flow by years for the Trenton (and Palisade) to Cambridge reach described in the March, 1962 Progress Report and the August, 1963 Progress Report by Mr. F. F. LeFever, former District Engineer of the U. S. Geological Survey. The full titles of these reports are listed at the end of this paper.

Numerous earlier studies were made by Mr. LeFever on other reaches of the Republican River which brought Mr. LeFever to the conclusion that a pilot study area should be chosen in the Republican Basin where there was the greatest concentration of irrigated land.

A reconnaissance field study was made on June 15-17, 1966, for a proposed continuation of the return flow studies in that basin. The decision was made to initiate a series of measurements along the Republican River between Trenton and Cambridge to determine whether a river inflow-outflow study would provide the answers acquired. Six sets of measurements were made and the results of these studies demonstrated that the so-called "seepage runs" are not a satisfactory basis for the determination of return flow and

Mr. K. A. Mackichan, District Engineer of the U.S.G.S. recommended that this procedure be discontinued.

Discussion of Study

The original study of the pilot area by Mr. LeFever which was first made for the years 1959-1960 indicated to Mr. LeFever that the ground water would have to be taken into consideration before the tables began to give results desired for determination of return flow. You will observe from the attached table that the return flow percentages for the year 1959 showed a gain of only 2.8 percent considering only surface water, but when ground water was taken into consideration the gain in flow reflected 27.9 percent. It just so happened that Mr. LeFever initiated his study on the Cambridge reach at a time when the river was changing from a losing stream to a gaining stream because of the return flow. The attached table was prepared to include the years back to 1954 to reflect this change, and you will observe that after 1959 the river-reach became a gaining stream and continued to be a gaining stream on an annual basis at least up through 1971.

Referring to the attached tabulation it will be noted that of a total of 4,680 square miles of drainage area in the reach, 1,050 square miles of the regulated area (Medicine Creek) is gaged and 2,750 square miles of the unregulated area, "Stinking Water, Blackwood, Driftwood, and Red Willow," is gaged, leaving only 880 square miles ungaged. In comparison with the ratio for other rivers

this represents a relatively small ratio of the ungaged to gaged intervening area. The contribution of water from the ungaged area is computed by determining the runoff per square mile from the regulated areas noted above and then multiplying this runoff factor by the number of square miles ungaged.

Beginning in 1962 the storage in Hugh-Butler necessitated the exclusion of Red Willow Creek data from the total for the unregulated areas. This reduced the unregulated tributary area from 2,750 square miles to 2,040 square miles commencing in 1962.

It should be noted that the Meeker-Driftwood Canal diverts directly from Swanson Lake rather than from the reach; but all return flow from this system occurs within the reach. After 1961 the Red Willow Canal also diverts outside of the adjusted reach; however, all of the water from this canal is used within the reach and is to be considered a part of the water applied.

The quantity of ground water applied was taken directly from the virgin flow studies of the administration beginning in 1959. The amount of well water applied in the reach prior to 1959 was estimated from the records of the Nebraska Department of Water Resources.

Conclusions

1. The attached tables should be self-explanatory except as noted above.

2. The percentage gain in the reach for the period 1959 through 1971 for surface water only averaged 27.5 percent. The percentage gain in the reach with ground water included averaged 40.7 percent. No definite conclusions can be drawn from the studies as to whether ground water should or should not be considered in return flow studies.

Recommendations

1. The attached table was prepared by the writer using the procedures adopted by Mr. LeFever for the purpose of determining the trend from year to year.

2. The U. S. G. S. did not participate in the preparations of the attached table. The writer recommends that the U. S. Geological Survey review the results of the table and make recommendations pertaining to the desirability of the continuation of the return flow studies.

| Line | | Drainage Area Sq. Miles | 1954 |
|------|--|-------------------------------|---------|
| 1 | Inflow | | |
| 2 | Republican at Trenton | (4910)8120 | 16,240 |
| 3 | Frenchman-Palisade | (980)1500 | 48,210 |
| 4 | Stinking Water Creek Palisade | (430)1390 | 24,130 |
| 5 | Blackwood | 290 | 1,850 |
| 6 | Driftwood | 360 | 1,040 |
| 7 | Red Willow-Red Willow | (400)710 | 22,000 |
| 8 | Medicine Below H.S. | (660)1050 | 39,470 |
| 10 | Total Unregulated Tributary | (1480)2750 | 49,020 |
| 12 | Total Gaged Inflow | (8030)13420 | 152,940 |
| 14 | Ungaged Inflow Est. | 880 | 15,200 |
| 16 | Total Inflow Adjusted | | 168,140 |
| 19 | Diverted or Withdrawn Surface | | 33,100 |
| | Culbertson Canal | | |
| 20 | Riverside Canal | | 2,390 |
| 21 | Meeker-Driftwood | | |
| | Meeker Canal | | 12,230 |
| 22 | Red Willow | | 0 |
| 23 | Bartley | | 0 |
| 25 | Wells--Acre-Feet Pumped | | 5,150 |
| 26 | Total Applied | | 52,870 |
| 27 | Surface Water | | 47,700 |
| 28 | Computed Flow at Camb. with Wells | | 115,270 |
| 29 | Computed Flow at Camb. less Wells | | 120,420 |
| 30 | Record Flow at Cambridge | | 102,500 |
| 31 | Return Flow Line 30 minus line 28 | | -12,770 |
| 32 | Percent Gain or Loss. Percent of line 26 | | -24.2 |
| 33 | Return Flow Line 30 minus line 29 | | -17,920 |
| 34 | Percent Gain or Loss, Percent of line 27 | | -37.6 |
| 35 | Rainfall S.W. Dist.--Inches | | 113.5" |

Line 28 equals line 16 minus line 26 plus Meeker-Driftwood and Red Willow

Line 29 equals line 28 plus line 25

*After Hugh Buttler Res. Completed.

E=Estimated

REPUBLICAN RIVER RETURN FLOW STUDY
WATER YEAR (ACRE-FEET)

| 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 |
|---------|---------|---------|---------|---------|---------|---------|
| 37,620 | 25,570 | 120,700 | 123,100 | 96,270 | 67,950 | 25,600 |
| 57,150 | 67,590 | 67,720 | 70,850 | 74,720 | 83,580 | 78,970 |
| 25,260 | 33,320 | 30,150 | 35,580 | 29,670 | 41,420 | 28,370 |
| 3,670 | 4,300 | 4,690 | 4,620 | 3,260 | 10,850 | 1,510 |
| 1,020 | 12,600 | 10,540 | 5,940 | 3,440 | 18,740 | 2,700 |
| 28,480 | 23,240 | 35,640 | 30,150 | 24,440 | 45,090 | 24,140 |
| 44,720 | 30,510 | 47,770 | 49,770 | 50,750 | 75,990 | 32,930 |
| 58,430 | 73,460 | 81,020 | 126,060 | 60,800 | 116,100 | 56,720 |
| 197,920 | 197,130 | 317,210 | 320,010 | 282,550 | 343,630 | 194,220 |
| 18,700 | 23,500 | 26,000 | 41,400 | 19,460 | 37,160 | 18,150 |
| 216,620 | 220,630 | 343,210 | 361,410 | 302,010 | 380,790 | 212,370 |
| 32,430 | 39,660 | 32,570 | 28,040 | 22,070 | 22,040 | 39,650 |
| E-2,400 | E-2,400 | E2,400 | E-1,500 | E-2,300 | E-2,200 | E-2,000 |
| | | 3,430 | 8,980 | 29,670 | 33,790 | 31,940 |
| 11,970 | 13,830 | 10,070 | 10,150 | 620 | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11,620 | 10,100 | 8,480 | 8,690 | 10,810 | 11,690 | 10,910 |
| 7,900 | 12,300 | 15,600 | 4,150 | 22,700 | 22,700 | 23,200 |
| 66,320 | 78,290 | 72,550 | 61,510 | 88,170 | 92,420 | 107,700 |
| 58,420 | 65,990 | 56,950 | 57,360 | 65,470 | 69,720 | 84,500 |
| 150,300 | 142,340 | 274,090 | 308,880 | 243,510 | 322,160 | 136,610 |
| 158,200 | 154,640 | 289,690 | 313,030 | 266,210 | 344,860 | 159,810 |
| 136,800 | 123,600 | 307,800 | 310,200 | 268,000 | 371,000 | 175,400 |
| -13,500 | -18,740 | +33,710 | +1,320 | +24,590 | 48,940 | +38,790 |
| -20.3 | -23.9 | +46.5 | +2.2 | +27.9 | +53.0 | +36.0 |
| -22,400 | -31,040 | +18,110 | -2,830 | +1,790 | +26,240 | +15,590 |
| -38.4 | -47.0 | +31.9 | -4.8 | +2.8 | +37.6 | +18.5 |
| ±15.0" | 60% | ----- | 22.09" | 13.12" | 11.00" | 15.67" |
| | Norm | | +3.66 | -2.01 | -4.06 | +1.24 |

Canal diversions.

M.D.=Meeker-Driftwood

| 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 |
|---------|---------|---------|---------|---------|---------|---------|
| 110,000 | 55,390 | 26,500 | 27,640 | 112,400 | 25,170 | 30,090 |
| 80,980 | 72,580 | 66,310 | 61,190 | 71,090 | 82,030 | 67,950 |
| 39,210 | 33,980 | 32,100 | 33,310 | 33,190 | 35,740 | 29,640 |
| 12,680 | 3,110 | 3,690 | 6,290 | 4,670 | 5,300 | 4,250 |
| 13,110 | 5,280 | 6,150 | 11,400 | 5,510 | 5,120 | 7,410 |
| 14,670 | 6,790 | 6,930 | 8,760 | 9,120 | 18,460 | 13,750 |
| 86,410 | 66,250 | 45,880 | 32,650 | 43,830 | 68,600 | 49,650 |
| *65,000 | *42,370 | *41,940 | *51,000 | *43,370 | *46,160 | *41,300 |
| 357,060 | 243,380 | 187,560 | 181,240 | 279,810 | 240,420 | 202,740 |
| 28,040 | 18,200 | 18,050 | 22,000 | 18,800 | 19,900 | 17,800 |
| 385,100 | 261,580 | 205,610 | 203,240 | 298,610 | 260,320 | 220,540 |
| 36,090 | 50,700 | 48,670 | 44,560 | 52,030 | 49,420 | 52,530 |
| E-1500 | 1,950 | ±2,000 | E2,000 | E2,300 | 2,270 | 1,720 |
| 25,790 | 40,740 | 34,980 | 29,600 | 34,560 | 33,570 | 35,620 |
| 0 | 2,930 | 5,680 | 6,080 | 5,930 | 6,960 | 9,100 |
| 8,430 | 11,530 | 11,246 | 9,070 | 7,280 | 8,940 | 13,330 |
| 4,660 | 25,100 | 20,800 | 13,300 | 16,020 | 15,000 | 18,700 |
| 76,470 | 132,950 | 123,376 | 104,610 | 118,120 | 116,160 | 131,000 |
| 71,810 | 107,850 | 102,576 | 91,310 | 102,100 | 101,160 | 112,300 |
| 334,420 | 172,300 | 122,894 | 134,310 | 220,980 | 184,690 | 134,260 |
| 339,080 | 197,400 | 143,694 | 147,610 | 237,000 | 199,690 | 152,960 |
| 389,000 | 212,800 | 153,900 | 187,400 | 280,600 | 238,900 | 166,000 |
| +54,580 | +40,500 | +31,006 | +53,090 | +59,620 | +54,210 | +31,740 |
| +71.5 | +30.5 | +24.8 | +50.8 | +50.4 | +46.6 | +24.2 |
| +49.920 | +15,400 | +10,206 | +39,790 | +43,600 | +39,210 | +13,040 |
| +69.5 | +14.1 | +10.0 | +43.5 | +42.8 | +38.8 | +10.6 |
| 22.81" | 18.68" | ----- | 27.0" | 18.54 | ----- | |
| +8.34 | +0.12 | | +8.45 | +0.01 | | |

| 1969 | 1970 | 1971 |
|---------|---------------------|---------------------|
| 25,500 | 46,850 | 12,830 |
| 63,250 | 59,790 | 39,360 |
| 29,450 | 27,380 | 29,860 |
| 4,830 | 3,180 | 3,870 |
| 5,190 | 5,370 | 5,850 |
| 15,460 | 12,480 | 11,010 |
| 58,540 | 51,520 | 33,950 |
| *39,470 | 35,930 | 39,580 |
| 202,220 | 206,570 | 136,730 |
| 17,000 | 15,500 | 17,000 |
| 219,220 | 222,070 | 153,730 |
| 53,230 | 48,720 | 52,190 |
| 1,350 | 1,510 | 2,110 |
| 33,950 | 42,830 | 41,680 |
| 7,600 | 8,860 | 9,370 |
| 9,970 | 12,550 | 7,560 |
| 15,200 | 21,400 | 23,900 |
| 121,300 | 135,870 | 136,810 |
| 106,100 | 114,470 | 112,910 |
| 139,670 | 137,890 | 67,970 |
| 154,870 | 159,290 | 91,870 |
| 187,500 | 173,400 | 133,100 |
| +47,930 | 35,510 | 65,130 |
| +39.4 | 26 ¹ | 47 ⁶ |
| +32,730 | 14,110 ₃ | 41,230 ₅ |
| +30.8 | 12 ² | 36 ⁵ |

References

1. Progress Report on Investigation of Feasibility of Pilot Study of Return Flow in Republican Basin in Nebraska. F.F. LeFever, March 1962.

2. Progress Report on Investigation of Feasibility of Pilot Study of Return Flow in Republican River Basin in Nebraska. F. F. LeFever, August, 1963.

3. Conference in U.S.G.S. Office June 27, 1966.
Participants: Marion E. Ball, Assistant Director,
Nebraska Department of Water Resources.

K. A. MacKichan, District Chief,
U.S.G.S.

Butler Shaffer, Hydraulic Engineer,
U.S.G.S.

Purpose: Review of findings of Republican
River reconnaissance of June 15-17,
1966, for a proposed continuation
of return flow studies in that
basin.