**UNITED STATES DEPARTMENT OF THE INTERIOR**
**OSCAR L. CHAPMAN, Secretary**

**BUREAU OF RECLAMATION**
**Michael W. Straus, Commissioner**

Region 7-Denver, Colorado
Avery A. Batson, Regional Director

# Definite Plan Report
# Frenchman-Cambridge Division
# Nebraska

Volume 1
General Plan of Development
including
Enders Dam, Trenton Dam, and Medicine Creek Dam

Multiple-purpose facilities in the
Frenchman-Cambridge Division
Kansas River Basin
Missouri River Basin Project

**Appendix II---Water supply**
**Part 3 of 5**

**February 1951** **Copy no. 3**

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KS002178

UNITED STATES DEPARTMENT OF THE INTERIOR
OSCAR L. CHAPMAN, Secretary

BUREAU OF RECLAMATION
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Appendix II - - - Water Supply

Part 3 of 5

February 1951

Copy No. 3

KS002179

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Regional Office, Region 7
318 New Customhouse
Denver 2, Colorado

In Reply Refer to:
7-740

June 15, 1951

To: Commissioner
Attention: 700

From: Regional Director

Subject: Transmittal of Definite Plan Report on the Frenchman-Cambridge Division, Missouri River Basin Project

1. We have completed the preparation of our Definite Plan Report on the Frenchman-Cambridge Division, Missouri River Basin Project, and are shipping to you, under separate cover, twenty copies of the report together with six sets of five appendixes.

2. Construction is completed on two of the major features of the Division--Medicine Creek and Enders Dams. Trenton Dam is under construction, and Red Willow Dam, a Corps of Engineers development, is yet to be constructed. Cambridge Diversion Dam and the major portion of Cambridge Canal are constructed. The Government has acquired title to and rehabilitated the Meeker Canal and has constructed a temporary diversion dam serving this canal. At the present time Medicine Creek Reservoir is spilling and Enders Reservoir is filling rapidly; however, approximately 2,700 acres only can be served from Meeker Canal, and about 2,100 acres from canal side turnouts of the completed portion of Cambridge Canal. Construction of the Cambridge Canal has been stopped, no laterals have been built, and the only current progress is the continued construction of Trenton Dam.

3. Except for an interim Warren Act proposal, no arrangement has been made to provide service to any of the privately owned canals, the largest of which is Culbertson, now serving 9,450 acres. The owners of this canal have requested the Bureau to make an offer of terms to take over and rebuild their works. Such arrangements would allow for the enlargement of the canal to serve the entire Frenchman Unit in accordance with the division plan.

4. Construction of the Cambridge Canal was stopped recently because certain provisions of the repayment contract with the Frenchman-Cambridge Irrigation District were not approved in the confirmation proceedings in the District Court, McCook, Nebraska. This case was appealed to the Nebraska Supreme Court, which ruled that it had no

jurisdiction because the appeal was filed after the allotted time for rehearing. In recent weeks the objectionable provisions of the contract have been revised and agreed to by the District and the Bureau. It is anticipated that the revised contract may be confirmed. The reconfirmation proceedings are now set for hearing in McCook on June 30, 1951.

5. The successful negotiation and confirmation of this contract is essential before any further action is taken in the Frenchman-Cambridge Division. It is vital, however, to set forth objectives in respect to the physical plan of development, plans for irrigation district reorganization, and bases for negotiation of repayment contracts. These plans are set forth in the report and summarized in this letter together with my recommendations.

Plan of Development

6. The Frenchman-Cambridge Division includes Enders Dam and Reservoir, Medicine Creek Dam and Reservoir, Trenton Dam and Swanson Lake, all Bureau of Reclamation facilities; and Red Willow Dam and Reservoir to be constructed by the Corps of Engineers. These storage facilities, and appurtenant diversion and distribution works, will provide for irrigation of 68,570 acres, flood protection in a large segment of the Republican River Basin, fish and wildlife conservation, and enhancement of recreational resources.

7. The physical plan is essentially the same as that originally presented in Senate Document 191. That plan envisioned four multiple-purpose reservoirs with a combined storage capacity of 342,000 acre-feet and the irrigation of 69,225 acres. Reservoir storage has been enlarged to 471,900 acre-feet to provide needed increases for flood control and irrigation. The irrigation of 11,300 acres by wells has been replaced by an equivalent gravity area to conform with state law requiring a common water supply for an irrigation district. Also, the irrigation system was redesigned to include acreages which could be served more economically.

8. The physical plan provides for the most desirable and feasible development of the division's water resources from both engineering and economic standpoints. In formulating the plan, consideration was given to the most efficient use of facilities constructed, under construction, or planned by the Bureau and the Corps of Engineers. I recommend your approval of this physical plan of development.

District Reorganization

9. Development of 68,570 irrigable acres in the division requires district reorganization for 67,680 acres and a supply of supplemental water under Warren Act contracts for 890 acres. At present there are two organized irrigation districts in the Frenchman-Cambridge Division.

The Frenchman Valley Irrigation District was organized in 1911 under the laws of Nebraska, and is now functioning as a district operating the Culbertson Canal serving 9,450 acres in Frenchman Creek Valley. The Frenchman-Cambridge Irrigation District was formally organized April 8, 1946. This organization was effected to contract with the Bureau of Reclamation under an earlier plan of development, and contained 41,000 acres which has now been reduced to 36,990 acres largely because of land reclassification. There are, therefore, 21,240 acres of new lands which to date have not been incorporated into either of the irrigation districts.

10. The most desirable plan from an operating standpoint would be a merger of the two districts so that all of the land in the Frenchman-Cambridge Division would be in one district. The Frenchman Valley District officials, however, are not favorable to a merger with the Frenchman-Cambridge District as they are unwilling to lose their identity and feel that their position as an operating district would not be enhanced by being absorbed in a larger inexperienced district. Both districts are agreeable to the enlargement of their boundaries to include adjoining new lands, providing suitable repayment rates are established.

11. In view of the interests of the Frenchman Valley District, the plan proposes to revise the boundaries of the Frenchman Valley Irrigation District and to expand the area from 9,450 acres to include all of the 22,020 acres in the Frenchman Unit. This enlargement would be made to comply with changed features of the division plan and would include 3,550 acres in the Farmers and Riverside Canal areas now incorporated in the Frenchman-Cambridge Irrigation District. The existing Frenchman-Cambridge Irrigation District, containing 36,990 acres, would be modified and enlarged to 45,660 acres. The enlarged district would include additional areas of 9,620 acres in the Meeker-Driftwood Unit, 1,000 acres in Red Willow Unit, and 1,600 acres in the Cambridge Unit. The withdrawal of the 3,550 acres from the Frenchman-Cambridge Irrigation District is desirable, for these acres are located within the Frenchman Unit and will receive water supply service from a common source, the Culbertson Canal and its extension. The major portion of the additional lands in the Meeker-Driftwood Unit represents a change from the original plan owing to the relocation of Culbertson Dam to the Trenton site. The areas in the Red Willow and the Cambridge Units were selected in the redetermination of irrigable areas.

12. Careful consideration was given to other possible plans of district reorganization. The criteria used as a basis for evaluation of the various plans were efficiency of operation, present extent of district organization, the provisions of Nebraska statutes governing single source of water supply, and the acceptibility by the existing

districts and potential water users. Tables A and B, attached, entitled "Extent of District Organization" and the "Evaluation of Various Plans for District Reorganization" show a tabular analysis of this problem. The plan as presented in the report; namely, enlargement of the two existing districts, is the only one that satisfactorily meets the above criteria. I recommend your approval of this plan for reorganization of districts.

Repayment Contracts

13. The division plan requires a repayment contract with each of the two enlarged districts. The existing Frenchman-Cambridge Irrigation District contract must be revised to provide repayment for the enlarged district of 45,660 acres. A repayment contract with the Frenchman Valley Irrigation District is yet to be negotiated and should include the entire Frenchman Unit of 22,020 acres, as certain irrigation facilities on all of these lands are to be constructed by the Bureau.

14. As presented in the report, the analysis of repayment obligation for lands in the Frenchman-Cambridge Irrigation District reflects the originally negotiated amount of $1.60 per acre per year for a total of 41,000 acres. The analysis for the new lands to be added to the Frenchman-Cambridge District is based on full repayment capacity less a 20 percent contingency factor. The analysis for the enlarged Frenchman Valley Irrigation District also is based on full repayment capacity less a 20 percent contingency factor, with the exception of the 3,550 acres now organized in the Frenchman-Cambridge Irrigation District. The latter lands are a part of the original district contracted at the $1.60 rate; therefore, the analysis contains that rate to facilitate their transfer to the Frenchman Valley District. Tables C and D, attached, are pertinent to both district reorganization and the problem of repayment rates. They show, respectively, payment capacity per acre of irrigable land for various plans of district organization and adequacy of various repayment rates per acre for two plans of district organizatior

15. The precedent resulting from the Frenchman-Cambridge Irrigation District contract at the $1.60 rate will present serious problems in obtaining a higher repayment rate on any new lands within the Frenchman-Cambridge Division, because they are in the same general locality and are physically and economically similar. The $1.60 rate was basic to the district formation and the repayment contract, now awaiting confirmation. To accomplish prompt enlargement of the Frenchman-Cambridge Irrigation District, it is essential that the $1.60 rate be used for the 4,660 acres of added lands in the proposed reorganization. However, the District must understand the limitations imposed by this rate. It must understand that the rate of $1.60 per acre per year will provide a water supply system as set forth in Section 9E of the 1939 Reclamation Law; that the rate will provide a distribution system and part of the necessary drains within the financial limitation of the $1.60 per acre

to repay the cost of such in a 40-year period. It must understand, further, that it will be required to build and finance additional drainage as needed to protect the irrigated lands from seepage. The alternative to this arrangement will be for the irrigation district to pay enough more than the $1.60 per acre per year to repay in 40 years the cost of additional drainage.

16. A repayment contract with the Frenchman Valley Irrigation District should be negotiated at the same rate of $1.60, because the owners of the 3,550 acres now covered by the Frenchman-Cambridge Irrigation District contract would be unwilling to change districts if charged a higher rate. The existing Frenchman Valley Irrigation District also is unwilling to pay a higher rate. Although its canal system is in need of major repair, the District is a going concern with low operating costs and no bonded debt.

17. The use of the $1.60 repayment rate will facilitate early reorganization of the two districts and renegotiation of repayment contracts necessary for continuation of development according to the division plan. This will permit the most economic use of irrigation features and eliminate the need for construction of a costly permanent Meeker Diversion Dam; the originally proposed Farmers-Riverside Diversion Dam; and an expensive canal extension through presently irrigated lands and the town of Culbertson. All of these costly works must be constructed if reorganization is not accomplished and all lands under the existing contract are to be served. Also, without reorganization a large portion of the most economical irrigation development of the division would be precluded.

18. I recommend that the two reorganized districts--the Frenchman-Cambridge and the Frenchman Valley--be given the alternative of paying $1.60 per acre per year against their construction charge obligation for a 40-year contractual period, with the understanding that they will agree to build any necessary drains which can not be paid for from proceeds of the above rate; or that the districts increase the $1.60 per acre per year rate to an amount adequate to finance the distribution system and all necessary drainage, plus some payment against the construction cost of the water supply works. Either alternative is based upon the assumption that the cost of the distribution and drainage system constructed by the Government must be repaid in forty years from the termination of the development period. Under the first alternative the districts must agree to build drains as needed and not provided for under the $1.60 per acre rate. Such drains as would be built by the districts must be approved by the Bureau. Under the second alternative a similar provision would apply except that the Government would be in a position to construct a greater portion of the drainage system, the

extent depending upon the adequacy of the repayment rate. Each of the two proposed districts has adequate capacity to pay costs of distribution and drainage systems and operation and maintenance charges.

19. As soon as the repayment contract with existing Frenchman-Cambridge Irrigation District is confirmed and the physical plan of development for the division approved, construction of certain facilities may be carried forward at the same time that negotiations for district reorganization and further repayment contracts are being forwarded. During this period construction of the following features would be in conformance with the plan of development and the existing contract: completion of the irrigation system for the Cambridge Canal in the Cambridge Unit; and construction of Bartley Diversion Dam and the Bartley Canal in the Red Willow Unit. These features will provide for the irrigation of approximately 23,000 acres.

20. The achievement of district reorganization and the negotiation of suitable repayment contracts would permit the completion of the division plan. The construction of irrigation facilities for the Frenchman and Meeker-Driftwood Units and the remaining portions of the Red Willow and Cambridge Units could then be accomplished in accordance with the construction program as set forth in the report. This development would provide for irrigation of an additional 45,000 acres of land to bring to completion the full development of the division.

/s/ Avery A. Batson

Copy: Under separate cover

Copy to: Chief Engineer, Attn: 204 (w/7 copies of the report and 2 sets of appendixes)
Chief, Hydrology Div., Attn: 750 (w/3 copies of report 1 set of appendixes)

TABLE A. EXTENT OF DISTRICT ORGANIZATION

| UNIT | TOTAL ACRES | FRENCHMAN VALLEY IRRIGATION DIST. | | FRENCHMAN-CAMBRIDGE IRRIGATION DISTRICT | | UNORGANIZED | |
|---|---|---|---|---|---|---|---|
| | | Acres | Percent of Total | Acres | Percent of Total | Acres | Percent of Total |
| All Units | 67,680 | 9,450 | 14 | 36,990 | 55 | 21,240 | 31 |
| Frenchman | 22,020 | 9,450 | 43 | 3,550 | 16 | 9,020 | 41 |
| Meeker-Driftwood | 16,440 | — | — | 6,820 | 41 | 9,620 | 59 |
| Red Willow | 11,990 | — | — | 10,990 | 92 | 1,000 | 8 |
| Cambridge | 17,230 | — | — | 15,630 | 91 | 1,600 | 9 |

TABLE B. EVALUATION OF VARIOUS PLANS FOR DISTRICT REORGANIZATION

| Criteria | Enlargement of Existing Districts* | One Dist. | 2 districts: Frenchman and Meeker Driftwood; Red Willow and Cambridge | 5 separate districts or other combinations |
|---|---|---|---|---|
| 1. Efficiency of operation and economy of maintenance, considering distance and best use of manpower, material and equipment. | S | S | S | U |
| 2. Present extent of district organization with special reference to ease of inclusion and exclusion of lands and dissolution of district or districts. | S | U** | U | U |
| 3. Acceptability of plans by existing Frenchman-Cambridge and Frenchman Valley Districts. | S | U** | U | U |
| 4. Irrigation under a common source of water supply consistent with physical plan and Nebraska Statutes governing district organization. | S | S | S | S |

S--Satisfactory; U--Unsatisfactory

*Existing Frenchman Valley District enlarged to include all of the 22,020 acres in Frenchman Unit and existing Frenchman-Cambridge District to include remaining units totaling 45,660 acres.

**Length of time necessary to effect reorganization and merger and general disapproval expressed by district officials resulted in the rating of these two items as unsatisfactory.

Table C. Annual Payment Capacity, Operation and Maintenance Costs, and Amortization Capacity per Acre of Irrigable Land for Various Plans of District Organization
Frenchman-Cambridge Division

| Items | Five Districts | | | | | | | | | | One | | Two districts | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Culbertson Canal | | Meeker-Driftwood Canal | | McCook and Red Willow Canals | | Bartley Canal | | Cambridge and Holbrook Canals | | District | | Frenchman Valley | | Frenchman Cambridge | |
| | Acres | Pct. | Acres | Pct. | Acres | Pct. | Acres | Pct. | Acres | Pct. | Acres | Pct. | Acres | Pct. | Acres | Pct. |
| Irrigable land | | | | | | | | | | | | | | | | |
| Class 1 | 11,993 | 55 | 8,034 | 49 | 2,347 | 47 | 4,086 | 58 | 9,516 | 55 | 35,976 | 53 | 11,993 | 55 | 23,983 | 53 |
| Class 2 | 8,625 | 39 | 7,904 | 48 | 2,470 | 50 | 2,621 | 37 | 7,028 | 41 | 28,648 | 42 | 8,625 | 39 | 20,023 | 44 |
| Class 3 | 1,402 | 6 | 502 | 3 | 143 | 3 | 323 | 5 | 686 | 4 | 3,056 | 5 | 1,402 | 6 | 1,654 | 3 |
| Total | 22,020 | 100 | 16,440 | 100 | 4,960 | 100 | 7,030 | 100 | 17,230 | 100 | 67,680 | 100 | 22,020 | 100 | 45,660 | 100, |
| Payment capacity | | | | | | | | | | | | | | | | |
| Class 1 | $9.09 | | $9.09 | | $6.52 | | $6.52 | | $6.52 | | $7.95 | | $9.09 | | $7.38 | |
| Class 2 | 4.37 | | 4.64 | | 3.55 | | 3.55 | | 3.96 | | 4.20 | | 4.37 | | 4.13 | |
| Class 3 | 3.73 | | 4.57 | | 2.42 | | 2.42 | | 2.22 | | 3.33 | | 3.73 | | 2.99 | |
| Average | 6.89 | | 6.81 | | 4.92 | | 5.22 | | 5.31 | | 6.15 | | 6.89 | | 5.79 | |
| Estimated construction cost | | | | | | | | | | | | | | | | |
| Laterals | 1.33 | | 1.42 | | 1.16 | | 0.80 | | 1.39 | | 1.30 | | 1.33 | | 1.28 | |
| Drains | 1.01 | | 0.97 | | 1.11 | | 1.11 | | 1.06 | | 1.02 | | 1.01 | | 1.02 | |
| Possible contractual obligation based upon full payment capacity | | | | | | | | | | | | | | | | |
| Payment capacity | 6.89 | | 6.81 | | 4.92 | | 5.22 | | 5.31 | | 6.15 | | 6.89 | | 5.79 | |
| Operation and maintenance | 2.40 | | 2.35 | | 3.01 | | 2.75 | | 2.80 | | 2.60 | | 2.40 | | 2.65 | |
| Amortization capacity | 4.49 | | 4.46 | | 1.91 | | 2.47 | | 2.50 | | 3.55 | | 4.49 | | 3.14 | |
| Possible distribution of amortization capacity | | | | | | | | | | | | | | | | |
| Laterals | 1.33 | | 1.42 | | 1.16 | | 0.80 | | 1.39 | | 1.30 | | 1.33 | | 1.28 | |
| Water service | .20 | | .20 | | .20 | | .20 | | .20 | | .20 | | .20 | | .20 | |
| Drains | 1.01 | | .97 | | .55 | | 1.11 | | .92 | | 1.02 | | 1.01 | | 1.02 | |
| Unobligated balance | 1.95 | | 1.87 | | None | | .36 | | None | | 1.03 | | 1.95 | | .64 | |
| Total | 4.49 | | 4.46 | | 1.91 | | 2.47 | | 2.51 | | 3.55 | | 4.49 | | 3.14 | |
| Adequacy of proposed repayment | | | | | | | | | | | | | | | | |
| Cost of drainage system | $1.01 | | $0.97 | | $1.11 | | $1.11 | | $1.06 | | $1.02 | | $1.01 | | $1.02 | |
| Percentage payable | 293 | | 292 | | 50 | | 132 | | 87 | | 201 | | 293 | | 163 | |
| Possible contractual obligation based upon 80 percent of payment capacity | | | | | | | | | | | | | | | | |
| Payment capacity | $5.51 | | $5.45 | | $3.94 | | $4.18 | | $4.25 | | $4.92 | | $5.51 | | $4.63 | |
| Operation and maintenance | 2.40 | | 2.35 | | 3.01 | | 2.75 | | 2.80 | | 2.60 | | 2.40 | | 2.65 | |
| Amortization capacity | 3.11 | | 3.10 | | 0.93 | | 1.43 | | 1.45 | | 2.32 | | 3.11 | | 1.98 | |
| Possible distribution of amortization capacity | | | | | | | | | | | | | | | | |
| Laterals | 1.33 | | 1.42 | | 0.93 | | 0.80 | | 1.39 | | 1.30 | | 1.33 | | 1.28 | |
| Water service | .20 | | .20 | | None | | .20 | | .06 | | .20 | | .20 | | .20 | |
| Drains | 1.01 | | .97 | | None | | .43 | | None | | .82 | | 1.01 | | .50 | |
| Unobligated balance | .57 | | .51 | | None | | None | | None | | None | | .57 | | None | |
| Total | 3.11 | | 3.10 | | 0.93 | | 1.43 | | 1.45 | | 2.32 | | 3.11 | | 1.98 | |
| Adequacy of proposed repayment | | | | | | | | | | | | | | | | |
| Cost of drainage system | $1.01 | | $0.97 | | $1.11 | | $1.11 | | $1.06 | | $1.02 | | $1.01 | | $1.02 | |
| Percentage payable | 156 | | 153 | | None | | 39 | | None | | 80 | | 156 | | 49 | |

TABLE D. ADEQUACY OF VARIOUS REPAYMENT RATES PER ACRE

TWO PLANS OF DISTRICT ORGANIZATION, FRENCHMAN-CAMBRIDGE DIVISION

| Plan of reorganization and repayment rates | Payment capacity | Operation and Maintenance | Possible contractual obligation | | | | Cost of drains | |
|---|---|---|---|---|---|---|---|---|
| | | | Laterals | Water service | Drains | Surplus | Amount | Percent Payable |
| Recommended reorganization of existing districts | | | | | | | | |
| Frenchman Valley (22,020 acres) | | | | | | | | |
| $4.49 or 100 percent | $ 6.89 | $ 2.40 | $ 1.33 | $ 0.20 | $ 1.01 | $ 1.95 | $ 1.01 | 100 |
| 3.11 or 80 percent | 6.89 | 2.40 | 1.33 | .20 | 1.01 | .57 | 1.01 | 100 |
| 2.50 or 71 percent | 6.89 | 2.40 | 1.33 | .20 | .97 | -.04 | 1.01 | 96 |
| 1.60* or 58 percent | 6.89 | 2.40 | 1.33 | .18* | .09 | -.92 | 1.01 | 9 |
| Frenchman-Cambridge (45,660 acres) | | | | | | | | |
| $3.14 or 100 percent | 5.79 | 2.65 | 1.28 | 0.20 | 1.02 | 0.64 | 1.02 | 100 |
| 2.50 or 89 percent | 5.79 | 2.65 | 1.28 | .20 | 1.02 | None | 1.02 | 100 |
| 1.98 or 80 percent | 5.79 | 2.65 | 1.28 | .20 | .50 | -.52 | 1.02 | 49 |
| 1.60* or 73 percent | 5.79 | 2.65 | 1.28 | .18* | .14 | -.92 | 1.02 | 14 |
| Reorganization as one district (67,680 acres) | | | | | | | | |
| $3.55 or 100 percent | 6.15 | 2.60 | 1.30 | 0.20 | 1.02 | 1.03 | 1.02 | 100 |
| 2.50 or 83 percent | 6.15 | 2.60 | 1.30 | .20 | 1.00 | -.02 | 1.02 | 98 |
| 2.32 or 80 percent | 6.15 | 2.60 | 1.30 | .20 | .82 | -.20 | 1.02 | 80 |
| 1.60* or 68 percent | 6.15 | 2.60 | 1.30 | .18* | .12 | -.90 | 1.02 | 12 |

*As provided in existing contract with Frenchman-Cambridge Irrigation District, $1.42 for construction and $ .18 for water supply.

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In Reply Refer To:
737

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
Washington 25, D.C.

September 13, 1951

To: Regional Director, Denver, Colorado

From: Commissioner

Subject: Definite Plan Report on the Frenchman-Cambridge Division, Missouri River Basin Project

Reference is made to your letter of June 15, 1951, submitting the definite plan report on the Frenchman-Cambridge Division, Missouri River Basin Project to this office and recommending that the plan of development and your proposals relative to reorganization of districts and repayment contracts be approved.

The report is a well organized, comprehensive, and factual record of project investigations and plans. It recognizes that project construction, already well underway, must be completed in the best way possible, and every effort made to obtain the best repayment contract possible. Toward this end, the report and the physical plan of development proposed therein, your plan for irrigation district reorganization, and your proposals regarding repayment contracts are hereby approved. The comments of the various offices here, of the Chief Engineer, and of the Chief, Branch of Hydrology, are summarized in the following paragraphs for your information and for your consideration and guidance when the report is first revised.

The project land discussions and the agricultural economy analyses are comprehensive and thorough. However, exception is taken to the procedure of establishing economic classes, such as A, B, & C, for repayment considerations. In this instance, the basis for the regrouping of the Bureau land subclasses appears to be sufficiently justifiable. Apparently, the differentials in permissible development cost limits, established for the land classification, were inadequate for the type of economy anticipated. Experience has demonstrated, however, that it is more desirable to revise the land classification than to carry two repayment classification designations for a specific land tract. The statements on payment capacity and recommendations pertinent to contract negotiations, therefore, should be limited in terms of the basic Bureau land classes and in accordance with Table C of your June 15 letter of transmittal. Thereby, Groups A, B, and C become land classes 1, 2, and 3. The land classification should be revised in accordance with the regroupings shown in Table 13 of Appendix VIII, and supplementary statements should be appended to the report describing this action and the results.

It would be desirable, as a matter of record in the definite plan report, that the economic study for the Frenchman-Cambridge Division be revised on the basis of the proposed new price level and new procedure for evaluating benefits and costs and the increased flood control benefits to the project as a result of the recent floods in the area. You have been previously authorized to use this new procedure for benefit-cost analyses in evaluating Missouri Basin Units. In regard to the revised flood control benefits, we presume that the floods that have occurred recently in the general area and to the south warrant a restudy of flood control benefits.

Chapter 5 (Water Supply) of the report should include appropriate language to indicate that the Republican River Compact has been considered and complied with in the water supply studies. A summary of the study of the Republican River Basin, showing compliance with the Compact, should be presented and a statement or table included showing that the Frenchman-Cambridge Division could be operated with tolerable shortages if Colorado and Kansas were to utilize all their allocated waters.

The report states that more detailed studies were being made for revised estimates of sedimentation that will take place in the proposed reservoirs in the Kansas River Basin. It is stated that these studies, although not final, indicate some disagreement with the original estimates. These sediment studies should be completed as soon as possible in order that a firm estimate of the amount of space require for sediment can be made for the Enders, Swanson Lake, and Medicine Creek Reservoirs. If the studies indicate that there is an appreciable increase in the amount of storage space required for sediment, it is possible that the acreage to be irrigated in the Frenchman-Cambridge Division may need to be decreased.

In connection with the cost estimates, appropriate methods of estimating were used to determine the field cost of the various properties, exclusive of contingencies, and, in general, the unit prices are believed to be adequate. However, the allowance for contingencies for some of the properties appears to be low, especially where the estimates are based on meager data. In most cases, with the exception of the properties where the work is completed or partly completed, the contingency item is listed as 15 percent on the DC-1. The allowance for contingencies should vary from 15 percent for preliminary estimates to 25 percent for reconnaissance estimates, as recommende in the Manual, Volume X, Chapter 8.3, depending upon the amount and certainty of the data. The general allowances for investigations, engineering, and general expenses also appear to be low.

The drainage plan presented in the report comprises a preliminary estimate made with only a few days' study of very limited available data and field conditions in February 1950. Up to the time of the report, little progress had been made toward collecting and interpreting the basic data considered necessary for the development of the drainage plan for the definite plan report. This indicates that, as a result of more detailed study in this connection, there may be an increase in the project cost for drainage. Also, an examination of the project O&M cost indicates that the requirements for drain maintenance have not been fully recognized. Completion of the irrigable area surveys and studies necessary to formulate a drainage plan, which the report indicates are underway, would permit (1) the establishment of the irrigable area with the assurance of no further significant changes, (2) a reappraisal of project drainage requirements on a more rational basis, and (3) a review of cost estimates for drainage and for drain maintenance.

In the discussion of project repayment in the report, the districts' obligations include $677,000 for land drainage, which is only 36 percent of the estimated cost for drainage. This is on the basis of $1.60 per acre payment by the districts. Your letter of transmittal proposes that the districts be given the alternative of increasing the $1.60 to pay the remainder of the drainage cost or, in lieu thereof, building the drainage works needed after the drain construction cost reaches $677,000. We agree that one or the other is necessary. Whichever procedure is followed, the obligations of the district should be made very clear in the contracts. Any drainage works to be built by the districts should have prior approval by the Bureau.

It is noted that the plan for this Division does not propose any development of power. Even if power development is not included, the power potentialities should, nevertheless, be discussed. If the development of power was not considered, a statement justifying this position should be included in the report. On the other hand, if studies relating to development of power were made, the results should be summarized and included in the report.

In addition to the above comments, your attention is called to the more detailed comments of the Chief Engineer and the Chief, Hydrology Branch, and to minor discrepancies which were noted by these two offices.

/s/ Michael W. Straus

In duplicate
Copies to: Chief, Engineer, Denver, Colorado
Chief Hydrology Branch, Denver, Colorado

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In reply refer to:
204

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
DENVER FEDERAL CENTER
DENVER 2, COLORADO

August 23, 1951

To: Commissioner

From: Chief Engineer

Subject: Review of definite plan report on Frenchman-Cambridge Division Missouri River Basin Project, Nebraska, dated February 1951

Please refer to memorandum to the Washington conferees on the review of the above report from Acting Assistant Director, Branch of Project Planning, D. V. McCarthy.

Cost Estimates

The Official Estimate PF-1 revised 12-7-50 is included in Appendix I, Designs and Estimates. The total estimated cost of the division, exclusive of the Red Willow Dam and Reservoir, based on January 1950 prices, is shown as $68,457,000. The Basic Estimate DC-1 which supports the PF-1 is not included in either the report or the appendix. However, a DC-1 estimate dated April 1951, showing the total estimated cost to be $66,597,000 based on April 1951 prices, is available in this office. The two estimates are not comparable because of the wide variations in the breakdown of costs by accounts, and therefore the costs shown on the PF-1 cannot be checked with the data available. Since prices as of January 1950 and April 1951 are about the same, apparently these wide variations in account costs are due to changes in property classification and possibly design changes and more complete data.

A very good description of the various properties, including sizes of structures, capacities, specifications, extra work orders, orders for changes, data upon which estimates are based, etc., is included on the April 1951 DC-1 estimate. These show that the estimates vary from accurate estimates based on actual cost data to reconnaissance estimates based on very meager data.

Appropriate methods of estimating were used to determine the field cost of the various properties exclusive of contingencies, and in general the unit prices are believed to be adequate. However, the allowance for contingencies for some of the properties appears to be low, especially where the estimates are based on meager data. In most cases, with the exception of the properties where the work is completed or partly completed, the contingency item is listed as 15 percent on the DC-1. The allowance for contingencies should vary from 15 percent for preliminary estimates to 25 percent for reconnaissance estimates, as recommended in the Manual, Volume X, Chapter 8.3, dependent upon the amount and certainty of the data.

Where several assumptions are required in estimating a particular property or type of property, for example, a drainage system based on an estimated percentage of land requiring drainage, an estimated length of drains per acre, and an estimated cost per mile of drains, the contingency allowance should probably be even greater than 25 percent. Another example is a lateral system based on an estimated length of laterals per acre, and an estimated cost per mile. There may also be instances where contingencies are erroneously omitted in the estimate because the estimate is based on similar work that was completed without any changes of plan or other uncertainties of any kind. This is a rare possibility, but nevertheless it should be considered in estimating. The general allowances for investigations, engineering, and general expenses are also low.

Canal and Lateral System

The details of the plans for the construction work still to be done on the canals and lateral system are not given, so no comments can be made as to their adequacy.

Dams

Three storage dams are involved in the Frenchman-Cambridge Division; Enders, Medicine Creek, and Trenton. Since the designs shown in the report are specifications designs prepared by the office of the Chief Engineer, and the estimates shown are based on construction costs for Enders and Medicine Creek Dams and on contract costs for Trenton Dam, they are considered to be entirely satisfactory.

Drainage

The drainage plan presented in the report comprises a preliminary estimate made with but a few days' study of very limited available data and field conditions in February 1950. The purpose of this estimate at that time was to develop a revised project cost to present at a meeting with the Irrigation District shortly after the estimate was made. Up to the time of the report, little progress had been made toward collecting and interpreting the basic data considered necessary for the development of a drainage plan for the definite plan report. It is mentioned in the appendixes that the determination of the irrigable area has not been completed and that exploration of the substrata for drainage appraisal is only partially completed. Preliminary results of sodium and permeability tests on lands in the Cambridge Unit indicate that some 2,000 acres presently designated as irrigable may be found unsuitable for irrigation development. The results also point toward the possibility of an increase in project costs for drainage.

With respect to operation and maintenance costs for the project, the appendix lists personnel and equipment deemed necessary and presents the estimated average cost for the Division of $176,000 per year. This cost and the inclusion of only one dragline in the equipment list lead to the conclusion that the requirements for drain maintenance have not been fully recognized.

In the discussion of project repayment, the recommended obligation for the Frenchman-Cambridge District includes $677,000 for land drainage. This is only 36 percent of the estimated cost for drainage of $1,872,000. The statement is made that it is not possible to increase the repayment obligation to cover this deficit because of past contractual commitments which limit the repayment liability. The report assumes that when the need for drain construction exceed $677,000 the district will pay for such construction from its surplus payment capacity. Under the existing contract there will be only $178,000, or about 10 percent of the total estimated cost, left for drain construction if the bids coincide with the estimated costs of the lateral system.

The completion of the irrigable area surveys and the studies necessary to formulate a drainage plan would permit (1) the establishment of the irrigable area with the assurance of no further significant changes, (2) a reappraisal of project drainage requirements on a more rational basis, and (3) a review of the cost estimates for drainage operation and maintenance of the Division. The situation is not desirable because of the repayment limitation and will probably lead to a considerable loss of land because negotiation of additional contracts for drain construction will be difficult and actual construction cannot be anticipated before considerable damage is experienced. Nevertheless, under the circumstances, there does not appear to be a practical alternative to the procedure set forth in the report.

/s/ L. N. McClellan

Enclosure:
Reconciliations and Discrepancies

Copy to: Assistant to Commissioner--Engineering
Regional Director, Denver, Colorado

Definite Plan Report—Frenchman-Cambridge Division

Reconciliations and
Discrepancies

Summary Sheets

Page iii. Beverly-Riverside Canal. This is shown as Riverside on General Map.

Report

Page 5, Paragraph 4, Line 6. 47 miles. Summary sheet vii gives 49.3.

Page 9, Paragraph 5, Line 2 and Table, page 13, 92,200 acre-feet. Table, page 4, gives 92,300.

Page 13. Frenchman Unit Cost $7,703,700. Summary Sheet iii gives $7,703,500.

Page 14. Meeker Driftwood. Cost $6,173,200. Summary sheet iii gives $6,173,000.

Page 15. Cambridge. Cost $9,280,500. Summary sheet iii gives $9,280,300.

Page 15. Development Project Plan. Cost $1,806,000. SummarySheet iv gives $1,806,200.

Page 17, Paragraph 3, Line 4. Change filty to silty.

Page 46, Paragraph 2, Line 2. 2,676,400 cubic yards. Summary Sheet, page vii, says 2,000,000.

Page 49, Paragraph 1, Line 8. 165 cfs. Summary Sheet vii says 180 cfs.

Page 63, Paragraph 1, Line 10. 1.87 acre-feet. Summary Sheet, page vi, bottom table, gives 1.86.

Page 80, Paragraph 5, and table, Page 81, do not agree with the classification shown in table at top of Page v, Summary Sheets.

Page 85, Paragraph 2, Lines 2 and 3. 158 and 156 days. Page 16, last line, says 155 days.

In order to conform with the Uniform Cost Classification, the items "Fencing" and "Cattle guards" shown on the DC-1 in Account 37 under Property Class 06 should be shown in Account 33, Structures and Improvements.

KS002197

Frenchman-Cambridge Division Definite Plan Report

Missouri River Basin Project

| | | |
|---|---|---|
| Part 1 | General Plan of Development | |

Appendixes

| | | |
|---|---|---|
| Part 2 | Appendix I | Designs and Estimates |
| Part 3 | Appendix II | Water Supply |
| Part 4 | Appendix III | Flood Hydrology |
| | IV | Sediment Control |
| | V | Fish and Wildlife |
| | VI | Recreation |
| Part 5 | Appendix VII | Project Lands |
| | VIII | Agricultural Economy |
| | IX | Financial Analysis |

S U M M A R Y   S H E E T S

Frenchman-Cambridge Division, Kansas River District
Missouri River Basin Project

LOCATION: Southwestern Nebraska, on the Republican River and tributaries, extending from Enders and Trenton to 3 miles east of Orleans, Region 7.

AUTHORIZED: December 22, 1944, by Act of Congress (P. L. 534, 78th Congress, 2d Session). See Senate Document 247, 78th Congress, 2d Session, 1944.

PLAN

The Frenchman-Cambridge Division is being developed on the Republican River and 4 of its tributaries in Nebraska. Division works will regulate run-off for flood and sediment control and for irrigation of 68,570 acres, including 13,550 acres now irrigated. Enders, Trenton, Medicine Creek, and Red Willow Dams (the latter to be constructed by the Corps of Engineers) will store water for irrigation use. Lands will be served by 14 canals which will divert by gravity from the reservoirs or from 4 diversion dams. No municipalities will be furnished water and no power will be developed in the division. Repayment of distribution system costs and a token payment on other costs will be provided for by a combination water service and repayment contract in accordance with Sections 9(d) and 9(e) of the Reclamation Act of 1939. Successive 40-year repayment contracts and revenue from Missouri River Basin power sales will be required to pay remaining reimbursable costs. Water will be provided to the McLain Canal and stream pumps under the provisions of the Warren Act. Substantial annual benefits will accrue from irrigation, flood control, fish and wildlife conservation, recreation, and stream pollution abatement. Intangible benefits will arise from sediment control and from stabilization of agriculture and business in the area.

DEFINITE PLAN REPORTS

Vol. 1 . . . . . General Plan of Development for Frenchman-Cambridge Division, including Enders Dam, Trenton Dam, and Medicine Creek Dam

Vol. 2 . . . . . Bartley Canal, Red Willow Unit

Subsequent design volumes will be prepared in the order determined by construction schedules.



Rev. No. 1 2/5/52

## COSTS

| | |
|---|---|
| Total Division | $77,997,000 |
| Total Dams | $48,431,000 |

| | |
|---|---|
| Enders Dam and Reservoir | $ 8,231,000 |
| Trenton Dam and Swanson Lake | 23,654,000 |
| Red Willow Dam and Reservoir (USCE) | 9,540,000 |
| Medicine Creek Dam and Reservoir | 7,006,000 |

Frenchman Unit — Total unit. . . $7,703,500

Culbertson Diversion Dam . . . . . . . . . . . . . . . . 58,600

| Canals | Canals | Distribution System | Drainage System | |
|---|---|---|---|---|
| Culbertson | $2,548,800 | $593,300) | | |
| Beverly-Riverside | 384,100 | 118,100) | | |
| Farmers | 42,400 | 21,900) | $888,400 | |
| Culbertson Ext.) | | | | |
| Culb. Ext. Upper) | 2,611,000 | 436,900) | | |
| Culb. Ext. Lower) | | | | |
| Subtotals for unit | $5,586,300 | $1,170,200 | $888,400 | $7,644,900 |

Meeker-Driftwood Unit — Total unit. . . $6,173,000

| Canals | Canals | Distribution System | Drainage System | |
|---|---|---|---|---|
| Upper Meeker | $1,320,100) | | | |
| Driftwood | 2,579,900) | $930,700 | $637,100 | |
| Meeker Extension | 705,200) | | | |
| Subtotals for unit | $4,605,200 | $930,700 | $637,100 | $6,173,000 |

Red Willow Unit — Total unit. . . $4,603,000

Red Willow Creek Diversion Dam . . . . . . . . . . . . . . 425,300

Bartley Diversion Dam. . . . . . . . . . . . . . . . . . 359,000

| Canals | Canals | Distribution System | Drainage System | |
|---|---|---|---|---|
| McCook | $ 91,100 | $ 25,700 | $ - | |
| Red Willow | 1,250,900 | 204,300 | 193,000 | |
| Bartley | 1,518,600 | 223,800 | 311,300 | |
| Subtotals for unit | $2,860,600 | $453,800 | $504,300 | $3,818,700 |

Cambridge Unit — Total unit. . . $9,280,300

Cambridge Diversion Dam. . . . . . . . . . . . . . . . . . 550,000

Cambridge Diversion Dam Extension. . . . . . . . . . . . . 327,500

| Canals | Canals | Distribution System | Drainage System | |
|---|---|---|---|---|
| Cambridge | $6,200,700 | $943,800 | $668,500 | |
| Holbrook | 512,000 | 15,900 | 61,900 | |
| Subtotals for unit | $6,712,700 | $959,700 | $730,400 | $8,402,800 |

| | | |
|---|---|---|
| Other Costs | Subtotal Development Costs | $1,806,200 |
| Frenchman-Cambridge farm unit development . . . . . . . . | | 52,000 |
| General service equipment . . . . . . . . . . . . . . . . . . . . | | 81,300 |
| Operation and maintenance during construction . . . . . . | | 372,900 |
| Development of project plan . . . . . . . . . . . . . . . . . | | 1,300,000 |

BENEFITS AND REPAYMENT

| | Flood control | Fish and wildlife | Recreation | Irrigation 90-yr period | Total |
|---|---|---|---|---|---|
| Enders Dam & Reservoir | $181,900 | $4,000 | $22,500 | | |
| Frenchman Unit | | -100 | | $388,400 | $596,700 |
| Trenton Dam & Swanson Lake | 243,800 | 5,900 | 38,000 | | |
| Meeker-Driftwood Unit | | 3,200 | | 196,000 | 486,900 |
| Red Willow Dam & Reservoir (USCE) | 47,500 | not available | not available | | |
| Red Willow Unit | | 2,000 | | 193,000 | 242,500 |
| Medicine Creek Dam & Reservoir | 76,800 | 4,500 | 27,900 | | |
| Cambridge Unit | | a/ | | 270,600 | 379,800 |
| Subtotals | $550,000 | $19,500 | $88,400 | $1,048,000 | $1,705,900 |
| Pollution abatement benefit resulting from maintaining 50 cfs minimum flow in river at McCook | | | | | 13,600 |
| Total (rounded) | | | | | $1,720,000 |

a/ Included in Red Willow Unit benefits

Benefit-cost ratio, 90-yr. period . . . . . . . . . . .69 : 1.00

IRRIGATION REPAYMENT - 40 YEARS

| | |
|---|---|
| Frenchman Valley Irrigation District, 22,020 ac. . . . | $2,524,900 |
| Frenchman-Cambridge Irrigation District, 45,660 ac. . . | 3,021,400 |
| McLain Canal and stream pumps, 890 ac. . . . . . . . . | 35,600 |
| Total . . . . . . . . . . . . . . . . . . . . . . . . | $5,581,900 |

| | | |
|---|---|---|
| Allocation, tentative | | |
| Nonreimbursable; flood control . . . . | $19,337,000 | |
| Reimbursable; irrig., rec., f&w . . . . . . . . . . . | | 58,660,000 |
| Irrigation repayment, 1st 40 yrs. . . . . . . . . . . | | 5,582,000 |
| Balance to be repaid by successive repayment contracts and Missouri Basin power revenues . . . . . . . . . . . . . . | | $53,078,000 |

## IRRIGATION

Classification of irrigable land

| Item | Class 1 (acres) | Class 2 (acres) | Class 3 (acres) | Total (acres) |
|---|---|---|---|---|
| Frenchman Unit | 11,993 | 8,625 | 1,402 | 22,020 |
| Meeker-Driftwood Unit | 8,034 | 7,904 | 502 | 16,440 |
| Red Willow Unit | 6,433 | 5,091 | 466 | 11,990 |
| Cambridge Unit | 9,516 | 7,028 | 686 | 17,230 |
| Subtotals | 35,976 | 28,648 | 3,056 | 67,680 |
| McLain Canal & Stream Pumps | | | | 890 |
| Total | | | | 68,570 |

Present status of irrigable land

| Item | Non-irrigated (acres) | Gravity irrigated (acres) | Pump irrigated (acres) | Total (acres) |
|---|---|---|---|---|
| Frenchman Unit | 11,485 | 9,980 | 555 | 22,020 |
| Meeker-Driftwood Unit | 13,516 | 2,680 | 244 | 16,440 |
| Red Willow Unit | 11,167 | - | 823 | 11,990 |
| Cambridge Unit | 15,575 | - | 1,655 | 17,230 |
| Subtotals | 51,743 | 12,660 | 3,277 | 67,680 |
| McLain Canal & Stream Pumps | - | 180 | 710 | 890 |
| Totals | 51,743 | 12,840 | 3,987 | 68,570 |

Present distribution of irrigable land by irrigation districts

| Item | Included in Frnch.-Camb. Irr. Dist. (acres) | Included in Frnch.Valley Irr. Dist. (acres) | To be included in an Irr. Dist. (acres) | Total (acres) |
|---|---|---|---|---|
| Frenchman Unit | 3,550 | 9,450 | 9,020 | 22,020 |
| Meeker-Driftwood Unit | 6,820 | - | 9,620 | 16,440 |
| Red Willow Unit | 10,990 | - | 1,000 | 11,990 |
| Cambridge Unit | 15,630 | - | 1,600 | 17,230 |
| Subtotals | 36,990 | 9,450 | 21,240 | 67,680 |
| McLain Canal & Stream Pumps | | | | 890 |
| Total | | | | 68,570 |

Anticipated distribution of irrigable land by irrigation districts

| | Frnch. Camb. Irr. Dist. (acres) | Frnch. Valley Irr. Dist. (acres) | Warren Act Contract (acres) | Total |
|---|---|---|---|---|
| Frenchman Unit | - | 22,020 | - | 22,020 |
| Meeker-Driftwood Unit | 16,440 | - | - | 16,440 |
| Red Willow Unit | 11,990 | - | - | 11,990 |
| Cambridge Unit | 17,230 | - | - | 17,230 |
| McLain Canal & Stream Pumps | - | - | 890 | 890 |
| Total | 45,660 | 22,020 | 890 | 68,570 |

Amortization data Frenchman-Cambridge Division

| | Land Payment Capacity | | | |
|---|---|---|---|---|
| | Class A | Class B | Class C | Average |
| Payment Capacity/ac/yr | $7.67 | $3.69 | $3.35 | $6.15 |
| O&M & Replacements/ac/yr | 2.60 | 2.60 | 2.60 | 2.60 |
| Amortization Capacity/ac/yr | $5.07 | $1.09 | $ .75 | $3.55 |

Life of repayment contract (after 5-year development period) - 40 years.

Farm operating units: At present, based on acres of cropland; 125 units under 125 acres; 194 units, 125-249 acres; 83 units, 250-374 acres; 52 units, 375-499 acres; and 47 units, 500 acres and over. Anticipated, based on acres of irrigable land in existing farms; 131 units under 50 acres; 109 units, 50-99 acres; 106 units, 100-149 acres; 69 units, 150-199 acres; and 86 units, 200 acres and over.

Ownership units: At present 489 units under 160 acres of irrigable land; 110 units, 161-320 acres; and 18 units, 321 acres and over. No water to be delivered to more than 160 irrigable acres under single ownership or 320 acres in joint tenancy.

Growing season 158 days at McCook and 156 days at Cambridge.

Elevation of project area, msl 2,735 to 2,015 ft.

| | Units | | | |
|---|---|---|---|---|
| | Frenchman (feet) | Meeker-Driftwood (feet) | Red Willow (feet) | Cambridge (feet) |
| Consumptive use requirement average annual | 2.46 | 2.46 | 2.48 | 2.48 |
| Effective precipitation average annual | 1.39 | 1.43 | 1.50 | 1.54 |
| Diversion requirement average annual | 2.05 | 1.95 | 1.86 | 1.78 |

| Canals | Length (miles) | Initial Capacity (cfs) | Acres served | First water to be applied a/ | All project lands to be irrigated a/ |
|---|---|---|---|---|---|
| Culbertson | 25.8 | 405 | 10,800 | April 1955 | April 1956 |
| Beverly-Riverside | 14.8 | 60 | 2,870 | April 1956 | April 1957 |
| Farmers | 2.2 | 12 | 410 | April 1956 | April 1956 |
| Culbertson Extension | 15.5 | 180 | 1,720 | April 1955 | April 1957 |
| Culbertson Extension (Upper) | 13.2 | 78 | 3,580 | April 1955 | April 1957 |
| Culbertson Extension (Lower) | 7.2 | 42 | 2,640 | April 1955 | April 1956 |
| Upper Meeker | 19.4 | 300 | 5,210 | April 1954 | April 1955 |
| Driftwood | 17.3 | 205 | 4,620 | April 1955 | April 1956 |
| Meeker Extension b/ | | | 6,610 | April 1955 | April 1956 |
| McCook c/ | 5.3 | 18 | 600 | April 1956 | April 1957 |
| Red Willow c/ | 21.7 | 100 | 4,360 | May 1955 | May 1957 |
| Bartley | 19.8 | 130 | 7,030 | April 1954 | April 1955 |
| Cambridge | 49.3 | 325 | 15,630 | April 1951 | April 1953 |
| Holbrook | 17.0 | 36 | 1,600 | April 1958 | April 1958 |

a/ Subject to availability of appropriations due to national emergency.

b/ Includes 2 canal sections, one 5.5 miles long, initial capacity 24 second-feet and one 10.7 miles long, initial capacity 100 second-feet.

c/ Subject to construction of Red Willow Reservoir by the Corps of Engineers.

MUNICIPAL WATER — None

POWER — None

DAMS

Location

| | |
|---|---|
| Enders: | On Frenchman Creek one mile south of Enders |
| Trenton: | On Republican River 2½ miles west of Trenton |
| Red Willow: | On Red Willow Creek 10 miles north of McCook |
| Medicine Creek: | On Medicine Creek 9 miles north of Cambridge |

| | Type | Maximum structural height (ft) | Volume (cu yds) | Spillway capacity (cfs) |
|---|---|---|---|---|
| Enders | Earth-fill | 134 ± | 1,700,000 | 200,000 |
| Trenton | Earth-fill | 144 ± | 7,800,000 | 133,000 |
| Red Willow (USCE) | Earth-fill | 90 ± | — | 102,000 |
| Medicine Creek | Earth-fill | 180 ± | 2,000,000 | 97,800 |

RESERVOIRS

| | Enders | Swanson Lake | Red Willow (USCE) | Medicine Creek |
|---|---|---|---|---|
| Elevation at maximum controlled storage, msl | 3,127.0 | 2,773.0 | 2,559.0 | 2,386.2 |
| Active storage, ac-ft. Initial conditions | 66,000 | 251,900 | 48,500 | 86,300 |
| Capacity below bottom outlets ac-ft. Initial conditions | 8,500 | 4,700 | 0 | 6,000 |
| Storage allotted for 50 years of operation as follows: | | | | |
| Conservation ac-ft | 5,500 | 0 | 0 | 800 |
| Sedimentation ac-ft | 10,000 | 64,000 | 8,500 a/ | 15,000 |
| Irrigation ac-ft | 29,000 | 58,800 | 18,000 a/ | 24,200 |
| Flood control ac-ft | 30,000 | 133,800 | 22,000 | 52,300 |
| Total ac-ft | 74,500 | 256,600 | 48,500 | 92,300 |

a/ Based on Bureau of Reclamation Studies

DIVERSION DAMS

| | Culbertson | Red Willow Creek | Bartley | Cambridge |
|---|---|---|---|---|
| Type | Concrete with stoplogs and vertical lift gates | Earth dike & concrete weir over-flow section | Concrete slab on sheet piling | Concrete ogee section (weir) |
| Height above old stream bed, ft | 10 | 22 | 3 | 2 |
| Initial canal capacity, cfs | 405 | 118 | 130 | 325 |
| Design flood, cfs | - | - | - | 94,000 |

HYDROLOGY

| | Enders | Trenton | Red Willow (USCE) | Medicine Creek |
|---|---|---|---|---|
| Contributing drainage area sq mi | 820 | 4,003 | 296 | 656 |
| Annual run-off average ac-ft (1929-1947) | 60,700 | 151,000 | 19,900 | 58,500 |
| Annual run-off maximum ac-ft | 65,100 (1935) | 542,200 (1935) | 30,800 (1947) | 125,500 (1947) |
| Annual run-off minimum ac-ft | 54,500 (1939) | 74,000 (1940) | 12,700 (1939) | 37,200 (1929) |
| Peak discharge of records, cfs | 11,600 (June 1940) | 200,000 (May 1935) | 30,000 (June 1947) | 111,000 (June 1947) |
| Minimum discharge of records, cfs | 5 (March 1938) | 0 Intermit- tently | 4.2 (Sept 1943) | 6 (Jan 1938) |
| Inflow design flood, ac-ft | 300,000 vol. 84 hrs | 396,000 vol. 72 hrs | 140,000 | 300,000 vol. 72 hrs |
| Inflow design flood, peak discharge, cfs | 200,000 | 295,000 | 130,000 | 200,000 |

REMARKS

The Frenchman-Cambridge Division contains 68,570 acres classified as irrigable. The plan for ultimate development of these irrigable lands provides for contracts with 2 irrigation districts. The Frenchman-Cambridge Irrigation District, which will include the Meeker-Driftwood, Red Willow, and Cambridge Units, was organized in 1946. At present this district contains 36,990 acres; after final development it will be expanded to a total of 45,660 acres. The Frenchman Valley Irrigation District, which was originally organized in 1911, now comprises 9,450 acres. After reorganization is accomplished, the Frenchman Valley Irrigation District will include all of the 22,020 acres in the Frenchman Unit. The remaining 890 acres of the division consists of private developments which will be sold water under a Warren Act contract.

Construction of Enders Dam, Medicine Creek Dam, and Cambridge Diversion Dam is completed. The Cambridge Canal is under construction and rehabilitation of the existing Meeker Canal has been effected. Total construction costs for the Frenchman-Cambridge Division to November 30, 1950 was $25,652,000. Funds available for fiscal year 1951 are $11,895,000.

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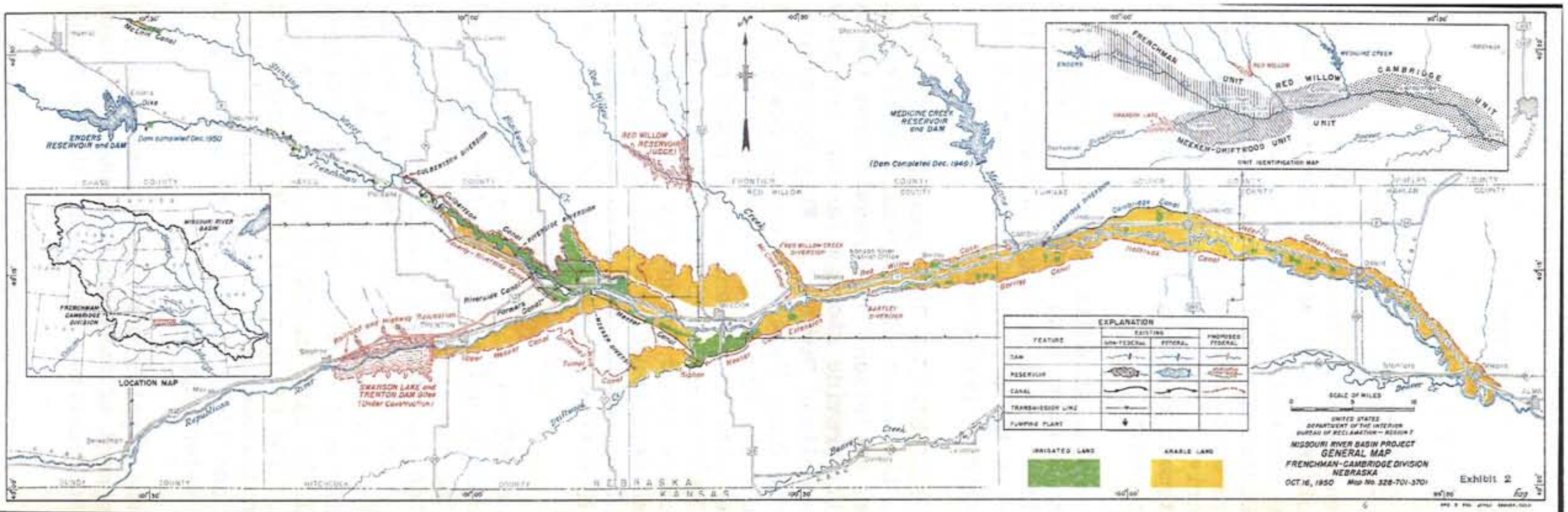
LIST OF TABLES--Continued

LIST OF TABLES--Continued

LIST OF TABLES—Continued

# LIST OF EXHIBITS

## LIST OF EXHIBITS (Continued)



ENDERS RESERVOIR and DAM
Dam completed Dec. 1950
MEDICINE CREEK RESERVOIR and DAM
(Dam Completed Dec. 1949)
RED WILLOW RESERVOIR (UDC)
SWANSON LAKE and TRENTON DAM Sites (Under Construction)
LOCATION MAP
UNIT IDENTIFICATION MAP
FRENCHMAN UNIT
RED WILLOW UNIT
CAMBRIDGE UNIT
MEEKER-DRIFTWOOD UNIT
EXPLANATION
FEATURE
EXISTING
NON-FEDERAL
FEDERAL
PROPOSED FEDERAL
DAM
RESERVOIR
CANAL
TRANSMISSION LINE
PUMPING PLANT
IRRIGATED LAND
ARABLE LAND
SCALE OF MILES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION — REGION 7
MISSOURI RIVER BASIN PROJECT
GENERAL MAP
FRENCHMAN-CAMBRIDGE DIVISION
NEBRASKA
OCT. 16, 1950 Map No. 328-701-3701
Exhibit 2
NEBRASKA
KANSAS


KS002220

# CHAPTER I

# I N T R O D U C T I O N

## Summary and Conclusions

The water supply study presented in this report shows all the anticipated operative uses of water. The study takes into consideration the future requirements for water above and below the Frenchman-Cambridge Division as well as the requirements in the division. The factors which make up the total use of water are planned irrigation, private irrigation, farm ponds, recreation, stream pollution abatement requirements, and municipal, domestic, and industrial requirements.

This water supply appendix includes a summary of the depletions to the inflow to Swanson Lake made by the Upper Republican Divison of the Republican River drainage and upstream private development and also summarizes the effect of the Frenchman-Cambridge Division development on the Bostwick Division.

The water available for development of the Frenchman-Cambridge Division is the water supply remaining after upstream development. Upstream depletions will result from the building of 4 reservoirs which will provide storage for the irrigation of 13,000 acres in the Upper Republican Division. Wray Reservoir, on the Upper Republican River, Bonny Reservoir on the South Fork of the Republican River, and Parks Reservoir on Rock Creek would have irrigation storage capacity at the end of 50 years of operation of 8,000, 33,000, and 10,000 acre-feet, respectively. Pioneer Reservoir would be built to provide flood protection. Besides the foregoing depletions for planned development, depletions totaling 800 acre-feet were made for the development of farm ponds and depletions were made for the private development of 6,700 acres in the Upper Republican Division.

Irrigation of 68,570 acres in the Frenchman-Cambridge Division would be accomplished by using water stored in 4 reservoirs. These reservoirs at the end of 50 years of operation would have the following active irrigation storage capacities: Enders Reservoir, 29,000 acre-feet; Swanson Lake, 58,800 acre-feet; Red Willow Reservoir, 18,000 acre-feet; and Medicine Creek Reservoir, 24,200 acre-feet. These reservoirs will provide sufficient storage capacity for irrigation of all the land in the division which is economically feasible to irrigate. The study shows 22,910 acres in the Frenchman Unit, 16,440 acres in the Meeker-Driftwood Unit, 11,990 acres in the Red Willow Unit, and 17,230 acres in the Cambridge Unit can be provided an adequate water supply.

The study anticipates that 1,100 acre-feet of water will be used by the development of farm ponds along Frenchman, Stinking Water, Red Willow, and Medicine Creeks, and that a total of 8,950 acres will be irrigated by private development along these creeks. Depletions of the water supply for this pond and private irrigation development were made.

Water requirements for municipal, domestic, and industrial uses were also considered. No depletions for these uses in the Frenchman-Cambridge Division were made because water for them is now obtained from wells and no important increase can be foreseen.

Stream pollution abatement has been studied by the Public Health Service and they have recommended minimum flows at critical points along the river. An analysis of stream-flow conditions after the proposed development shows that there will be sufficient water in the river at the critical points to meet these minimum flow recommendations, except during August 1931, August, September, and October 1943, and October 1944. Releases were made from Medicine Creek Reservoir to meet these Public Health requirements.

After depletions to the water supply for the development of the Frenchman-Cambridge Division were made another study was made to show the amount of water that will be needed for the development of the downstream areas. This study shows that there is a water supply for the development of downstream areas after all planned upstream development takes place. The downstream depletions will be reported in detail at a later date.

Stream-flow historical records are not available at all stations for the entire period of study and it was necessary to estimate flows at several stations by correlating with existing records at nearby stations. The accuracy of historical flow records is considered to be good to fair, depending upon the type of station, except for periods of ice effect when all records are considered to be poor. The stream-flow estimates are all considered to be reasonable.

This proposed plan does not contemplate pumping from the ground water for any planned development. It is anticipated, however, that some of the proposed private developments will be accomplished by developing wells. An observation program of the ground-water table is being initiated by the Geological Survey by establishing observation wells. This program will make it possible to note any changes in the ground-water table due to irrigation and will enable early detection of problem areas resulting from poor drainage.

All surface water which has been analyzed for mineral constituents are "excellent" for irrigation. Wells generally provide excellent irrigation water although some of them have water with a slightly high total salt content which makes it necessary to rate them as providing only "good" irrigation water.

Introduction

All water requirements are based upon the Lowry-Johnson method for determining consumptive use. The weather records used in making the study are available at stations in or near the area for which water requirements were determined.

In general it is anticipated that owners of water rights along the Republican River will choose to obtain water from the surface distribution provided by the Frenchman-Cambridge Irrigation District rather than exercise their water rights and continue pumping from the river. A water supply for the land irrigated under these rights has been provided because these lands are included in the acreage for which water supplies have been determined.

Water rights in the Frenchman-Cambridge Division for the use of natural flow and stored water are senior to any downstream rights except for the storage right in Harlan County Reservoir, which is senior to the Swanson Lake and Red Willow Reservoirs.

This study is based upon the supposition that the owners of lands under the present Meeker Canal and the Culbertson Canal will choose to receive a water supply from the Bureau of Reclamation and will sign a contract for delivery of water.

The owners of lands under the Culbertson Canal are in the Frenchman Valley Irrigation District. If they should sign a contract for purchasing supplemental water only, and do not choose to sign a contract for rehabilitation of their canal, the problem of serving the McCook tablelands will be materially increased because it is proposed to serve this area by extending the Culbertson Canal.

Monthly operation studies for each of the 4 reservoirs were made using the water available to the division after upstream depletions due to future development. These studies were made using the stream flow and weather conditions that existed during the period 1929 through 1947. This period was used because it contains the period 1931 through 1940 which is the longest known period of sustained drought. It is shown that there is an adequate water supply to meet demands that would be made during such a period.

The studies were made with each reservoir storing all the water flowing into it and allowing water to spill only when the reservoir was full. Return flows entering the stream from irrigated lands were rediverted in the operation studies at the first downstream diversion dam and were effective in materially reducing the storage requirements from reservoirs. During the winter season they contributed to the stream flow and to the inflow of downstream reservoirs.

An analysis of shortages in the water supply studies was made to show the effect of enforcing priority of storage and it is shown that it would have been necessary to pass water downstream only once during the period of study, if priority rights were enforced. The amount of water that could have been demanded by downstream reservoirs would not have been enough to cause intolerable shortages on the upstream lands. The use of storage water is based upon the concept that storage water can be administered to supplement natural flow so that all areas proposed for development will share the water supply.

The operation studies presented herein show there is sufficient water to develop all irrigable lands in the Frenchman-Cambridge Division. An analysis of priority administration shows the junior priorities of Swanson Lake and Red Willow Reservoirs will not prohibit the development of lands served by them.

Recent sedimentation studies indicate that more sediment will be deposited in Medicine Creek Reservoir than was provided for as a result of original estimates. The studies also show that less sediment will be deposited in Enders Reservoir and Swanson Lake than originally estimated. The additional storage space in these two reservoirs which are upstream from the Cambridge Unit lands will be used to offset the reduction in space due to the accumulation of sediment in Medicine Creek Reservoir. The maximum use of the reservoirs will be accomplished by construction at the earliest date of the proposed canal systems.

## General Plan for Development of Frenchman-Cambridge Division

This report provides the water supply information for the general plan of development for the Frenchman-Cambridge Division and gives definite plan water supply data for Enders and Medicine Creek Reservoirs and Swanson Lake. A definite plan of operation of these reservoirs must necessarily include detailed analysis of water requirements for all of the irrigation systems involved. In addition it has been necessary to provide complete information of the Red Willow Unit in order to determine the water from the Republican River divertable at the Cambridge Diversion Dam.

Although the definite plan reports for the canal systems, served from these reservoirs, are not scheduled until later dates, definite plan water supply data is included in this report for these canal systems and the lands which are served. If there is no subsequent change in plan, the water supply data for these canal systems so included, will not be resubmitted, but reference will be made to this report and additional supplemental data will be transmitted.

The proposed plan for the irrigation development of the Frenchman-Cambridge Division is a plan for the development of the portion of the Republican River drainage basin west of Harlan County Reservoir and east of Swanson Lake and Enders Reservoirs. This area is outlined on the Kansas River Basin map, exhibit 1. The existing development and the proposed development are outlined on the division map, exhibit 2.

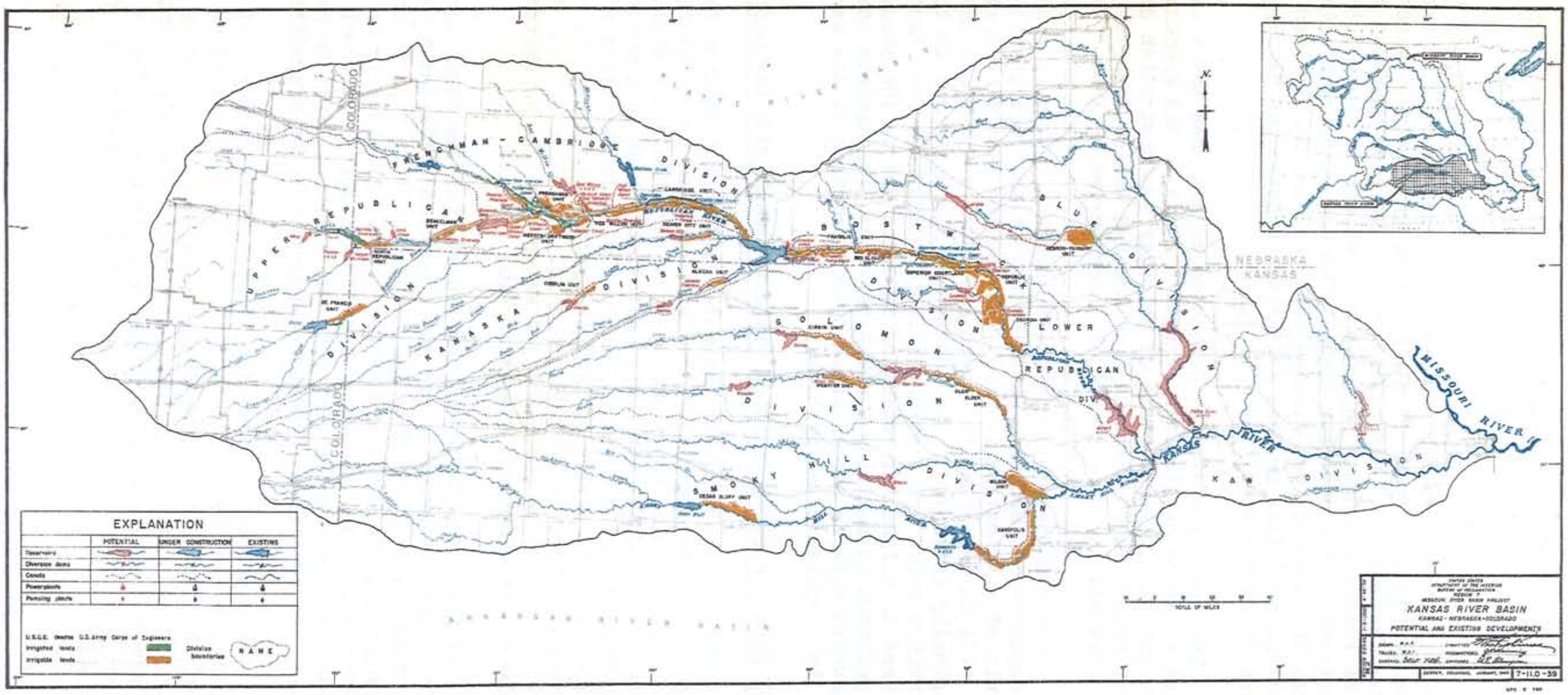
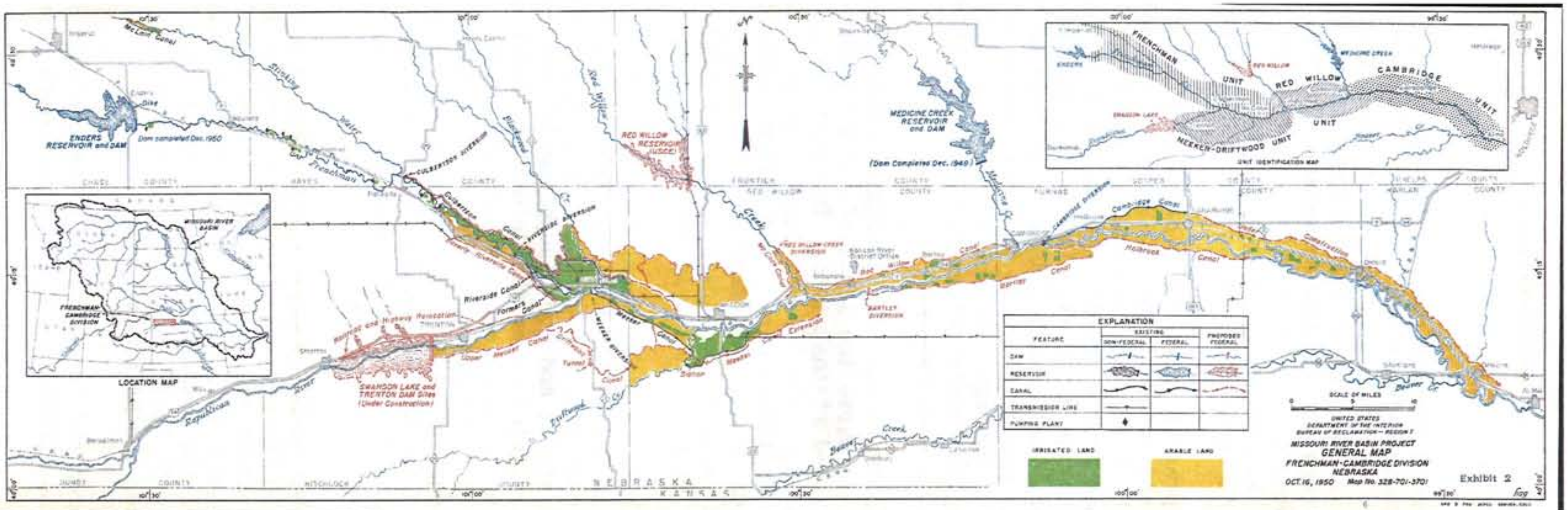





Exhibit 1

KS002225



ENDERS RESERVOIR and DAM
Dam completed Dec. 1950
MEDICINE CREEK RESERVOIR and DAM
(Dam Completed Dec. 1949)
RED WILLOW RESERVOIR (UDCE)
SWANSON LAKE and TRENTON DAM Sites (Under Construction)
LOCATION MAP
FRENCHMAN-CAMBRIDGE DIVISION
MISSOURI RIVER BASIN
FRENCHMAN UNIT
RED WILLOW UNIT
CAMBRIDGE UNIT
MEEKER-DRIFTWOOD UNIT
UNIT IDENTIFICATION MAP
EXPLANATION
FEATURE
EXISTING
NON-FEDERAL
FEDERAL
PROPOSED FEDERAL
DAM
RESERVOIR
CANAL
TRANSMISSION LINE
PUMPING PLANT
IRRIGATED LAND
ARABLE LAND
SCALE OF MILES
0
5
10
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION — REGION 7
MISSOURI RIVER BASIN PROJECT
GENERAL MAP
FRENCHMAN-CAMBRIDGE DIVISION
NEBRASKA
OCT. 16, 1950 Map No. 328-701-3701
Exhibit 2
NEBRASKA
KANSAS


KS002226

## Introduction

Four reservoirs are planned for the development of irrigation in the Frenchman-Cambridge Division. These would be multiple-purpose reservoirs and will provide recreational facilities and flood control benefits in addition to irrigation storage. The 4 reservoirs would provide storage for 130,000 acre-feet of irrigation water, which would be adequate for irrigation of the 68,570 irrigable acres in the division. No production of power from these reservoirs is planned, because it is not considered economically feasible.

At the present time, there are 15,937 acres being irrigated in the division, and an additional 3,105 acres are not in the district which are or can be irrigated from wells. There are 12,660 acres which are irrigated from a gravity system and 3,277 acres now irrigated from wells in the district. Due to the low flow of the streams in the late summer, the irrigated land is in need of a supplemental water supply. Any new development in the division is dependent upon the construction of storage reservoirs to make available, during the irrigation season, the winter flows and flood runoff that is normally lost.

The Frenchman-Cambridge Irrigation District was organized on April 8, 1946, to serve the lands of the Frenchman-Cambridge Division as it existed at that time. The district as organized includes the land under the Farmers Canal, Riverside Canal, Meeker Canal, Red Willow Northside Canal, Red Willow Southside Canal and Cambridge Northside Canal, amounting to about 41,000 acres. This district signed a repayment contract on May 29, 1947, with the United States, to supply water to these lands.

The original plan of development for this district provided for storage only in Enders and Medicine Creek Reservoirs, since there was an adequate water supply from these sources for the 41,000 acres included in the district and for a supplemental water supply to the lands now being irrigated under the Culbertson Canal and the 890 acres served by stream pumps and a stream diversion. Subsequent to the formation of this Irrigation District, the construction of the Trenton Dam has been initiated under an emergency flood control appropriation, and the Red Willow Dam has been added to the plan of development allowing for the development of a larger area to be irrigated, totaling 68,570 acres.

Lands that would be served under the present plan, that are not included in the present Frenchman-Cambridge Irrigation District, include lands now served by the Culbertson Canal in the Frenchman Irrigation Districts and new lands that would be served under extension of the present Culbertson Canal, new lands under the Beverly-Riverside Canal, new lands in Meeker-Driftwood Unit, and new lands under the Holbrook Canal.

It is proposed to negotiate a new contract with the Frenchman-Cambridge Irrigation District and exchange Enders storage water for

Swanson Lake storage water so that the area under the Culbertson Canal could be served. Under the present plan Enders Dam would serve the Frenchman Creek Unit outlined in exhibits 1 and 2. For simplicity in operational problems, it has been proposed to incorporate all the land in the Frenchman-Cambridge Division into one irrigation district. Because the Frenchman Valley Irrigation District may not wish to lose its identity, one alternate plan has been proposed. Under this plan, the land now in the Frenchman-Cambridge Irrigation District under the Riverside and Farmers Canals and the land west of McCook and east of the Red Willow-Hitchcock County line would be withdrawn from the district. This land along with the land under the Culbertson Canal Extension and land under the Beverly Canal could then be added to the Frenchman Valley Irrigation District and could then be served from Enders Reservoir as one unit.

Three of the dams (Enders, Trenton, and Medicine Creek) are being constructed by the Bureau of Reclamation. Medicine Creek Dam was completed in December 1949, Enders in October 1950 and Trenton Dam, which is now under construction is scheduled for completion in January 1954. It is planned that the Corps of Engineers will construct Red Willow Dam. Construction of these dams was authorized by Public Law 534, 78th Congress, as units included in the Missouri River Basin Project. The plan of development outlined in Senate Document No. 191, was revised by Senate Document No. 247 as a coordinated plan of the Corps of Engineers and the Bureau of Reclamation.

The water supply for the development of irrigation in the Frenchman-Cambridge Division will be water stored in Swanson Lake, Enders, Red Willow and Medicine Creek Reservoirs and sectional accretions in stream flow between the storage reservoirs and the diversion dams including return flows from irrigated lands. The distribution of stored waters as assumed in the studies can be accomplished if the Federal Government will retain control of the water stored in reservoirs built, or to be built with federal funds for irrigation purposes, to the extent that such storage water can be administered to supplement natural flow so that all areas proposed for development in the Republican Basin will share the available water supply.

Exhibit 3 is a bar graph showing the available stream-flow records that have been used in this study. Table 1 lists all stream-flow stations in the division and adjoining drainage areas where records were used in this study. The period of record, type of gage, source of data and average flow are shown for each station.

Exhibit 4 is a map showing the location of all gaging stations listed in table 1.

Exhibit 5 presents graphs of historical precipitation over the different units in the Frenchman-Cambridge Division. The graph for

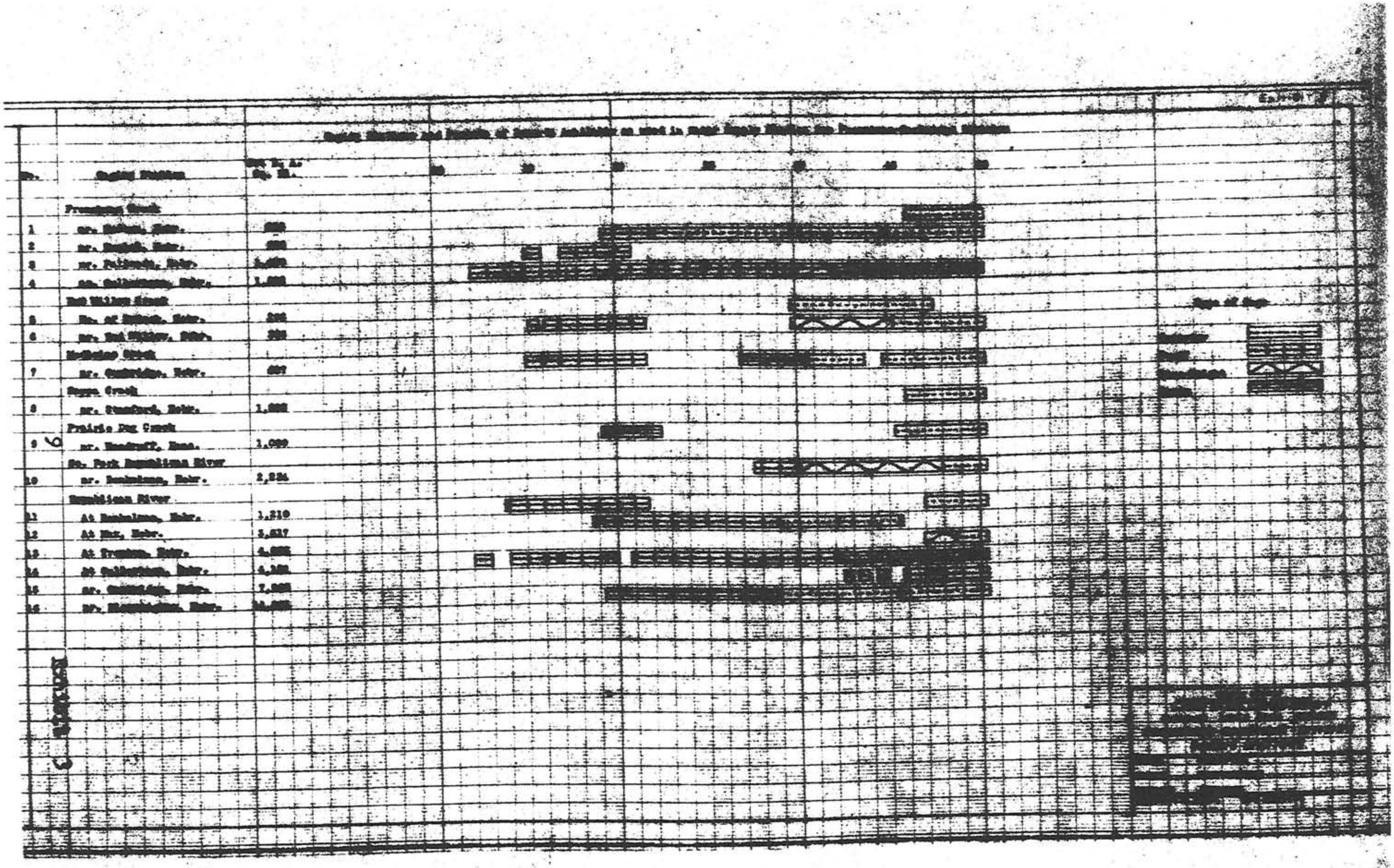
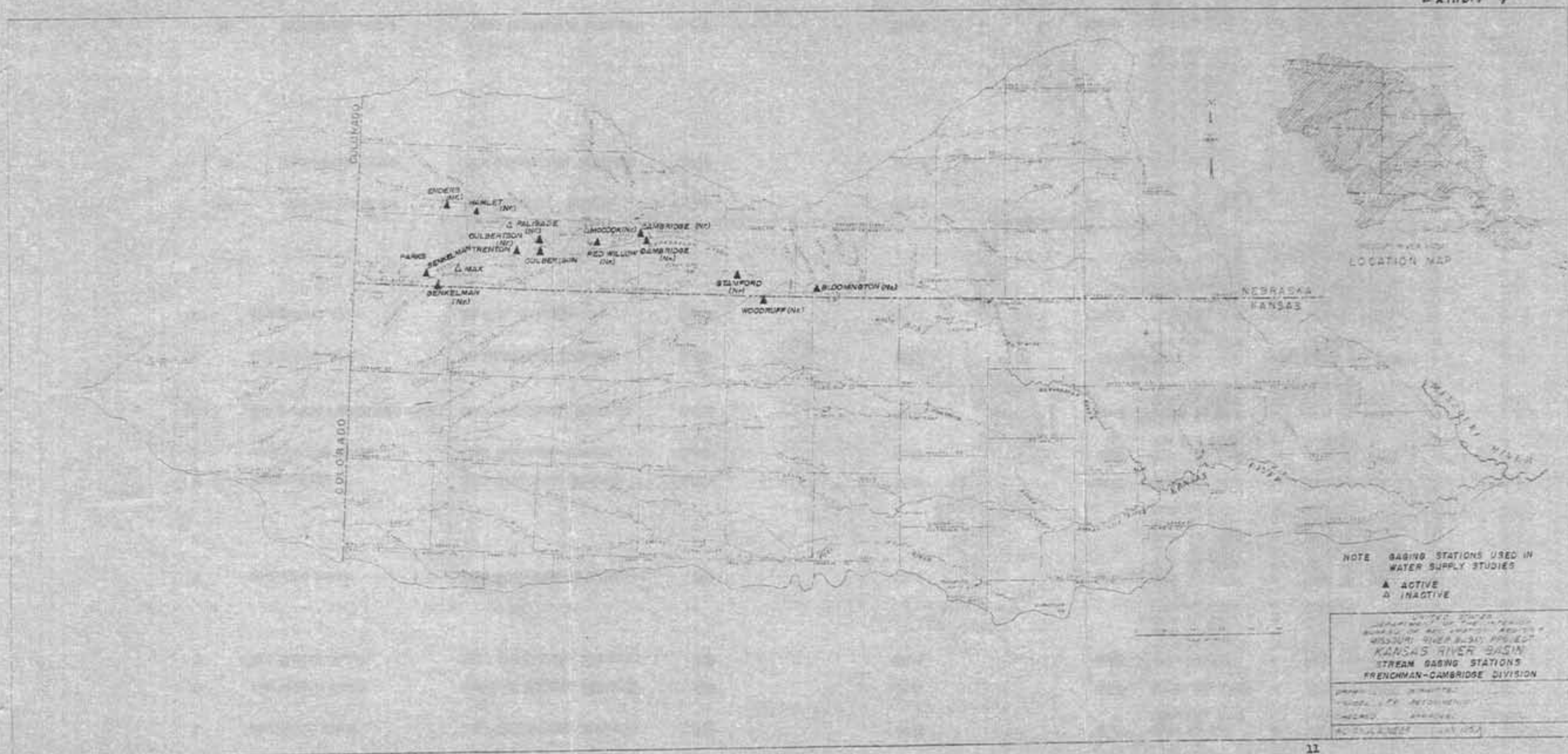

Sappa Creek
Prairie Dog Creek
1,099
2,224
1,210

Table 1



KS002230

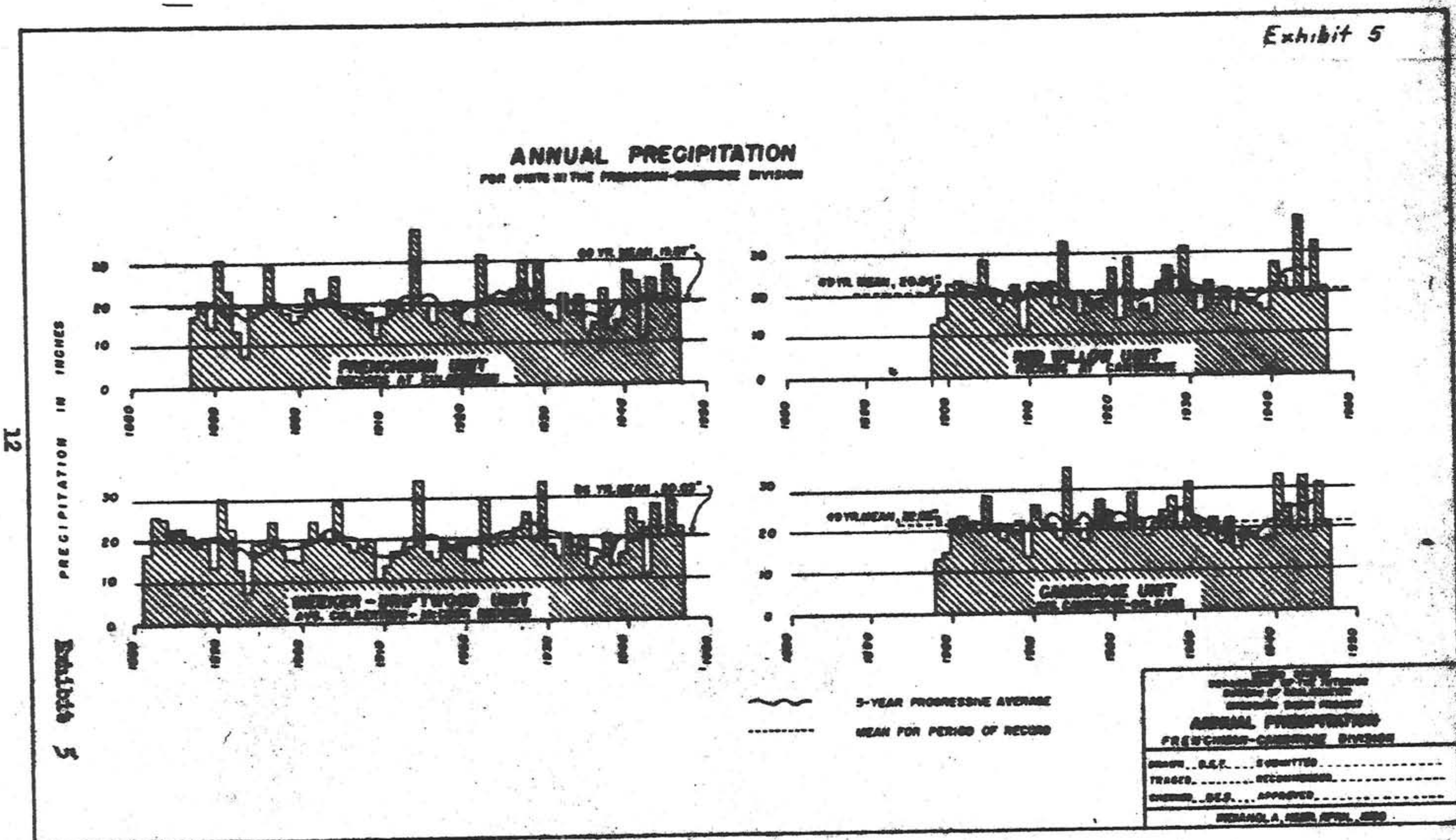
EXHIBIT 4






KS002231

Exhibit 5






KS002232

the Meeker-Driftwood Unit is fairly representative of the area and is the mean of records for McCook and Culbertson. Using the data for the Meeker-Driftwood Unit, it is interesting to note that the occurrence of droughts has been fairly frequent during the period of record, 1882-1947. The average annual precipitation for this period was 20.03 inches. Some periods of sustained drought, when the total annual precipitation remained less than 20.03 inches, and the respective totals of annual precipitation for the drought periods are as follows:

| | |
|---|---|
| 1893-96 (4 years) | 14.91 inches |
| 1898-1901 (4 years) | 17.00 inches |
| 1906-14 (9 years) | 17.04 inches |
| 1916-22 (7 years) | 16.93 inches |
| 1931-40 (10 years) | 17.20 inches 1/ |

The Bureau of Reclamation has filed with the state of Nebraska for appropriation rights to water stored in Enders and Medicine Creek Reservoirs for irrigation. These filings include space in the reservoirs for sediment and dead storage. At this date, no filings have yet been made for appropriation rights for water to be stored in Red Willow and Swanson Lake Reservoirs. A filing for the right to construct Trenton Dam was made with the Nebraska Department of Roads and Irrigation on November 19, 1949. The dates of filing and storage rights applied for Enders and Medicine Creek Reservoirs are as follows:

| Reservoir | Storage | Priority Date |
|---|---|---|
| Enders | 44,079 ac-ft | May 1, 1946 |
| Medicine Creek | 40,000 ac-ft | May 1, 1946 |

The reservoirs are so located that it would be physically possible to serve more than one unit with storage water from each of the 3 upper reservoirs in Nebraska, Enders, Swanson Lake, and Red Willow, but the plan of development presented herein, which is based on the available river flow record for the 19-year period of study (1929-1947) indicates that it would not be necessary to release stored water from more than one reservoir to serve any unit.

It should be noted that the appropriation for the storage of water in Harlan County Reservoir has a priority date of January 26, 1948, which is junior to the Medicine Creek and Enders Reservoir appropriations but senior to that of the Red Willow and Swanson Lake Reservoirs. The Republican basin studies indicate that the Frenchman-Cambridge development will not adversely affect the proposed development

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1/ Includes the 3 years of 1933, 1935, and 1938, which were slightly above average.

of the downstream Bostwick Division which will be served from Harlan County and Lovewell Reservoirs.

The 10-year period of 1931 through 1940 is considered to be the most critical and is included in the period of operation studies (1929-47). It is very probable that droughts in the 1893 through 1901 period would have been alleviated by carry-over reservoir storage from the wet years of 1891 and 1897. The wet year of 1905 would have provided storage water for the dry period of 1906-14, the records indicate the reservoirs would have spilled in 1915, one of the wettest years on record, thus providing carry-over reservoir storage for the dry years of 1916 through 1922.

It is apparent from exhibit 5 that the wet period of 1927 through 1930, having an average annual precipitation of 25.66 inches, would have provided enough run-off to fill the storage reservoirs. Trial river and reservoir operation studies indicate that all of the reservoirs would have spilled, or very nearly spilled, in 1928 and 1930. For this reason, all of the reservoirs were assumed full at the beginning of the operation studies.

The irrigation storage that will be available in the reservoirs after 50 years of operation has been used in this study. A separate appendix is being prepared and will be submitted at a later date to show the effect of sediment deposition on the reservoir content.

## CHAPTER II

## F R E N C H M A N   U N I T

### General Plan for Development

Under the proposed plan for development of the Frenchman Unit an adequate water supply would be provided by the storage in Enders Reservoir to furnish a needed supplemental supply to all land now irrigated in the unit and to irrigate all the remaining irrigable land in the Frenchman Valley. There is a possibility that a considerable area above Palisade will be developed by private means. The stream flow above Enders Dam was depleted by a quantity large enough to irrigate an additional 4,850 acres, and the accretion of stream flow between Enders Dam and Palisade was decreased enough to irrigate an additional 1,750 acres. This 1,750 acres would be located along Frenchman Creek and along Stinking Water Creek. Releases were made from Enders Reservoir sufficient to furnish a supplemental water supply for 890 acres between Enders Dam and Palisade, Nebraska, that are now irrigated by pumps and stream diversion.

The Culbertson Diversion Dam at Palisade, Nebraska, would be rebuilt and the entire area in the unit would be served by diversions from this dam. Two main canals would serve the area, see exhibit 2. The Culbertson Canal would be reconstructed to a capacity of 405 second-feet and have a total length of approximately 64 miles. This would include the area now served by the Culbertson Canal, the area under the proposed extension of the Culbertson Canal, and the area under the Farmers Canal. The area on the south side of the creek would be served by the Beverly-Riverside Canal which would divert water from the Culbertson Canal at a point approximately 3 miles below the Culbertson Diversion Dam, crossing Frenchman Creek through a siphon. Diversion works serving the present Beverly-Riverside and Farmers Canals would be abandoned.

Construction of Enders Dam was commenced on March 11, 1947. The closure of the dam was made October 24, 1950.

### Reservoir capacities

Enders Reservoir is designed with sufficient capacity to provide adequate space for the accumulation of sediment. It is estimated that 10,000 acre-feet of storage space is required. This amount was based on studies for small reservoirs with consideration for the size and use of the reservoirs studied and also the estimated sediment load of the Republican River.

The distribution of the amount of sediment estimated to be deposited in Enders Reservoir in 50 years was based on studies of actual sediment distribution in other Bureau of Reclamation reservoirs, adjusted to conform to the topography of Enders Reservoir. For a 100-year period the storage space required for sediment was estimated to be double that of a 50-year period.

Table 2.--Enders Reservoir storage capacity allocations

acre-feet

| | Initial conditions (no sediment) | | 50-year conditions (10,000 ac-ft sediment) | | 100-year conditions (20,000 ac-ft sediment) | |
|---|---|---|---|---|---|---|
| | accum. | alloc. | accum. | alloc. | accum. | alloc. |
| | 0 | | 0 | | 0 | |
| Dead storage | | 8,500 | | 5,500 | | 2,500 |
| Lip of irrig. outlet elev. 3080.0 feet | 8,500 | | 5,500 | | 2,500 | |
| Active irrig. storage | | 36,000 | | 29,000 | | 22,000 |
| Top of irrig. pool elev. 3112.3 feet | 44,500 | | 34,500 | | 24,500 | |
| Flood control storage | | 30,000 | | 30,000 | | 30,000 |
| Top of flood control pool elev. 3127.0 | 74,500 | | 64,500 | | 54,500 | |
| Total storage | | 74,500 | | 64,500 | | 54,500 |

Operation studies were based on conditions estimated to exist in the reservoir at the end of 50 years. The irrigation storage available at that time will be 29,000 acre-feet. Some water can reasonably be expected to be stored in the reservoir area as bank storage. The effect of bank storage would be to increase the storage capacity of the reservoir. This increased storage that might be claimed due to the bank storage has not been used in this study because the quantity and rate of inflow and outflow from the bank has not been established.

Sediment studies now in progress indicate that the estimated requirement of 10,000 acre-feet for sedimentation in 50 years used in this study may be reduced to about 2,000 acre-feet. Using the latter figure in this study would not change materially the present plan. Detailed sediment studies will appear in the Sediment Appendix.

Areas served

The present proposal requires that the Culbertson Diversion Dam near Palisade, Nebraska, be rehabilitated and used to divert water from Frenchman Creek to the Culbertson Canal which will serve 22,020 irrigable acres in the Frenchman Unit. Depletions have also been made to give a supplemental supply to 890 acres under the McClain Canal and stream pumps. The water released from Enders Dam and the gain in flow for Frenchman Creek, which will include the flow of Stinking Water Creek, will be diverted by the Culbertson Diversion Dam.

## Frenchman Unit

The existing Culbertson Canal will be enlarged and extended and will deliver water to the present Farmers Canal and to the Beverly-Riverside Canal. New land that will be served includes 1,350 acres in the presently irrigated area, 7,940 acres under the extension of the Culbertson Canal, 410 acres under the Farmers Canal and 2,340 acres under the Beverly-Riverside Canal. The Farmers Canal which at one time served 270 acres will be reconstructed to irrigate 410 acres. The old Farmers Canal head gate will be abandoned and the canal will be served with water through a lateral from the Culbertson Canal. An area of 2,870 acres will be irrigated from the Culbertson Canal on the south side of Frenchman Creek through the Beverly-Riverside Canal which will divert from the Culbertson Canal about 3 miles below the head gate. The canal will cross the creek in a siphon about 3 miles below the Culbertson Diversion Dam. The acreage under the Beverly-Riverside Canal includes 530 acres of land now irrigated under the Riverside Canal. The existing Riverside Diversion Dam will be abandoned.

The area to be served under the Beverly-Riverside Canal and the Farmers Canal was determined from the detailed land classification survey. The acreage to be served under the Culbertson Canal was obtained from a semidetailed land classification. A revision of these figures may be necessary after the soil survey is checked against topographic maps. The area under the Culbertson Canal extension and the stream pumps was determined by a reconnaissance land classification survey.

Table 3.--Project areas under each canal in the Frenchman Unit

| | Acres for irrigation in project | | |
|---|---|---|---|
| Canals | Presently irrigated | New lands | Total |
| Culbertson Canal | 9,450 | 1,350 | 10,800 |
| Beverly-Riverside Canal, gravity | 530 | 1,785 | 2,315 |
| " " ", wells | 555 | 0 | 555 |
| Farmers Canal | 0 | 410 | 410 |
| Culbertson Canal Extension | 0 | 7,940 | 7,940 |
| Stream Pumps | 890a/ | 0 | 890 |
| Total | 11,425 | 11,485 | 22,910 |

a/ Includes 180 acres under McClain Canal on Stinking Water Creek. The entire 890 acres are to receive storage benefits only.

### Water Resources

Frenchman Creek heads in Logan and Phillips Counties in eastern Colorado and flows southeastward, joining the Republican River at Culbertson, Nebraska. Frenchman Creek and its principal tributary, Stinking Water Creek, drain an area, a considerable portion of which is sand hills and therefore they have a very uniform flow throughout the year.

## Frenchman Unit

### Available stream-flow records

Historical records of the flow of Frenchman Creek at Enders, Hamlet, Palisade, and Culbertson were used to determine the available flow at required points. The period of record, average flow, type of gage, source of data, and the contributing drainage area for these stations are shown in table 2. Culbertson is the only station in the unit where historical records of the Frenchman Creek flow are complete for the entire period of study. The Palisade records are considered to be only fair. All other records used are considered to be good except for periods of ice effect when they are considered poor. The period of record at these stations is shown graphically in exhibit 3.

### Stream-flow correlations and estimates

Historical stream-flow records at all pertinent locations are not available for the entire periods of study, namely 1929 through 1947. The use of correlations with available records at other stations was necessary in order to complete the records for use in the operation studies.

Concurrent historical records of Frenchman Creek near Enders, Nebraska, were correlated with records near Hamlet, exhibit 6, and the missing Enders' records were supplied by entering the curve with the known runoff at the gage near Hamlet. Table 4 presents the historical and estimated runoff of Frenchman Creek near Enders (at Enders Dam Site) for the period of study.

Historical flow records of Frenchman Creek near Hamlet, Nebraska, for the period of study are complete with the exception of the October 1928 through April 1929. These months were estimated from a correlation curve, exhibit 7, on which concurrent historical records near Hamlet were plotted against historical records at Culbertson. Table 5 presents the monthly historical runoff of Frenchman Creek near Hamlet, Nebraska.

Exhibit 8 presents a curve resulting from plotting concurrent historical records of Frenchman Creek near Palisade with records at Culbertson. Using this curve and the historical records of the flow at Culbertson, the missing flow for the period January 1931 through September 1947 was estimated, see table 6.

Historical records for the period of study of Frenchman Creek runoff at Culbertson are shown in table 7.

### Ground water

Since 1934 a program supported by the University of Nebraska, the Nebraska Department of Roads and Irrigation, and the United States Geological Survey has been conducted to provide for periodic measurements of the depth of water in observation wells in the valleys of

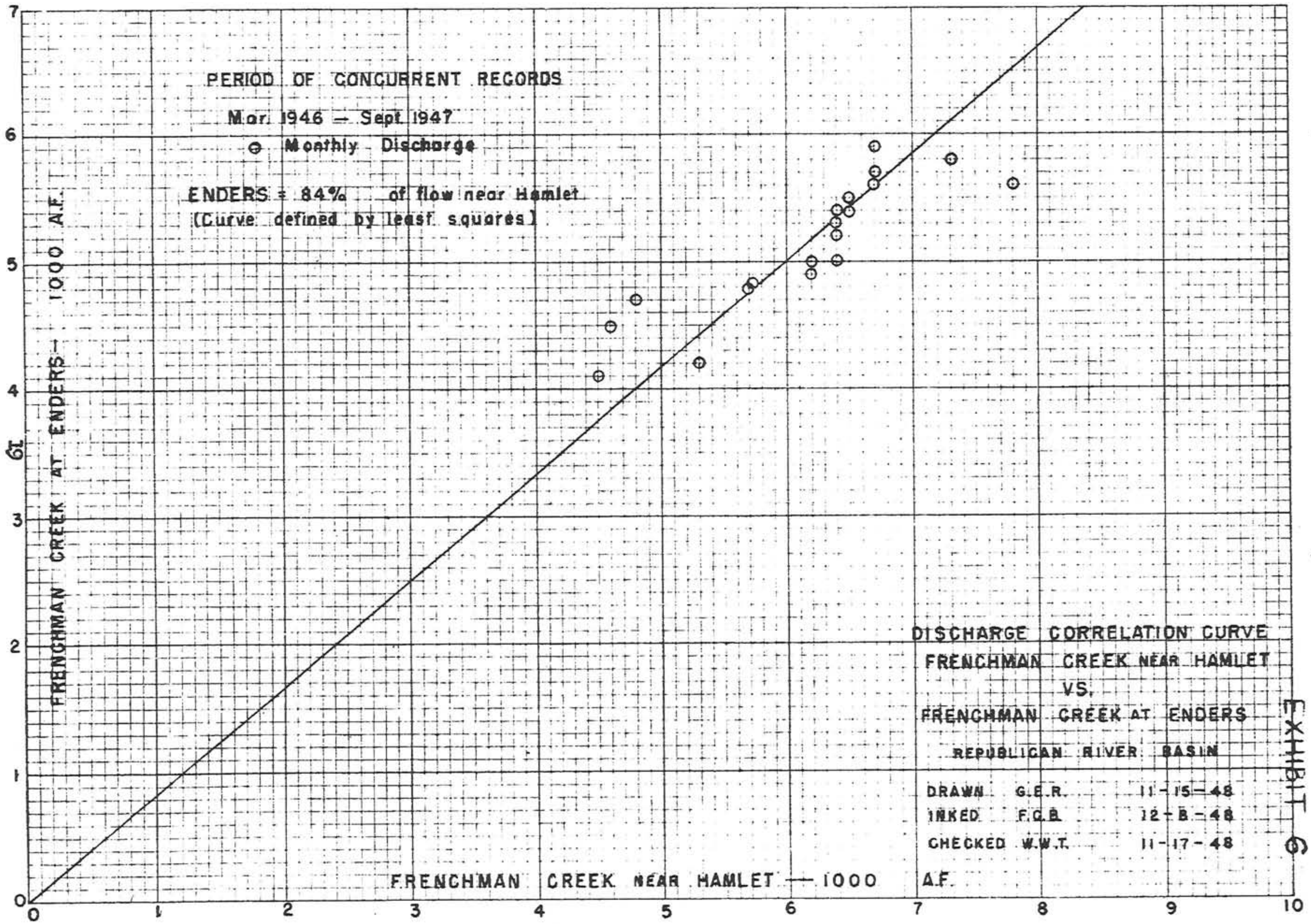

PERIOD OF CONCURRENT RECORDS
Mar. 1946 — Sept. 1947
Monthly Discharge
ENDERS = 84% of flow near Hamlet
(Curve defined by least squares)
FRENCHMAN CREEK AT ENDERS — 1000 A.F.
FRENCHMAN CREEK NEAR HAMLET — 1000 A.F.
DISCHARGE CORRELATION CURVE
FRENCHMAN CREEK NEAR HAMLET
VS.
FRENCHMAN CREEK AT ENDERS
REPUBLICAN RIVER BASIN
DRAWN G.E.R. 11-15-48
INKED F.C.B. 12-8-48
CHECKED W.W.T. 11-17-48
0
1
2
3
4
5
6
7
8
9
10
EXHIBIT 6

Table 4. Historical Run-off of Frenchman Creek at Enders Dam. 1/

(Discharge in 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 5.0 | 5.2 | 5.3 | 5.1 | 5.2 | 5.4 | 5.4 | 5.4 | 5.4 | 4.2 | 4.1 | 4.5 | 60.2 |
| 1930 | 4.7 | 4.7 | 4.4 | 4.1 | 4.8 | 4.9 | 4.8 | 5.3 | 5.1 | 4.7 | 4.5 | 4.1 | 56.1 |
| 1931 | 4.9 | 4.4 | 5.3 | 5.5 | 5.4 | 5.6 | 5.6 | 5.0 | 4.7 | 4.2 | 5.9 | 4.3 | 60.8 |
| 1932 | 4.7 | 4.7 | 4.9 | 5.4 | 5.8 | 5.4 | 4.9 | 4.8 | 5.4 | 4.7 | 5.0 | 4.3 | 60.0 |
| 1933 | 5.1 | 5.1 | 4.8 | 5.8 | 5.2 | 5.3 | 5.1 | 5.3 | 4.2 | 4.4 | 5.3 | 5.7 | 61.3 |
| 1934 | 5.1 | 5.2 | 5.5 | 5.6 | 5.2 | 6.3 | 5.1 | 4.6 | 6.0 | 4.1 | 4.4 | 4.7 | 61.8 |
| 1935 | 4.9 | 5.5 | 5.3 | 5.3 | 4.8 | 5.5 | 5.3 | 7.9 | 7.5 | 4.4 | 4.2 | 4.5 | 65.1 |
| 1936 | 4.7 | 5.2 | 5.3 | 5.6 | 5.5 | 5.8 | 5.6 | 6.3 | 4.8 | 3.9 | 4.2 | 4.5 | 61.4 |
| 1937 | 4.3 | 4.5 | 4.8 | 4.5 | 5.1 | 5.4 | 4.4 | 4.7 | 5.8 | 4.7 | 4.3 | 4.2 | 56.7 |
| 1938 | 4.4 | 4.5 | 4.8 | 4.9 | 4.7 | 4.9 | 4.9 | 5.0 | 6.2 | 5.3 | 4.1 | 5.0 | 58.7 |
| 1939 | 4.3 | 4.6 | 4.5 | 5.0 | 4.4 | 4.9 | 4.8 | 4.2 | 5.3 | 4.2 | 4.2 | 4.1 | 54.5 |
| 1940 | 4.3 | 4.3 | 4.4 | 4.3 | 5.0 | 5.2 | 4.5 | 4.2 | 12.7 | 5.2 | 4.8 | 4.6 | 63.5 |
| 1941 | 4.7 | 4.6 | 5.3 | 5.4 | 5.1 | 5.0 | 5.6 | 5.6 | 5.9 | 5.4 | 4.4 | 4.4 | 61.4 |
| 1942 | 5.3 | 4.9 | 5.1 | 5.6 | 5.4 | 5.9 | 5.8 | 6.0 | 5.9 | 4.5 | 4.4 | 6.1 | 64.9 |
| 1943 | 5.5 | 5.6 | 5.7 | 5.5 | 5.2 | 5.1 | 5.0 | 4.8 | 6.6 | 4.7 | 4.6 | 4.3 | 62.6 |
| 1944 | 4.6 | 4.9 | 4.9 | 5.3 | 5.3 | 5.6 | 5.7 | 5.9 | 5.1 | 5.0 | 4.6 | 4.1 | 61.0 |
| 1945 | 4.9 | 5.1 | 5.1 | 5.4 | 5.1 | 5.0 | 5.2 | 4.9 | 5.9 | 4.7 | 4.5 | 4.9 | 60.7 |
| 1946 | 5.5 | 4.8 | 5.0 | 5.6 | 5.0 | 5.4 | 4.8 | 5.0 | 4.2 | 4.8 | 4.1 | 5.7 | 59.9 |
| 1947 | 5.6 | 5.9 | 5.5 | 5.6 | 5.3 | 5.0 | 4.9 | 5.2 | 5.8 | 5.4 | 4.5 | 4.7 | 63.4 |
| 1948 | | | | | | | | | | | | | |
| Average | 4.9 | 4.9 | 5.1 | 5.2 | 5.1 | 5.3 | 5.1 | 5.2 | 5.9 | 4.7 | 4.5 | 4.7 | 60.7 |

1/ Oct. 1928-Feb. 1946 based on correlation with Frenchman Creek near Hamlet. Mar. 1946 - Sept. 1947 are records.

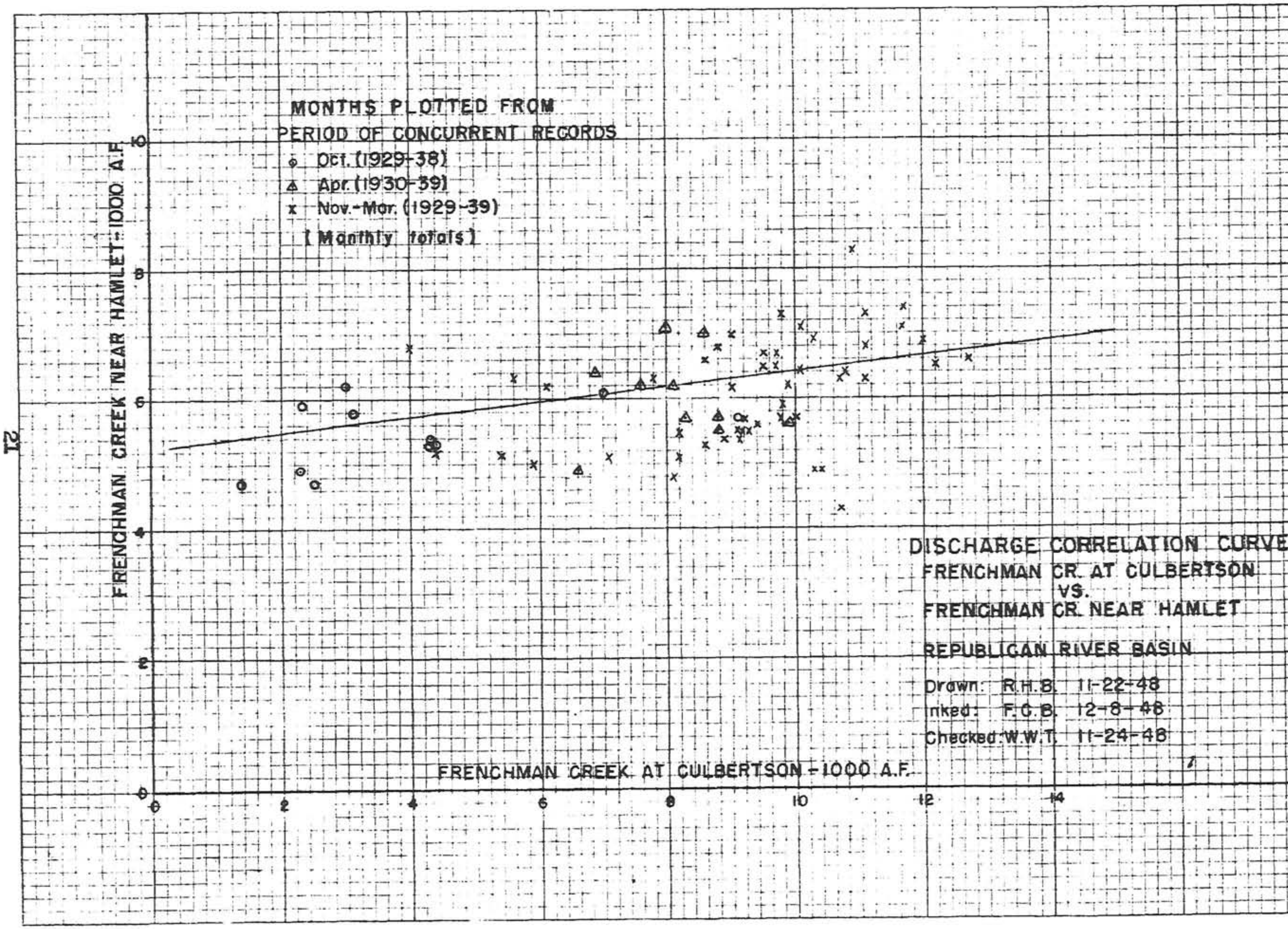

MONTHS PLOTTED FROM
PERIOD OF CONCURRENT RECORDS
Oct. (1929-38)
Apr. (1930-39)
Nov.-Mar. (1929-39)
(Monthly totals)
FRENCHMAN CREEK NEAR HAMLET-1000 A.F.
FRENCHMAN CREEK AT CULBERTSON-1000 A.F.
0
2
4
6
8
10
12
14
DISCHARGE CORRELATION CURVE
FRENCHMAN CR. AT CULBERTSON
VS.
FRENCHMAN CR. NEAR HAMLET
REPUBLICAN RIVER BASIN
Drawn: R.H.B. 11-22-48
Inked: F.C.B. 12-8-48
Checked: W.W.T. 11-24-48

EXHIBIT 7

Table 5. Historical Run-off of Frenchman Creek near Hamlet, Nebraska. 1/

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 6.0 | 6.3 | 6.4 | 6.2 | 6.3 | 6.6 | 6.6 | 6.6 | 6.7 | 4.5 | 4.3 | 5.1 | 71.6 |
| 1930 | 5.3 | 5.4 | 4.9 | 4.3 | 5.6 | 5.7 | 5.5 | 6.5 | 6.1 | 5.3 | 5.0 | 4.2 | 63.8 |
| 1931 | 5.7 | 4.9 | 6.5 | 6.8 | 6.6 | 7.0 | 7.0 | 6.0 | 5.4 | 4.5 | 7.6 | 4.7 | 72.7 |
| 1932 | 5.4 | 5.3 | 5.7 | 6.7 | 7.3 | 6.6 | 5.7 | 5.6 | 6.6 | 5.3 | 6.0 | 4.7 | 70.9 |
| 1933 | 6.2 | 6.2 | 5.5 | 7.3 | 6.3 | 6.5 | 6.2 | 6.4 | 4.5 | 4.8 | 6.5 | 7.2 | 73.6 |
| 1934 | 6.1 | 6.3 | 6.9 | 7.1 | 6.3 | 8.3 | 6.2 | 5.2 | 7.8 | 4.2 | 4.9 | 5.3 | 74.6 |
| 1935 | 5.8 | 6.8 | 6.4 | 6.4 | 5.5 | 6.8 | 6.4 | 11.3 | 10.4 | 4.9 | 4.5 | 5.0 | 80.2 |
| 1936 | 5.3 | 6.3 | 6.5 | 7.1 | 6.9 | 7.4 | 7.1 | 8.3 | 5.6 | 4.0 | 4.5 | 5.0 | 74.0 |
| 1937 | 4.7 | 5.0 | 5.5 | 5.1 | 6.2 | 6.7 | 4.9 | 5.4 | 7.4 | 5.3 | 4.6 | 4.5 | 65.3 |
| 1938 | 4.9 | 5.1 | 5.5 | 5.7 | 5.4 | 5.7 | 5.7 | 6.0 | 8.2 | 6.4 | 4.3 | 6.0 | 68.9 |
| 1939 | 4.7 | 5.2 | 5.1 | 5.9 | 4.8 | 5.8 | 5.6 | 4.4 | 6.4 | 4.5 | 4.4 | 4.3 | 61.1 |
| 1940 | 4.6 | 4.7 | 4.8 | 4.7 | 5.9 | 6.3 | 5.1 | 4.5 | 20.1 | 6.3 | 5.5 | 5.2 | 77.7 |
| 1941 | 5.3 | 5.2 | 6.5 | 6.7 | 6.1 | 6.0 | 7.1 | 7.1 | 7.5 | 6.7 | 4.9 | 4.9 | 74.0 |
| 1942 | 6.4 | 5.7 | 6.2 | 7.1 | 6.6 | 7.5 | 7.3 | 7.7 | 7.5 | 5.0 | 4.8 | 8.0 | 79.8 |
| 1943 | 6.9 | 7.0 | 7.2 | 6.8 | 6.3 | 6.1 | 5.9 | 5.6 | 8.9 | 5.4 | 5.2 | 4.6 | 75.9 |
| 1944 | 5.2 | 5.7 | 5.8 | 6.5 | 6.5 | 7.0 | 7.2 | 7.5 | 6.1 | 6.0 | 5.2 | 4.3 | 73.0 |
| 1945 | 5.7 | 6.1 | 6.2 | 6.6 | 6.2 | 6.0 | 6.3 | 5.7 | 7.5 | 5.3 | 5.0 | 5.7 | 72.3 |
| 1946 | 6.9 | 5.6 | 5.9 | 7.1 | 6.0 | 6.4 | 5.7 | 6.2 | 5.3 | 5.7 | 4.5 | 6.7 | 72.0 |
| 1947 | 7.8 | 6.7 | 6.5 | 6.7 | 6.4 | 6.4 | 6.2 | 6.4 | 7.3 | 6.5 | 4.6 | 4.8 | 76.3 |
| Avg. | 5.7 | 5.8 | 6.0 | 6.4 | 6.1 | 6.6 | 6.2 | 6.4 | 7.6 | 6.3 | 5.1 | 5.3 | 72.5 |

1/ Oct. 1928 - Apr. 1929 based on correlation with Frenchman Creek at Culbertson. Remainder are records.

EXHIBIT 8

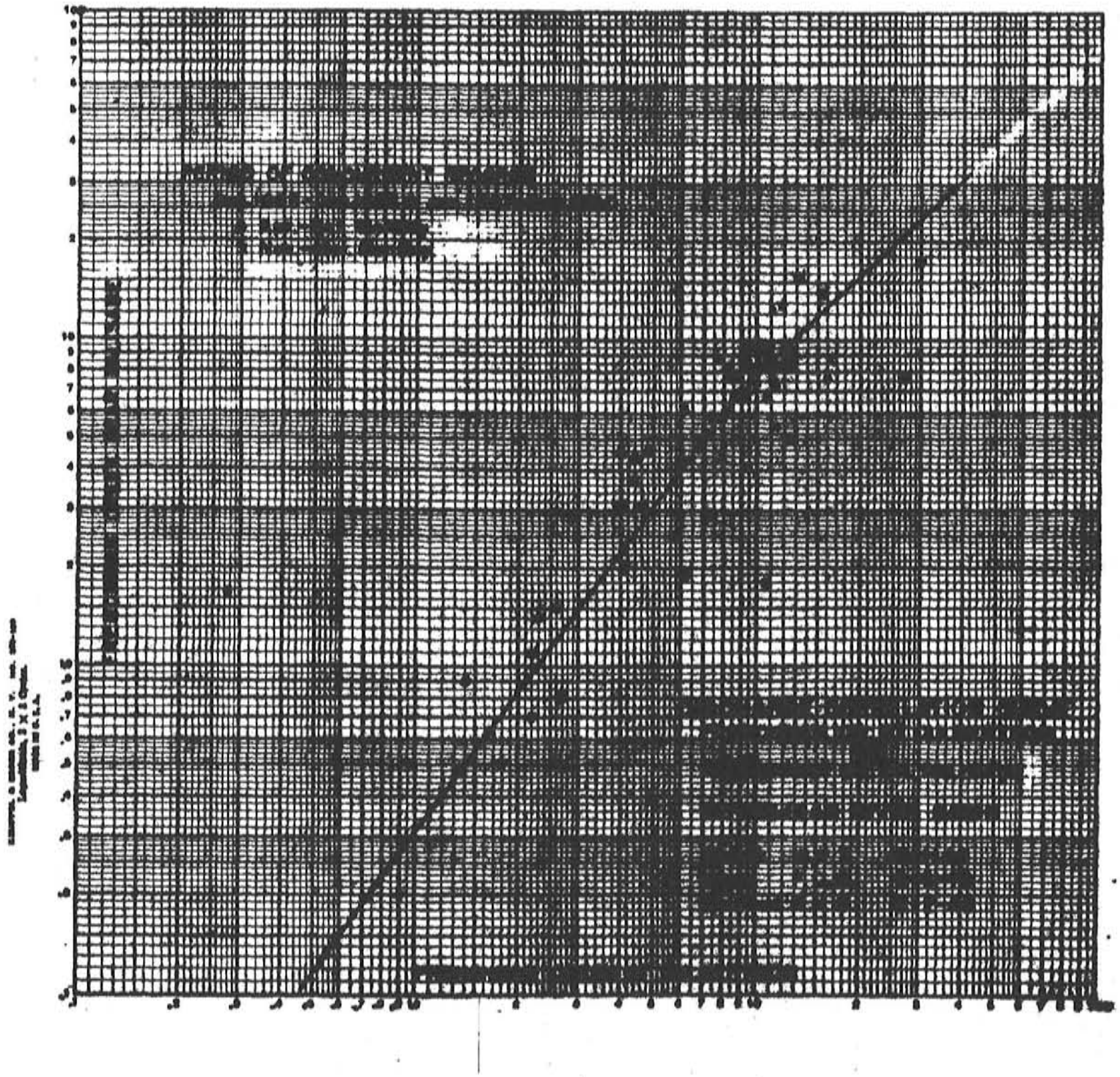




Exhibit 8

Table 6. Historical flow of Frenchman Creek near Palisade 1/

(Unit - 1000 Acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 4.3 | 12.4 | 8.2 | 8.1 | 9.1 | 9.1 | 8.2 | 8.7 | 4.4 | 0.5 | 0.2 | 1.4 | 74.6 |
| 1930 | 3.7 | 7.7 | 9.1 | 6.7 | 6.8 | 7.4 | 6.7 | 9.6 | 5.9 | 1.9 | 4.7 | 4.6 | 74.8 |
| 1931 | 9.0 | 9.5 | 12.0 | 6.7 | 6.5 | 6.9 | 6.5 | 4.6 | 1.4 | 1.4 | 5.1 | 1.0 | 70.6 |
| 1932 | 2.5 | 6.5 | 7.0 | 7.3 | 7.6 | 10.0 | 6.7 | 3.4 | 6.2 | 1.4 | 2.1 | 0.4 | 61.1 |
| 1933 | 1.5 | 4.2 | 6.2 | 8.7 | 8.7 | 9.6 | 6.1 | 4.2 | 0.6 | 0.6 | 6.2 | 9.7 | 66.3 |
| 1934 | 5.0 | 3.7 | 9.4 | 9.2 | 8.4 | 8.5 | 5.7 | 0.8 | 7.6 | 1.1 | 0.7 | 2.4 | 62.5 |
| 1935 | 1.6 | 2.3 | 7.8 | 8.4 | 7.0 | 8.7 | 5.0 | 23.2 | 18.0 | 5.2 | 1.0 | 3.4 | 91.6 |
| 1936 | 2.5 | 5.9 | 7.3 | 7.8 | 8.0 | 9.2 | 6.0 | 7.3 | 4.6 | 0.6 | 0.5 | 0.7 | 60.4 |
| 1937 | 0.5 | 3.9 | 7.1 | 5.1 | 6.8 | 7.3 | 4.6 | 1.2 | 7.5 | 1.3 | 0.6 | 0.8 | 46.7 |
| 1938 | 1.0 | 3.5 | 6.9 | 7.6 | 6.9 | 6.9 | 6.3 | 6.7 | 7.7 | 2.5 | 1.0 | 3.3 | 60.3 |
| 1939 | 1.2 | 2.6 | 6.2 | 7.6 | 6.1 | 7.5 | 7.5 | 1.9 | 3.8 | 1.4 | 0.5 | 0.5 | 46.8 |
| 1940 | 0.8 | 1.2 | 4.8 | 4.9 | 8.0 | 9.2 | 6.9 | 2.5 | 17.7 | 1.5 | 1.1 | 1.5 | 60.1 |
| 1941 | 3.7 | 4.8 | 10.0 | 8.7 | 8.2 | 8.0 | 8.7 | 6.7 | 8.0 | 4.8 | 0.8 | 1.8 | 74.2 |
| 1942 | 6.4 | 6.8 | 7.2 | 6.9 | 7.8 | 9.9 | 9.9 | 11.0 | 9.9 | 3.0 | 1.3 | 7.7 | 87.8 |
| 1943 | 7.1 | 7.3 | 8.1 | 7.6 | 7.6 | 8.4 | 6.6 | 1.6 | 6.0 | 0.7 | 0.4 | 0.5 | 61.9 |
| 1944 | 1.9 | 5.6 | 6.7 | 6.8 | 8.3 | 9.3 | 11.3 | 9.7 | 7.6 | 5.9 | 1.2 | 0.8 | 75.1 |
| 1945 | 3.5 | 5.8 | 7.2 | 7.2 | 7.2 | 7.2 | 6.9 | 3.6 | 9.2 | 3.0 | 1.9 | 3.1 | 65.8 |
| 1946 | 6.3 | 6.3 | 6.1 | 7.6 | 7.0 | 8.0 | 6.0 | 4.4 | 4.6 | 6.2 | 0.7 | 4.5 | 67.7 |
| 1947 | 9.8 | 8.7 | 7.9 | 7.5 | 7.3 | 8.4 | 7.7 | 6.0 | 9.0 | 7.2 | 0.9 | 1.4 | 81.8 |
| Total Avg. | 3.8 | 5.7 | 7.7 | 7.4 | 7.5 | 8.4 | 7.0 | 6.2 | 7.4 | 2.6 | 1.6 | 2.6 | 67.9 |

1/ Oct. 1928 - Dec. 1930 are records. Remainder are correlations with Frenchman Creek at Culbertson.

Table 7. Historical flow of Frenchman Creek at Culbertson. 1/

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 6.0 | 11.0 | 9.9 | 8.3 | 9.3 | 12.1 | 11.2 | 10.8 | 7.6 | 2.6 | 0.9 | 2.3 | 92.0 |
| 1930 | 4.4 | 8.9 | 10.4 | 10.7 | 9.4 | 10.0 | 8.8 | 9.8 | 7.4 | 6.3 | 6.7 | 4.8 | 97.6 |
| 1931 | 9.1 | 10.3 | 9.5 | 8.8 | 8.6 | 9.0 | 8.6 | 6.6 | 2.9 | 2.9 | 7.1 | 2.3 | 85.7 |
| 1932 | 4.3 | 8.6 | 9.2 | 9.5 | 9.8 | 12.7 | 8.8 | 5.3 | 8.2 | 2.8 | 3.8 | 1.2 | 84.2 |
| 1933 | 3.0 | 6.1 | 8.2 | 11.1 | 11.1 | 12.2 | 8.1 | 6.1 | 1.5 | 1.5 | 8.2 | 12.4 | 89.5 |
| 1934 | 7.0 | 5.6 | 12.0 | 11.7 | 10.7 | 10.9 | 7.6 | 1.9 | 9.8 | 2.4 | 1.7 | 4.2 | 85.5 |
| 1935 | 3.1 | 4.0 | 10.1 | 10.8 | 9.2 | 11.1 | 6.9 | 29.8 | 22.9 | 7.2 | 2.2 | 5.3 | 122.6 |
| 1936 | 4.3 | 7.8 | 9.7 | 10.1 | 10.3 | 11.7 | 8.0 | 9.6 | 6.6 | 1.6 | 1.3 | 1.7 | 82.7 |
| 1937 | 1.4 | 5.9 | 9.3 | 7.1 | 9.0 | 9.7 | 6.6 | 2.6 | 9.9 | 2.7 | 1.5 | 1.9 | 67.6 |
| 1938 | 2.3 | 5.4 | 9.1 | 9.8 | 9.1 | 9.1 | 8.3 | 8.8 | 10.0 | 4.3 | 2.3 | 5.2 | 83.7 |
| 1939 | 2.5 | 4.4 | 8.2 | 9.8 | 8.1 | 9.9 | 9.9 | 3.5 | 5.8 | 2.9 | 1.4 | 1.4 | 67.8 |
| 1940 | 1.9 | 2.5 | 6.8 | 6.9 | 10.3 | 11.6 | 9.1 | 4.3 | 22.7 | 3.0 | 2.4 | 3.0 | 84.5 |
| 1941 | 5.6 | 6.8 | 12.8 | 11.1 | 10.5 | 10.3 | 11.1 | 8.8 | 10.3 | 6.3 | 2.0 | 3.4 | 99.5 |
| 1942 | 8.5 | 9.0 | 9.5 | 9.1 | 10.1 | 12.6 | 12.6 | 14.0 | 12.6 | 4.9 | 2.7 | 10.0 | 115.6 |
| 1943 | 9.3 | 9.6 | 10.4 | 9.8 | 9.8 | 10.7 | 8.7 | 3.1 | 8.0 | 1.7 | 1.2 | 1.3 | 83.6 |
| 1944 | 3.6 | 7.5 | 8.8 | 9.0 | 10.6 | 11.8 | 14.4 | 12.3 | 9.8 | 7.9 | 2.5 | 2.0 | 100.2 |
| 1945 | 5.4 | 7.8 | 9.4 | 9.4 | 9.4 | 9.4 | 9.1 | 5.5 | 11.6 | 4.9 | 3.6 | 5.0 | 90.5 |
| 1946 | 8.4 | 8.3 | 8.1 | 9.8 | 9.2 | 10.3 | 8.0 | 6.0 | 6.6 | 8.2 | 1.7 | 6.5 | 91.5 |
| 1947 | 12.5 | 11.2 | 10.2 | 9.9 | 9.7 | 10.7 | 10.0 | 8.0 | 11.4 | 9.5 | 2.1 | 2.8 | 108.0 |
| Total Average | 5.4 | 7.4 | 9.6 | 9.6 | 9.7 | 10.8 | 9.3 | 8.3 | 9.3 | 4.4 | 2.9 | 4.0 | 91.2 |

1/ Mouth of Frenchman Creek

Frenchman Creek and the Republican River. It was not until 1945 that the more intensive ground-water investigations were initiated as part of the Missouri River Basin development plan.

A cooperative program between the Bureau of Reclamation and the Geological Survey has been established for the study of the ground water in the Frenchman Creek Valley. This program will establish a history of the conditions which will be used as a basis for observing ground-water changes resulting from irrigation.

Prior to June 1, 1950, there were 16 observation wells in the area between Enders Reservoir and Culbertson, Nebraska, from which the Geological Survey has collected ground-water data. There have been 27 observation wells added to the observation program of which 22 were jetted during May and June 1950, and 5 are used for irrigation.

The Bureau of Reclamation has requested the Geological Survey to prepare depth to ground-water and water-table contour maps of the area between Enders and Culbertson by August 1, 1951.

The over-all ground-water conditions during the period of record indicate that there has been no appreciable change in the ground-water level. In the Frenchman Creek Valley the depth to water table in the reach between Enders Dam and Culbertson range from 12 to 16 feet below the surface of the ground. "In the upland areas water is obtained from saturated sands and gravels of the Ogallala formation of Tertiary age in depths ranging from 75 to about 400 feet, but only a few of the wells are more than 250 feet deep. Wells in the alluvial valley lands range from 10 to 40 feet in depth depending on the thickness of alluvial deposits." 1/

Geologic cross sections of Frenchman Creek Valley near Enders and the Hayes-Hitchcock County line are shown in exhibits 9 and 10. A cross section of Stinking Water Creek near Wauneta is shown in exhibit 11.

Frenchman Creek lies 60 to 100 feet below the bordering upland. The stream has a relatively constant flow as a result of being spring-fed throughout most of its course.

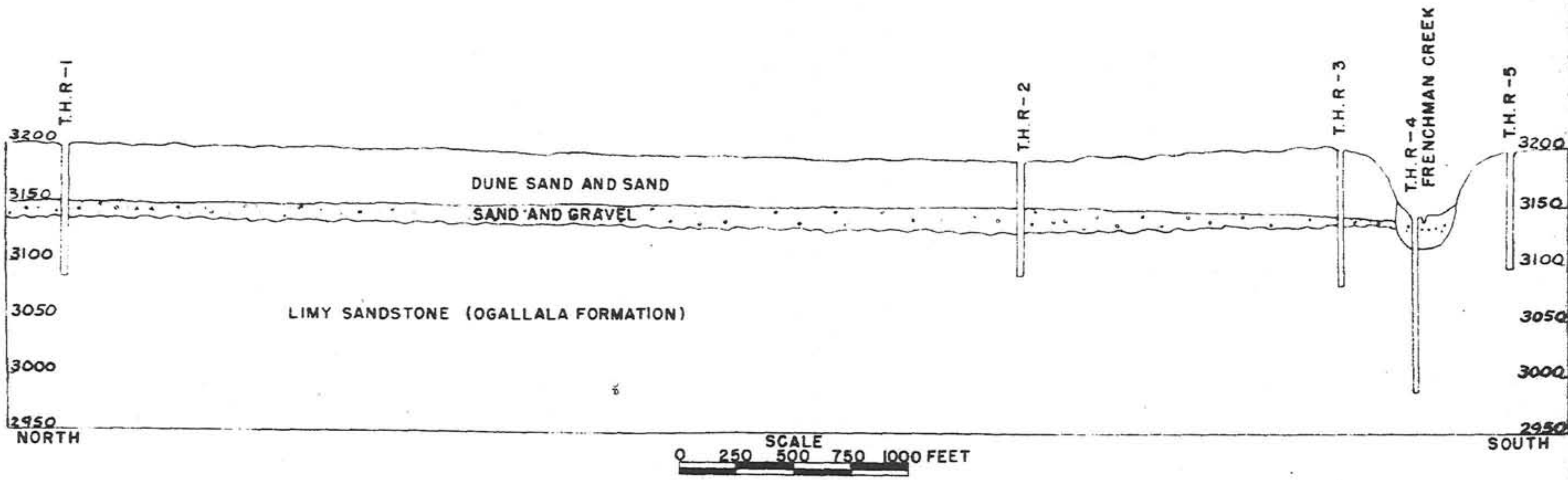
Pumping from wells for irrigation has been practiced for a number of years, and it is likely that future private developments of this type will take place to a limited extent.

Quality of water

Analyses of the mineral constituents of Frenchman Creek water taken from the creek at Enders and Culbertson have been made by the Geological Survey. The analyses which have been made since 1947 are listed in tables 8 and 9. Table 10 lists analyses of ground water taken from wells at Culbertson, Palisade, and Wauneta.

1/ Ground water in the Republican River Basin in Nebraska, Part IV, Hitchcock, Hayes, Dundy, and Chase Counties, by H.A. Waite, E.C. Reed, and D.S. Jones, Jr., published by the University of Nebraska, Conservation and Survey Division.

Exhibit 10




This section is located at a point about 5½ miles south of Imperial and extends in a northwest-southeast direction from a point about 6,000 feet northwest of Frenchman Creek to a point about 700 feet southeast of the Creek. (Nebraska Water Resources Survey, Water Supply Paper 1, Part IV.)

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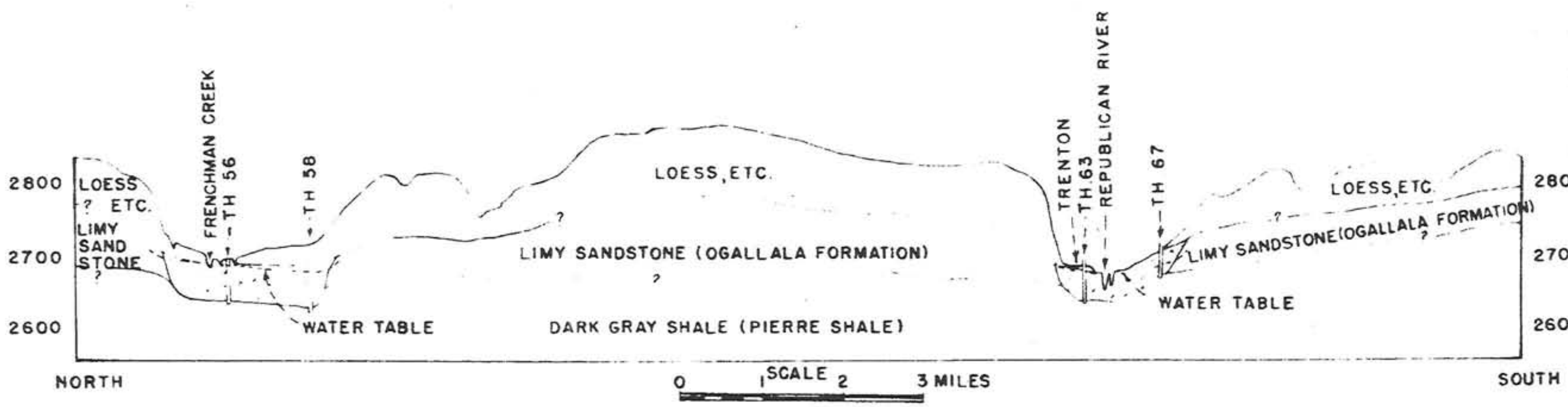
Exhibit 9

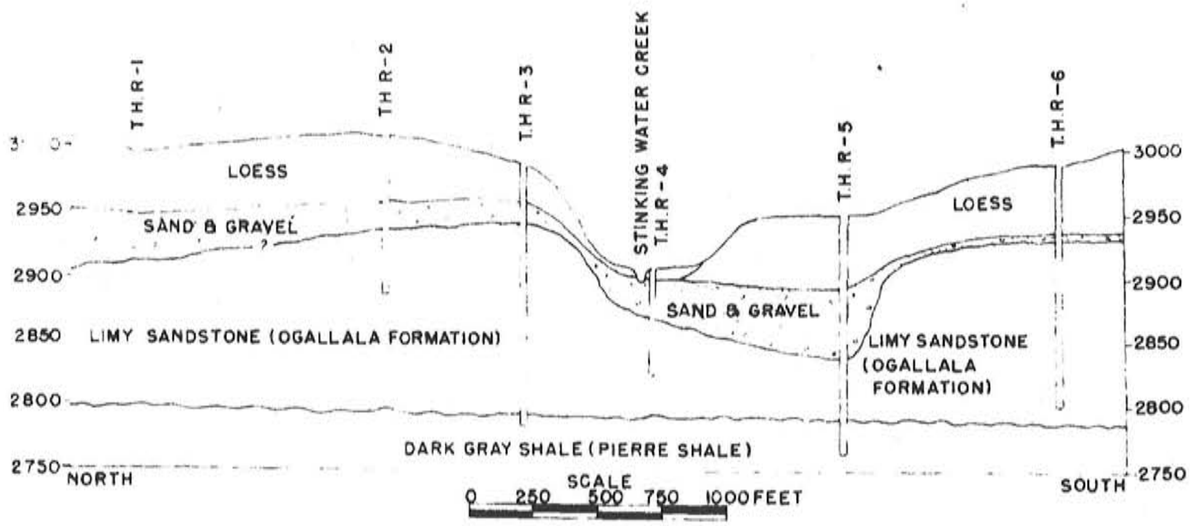
KS002247




This section is located one mile west of Trenton and extends in a north-south direction from a point on the Hayes-Hitchcock county line to a point 6 miles north of the Nebraska-Kansas state line. (Nebraska Water Resources Survey, Water Supply Paper 1, Part IV.

EXHIBIT 10

Exhibit //




This section is located at a point about 9½ miles north and about 1½ miles east of the southwest corner of Hayes County. It extends in a north-south direction from a point about [illegible],200 feet north of Stinking Water Creek to a point about 1,[illegible]00 feet south of the Creek. (Nebraska Water Resources Survey, Water Supply Paper 1, Part [illegible].)

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Table 8

UNITED STATES DEPARTMENT OF THE INTERIOR—GEOLOGICAL SURVEY—Water Resources Division

Drainage area ______________ square miles

U. S. Geological Survey
518 Federal Building
Lincoln 8, Nebraska

Table 8

Preliminary Records

... water year October ______ to September, ______

| | | | | | | | | | | | | | | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | Dissolved solids: Parts per million | Dissolved solids: Tons per acre-foot | Dissolved solids: Tons per day | Hardness | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.9 | 5.0 | [illegible] | [illegible] | [illegible] | --- | [illegible] | 9 | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .9 | 5.0 | .37 | [illegible] | [illegible] | --- | [illegible] | 6 | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .9 | 5.0 | .35 | [illegible] | [illegible] | --- | [illegible] | 2 | 35 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.9 | 2.4 | 0.04 | [illegible] | [illegible] | --- | [illegible] | | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .06 | [illegible] | [illegible] | --- | [illegible] | 0 | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | --- | [illegible] | 0 | [illegible] |
| [illegible] | Feb. 28 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | 0 | [illegible] |
| [illegible] | Mar. 29 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | 0 | [illegible] |
| [illegible] | Apr. 25 | [illegible] | [illegible] | 7.5 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | 0 | 16 |
| [illegible] | May 31 | [illegible] | [illegible] | 7.7 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 15 | [illegible] | 220 | 29 | [illegible] | [illegible] | 4.9 | [illegible] | [illegible] | | | [illegible] | 0 | 16 |
| [illegible] | June 26 | [illegible] | [illegible] | 8.0 | [illegible] | [illegible] | [illegible] | [illegible] | 11 | 25 | [illegible] | 214 | 23 | 2.0 | .7 | 5.0 | [illegible] | [illegible] | | | 156 | 0 | [illegible] |

UNITED STATES DEPARTMENT OF THE INTERIOR—GEOLOGICAL SURVEY—Water Resources Division

U. S. Geological Survey, [illegible] Building, Lincoln [illegible], Nebraska

*Table 9*

Drainage area [illegible] square miles

[illegible] constituents, in parts per million, [illegible], under water year October [illegible] to September [illegible]

Preliminary Records Subject to Revision

| Lab. No. | Date of Collection | Mean discharge (cfs) | Temperature (°F) | pH | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | [illegible] | Dissolved Solids: Parts per million | Dissolved Solids: Tons per acre-foot | Dissolved Solids: Tons per day | Hardness as $CaCO_3$: Total | Hardness as $CaCO_3$: Non-carbonate | Percent sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 11 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 6 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 7591 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 9142 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | 75 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | June 28 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

[illegible] — 1/ Mean daily discharge

Table 9

31

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Table 10. Mineral constituents, in parts per million, and related physical measurements of wells in the [illegible] Area

| Analysis number (1) | Owner and well number (2) | Date of collection (3) | Depth (feet): Well (4) | Depth (feet): To water (5) | Diameter (inches) (6) | Yield (gallons a minute) (7) | Temperature (°F) (8) | pH (9) | Specific conductance (micromhos at 25° C.) (10) | Silica ($SiO_2$) (11) | Iron (Fe) (12) | Calcium (Ca) (13) | Magnesium (Mg) (14) | Sodium (Na) (15) | Potassium (K) (16) | Bicarbonate ($HCO_3$) (17) | Sulfate ($SO_4$) (18) | Chloride (Cl) (19) | Fluoride (F) (20) | Nitrate ($NO_3$) (21) | Boron (B) (22) | [illegible] (23) | Dissolved solids (24) | Hardness as $CaCO_3$: Total (25) | Hardness as $CaCO_3$: Noncarbonate (26) | Percent sodium (27) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 503 | City of Culbertson 3-33-17ad | 5-13-47 | 62 | 39 | 18 | 250 | 56 | 7.7 | 106.0 | 49 | 0. | 135 | 36 | 33 | 30 | 348 | 240 | 55.0 | 0.5 | 50 | 0.21 | 0. | [illegible] | 485 | 198 | 12 |
| 505 | City of Palisade 4-34-14b1 | 6-8-47 | 105 | 30 | 24 | 350 | 54 | 8.4 | 44.8 | 66 | 0.6 | 55 | 16 | 20 | | 250 | 26 | 5.0 | .7 | 6.0 | .40 | 0. | 326 | 202 | 0 | 18 |
| 504 | City of Wauneta 5-36-11ac2 | 5-23-47 | 61 | 18 | 18 | 250 | 57 | 8.5 | 38.8 | 60 | 0. | 52 | 14 | | 13 | 226 | 19 | 5.0 | .9 | 2.0 | .46 | 0. | 270 | 187 | 8 | 13 |

## Frenchman Unit

The suitability of water for irrigation is dependent upon total salt concentration, percentage of sodium, boron concentration, and sodium carbonate or bicarbonate concentration. Permissible limits of total salt concentration, percentage of sodium and boron concentration are described by L. V. Wilcox, Agronomist, U. S. Regional Salinity Rubidoux Laboratory, Riverside, California.1/

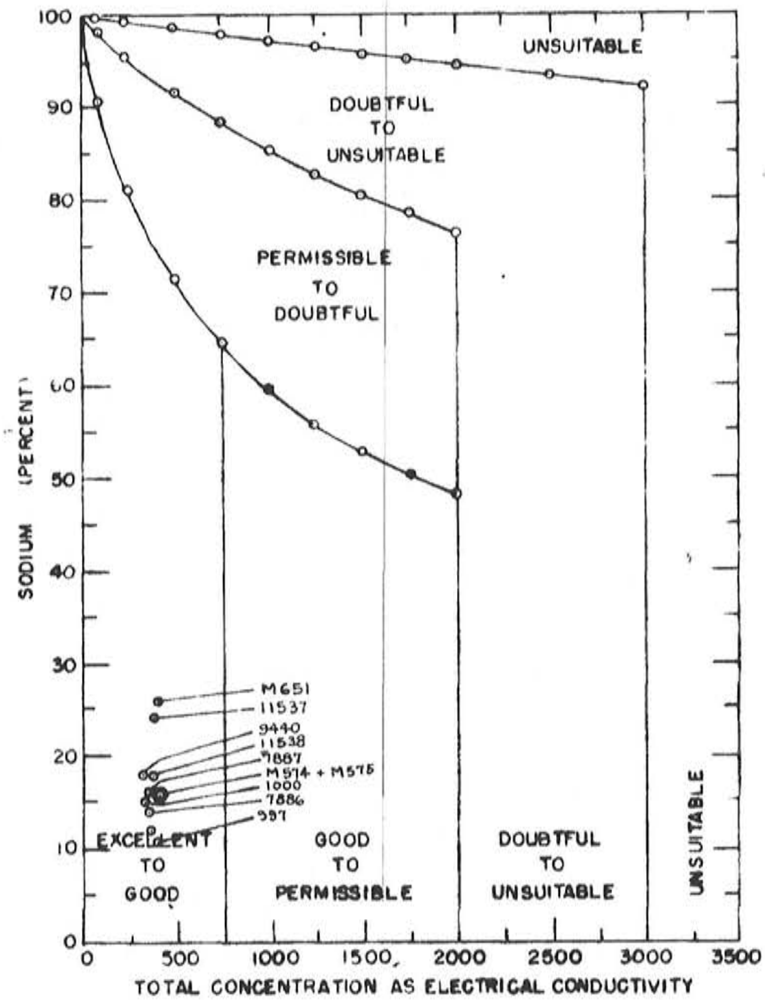
Total salt concentration and sodium percentage of the water analyses listed in tables 8 and 9 are plotted on charts, exhibits 12 and 13. These exhibits show the creek water at Enders and Culbertson is of excellent quality for irrigation insofar as total salts and sodium percentage are concerned. The boron concentration of these waters is low enough for use by all but the most sensitive crops; therefore Frenchman Creek water can be classified as excellent quality when boron concentration is considered. All water samples were studied to determine the sodium carbonate or bicarbonate concentration by making hypothetical chemical combinations. These hypothetical chemical combinations were made by drawing bar graphs of chemical equivalents showing the relationship of the carbonates and bicarbonates to the calcium, magnesium, sodium, and potassium. These bar graphs indicate that at times the Frenchman Creek water at Enders and Culbertson carries some concentration of sodium carbonate or bicarbonate. Although this indicates a possibility of damage to soil if this water is applied it is considered satisfactory for irrigation in this area because these waters have been used for irrigation since as early as 1890 without apparent detrimental effect to the soils.

Analysis of ground water taken from wells at Culbertson, Palisade, and Wauneta have been made and are listed in table 10. Exhibit 14 indicates the ground water is satisfactory for irrigation insofar as percentage of sodium and total salts are concerned. The largest amounts of boron reported in any of the samples analyzed is .11 p.p.m., which is not enough to cause damage to the most sensitive plants. A study of the sodium carbonate or bicarbonate concentration indicates there is no damaging concentration of these salts in the ground water of this area. Extensive use of ground water for irrigation in this unit is not contemplated, however, the analyses listed in table 10 indicate that ground water could be used in unforseen developments should make its use desirable.

The quality of water in the wells does not necessarily indicate the quality of the return flows. It is not planned to capture return flows in the unit and reuse them before they enter the stream. For this reason a detailed study to determine the return flow quality is not considered necessary. Return flows from the presently irrigated land do not materially deteriorate the creek water when they return to the stream. There is no noticeable difference in the quality of water as it passes downstream.

1/ "Quality of Water for Irrigation Use," U. S. Department of Agriculture Technical Bulletin 962.
"Explanation and Interpretation of Analyses of Irrigation Waters," USDA Circular No. 784.

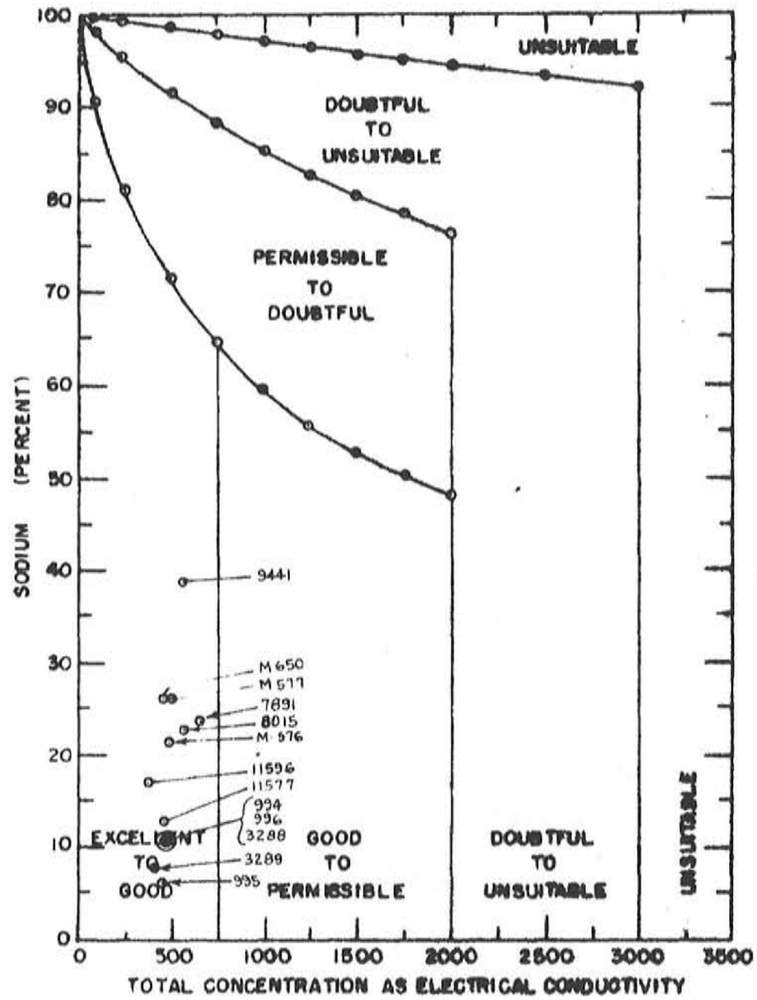
EXHIBIT [illegible] DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF WATER SAMPLES TAKEN FROM FRENCHMAN CREEK, ENDERS, NEBR.




USDA CIRCULAR NO. 784, MAY 1948

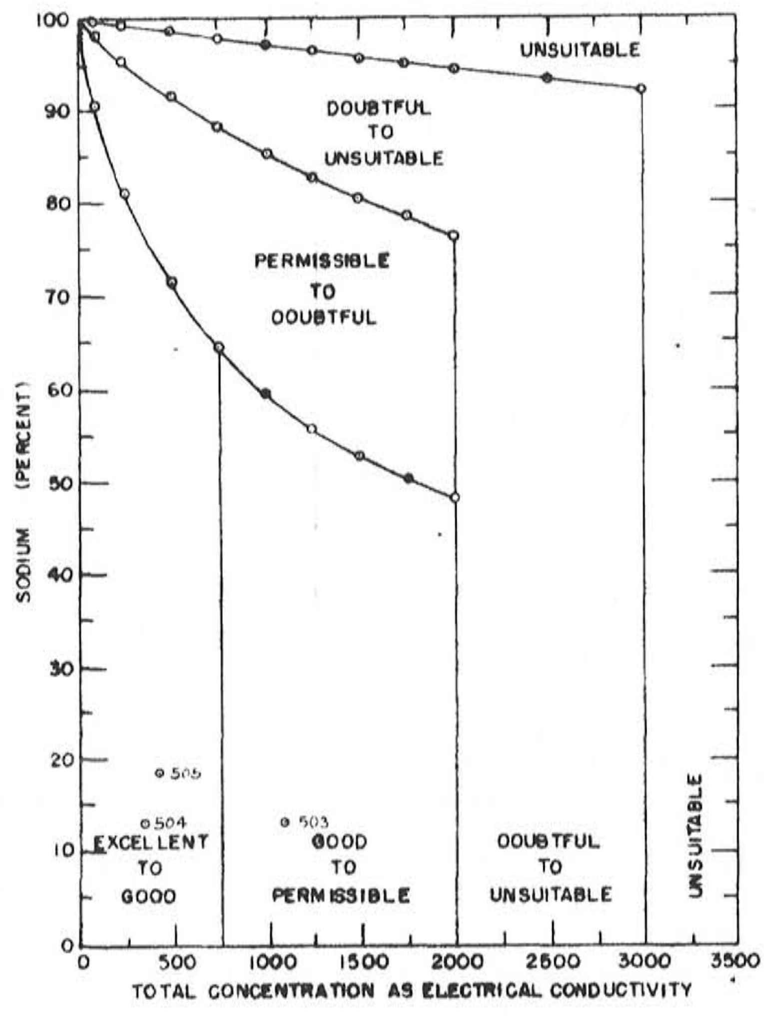
"EXPLANATION AND INTERPRETATION OF ANALYSIS OF IRRIGATION WATERS" L.V. WILCOX

EXHIBIT 13 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF WATER SAMPLES TAKEN FROM FRENCHMAN CREEK, CULBERTSON, NEBR.




USDA CIRCULAR NO. 784, MAY 1948
"EXPLANATION AND INTERPRETATION OF ANALYSIS OF IRRIGATION WATERS" L.V. WILCOX

EXHIBIT 14 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF WATER SAMPLES TAKEN FROM WELLS IN THE FRENCHMAN CREEK UNIT




USDA CIRCULAR NO. 784, MAY 1948

"EXPLANATION AND INTERPRETATION OF ANALYSIS OF IRRIGATION WATERS" L.V. WILCOX

All of the communities in the Republican River Valley use water pumped from wells for domestic water supplies and it is not anticipated that any of them will wish to use project water in the future. For this reason no data is presented to show the extent of pollution of surface water in this report.

The Public Health Service has prepared a detailed report showing the extent, types, and major sources of pollution of streams in the Kansas River Basin. 1/ Minimum stream flows necessary below reservoirs for sanitation are listed in the Public Health Service Report and are discussed in the section of this Appendix titled, "Releases for Public Health Service."

## Water Rights

The Legislative Act of 1895 is said to be declaratory of the existing Nebraska law as far as the right of a person to acquire a vested interest in the use of water by appropriation to a beneficial use is concerned. This was embodied in the State Constitution of 1920 Article XV, Sections 5, 6, and 7. The following provisions are made in Article XV, CS 1929:

> "The necessity of water for domestic use and for irrigation purposes in the State of Nebraska is hereby declared to be a natural want.
>
> "The use of water of every natural stream within the State of Nebraska is hereby dedicated to the people of the State for beneficial purposes, subject to the provisions of the following section.
>
> "The right to divert unappropriated waters of every natural stream for beneficial use shall never be denied except when such denial is demanded by the public interest. Priority of appropriation shall give the better right as between those using water for the same purpose, but when the waters of any natural stream are not sufficient for the use of all ..., those using the water for domestic purposes shall have preference over those claiming it for any other purpose, and those using the water for agricultural purposes shall have preference over those using the same for manufacturing purposes. Provided, no inferior right to the use of water .... shall be acquired by a superior right without just compensation therefore to the inferior user.
>
> "The use of waters of the State for power purposes shall be deemed a public use and shall never be alienated, but may be leased or otherwise developed by law prescribed."

1/ "Kansas River Basin Water Pollution Investigation" - Federal Security Agency, Public Health Service, June 1949.

The Supreme Court of Nebraska has stated that running water is public, juris; that the use of such water belongs to the public and is controlled by the state in its sovereign capacity and that a riparian proprietor cannot appropriate water without permission of the state. According to the Supreme Court the Department of Roads and Irrigation has large discretion in granting a right to make an appropriation. It is an administrative body having quasijudicial functions and, as such, is invested with reasonable discretion in the exercise of its supervisory power. An appropriation may be cancelled by the department if it appears upon a hearing that the water has not been put to beneficial use or has ceased to be used for more than 3 years. Such a cancellation by the department is subject to appeal.

Each appropriative right contains a fixed date which determines the right to divert water when the supply is not adequate for all users. This priority date is the date upon which the first step was taken to acquire the right, provided the appropriator is diligent in performing all subsequent acts in completing construction works and application of the water to beneficial use. The holder of the earliest priority on a stream has the first right to use whatever water is flowing in the stream and may use the entire flow if the quantity of water he has appropriated so requires. Each priority is senior to all those of later date and junior to all those of earlier date. Each appropriative right refers, in addition to the date of priority, to a specific rate of diversion in cubic feet per second.

Provisions for establishing the date of priority and the amount of water that may be appropriated are stated in chapter 81, article 6311 of the Nebraska Irrigation and water Power Laws. It is provided that "Each appropriation shall be determined in its priority and amount, by the time at which it shall have been made, and the amount of water which the works are constructed to carry. An appropriator shall at no time be entitled to the use of more than he can beneficially use for the purpose for which the appropriation may have been made.....No allotment from the natural flow of streams for irrigation shall exceed one cubic foot per second of time for each seventy acres of land, nor three acre-feet in the aggregate during one calendar year for each acre of land for which such appropriation shall have been made.....Provided, that these limitations do not apply to storage waters and provided, further, that where storage water is being used in addition to the natural flow, that the water superintendent shall, upon his request and within twenty-four hours thereof, be notified in writing by the user of such storage waters of the time of withdrawal from natural streams, to be distributed according to law."

A limitation of the use of stored water is set forth in chapter 46, article 617 of the State of Nebraska Irrigation and Water Power Laws, which states in part that "No appropriation of stored water for irrigation shall exceed three acre-feet during any calendar year."

## Frenchman Unit

### Active water rights

Above Enders Reservoir, in Nebraska, there are 17 provisional grants which have been made by the Department of Roads and Irrigation for use of water from Frenchman Creek. Out of the 17 provisional grants, 3 are for power purposes. All of these rights, with the exception of one, have been in use prior to the period of study and therefore their use of water is already reflected in stream-flow records. A summary of these active grants above Enders Dam and the area actually irrigated as determined by a field inspection are listed in table 11. The acreage listed under the provisional grant is an estimated figure determined by estimating the acreage to be 70 acres per second-foot of water granted in the water right.

Below Enders Reservoir and above Culbertson, Nebraska, there are 20 active provisional grants of which 14 will be included in the project area and will receive supplemental water from Enders Reservoir. The other 6 active grants are not included in the project area. A tabulation of these rights that are included in the project area and those not included in the project area are shown in tables 12 and 13.

Six provisional grants, totaling 355 second-feet owned by 4 power plants were recently purchased by the Bureau of Reclamation. A tabulation of these grants and the date of purchase are shown in table 14.

### Inactive water rights

Inactive provisional grants above and below Enders Reservoir which may not be reestablished as a result of the water laws of the State of Nebraska are shown in tables 15 and 16.

### Ground-water laws

No laws are on the State of Nebraska's statute books that regulate the use of ground water. A law relative to artesian water provides that only the quantity of water that will flow through a pipe one-half inch in diameter may be allowed to run to waste unless it is first put to beneficial use.

Nebraska laws defining land that may be included in a district provide that, "The person, firm, corporation, or municipal corporation whose land, within any proposed district, is provided with water by pumping either from well, lake, or stream, shall not be included therein except upon written application of the owner or owners of such land; Provided that 1,000 gallons per minute of water shall exempt 160 acres and lesser or greater amounts of water shall exempt in proportion."

It is interesting to note that under this law a person owning 160 acres and a pump producing 1,000 gallons per minute could not be included in the district unless he so petitioned.

Table 11.—Active Provisional Grants from Frenchman Creek above Enders Dam Site. 1/

| Carrier | Doc. or Applic. No. | Date of Priority | Location of Headgate S | T | R | Provisional Grant Use | Acres | C.F.S. | Area Actually Irrigated Acres |
|---|---|---|---|---|---|---|---|---|---|
| Champion Mills | D-179 | 12/31/87 | 21 | 6 | 39 | Power | - | 28.30 | - |
| Aberdeen Canal | D50a | 7/1/88 | 3 | 5 | 38 | Irrigation | 140 | 2.00 | 124 a/ |
| Champion Canal | D-47 | 12/23/90 | 23 | 6 | 40 | Irrigation | 1680 | 24.00 | - |
| Aberdeen Canal | D-50b | 2/2/91 | 3 | 5 | 38 | Irrigation | 35 | 0.50 | |
| Champion Supply Canal | A-1108 | 6/22/11 | 23 | 6 | 40 | Irrigation | - | 1000 A.F. | - |
| Kilpatrick Res. Canal | A-1160 | 6/22/11 | 30 | 6 | 39 | Supply | - | D-47 | 1680 |
| Aberdeen Canal | A-1117 | 7/29/11 | 3 | 5 | 38 | Irrigation | 110 | 1.57 | |
| Maranville Canal | D-70 | 12/8/94 | 12 | 6 | 41 | Irrigation | 420 | 6.00 | 177 |
| Inman Canal | D-79 | 2/28/95 | 17 | 6 | 40 | Irrigation | 105 | 1.50 | - |
| Inman Canal | A-436 | 2/10/98 | 17 | 6 | 40 | Irrigation | 450 | 6.43 | - |
| Inman Reservoir | A-1145 | 12/8/11 | 17 | 6 | 40 | Irrigation | - | 2,000 A.F. | 347 |
| Shallenberger Canal | A-423 | 12/21/97 | 25 | 6 | 39 | Irrigation | 124 | 1.77 | 43 |
| Champion Creamery | A-591 | 12/21/00 | 21 | 6 | 39 | Power | - | 34.40 | |
| Arterburn Reservoir | A-1142 | 11/28/11 | 11 | 6 | 41 | Resort | - | 1,800 A.F. | - |
| Imperial Power Plant | A-1474 | 2/7/17 | 25 | 6 | 39 | Power | - | 55.00 | - |
| Lake Imperial | A-1487 | 5/14/17 | 25 | 6 | 39 | Storage | - | 960 A.F. | 37 |
| Hoffmeister Pump | 2575 | 3/13/36 | 30 | 6 | 38 | Irrigation | - | - | 102 |
| White Mansfork & Reservoir | | Has irrigated several years | | | | no water rights | | | 56 |
| TOTAL | | | | | | | 3064 | 161.47 | 2566 |

a/ Total number of acres irrigated under Aberdeen Canals.
1/ Data except acreages published in Nebraska Bureau of Roads and Irrigation Biennial Reports.

Table 12. Active Provisional Grants below Enders Included in Project. 1/

| Carrier | Doc. or Applic. No. | Date of Priority | Location of Headgate S | T | R | Provisional Grant Use | Acres | C.F.S. | Area Actually Irrigated Acres |
|---|---|---|---|---|---|---|---|---|---|
| Culbertson Canal | D-29-30 | 5/16/90 | 31 | 5 | 33 | Irrigation | 15,050 | 215.00 | 9,450 |
| Farmers Canal | D-10 | 12/19/93 | 11 | 3 | 32 | " | 700 | 10.00 | 271 |
| Riverside Canal | D-18 | 7/28/94 | 33 | 4 | 32 | " | 840 | 12.00 | |
| | A-1674 | 7/3/27 | 33 | 4 | 32 | " | 213 | 2.90 | 532 |
| Grimm Pumps | A-2542 | 5/24/35 | 15 | 5 | 35 | " | 83 | 1.19 | 52 |
| Krausnick Pump | A-2705 | 3/2/37 | 3 | 5 | 37 | " | 39 | 0.56 | 21 |
| Wise Pump | A-2722 | 8/10/37 | 22 | 5 | 35 | " | 97 | 1.38 | 102 |
| Follett-Witt Pump | A-2805 | 11/20/37 | 35 | 5 | 34 | " | 32 | 0.46 | 42 |
| Severns Pump | A-1856 | 9/11/26 | 9 | 4 | 33 | " | 141 | 2.01 | |
| | A-2847 | 3/15/38 | 9 | 4 | 33 | " | 64 | 0.91 | 173 |
| Oliver Pump | A-2858 | 4/2/38 | 16 | 5 | 35 | " | 25 | 0.35 | 63 |
| Engall-Sims Pump | A-2908 | 2/9/39 | 17 | 5 | 35 | " | 86 | 1.23 | 90 |
| Gruver Pump | A-2910 | 2/27/39 | 5 | 4 | 33 | " | 72 | 1.03 | 81 |
| Handel Pump | A-3112 | 3/11/40 | 8 | 4 | 33 | " | 95 | 1.35 | 88 |
| McLain Canal a/ | D-65 | 9/24/94 | 28 | 7 | 37 | " | 175 | 2.50 | 180 |
| TOTAL | | | | | | | 17,712 | 252.87 | 11,145 |

a/ McLain Canal is located on Stinking Water Creek

1/ Data except acreages published in Nebraska Bureau of Roads and Irrigation Biennial Reports.

Table 13. Active Provisional Grants Below Enders Dam Site not Included in Project. 1/

| Carrier | Doc. or Applic. No. | Date of Priority | Location of Headgate S | T | R | Provisional Grant Use | Acres | C.F.S. | Area Actually Irrigated Acres |
|---|---|---|---|---|---|---|---|---|---|
| Follett-Krotter Pump | A-705 | 4/30/03 | 35 | 5 | 34 | Irrigation | 300 | 4.29) | |
| | A-720 | 8/11/03 | 35 | 5 | 34 | " | 180 | 2.57) | 712 |
| | A-975 | 1/15/10 | 35 | 5 | 34 | " | 399 | 5.70) | |
| Follett-Krotter Extension | A-2294 | 1/6/33 | 33 | 5 | 34 | " | 209 | 2.98) | |
| Krotter Canal | A-1047 | 12/15/10 | 35 | 5 | 34 | Irrigation | 169 | 2.42 | 138 |
| Oliver Canal | A-1285 | 4/28/13 | 7 | 5 | 35 | Irrigation | 224 | 3.20 | 119 |
| TOTAL | | | | | | | 1481 | 21.16 | 969 |

1/ Data except acreages published in Nebraska Bureau of Roads and Irrigation Biennial Reports.

Table 14. Water Rights Purchased by Bureau of Reclamation. 1/

| Carrier a/ | Doc. or Applic. No. | Date of Priority | Location of Headgate | | | Provisional Grant | | | Date of Purchase |
|---|---|---|---|---|---|---|---|---|---|
| | | | S | T | R | Use | Acres | C.F.S. | |
| Grosbach-Williams Power Plant | A-2338 | 7/27/33 | 5 | 5 | 37 | Power | - | 75.00 | 6/29/48 |
| Wauneta Power Plant | D-178 | 7/31/86 | 11 | 5 | 36 | Power | - | 35.00) | 3/29/49 |
| | A-1136 | 11/16/11 | 11 | 5 | 36 | Power | - | 75.00) | |
| Krotter Power Plant | A-1021 | 8/17/10 | 35 | 5 | 34 | Power | - | 55.00) | 10/14/48 |
| | A-1339 | 12/2/13 | 35 | 5 | 34 | Power | - | 65.00) | |
| Oliver Power Plant | A-1284 | 4/28/13 | 7 | 5 | 35 | Power | - | 50.00 | 6/10/48 |
| TOTAL | | | | | | | | 355.00 | |

a/ Grosbach-Williams Power Plant located above Enders Reservoir. All others are below Enders.

1/ Data except acreages published in Nebraska Bureau of Roads and Irrigation Biennial Reports.

Table 15. Inactive Provisional Grants above Enders Dam Site which may not be Re-established.1/

| | | | Location of Headgate | | | Provisional Grant | | |
|---|---|---|---|---|---|---|---|---|
| Carrier | Doc. or Applic. No. | Date of Priority | S | T | R | Use | Acres | C.F.S. |
| Lamar Rolling Mills | D-1013 | 12/30/87 | 18 | 6 | 40 | Power | - | 30.00 |
| Harlan Canal | D-56 | 7/1/88 | 1 | 5 | 38 | Irrigation | 140 | 2.00 |
| Gould Canal | D-67 | 10/9/94 | 1 | 5 | 38 | Irrigation | 140 | 2.00 |
| North Side Canal | A-246 | 2/25/96 | 21 | 6 | 39 | Irrigation | 55 | 0.79 |
| Hoke Canal | A-1094 | 5/1/11 | 21 | 6 | 39 | Irrigation | 90 | 1.29 |
| Krotter Imperial | A-1979 | 2/10/28 | 3 | 5 | 38 | Irrigation | - | 7000 A.F. |
| Krotter Imperial Power Plant | A-1980 | 2/10/28 | 3 | 5 | 38 | Power | - | 55.00 |
| Harlan Canal | A-2331 | 7/11/33 | 32 | 6 | 37 | Irrigation | 88 | 1.26 |
| TOTAL | | | | | | | 513 | 92.34 |

1/ Data except acreages published in Nebraska Bureau of Roads and Irrigation Biennial Reports.

Table 16.—Inactive Provisional Grants below Enders Dam site which may not be Re-established. a/

| | | | Location of headgate | | | Provisional Grant | | |
|---|---|---|---|---|---|---|---|---|
| Carrier | Doc. or Applic. No. | Date of Priority | S | T | R | Use | Acres | C.F.S. |
| Fuller Canal | D-62 | 6/12/94 | 4 | 5 | 36 | Irrigation | 1670 | 23.86 |
| Frenchman Valley Canal | D-38 | 8/23/94 | 31 | 5 | 33 | " | 378 | 5.40 |
| North Guernsey Canal | D-74 | 1/14/95 | 3 | 5 | 37 | " | 91 | 1.30 |
| South Guernsey Canal | D-75 | 1/14/95 | 10 | 5 | 37 | " | 1580 | 22.57 |
| Hagerman Canal | A-935 | 3/11/09 | 19 | 5 | 34 | " | 60 | .86 |
| Total | | | | | | | 3,779 | 53.99 |

a/ Data except acreages published in Nebraska Bureau of Roads and Irrigation Biennial Reports.

## Anticipated Water Use of Future Private Development

It is anticipated that in the future there will be other depletions to the water supply available to the Frenchman Unit besides those that will be caused by the development of the irrigable lands. These other future depletions to the water supply considered in this study will be water used by private irrigation development, water used by development of ponds, and water used for municipal and industrial requirements. Table 21 is a tabulation of the total depletions from possible future private development of irrigation and ponds on Frenchman Creek above Enders Dam. Table 22 shows the total depletions below Enders Dam.

### Water use for private irrigation development

Future areas which could be privately irrigated are approximate values determined by use of maps in the Bureau of Agricultural Economics publication, June 1941, "Water Facilities Area Plan for the Upper Republican Basin in Nebraska, Kansas, and Colorado." Above Enders it is estimated that private irrigators could irrigate 1,850 acres in Colorado and 3,000 acres in Nebraska in addition to that now being irrigated. Below Enders Reservoir and above Culbertson Diversion Dam, it is estimated that private operators could irrigate 1,750 acres, more than at present, of which 500 acres lie along Frenchman Creek and 1,250 acres lie in the valley of Stinking Water Creek.

Water that could be used by the development of the 4,850 acres above Enders and by development of the 1,750 acres below Enders is computed by multiplying the total acreage by the consumptive use requirements of irrigation water as computed for the Frenchman project area, table 34. These depletions are shown in tables 17 and 18.

Some of this possible future development could conceivably obtain water by pumping direct from the stream; however it is likely that most of this development will obtain its water by pumping from wells. This development from wells would deplete the total annual flow from the area and would not deplete the flow of the stream in the irrigation season as greatly as if water were taken direct from the stream. In this study it was assumed that the pumping was direct from the stream because this condition would impose the most severe demand upon the stream flow during the irrigation season.

Past and present uses of water above Enders Reservoir and in the reach of Frenchman Creek between Enders and Palisade, Nebraska, are already reflected in the historical stream-flow records. For this reason the presently irrigated lands were not considered when estimating the future depletions that will be incurred in the development of this area.

Table 17. Depletions for future private irrigation development of 4850 acres above Enders Reservoir in Nebraska and Colorado a/
1000 acre-feet

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0.6 | 0 | 0.6 | 1.6 | 2.0 | 0.5 | 0.1 | 5.4 |
| 1930 | 0 | 0 | 0.3 | 0.8 | 1.3 | 0.5 | 0 | 2.9 |
| 1931 | 0 | 0 | 0.3 | 1.9 | 1.0 | 1.2 | 0.5 | 4.9 |
| 1932 | 0.2 | 0.1 | 0.3 | 1.3 | 1.9 | 1.3 | 0.4 | 5.5 |
| 1933 | 0.6 | 0.6 | 1.3 | 1.3 | 0.5 | 0.2 | 0.7 | 5.2 |
| 1934 | 0.9 | 1.4 | 0.3 | 2.0 | 1.6 | 0.8 | 0.6 | 7.6 |
| 1935 | 0.4 | 0 | 0 | 1.8 | 1.4 | 0.5 | 0.5 | 4.6 |
| 1936 | 0.8 | 0.1 | 1.3 | 1.6 | 2.1 | 1.0 | 0.7 | 7.6 |
| 1937 | 1.0 | 1.0 | 0.1 | 1.6 | 1.5 | 1.3 | 0.3 | 6.8 |
| 1938 | 0.3 | 0 | 0.8 | 1.0 | 1.1 | 1.0 | 0.7 | 4.9 |
| 1939 | 0.7 | 0.9 | 0.4 | 2.1 | 1.7 | 1.3 | 0.7 | 7.8 |
| 1940 | 0.4 | 0.5 | 1.2 | 1.5 | 1.7 | 0.9 | 0.5 | 6.7 |
| 1941 | 0 | 0.1 | 0 | 0.8 | 1.6 | 0 | 0 | 2.5 |
| 1942 | 0 | 0 | 0 | 1.8 | 1.4 | 0 | 0.4 | 3.6 |
| 1943 | 0.7 | 1.1 | 1.0 | 1.7 | 1.1 | 1.5 | 0.5 | 7.6 |
| 1944 | 0 | 0 | 0.1 | 0.6 | 1.5 | 1.3 | 0.5 | 4.0 |
| 1945 | 0.3 | 0.2 | 0.5 | 1.3 | 0.7 | 0.5 | 0.6 | 4.1 |
| 1946 | 1.3 | 0 | 0.2 | 1.0 | 1.4 | 0.6 | 0 | 4.5 |
| 1947 | 0 | 0 | 0 | 0.3 | 1.9 | 0.7 | 0.3 | 3.2 |
| Total Average | 0.4 | 0.3 | 0.5 | 1.4 | 1.4 | 0.8 | 0.4 | 5.2 |

a/ Based upon consumptive use requirements of irrigation water for the Frenchman Unit.

Table 18--Depletions for future private irrigation development of 1750 acres above Palisade Diversion Dam and below Enders Reservoir
1,000 acre-feet a/

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0.2 | 0 | 0.2 | 0.6 | 0.7 | 0.2 | 0.1 | 2.0 |
| 1930 | 0 | 0 | .1 | .2 | .5 | .2 | 0 | 1.0 |
| 1931 | 0 | 0 | .1 | .7 | .3 | .4 | .2 | 1.7 |
| 1932 | .1 | 0 | .1 | .5 | .7 | .5 | .1 | 2.0 |
| 1933 | .2 | .2 | .5 | .5 | .2 | .1 | .2 | 1.9 |
| 1934 | .3 | .5 | .1 | .7 | .6 | .3 | .2 | 2.7 |
| 1935 | .1 | 0 | 0 | .6 | .5 | .2 | .2 | 1.6 |
| 1936 | .3 | 0 | .5 | .6 | .7 | .4 | .2 | 2.7 |
| 1937 | .4 | .4 | .1 | .5 | .5 | .4 | .1 | 2.4 |
| 1938 | .1 | 0 | .3 | .4 | .4 | .3 | .3 | 1.8 |
| 1939 | .3 | .3 | .1 | .6 | .6 | .5 | .3 | 2.7 |
| 1940 | .2 | .2 | .4 | .5 | .6 | .3 | .2 | 2.4 |
| 1941 | 0 | 0 | 0 | .3 | .6 | 0 | 0 | 0.9 |
| 1942 | 0 | 0 | 0 | .6 | .5 | 0 | .2 | 1.3 |
| 1943 | .3 | .4 | .3 | .6 | .4 | .5 | .2 | 2.7 |
| 1944 | 0 | 0 | 0 | .2 | .6 | .5 | .2 | 1.5 |
| 1945 | .1 | .1 | .2 | .4 | .3 | .2 | .2 | 1.5 |
| 1946 | .4 | 0 | .1 | .4 | .5 | .2 | 0 | 1.6 |
| 1947 | 0 | 0 | 0 | .1 | .7 | .3 | .1 | 1.2 |
| Total Average | 0.2 | 0.1 | 0.2 | 0.5 | 0.5 | 0.3 | 0.1 | 1.9 |

a/ Includes 1250 acres on Stinking Water Creek

## Water use for development of ponds

Pond development above and below Enders Reservoir is estimated to be very small. Depletions were made for an average annual total of 200 acre-feet above Enders and 300 acre-feet below Enders. These depletions and their estimated monthly distribution are shown in tables 19 and 20.

## Water use for municipal and industrial requirements

No allowance was made for future municipal and industrial use above or below Enders Dam. At the present time, all communities in the unit obtain their water supply from wells.

# Project Water Supply

The principle water supply that will be used in developing the Frenchman Unit will be water stored in Enders Reservoir. Stream-flow accretions on Frenchman Creek between the reservoir and Culbertson Diversion Dam are considered to be available for diversion at Culbertson Diversion Dam. Return flow from lands irrigated in the unit will not be available for reuse. The return flow has been determined to show the water that will be available below the Frenchman Unit. Depletions in the water supply due to future private development, tables 21 and 22, were used in determining the water available for future irrigation development.

## Reservoir inflow

The water supply available for storage is the historical runoff at the dam site depleted for possible future private development above the dam. The depleted inflow at Enders Reservoir, table 23, is the historical flow, table 4, less the depletions from possible future private development for irrigation and ponds, table 21. This water supply study is based upon an irrigation storage capacity for Enders Reservoir of 29,000 acre-feet, the irrigation storage capacity at the end of 50 years of operation.

## Stream-flow sectional accretions

In addition to the water stored in Enders Reservoir, the gain in flow between Enders and Culbertson Diversion Dam, less the depletions for private development, is available for project use. To determine this gain in flow, the historic diversions into Culbertson Canal, table 24, were added to the historical river flow at Palisade, table 6, to produce, table 25, the estimated historical flow of Frenchman Creek at Culbertson Diversion Dam. The historical runoff at Enders, table 4, was then subtracted from the estimated flow at Culbertson Diversion Dam to obtain the gain in flow on Frenchman Creek, table 26, in this section. This gain in the flow includes the water from Stinking Water Creek. The gain in this reach was then depleted for possible future private development, table 22, and is presented in table 27. This

Table 19--Depletions for future private development of ponds above Enders Reservoir in Nebraska on Frenchman Creek.

1,000 acre-feet

| Year | May | June | Total |
|---|---|---|---|
| 1929 | 0.1 | 0.1 | 0.2 |
| 1930 | .1 | .1 | .2 |
| 1931 | .1 | .1 | .2 |
| 1932 | .1 | .1 | .2 |
| 1933 | .1 | .1 | .2 |
| 1934 | .1 | .1 | .2 |
| 1935 | .1 | .1 | .2 |
| 1936 | .1 | .1 | .2 |
| 1937 | .1 | .1 | .2 |
| 1938 | .1 | .1 | .2 |
| 1939 | .1 | .1 | .2 |
| 1940 | .1 | .1 | .2 |
| 1941 | .1 | .1 | .2 |
| 1942 | .1 | .1 | .2 |
| 1943 | .1 | .1 | .2 |
| 1944 | .1 | .1 | .2 |
| 1945 | .1 | .1 | .2 |
| 1946 | .1 | .1 | .2 |
| 1947 | .1 | .1 | .2 |
| Total |  |  |  |
| Average | 0.1 | 0.1 | 0.2 |

Table 20--Depletions for future private development of ponds below Enders Reservoir on Frenchman Creek.

1,000 acre-feet

| Year | May | June | July | Total |
|---|---|---|---|---|
| 1929 | 0.1 | 0.1 | 0.1 | 0.3 |
| 1930 | .1 | .1 | .1 | .3 |
| 1931 | .1 | .1 | .1 | .3 |
| 1932 | .1 | .1 | .1 | .3 |
| 1933 | .1 | .1 | .1 | .3 |
| 1934 | .1 | .1 | .1 | .3 |
| 1935 | .1 | .1 | .1 | .3 |
| 1936 | .1 | .1 | .1 | .3 |
| 1937 | .1 | .1 | .1 | .3 |
| 1938 | .1 | .1 | .1 | .3 |
| 1939 | .1 | .1 | .1 | .3 |
| 1940 | .1 | .1 | .1 | .3 |
| 1941 | .1 | .1 | .1 | .3 |
| 1942 | .1 | .1 | .1 | .3 |
| 1943 | .1 | .1 | .1 | .3 |
| 1944 | .1 | .1 | .1 | .3 |
| 1945 | .1 | .1 | .1 | .3 |
| 1946 | .1 | .1 | .1 | .3 |
| 1947 | .1 | .1 | .1 | .3 |
| Total Average | 0.1 | 0.1 | 0.1 | 0.3 |

Table 21. Total depletions for future private development for irrigation and ponds above Enders Dam a/

(Unit -- 1000 acre-feet)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0.6 | 0.1 | 0.7 | 1.6 | 2.0 | 0.5 | 0.1 | 5.6 |
| 1930 | 0 | 0.1 | 0.4 | 0.8 | 1.3 | 0.5 | 0 | 3.1 |
| 1931 | 0 | 0.1 | 0.4 | 1.9 | 1.0 | 1.2 | 0.5 | 5.1 |
| 1932 | 0.2 | 0.2 | 0.4 | 1.3 | 1.9 | 1.3 | 0.4 | 5.7 |
| 1933 | 0.6 | 0.7 | 1.4 | 1.3 | 0.5 | 0.2 | 0.7 | 5.4 |
| 1934 | 0.9 | 1.5 | 0.4 | 2.0 | 1.6 | 0.8 | 0.6 | 7.8 |
| 1935 | 0.4 | 0.1 | 0.1 | 1.8 | 1.4 | 0.5 | 0.5 | 4.8 |
| 1936 | 0.8 | 0.2 | 1.4 | 1.6 | 2.1 | 1.0 | 0.7 | 7.8 |
| 1937 | 1.0 | 1.1 | 0.2 | 1.6 | 1.5 | 1.3 | 0.3 | 7.0 |
| 1938 | 0.3 | 0.1 | 0.9 | 1.0 | 1.1 | 1.0 | 0.7 | 5.1 |
| 1939 | 0.7 | 1.0 | 0.5 | 2.1 | 1.7 | 1.3 | 0.7 | 8.0 |
| 1940 | 0.4 | 0.6 | 1.3 | 1.5 | 1.7 | 0.9 | 0.5 | 6.9 |
| 1941 | 0 | 0.2 | 0.1 | 0.8 | 1.6 | 0 | 0 | 2.7 |
| 1942 | 0 | 0.1 | 0.1 | 1.8 | 1.4 | 0 | 0.4 | 3.8 |
| 1943 | 0.7 | 1.2 | 1.1 | 1.7 | 1.1 | 1.5 | 0.5 | 7.8 |
| 1944 | 0 | 0.1 | 0.2 | 0.6 | 1.5 | 1.3 | 0.5 | 4.2 |
| 1945 | 0.3 | 0.3 | 0.6 | 1.3 | 0.7 | 0.5 | 0.6 | 4.3 |
| 1946 | 1.3 | 0.1 | 0.3 | 1.0 | 1.4 | 0.6 | 0 | 4.7 |
| 1947 | 0 | 0.1 | 0.1 | 0.3 | 1.9 | 0.7 | 0.3 | 3.4 |
| Total Average | 0.4 | 0.4 | 0.6 | 1.4 | 1.4 | 0.8 | 0.4 | 5.4 |

a/ Includes depletions for developing 1850 acres in Colorado; 3000 acres for irrig. and 200 ac-ft depletion for ponds above Enders Dam Site and below Colo-Nebr. State line.

Table 22--Depletions from possible future private development of irrigation and ponds between Enders Dam and Palisade. a/

(1,000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0 | 0 | 0 | 0.2 | 0.1 | 0.3 | 0.7 | 0.7 | 0.2 | 0.1 | 0 | 0 | 2.3 |
| 1930 | 0 | 0 | 0 | 0 | .1 | .2 | .3 | .5 | .2 | 0 | 0 | 0 | 1.3 |
| 1931 | 0 | 0 | 0 | 0 | .1 | .2 | .8 | .3 | .4 | .2 | 0 | 0 | 2.0 |
| 1932 | 0 | 0 | 0 | .1 | .1 | .2 | .6 | .7 | .5 | .1 | 0 | 0 | 2.3 |
| 1933 | 0 | 0 | 0 | .2 | .3 | .6 | .6 | .2 | .1 | .2 | 0 | 0 | 2.2 |
| 1934 | 0 | 0 | 0 | .3 | .6 | .2 | .8 | .6 | .3 | .2 | 0 | 0 | 3.0 |
| 1935 | 0 | 0 | 0 | .1 | .1 | .1 | .7 | .5 | .2 | .2 | 0 | 0 | 1.9 |
| 1936 | 0 | 0 | 0 | .3 | .1 | .6 | .7 | .7 | .4 | .2 | 0 | 0 | 3.0 |
| 1937 | 0 | 0 | 0 | .4 | .5 | .2 | .6 | .5 | .4 | .1 | 0 | 0 | 2.7 |
| 1938 | 0 | 0 | 0 | .1 | .1 | .4 | .5 | .4 | .3 | .3 | 0 | 0 | 2.1 |
| 1939 | 0 | 0 | 0 | .3 | .4 | .2 | .7 | .6 | .5 | .3 | 0 | 0 | 3.0 |
| 1940 | 0 | 0 | 0 | .2 | .3 | .5 | .6 | .6 | .3 | .2 | 0 | 0 | 2.7 |
| 1941 | 0 | 0 | 0 | 0 | .1 | .1 | .4 | .6 | 0 | 0 | 0 | 0 | 1.2 |
| 1942 | 0 | 0 | 0 | 0 | .1 | .1 | .7 | .5 | 0 | .2 | 0 | 0 | 1.6 |
| 1943 | 0 | 0 | 0 | .3 | .5 | .4 | .7 | .4 | .5 | .2 | 0 | 0 | 3.0 |
| 1944 | 0 | 0 | 0 | 0 | .1 | .1 | .3 | .6 | .5 | .2 | 0 | 0 | 1.8 |
| 1945 | 0 | 0 | 0 | .1 | .2 | .3 | .5 | .3 | .2 | .2 | 0 | 0 | 1.8 |
| 1946 | 0 | 0 | 0 | .4 | .1 | .2 | .5 | .5 | .2 | 0 | 0 | 0 | 1.9 |
| 1947 | 0 | 0 | 0 | 0 | .1 | .1 | .2 | .7 | .3 | .1 | 0 | 0 | 1.5 |
| Total Average | 0 | 0 | 0 | 0.1 | 0.2 | 0.3 | 0.6 | 0.5 | 0.3 | 0.2 | 0 | 0 | 2.2 |

a/ Includes depletions required for private development of 1750 acres and 300 acre-feet for depletions due to ponds.

Table 23. Depleted inflow into Enders Reservoir a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 5.1 | 5.2 | 5.4 | 4.8 | 5.3 | 4.7 | 2.6 | 2.1 | 4.0 | 4.6 | 4.7 | 4.4 | 52.9 |
| 1930 | 4.1 | 4.8 | 4.9 | 4.8 | 5.2 | 4.7 | 3.9 | 3.2 | 3.6 | 4.9 | 4.4 | 5.3 | 53.8 |
| 1931 | 5.5 | 5.4 | 5.6 | 5.6 | 4.9 | 4.3 | 2.3 | 4.9 | 3.1 | 4.2 | 4.7 | 4.9 | 55.4 |
| 1932 | 5.4 | 5.8 | 5.4 | 4.7 | 4.6 | 5.0 | 3.4 | 3.1 | 3.0 | 4.7 | 5.1 | 4.8 | 55.0 |
| 1933 | 5.8 | 5.2 | 5.3 | 4.5 | 4.6 | 2.8 | 3.1 | 4.8 | 5.5 | 4.4 | 5.2 | 5.5 | 56.7 |
| 1934 | 5.6 | 5.2 | 6.3 | 4.2 | 3.1 | 5.6 | 2.1 | 2.8 | 3.9 | 4.3 | 5.5 | 5.3 | 53.9 |
| 1935 | 5.3 | 4.8 | 5.5 | 4.9 | 7.8 | 7.4 | 2.6 | 2.8 | 4.0 | 4.2 | 5.2 | 5.3 | 59.8 |
| 1936 | 5.6 | 5.5 | 5.8 | 4.8 | 6.1 | 3.4 | 2.3 | 2.1 | 3.5 | 3.6 | 4.5 | 4.8 | 52.0 |
| 1937 | 4.5 | 5.1 | 5.4 | 3.4 | 3.6 | 5.6 | 3.1 | 2.8 | 2.9 | 4.1 | 4.5 | 4.8 | 49.8 |
| 1938 | 4.9 | 4.7 | 4.9 | 4.6 | 4.9 | 5.3 | 4.3 | 3.0 | 4.0 | 3.6 | 4.6 | 4.5 | 53.3 |
| 1939 | 5.0 | 4.4 | 4.9 | 4.1 | 3.2 | 4.8 | 2.1 | 2.5 | 2.8 | 3.6 | 4.3 | 4.4 | 46.1 |
| 1940 | 4.3 | 5.0 | 5.2 | 4.1 | 3.6 | 11.4 | 3.7 | 3.1 | 3.7 | 4.2 | 4.6 | 5.3 | 58.2 |
| 1941 | 5.4 | 5.1 | 5.0 | 5.6 | 5.4 | 5.8 | 4.6 | 2.8 | 4.4 | 5.3 | 4.9 | 5.1 | 59.4 |
| 1942 | 5.6 | 5.4 | 5.9 | 5.8 | 5.9 | 5.8 | 2.7 | 3.0 | 6.1 | 5.1 | 5.6 | 5.7 | 62.6 |
| 1943 | 5.5 | 5.2 | 5.1 | 4.3 | 3.6 | 5.5 | 3.0 | 3.5 | 2.8 | 4.1 | 4.9 | 4.9 | 52.4 |
| 1944 | 5.3 | 5.3 | 5.6 | 5.7 | 5.8 | 4.9 | 4.4 | 3.1 | 2.8 | 4.4 | 5.1 | 5.1 | 57.5 |
| 1945 | 5.4 | 5.1 | 5.0 | 4.9 | 4.6 | 5.3 | 3.4 | 3.8 | 4.4 | 4.9 | 4.8 | 5.0 | 56.6 |
| 1946 | 5.6 | 5.0 | 5.4 | 3.5 | 4.9 | 3.9 | 3.8 | 2.7 | 5.1 | 5.6 | 5.9 | 5.5 | 56.9 |
| 1947 | 5.6 | 5.3 | 5.0 | 4.9 | 5.1 | 5.7 | 5.1 | 2.6 | 4.0 | -- | -- | -- | 43.3 |
| Total Average | 5.2 | 5.1 | 5.3 | 4.7 | 4.8 | 5.4 | 3.3 | 3.1 | 3.9 | 4.4 | 4.9 | 5.0 | 55.1 |

a/ Historic flow near Enders less depletions for future private development of irrigation and ponds above Enders Dam Site.

Table 24.--Historical diversions from Frenchman Creek into Culbertson Canal a/

(Unit 1,000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 4.6 | 0.9 | 0 | 0 | 0 | 0 | 0 | 1.5 | 3.4 | 5.4 | 5.8 | 4.9 | 26.5 |
| 1930 | 4.9 | 0 | 0 | 0 | 0 | 0 | 0 | 3.9 | 3.5 | 6.6 | 5.5 | 2.9 | 27.3 |
| 1931 | 2.0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1 | 5.1 | 5.2 | 4.6 | 4.6 | 23.6 |
| 1932 | 4.5 | 0 | 0 | 0 | 0 | 0 | 1.6 | 4.4 | 2.8 | 6.0 | 6.6 | 5.5 | 31.4 |
| 1933 | 7.0 | 2.9 | 0 | 0 | 0 | 0 | 2.3 | 3.4 | 6.0 | 5.7 | 4.4 | 1.3 | 33.0 |
| 1934 | 3.9 | 4.4 | 0 | 0 | 0 | 0 | 0 | 6.1 | 3.3 | 5.3 | 5.3 | 3.4 | 31.7 |
| 1935 | 5.3 | 4.5 | 0 | 0 | 0 | 0 | 2.4 | 3.4 | 0.6 | 4.8 | 5.3 | 4.1 | 30.4 |
| 1936 | 4.6 | 0.8 | 0 | 0 | 0 | 0 | 2.9 | 3.4 | 3.9 | 4.5 | 5.1 | 4.9 | 30.1 |
| 1937 | 4.6 | 1.0 | 0 | 0 | 0 | 0 | 1.8 | 5.2 | 2.9 | 5.3 | 5.4 | 4.8 | 31.0 |
| 1938 | 4.7 | 2.5 | 0 | 0 | 0 | 0 | 1.1 | 3.4 | 3.1 | 4.6 | 5.1 | 3.6 | 28.1 |
| 1939 | 4.7 | 3.3 | 0 | 0 | 0 | 0 | 0 | 5.1 | 4.1 | 4.8 | 5.5 | 4.8 | 32.3 |
| 1940 | 4.7 | 4.5 | 0.1 | 0 | 0 | 0 | 0.3 | 4.5 | 3.8 | 6.0 | 5.5 | 4.9 | 34.3 |
| 1941 | 3.4 | 1.6 | 0 | 0 | 0 | 0 | 0 | 2.5 | 2.8 | 3.7 | 4.7 | 3.4 | 22.1 |
| 1942 | 2.0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0.5 | 1.5 | 3.7 | 5.2 | 1.6 | 14.6 |
| 1943 | 1.3 | 0 | 0 | 0 | 0 | 0 | 0.7 | 5.0 | 3.3 | 5.7 | 5.7 | 5.2 | 26.9 |
| 1944 | 4.2 | 0.8 | 0 | 0 | 0 | 0 | 0 | 0.9 | 2.7 | 3.5 | 5.4 | 4.4 | 21.9 |
| 1945 | 4.0 | 1.7 | 0 | 0 | 0 | 0 | 0.2 | 4.4 | 2.0 | 3.8 | 4.6 | 4.2 | 24.9 |
| 1946 | 3.2 | 0.8 | 0 | 0 | 0 | 0 | 0.9 | 3.6 | 3.5 | 3.2 | 4.9 | 4.0 | 24.1 |
| 1947 | 1.9 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1 | 2.9 | 2.0 | 5.5 | 3.8 | 19.2 |
| Total | | | | | | | | | | | | | |
| Average | 4.0 | 1.6 | 0 | 0 | 0 | 0 | 0.7 | 3.5 | 3.2 | 4.7 | 5.3 | 4.0 | 27.0 |

a/ Records except for May-Oct. 1930 which are assumed to be same use per acre as Meeker Canal.

Table 25.—Estimated historical flow of Frenchman Creek at Culbertson Diversion Dam a/

(Unit - 1,000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 8.9 | 13.3 | 8.2 | 8.1 | 9.1 | 9.1 | 8.2 | 10.2 | 7.8 | 5.9 | 6.0 | 6.3 | 101.1 |
| 1930 | 8.6 | 7.7 | 9.1 | 6.7 | 6.8 | 7.3 | 6.7 | 13.5 | 9.4 | 8.5 | 10.2 | 7.5 | 102.1 |
| 1931 | 11.0 | 9.5 | 12.0 | 7.0 | 6.5 | 6.9 | 6.5 | 6.7 | 6.5 | 6.6 | 9.7 | 5.6 | 94.5 |
| 1932 | 7.0 | 6.5 | 7.0 | 7.3 | 7.6 | 10.0 | 8.3 | 7.8 | 9.0 | 7.4 | 8.7 | 5.9 | 92.5 |
| 1933 | 8.5 | 7.1 | 6.2 | 8.7 | 8.7 | 9.6 | 8.4 | 7.6 | 6.6 | 6.3 | 10.6 | 11.0 | 99.3 |
| 1934 | 8.9 | 8.1 | 9.4 | 9.2 | 8.4 | 8.5 | 5.7 | 6.9 | 10.9 | 6.4 | 6.0 | 5.8 | 94.2 |
| 1935 | 6.9 | 6.8 | 7.8 | 8.4 | 7.0 | 8.7 | 7.4 | 26.6 | 18.6 | 10.0 | 6.3 | 7.5 | 122.0 |
| 1936 | 7.1 | 6.7 | 7.3 | 7.8 | 8.0 | 9.2 | 8.9 | 10.7 | 8.5 | 5.1 | 5.6 | 5.6 | 90.5 |
| 1937 | 5.1 | 4.9 | 7.1 | 5.1 | 6.8 | 7.3 | 6.4 | 6.4 | 10.4 | 6.6 | 6.0 | 5.6 | 77.7 |
| 1938 | 5.7 | 6.0 | 6.9 | 7.6 | 6.9 | 6.9 | 7.4 | 10.1 | 10.8 | 7.1 | 6.1 | 6.9 | 88.4 |
| 1939 | 5.9 | 5.9 | 6.2 | 7.6 | 6.1 | 7.5 | 7.5 | 7.0 | 7.9 | 6.2 | 6.0 | 5.3 | 79.1 |
| 1940 | 5.5 | 5.7 | 4.9 | 4.9 | 8.0 | 9.2 | 7.2 | 7.0 | 21.5 | 7.5 | 6.6 | 6.4 | 94.4 |
| 1941 | 7.1 | 6.4 | 10.0 | 8.7 | 8.2 | 8.0 | 8.7 | 9.2 | 10.8 | 8.5 | 5.5 | 5.2 | 96.3 |
| 1942 | 8.4 | 6.9 | 7.2 | 6.9 | 7.8 | 9.9 | 9.9 | 11.5 | 11.4 | 6.7 | 6.5 | 9.3 | 102.4 |
| 1943 | 8.4 | 7.3 | 8.1 | 7.6 | 7.6 | 8.4 | 7.3 | 6.6 | 9.3 | 6.4 | 6.1 | 5.7 | 88.8 |
| 1944 | 6.1 | 6.4 | 6.7 | 6.8 | 8.3 | 9.3 | 11.3 | 10.6 | 10.3 | 9.4 | 6.6 | 5.2 | 97.0 |
| 1945 | 7.5 | 7.5 | 7.2 | 7.2 | 7.2 | 7.2 | 7.1 | 8.0 | 11.2 | 6.8 | 6.5 | 7.3 | 90.7 |
| 1946 | 9.5 | 7.1 | 6.1 | 7.6 | 7.0 | 8.0 | 6.9 | 8.0 | 8.1 | 9.4 | 5.6 | 8.5 | 91.8 |
| 1947 | 11.7 | 8.7 | 7.9 | 7.5 | 7.3 | 8.4 | 7.7 | 9.1 | 11.9 | 9.2 | 6.4 | 5.2 | 101.0 |
| Total Avg. | 7.7 | 7.3 | 7.7 | 7.4 | 7.6 | 8.4 | 7.7 | 9.7 | 10.5 | 7.4 | 6.9 | 6.6 | 94.9 |

a/ Oct. 1928 - Dec. 1930 are records plus Culbertson Canal diversions. Remainder are correlations with Frenchman Creek at Culbertson plus Culbertson Canal diversions.

Table 26.—Inflow on Frenchman Creek between Enders Dam and Culbertson Diversion Dam a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | | | | | | | | | | 3.9 | 8.1 | 2.9 | 14.9 |
| 1929 | 3.0 | 3.9 | 3.7 | 2.8 | 4.8 | 2.4 | 1.7 | 1.9 | 1.8 | 3.9 | 3.0 | 4.7 | 37.6 |
| 1930 | 2.6 | 2.0 | 2.5 | 1.9 | 8.2 | 4.3 | 3.8 | 5.7 | 3.4 | 6.1 | 5.1 | 6.7 | 52.3 |
| 1931 | 1.5 | 1.1 | 1.3 | 0.9 | 1.7 | 1.8 | 2.4 | 3.8 | 1.3 | 2.3 | 1.8 | 2.1 | 22.0 |
| 1932 | 1.9 | 1.8 | 4.6 | 3.4 | 3.0 | 3.6 | 2.7 | 3.7 | 1.6 | 3.4 | 2.0 | 1.4 | 33.1 |
| 1933 | 2.9 | 3.5 | 4.3 | 3.3 | 2.3 | 2.4 | 1.9 | 5.3 | 5.3 | 3.8 | 2.9 | 3.9 | 41.8 |
| 1934 | 3.6 | 3.2 | 2.2 | 0.6 | 2.3 | 4.9 | 2.3 | 1.6 | 1.1 | 2.0 | 1.3 | 2.5 | 27.6 |
| 1935 | 3.1 | 2.2 | 3.2 | 2.1 | 18.7 | 11.1 | 5.6 | 2.1 | 3.0 | 2.4 | 1.5 | 2.0 | 57.0 |
| 1936 | 2.2 | 2.5 | 3.4 | 3.3 | 4.4 | 3.7 | 1.2 | 1.4 | 1.1 | 0.8 | 0.4 | 2.3 | 26.7 |
| 1937 | 0.6 | 1.7 | 1.9 | 2.0 | 1.7 | 4.6 | 1.9 | 1.7 | 1.4 | 1.3 | 1.5 | 2.1 | 22.4 |
| 1938 | 2.7 | 2.2 | 2.0 | 2.5 | 5.1 | 4.6 | 1.8 | 2.0 | 1.9 | 1.6 | 1.3 | 1.7 | 29.4 |
| 1939 | 2.6 | 1.7 | 2.6 | 2.7 | 2.8 | 2.6 | 2.0 | 1.8 | 1.2 | 1.2 | 1.4 | 0.5 | 23.1 |
| 1940 | 0.6 | 3.0 | 4.0 | 2.7 | 2.8 | 8.8 | 2.3 | 1.8 | 1.8 | 2.4 | 1.8 | 4.7 | 36.7 |
| 1941 | 3.3 | 3.1 | 3.0 | 3.1 | 3.6 | 4.9 | 3.1 | 1.1 | 0.8 | 3.1 | 2.0 | 2.1 | 33.2 |
| 1942 | 1.3 | 2.4 | 4.0 | 4.1 | 5.5 | 5.5 | 2.2 | 2.1 | 3.2 | 2.9 | 1.7 | 2.4 | 37.3 |
| 1943 | 2.1 | 2.4 | 3.3 | 2.3 | 1.8 | 2.7 | 1.7 | 1.5 | 1.4 | 1.5 | 1.5 | 1.8 | 24.0 |
| 1944 | 1.5 | 3.0 | 3.7 | 5.6 | 4.7 | 5.2 | 4.4 | 2.0 | 1.1 | 2.6 | 2.4 | 2.1 | 38.3 |
| 1945 | 1.8 | 2.1 | 2.2 | 1.9 | 3.1 | 5.3 | 2.1 | 2.0 | 2.4 | 4.0 | 2.3 | 1.1 | 30.3 |
| 1946 | 2.0 | 2.0 | 2.6 | 2.1 | 3.0 | 3.9 | 4.6 | 1.5 | 2.8 | 6.1 | 2.8 | 2.4 | 35.8 |
| 1947 | 1.9 | 2.0 | 3.4 | 2.8 | 3.9 | 6.1 | 3.8 | 1.9 | 0.5 | | | | 26.3 |
| Total Average | 2.2 | 2.4 | 3.0 | 2.6 | 4.4 | 4.7 | 2.7 | 2.4 | 1.9 | 2.9 | 2.4 | 2.6 | 34.2 |

a/ Culbertson Diversion Dam run-off considered same as run-off of Frenchman Creek near Palisade plus diversions into the canal.

Table 27.—Depleted inflow on Frenchman Creek between Enders Dam Site and Culbertson Diversion Dam. a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | — | — | — | — | — | — | — | — | — | 3.7 | 8.1 | 2.9 | 14.7 |
| 1929 | 3.0 | 3.9 | 3.7 | 2.6 | 4.7 | 2.1 | 1.0 | 1.2 | 1.6 | 3.8 | 3.0 | 4.7 | 35.3 |
| 1930 | 2.6 | 2.0 | 2.5 | 1.9 | 8.1 | 4.1 | 3.5 | 5.2 | 3.2 | 6.1 | 5.1 | 6.7 | 51.0 |
| 1931 | 1.5 | 1.1 | 1.3 | 0.9 | 1.6 | 1.6 | 1.6 | 3.5 | 0.9 | 2.1 | 1.8 | 2.1 | 20.0 |
| 1932 | 1.9 | 1.8 | 4.6 | 3.3 | 2.9 | 3.4 | 2.1 | 3.0 | 1.1 | 3.3 | 2.0 | 1.4 | 30.8 |
| 1933 | 2.9 | 3.5 | 4.3 | 3.1 | 2.0 | 1.8 | 1.3 | 5.1 | 5.2 | 3.6 | 2.9 | 3.9 | 39.6 |
| 1934 | 3.6 | 3.2 | 2.2 | 0.3 | 1.7 | 4.7 | 1.5 | 1.0 | 0.8 | 1.8 | 1.3 | 2.5 | 24.6 |
| 1935 | 3.1 | 2.2 | 3.2 | 2.0 | 18.6 | 11.0 | 4.9 | 1.6 | 2.8 | 2.2 | 1.5 | 2.0 | 55.1 |
| 1936 | 2.2 | 2.5 | 3.4 | 3.0 | 4.3 | 3.1 | 0.5 | 0.7 | 0.7 | 0.6 | 0.4 | 2.3 | 23.7 |
| 1937 | 0.6 | 1.7 | 1.9 | 1.6 | 1.2 | 4.4 | 1.3 | 1.2 | 1.0 | 1.2 | 1.5 | 2.1 | 19.7 |
| 1938 | 2.7 | 2.2 | 2.0 | 2.4 | 5.0 | 4.2 | 1.3 | 1.6 | 1.6 | 1.3 | 1.3 | 1.7 | 27.3 |
| 1939 | 2.6 | 1.7 | 2.6 | 2.4 | 2.4 | 2.4 | 1.3 | 1.2 | 0.7 | 0.9 | 1.4 | 0.5 | 20.1 |
| 1940 | 0.6 | 3.0 | 4.0 | 2.5 | 2.5 | 8.3 | 1.7 | 1.2 | 1.5 | 2.2 | 1.8 | 4.7 | 34.0 |
| 1941 | 3.3 | 3.1 | 3.0 | 3.1 | 3.5 | 4.8 | 2.7 | 0.5 | 0.8 | 3.1 | 2.0 | 2.1 | 32.0 |
| 1942 | 1.3 | 2.4 | 4.0 | 4.1 | 5.4 | 5.4 | 1.5 | 1.6 | 3.2 | 2.7 | 1.7 | 2.4 | 35.7 |
| 1943 | 2.1 | 2.4 | 3.3 | 2.0 | 1.3 | 2.3 | 1.0 | 1.1 | 0.9 | 1.3 | 1.5 | 1.8 | 21.0 |
| 1944 | 1.5 | 3.0 | 3.7 | 5.6 | 4.6 | 5.1 | 4.1 | 1.4 | 0.6 | 2.4 | 2.4 | 2.1 | 36.5 |
| 1945 | 1.8 | 2.1 | 2.2 | 1.8 | 2.9 | 5.0 | 1.6 | 1.7 | 2.2 | 3.8 | 2.3 | 1.1 | 28.5 |
| 1946 | 2.0 | 2.0 | 2.6 | 1.7 | 2.9 | 3.7 | 4.1 | 1.0 | 2.6 | 6.1 | 2.8 | 2.4 | 33.9 |
| 1947 | 1.9 | 2.0 | 3.4 | 2.8 | 3.8 | 6.0 | 3.6 | 1.2 | 0.2 | — | — | — | 24.9 |
| Total Average | 2.2 | 2.4 | 3.0 | 2.5 | 4.2 | 4.4 | 2.1 | 1.8 | 1.7 | 2.7 | 2.4 | 2.6 | 32.0 |

a/ Stream accretions between Enders and Culbertson Diversion Dam less depletions by possible future private development of irrigation and ponds.

sectional gain was utilized only during the summer by diverting the amount necessary to meet the diversion requirements of lands under the Frenchman Unit. Water in excess of these diversion requirements was passed downstream as waste water.

Return flow

It has been explained, while discussing the project water supply, that no return flows are considered available for reuse in the Frenchman Unit. The return flows that will result from future irrigation development are figured for the purpose of determining the flow passing the unit and available for use downstream.

Return flow is the residual portion diverted which is not consumed by evaporation or transpiration. Return flows entering the stream as live flow are conventionally computed to be a percentage of the difference between diversion and crop irrigation requirements. Because return flows from lands presently irrigated are reflected in the historical flow records, all return flow from the irrigated land under full development cannot be considered as increased flow due to development of this unit. The annual increase in return flow due to the planned development, table 28,was obtained by determining the return flow from the annual increase in diversion requirement over present diversions. This was done by computing the difference between diversions required for the planned development, table 36, and the historic diversion, table 24. The return flow from the increase in diversion requirement was then determined to be 75 percent of the water that would be lost in canals and on the farm in distributing the increased requirement to the crop. Canal and farm losses are determined to be 25 and 30 percent, respectively, in the following water requirements discussion.

An evaluation of the physical conditions in the area indicates there are no large areas which would cause great losses of return flows due to increased consumptive use by trees or other vegetation. It is estimated that 75 percent of farm losses and distribution losses will reach the stream bed from the Frenchman Unit.

Monthly distribution of return flow in percent of annual return flow used to determine the distribution of return flows from additional diversions is as follows:

| | percent | | percent | | percent | | percent |
|---|---|---|---|---|---|---|---|
| January | 7 | April | 6 | July | 9 | Oct. | 11 |
| February | 6 | May | 7 | August | 11 | Nov. | 9 |
| March | 6 | June | 8 | Sept. | 12 | Dec. | 8 |

These percentages are nearly the same as found in the North Platte Project. They have been altered slightly because a longer irrigation season is expected in this area. The distribution of return flows resulting from the increased diversions required for development of this unit are listed in table 29.

Table 28.--Determination of increase in annual return flow over historical return flow for Frenchman Unit

(Unit - 1000 acre-feet)

| Year | Annual diversion requirements | Annual historic diversions a/ | Increase in diversion requirements | Return flow from increased diversions b/ |
|---|---|---|---|---|
| 1929 | 48.8 | 25.9 | 22.9 | 8.2 |
| 1930 | 24.3 | 24.4 | -0.1 | 0 |
| 1931 | 43.1 | 26.1 | 17.0 | 6.1 |
| 1932 | 49.8 | 36.8 | 13.0 | 4.6 |
| 1933 | 47.0 | 31.4 | 15.6 | 5.6 |
| 1934 | 59.1 c/ | 33.2 | 25.9 | 9.2 |
| 1935 | 40.8 | 26.0 | 14.8 | 5.3 |
| 1936 | 53.5 c/ | 30.3 | 23.2 | 8.3 |
| 1937 | 50.0 c/ | 32.6 | 17.4 | 6.2 |
| 1938 | 44.3 | 28.9 | 15.4 | 5.5 |
| 1939 | 57.8 c/ | 33.6 | 24.2 | 8.6 |
| 1940 | 60.5 | 30.0 | 30.5 | 10.9 |
| 1941 | 23.2 | 19.2 | 4.0 | 1.4 |
| 1942 | 31.8 | 13.8 | 18.0 | 6.4 |
| 1943 | 60.5 | 30.6 | 29.9 | 10.6 |
| 1944 | 36.7 | 22.6 | 14.1 | 5.0 |
| 1945 | 36.7 | 23.2 | 13.5 | 4.8 |
| 1946 | 40.1 | 22.0 | 18.1 | 6.4 |
| 1947 | 29.5 | 20.7 | 8.8 | 3.1 |
| Total Average | 44.1 | 26.9 | 17.2 | 6.1 |

a/ Calendar year

b/ Return flow from increased diversions is equal to 75% (25% of the diversion requirement + 30% of the farm delivery requirement)

c/ Shortage year, annual diversion requirement is diversion made in operation study.

Table 29.—Distribution of return flow from additional diversions, a/ - Frenchman Unit

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % of Annual | 7 | 6 | 6 | 6 | 7 | 8 | 9 | 11 | 12 | 11 | 9 | 8 | |
| 1929 b/ | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.9 | 1.0 | 0.9 | 0.7 | 0.7 | 7.8 |
| 1930 | .6 | .5 | .5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.6 |
| 1931 | 0 | 0 | 0 | .4 | .4 | .5 | 0.5 | 0.7 | 0.7 | 0.7 | 0.5 | .5 | 4.9 |
| 1932 | .4 | .4 | .4 | .3 | .3 | .4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | .4 | 4.9 |
| 1933 | .3 | .3 | .3 | .3 | .4 | .5 | 0.5 | 0.6 | 0.7 | 0.6 | 0.5 | .5 | 5.5 |
| 1934 | .4 | .3 | .3 | .6 | .6 | .7 | 0.8 | 1.0 | 1.1 | 1.0 | 0.8 | .7 | 8.3 |
| 1935 | .7+ | .6 | .6 | .3 | .4 | .4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | .4 | 6.2 |
| 1936 | .4 | .3 | .3 | .5 | .6 | .7 | 0.7 | 0.9 | 1.0 | 0.9 | 0.7 | .7 | 7.7 |
| 1937 | .6 | .5 | .5 | .4 | .4 | .5 | 0.5 | 0.7 | 0.7 | 0.7 | 0.6 | .5 | 6.6 |
| 1938 | .4 | .4 | .4 | .3 | .4 | .4 | 0.5 | 0.6 | 0.7 | 0.6 | 0.5 | .5 | 5.7 |
| 1939 | .4 | .3 | .3 | .5 | .6 | .7 | 0.8 | 0.9 | 1.0 | 1.0+ | 0.8 | .7 | 8.0 |
| 1940 | .6 | .5 | .5 | .6 | .8 | .9 | 1.0 | 1.2 | 1.3 | 1.2 | 1.0 | .9 | 10.5 |
| 1941 | .8 | .6 | .6 | .1 | .1 | .1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | .1 | 3.1 |
| 1942 | .1 | .1 | .1 | .4 | .4 | .5 | 0.6 | 0.7 | 0.8 | 0.7 | 0.6 | .5 | 5.5 |
| 1943 | .4 | .4 | .4 | .6 | .7 | .8 | 1.0 | 1.2 | 1.3 | 1.2 | 1.0 | .9+ | 9.9 |
| 1944 | .7 | .6 | .6 | .3 | .4 | .4 | 0.4 | 0.5 | 0.6 | 0.5 | 0.5 | .4 | 5.9 |
| 1945 | .4 | .3 | .3 | .3 | .3 | .4 | 0.4 | 0.5 | 0.6 | 0.5 | 0.4 | .4 | 4.8 |
| 1946 | .4+ | .3 | .3 | .4 | .4 | .5 | 0.6 | 0.7 | 0.8 | 0.7 | 0.6 | .5 | 6.2 |
| 1947 | .4 | .4 | .4 | .2 | .2 | .2 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | .3 | 3.7 |
| Total Average | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.7 | 0.7 | 0.7 | 0.5 | 0.5 | 6.1 |

a/ Corrected for all shortages.

b/ Jan., Feb., and Mar., Aug. for all other years used.

## Frenchman Unit

### Water Requirements

Water requirements for the Frenchman Unit that will create a demand on Enders Reservoir include the water required for irrigating the lands, water lost due to evaporation from the reservoir and water lost as seepage from the reservoir. The water requirement for irrigation is dependent upon the consumptive use of water by irrigated crops, the effective precipitation in the area, transportation losses, and farm losses.

#### Determination of irrigation and diversion requirements

Requirements for irrigation water, as treated in the Frenchman Project area, are based on the several factors listed above affecting the use of water.

The procedure followed for determining the irrigation and diversion requirement was as follows: The consumptive use and the effective precipitation were first determined. The consumptive use of irrigation water was then determined by subtracting the effective precipitation from the consumptive use. The diversion requirements were then determined as explained in the following discussion of diversion requirements. Determination of the above factors is shown in the following discussion:

Consumptive use.—The Lowry-Johnson method was employed in determining the consumptive use requirements for the project area.1/ This method establishes a relationship between effective heat units and annual consumptive use of water. The correlation was established with reference to a considerable number of irrigated areas receiving a full water supply where the difference between total inflows and outflows could be observed. Consumptive use requirements were determined by using temperature data recorded by the weather station at Culbertson, Nebraska. This station is considered to represent the average conditions existing in the project area. By determining the accumulated maximum daily temperatures in degrees above a minimum of 32 degrees during the effective growing season, it is possible to determine the annual consumptive use by using the Lowry-Johnson curve. The effective growing season is defined from a smoothed curve showing the date on which the minimum temperature rises above 32 degrees in the spring and remains above it until the temperature drops below that temperature in the fall. Table 30 presents the computed effective heat in day degrees and the annual consumptive use in feet for the Frenchman Unit.

The annual consumptive use, table 30, was distributed throughout the year, table 31, by using the following percentages of the annual consumptive use.

1/ "Consumptive Use of Water for Agriculture," by Lowry and Johnson, Trans. A.S.C.E., P. 1243, Vol. 107, 1942.

Table 30--Effective heat and consumptive use - day degrees, Frenchman Unit a/

| Year | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Total | Consumptive Use in feet b/ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 66 | 1086 | 1302 | 1569 | 1903 | 1968 | 1230 | 997 | | 10,121 | 2.43 |
| 1930 | | 1150 | 1271 | 1560 | 1910 | 1767 | 1491 | 850 | | 9,999 | 2.41 |
| 1931 | | 823 | 1370 | 1740 | 1934 | 1758 | 1605 | 1197 | | 10,427 | 2.47 |
| 1932 | | 982 | 1513 | 1551 | 1984 | 1820 | 1442 | 673 | | 9,965 | 2.40 |
| 1933 | | 963 | 1311 | 1914 | 1913 | 1628 | 1515 | 1228 | 61 | 10,533 | 2.50 |
| 1934 | 93 | 1194 | 1693 | 1779 | 2114 | 1854 | 1338 | 1286 | 290 | 11,641 | 2.67 |
| 1935 | 205 | 954 | 1011 | 1512 | 1987 | 1820 | 1413 | 862 | | 9,764 | 2.37 |
| 1936 | | 1065 | 1420 | 1788 | 2117 | 2055 | 1587 | 879 | | 10,911 | 2.55 |
| 1937 | | 763 | 1321 | 1551 | 2015 | 2000 | 1578 | 989 | | 10,217 | 2.44 |
| 1938 | 109 | 1017 | 1286 | 1671 | 1990 | 1993 | 1584 | 1140 | | 10,790 | 2.54 |
| 1939 | | 727 | 1575 | 1774 | 2065 | 1872 | 1671 | 797 | | 10,481 | 2.49 |
| 1940 | | 864 | 1414 | 1761 | 2015 | 1798 | 1539 | 1258 | | 10,649 | 2.51 |
| 1941 | | 877 | 1472 | 1512 | 1814 | 1866 | 1422 | 1014 | | 9,977 | 2.41 |
| 1942 | 48 | 1053 | 1318 | 1503 | 1956 | 1767 | 1302 | 1051 | | 9,998 | 2.41 |
| 1943 | | 1089 | 1240 | 1608 | 2009 | 2015 | 1533 | 883 | | 10,377 | 2.47 |
| 1944 | | 444 | 1463 | 1578 | 1730 | 1773 | 1539 | 1137 | | 9,664 | 2.36 |
| 1945 | | 764 | 1352 | 1347 | 1876 | 1795 | 1509 | 1045 | | 9,688 | 2.36 |
| 1946 | 525 | 1335 | 1212 | 1713 | 1925 | 1758 | 1494 | 825 | | 10,787 | 2.54 |
| 1947 | | 719 | 1256 | 1446 | 1792 | 2015 | 1632 | 1463 | 36 | 10,359 | 2.47 |
| Total | | | | | | | | | | | |
| Average | | | | | | | | | | 10,334 | 2.46 |

a/ Based upon temperatures recorded at Culbertson, Nebraska.
b/ From Lowry and Johnson Curve.

Table 31.--Distribution of Consumptive Use - Frenchman Unit

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Feet per acre | | | | | | | | |
| 1929 | 0.02 | 0.05 | 0.12 | 0.20 | 0.24 | 0.34 | 0.46 | 0.44 | 0.29 | 0.15 | 0.07 | 0.05 | 2.43 |
| 1930 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .15 | .07 | .05 | 2.41 |
| 1931 | .02 | .05 | .12 | .20 | .25 | .35 | .47 | .44 | .30 | .15 | .07 | .05 | 2.47 |
| 1932 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .14 | .07 | .05 | 2.40 |
| 1933 | .02 | .05 | .12 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.50 |
| 1934 | .03 | .05 | .13 | .21 | .27 | .38 | .51 | .48 | .32 | .16 | .08 | .05 | 2.67 |
| 1935 | .02 | .05 | .12 | .19 | .24 | .33 | .45 | .43 | .28 | .14 | .07 | .05 | 2.37 |
| 1936 | .02 | .05 | .13 | .20 | .26 | .36 | .48 | .46 | .31 | .15 | .08 | .05 | 2.55 |
| 1937 | .02 | .05 | .12 | .20 | .25 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.44 |
| 1938 | .03 | .05 | .13 | .20 | .25 | .36 | .48 | .46 | .30 | .15 | .08 | .05 | 2.54 |
| 1939 | .03 | .05 | .12 | .20 | .25 | .35 | .47 | .45 | .30 | .15 | .07 | .05 | 2.49 |
| 1940 | .02 | .05 | .13 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.51 |
| 1941 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .15 | .07 | .05 | 2.41 |
| 1942 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .15 | .07 | .05 | 2.41 |
| 1943 | .02 | .05 | .12 | .20 | .25 | .35 | .47 | .44 | .30 | .15 | .07 | .05 | 2.47 |
| 1944 | .02 | .05 | .12 | .19 | .24 | .33 | .45 | .42 | .28 | .14 | .07 | .05 | 2.36 |
| 1945 | .02 | .05 | .12 | .19 | .24 | .33 | .45 | .42 | .28 | .14 | .07 | .05 | 2.36 |
| 1946 | .03 | .05 | .13 | .20 | .25 | .36 | .48 | .46 | .30 | .15 | .08 | .05 | 2.54 |
| 1947 | .02 | .05 | .12 | .20 | .25 | .35 | .47 | .44 | .30 | .15 | .07 | .05 | 2.47 |
| Total Average | 0.02 | 0.05 | 0.12 | 0.20 | 0.25 | 0.35 | 0.47 | 0.44 | 0.29 | 0.15 | 0.07 | 0.05 | 2.46 |

Frenchman Unit

| month | percent | month | percent | month | percent |
|---|---|---|---|---|---|
| January | 1 | May | 10 | Sept. | 12 |
| February | 2 | June | 14 | Oct. | 6 |
| March | 5 | July | 19 | Nov. | 3 |
| April | 8 | Aug. | 18 | Dec. | 2 |

These percentages are based upon published data secured during consumptive use studies for the Mason Creek area of the Boise Project, Idaho and for the Mesilla Valley, Rio Grande Project, New Mexico. The percentages used in this study for the months of July and August are slightly higher than the Boise and Rio Grande data because it is anticipated that the July and August requirements will be high due to the crops that will probably be grown.

Precipitation over project area.--Precipitation, as well as temperature data, were obtained from the U. S. Weather Bureau station at Culbertson, Nebraska. A tabulation of precipitation in inches, recorded at Culbertson, Nebraska, for the period of study is shown in table 32.

Since not all precipitation falling on a project area is effective in meeting consumptive use requirements, the recorded precipitation must be adjusted to compensate for factors such as amount and intensity, character of soil surface, storage capacity, and rate of consumptive use.

Percentages of effectiveness were applied to increments of monthly rainfall to determine the effective precipitation for this area. An average of the incremental percentages suggested in the Water Requirement Section of the Bureau Manual were used.

| Precipitation increment inches | Effective precipitation inches | |
|---|---|---|
| | percent | accumulated |
| 1 | 95 | 0.95 |
| 2 | 90 | 1.85 |
| 3 | 82 | 2.67 |
| 4 | 66 | 3.33 |
| 5 | 47 | 3.82 |
| 6 | 20 | 4.02 |
| 7 and over | 8 | 4.10 |

Effective precipitation as determined for the Frenchman Unit is shown in table 33.

Consumptive use requirements of irrigation water.--The consumptive use requirements of irrigation water, table 34, is computed by subtracting the effective precipitation from the consumptive use. It will be noted however that table 34 cannot be determined by subtracting the effective precipitation, table 33, from the consumptive use, table 31. This is because the soil acts as a reservoir

Table 32 -- Precipitation at Culbertson, Nebraska -- Inches a/

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | .20 | .75 | .05 | 1.86 | 5.31 | 2.54 | 1.67 | .38 | 2.53 | 1.62 | 1.28 | 0 | 18.19 |
| 1930 | 1.00 | .46 | .67 | 3.94 | 4.44 | 2.75 | 4.78 | 2.14 | 2.38 | 4.62 | 2.03 | .53 | 29.74 |
| 1931 | 0 | 1.02 | 3.21 | 1.13 | 1.19 | 3.18 | .87 | 3.30 | .58 | .62 | 1.26 | .32 | 16.68 |
| 1932 | .60 | .50 | .20 | 2.26 | 3.40 | 3.90 | 2.62 | .51 | .38 | .64 | 0 | .15 | 15.16 |
| 1933 | .03 | .30 | 1.53 | 1.93 | 2.79 | .98 | 2.88 | 7.33 | 3.81 | 0 | .30 | .10 | 21.98 |
| 1934 | .20 | 1.56 | .07 | 1.22 | .80 | 4.81 | 1.10 | 2.01 | 2.13 | .56 | 2.00 | .75 | 17.21 |
| 1935 | .20 | .38 | .46 | 1.45 | 8.33 | 4.27 | .42 | 1.92 | 2.21 | .44 | 1.25 | .23 | 21.56 |
| 1936 | .53 | .22 | .56 | 1.17 | 4.37 | 1.20 | 1.99 | .36 | 1.17 | .10 | T | .32 | 11.99 |
| 1937 | .64 | .12 | 1.19 | .64 | 1.38 | 4.84 | 1.63 | 1.85 | .40 | 1.19 | .08 | .30 | 14.26 |
| 1938 | .24 | .14 | 1.89 | 2.32 | 7.80 | 2.05 | 3.76 | 3.35 | 1.41 | .02 | .04 | .13 | 23.15 |
| 1939 | .50 | .43 | 1.81 | 1.38 | 1.52 | 3.57 | .53 | 1.47 | .39 | .03 | T | .84 | 12.47 |
| 1940 | .91 | .19 | 2.97 | .58 | 1.87 | 1.28 | 2.31 | 1.26 | 1.54 | .52 | .45 | 1.13 | 15.01 |
| 1941 | 1.09 | .29 | .76 | 2.88 | 2.94 | 5.32 | 4.52 | 1.39 | 5.61 | 1.16 | .20 | 1.50 | 27.66 |
| 1942 | .32 | .87 | .82 | 5.82 | 1.79 | 5.72 | .94 | 1.97 | 4.61 | .61 | .54 | .39 | 24.40 |
| 1943 | .26 | .08 | .76 | 1.71 | 1.15 | 2.03 | 1.39 | 2.78 | .05 | .60 | .25 | .17 | 11.24 |
| 1944 | 1.97 | .99 | 1.71 | 7.91 | 2.53 | 1.58 | 5.88 | 1.28 | .04 | .52 | 1.02 | .33 | 25.76 |
| 1945 | .54 | .26 | .31 | 2.57 | 3.40 | 3.19 | 2.58 | 3.80 | 2.34 | .29 | .20 | .33 | 19.81 |
| 1946 | .12 | .13 | 1.74 | .15 | 4.91 | 4.40 | 3.81 | 2.27 | 2.23 | 6.06 | 2.21 | .10 | 28.13 |
| 1947 | .26 | .35 | .46 | 2.95 | 2.73 | 8.18 | 4.58 | .45 | 2.04 | .81 | 1.22 | .93 | 24.96 |
| Total | | | | | | | | | | | | | 379.36 |
| Average | 0.51 | 0.48 | 1.11 | 2.31 | 3.30 | 3.46 | 2.54 | 2.10 | 1.89 | 1.07 | .75 | .45 | 19.97 |

a/ U. S. Weather Bureau Published records

Table 33. Effective precipitation for Frenchman Unit a/

(Feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.02 | 0.06 | 0 | 0.14 | 0.33 | 0.19 | 0.13 | 0.03 | 0.19 | 0.13 | 0.10 | 0 | 1.32 |
| 1930 | .08 | .04 | .05 | .27 | .30 | .21 | .31 | .16 | .18 | .30 | .16 | .04 | 2.10 |
| 1931 | 0 | .08 | .23 | .09 | .09 | .23 | .07 | .24 | .05 | .05 | .10 | .03 | 1.26 |
| 1932 | .05 | .04 | .02 | .18 | .25 | .27 | .20 | .04 | .03 | .05 | 0 | .01 | 1.14 |
| 1933 | 0 | .02 | .12 | .15 | .21 | .08 | .21 | .34 | .27 | 0 | .02 | .01 | 1.43 |
| 1934 | .02 | .12 | .01 | .10 | .07 | .31 | .09 | .15 | .16 | -.04 | .15 | .06 | 1.28 |
| 1935 | .02 | .03 | .04 | .11 | .34 | .29 | .03 | .15 | .18 | .04 | .10 | .02 | 1.35 |
| 1936 | .04 | .02 | .04 | .09 | .29 | .09 | .15 | .03 | .09 | .01 | 0 | .03 | .88 |
| 1937 | .05 | .01 | .09 | .05 | .11 | .31 | .13 | .14 | .03 | .09 | .01 | .02 | 1.04 |
| 1938 | .02 | .01 | .15 | .18 | .34 | .16 | .27 | .24 | .11 | 0 | 0 | .01 | 1.49 |
| 1939 | .04 | .03 | .14 | .11 | .12 | .26 | .04 | .11 | .03 | 0 | 0 | .07 | .95 |
| 1940 | .07 | .02 | .22 | .05 | .14 | .10 | .18 | .10 | .12 | .04 | .04 | .09 | 1.17 |
| 1941 | .09 | .02 | .06 | .21 | .22 | .33 | .30 | .11 | .33 | .09 | .02 | .12 | 1.90 |
| 1942 | .03 | .07 | .07 | .33 | .14 | .33 | .07 | .15 | .30 | .05 | .04 | .03 | 1.61 |
| 1943 | .02 | .01 | .06 | .13 | .09 | .16 | .11 | .21 | 0 | .05 | .02 | .02 | .88 |
| 1944 | .15 | .08 | .13 | .34 | .19 | .12 | .33 | .10 | 0 | .04 | .08 | .03 | 1.59 |
| 1945 | .04 | .02 | .02 | .19 | .25 | .23 | .19 | .27 | .18 | .02 | .02 | .03 | 1.46 |
| 1946 | .01 | .01 | .13 | .01 | .32 | .30 | .27 | .18 | .18 | .34 | .18 | .01 | 1.94 |
| 1947 | .02 | .03 | .04 | .22 | .20 | .34 | .30 | .04 | .16 | .07 | .10 | .07 | 1.59 |
| Total Average | 0.04 | 0.04 | 0.08 | 0.15 | 0.21 | 0.23 | 0.18 | 0.15 | 0.14 | 0.07 | 0.06 | 0.04 | 1.39 |

a/ Based upon Culbertson, Nebraska, precipitation records.

9600
11522
21,122

Table 34--Consumptive Use Requirements of Irrigation Water
Frenchman Unit

Unit - acre-feet per acre

| Year | Apr.[a] | May[a] | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | .13 | 0 | .13 | .33 | .41 | .10 | .02 | 1.12 |
| 1930 | 0 | 0 | .03 | .15 | .27 | .11 | 0 | .56 |
| 1931 | 0 | 0 | .04 | .40 | .20 | .25 | .10 | .99 |
| 1932 | .05 | .02 | .07 | .26 | .39 | .26 | .09 | 1.14 |
| 1933 | .13 | .12 | .27 | .27 | .11 | .03 | .15 | 1.08 |
| 1934 | .19 | .28 | .07 | .42 | .33 | .16 | .12 | 1.57 |
| 1935 | .09 | 0 | 0 | .37 | .28 | .10 | .10 | .94 |
| 1936 | .16 | .02 | .27 | .33 | .43 | .22 | .14 | 1.57 |
| 1937 | .22 | .21 | .03 | .33 | .30 | .26 | .06 | 1.41 |
| 1938 | .08 | 0 | .17 | .21 | .22 | .19 | .15 | 1.02 |
| 1939 | .15 | .18 | .09 | .43 | .34 | .27 | .15 | 1.61 |
| 1940 | .09 | .11 | .25 | .30 | .35 | .18 | .11 | 1.39 |
| 1941 | 0 | .02 | .01 | .16 | .32 | 0 | .02 | .53 |
| 1942 | 0 | 0 | 0 | .36 | .28 | 0 | .09 | .73 |
| 1943 | .15 | .23 | .19 | .36 | .23 | .30 | .10 | 1.56 |
| 1944 | 0 | 0 | .02 | .12 | .32 | .28 | .10 | .84 |
| 1945 | .06 | .05 | .10 | .26 | .15 | .10 | .12 | .84 |
| 1946 | .26 | 0 | .05 | .21 | .28 | .12 | 0 | .92 |
| 1947 | 0 | 0 | 0 | .06 | .40 | .14 | .08 | .68 |
| Average | .09 | .07 | .09 | .28 | .30 | .16 | .09 | 1.08 |

a/ Includes one-half of portion of Nov.-Mar. requirement not met by the effective precipitation period.

1,54 Req. Farm Del.

H&RW
11,522
1,54 A F/ac Req. Farm Del

F.V.
9600
1,54
38400
48000
9600
14784 00

0.7 ) 1,08
7
38
35
30
28

46088
57610
11522
17,743.88

and any unused effective precipitation is available for use in the following month. For this reason the moisture requirement for any one month is dependent upon the moisture conditions of the previous month. All unused effective precipitation is considered to be available for use in the following month up to a maximum of 0.5 of a foot.

Consumptive use requirements for the November through March period, not supplied by effective precipitation, were satisfied during April and May. Half the deficiency being supplied in April and half in May.

Diversion requirements.--In order to satisfy the crop irrigation requirement, it is necessary to divert sufficient additional water to overcome transportation and farm losses. These estimates were made by operation specialists from the Bureau of Reclamation office in Region 7. For the Frenchman Unit the farm loss was estimated to be 30 percent of the farm delivery requirement. Therefore the consumptive use requirement of irrigation water is multiplied by the ratio of 100 over 100 minus the 30 percent for farm loss to give the farm delivery requirement.

Transportation losses in the distribution system include water consumed by evaporation, transpiration by canal-bank vegetation, and seepage or percolation losses. The estimated percentage loss of water between the diversion point and the farm head gate was based on these factors together with the length of canals evolved. Canal losses were estimated to be 25 percent of the diversion requirement. The farm delivery requirement is multiplied by the ratio of 100 over 100 minus the 25 percent transportation loss to give diversion requirements. Diversion requirements for the Frenchman Unit in acre-feet per acre irrigated are shown in table 35.

Diversion requirements for the Frenchman Unit are computed as the total acreage irrigated multiplied by the diversion requirements in acre-feet per acre. The requirements for 22,910 acres, the total irrigable land in the unit, are shown in table 36.

Evaporation from reservoir

It is important to consider the loss of water from the reservoir surface area caused by evaporation in water supply studies. Records of evaporation at Enders Reservoir have not been collected, therefore, it was necessary to utilize evaporation records collected at North Platte, Nebraska.

Gross evaporation.--The evaporation from a 2 by 6 foot sunken pan have been recorded by the Bureau of Plant Industry at North Platte, Nebraska. The recorded evaporation was corrected to free water surface evaporation by applying a coefficient of 0.94 to the recorded evaporation. Table 37 lists the free water surface evaporation as determined from the North Platte evaporation records.

Table 35--Diversion requirements for the Frenchman Unit

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| | | | Acre-feet per acre irrigated | | | | | |
| 1929 | 0.24 | 0 | 0.25 | 0.63 | 0.78 | 0.19 | 0.04 | 2.13 |
| 1930 | 0 | 0 | .06 | .28 | .51 | .21 | 0 | 1.06 |
| 1931 | 0 | 0 | .08 | .76 | .38 | .47 | .19 | 1.88 |
| 1932 | .10 | .04 | .13 | .50 | .74 | .49 | .17 | 2.17 |
| 1933 | .25 | .23 | .51 | .51 | .21 | .06 | .28 | 2.05 |
| 1934 | .36 | .53 | .13 | .80 | .63 | .30 | .23 | 2.98 |
| 1935 | .17 | 0 | 0 | .70 | .53 | .19 | .19 | 1.78 |
| 1936 | .30 | .04 | .51 | .63 | .82 | .42 | .26 | 2.98 |
| 1937 | .42 | .40 | .06 | .63 | .57 | .49 | .11 | 2.68 |
| 1938 | .15 | 0 | .32 | .40 | .42 | .36 | .29 | 1.94 |
| 1939 | .28 | .34 | .17 | .82 | .65 | .51 | .29 | 3.06 |
| 1940 | .17 | .21 | .48 | .57 | .66 | .34 | .21 | 2.64 |
| 1941 | 0 | .04 | .02 | .30 | .61 | 0 | .04 | 1.01 |
| 1942 | 0 | 0 | 0 | .69 | .53 | 0 | .17 | 1.39 |
| 1943 | .28 | .44 | .36 | .68 | .44 | .57 | .19 | 2.96 |
| 1944 | 0 | 0 | .04 | .23 | .61 | .53 | .19 | 1.60 |
| 1945 | .11 | .10 | .19 | .49 | .29 | .19 | .23 | 1.60 |
| 1946 | .49 | 0 | .10 | .40 | .53 | .23 | 0 | 1.75 |
| 1947 | 0 | 0 | 0 | .11 | .76 | .27 | .15 | 1.29 |
| Total Average | 0.17 | 0.13 | 0.18 | 0.53 | 0.56 | 0.31 | 0.17 | 2.05 |



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Table 36.--Diversion requirements of Frenchman Unit for 22,910 Acres

(Unit - 1,000 acre-feet)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 5.5 | 0 | 5.7 | 14.4 | 17.9 | 4.4 | 0.9 | 48.8 |
| 1930 | 0 | 0 | 1.4 | 6.4 | 11.7 | 4.8 | 0 | 24.3 |
| 1931 | 0 | 0 | 1.8 | 17.4 | 8.7 | 10.8 | 4.4 | 43.1 |
| 1932 | 2.3 | 0.9 | 3.0 | 11.5 | 17.0 | 11.2 | 3.9 | 49.8 |
| 1933 | 5.7 | 5.3 | 11.7 | 11.7 | 4.8 | 1.4 | 6.4 | 47.0 |
| 1934 | 8.2 | 12.1 | 3.0 | 18.3 | 14.4 | 6.9 | 5.3 | 68.2 |
| 1935 | 3.9 | 0 | 0 | 16.0 | 12.1 | 4.4 | 4.4 | 40.8 |
| 1936 | 6.9 | 0.9 | 11.7 | 14.4 | 18.8 | 9.6 | 6.0 | 68.3 |
| 1937 | 9.6 | 9.2 | 1.4 | 14.4 | 13.1 | 11.2 | 2.5 | 61.4 |
| 1938 | 3.4 | 0 | 7.3 | 9.2 | 9.6 | 8.2 | 6.6 | 44.3 |
| 1939 | 6.4 | 7.8 | 3.9 | 18.8 | 14.9 | 11.7 | 6.6 | 70.1 |
| 1940 | 3.9 | 4.8 | 11.0 | 13.1 | 15.1 | 7.8 | 4.8 | 60.5 |
| 1941 | 0 | 0.9 | 0.5 | 6.9 | 14.0 | 0 | 0.9 | 23.2 |
| 1942 | 0 | 0 | 0 | 15.8 | 12.1 | 0 | 3.9 | 31.8 |
| 1943 | 6.4 | 10.1 | 8.2 | 15.6 | 10.1 | 13.1 | 4.4 | 67.9 |
| 1944 | 0 | 0 | 0.9 | 5.3 | 14.0 | 12.1 | 4.4 | 36.7 |
| 1945 | 2.5 | 2.3 | 4.4 | 11.2 | 6.6 | 4.4 | 5.3 | 36.7 |
| 1946 | 11.2 | 0 | 2.3 | 9.2 | 12.1 | 5.3 | 0 | 40.1 |
| 1947 | 0 | 0 | 0 | 2.5 | 17.4 | 6.2 | 3.4 | 29.5 |
| Total Average | 4.0 | 2.9 | 4.1 | 12.2 | 12.9 | 7.0 | 3.9 | 47.0 |

Table 37 - Evaporation from free water surface at North Platte, Nebraska a/

| Year | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|
| 1929 | 5.04 | 5.18 | 6.19 | 8.40 | 7.61 | 3.92 | 36.34 |
| 1930 | 4.05 | 5.39 | 5.81 | 7.67 | 6.19 | 4.52 | 33.63 |
| 1931 | 4.30 | 6.39 | 7.71 | 9.65 | 8.07 | 7.19 | 43.31 |
| 1932 | 5.12 | 7.24 | 6.57 | 8.07 | 7.74 | 5.89 | 40.63 |
| 1933 | 5.82 | 5.54 | 9.11 | 10.02 | 5.57 | 6.24 | 42.30 |
| 1934 | 5.95 | 9.02 | 9.95 | 12.50 | 9.06 | 5.25 | 51.73 |
| 1935 | 4.63 | 4.03 | 5.54 | 9.21 | 8.05 | 4.94 | 36.40 |
| 1936 | 4.99 | 5.60 | 8.56 | 10.99 | 8.85 | 6.76 | 45.75 |
| 1937 | 4.74 | 6.19 | 6.44 | 8.98 | 8.52 | 6.19 | 41.06 |
| 1938 | 4.17 | 5.11 | 7.40 | 9.45 | 9.87 | 4.99 | 40.99 |
| 1939 | 4.57 | 6.88 | 8.84 | 10.82 | 8.55 | 8.46 | 48.12 |
| 1940 | 4.52 | 7.41 | 9.38 | 9.89 | 7.76 | 6.15 | 45.11 |
| 1941 | 3.74 | 6.03 | 6.03 | 7.54 | 7.34 | 5.98 | 36.66 |
| 1942 | 3.75 | 5.69 | 5.56 | 7.38 | 6.58 | 3.97 | 32.93 |
| 1943 | 5.40 | 4.37 | 6.56 | 8.25 | 7.31 | 6.15 | 38.04 |
| 1944 | 2.89 | 6.38 | 6.76 | 7.19 | 7.03 | 5.36 | 35.59 |
| 1945 | 3.72 | 5.04 | 5.35 | 6.48 | 6.09 | 5.60 | 32.28 |
| 1946 | 5.29 | 5.56 | 7.08 | 7.93 | 7.01 | 5.05 | 37.92 |
| 1947 | 3.17 | 4.55 | 5.66 | 6.61 | 7.75 | 5.83 | 33.57 |
| Total Average | 4.52 | 5.87 | 7.08 | 8.79 | 7.63 | 5.71 | 39.6 |

a/ Determined from North Platte evaporation records by multiplying sunken pan evaporation rates by 0.94.

A study published by the Minnesota Resources Commission was the basis for determining monthly evaporation rates from the reservoir.1/ A series of charts showing the mean reservoir evaporation rates by months over the entire area of the United States was presented.

For the April through September period, use was made of actual evaporation records at North Platte, Nebraska, corrected to free water surface evaporation, table 37. These evaporation rates were shifted to the Enders Reservoir area by applying monthly factors taken from the mean monthly evaporation curves as published by the Minnesota Resources Commission.

| Month | Factor |
|---|---|
| April | 1.07 |
| May | 1.06 |
| June | 1.04 |
| July | 1.05 |
| August | 1.03 |
| September | 1.03 |

Records of evaporation are not collected at the North Platte station during the winter because of freezing weather, therefore, evaporation rates for Enders Reservoir were assumed to be the same as those for that area as published in the Meyer study.

| Month | Evaporation rate (inches) |
|---|---|
| January | 1.25 |
| February | 1.35 |
| March | 2.40 |
| October | 4.95 |
| November | 2.85 |
| December | 1.45 |

Gross evaporation in inches determined for Enders Reservoir is shown in table 38.

Precipitation over reservoir.--Runoff from precipitation in the reservoir area is relatively small, therefore, all the precipitation was considered to be consumed within that area. Precipitation over the reservoir is considered the same as that recorded at Imperial, Nebraska. See table 39.

Net reservoir evaporation.--Net reservoir evaporation loss is computed to be the difference between future and past consumptive uses from the reservoir area. For this study, the net evaporation is computed as the gross evaporation from a free water surface minus precipitation over the reservoir area. The net evaporation in inches determined for Enders Reservoir is presented in table 40.

1/ "Evaporation from Lakes and Reservoirs," published by the Minnesota Resources Commission, June 1942.

Table 38. Gross evaporation from Enders Reservoir a/ (Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.25 | 1.35 | 2.40 | 5.39 | 5.49 | 6.44 | 8.82 | 7.84 | 4.04 | 4.95 | 2.85 | 1.45 | 52.27 |
| 1930 | 1.25 | 1.35 | 2.40 | 4.33 | 5.71 | 6.04 | 8.05 | 6.38 | 4.66 | 4.95 | 2.85 | 1.45 | 49.42 |
| 1931 | 1.25 | 1.35 | 2.40 | 4.60 | 6.77 | 8.02 | 10.13 | 8.31 | 7.41 | 4.95 | 2.85 | 1.45 | 59.49 |
| 1932 | 1.25 | 1.35 | 2.40 | 5.48 | 7.67 | 6.83 | 8.47 | 7.97 | 6.07 | 4.95 | 2.85 | 1.45 | 56.74 |
| 1933 | 1.25 | 1.35 | 2.40 | 6.23 | 5.87 | 9.47 | 10.52 | 5.74 | 6.43 | 4.95 | 2.85 | 1.45 | 58.51 |
| 1934 | 1.25 | 1.35 | 2.40 | 6.37 | 9.56 | 10.35 | 13.12 | 9.33 | 5.41 | 4.95 | 2.85 | 1.45 | 68.39 |
| 1935 | 1.25 | 1.35 | 2.40 | 4.95 | 4.27 | 5.76 | 9.67 | 8.29 | 5.09 | 4.95 | 2.85 | 1.45 | 52.28 |
| 1936 | 1.25 | 1.35 | 2.40 | 5.34 | 5.94 | 8.90 | 11.54 | 9.12 | 6.96 | 4.95 | 2.85 | 1.45 | 62.05 |
| 1937 | 1.25 | 1.35 | 2.40 | 5.07 | 6.56 | 6.70 | 9.43 | 8.78 | 6.38 | 4.95 | 2.85 | 1.45 | 57.17 |
| 1938 | 1.25 | 1.35 | 2.40 | 4.46 | 5.42 | 7.70 | 9.92 | 10.17 | 5.14 | 4.95 | 2.85 | 1.45 | 57.06 |
| 1939 | 1.25 | 1.35 | 2.40 | 4.89 | 7.29 | 9.19 | 11.36 | 8.81 | 8.71 | 4.95 | 2.85 | 1.45 | 64.50 |
| 1940 | 1.25 | 1.35 | 2.40 | 4.84 | 7.85 | 9.76 | 10.38 | 7.99 | 6.33 | 4.95 | 2.85 | 1.45 | 61.40 |
| 1941 | 1.25 | 1.35 | 2.40 | 4.00 | 6.39 | 6.27 | 7.92 | 7.56 | 6.16 | 4.95 | 2.85 | 1.45 | 52.55 |
| 1942 | 1.25 | 1.35 | 2.40 | 4.01 | 6.03 | 5.78 | 7.75 | 6.78 | 4.09 | 4.95 | 2.85 | 1.45 | 48.69 |
| 1943 | 1.25 | 1.35 | 2.40 | 5.78 | 4.63 | 6.82 | 8.66 | 7.53 | 6.33 | 4.95 | 2.85 | 1.45 | 54.00 |
| 1944 | 1.25 | 1.35 | 2.40 | 3.09 | 6.76 | 7.03 | 7.53 | 7.24 | 5.52 | 4.95 | 2.85 | 1.45 | 51.42 |
| 1945 | 1.25 | 1.35 | 2.40 | 3.98 | 5.34 | 5.56 | 6.80 | 6.27 | 5.77 | 4.95 | 2.85 | 1.45 | 47.97 |
| 1946 | 1.25 | 1.35 | 2.40 | 5.66 | 5.89 | 7.36 | 8.33 | 7.22 | 5.20 | 4.95 | 2.85 | 1.45 | 53.91 |
| 1947 | 1.25 | 1.35 | 2.40 | 3.39 | 4.82 | 5.89 | 6.94 | 7.98 | 6.00 | 4.95 | 2.85 | 1.45 | 49.27 |
| Total Average | 1.25 | 1.35 | 2.40 | 4.84 | 6.22 | 7.36 | 9.23 | 7.86 | 5.88 | 4.95 | 2.85 | 1.45 | 55.64 |

a/ Oct. through Mar. estimated from Meyer's maps. Other months based on correction factors for records at North Platte, Nebr. 1.07 for Apr., 1.06 for May, 1.04 for June, 1.05 for July, 1.03 for Aug., and 1.03 for Sept.

Table 39--Precipitation at Imperial, Nebraska--Inches a/

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.25 | 1.30 | 0.44 | 4.63 | 2.32 | 3.45 | 4.53 | 0.67 | 3.92 | 2.40 | 1.46 | 0.13 | 25.50 |
| 1930 | 1.01 | 0.50 | 0.50 | 1.68 | 7.43 | 2.50 | 4.68 | 3.96 | 1.38 | 4.22 | 3.34 | 0.22 | 31.42 |
| 1931 | T | 1.22 | 2.20 | 1.69 | 2.14 | 2.22 | 3.15 | 1.55 | 0.62 | 0.34 | 0.75 | 0.63 | 16.51 |
| 1932 | 0.24 | 0.85 | 0.35 | 4.49 | 0.57 | 2.57 | 4.94 | 2.31 | 0.89 | 0.46 | 0.10 | 0.59 | 18.36 |
| 1933 | 0.05 | 0.20 | 1.07 | 2.85 | 2.40 | 0.74 | 1.13 | 9.59 | 3.10 | 0 | 0.17 | 1.18 | 22.48 |
| 1934 | 0.44 | 1.25 | 0.40 | 0.18 | 1.84 | 4.87 | 0.36 | 2.64 | 1.79 | 0.11 | 0.53 | 0.47 | 14.88 |
| 1935 | 0.04 | 0.38 | 0.39 | 1.48 | 9.21 | 3.10 | 0.70 | 2.20 | 1.59 | 0.57 | 0.80 | 0.01 | 20.47 |
| 1936 | 0.52 | 0.14 | 0.88 | 1.25 | 4.54 | 3.09 | 2.51 | 1.46 | 0.54 | 0.38 | T | 0.24 | 15.55 |
| 1937 | 0.71 | 0.14 | 0.84 | 0.21 | 2.48 | 3.88 | 2.00 | 2.06 | 0.70 | 0.64 | 0.26 | 0.54 | 14.46 |
| 1938 | 0.14 | 0.32 | 1.17 | 3.62 | 4.36 | 2.77 | 1.94 | 0.94 | 3.58 | 0.02 | 0.16 | 0.17 | 19.19 |
| 1939 | 0.70 | 0.42 | 1.56 | 1.71 | 1.84 | 4.69 | 0.47 | 2.20 | 0.34 | 0.18 | T | 0.84 | 14.95 |
| 1940 | 0.68 | 0.07 | 2.34 | 0.74 | 1.21 | 3.75 | 2.24 | 1.11 | 2.82 | 1.55 | 0.36 | 0.72 | 17.59 |
| 1941 | 1.27 | 0.32 | 0.93 | 3.75 | 2.28 | 1.46 | 3.47 | 1.20 | 2.84 | 1.57 | 0.24 | 0.95 | 20.28 |
| 1942 | 0.55 | 1.40 | 0.93 | 3.25 | 5.21 | 5.65 | 1.45 | 3.49 | 6.84 | 1.59 | 0.57 | 0.38 | 31.31 |
| 1943 | 0.23 | 0.14 | 1.16 | 0.80 | 1.25 | 4.93 | 2.73 | 0.96 | 0.15 | 0.68 | 0.28 | 0.96 | 14.27 |
| 1944 | 1.73 | 0.75 | 1.29 | 5.05 | 2.09 | 3.47 | 4.68 | 0.60 | 0.22 | 0.66 | 1.16 | 0.36 | 22.06 |
| 1945 | 0.49 | 0.25 | 0.20 | 2.61 | 2.88 | 3.89 | 1.92 | 2.18 | 2.80 | 1.08 | 0.18 | 0.24 | 18.72 |
| 1946 | 0.05 | 0.15 | 1.89 | 0.67 | 3.77 | 3.51 | 2.41 | 2.29 | 3.40 | 2.98 | 1.31 | 0.04 | 22.47 |
| 1947 | 0.21 | T | 1.01 | 2.36 | 3.06 | 5.32 | 1.98 | 0.46 | 2.24 | 0.56 | 0.73 | 0.65 | 18.58 |
| Total | | | | | | | | | | | | | 379.05 |
| Average | 0.49 | 0.52 | 1.03 | 2.27 | 3.20 | 3.47 | 2.49 | 2.20 | 2.09 | 1.05 | 0.65 | 0.49 | 19.95 |

a/ U. S. Weather Bureau Published records

Table 40—Net evaporation from Enders Reservoir a/ (Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.00 | 0.05 | 1.96 | 0.76 | 3.17 | 2.99 | 4.29 | 7.17 | 0.12 | 2.55 | 1.39 | 1.32 | 26.77 |
| 1930 | 0.24 | 0.85 | 1.90 | 2.65 | -1.72 | 3.54 | 3.37 | 2.42 | 3.28 | 0.73 | -0.49 | 1.23 | 18.00 |
| 1931 | 1.25 | 0.13 | 0.20 | 2.91 | 4.63 | 5.80 | 6.98 | 6.76 | 6.79 | 4.61 | 2.10 | 0.82 | 42.98 |
| 1932 | 1.01 | 0.50 | 2.05 | 0.99 | 7.10 | 4.26 | 3.53 | 5.66 | 5.18 | 4.49 | 2.75 | 0.86 | 38.38 |
| 1933 | 1.20 | 1.15 | 1.33 | 3.38 | 3.47 | 8.73 | 9.39 | -3.85 | 3.33 | 4.95 | 2.68 | 0.27 | 36.03 |
| 1934 | 0.81 | 0.10 | 2.00 | 6.19 | 7.72 | 5.48 | 12.76 | 6.69 | 3.62 | 4.84 | 2.32 | -0.98 | 53.51 |
| 1935 | 1.21 | 0.97 | 2.01 | 3.47 | -4.94 | 2.66 | 8.97 | 6.09 | 3.50 | 4.38 | 2.05 | 1.44 | 31.81 |
| 1936 | 0.73 | 1.21 | 1.52 | 4.09 | 1.40 | 5.81 | 9.03 | 7.66 | 6.42 | 4.57 | 2.85 | 1.21 | 46.50 |
| 1937 | 0.54 | 1.21 | 1.56 | 4.86 | 4.08 | 2.82 | 7.43 | 6.72 | 5.68 | 4.31 | 2.59 | 0.91 | 42.71 |
| 1938 | 1.11 | 1.03 | 1.23 | 0.84 | 1.06 | 4.93 | 7.98 | 9.23 | 1.56 | 4.93 | 2.69 | 1.28 | 37.87 |
| 1939 | 0.55 | 0.93 | 0.84 | 3.18 | 5.45 | 4.50 | 10.89 | 6.61 | 8.37 | 4.77 | 2.85 | 0.61 | 49.55 |
| 1940 | 0.57 | 1.28 | 0.06 | 4.10 | 6.64 | 6.01 | 8.14 | 6.88 | 3.51 | 3.40 | 2.49 | 0.73 | 43.81 |
| 1941 | -0.02 | 1.03 | 1.47 | 0.25 | 4.11 | 4.81 | 4.45 | 6.36 | 3.32 | 3.38 | 2.61 | 0.50 | 32.27 |
| 1942 | 0.70 | -0.05 | 1.47 | 0.76 | 0.82 | 0.13 | 6.30 | 3.29 | -2.75 | 3.36 | 2.28 | 1.07 | 17.38 |
| 1943 | 1.02 | 1.21 | 1.24 | 4.98 | 3.38 | 1.89 | 5.93 | 6.57 | 6.18 | 4.27 | 2.57 | 0.49 | 39.73 |
| 1944 | -0.48 | 0.60 | 1.11 | -1.96 | 4.67 | 3.56 | 2.85 | 6.64 | 5.30 | 4.29 | 1.69 | 1.09 | 29.36 |
| 1945 | 0.76 | 1.10 | 2.20 | 1.37 | 2.46 | 1.67 | 4.88 | 4.09 | 2.97 | 3.87 | 2.67 | 1.21 | 29.25 |
| 1946 | 1.20 | 1.20 | 0.51 | 4.99 | 2.12 | 3.85 | 5.92 | 4.93 | 1.80 | 1.97 | 1.54 | 1.41 | 31.44 |
| 1947 | 1.04 | 1.35 | 1.39 | 1.03 | 1.76 | 0.57 | 4.96 | 7.52 | 3.76 | 4.39 | 2.12 | 0.80 | 30.69 |
| Total Average | 0.76 | 0.83 | 1.37 | 2.57 | 3.02 | 3.90 | 6.74 | 5.65 | 3.79 | 3.90 | 2.20 | 0.96 | 35.69 |

a/ Gross evaporation less precipitation at Imperial, Nebraska. Negative values indicate the amount that precipitation exceeds gross evaporation.

To facilitate computations necessary in connection with monthly reservoir operations, a series of curves, one for each inch of evaporation, were drawn by plotting the reservoir content in 1,000 acre-feet as ordinates and evaporation loss in 1,000 acre-feet as abscissas. By entering the curve with an average reservoir content and the monthly evaporation rate in inches the corresponding evaporation loss for any month was indicated. The reservoir evaporation curves are shown in exhibit 15.

Seepage

It is expected that some seepage will occur from Enders Reservoir. Estimates based on geologic and construction data obtained at the dam site indicate that the seepage loss from the reservoir will be from 0 to 8 second-feet. In the operation study a constant seepage of 5 second-feet or 300 acre-feet a month was used. This seepage was not used to satisfy any of the irrigation demands but was allowed to pass downstream.

## Water Utilization

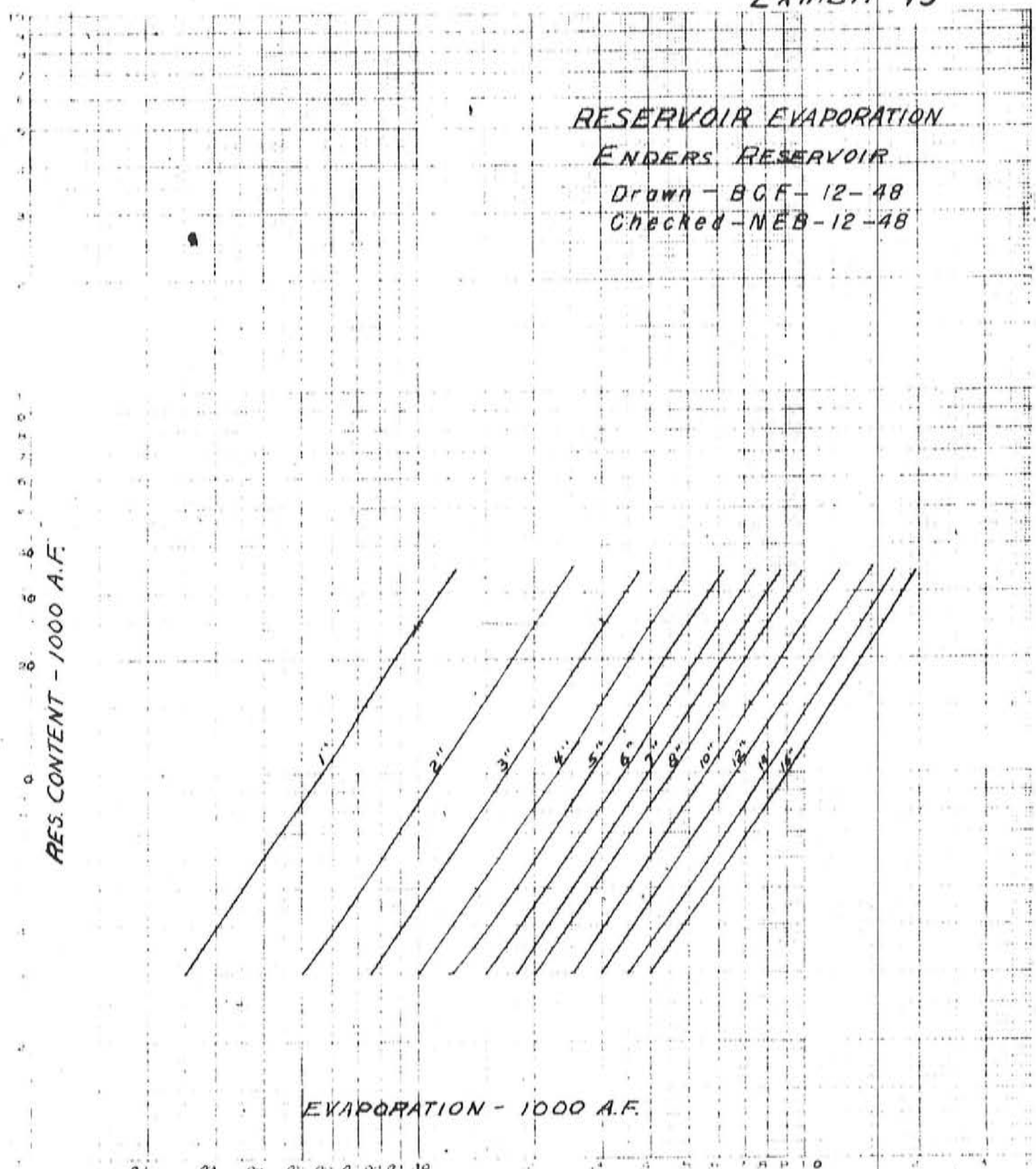
A reservoir operation study showing the water delivery on a monthly basis has been made to determine the adequacy of the water supply available to the unit for development. The study was based upon water supply and climatic conditions existing during the period 1929 through 1947. This period was selected for the study because it includes the 10-year period 1931-1940 which is considered to be the most critical period of water supply that has ever been experienced in this area. It is reasonably certain that if the water supply is enough to satisfy conditions existing during this period without intolerable shortages, that there will be an adequate water supply for all the planned development. The 1940-1947 period of the study supplies information as to conditions when the water supply is more nearly normal. The records of stream flow during this period are also somewhat more complete than those for the previous period.

Reservoir operations

The operation study is based upon conditions expected to exist in the Enders Reservoir after 50 years of use. It is estimated that the storage capacity at this time will be decreased from the initial content by 10,000 acre-feet due to accumulation of sediment in the reservoir. Water available for development of the unit was determined after making depletions for all development that will occur due to private development of irrigation and ponds.

Table 41 shows the computations made in the operation study. The following operation criteria were used in making the operation study:

EXHIBIT 15






KS002298

Table 41. Operation study showing operation of [illegible] Reservoir, [illegible]

(Values in 1000 acre-feet unless indicated otherwise)

| Year | Month | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | [illegible] | [illegible] (in.) | [illegible] | [illegible] | [illegible] | [illegible] 24,000 a.c. | [illegible] | Change in storage | [illegible] at end of month | [illegible] | [illegible] | Shortage |
| Source | | Table 38 | Table 40 | Col. 11 & 4 / & / Table 15 | | Table 37 | Table 39 | Col. 8-7 | Col. 3-4 / -5-6-10 / -14 | Col. 11+10 | Col. 11 + 10 exceeding 24,000 A. F. | Col. 6 + 7 / Col. 6 if 7 / is diverted | |
| 1949 | Jan. | 8.1 | 1.03 | 0.2 | 0.1 | 3.9 | | | 0 | 24.0 | 4.7 | 3.3 | |
| | Feb. | 8.6 | 0.08 | 0 | .5 | 3.9 | | | 0 | 24.0 | 4.0 | 4.0 | |
| | Mar. | 6.4 | 1.03 | 0.2 | .5 | 3.7 | | | 0 | 24.0 | 4.0 | 4.0 | |
| | Apr. | 4.6 | 0.78 | 0.1 | .5 | 3.6 | 8.6 | 2.9 | 0 | 24.0 | 1.8 | 0.8 | |
| | May | 5.3 | 3.17 | 0.4 | .5 | 6.7 | 0 | 0 | 0 | 24.0 | 4.4 | 0.0 | |
| | June | 4.7 | 2.40 | 0.4 | .5 | 2.1 | 8.7 | 8.6 | 0 | 24.0 | 0.4 | 0.8 | |
| | July | 2.6 | 4.00 | 0.6 | .5 | 1.0 | 24.6 | 13.6 | -11.6 | 12.4 | 0 | 0.8 | |
| | Aug. | 2.1 | 7.17 | 0.6 | .5 | 1.2 | 17.9 | 10.7 | -15.4 | 7.0 | 0 | 0.8 | |
| | Sept. | 4.0 | 0.12 | 0 | .5 | 1.0 | 4.6 | 2.0 | + 0.9 | 7.9 | 0 | 0.8 | |
| | Oct. | 4.2 | 2.00 | 0.1 | .5 | 3.0 | 0.9 | 0 | + 6.2 | 14.1 | 0 | 2.2 | |
| | Nov. | 4.7 | 1.30 | 0.1 | .5 | 3.0 | | | + 6.5 | 16.6 | 0 | 3.3 | |
| | Dec. | 4.6 | 1.02 | 0.1 | .5 | 4.7 | | | + 6.0 | 20.6 | 0 | 8.0 | |
| | Total | 52.9 | 28.77 | 2.5 | 5.6 | 39.5 | 40.6 | 30.4 | | - -23.6 | 21.0 | 29.5 | |
| 1950 | Jan. | 6.1 | 0.04 | 0 | 0.5 | 2.6 | | | + 3.6 | 24.2 | 0 | 8.0 | |
| | Feb. | 4.6 | 0.08 | 0.1 | .5 | 3.0 | | | + 6.4 | 28.6 | 0 | 2.5 | |
| | Mar. | 4.0 | 1.00 | 0.2 | .5 | 5.5 | | | + 4.4 | 33.0 | 0 | 2.6 | |
| | Apr. | 4.0 | 2.00 | 0.3 | .5 | 1.9 | 0 | 0 | + 1.0 | 34.0 | 3.8 | 2.2 | |
| | May | 5.2 | -1.78 | -0.2 | .5 | 8.1 | 0 | 0 | 0 | 34.0 | 8.1 | 6.4 | |
| | June | 4.7 | 3.04 | 0.4 | .5 | 4.1 | 1.4 | 0 | 0 | 34.0 | 4.6 | 1.0 | |
| | July | 3.8 | 3.07 | 0.4 | .5 | 3.0 | 6.4 | 2.0 | 0 | 34.0 | 0.8 | 0.8 | |
| | Aug. | 3.3 | 3.00 | 0.6 | .5 | 6.2 | 11.7 | 0.8 | - 3.9 | 30.1 | 0 | 0.8 | |
| | Sept. | 2.6 | 3.20 | 0.0 | .5 | 6.5 | 4.0 | 1.0 | + 1.0 | 31.6 | 0 | 0.8 | |
| | Oct. | 4.8 | 0.78 | 0.1 | .5 | 6.1 | 0 | 0 | + 3.0 | 34.0 | 1.0 | 0.4 | |
| | Nov. | 4.4 | -0.40 | -0.1 | .5 | 6.1 | | | 0 | 34.0 | 4.2 | 6.4 | |
| | Dec. | 3.8 | 1.28 | 0.1 | .5 | 6.7 | | | 0 | 34.0 | 6.0 | 7.0 | |
| | Total | 53.8 | 13.60 | 2.0 | 3.6 | 62.0 | 24.6 | 11.0 | | - +10.0 | 28.0 | 41.0 | |
| 1951 | Jan. | 5.5 | 1.30 | 0.1 | 0.5 | 1.8 | | | 0 | 34.0 | 5.1 | 1.0 | |
| | Feb. | 6.4 | 0.30 | 0 | .5 | 1.8 | | | 0 | 34.0 | 5.1 | 1.5 | |
| | Mar. | 6.6 | 0.30 | 0 | .5 | 1.8 | | | 0 | 34.0 | 8.5 | 1.6 | |
| | Apr. | 6.5 | 2.02 | 0.6 | .5 | 6.0 | 0 | 0 | 0 | 34.0 | 6.9 | 1.8 | |
| | May | 6.6 | 4.08 | 0.6 | .5 | 1.8 | 0 | 0 | 0 | 34.0 | 4.0 | 1.8 | |
| | June | 4.8 | 6.00 | 0.7 | .5 | 3.0 | 1.0 | 0.2 | 0 | 34.0 | 3.2 | 0.5 | |
| | July | 5.5 | 6.88 | 0.7 | .5 | 1.6 | 27.6 | 22.0 | -16.5 | 18.5 | 0 | 0.8 | |
| | Aug. | 4.8 | 6.78 | 0.6 | .5 | 2.5 | 6.7 | 0.2 | - 1.2 | 16.4 | 0 | 0.8 | |
| | Sept. | 5.1 | 0.72 | 0.8 | .5 | 0.0 | 10.6 | 9.2 | - 7.6 | 10.7 | 0 | 0.5 | |
| | Oct. | 4.2 | 4.08 | 0.5 | .5 | 2.1 | 4.6 | 2.3 | + 1.3 | 12.0 | 0 | 0.8 | |
| | Nov. | 4.7 | 2.20 | 0.5 | .5 | 1.8 | | | + 6.2 | 18.2 | 0 | 2.2 | |
| | Dec. | 4.0 | 4.08 | 0.1 | .5 | 2.1 | | | + 6.0 | 20.7 | 0 | 2.4 | |
| | Total | 58.4 | 40.08 | 4.2 | 5.6 | 30.0 | 48.1 | 38.6 | | - -13.5 | 27.8 | 18.9 | |
| 1952 | Jan. | 8.4 | 1.01 | 0.1 | 0.3 | 1.9 | | | + 0.0 | 26.7 | 0 | 2.3 | |
| | Feb. | 5.0 | 0.00 | 0.1 | .5 | 1.0 | | | + 0.6 | 31.3 | 0 | 2.1 | |
| | Mar. | 5.4 | 2.05 | 0.2 | .5 | 4.5 | | | + 2.0 | 34.0 | 3.8 | 4.9 | |
| | Apr. | 4.7 | 0.98 | 0.1 | .5 | 8.8 | 8.5 | 0 | 0 | 34.0 | 4.5 | 1.8 | |
| | May | 4.6 | 7.10 | 0.9 | .5 | 2.9 | 0.0 | 0 | 0 | 34.0 | 8.4 | 2.3 | |
| | June | 6.0 | 4.20 | 0.6 | .5 | 3.6 | 3.0 | 0 | 0 | 34.0 | 4.2 | 0.7 | |
| | July | 2.4 | 2.62 | 0.4 | .5 | 3.4 | 11.6 | 8.4 | - 6.7 | 27.3 | 0 | 0.2 | |
| | Aug. | 2.1 | 5.06 | 0.6 | .5 | 3.0 | 17.0 | 14.0 | -11.7 | 15.6 | 0 | 0.8 | |
| | Sept. | 2.0 | 6.18 | 0.8 | .5 | 1.1 | 11.2 | 10.1 | - 7.7 | 7.9 | 0 | 0.8 | |
| | Oct. | 4.7 | 4.40 | 0.8 | .5 | 3.0 | 3.0 | 0.6 | + 3.5 | 11.4 | 0 | 0.8 | |
| | Nov. | 6.1 | 5.75 | 0.8 | .5 | 2.0 | | | + 4.6 | 16.0 | 0 | 3.6 | |
| | Dec. | 4.6 | 0.06 | 0.1 | .5 | 1.4 | | | + 4.4 | 20.4 | 0 | 1.7 | |
| | Total | 56.0 | 38.30 | 5.7 | 5.6 | 30.6 | 40.8 | 34.1 | | - - 0.5 | 18.9 | 20.7 | |
| 1953 | Jan. | 5.8 | 1.80 | 0.1 | 0.3 | 2.0 | | | + 3.4 | 28.6 | 0 | 3.8 | |
| | Feb. | 5.5 | 1.15 | 0.1 | .5 | 2.5 | | | + 6.0 | 30.6 | 0 | 8.6 | |
| | Mar. | 6.5 | 1.00 | 0.2 | .5 | 4.5 | | | + 3.4 | 34.0 | 1.4 | 4.6 | |
| | Apr. | 4.6 | 3.20 | 0.4 | .5 | 3.1 | 8.7 | 2.6 | 0 | 34.0 | 1.8 | 0.8 | |
| | May | 4.4 | 2.47 | 0.4 | .5 | 2.0 | 6.3 | 8.8 | 0 | 34.0 | 0.6 | 0.0 | |
| | June | 2.6 | 6.78 | 1.0 | .5 | 1.2 | 11.7 | 2.9 | - 8.4 | 25.6 | 0 | 0.8 | |
| | July | 2.1 | 9.80 | 0.0 | .5 | 1.3 | 11.7 | 16.6 | - 8.6 | 17.2 | 0 | 0.8 | |
| | Aug. | 4.0 | -3.00 | -0.2 | .5 | 6.1 | 4.0 | 0 | + 4.0 | 22.0 | 0 | 0.6 | |
| | Sept. | 5.3 | 5.20 | 0.5 | .5 | 5.3 | 1.4 | 0 | + 4.9 | 26.9 | 0 | 4.1 | |
| | Oct. | 4.4 | 4.05 | 0.5 | .5 | 4.6 | 3.6 | 2.0 | + 0.8 | 27.7 | 0 | 0.5 | |
| | Nov. | 6.2 | 2.00 | 0.3 | .5 | 2.0 | | | + 6.6 | 28.3 | 0 | 2.2 | |
| | Dec. | 5.5 | 0.27 | 0 | .5 | 5.0 | | | + 1.7 | 34.0 | 3.5 | 6.8 | |
| | Total | 66.7 | 34.05 | 6.0 | 5.6 | 30.5 | 47.0 | 30.0 | | - +13.0 | 6.7 | 20.3 | |
| 1954 | Jan. | 8.0 | 0.02 | 0.1 | 0.5 | 2.0 | | | 0 | 34.0 | 8.8 | 8.8 | |
| | Feb. | 5.2 | 0.10 | 0 | .5 | 3.2 | | | 0 | 34.0 | 4.8 | 2.0 | |
| | Mar. | 6.8 | 2.00 | 0.6 | .5 | 3.2 | | | 0 | 34.0 | 8.8 | 3.5 | 0 |
| | Apr. | 4.2 | 6.19 | 0.7 | .5 | 6.5 | 6.2 | 7.0 | - 4.7 | 29.3 | 0 | 0.6 | 0 |
| | May | 5.1 | 7.32 | 0.6 | .5 | 1.7 | 12.1 | 10.6 | - 8.4 | 20.8 | 0 | 3.0 | 0 |
| | June | 5.6 | 8.48 | 0.6 | .5 | 6.7 | 5.0 | 0 | + 6.0 | 20.7 | 0 | 0.8 | 0 |
| | July | 8.1 | 10.76 | 1.0 | .5 | 1.0 | 20.5 | 16.6 | -10.0 | 9.7 | 0 | 0.8 | 0.6 |
| | Aug. | 3.6 | 6.00 | 0.8 | .5 | 1.0 | 24.4 | 15.6 | - 4.7 | 5.0 | 0 | 0.8 | 2.6 |
| | Sept. | 3.9 | 3.62 | 0.1 | .5 | 0.5 | 8.9 | 6.1 | 0 | 5.0 | 0 | 0.8 | 0 |
| | Oct. | 4.3 | 6.04 | 0.2 | .5 | 1.6 | 6.3 | 5.5 | + 8.3 | 8.8 | 0 | 0.3 | |
| | Nov. | 5.2 | 2.32 | 0.1 | .3 | 1.5 | | | + 6.1 | 16.4 | 0 | 1.0 | |
| | Dec. | 5.5 | 0.88 | 0.1 | .5 | 2.5 | | | + 4.5 | 18.9 | 0 | 3.6 | |
| | Total | 55.9 | 53.81 | 4.1 | 3.5 | 30.6 | 68.2 | 60.1 | | - -18.7 | 18.9 | 10.1 | 3.1 |



Table 41

Table 41. Operation study showing operation of [illegible] Reservoir, Frenchman Unit

(Values in 1000 acre-feet unless indicated otherwise)

| Year Month | Inflow into res. [illegible] | [illegible] (in.) | [illegible] loss | Seepage | [illegible] to [illegible] | Div. req'd [illegible] ac. | [illegible] to be [illegible] | [illegible] in [illegible] | Res. content at end of month | [illegible] | [illegible] water passed [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| | | | Col. 3 x [illegible] & Exhibit 18 | | | | | Col. 2-3-4-5-6-8 -11 | | Col. 10 exceeding 85,000 A. F. | Col. 6 if 7 is diverted | |
| Source | Table 59 | Table 60 | | | Table 57 | Table 58 | Col. 8-7 | | Col. [illegible] | | | |
| 1935 Jan. | 5.2 | 1.37 | 0.1 | 0.3 | 2.1 | | | + 4.9 | [illegible] | 0 | 2.6 | |
| Feb. | 4.0 | 0.97 | 0.1 | .3 | 2.2 | | | + 4.4 | [illegible] | 0 | 2.6 | |
| Mar. | 5.6 | 2.01 | 0.1 | .3 | 3.3 | | | + 5.0 | [illegible] | 0 | 0.5 | |
| Apr. | 6.3 | 3.67 | 0.4 | .3 | 2.0 | 5.0 | 1.0 | + 2.3 | [illegible] | 0 | 18.0 | |
| May | 7.6 | -1.35 | -0.0 | .3 | 10.6 | 0 | 0 | + 2.1 | [illegible] | 2.0 | 11.3 | |
| June | 7.4 | 2.62 | 0.3 | .3 | 11.0 | 0 | 0 | 0 | [illegible] | 6.6 | 0.3 | |
| July | 5.6 | 0.07 | 1.0 | .3 | 4.9 | 16.0 | 11.1 | - 6.6 | [illegible] | 0 | 0.3 | |
| Aug. | 5.6 | 6.60 | 0.6 | .3 | 1.6 | 12.1 | 10.6 | - 6.6 | 18.7 | 0 | 0.3 | |
| Sept. | 4.0 | 3.60 | 0.5 | .3 | 2.6 | 4.4 | 1.6 | + 2.6 | 17.6 | 0 | 0.3 | |
| Oct. | 4.2 | 4.30 | 0.4 | .3 | 2.2 | 4.4 | 2.2 | + 1.3 | 20.2 | 0 | 1.0 | |
| Nov. | 5.2 | 3.05 | 0.1 | .3 | 1.6 | | | + 4.7 | 22.6 | 0 | 2.5 | |
| Dec. | 5.5 | 1.66 | 0.1 | .3 | 2.0 | | | + 4.9 | 26.6 | 0 | | |
| Total | 60.0 | 31.01 | 3.0 | 3.6 | 60.1 | 40.0 | 27.5 | | = +10.1 | 18.6 | 48.2 | |
| 1936 Jan. | 5.6 | 0.95 | 0.1 | 0.3 | 2.2 | | | + 6.2 | 30.6 | 0 | 2.6 | |
| Feb. | 5.5 | 1.31 | 0.1 | .3 | 2.5 | | | + 0.4 | 34.0 | 4.7 | 2.6 | |
| Mar. | 5.6 | 1.66 | 0.3 | .3 | 3.4 | | | 0 | 35.0 | 6.9 | 5.7 | |
| Apr. | 4.6 | 4.00 | 0.5 | .3 | 3.0 | 6.8 | 3.0 | 0 | 36.0 | 0.1 | 0.3 | 0 |
| May | 6.1 | 3.60 | 0.5 | .3 | 4.3 | 6.9 | 0 | 0 | 36.0 | 6.6 | 3.7 | 0 |
| June | 3.6 | 5.01 | 0.7 | .3 | 2.1 | 11.7 | 6.6 | - 6.6 | 37.0 | 0 | 0.3 | 0 |
| July | 2.3 | 9.05 | 0.9 | .3 | 0.5 | 14.4 | 16.9 | -12.7 | 26.1 | 0 | 0.3 | 0.8 |
| Aug. | 2.1 | 7.05 | 0.4 | .3 | 0.7 | 10.6 | 10.1 | -10.1 | 6.0 | 0 | 0.3 | 2.9 |
| Sept. | 3.6 | 6.45 | 0.2 | .3 | 0.7 | 6.6 | 6.9 | 0 | 6.0 | 0 | 0.3 | 2.5 |
| Oct. | 3.6 | 6.57 | 0.2 | .3 | 0.6 | 6.0 | 6.4 | 0 | 6.0 | 0 | 0.7 | |
| Nov. | 4.5 | 3.05 | 0.1 | .3 | 0.4 | | | + 4.1 | 6.6 | 0 | 2.6 | |
| Dec. | 4.5 | 1.31 | 0.1 | .3 | 2.0 | | | + 4.4 | 10.6 | 0 | | |
| Total | [illegible] | 49.05 | 3.9 | 3.6 | 28.7 | 60.5 | 50.0 | | = -16.0 | 18.7 | 17.6 | 14.6 |
| 1937 Jan. | 4.6 | [illegible] | 0 | 0.3 | 0.6 | | | + 4.8 | 17.7 | 0 | 0.6 | |
| Feb. | 5.1 | 1.81 | 0.1 | .3 | 1.7 | | | + 4.7 | [illegible] | 0 | 2.0 | |
| Mar. | 5.4 | 1.80 | 0.1 | .3 | 1.9 | | | + 6.0 | 27.4 | 0 | 2.2 | 0 |
| Apr. | 5.6 | [illegible] | 0.5 | .3 | 1.6 | 9.5 | 9.0 | - 0.4 | [illegible] | 0 | 0.5 | 0 |
| May | 6.0 | [illegible] | 0.6 | .3 | 1.2 | 9.2 | 0.0 | - 0.1 | 30.9 | 0 | 0.5 | 0 |
| June | 6.6 | 2.38 | 0.2 | .3 | 0.5 | 1.4 | 0 | + [illegible] | [illegible] | 0 | 3.3 | 0 |
| July | 5.1 | 7.45 | 0.6 | .3 | 1.9 | 14.6 | 16.1 | -20.0 | 11.6 | 0 | 0.3 | 2.6 |
| Aug. | 5.6 | 6.72 | 0.3 | .3 | 1.2 | 13.1 | 11.9 | - 0.3 | [illegible] | 0 | 0.3 | 7.6 |
| Sept. | 5.0 | [illegible] | 0.3 | .3 | 1.6 | 11.6 | 10.2 | 0 | [illegible] | 0 | 0.3 | 0 |
| Oct. | 4.1 | 4.01 | 0.2 | .3 | 1.6 | 3.5 | 1.5 | + 2.6 | 7.0 | 0 | 0.6 | |
| Nov. | 4.5 | 2.80 | 0.1 | .3 | 1.5 | | | + [illegible] | 11.6 | 0 | 1.0 | |
| Dec. | 4.5 | 0.81 | 0.1 | .3 | 3.1 | | | + [illegible] | 16.6 | 0 | 2.4 | |
| Total | 60.6 | 48.71 | 2.8 | 3.6 | 19.7 | 63.4 | 60.5 | | = + 9.5 | 0 | 16.6 | 13.6 |
| 1938 Jan. | 4.9 | 1.11 | 0.1 | 0.3 | 2.7 | | | + 4.3 | 30.3 | 0 | 3.0 | |
| Feb. | 4.7 | 1.05 | 0.1 | .3 | 2.2 | | | + 4.3 | 30.8 | 0 | 2.5 | |
| Mar. | 6.9 | 1.50 | 0.1 | .3 | 3.0 | | | + [illegible] | 30.1 | 0 | 2.6 | |
| Apr. | 6.6 | 0.86 | 0.1 | .3 | 2.4 | 3.4 | 1.0 | + 3.3 | 30.3 | 0 | 0.3 | |
| May | 4.9 | 1.05 | 0.1 | .3 | 5.9 | 0 | 0 | + 1.7 | 36.0 | 2.0 | 6.5 | |
| June | 9.3 | 4.55 | 0.6 | .3 | 4.2 | 7.3 | 3.1 | 0 | 36.0 | 1.2 | 0.9 | |
| July | 4.5 | 7.00 | 0.9 | .3 | 1.3 | 8.2 | 7.9 | - 4.6 | 29.2 | 0 | 0.3 | |
| Aug. | 5.0 | 9.57 | 0.5 | .3 | 1.0 | 9.6 | 8.0 | - 4.6 | 23.0 | 0 | 0.3 | |
| Sept. | 4.0 | 1.56 | 0.1 | .3 | 1.6 | 5.5 | 6.6 | - 3.0 | 20.0 | 0 | 0.3 | |
| Oct. | 3.6 | 4.55 | 0.4 | .3 | 1.5 | 6.6 | 6.2 | - 3.4 | 17.3 | 0 | 0.5 | |
| Nov. | 6.6 | 5.60 | 0.2 | .3 | 1.5 | | | + 6.3 | 21.7 | 0 | 1.6 | |
| Dec. | 4.5 | 1.20 | 0.1 | .3 | 1.7 | | | + 4.1 | [illegible] | 0 | 3.0 | |
| Total | 68.3 | 37.87 | 3.7 | 3.6 | 27.5 | 60.3 | 31.0 | | = +10.0 | 4.1 | 20.6 | |
| 1939 Jan. | 3.0 | 0.65 | 0.1 | 0.3 | 2.6 | | | + 4.6 | 30.4 | 0 | 2.9 | |
| Feb. | 4.4 | 0.93 | 0.1 | .3 | 1.7 | | | + 3.6 | 30.0 | 0.4 | 2.0 | |
| Mar. | 4.9 | 0.84 | 0.1 | .3 | 2.0 | | | 0 | [illegible] | 4.5 | 2.0 | |
| Apr. | 4.1 | 5.18 | 0.4 | .3 | 3.4 | 6.4 | 4.0 | - 0.6 | 30.4 | 0 | 0.3 | 0 |
| May | 5.2 | 5.65 | 0.6 | .3 | 2.6 | 7.5 | 0.6 | - 3.1 | 30.6 | 0 | 0.9 | 0 |
| June | 4.6 | 6.80 | 0.9 | .3 | 3.6 | 5.9 | 1.0 | + 3.0 | 25.8 | 0 | 0.3 | 0 |
| July | 3.1 | 10.89 | 1.1 | .3 | 1.5 | 10.6 | 17.6 | -20.0 | 10.0 | 0 | 0.3 | 0 |
| Aug. | 2.6 | 9.01 | 0.4 | .3 | 1.2 | 20.9 | 15.7 | -11.0 | 6.0 | 0 | 0.3 | 0.9 |
| Sept. | 2.5 | 6.37 | 0.5 | .3 | 0.7 | 12.7 | 12.0 | 0 | 6.0 | 0 | 0.3 | 3.0 |
| Oct. | 3.6 | 4.77 | 0.2 | .3 | 0.0 | 6.6 | 8.7 | 0 | 5.0 | 0 | 0.3 | 3.6 |
| Nov. | 4.3 | 2.65 | 0.1 | .3 | 1.6 | | | + 3.9 | 6.0 | 0 | 1.7 | |
| Dec. | 4.4 | 0.81 | 0 | .3 | 0.6 | | | + 4.1 | 10.0 | 0 | 0.9 | |
| Total | 48.1 | 60.55 | 3.9 | 3.6 | 20.1 | 70.1 | 60.0 | | = -18.0 | 4.9 | 15.4 | 22.6 |
| 1940 Jan. | 4.3 | 0.97 | 0 | 0.3 | 0.6 | | | + 4.0 | 17.0 | 0 | 0.9 | |
| Feb. | 5.0 | 1.20 | 0.1 | .3 | 3.0 | | | + 4.0 | 21.6 | 0 | 3.3 | |
| Mar. | 6.2 | 0.06 | 0 | .3 | 4.0 | | | + 4.0 | 26.5 | 0 | 4.3 | |
| Apr. | 4.1 | 4.10 | 0.6 | .3 | 2.5 | 6.0 | 1.4 | + 8.0 | 30.0 | 0 | 0.3 | |
| May | 3.6 | 6.06 | 0.7 | .3 | 2.5 | 6.6 | 5.5 | + 0.5 | 30.0 | 0 | 0.5 | |
| June | 11.4 | 6.01 | 0.7 | .3 | 0.5 | 11.0 | 3.7 | + 3.5 | [illegible] | 2.6 | 0.8 | |
| July | 3.7 | 8.14 | 0.9 | .3 | 1.7 | 13.1 | 11.4 | - 0.9 | 30.1 | 0 | 0.3 | |
| Aug. | 3.1 | 6.60 | 0.7 | .3 | 1.2 | 15.1 | 18.0 | -11.0 | 15.5 | 0 | 0.3 | |
| Sept. | 3.7 | 3.01 | 0.2 | .3 | 1.6 | 7.0 | 6.0 | - 3.1 | 20.5 | 0 | [illegible] | |
| Oct. | 4.2 | 3.60 | 0.3 | .3 | 2.2 | 4.0 | 3.4 | + 1.1 | 11.0 | 0 | [illegible] | |
| Nov. | 4.6 | 2.40 | 0.2 | .3 | 1.5 | | | + 6.1 | 15.6 | 0 | [illegible] | |
| Dec. | 5.3 | 0.73 | 0.1 | .3 | 4.7 | | | + 6.9 | 20.5 | 0 | 0.0 | |
| Total | 60.2 | 43.01 | 4.2 | 3.6 | 26.0 | 60.6 | 40.6 | | = + 7.5 | 2.6 | 37.9 | |

14.8/68.3 = 22%

80 Table 41 (cont)

KS002300

Table 41. Operation study showing operation of [illegible] Reservoir, [illegible] Unit

(Values in 1000 acre-feet unless indicated otherwise)

| Year | Month | Inflow into reservoir | Evap. rate (ft.) | Evap. loss | Seepage | Pumping - [illegible] | Irr. req't [illegible] | Water to be [illegible] | [illegible] | Res. content at end of month | Reservoir spills | River water passed downstream | Shortage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Source | | Table 38 | Table 40 | [illegible] | | Table 37 | Table 39 | Col. 8-7 | [illegible] | Col. [illegible] | Col. 11 = 10 exceeding [illegible] A. F. | Col. [illegible] | |
| 1941 | Jan. | 5.4 | [illegible] | 0 | 0.3 | 3.3 | | | [illegible] | [illegible] | 0 | 3.3 | |
| | Feb. | 6.1 | 1.08 | 0.1 | .3 | 3.1 | | | [illegible] | 30.1 | 0 | 3.4 | |
| | Mar. | 8.0 | 1.07 | 0.3 | .3 | 3.0 | | | [illegible] | 34.0 | 0.6 | 3.3 | |
| | Apr. | 5.6 | 0.23 | 0 | .3 | 3.1 | 0 | 0 | [illegible] | 30.0 | 5.3 | 2.6 | |
| | May | 5.4 | 6.21 | 0.6 | .3 | 3.6 | 0.9 | 0 | [illegible] | 34.0 | 4.6 | 3.9 | |
| | June | 6.6 | 6.01 | 0.6 | .3 | 4.6 | 0.6 | 0 | [illegible] | 34.0 | 4.9 | 4.6 | |
| | July | 4.6 | 4.05 | 0.5 | .3 | 3.7 | 0.9 | 4.2 | [illegible] | 33.0 | 0 | 0.3 | |
| | Aug. | 2.0 | 6.36 | 0.7 | .3 | 0.6 | 14.0 | 23.6 | [illegible] | 31.0 | 0 | 0.3 | |
| | Sept. | 4.6 | 5.23 | 0.5 | .3 | 0.0 | 0 | 0 | [illegible] | 33.7 | 0 | 1.1 | |
| | Oct. | 5.3 | 3.38 | 0.4 | .3 | 3.1 | 0.9 | 0 | [illegible] | 30.3 | 0 | 2.6 | |
| | Nov. | 6.0 | 3.02 | 0.3 | .3 | 3.0 | | | [illegible] | 34.0 | 0.6 | 2.3 | |
| | Dec. | 3.1 | 0.80 | 0.1 | .3 | 2.1 | | | 0 | 34.0 | 4.7 | 2.6 | |
| | Total | 56.6 | 33.37 | 3.7 | 3.6 | 33.0 | 33.3 | 27.9 | | - c18.7 | 30.7 | 30.1 | |
| 1942 | Jan. | 5.6 | 0.70 | 0.1 | 0.3 | 1.6 | | | 0 | 34.0 | 6.8 | 1.6 | |
| | Feb. | 5.6 | -0.03 | 0 | .3 | 2.6 | | | 0 | 34.0 | 8.1 | 3.7 | |
| | Mar. | 6.6 | 1.47 | 0.2 | .3 | 4.0 | | | 0 | 34.0 | 6.4 | 4.3 | |
| | Apr. | 5.6 | 0.75 | 0.1 | .3 | 4.1 | 0 | 0 | 0 | 34.0 | 5.4 | 4.4 | |
| | May | 3.9 | 0.63 | 0.1 | .3 | 3.6 | 0 | 0 | 0 | 34.0 | 3.8 | 3.7 | |
| | June | 6.8 | 0.15 | 0 | .3 | 3.6 | 0 | 0 | 0 | 30.0 | 3.5 | 3.7 | |
| | July | 2.7 | [illegible] | 0.7 | .3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0.7 | |
| | Aug. | [illegible] | [illegible] | [illegible] | .3 | [illegible] | [illegible] | [illegible] | [illegible] | 21.4 | 0 | 0.3 | |
| | Sept. | [illegible] | [illegible] | [illegible] | .3 | [illegible] | [illegible] | [illegible] | [illegible] | 13.3 | 0 | 0.3 | |
| | Oct. | 3.1 | [illegible] | [illegible] | .3 | [illegible] | 0 | [illegible] | [illegible] | 19.3 | 0 | 0.6 | |
| | Nov. | 3.1 | 3.33 | [illegible] | .3 | 3.7 | 3.9 | [illegible] | [illegible] | 26.3 | 0 | 3.6 | |
| | Dec. | [illegible] | 1.87 | [illegible] | .3 | 1.7 | | [illegible] | [illegible] | 27.7 | 0 | 3.0 | |
| | Total | [illegible] | 17.30 | 3.0 | 3.6 | 33.7 | 33.0 | [illegible] | [illegible] | - - 1.6 | 33.1 | 33.6 | |
| 1943 | Jan. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | + 1.0 | 34.0 | 4.1 | 3.4 | |
| | Feb. | [illegible] | [illegible] | [illegible] | .3 | [illegible] | | | 0 | [illegible] | 6.7 | 3.7 | |
| | Mar. | [illegible] | [illegible] | [illegible] | .3 | [illegible] | | | 0 | [illegible] | 4.0 | 3.6 | |
| | Apr. | [illegible] | [illegible] | [illegible] | .3 | [illegible] | [illegible] | | [illegible] | [illegible] | 0 | 0.6 | 0 |
| | May | [illegible] | [illegible] | [illegible] | .3 | [illegible] | 13.1 | [illegible] | [illegible] | [illegible] | 0 | 0.3 | 0 |
| | June | [illegible] | [illegible] | [illegible] | .3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0.3 | 0 |
| | July | [illegible] | [illegible] | [illegible] | .3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0.3 | 0 |
| | Aug. | [illegible] | 6.37 | [illegible] | .3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0 | 0.3 | 0 |
| | Sept. | [illegible] | 6.20 | [illegible] | .3 | 0.6 | 13.1 | [illegible] | [illegible] | 6.0 | 0 | 0.3 | 7.6 |
| | Oct. | 4.1 | 4.37 | [illegible] | .3 | 1.3 | 4.6 | [illegible] | [illegible] | 3.0 | 0 | 0.6 | 0 |
| | Nov. | 4.3 | 3.37 | 0.1 | .3 | 1.6 | | | [illegible] | 10.0 | 0 | 1.0 | |
| | Dec. | [illegible] | [illegible] | [illegible] | .3 | 1.0 | | | + 6.6 | [illegible] | 0 | 2.1 | |
| | Total | [illegible] | [illegible] | 3.3 | 3.6 | 33.0 | 67.0 | [illegible] | | - [illegible] | 30.4 | 34.7 | 7.6 |
| 1944 | Jan. | 3.3 | [illegible] | 0 | 0.3 | 1.3 | | | [illegible] | [illegible] | 0 | [illegible] | |
| | Feb. | 6.3 | 0.30 | 0.1 | .3 | 3.0 | | | + 4.0 | 30.6 | 0 | 3.3 | |
| | Mar. | 6.6 | 1.11 | 0.1 | .3 | 3.7 | | | + 6.2 | 30.7 | 0 | [illegible] | |
| | Apr. | 6.7 | -1.30 | -0.2 | .3 | 3.0 | 0 | 0 | + 4.3 | 34.0 | 1.3 | [illegible] | |
| | May | 3.6 | 4.57 | 0.6 | .3 | 4.6 | 0 | 0 | 0 | 34.0 | 0.6 | 4.6 | |
| | June | 4.3 | 3.64 | 0.4 | .3 | 5.1 | 0.2 | 0 | 0 | 34.0 | 4.3 | 0.6 | |
| | July | 4.1 | 3.33 | 0.3 | .3 | 4.1 | 3.3 | 1.2 | 0 | 34.0 | 3.6 | 0.3 | |
| | Aug. | 3.3 | 6.31 | 0.3 | .3 | 1.6 | 14.0 | [illegible] | [illegible] | 30.0 | 0 | 0.3 | |
| | Sept. | 3.6 | 5.30 | 0.4 | .3 | 0.6 | 13.1 | [illegible] | - 9.4 | 30.4 | 0 | 0.3 | |
| | Oct. | 4.6 | 6.30 | 0.3 | .3 | 2.4 | 6.6 | 3.6 | - 1.6 | 14.0 | 0 | 0.3 | |
| | Nov. | 5.1 | 1.60 | 0.1 | .3 | 3.6 | | | + 1.5 | 18.6 | 0 | 0.6 | |
| | Dec. | 5.1 | 1.30 | 0.1 | .3 | 2.1 | | | + 4.7 | 20.6 | 0 | 3.7 | |
| | Total | 57.6 | 30.30 | 3.0 | 3.6 | 36.6 | 36.7 | 37.3 | + 6.7 | - c10.6 | 13.0 | 30.7 | |
| 1945 | Jan. | 3.4 | 0.76 | 0.1 | 0.3 | 1.6 | | | + 3.6 | 30.3 | 0 | 3.3 | |
| | Feb. | 5.1 | 1.10 | 0.1 | .3 | 3.1 | | | + 3.6 | 34.0 | 0 | 3.6 | |
| | Mar. | 6.6 | 2.30 | 0.3 | .3 | 3.3 | | | 0 | 30.0 | 6.3 | 3.3 | |
| | Apr. | 4.0 | 1.37 | 0.2 | .3 | 1.6 | | | 0 | 34.0 | 4.6 | 0.6 | |
| | May | 4.6 | 2.60 | 0.3 | .3 | 3.0 | 3.0 | 0.7 | 0 | 34.0 | 3.7 | 0.3 | |
| | June | 3.3 | 3.67 | 0.3 | .3 | 3.0 | [illegible] | 0 | 0 | 34.0 | 4.0 | 0.9 | |
| | July | 3.4 | 6.06 | 0.6 | .3 | [illegible] | [illegible] | 0 | 0 | 36.3 | 4.3 | 0.3 | |
| | Aug. | 3.6 | 6.30 | 0.6 | .3 | 1.4 | 11.0 | 6.4 | - 7.0 | 27.0 | 0 | 0.3 | |
| | Sept. | 4.4 | 3.67 | 0.6 | .3 | 1.7 | 6.6 | 4.9 | - 1.6 | 26.3 | 0 | 0.3 | |
| | Oct. | 4.9 | 3.67 | 0.5 | .3 | 2.2 | 4.4 | 2.2 | + 1.6 | 30.3 | 0 | 0.3 | |
| | Nov. | 4.3 | 3.67 | 0.4 | .3 | 3.0 | 3.6 | 1.6 | + 2.7 | 30.6 | 0 | 0.3 | |
| | Dec. | 6.0 | 1.81 | 0.3 | .3 | 3.3 | | | + 6.2 | 33.7 | 0 | 2.6 | |
| | Total | 56.3 | 30.03 | 3.3 | 3.6 | 33.3 | 36.7 | 18.9 | + 6.2 | 34.0 | 4.3 | 1.6 | |
| | | | | | | 1.1 | | | | - - 3.3 | 33.1 | 14.0 | |
| 1946 | Jan. | 3.6 | 1.30 | 0.1 | 0.3 | 2.0 | | | 0 | 34.0 | 3.2 | 1.3 | |
| | Feb. | 5.0 | 1.30 | 0.1 | .3 | 2.0 | | | 0 | 34.0 | 4.6 | 1.3 | |
| | Mar. | 6.4 | 0.31 | 0.1 | .3 | 3.4 | | | 0 | 34.0 | 3.0 | 3.3 | |
| | Apr. | 3.3 | 3.30 | 0.3 | .3 | 1.7 | 11.3 | 3.3 | - 3.3 | 37.1 | 0 | 0.3 | |
| | May | 4.9 | 3.13 | 0.3 | .3 | 3.3 | 0 | 0 | - 4.6 | 31.3 | 0 | 0.3 | |
| | June | 3.0 | 3.30 | 0.4 | .3 | 3.7 | 3.3 | 0 | + 3.6 | 33.0 | 0 | 1.3 | |
| | July | 1.6 | 6.30 | 0.7 | .3 | 6.3 | 3.3 | 3.1 | + 3.3 | 33.0 | 0.7 | 1.7 | |
| | Aug. | 2.7 | 6.30 | 0.3 | .3 | 1.3 | 33.1 | 11.3 | - 3.3 | 33.7 | 0 | 0.3 | |
| | Sept. | 0.1 | 1.30 | 0.2 | .3 | 3.6 | 3.3 | 3.7 | - 3.3 | 33.7 | 0 | 0.3 | |
| | Oct. | 3.6 | 1.37 | 0.2 | .3 | 0.1 | 0 | 0 | + 1.0 | 36.4 | 0 | 0.3 | |
| | Nov. | 3.3 | 1.34 | 0.2 | .3 | 3.3 | | | + 3.1 | 30.3 | 0 | 3.4 | |
| | Dec. | 3.5 | 1.61 | 0.2 | .3 | 3.4 | | | + 4.3 | 34.0 | 0.9 | 3.1 | |
| | Total | 36.9 | 31.44 | 3.3 | 3.6 | [illegible] | 60.1 | 33.4 | 0 | 34.0 | 3.0 | 3.7 | |
| | | | | | | | | | | - 0 | 31.4 | 30.3 | |

81 Table 41 (cont).

Table 41. Operation study showing operation of Madera Reservoir, Friant [illegible] Unit

(Values in 1000 acre-feet unless indicated otherwise)

| Year | Month | Depleted inflow into reservoir | Evap. rate (in.) | Reservoir losses: Evap. Loss | Reservoir losses: Seepage | Pumping - Madera to [illegible] | Div. req't [illegible] ac. | [illegible] to be [illegible] | Change in cont. | Res. content at end of month | Reservoir spills | River [illegible] passed [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Source | | Table 35 | Table 40 | Col. 11 & 4 & Exhibit 19 | | Table 37 | Table 38 | Col. 8-7 | Col. 3-5 +6-9-12 -13 | Col. 11+10 | Col. 11 + 10 exceeding [illegible] A. F. | Col. [illegible] Col. 8 if 7 is diverted | |
| 1947 | Jan. | 5.5 | 1.04 | 0.1 | 0.3 | 1.9 | | | 0 | 34.0 | 5.2 | 3.3 | |
| | Feb. | 6.3 | 1.36 | 0.2 | .3 | 2.0 | | | 0 | 34.0 | 4.8 | 2.5 | |
| | Mar. | 5.0 | 1.59 | 0.3 | .3 | 3.4 | | | 0 | 34.0 | 4.8 | 2.7 | |
| | Apr. | 4.9 | 1.03 | 0.1 | .3 | 2.8 | 0 | 0 | 0 | 34.0 | 4.5 | 3.3 | |
| | May | 6.1 | 1.76 | 0.2 | .3 | 3.8 | 0 | 0 | 0 | 34.0 | 4.6 | 4.1 | |
| | June | 5.7 | 0.67 | 0.1 | .3 | 6.0 | 0 | 0 | 0 | 34.0 | 5.3 | 6.8 | |
| | July | 5.1 | 4.96 | 0.6 | .3 | 3.6 | 2.6 | 0 | 0 | 34.0 | 4.8 | 1.4 | |
| | Aug. | 2.6 | 7.62 | 0.8 | .3 | 1.2 | 17.6 | 20.8 | -14.7 | 19.3 | 0 | 0.3 | |
| | Sept. | 4.0 | 3.76 | 0.3 | .3 | 0.2 | 6.2 | 6.0 | - 3.6 | 16.7 | 0 | 0.3 | |
| | Oct. | - | - | - | - | - | - | - | - | - | - | - | |
| | Nov. | - | - | - | - | - | - | - | - | - | - | - | |
| | Dec. | - | - | - | - | - | - | - | - | - | - | - | |
| | Total | 43.3 | | 2.6 | 2.7 | 24.9 | 26.1 | 22.8 | | = -17.3 | 33.1 | 33.7 | |
| | Jan. | | | | | | | | | | | | |
| | Feb. | | | | | | | | | | | | |
| | Mar. | | | | | | | | | | | | |
| | Apr. | | | | | | | | | | | | |
| | May | | | | | | | | | | | | |
| | June | | | | | | | | | | | | |
| | July | | | | | | | | | | | | |
| | Aug. | | | | | | | | | | | | |
| | Sept. | | | | | | | | | | | | |
| | Oct. | | | | | | | | | | | | |
| | Nov. | | | | | | | | | | | | |
| | Dec. | | | | | | | | | | | | |
| | Total | | | | | | | | | | | | |
| | Jan. | | | | | | | | | | | | |
| | Feb. | | | | | | | | | | | | |
| | Mar. | | | | | | | | | | | | |
| | Apr. | | | | | | | | | | | | |
| | May | | | | | | | | | | | | |
| | June | | | | | | | | | | | | |
| | July | | | | | | | | | | | | |
| | Aug. | | | | | | | | | | | | |
| | Sept. | | | | | | | | | | | | |
| | Oct. | | | | | | | | | | | | |
| | Nov. | | | | | | | | | | | | |
| | Dec. | | | | | | | | | | | | |
| | Total | | | | | | | | | | | | |

## Frenchman Unit

1. Method of meeting irrigation demands.
   a. Sectional gains available for diversion at Culbertson Diversion Dam were first diverted to meet irrigation demands.

   b. Irrigation demands not met by sectional gains were met by releases from Enders Reservoir.

2. Requirements for other than irrigation demands.

   a. Historically, no negative sectional gains occurred in the section of the creek between Enders Dam and Culbertson Diversion Dam, therefore, it was not necessary to make releases from the reservoir for any purpose other than irrigation demands.

   b. Evaporation losses were determined in accordance with the reservoir content and monthly evaporation rate.

   c. Seepage was estimated to be 300 acre-feet per month.

3. Reservoir content.

   a. The reservoir irrigation pool is full when the reservoir reaches a content of 34,000 acre-feet. Any water available for storage after this content was reached was spilled.

   b. No releases could be made from the reservoir when it was drawn down to a content of 5,000 acre-feet.

4. Integration of operation with other units.

   a. No releases from upstream reservoirs were made to help satisfy demands in this unit.

   b. No releases were made to help meet downstream demands.

A column by column explanation of the operation table 41 follows:

1. Shows the years through which the operation study was made, namely 1929 through 1947.

2. Shows the months for each year for the operational period.

3. The depleted inflow, table 23, is the historic flow at Enders Dam less the anticipated depletions by future development above Enders. It is the water considered available for regulation.

4. Evaporation rate, table 40, is the net reservoir evaporation.

5. Evaporation loss is obtained by entering the evaporation chart, exhibit 15, with an average reservoir content, as determined from Column 11, and computing the loss therefrom.

6. Seepage is estimated as 5 second-feet, and was allowed to pass downstream to meet public health and fish requirements.

7. Sectional gains between Enders Reservoir and the diversion dam at Palisade. The sectional gain, table 27, is the historic gain in excess of anticipated depletions by future private development above the diversion dam and below Enders Reservoir.

8. Total diversion requirements for 22,910 acres in the Frenchman Unit. See table 36.

9. Demand on the reservoir is that portion of the diversion requirements not supplied by the sectional gain. It is obtained by subtracting Column 7 from Column 8.

10. Change in reservoir content is computed as follows: (Col. 3) - (Col. 5 + Col. 6 + Col. 9 + Col. 12 - Col. 14)

11. The content at the end of the month equals the content at the end of the previous month corrected by the change in content as computed in Col. 10.

12. Shows such spill as may be necessary to avoid showing a content at the end of any month (Col. 11) greater than the capacity of dead storage pool plus the irrigation pool or greater than 34,000 acre-feet.

13. Waste passed downstream at Culbertson Diversion Dam is computed to be that part of the sectional gain not diverted at the diversion dam. It is the seepage, Col. 6, if there is a demand on the reservoir in Col. 9. If there is no demand on the reservoir in Col. 9, it is Col. 6 plus Col. 7, corrected by any diversion requirement in Col. 8 which is supplied by stream accretions.

14. Shows such shortages as may be necessary to avoid showing a content at the end of any month (Col. 11) less than the capacity of the dead storage or 5,000 acre-feet.

Table 42 summarizes the Enders Reservoir operation study by years. This table shows that it was necessary to spill water from the reservoir in every year of the study except one. The average spill for the period of study was 16,200 acre-feet per year. There would have been 5 years in which it would have been impossible to meet the entire demand of all the irrigated lands. The largest shortage was one computed for 1935, when 14,800 acre-feet could not be delivered. This shortage would have been 13.3 percent of the consumptive use requirement for the unit.

Table 42.--Summary of reservoir operation - Enders Reservoir

(Unit - 1,000 acre-feet)

| Year | Depleted inflow | Res. Losses Evap. | Res. Losses Seepage | Pickup Enders to Palisade | Div. Req't. 22,910 | Irrig. Demand to be met | Res. Cont. End of Year | Spills | Shortage Actual | Shortage %C.U. | Waste Passed downstream a/ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | - | - | - | - | - | - | 34.0 | - | - | - | - |
| 1929 | 52.9 | 2.5 | 3.6 | 35.3 | 48.8 | 39.4 | 20.4 | 21.0 | 0 | 0 | 29.5 |
| 1930 | 53.8 | 2.0 | 3.6 | 51.0 | 24.3 | 11.0 | 34.0 | 23.6 | 0 | 0 | 41.3 |
| 1931 | 55.4 | 4.2 | 3.6 | 20.0 | 43.1 | 33.4 | 20.7 | 27.5 | 0 | 0 | 13.9 |
| 1932 | 55.0 | 3.7 | 3.6 | 30.8 | 49.8 | 34.1 | 20.4 | 13.9 | 0 | 0 | 18.7 |
| 1933 | 56.7 | 3.8 | 3.6 | 39.6 | 47.0 | 29.0 | 34.0 | 6.7 | 0 | 0 | 25.2 |
| 1934 | 53.9 | 4.1 | 3.6 | 24.6 | 68.2 | 58.1 | 15.3 | 15.9 | 9.1 | 7.9 | 18.1 |
| 1935 | 59.8 | 3.0 | 3.6 | 55.1 | 40.8 | 27.3 | 28.4 | 12.8 | 0 | 0 | 45.2 |
| 1936 | 52.0 | 3.6 | 3.6 | 23.7 | 68.3 | 58.8 | 13.5 | 15.7 | 14.8 | 13.3 | 17.8 |
| 1937 | 49.8 | 2.8 | 3.6 | 19.7 | 61.4 | 52.5 | 15.8 | 0 | 11.4 | 10.7 | 14.4 |
| 1938 | 53.3 | 3.7 | 3.6 | 27.3 | 44.3 | 31.9 | 25.8 | 4.1 | 0 | 0 | 18.5 |
| 1939 | 46.1 | 3.9 | 3.6 | 20.1 | 70.1 | 58.8 | 13.0 | 4.9 | 12.3 | 11.2 | 12.4 |
| 1940 | 58.2 | 4.2 | 3.6 | 34.0 | 60.5 | 40.6 | 20.3 | 2.5 | 0 | 0 | 17.7 |
| 1941 | 59.4 | 3.7 | 3.6 | 32.0 | 23.2 | 17.7 | 34.0 | 20.7 | 0 | 0 | 30.1 |
| 1942 | 62.6 | 1.9 | 3.6 | 35.7 | 31.8 | 26.0 | 33.0 | 32.1 | 0 | 0 | 33.5 |
| 1943 | 52.4 | 3.2 | 3.6 | 21.0 | 67.9 | 58.0 | 14.6 | 13.4 | 7.4 | 6.9 | 14.7 |
| 1944 | 57.5 | 3.0 | 3.6 | 36.5 | 36.7 | 27.3 | 25.2 | 13.0 | 0 | 0 | 30.7 |
| 1945 | 56.6 | 3.2 | 3.6 | 28.5 | 36.7 | 18.9 | 34.0 | 22.1 | 0 | 0 | 14.3 |
| 1946 | 56.9 | 3.5 | 3.6 | 33.9 | 40.1 | 28.4 | 34.0 | 21.4 | 0 | 0 | 25.8 |
| 1947 | 43.3 | 2.6 | 2.7 | 24.9 | 26.1 | 22.2 | 16.7 | 33.1 | 0 | 0 | 23.7 |
| Total | | | | | | | | | | | |
| Average | 55.2 | 3.3 | 3.6 | 31.7 | 46.8 | 35.4 | 24.7 | 16.2 | 2.9 | | 23.8 |

a/ Includes seepage, but does not include spills.

Sheet 1 of 2



KS002305

Table 42 (Con't)--Summary of reservoir operations - Enders Reservoir

| | 1934 | 1936 | 1937 | 1939 | 1943 |
|---|---|---|---|---|---|
| Total diversion shortage (1,000 ac-ft) | 0.91 | 14.8 | 11.4 | 12.3 | 7.4 |
| Diversion shortage ac-ft/ac irrigated | 0.40 | 0.65 | 0.50 | 0.54 | 0.32 |
| Shortage to crop in ac-ft/ac | 0.21 | 0.34 | 0.26 | 0.28 | 0.17 |
| Consumptive use requirement ac-ft/ac | 2.67 | 2.55 | 2.44 | 2.49 | 2.47 |
| Shortage in percent of consumptive use | 7.9 | 13.3 | 10.7 | 11.2 | 6.9 |

accum'd 50.0%

## Frenchman Unit

The computation of shortages in percent of the consumptive use is shown on sheet 2, table 42. The actual shortage was first converted to acre-feet per acre by dividing the total diversion shortage by 22,910 acres, the irrigated area in the unit. The shortage to the crop was then computed by computing the amount of the diversion shortage that would be lost due to the 25 percent canal losses and the 30 percent farm delivery losses. The shortage in percent of consumptive use is the ratio of the crop shortage to annual consumptive use.

Exhibit 16 is a graphic chart showing the proposed operation of Enders Reservoir. Three hydrographs are shown on this chart. The hydrograph at the top of the chart shows the water that will flow into the reservoir.

The second hydrograph shows the total diversions that must be made to meet all irrigation demands. The amount of this water that is supplied from reservoir releases, the amount that is supplied by direct reservoir inflow, and the amount that will be supplied from sectional gains is shown. If the diversion requirements were not met the shortage is indicated.

The third hydrograph on this exhibit shows the reservoir content and the spills from the reservoir that were made after the reservoir was filled.

Releases for Public Health Service.--Studies made by the Public Health Service indicate that the required flow of Frenchman Creek at Wauneta and Culbertson, Nebraska, is 4 second-feet during the summer months.1/ This requirement will be met without making releases from Enders Reservoir primarily for this purpose. This is possible because it is estimated the seepage from Enders Reservoir will be 5 second-feet, and this seepage is not used to supply irrigation demands. The estimated flow of Frenchman Creek at Culbertson after development is shown in table 45. This flow will be made up of the return flows from additional diversions for development of new lands, table 29, the historical accretions of flow between Palisade and Culbertson, table 44, wastes passing Culbertson Diversion Dam and the seepage and spills from Enders Reservoir. The historical accretion of flow was determined by subtracting the historical flow at Palisade, table 6, from the historical flow at Culbertson, table 7.

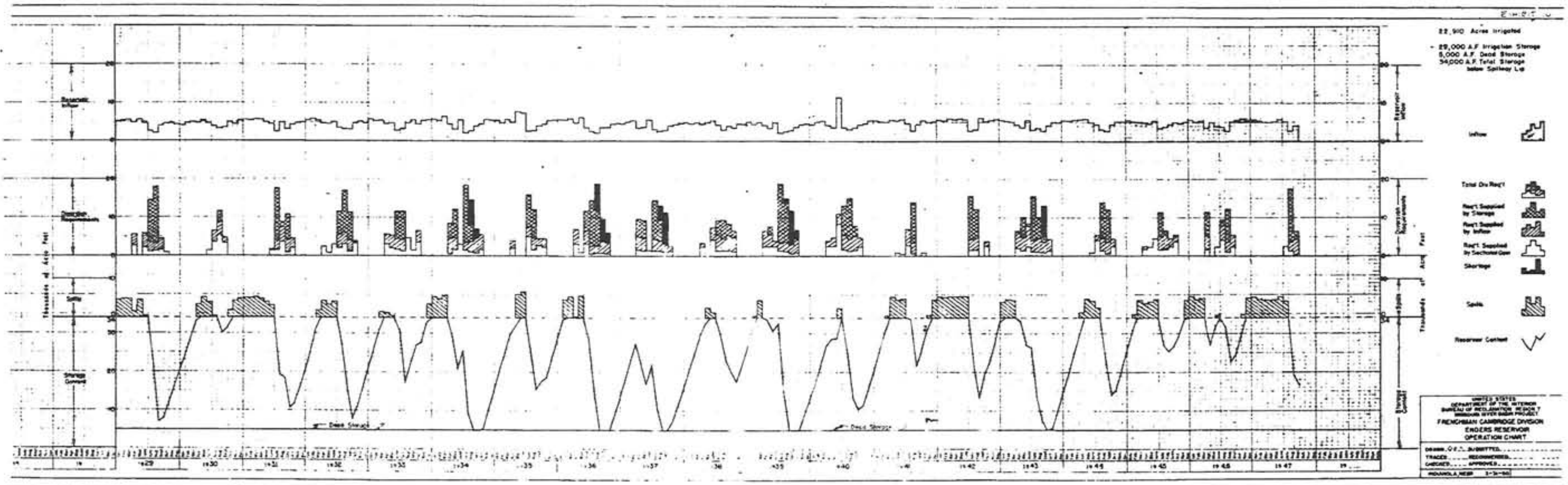
### Water passing the unit after development

The estimated flow of Frenchman Creek at Culbertson, table 45, is determined as the flow that will pass the unit after development. This flow is composed of the sum of the spills, seepage and wastes from Enders Reservoir, table , as determined by the operation study, plus the accretions of Frenchman Creek, table 44.

### Requirements for fish and wildlife

No water releases from the reservoirs for requirements of fish have been made in this study. In the past the Republican River has

1/ "Kansas River Basin Water Pollution Investigation," Public Health Service, June 1949, P. 121.


22,910 Acres Irrigated
29,000 A.F. Irrigation Storage
5,000 A.F. Dead Storage
34,000 A.F. Total Storage below Spillway Lip
Inflow
Total Div. Req't
Req't Supplied by Storage
Req't Supplied by Inflow
Req't Supplied by Sectional Gain
Shortage
Spills
Reservoir Content
Reservoir Inflow
Diversion Requirements
Spills
Storage Content
Thousands of Acre Feet
Dead Storage
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION REGION 7
FRENCHMAN CAMBRIDGE DIVISION
ENDERS RESERVOIR
OPERATION CHART

KS002308

Table 43--Sum of spills, seepage and wastes in the operation study of Enders Reservoir

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 8.0 | 9.1 | 8.9 | 1.8 | 9.6 | 0.7 | 0.3 | 0.3 | 0.3 | 3.2 | 3.3 | 5.0 | 50.5 |
| 1930 | 2.9 | 2.3 | 2.8 | 5.4 | 13.5 | 7.0 | 0.6 | .3 | 0.3 | 8.3 | 9.6 | 11.9 | 64.9 |
| 1931 | 6.9 | 6.5 | 6.9 | 6.1 | 5.9 | 3.4 | 0.3 | .3 | 0.3 | 0.3 | 2.1 | 2.4 | 41.4 |
| 1932 | 2.2 | 2.1 | 6.9 | 5.6 | 5.7 | 4.9 | 0.3 | .3 | 0.3 | 0.3 | 2.3 | 1.7 | 32.6 |
| 1933 | 3.2 | 3.8 | 6.0 | 1.5 | 0.9 | 0.3 | 0.3 | .6 | 4.1 | 0.3 | 3.2 | 7.7 | 31.9 |
| 1934 | 9.1 | 8.4 | 8.3 | 0.3 | 2.0 | 0.3 | 0.3 | .3 | 0.3 | 0.3 | 1.6 | 2.8 | 34.0 |
| 1935 | 3.4 | 2.5 | 3.5 | 0.3 | 24.9 | 18.1 | 0.3 | .3 | 0.3 | 0.3 | 1.8 | 2.3 | 58.0 |
| 1936 | 2.5 | 7.5 | 9.0 | 0.4 | 9.3 | 0.3 | 0.3 | .3 | 0.3 | 0.3 | 0.7 | 2.6 | 33.5 |
| 1937 | 0.9 | 2.0 | 2.2 | 0.3 | 0.3 | 3.3 | 0.3 | .3 | 0.3 | 0.3 | 1.8 | 2.4 | 14.4 |
| 1938 | 3.0 | 2.5 | 2.3 | 0.3 | 8.1 | 1.6 | 0.3 | .3 | 0.3 | 0.3 | 1.6 | 2.0 | 22.6 |
| 1939 | 2.9 | 2.4 | 7.4 | 0.3 | 0.3 | 0.3 | 0.3 | .3 | 0.3 | 0.3 | 1.7 | 0.8 | 17.3 |
| 1940 | 0.9 | 3.3 | 4.3 | 0.3 | 0.3 | 2.8 | 0.3 | .3 | 0.3 | 0.3 | 2.1 | 5.0 | 20.2 |
| 1941 | 3.6 | 3.4 | 3.9 | 8.7 | 7.5 | 9.5 | 0.3 | .3 | 1.1 | 2.5 | 2.9 | 7.1 | 50.8 |
| 1942 | 6.8 | 7.8 | 9.7 | 9.8 | 11.2 | 11.2 | 0.3 | .3 | 3.5 | 0.3 | 2.0 | 2.7 | 65.6 |
| 1943 | 6.5 | 7.4 | 8.2 | 0.3 | 0.3 | 0.3 | 0.3 | .3 | 0.3 | 0.3 | 1.8 | 2.1 | 28.1 |
| 1944 | 1.8 | 3.3 | 4.0 | 7.2 | 9.8 | 8.7 | 2.9 | .3 | 0.3 | 0.3 | 2.7 | 2.4 | 43.7 |
| 1945 | 2.1 | 3.3 | 6.9 | 4.0 | 4.9 | 5.7 | 0.3 | .3 | 0.3 | 0.3 | 2.6 | 5.7 | 36.4 |
| 1946 | 7.5 | 6.9 | 7.9 | 0.3 | 3.2 | 2.4 | 0.3 | .3 | 0.3 | 6.4 | 4.0 | 7.7 | 47.2 |
| 1947 | 7.4 | 7.1 | 8.2 | 7.6 | 8.7 | 11.6 | 5.6 | .3 | 0.3 | — | — | — | 56.8 |
| Average | 4.3 | 4.8 | 6.2 | 3.2 | 6.7 | 4.9 | 0.7 | 0.3 | 0.7 | 1.4 | 2.7 | 4.1 | 40.0 |

Table 44.--Historical accretions of Frenchman Creek between Palisade and Culbertson.

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.7 | -1.4 | 1.7 | 0.2 | 0.2 | 3.0 | 3.0 | 2.1 | 3.2 | 2.1 | 0.7 | 0.9 | 17.4 |
| 1930 | 0.7 | 1.2 | 1.3 | 4.0 | 2.6 | 2.6 | 2.1 | 0.2 | 1.5 | 4.4 | 2.0 | 0.2 | 22.8 |
| 1931 | 0.1 | 0.8 | -2.5 | 2.1 | 2.1 | 2.1 | 2.1 | 2.0 | 1.5 | 1.5 | 2.0 | 1.3 | 15.1 |
| 1932 | 1.8 | 2.1 | 2.2 | 2.2 | 2.2 | 2.7 | 2.1 | 1.9 | 2.0 | 1.4 | 1.7 | 0.8 | 23.1 |
| 1933 | 1.5 | 1.9 | 2.0 | 2.4 | 2.4 | 2.6 | 2.0 | 1.9 | 0.9 | 0.9 | 2.0 | 2.7 | 23.2 |
| 1934 | 2.0 | 1.9 | 2.6 | 2.5 | 2.3 | 2.4 | 1.9 | 1.1 | 2.2 | 1.3 | 1.0 | 1.8 | 23.0 |
| 1935 | 1.5 | 1.7 | 2.3 | 2.4 | 2.2 | 2.4 | 1.9 | 6.6 | 4.9 | 2.0 | 1.2 | 1.9 | 31.0 |
| 1936 | 1.8 | 1.9 | 2.4 | 2.3 | 2.3 | 2.5 | 2.0 | 2.3 | 2.0 | 1.0 | 0.8 | 1.0 | 22.3 |
| 1937 | 0.9 | 2.0 | 2.2 | 2.0 | 2.2 | 2.4 | 2.0 | 1.4 | 2.4 | 1.4 | 0.9 | 1.1 | 20.9 |
| 1938 | 1.3 | 1.9 | 2.2 | 2.2 | 2.2 | 2.2 | 2.0 | 2.1 | 2.3 | 1.8 | 1.3 | 1.9 | 23.4 |
| 1939 | 1.3 | 1.8 | 2.0 | 2.2 | 2.0 | 2.4 | 2.4 | 1.6 | 2.0 | 1.5 | 0.9 | 0.9 | 21.0 |
| 1940 | 1.1 | 1.3 | 2.0 | 2.0 | 2.3 | 2.4 | 2.2 | 1.8 | 5.0 | 1.5 | 1.3 | 1.5 | 24.4 |
| 1941 | 1.9 | 2.0 | 2.8 | 2.4 | 2.3 | 2.3 | 2.4 | 2.1 | 2.3 | 2.0 | 1.2 | 1.6 | 25.3 |
| 1942 | 2.1 | 2.2 | 2.3 | 2.2 | 2.3 | 2.7 | 2.7 | 3.0 | 2.7 | 1.9 | 1.4 | 2.3 | 27.8 |
| 1943 | 2.2 | 2.3 | 2.3 | 2.2 | 2.2 | 2.3 | 2.1 | 1.5 | 2.0 | 1.0 | 0.8 | 0.8 | 21.7 |
| 1944 | 1.7 | 1.9 | 2.1 | 2.2 | 2.3 | 2.5 | 3.1 | 2.6 | 2.2 | 2.0 | 1.3 | 1.2 | 25.1 |
| 1945 | 1.9 | 2.0 | 2.2 | 2.2 | 2.2 | 2.2 | 2.2 | 1.9 | 2.4 | 1.9 | 1.7 | 1.9 | 24.7 |
| 1946 | 2.1 | 2.1 | 2.0 | 2.2 | 2.2 | 2.3 | 2.0 | 1.6 | 2.0 | 2.0 | 1.0 | 2.0 | 23.5 |
| 1947 | 2.7 | 2.5 | 2.3 | 2.4 | 2.4 | 2.3 | 2.3 | 2.0 | 2.4 | 2.3 | 1.2 | 1.4 | 26.2 |
| Total Average | 1.6 | 1.7 | 1.9 | 2.2 | 2.2 | 2.4 | 2.2 | 2.1 | 2.4 | 1.8 | 1.3 | 1.4 | 23.2 |

Table 45.—Estimated flow of Frenchman Creek at Culbertson, Nebraska, after development of Frenchman Unit. a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 8.6 | 9.7 | 12.3 | 5.3 | 12.3 | 4.5 | 3.1 | 1.9 | 2.2 | 4.8 | 5.2 | 7.0 | 76.9 |
| 1930 | 7.5 | 5.4 | 5.9 | 7.5 | 13.7 | 8.5 | 5.0 | 2.3 | 0.5 | 8.4 | 10.4 | 9.4 | 84.5 |
| 1931 | 9.0 | 8.6 | 9.0 | 8.6 | 8.3 | 5.4 | 2.3 | 3.0 | 2.3 | 2.8 | 4.7 | 5.1 | 69.1 |
| 1932 | 4.8 | 4.7 | 10.0 | 8.0 | 7.9 | 7.3 | 2.1 | 2.5 | 1.6 | 2.3 | 4.6 | 4.1 | 69.9 |
| 1933 | 5.9 | 6.5 | 8.9 | 3.8 | 3.2 | 1.7 | 1.7 | 3.2 | 7.5 | 2.9 | 5.6 | 10.8 | 61.7 |
| 1934 | 12.0 | 11.0 | 11.0 | 2.8 | 3.7 | 3.2 | 2.4 | 2.3 | 3.2 | 2.8 | 4.1 | 5.8 | 64.3 |
| 1935 | 6.5 | 5.3 | 6.5 | 2.5 | 31.9 | 23.4 | 2.8 | 2.1 | 2.8 | 2.7 | 4.2 | 5.1 | 95.8 |
| 1936 | 5.2 | 10.1 | 11.8 | 2.9 | 12.2 | 3.0 | 2.0 | 2.0 | 2.3 | 2.1 | 3.4 | 5.5 | 62.5 |
| 1937 | 3.5 | 4.7 | 5.1 | 2.7 | 2.1 | 6.2 | 2.2 | 1.9 | 2.1 | 2.3 | 4.3 | 5.1 | 42.2 |
| 1938 | 5.6 | 5.1 | 4.9 | 2.6 | 10.6 | 4.3 | 2.6 | 2.2 | 2.9 | 2.2 | 3.9 | 4.5 | 51.4 |
| 1939 | 5.5 | 4.7 | 10.1 | 3.2 | 2.5 | 3.0 | 2.6 | 2.1 | 2.2 | 2.4 | 3.8 | 3.5 | 45.6 |
| 1940 | 3.5 | 6.1 | 7.2 | 3.1 | 2.9 | 8.7 | 2.8 | 2.8 | 3.1 | 3.4 | 5.1 | 8.7 | 57.4 |
| 1941 | 6.8 | 6.3 | 6.8 | 11.2 | 9.7 | 11.9 | 2.4 | 1.6 | 2.9 | 4.8 | 5.2 | 9.5 | 79.1 |
| 1942 | 9.1 | 10.2 | 12.5 | 12.9 | 14.6 | 14.4 | 2.8 | 2.4 | 6.6 | 3.2 | 4.9 | 5.5 | 99.1 |
| 1943 | 9.1 | 10.0 | 10.9 | 3.0 | 2.5 | 3.1 | 2.3 | 2.3 | 2.4 | 3.2 | 4.7 | 5.1 | 58.6 |
| 1944 | 4.7 | 6.2 | 7.1 | 10.6 | 12.8 | 11.3 | 5.3 | 2.1 | 2.1 | 2.7 | 5.2 | 5.0 | 75.1 |
| 1945 | 4.7 | 5.8 | 9.4 | 6.5 | 7.1 | 8.5 | 2.6 | 2.5 | 2.8 | 2.9 | 5.1 | 8.1 | 66.0 |
| 1946 | 10.1 | 9.4 | 10.5 | 2.7 | 5.2 | 4.9 | 2.9 | 2.0 | 3.1 | 9.8 | 7.1 | 10.5 | 78.2 |
| 1947 | 10.2 | 9.9 | 10.9 | 10.1 | 10.9 | 14.2 | 8.2 | 1.8 | 2.1 | - | - | - | 78.3 |
| Total | | | | | | | | | | | | | |
| Average | 7.0 | 7.4 | 9.0 | 5.8 | 9.2 | 7.8 | 3.1 | 2.3 | 2.9 | 3.6 | 5.1 | 6.6 | 69.8 |

a/ Includes return flow from new lands, historical accretions between Palisade and Culbertson, waste passing Culbertson Diversion Dam and seepage and spills from Enders Dam.

dried up during extremely dry seasons. Seepage from the dams and return flows from irrigated lands are expected to establish a live stream at all times. It is anticipated that the minimum flow requirements for public health will be sufficient for fish habitat requirements.

## Summary

Reservoir operation studies in this report indicate that during the period of operation, 1929-1947, spills would have occurred in all years but 1937. Shortages would have occurred in 1934, 1936, 1937, 1939, and 1943; however since none of the shortages would have been greater than 13.3 percent of the consumptive use requirements, the water supply would have been adequate for the irrigated area of 22,910 acres proposed to be served in the Frenchman Unit by use of Enders Reservoir.

CHAPTER III

# MEEKER-DRIFTWOOD UNIT

## General Plan for Development

The Meeker-Driftwood Unit is located on the Republican River immediately below the Trenton Dam, see exhibit 2. It is the upper unit on the Republican River of the Frenchman-Cambridge Division.

The proposed plan for the development of irrigation in this unit would provide an adequate water supply for irrigating 13,760 acres of new lands on the south side of the river in addition to furnishing a supplemental supply for the 2,680 acres presently irrigated from the Meeker Canal. This would be accomplished by utilizing the water stored in Swanson Lake which is on the Republican River about 2 1/2 miles west of Trenton, Nebraska.

### Reservoir capacity

The sediment storage requirement for Swanson Lake was determined to be 64,000 acre-feet for 50 years accumulation. This estimate was based on actual sediment distribution in other Bureau of Reclamation reservoirs adjusted to conform to the conditions expected to exist at Swanson Lake.

Table 46.--Swanson Lake storage capacity allocations

| | | All values in acre-feet | | | | | |
|---|---|---|---|---|---|---|---|
| | Elev. (ft) | Initial conditions no sediment | | 50-year conditions (64,000 ac-ft sediment) | | 100-year condi- tions (128,000 ac-ft sediment | |
| | | Accum. | Alloc. | Accum. | Alloc. | Accum. | Alloc. |
| Dead Storage | | | 4,700 | | 0 | | 0 |
| Canal outlet | 2710.0 | 4,700 | | 0 | | 0 | |
| Active irrig. storage | | | 118,100 | | 58,800 | | 0 |
| Irrig. storage pool (top) | 2752.0 | 122,800 | | 58,800 | | *0 | |
| Flood control storage | | | 133,800 | | 133,800 | | 133,800 |
| Top of flood cont. pool | 2773.0 | 256,600 | | 192,600 | | 133,800 | |
| Total storage | | | 256,600 | | 192,600 | | 133,800 |

*Assuming that 5,200 acre-feet of sediment passes through reservoir.

## Meeker-Driftwood Unit

Operation studies were based upon conditions in the reservoir estimated to exist at the end of 50 years when the irrigation storage available will be 58,800 acre-feet. The effect of bank storage will tend to increase the storage capacity of the reservoir, however, none of this possible increase in storage capacity has been used in this study because the quantity and rate of inflow and outflow from the banks has not been established.

### Acres served

By utilizing the planned 58,800 acre-feet of storage capacity in Swanson Lake, it is planned to serve a total of 16,440 acres in the Meeker-Driftwood Unit. There are 2,680 acres irrigated by the present Meeker Canal and 244 acres which would be served by the Driftwood Canal and are now irrigated by wells in the unit. An irrigable area of 339 acres under the present Meeker Canal, but not served by it, was not included in the water supply study because it can be irrigated from existing wells. This area petitioned out of the Frenchman-Cambridge Division at the time of its formation. Water for the Meeker Canal lands is being diverted from the Republican River at the present time by the Meeker Diversion Dam. This diversion dam is a temporary structure approximately one mile below Culbertson. It was rehabilitated by the Bureau of Reclamation in 1947 and is now being operated by the Bureau pending completion of Trenton Dam.

A summary of the areas in the unit that would be served water for irrigation under this plan of development is shown in table 47. The acreages listed were determined from detailed land classification surveys of all the area except that which will be served under the Driftwood Canal. Completion of the detailed land classification of the Driftwood area may result in a minor revision on acreage used.

Under this plan of development, water would be transported from Trenton Dam through the Upper Meeker, Meeker, and Driftwood Canals and the Meeker Canal Extension. The Upper Meeker Canal would directly serve 5,210 acres of new land and supply a portion of the existing Meeker Canal. The Driftwood Canal, branching off from the Upper Meeker Canal, would directly serve 4,620 acres in addition to supplying another portion of the existing Meeker Canal and the Meeker Canal Extension. The present Meeker Canal and the Meeker Canal Extension would serve the 2,680 acres that are presently irrigated and 3,930 acres of new lands. The Upper Meeker Canal is planned to have an initial capacity of 300 second-feet. There would be a total of 53 miles of main canals supplying the 16,440 acres in this unit.

## Meeker-Driftwood Unit

Table 47.--Areas served in the Meeker-Driftwood Unit

| Canal | Presently irrigated | New lands | Total |
|---|---|---|---|
| Upper Meeker Canal | 0 | 5,210 | 5,210 |
| Driftwood Canal | 244 | 4,376 | 4,620 |
| Meeker Canal Extension | 2,680 | 3,930 | 6,610 |
| Total | 2,924 | 13,516 | 16,440 |

### Water Resources

This study is based upon the depleted water supply that will be available to the unit after all probable future upstream development takes place in the Republican River Basin. For this reason it was necessary to determine the future depletions to the water supply that will take place above the unit by all probable future Bureau and private development before the water available for storage in Swanson Lake could be determined. The Upper Republican Division, see location map exhibit 1, includes all the drainage area above Trenton Dam. Depletions made in the water supply study for development of this unit are listed in table 51.

The Upper Republican Division lies in the states of Colorado, Kansas, and Nebraska. The main streams in the division are the North Fork of the Republican, the Arikaree, and the South Fork of the Republican which drain into the Republican River. The plan for development of the Upper Republican Division calls for construction of 4 reservoirs in the 3 units of the division. Wray Reservoir on the North Fork of the Republican River would store water for development of the North Republican Unit. The Pioneer Dam on the Arikaree above the North Republican Unit would regulate flood flows. Bonny Reservoir on the the South Fork of the Republican would store water for development of the St. Francis Unit. Parks Reservoir on Rock Creek would store water for the development of the Benkelman Unit. Storage allocations for the various reservoirs of the Upper Republican Division are shown in table 48.

Evaporation losses from these reservoirs were determined by using the same general procedure that was used in determining evaporation losses from the reservoirs of the Frenchman-Cambridge Division. The annual evaporation losses from the reservoirs of the Upper Republican Division are shown in table 51. Evaporation losses from reservoirs are shown to be 30 percent of the total depletions to the water supply due to the probable future development of the Upper Republican Division.

Table 48.—Reservoir storage capacities for reservoirs in Upper Republican Division above Swanson Lake

(Storage in acre-feet)

| Reservoir | Conservation or Dead at End of First 50 Years | 50-Years Sediment | Active Irrig. at End of First 50 Years | Flood Control | Total |
|---|---|---|---|---|---|
| Wray | 0 | 500 | 8,000 | 1,000. | 9,500 |
| Pioneer a/ | 10,000 | | | 73,000 | |
| Parks | 0 | 500 | 10,000 | 0 | 10,500 |
| Bonny b/ | 1,000 | 9,000 | 33,000 | 132,000 | 175,000 |
| Total | | | 51,000 | 206,000 | |

a/ To be constructed by Corps of Engineers

b/ Under construction by Bureau of Reclamation. Estimated to be completed by December 1950.

Meeker-Driftwood Unit

Depletions for private development, depletions due to the development of farm ponds, and depletions due to irrigation development, as well as the above evaporation losses were determined in the water supply study of the Upper Republican Division.

A total of 6,700 acres has been considered as the area which will be developed by future private development of irrigation above or in the Upper Republican Division. The acreages of the areas where probable future private development will take place are listed in table 49. Depletions to the water supply available to the unit are estimated to be equal to the consumptive use of irrigation water. The consumptive use of irrigation water for private development was determined by using the same consumptive use requirements and effective precipitation that was determined for the unit where the depletion due to private development will occur.

The only depletions due to pond development were estimated to be 200 acre-feet per year above the Pioneer Reservoir and 700 acre-feet per year above and 200 acre-feet per year below Bonny Dam. These depletions are included with annual depletions in the Upper Republican Division listed in table 51.

Acreages of the potential project lands in the Upper Republican Division are listed in table 50 for each unit and a break-down of the acreages in each state is shown. These acreages are based upon reconnaissance land classification surveys. Average depletion due to private development is shown in table 51 to be 23 percent of the total depletion in the division for the 19-year period of study.

Consumptive use requirements and effective precipitation for the St. Francis Unit were based upon the temperature and precipitation recorded at St. Francis, Kansas. Temperature and precipitation records recorded at Wray, Colorado were used for the consumptive use and effective precipitation determination for the North Republican Unit. For Benkelman Unit an average of the temperature records recorded at Wray, Colorado, Culbertson, Nebraska and St. Francis, Kansas were used for the consumptive use determination, rainfall data recorded at Benkelman were used to determine effective precipitation.

Diversion requirements for lands in the Upper Republican Division were determined by applying farm loss of 30 percent to the consumptive use of irrigation water requirement for each unit and a 25 percent canal loss to the farm delivery requirement. The diversion requirements for the canals in the division are listed in table 51.

Table 49.—Areas of probable future private development, Upper Republican Division.

| North Republican Unit | Acres | |
|---|---|---|
| Above Wray Dam | 840 | |
| Wray Dam to Pioneer Division | 450 | |
| Pioneer Division to Haigler | 210 | |
| Above Pioneer Reservoir | 400 | |
| Total | 1900 | |
| St. Francis Unit | | |
| Above Bonny Dam | 3100 | |
| Below Bonny Dam | 1700 | |
| Total | 4800 | |
| Benkelman Unit | | |
| Total | 0 | |
| Total | | 6700 |

Table 50--Potential Project Lands in the Upper Republican Division

(Unit - acres)

| Unit | Colorado New Lands | Colorado Presently Irrigated | Kansas New Lands | Kansas Presently Irrigated | Nebraska New Lands | Nebraska Presently Irrigated | Total New Lands | Total Presently Irrigated | Total to be Irrigated |
|---|---|---|---|---|---|---|---|---|---|
| North Republican | | | | | | | | | |
| Pioneer Canal | 0 | 650 | 0 | 0 | 0 | 2030 | 0 | 2680 | 2680 |
| Haigler Canal | 0 | 0 | 0 | 0 | 1700 | 700 | 1700 | 700 | 2400 |
| Total | 0 | 650 | 0 | 0 | 1700 | 2730 | 1700 | 3380 | 5080 |
| St. Francis Unit | | | | | | | | | |
| Hale Ditch | 200 | 520 | 0 | 0 | 0 | 0 | 200 | 520 | 720 |
| St. Francis Canal | 1200 | 0 | 1800 | 0 | 0 | 0 | 3000 | 0 | 3000 |
| Total | 1400 | 520 | 1800 | 0 | 0 | 0 | 3200 | 520 | 3720 |
| Benkelman Unit | | | | | | | | | |
| Parks Canal | 0 | 0 | 0 | 0 | 0 | 1300 | 0 | 1300 | 1300 |
| Benkelman Canals | 0 | 0 | 0 | 0 | 3400 | 300 | 3400 | 300 | 3700 |
| Total | 0 | 0 | 0 | 0 | 3400 | 1600 | 3400 | 1600 | 5000 |
| Grand Total | 1400 | 1170 | 1800 | 0 | 5100 | 4330 | 8300 | 5500 | 13,800 |

Table 51

Table . . Average annual depletions for future development in the Upper Republican Division in 1000 acre-feet

North Republican Unit

| Year | Private Depletions by Irrigation: A Ponds Above Wray Dam (840 ac.) | Wray Dam to Pioneer Diversion (480 ac.) | Pioneer Diversion to Haigler (210 ac.) | Above Pioneer Reservoir (400 ac.) | Total | Depletions due to Bureau planned development, Pioneer Area: Historic Diversions (2880 ac) | Required Diversions (2880 ac) | Pioneer Supply (2880 ac) | Haigler Area: Diversion requirement (3400 ac) | Return Flow (3400 ac) | Haigler Area Depletions (3400 ac) | Reservoir Evaporation: Wray Reservoir | Pioneer Reservoir | Total Evap. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.8 | 0.4 | 0.2 | 0.6 | 2.0 | 10.8 | 10.6 | 0 | 4.3 | 1.6 | 2.8 | 1.8 | 2.2 | 4.0 | 8.8 |
| 1930 | 0.7 | .4 | .2 | .7 | 2.0 | 10.2 | 10.2 | 0 | 4.1 | 1.6 | 2.8 | 1.2 | 2.1 | 3.2 | 6.8 |
| 1931 | 1.3 | .7 | .3 | .8 | 3.1 | 16.0 | 16.0 | 0 | 7.0 | 2.3 | 4.7 | 2.2 | 2.0 | 4.2 | 12.0 |
| 1932 | 0.8 | .6 | .2 | .6 | 2.2 | 10.1 | 10.1 | 0 | 4.9 | 1.0 | 2.0 | 2.0 | 2.9 | 4.9 | 10.1 |
| 1933 | .9 | .8 | .3 | .8 | 2.4 | 12.2 | 12.2 | 0 | 5.1 | 1.8 | 3.3 | 1.8 | 2.6 | 4.3 | 10.0 |
| 1934 | 1.5 | .8 | .6 | .9 | 3.6 | 12.4 | 13.3 | 0.8 | 7.9 | 2.5 | 5.4 | 3.0 | 2.3 | 5.3 | 16.1 |
| 1935 | .7 | .4 | .3 | .7 | 2.0 | 11.7 | 11.7 | 0 | 3.9 | 1.7 | 2.2 | 1.9 | 2.0 | 3.9 | 8.1 |
| 1936 | 1.0 | .6 | .3 | .8 | 2.7 | 11.8 | 12.0 | 0.5 | 5.5 | 1.9 | 3.6 | 2.0 | 2.9 | 4.9 | 11.7 |
| 1937 | 1.2 | .6 | .3 | .6 | 2.9 | 11.0 | 11.9 | 0.9 | 6.3 | 2.2 | 4.1 | 1.9 | 2.0 | 4.9 | 12.8 |
| 1938 | 1.1 | .6 | .3 | .9 | 2.8 | 10.8 | 10.6 | 0.4 | 5.8 | 2.1 | 3.7 | 1.7 | 2.8 | 4.5 | 11.4 |
| 1939 | 1.2 | .7 | .3 | .7 | 2.9 | 13.4 | 13.4 | 0 | 6.7 | 2.4 | 4.3 | 1.9 | 3.3 | 5.2 | 12.4 |
| 1940 | 1.1 | .6 | .3 | .7 | 2.7 | 11.8 | 11.7 | 0.2 | 5.8 | 2.1 | 3.7 | 1.9 | 3.0 | 4.9 | 11.9 |
| 1941 | 0.6 | .3 | .2 | .6 | 1.7 | 10.2 | 10.2 | 0 | 3.3 | 1.3 | 2.0 | 1.0 | 1.7 | 2.7 | 6.4 |
| 1942 | 0.7 | .4 | .2 | .6 | 1.9 | 9.3 | 9.7 | 0.4 | 3.7 | 1.3 | 2.4 | 1.2 | 1.7 | 2.9 | 7.6 |
| 1943 | 1.2 | .7 | .3 | .9 | 3.2 | 15.6 | 16.0 | 1.4 | 7.2 | 2.4 | 4.8 | 1.8 | 2.8 | 4.7 | 14.1 |
| 1944 | 0.8 | .4 | .3 | .6 | 2.0 | 15.0 | 15.0 | 0 | 4.2 | 1.7 | 2.5 | 1.5 | 2.0 | 3.5 | 8.0 |
| 1945 | 0.9 | .5 | .2 | .8 | 2.1 | 12.7 | 13.3 | 0.6 | 4.6 | 1.6 | 3.0 | 1.3 | 2.0 | 3.3 | 9.0 |
| 1946 | 0.9 | .5 | .2 | .7 | 2.3 | 13.8 | 14.5 | 1.0 | 4.8 | 1.7 | 3.1 | 1.5 | 1.6 | 3.1 | 9.6 |
| 1947 | 0.8 | .4 | .2 | .7 | 2.2 | 13.0 | 13.0 | 0 | 4.6 | 1.6 | 3.0 | 1.3 | 2.2 | 3.6 | 8.7 |
| Total | 18.4 | 10.1 | 4.7 | 13.6 | 46.8 | 236.3 | 238.3 | 5.4 | 99.7 | 35.5 | 64.2 | 32.5 | 46.8 | 79.3 | 186.7 |
| Avg. | 1.0 | 0.5 | 0.2 | 0.7 | 2.6 | 11.9 | 12.2 | .3 | 5.2 | 1.9 | 3.4 | 1.7 | 2.5 | 4.2 | 10.4 |

St. Francis Unit and Benkelman Unit

| Year | St. Francis: Depletions Private Irrigation and ponds above Bonny (3100 ac) | Depletions for irrig. & ponds below Bonny (1700 ac) | Total for Private Develop. St.Fra.Div. | Bureau planned develop.: Divers. requir. (3720 ac) | Return Flow (3720 ac) | Depletions due to planned develop. | Evap. from Bonny Reservoir | Total deplet. | Benkelman Unit: Private deplet. | Bureau planned development, Park Canal: Diversions (1200 ac) | Return Flow (1200 ac) | Depletions (1200 ac) | Benkelman Canal: Diversions (3700 ac) | Return Flow (3700 ac) | Depletions (3700 ac) | Total deplet. for Unit | Evap. from Parks Reservoir | Total deplet. Benk. Unit | Total deplet. for division |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 2.4 | 1.3 | 3.7 | 8.4 | 2.5 | 5.9 | 5.5 | 12.1 | | 2.6 | 1.2 | 1.4 | 7.6 | 3.1 | 4.5 | 5.7 | 1.0 | 6.7 | 27.6 |
| 1930 | 3.0 | 1.8 | 4.3 | 6.3 | 2.5 | 3.8 | 4.1 | 12.2 | | 1.5 | 0.8 | 0.7 | 4.2 | 2.0 | 2.2 | 2.9 | 0.8 | 3.7 | 26.4 |
| 1931 | 3.6 | 2.0 | 5.6 | 8.6 | 3.3 | 5.3 | 6.3 | 17.2 | | 2.9 | 1.3 | 1.6 | 11.2 | 4.0 | 7.2 | 9.2 | 1.2 | 11.0 | 41.2 |
| 1932 | 2.4 | 1.8 | 4.2 | 7.5 | 3.2 | 4.3 | 6.5 | 16.0 | | 3.2 | 1.6 | 1.6 | 11.0 | 4.5 | 6.5 | 8.8 | 1.3 | 10.1 | 36.2 |
| 1933 | 4.3 | 2.3 | 6.6 | 9.7 | 3.8 | 5.9 | 5.9 | 18.9 | None | 4.2 | 1.7 | 2.5 | 12.1 | 4.6 | 7.5 | 9.8 | 1.1 | 10.9 | 39.3 |
| 1934 | 5.3 | 3.2 | 8.5 | 16.2 | 6.0 | 9.2 | 9.1 | 26.8 | | 5.3 | 2.1 | 3.2 | 16.2 | 6.0 | 9.2 | 12.4 | 1.2 | 13.6 | 56.0 |
| 1935 | 4.1 | 2.5 | 6.6 | 9.6 | 4.1 | 5.5 | 6.3 | 18.0 | | 3.1 | 1.4 | 1.7 | 8.7 | 4.1 | 4.6 | 6.3 | 1.0 | 7.3 | 33.4 |
| 1936 | 4.3 | 2.5 | 6.8 | 11.1 | 4.4 | 6.7 | 7.0 | 20.5 | | 4.0 | 1.6 | 2.4 | 11.4 | 4.5 | 6.9 | 9.3 | 1.0 | 10.3 | 42.5 |
| 1937 | 4.2 | 2.4 | 6.6 | 10.5 | 4.4 | 6.1 | 5.8 | 18.4 | | 4.2 | 1.7 | 2.5 | 12.1 | 4.8 | 7.3 | 9.8 | 1.0 | 10.8 | 42.2 |
| 1938 | 4.0 | 2.2 | 6.2 | 9.8 | 3.5 | 6.4 | 5.5 | 17.1 | | 3.3 | 1.6 | 2.2 | 11.1 | 4.6 | 6.5 | 8.8 | 1.2 | 10.0 | 38.5 |
| 1939 | 4.4 | 2.5 | 6.9 | 11.6 | 4.5 | 7.1 | 6.3 | 20.3 | | 3.7 | 1.5 | 2.2 | 10.5 | 4.3 | 6.2 | 8.4 | 1.0 | 9.4 | 42.1 |
| 1940 | 4.1 | 2.4 | 6.5 | 11.5 | 4.7 | 6.8 | 4.6 | 17.9 | | 4.5 | 1.8 | 2.7 | 12.8 | 5.1 | 7.7 | 10.4 | 0.7 | 11.1 | 40.4 |
| 1941 | 2.4 | 1.3 | 3.7 | 4.3 | 2.6 | 1.8 | 3.6 | 9.1 | | 2.7 | 1.2 | 1.5 | 7.0 | 3.6 | 4.2 | 5.7 | 0.9 | 6.6 | 22.1 |
| 1942 | 2.8 | 1.4 | 4.2 | 6.4 | 3.1 | 3.3 | 4.7 | 12.2 | | 2.3 | 1.0 | 1.3 | 6.5 | 2.7 | 3.8 | 5.1 | 0.8 | 5.9 | 25.7 |
| 1943 | 4.1 | 2.4 | 6.5 | 10.8 | 3.9 | 6.9 | 6.1 | 19.5 | | 4.4 | 1.6 | 2.8 | 12.7 | 4.8 | 7.9 | 10.7 | 1.0 | 11.7 | 45.3 |
| 1944 | 2.5 | 2.0 | 4.5 | 7.9 | 3.5 | 4.4 | 4.0 | 12.9 | | 2.8 | 1.2 | 1.6 | 7.3 | 2.8 | 4.5 | 6.1 | 0.5 | 6.6 | 26.5 |
| 1945 | 3.0 | 1.6 | 4.6 | 7.0 | 2.9 | 4.1 | 4.6 | 13.1 | | 2.8 | 1.1 | 1.6 | 7.2 | 3.0 | 4.2 | 5.8 | 0.9 | 6.7 | 28.8 |
| 1946 | 4.5 | 2.5 | 7.0 | 10.5 | 4.1 | 6.4 | 5.8 | 19.2 | | 3.2 | 1.2 | 2.1 | 6.4 | 2.8 | 3.7 | 7.8 | 0.9 | 8.7 | 37.1 |
| 1947 | 2.9 | 1.5 | 4.4 | 8.6 | 3.7 | 2.9 | 5.3 | 12.6 | | 2.2 | 1.3 | 1.9 | 9.0 | 3.7 | 5.3 | 7.2 | 0.9 | 8.1 | 29.4 |
| Total | 70.0 | 38.1 | 109.1 | 188.6 | 98.4 | 98.2 | 108.4 | 312.7 | | 66.1 | 26.9 | 39.2 | 188.4 | 77.0 | 111.4 | 150.6 | 18.4 | 169.0 | 678.4 |
| Avg. | 3.7 | 2.1 | 5.7 | 9.9 | 3.6 | 5.2 | 5.5 | 16.4 | | 3.5 | 1.4 | 2.0 | 9.9 | 4.1 | 5.9 | 7.9 | 1.0 | 9.0 | 35.7 |

434.1 / 11 or 39.4

| | Avg. dep. 1000 ac. ft. | Percent of Total | Depletions in ac. ft/ac. |
|---|---|---|---|
| Average depletions for all private development 6,700 acres plus pond depletions | 8.1 | 23 | 1.22 |
| Average depletions for all reservoir evaporation | 10.7 | 30 | |
| Average depletions for development of all units 6,300 acres new lands and 5,900 acres presently irrigated | | | |
| Depletions for full water supply to 11,180 acres | 16.1 | | 1.49 |
| Depletions for supplemental supply to 2,880 acres | 0.3 | | |
| Total | 16.4 | 47 | 1.32 |
| Total Depletions | 35.7 | 100 | |



Table 51

KS002320

## Meeker-Driftwood Unit

Return flows in the Upper Republican Division were estimated to be equal to 75 percent of the difference between the diversion requirements and the consumptive use of irrigation water. The same monthly distribution was used for return flows entering the stream as was used for the Frenchman Unit. Annual depletions due to the planned irrigation development in the Upper Republican Division are determined in table 51 by subtracting the return flow from the diversion requirements. This table shows the average depletion for the 19-year period of study would be 3,700 acre-feet in the North Republican Unit, 5,200 acre-feet in the St. Francis Unit, and 7,900 acre-feet in the Benkelman Unit. The average depletion for the planned development in the North Republican Unit is shown in table 51 to be 47 percent of all the depletions for the division.

The factors necessary to determine irrigation requirements were computed on a monthly bases. These requirements were used in a study showing the operation of the reservoirs in the division. This operation study and the return flows from the planned development was used to determine table 52, the flow that will pass Benkelman Diversion Dam after development.

The operation studies of the reservoirs in the Upper Republican Division, 1929 through 1947, show there would be very few shortages and that the reservoirs would spill in most years. The operation study of Wray Reservoir shows that no shortage would be incurred in irrigating the 5,080 acres in the North Republican Unit. Wray Reservoir is shown to spill every year.

Pioneer Reservoir has no demand upon it for irrigation, therefore it would spill every year.

The operation study of Bonny Reservoir shows no shortage in the water supply when the 3,720 acres in the St. Francis Unit are irrigated. The reservoir is shown to spill every year except 1937 and 1940.

The operation study of Parks Reservoir shows the 5,000 acres in the Benkelman Unit could be given a full water supply except in 1940 when a shortage of 1,800 acre-feet would have occurred. This shortage would be equal to 6.6 percent of the consumptive use requirement. The reservoir is shown to spill every year except 1937 and 1940.

Swanson Lake will regulate the flow of the Republican River. High flows and water that otherwise would pass downstream unused, not exceeding the capacity of the irrigation pool, will be stored for use when the water is needed. Water available for storage in Swanson Lake will consist of the increase in flow of the Republican River between Benkelman Diversion Dam and Swanson Lake, the flow passing Benkelman Diversion after development of the Upper Republican Division and the return flow from 3,700 acres irrigated between Benkelman Diversion and Swanson Lake.

Table 52--Flow in Republican River Passing Benkelman Diversion after Development

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 7.5 | 5.8 | 14.2 | 7.1 | 9.1 | 3.8 | 0.8 | 0.4 | 1.3 | 3.2 | 4.6 | 5.9 | 63.7 |
| 1930 | 6.9 | 10.8 | 8.9 | 3.8 | 12.4 | 10.0 | 1.2 | 4.2 | 2.2 | 9.1 | 7.9 | 7.8 | 85.2 |
| 1931 | 9.0 | 14.6 | 13.3 | 12.5 | 2.6 | 2.9 | 0.4 | 0.4 | 0.4 | 0.4 | 4.8 | 7.7 | 69.0 |
| 1932 | 8.5 | 10.1 | 11.3 | 5.4 | 1.0 | 11.3 | 0.4 | 8.4 | 3.4 | 2.0 | 7.3 | 9.3 | 78.4 |
| 1933 | 11.4 | 10.7 | 9.9 | 2.3 | 5.0 | 0.4 | 4.6 | 6.3 | 13.0 | 3.2 | 7.5 | 12.6 | 86.9 |
| 1934 | 12.1 | 12.0 | 13.3 | 1.6 | 0.4 | 3.9 | 0.4 | 0.4 | 0.4 | 0.4 | 4.1 | 7.9 | 56.9 |
| 1935 | 7.1 | 5.7 | 7.5 | 1.9 | 214.9 | 151.6 | ~~0.4~~ | ~~1.1~~ | 1.6 | 0.4 | 5.9 | 8.5 | 406.6 |
| 1936 | 7.6 | 8.9 | 11.7 | 7.0 | 25.6 | 4.1 | 0.4 | 0.4 | 0.4 | 0.4 | 4.5 | 5.5 | 76.5 |
| 1937 | 5.1 | 9.9 | 7.8 | 0.4 | 0.6 | 0.6 | 0.4 | 0.4 | 0.9 | 1.4 | 3.8 | 4.6 | 35.9 |
| 1938 | 5.2 | 4.8 | 5.8 | 5.4 | 21.3 | 4.0 | 5.9 | 6.6 | 16.0 | 0.4 | 5.6 | 8.4 | 89.4 |
| 1939 | 9.1 | 5.2 | 11.6 | 6.0 | 0.4 | 2.2 | 0.4 | 0.4 | 0.4 | 0.4 | 2.9 | 4.0 | 43.0 |
| 1940 | 4.0 | 5.2 | 8.2 | 2.1 | 0.4 | 0.4 | 0.4 | 0.4 | 9.6 | 0.9 | 2.5 | 3.1 | 37.2 |
| 1941 | 3.4 | 6.0 | 7.7 | 10.7 | 1.6 | 17.2 | 24.1 | 9.8 | 4.4 | 9.4 | 8.5 | 10.3 | 113.1 |
| 1942 | 11.2 | 12.4 | 37.6 | 13.5 | 7.4 | 13.5 | 0.4 | 2.9 | 11.9 | 10.1 | 10.6 | 12.6 | 144.1 |
| 1943 | 11.5 | 10.0 | 9.9 | 2.3 | 3.7 | 0.9 | 0.4 | 0.4 | 0.4 | 0.4 | 2.8 | 4.4 | 47.1 |
| 1944 | 3.5 | 4.8 | 7.3 | 18.5 | 11.2 | 0.5 | 21.5 | 0.4 | 0.4 | 1.0 | 2.4 | 5.2 | 76.7 |
| 1945 | 7.6 | 9.1 | 5.7 | 10.3 | 4.3 | 15.7 | 0.4 | 0.4 | 0.4 | 0.4 | 3.4 | 4.7 | 62.4 |
| 1946 | 9.0 | 11.2 | 12.6 | 0.4 | 12.0 | 1.4 | 38.9 | 0.4 | 0.4 | 4.6 | 9.0 | 7.1 | 107.0 |
| 1947 | 7.6 | 9.3 | 16.4 | 18.6 | 18.8 | 19.6 | 2.7 | 0.4 | 0.4 | 0.4 | 3.2 | 4.0 | 101.4 |
| Avg. | 7.8 | 8.8 | 11.6 | 6.8 | 18.6 | 13.9 | 5.5 | 2.3 | 3.6 | 2.5 | 5.3 | 7.0 | 93.7 |

## Meeker-Driftwood Unit

### Available stream-flow records

Records of the stream flow at Max, Trenton, and Culbertson were used in determining the water available for use in this unit and in extending the historical records. The period for which records of flow have been made, the type of gage used, the drainage area, and the agency reporting the flow records are listed in table 1. The record of flow at these stations is considered good except for periods of ice effect when they are considered poor. The period of record for these stations and other stations in the division are shown graphically on exhibit 4.

### Stream-flow correlations and estimates

For the period prior to November 25, 1946, no stream-flow records are available for Trenton, Nebraska; therefore it was necessary to estimate the missing records to complete stream-flow data for the period of study, 1929 through 1947. Concurrent records of runoff of the Republican River at Trenton and Culbertson were plotted as shown on exhibit 17 and a curve was drawn through the plotted points. This curve indicates that the relationship between the runoff at the two stations is constant and the runoff at Trenton is estimated to be 96.5 percent of the runoff at Culbertson. The historical flow of the Republican River at Trenton, Nebraska, which is 2½ miles below Trenton Dam, was used in this study for the flow at Trenton Dam. The historical flow at Trenton is listed in table 53. Runoff records listing the historical flow of the Republican River at Culbertson are shown in table 54. Historical runoff records of the Republican River flow at Culbertson are actual records except for April and October of 1929, and January through September of 1930. These missing periods were estimated from a correlation curve, exhibit 18, obtained by plotting the historical flow of the Republican River at Max vs. Culbertson, Nebraska. Historical runoff records of the Republican River at Max are shown in table 55.

### Ground water

At one time the Bureau of Reclamation contemplated a wells development known as the McCook Wells Unit, of about 2,000 acres on the North side of the Republican River between McCook and Red Willow, Nebraska. It was planned that the ground water for this area would be recharged by return flow from an area of 3,200 acres above the McCook Wells Unit to be served by water from Red Willow Reservoir. Reclassification of project lands reduced the area of the proposed wells unit from 2,000 acres to 724 acres. Later studies of the unit indicated that development by the Bureau of Reclamation was not economically feasible. Other reasons for not developing the McCook Wells Unit were that reclassification of lands to be served by Red Willow Reservoir eliminated that portion of the project area from which return flows were to be used to recharge ground water, and the state laws of Nebraska do not make provision for wells units to be included in the formation of irrigation districts.

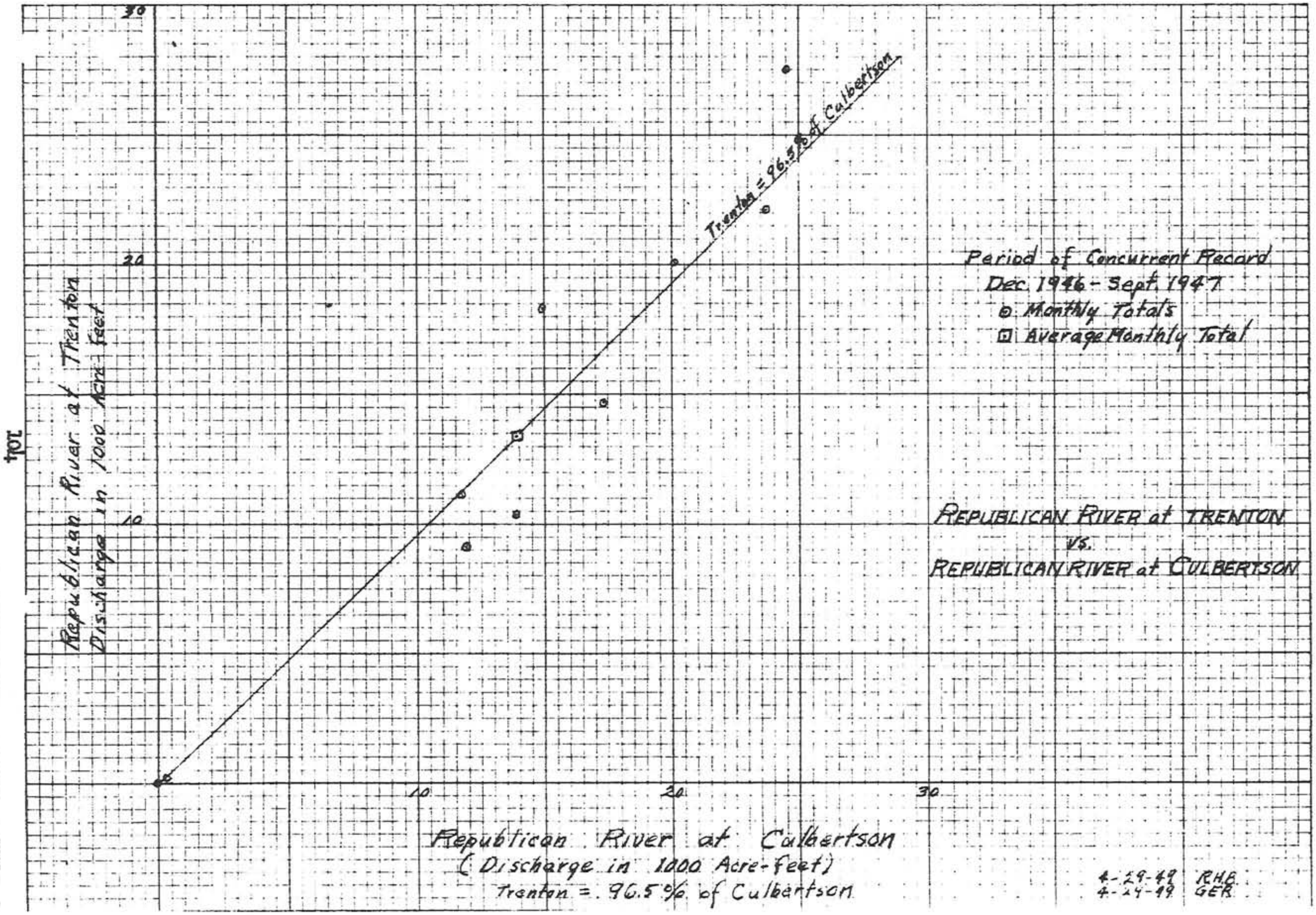



EXHIBIT 17

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Table 53--Historical Runoff of Republican River at Trenton, Nebraska - Trenton Dam Site a/
1,000 acre-feet

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 8.1 | 14.6 | 5.4 | 9.0 | 6.8 | 20.6 | 16.8 | 15.7 | 8.7 | 0.4 | 3.0 | 5.1 | 114.2 |
| 1930 | 7.7 | 11.3 | 9.8 | 9.8 | 10.3 | 11.5 | 11.9 | 17.4 | 14.1 | 3.9 | 10.5 | 8.1 | 126.3 |
| 1931 | 9.6 | 8.9 | 15.1 | 10.3 | 14.2 | 12.3 | 12.2 | 6.8 | 6.7 | 0.3 | 1.8 | 0.8 | 99.0 |
| 1932 | 3.6 | 9.5 | 10.1 | 11.3 | 8.9 | 9.3 | 8.6 | 7.2 | 11.1 | 5.8 | 9.6 | 1.1 | 96.1 |
| 1933 | 4.2 | 7.3 | 9.2 | 11.0 | 9.4 | 10.8 | 7.8 | 14.3 | 2.7 | 2.5 | 77.9 | 36.7 | 193.8 |
| 1934 | 7.9 | 8.7 | 12.5 | 11.6 | 11.8 | 10.9 | 8.4 | 1.4 | 8.5 | 0.2 | 0.6 | 0 | 82.5 |
| 1935 | 1.2 | 5.1 | 10.8 | 11.9 | 10.4 | 13.1 | 7.9 | 234.5 | 201.2 | 22.8 | 14.4 | 8.9 | 542.2 |
| 1936 | 3.5 | 5.7 | 10.6 | 8.0 | 9.6 | 13.7 | 13.8 | 45.3 | 19.5 | 0.3 | 3.9 | 0 | 133.9 |
| 1937 | 3.6 | 5.6 | 7.1 | 4.2 | 9.4 | 14.9 | 10.4 | 18.8 | 21.4 | 2.6 | 2.0 | 9.4 | 109.4 |
| 1938 | 5.3 | 6.1 | 5.9 | 8.4 | 9.8 | 10.1 | 10.5 | 30.4 | 19.6 | 17.0 | 12.5 | 21.0 | 156.6 |
| 1939 | 2.6 | 4.7 | 7.0 | 10.5 | 3.3 | 20.4 | 12.6 | 3.4 | 27.3 | 5.5 | 5.4 | 0 | 102.7 |
| 1940 | 0.1 | 2.4 | 4.3 | 4.5 | 18.3 | 16.3 | 7.0 | 2.7 | 7.0 | 1.2 | 0.3 | 9.9 | 74.0 |
| 1941 | 3.3 | 10.8 | 12.6 | 16.2 | 9.2 | 9.9 | 21.0 | 9.8 | 48.4 | 32.7 | 21.1 | 7.5 | 202.5 |
| 1942 | 11.4 | 9.9 | 8.5 | 6.8 | 12.8 | 48.1 | 13.9 | 13.2 | 21.3 | 2.0 | 15.5 | 17.7 | 181.1 |
| 1943 | 11.0 | 9.8 | 20.1 | 9.5 | 14.2 | 8.1 | 7.2 | 8.2 | 9.2 | 0 | 0 | 0 | 97.3 |
| 1944 | 0 | 1.4 | 3.3 | 16.2 | 16.3 | 15.8 | 37.6 | 18.5 | 9.0 | 33.0 | 1.7 | 0.1 | 152.9 |
| 1945 | 3.3 | 5.8 | 9.8 | 13.9 | 13.0 | 8.7 | 11.9 | 9.5 | 22.3 | 5.3 | 5.9 | 1.5 | 110.9 |
| 1946 | 4.9 | 6.1 | 3.6 | 7.7 | 10.1 | 14.1 | 5.6 | 16.8 | 8.8 | 48.4 | 1.0 | 1.0 | 128.1 |
| 1947 | 15.6 | 16.8 | 11.2 | 9.1 | 14.7 | 22.2 | 18.4 | 20.1 | 27.5 | 10.4 | 0.1 | 0 | 166.1 |
| Total Avg. | 5.6 | 7.9 | 9.3 | 10.0 | 11.2 | 15.3 | 12.8 | 26.0 | 26.0 | 10.2 | 9.9 | 6.8 | 151.0 |

a/ Values beginning with Dec. 1946 are records. Remainder are estimated to be 96.5% of Culbertson

129.3 w/o 1935

Table 54--Historical Run-off of Republican River at Culbertson a/
Discharge in 1,000 acre-feet

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 8.4 | 15.1 | 5.6 | 9.3 | 7.0 | 21.4 | 17.4 | 16.3 | 9.0 | 0.4 | 3.1 | 5.3 | 118.3 |
| 1930 | 8.0 | 11.7 | 10.2 | 10.1 | 10.7 | 11.9 | 12.3 | 18.0 | 14.6 | 4.0 | 10.9 | 8.4 | 130.8 |
| 1931 | 10.0 | 9.2 | 15.6 | 10.7 | 14.7 | 12.7 | 12.6 | 7.0 | 6.9 | 0.3 | 1.9 | 0.8 | 102.4 |
| 1932 | 3.7 | 9.8 | 10.5 | 11.7 | 9.2 | 9.6 | 8.9 | 7.5 | 11.5 | 6.0 | 9.9 | 1.1 | 99.4 |
| 1933 | 4.4 | 7.6 | 9.5 | 11.4 | 9.7 | 11.2 | 8.1 | 14.8 | 2.8 | 2.6 | 80.6 | 38.0 | 200.7 |
| 1934 | 8.2 | 9.0 | 12.9 | 12.0 | 12.2 | 11.3 | 8.7 | 1.5 | 8.8 | 0.2 | 0.6 | 0 | 85.4 |
| 1935 | 1.2 | 5.3 | 11.2 | 12.3 | 10.8 | 13.6 | 8.2 | 243.1 | 208.4 | 23.6 | 14.9 | 9.2 | 561.8 |
| 1936 | 3.6 | 5.9 | 11.0 | 8.3 | 10.0 | 14.2 | 14.3 | 46.9 | 20.2 | 0.3 | 4.0 | 0 | 138.7 |
| 1937 | 3.7 | 5.8 | 7.4 | 4.4 | 9.7 | 15.4 | 10.8 | 19.5 | 22.2 | 2.7 | 2.1 | 9.7 | 113.4 |
| 1938 | 5.5 | 6.3 | 6.1 | 8.7 | 10.2 | 10.5 | 10.9 | 31.5 | 20.3 | 17.6 | 12.9 | 21.8 | 162.3 |
| 1939 | 2.7 | 4.9 | 7.3 | 10.9 | 3.4 | 21.1 | 13.0 | 3.5 | 28.3 | 5.7 | 5.6 | 0 | 106.4 |
| 1940 | 0.1 | 2.5 | 4.5 | 4.7 | 19.0 | 16.9 | 7.3 | 2.8 | 7.2 | 1.2 | 0.3 | 10.3 | 76.8 |
| 1941 | 3.4 | 11.2 | 13.1 | 16.8 | 9.5 | 10.3 | 21.8 | 10.1 | 50.1 | 33.9 | 21.9 | 7.8 | 209.9 |
| 1942 | 11.8 | 10.3 | 8.8 | 7.1 | 13.3 | 49.8 | 14.4 | 13.7 | 22.1 | 2.1 | 16.1 | 18.3 | 187.8 |
| 1943 | 11.4 | 10.2 | 20.8 | 9.8 | 14.7 | 8.4 | 7.5 | 8.5 | 9.5 | 0 | 0 | 0 | 100.8 |
| 1944 | 0 | 1.5 | 3.4 | 16.8 | 16.9 | 16.4 | 39.0 | 19.2 | 9.3 | 34.2 | 1.8 | 0.1 | 158.6 |
| 1945 | 3.4 | 6.0 | 10.2 | 14.4 | 13.5 | 9.0 | 12.3 | 9.8 | 23.1 | 5.5 | 6.1 | 1.6 | 114.9 |
| 1946 | 5.1 | 6.3 | 3.7 | 8.0 | 10.5 | 14.6 | 5.8 | 17.4 | 9.1 | 50.1 | 1.0 | 1.0 | 132.6 |
| 1947 | 16.1 | 17.4 | 11.7 | 11.9 | 17.3 | 23.8 | 14.8 | 20.1 | 24.4 | 13.8 | 0.2 | 0 | 171.5 |
| Av. 1929-47 | 5.8 | 8.2 | 9.7 | 10.5 | 11.7 | 15.9 | 13.1 | 26.9 | 26.7 | 10.8 | 10.2 | 7.0 | 156.5 |

a/ April and October 1929 and January 1930 through September 1930 based on correlation between Max and Culbertson.

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Exhibit 18

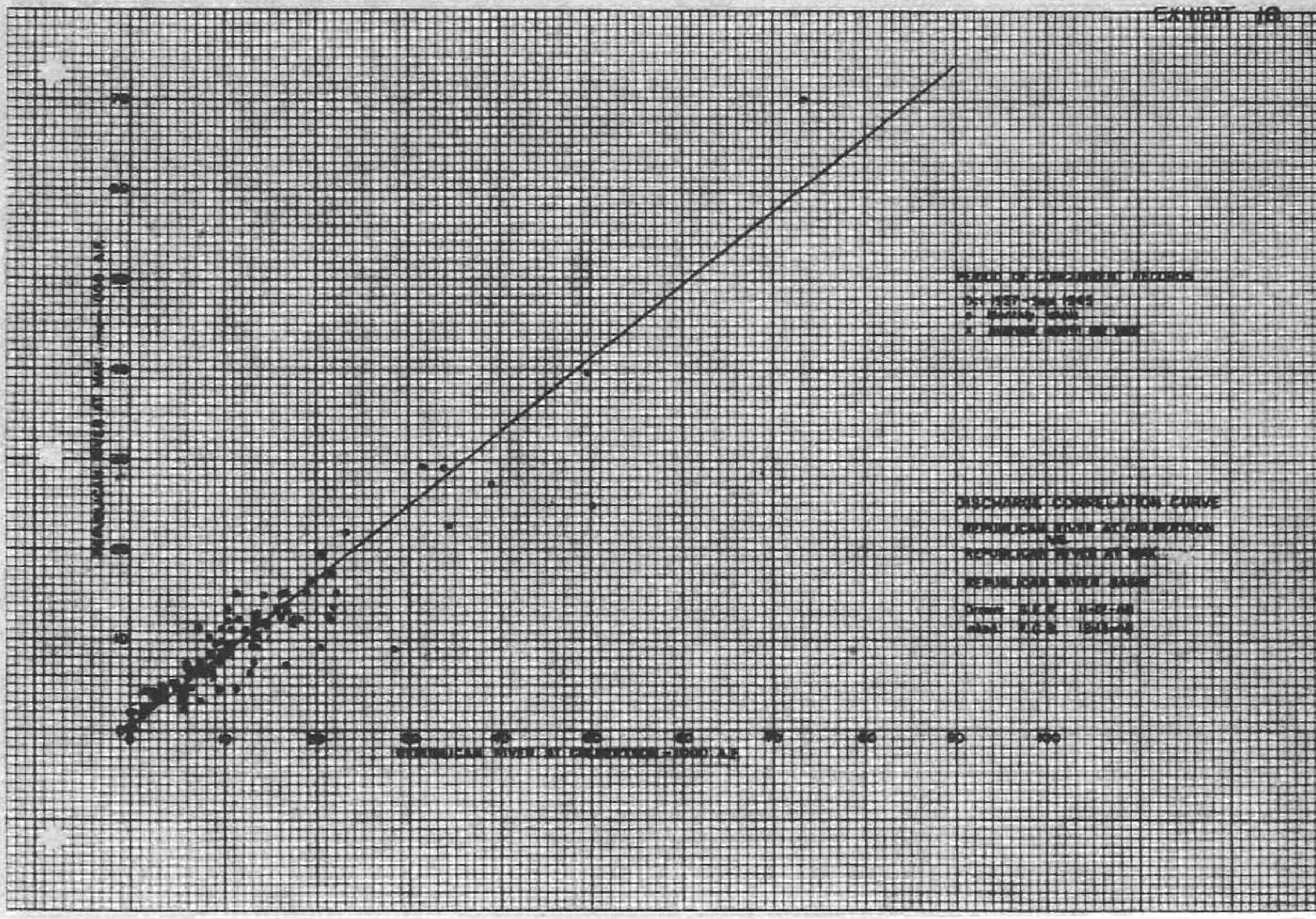

Table 55--Historical Run-off of Republican River at Max, Nebraska a/
Discharge in 1,000 acre-feet.

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929b/ | 7.4 | 12.1 | 9.0 | 8.7 | 9.2 | 15.7 | 14.7 | 14.1 | 7.9 | 5.0 | 1.2 | 5.9 | 110.9 |
| 1930 | 7.1 | 9.9 | 9.0 | 8.7 | 9.2 | 10.1 | 10.5 | 15.1 | 12.3 | 3.9 | 9.3 | 7.2 | 112.3 |
| 1931 | 13.0 | 8.7 | 8.1 | 9.0 | 15.3 | 15.9 | 15.6 | 8.3 | 8.1 | 0 | 2.3 | 0.4 | 104.7 |
| 1932 | 3.0 | 8.1 | 9.8 | 11.1 | 8.6 | 9.0 | 8.7 | 11.1 | 14.5 | 4.8 | 10.7 | 2.1 | 101.5 |
| 1933 | 6.9 | 9.3 | 9.4 | 8.6 | 8.1 | 12.7 | 7.4 | 12.2 | 1.5 | 4.9 | 42.2 | 38.1 | 161.3 |
| 1934 | 8.1 | 6.6 | 11.4 | 10.4 | 10.9 | 15.8 | 11.2 | 1.7 | 12.5 | 0.5 | 3.6 | 0.6 | 93.3 |
| 1935 | 2.6 | 5.7 | 10.6 | 10.8 | 9.6 | 12.1 | 7.7 | 232.8 | 159.2 | 14.8 | 10.1 | 8.2 | 484.2 |
| 1936 | 4.4 | 8.3 | 10.2 | 8.3 | 8.4 | 11.1 | 13.1 | 42.0 | 9.9 | 0.8 | 2.3 | 0.6 | 119.4 |
| 1937 | 4.0 | 4.6 | 7.7 | 3.8 | 8.9 | 19.6 | 7.4 | 14.1 | 8.6 | 1.6 | 1.4 | 9.0 | 90.7 |
| 1938 | 4.1 | 4.8 | 6.9 | 6.8 | 9.4 | 9.5 | 11.1 | 29.4 | 9.2 | 12.4 | 6.2 | 17.5 | 127.3 |
| 1939 | 3.6 | 4.8 | 7.4 | 9.7 | 3.3 | 12.9 | 9.3 | 3.6 | 9.0 | 4.4 | 2.5 | 0 | 70.5 |
| 1940 | 2.0 | 4.2 | 5.2 | 5.2 | 15.3 | 13.4 | 6.9 | 4.0 | 3.2 | 1.8 | 0.1 | 13.6 | 74.9 |
| 1941 | 4.3 | 4.8 | 7.6 | 13.9 | 7.8 | 9.5 | 12.1 | 8.2 | 25.0 | 29.1 | 13.9 | 6.3 | 142.5 |
| 1942 | 12.2 | 8.6 | 6.4 | 11.5 | 12.3 | 39.8 | 15.0 | 13.0 | 15.1 | 2.5 | 12.5 | 12.2 | 161.1 |
| 1943 | 15.1 | 12.1 | 19.5 | 11.2 | 11.8 | 10.3 | 7.6 | 8.6 | 4.8 | 0.1 | 0 | 0 | 101.1 |
| 1944 | 2.0 | 4.3 | 5.0 | 7.2 | 15.4 | 15.1 | 27.2 | 16.8 | 8.0 | 22.8 | 2.3 | 1.0 | 127.1 |
| 1945 | 4.6 | 7.4 | 9.1 | 12.0 | 9.3 | 9.8 | 11.1 | 10.0 | 22.0 | 3.5 | 5.9 | 2.5 | 107.2 |
| 1946 | 4.9 | 5.8 | 3.5 | 7.0 | 9.0 | 12.5 | 5.1 | 14.6 | 8.0 | 41.5 | 1.3 | 1.3 | 114.5 |
| 1947 | 13.6 | 14.6 | 10.0 | 10.1 | 14.5 | 19.9 | 12.4 | 16.9 | 20.3 | 11.8 | 0.8 | 0 | 144.9 |
| Av. 1929-47 | 6.5 | 7.6 | 8.7 | 9.2 | 10.3 | 14.4 | 11.3 | 25.1 | 18.9 | 8.7 | 6.8 | 6.7 | 134.2 |

a/ October 1928 through September 1945 are historical records with exceptions in b/.
October 1945 through September 1947 based on a correlation with the Republican River at Culbertson.

b/ December 1928 through February 1929 and December 1929 through February 1930 are estimates taken from the B.A.E. report based on the mean monthly value of all records up to, and including, 1939.

Meeker-Driftwood Unit

The ground-water conditions described herein were obtained from information supplied in a publication of Water Supply Papers by the University of Nebraska. 1/ Additional information was obtained from the Geological Survey. 2/

The Republican River Valley in the area of the Meeker-Driftwood Unit is characterized by a buried channel with relatively low bedrock and comparatively thick overlying deposits of water-bearing sand and gravel. The water table is at a relatively shallow depth ranging from approximately 6 to 30 feet below the surface of the ground. Conditions are favorable for infiltration of precipitation and direct recharge to the ground water from stream flow.

"The yield of wells installed in the alluvium of the Republican Valley region range from several gallons to more than 1,000 gallons a minute. It is reported that one of the municipal wells at McCook, drilled on the south side of the Republican River, was 84 feet deep and yielded 900 gallons a minute with a draw-down of only 7 feet. The depth to water level in this well was about 20 feet. It is also reported that irrigation wells situated in the same productive belt of the alluvium on the south side of the river near McCook have yielded more than 1,000 gallons a minute.

"The yields of wells installed on the uplands both north and south of the Republican River are considerably less. Many of the wells top the saturated part of the Ogallala formation that underlies much of the upland areas. One well, installed in the northwestern part of the county (Red Willow), was completed to a depth of 334 feet, the bottom of the water-bearing sands being 329 feet and the static water level at a depth of 240 feet. This well is situated in the general vicinity of test hole 126 shown on Profile section"..., exhibit 19, "and derives its water supply from the Ogallala formation. It is reported that the well yielded 125 gallons a minute with a draw-down of 57 feet. It is believed that, in general, the yields of ordinary domestic and livestock wells in the upland areas are somewhat less than this amount." 1/

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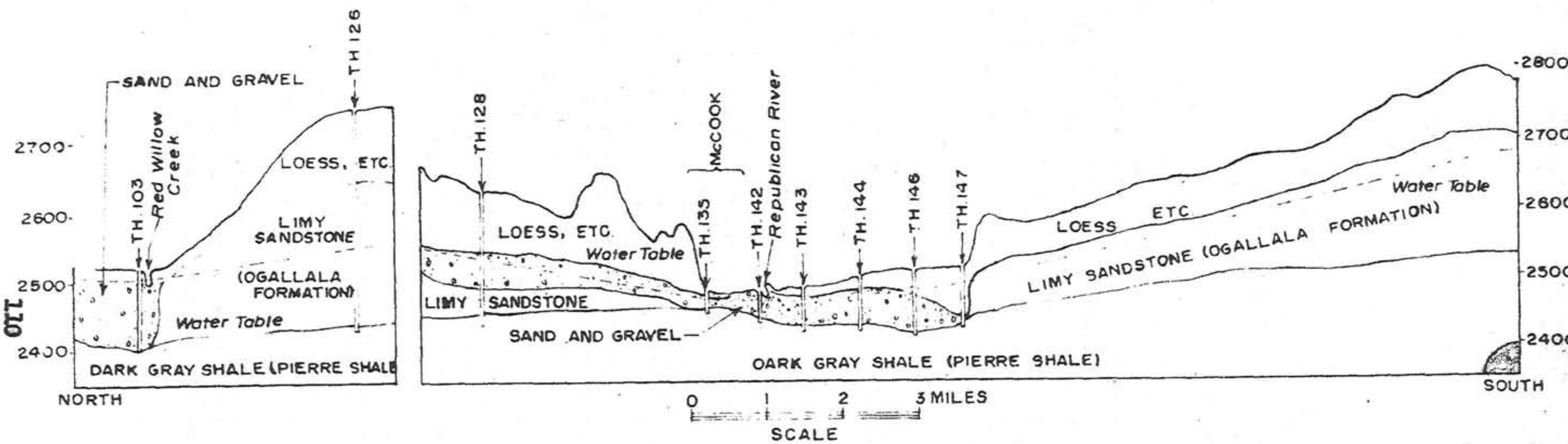
1/ Ground water in the Republican River Basin in Nebraska, Part III, Red Willow and Frontier Counties, by H. A. Waite, E. C. Reed, and D. S. Jones, Jr., published by the University of Nebraska, Conservation and Survey Division.

2/ Progress Report on the Ground Water Hydrology of the Republican and Frenchman River Valleys, Circular 19, by Herbert A. Waite and others, published by the U. S. Department of the Interior, Geological Survey, August 1948.




This section is located at the west edge of McCook and extends in a north-south direction from the Frontier-Red Willow county line to a point 2.5 miles north of the Nebraska-Kansas state line. A break in the profile section representing a distance of about 3.5 miles occurs near the middle of the interstream divide between the Republican Valley and the valley of Red Willow Creek. (Nebraska Water Resources Survey, Water Supply Paper 1, Part III)

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EXHIBIT 19

## Meeker-Driftwood Unit

Profiles of the Republican River Valley at Trenton and near McCook are shown on exhibits 10 and 11.

A cooperative program between the Bureau of Reclamation and the Geological Survey has been established for the study of the ground water in the Republican River Valley below Swanson Lake. This program will establish a history of the conditions which will be used as a basis for observing ground-water changes resulting from irrigation.

Ground-water observations were made by the Geological Survey for 13 observation wells prior to May 1, 1950. Periodic observation of these wells will be continued along with periodic observation of 80 additional wells of which 5 are existing farm wells, and 75 are new wells jetted in by the Geological Survey during May and June 1950. Information collected from these wells will be utilized by the Geological Survey in preparing depth to ground water and water-table contour maps of the Meeker-Driftwood Area. The Bureau of Reclamation requested these maps to be furnished to them by April 1, 1951.

### Quality of water

The Geological Survey has made analyses of water taken from the Republican River at Max and Trenton, Nebraska. The analyses made in 1947, 1948, and 1949 are listed in tables 56 and 57.

These analyses indicate the quality of the water that will be available for storage in Swanson Lake. Return flows resulting from upstream development could deteriorate the quality of the water in the stream if they accumulate enough salts before entering the stream. Since return flows from planned development above Swanson Lake will be a minor part of the total flow, and because present accretions do not noticeably deteriorate the water quality, it is not considered that future return flow from upstream development will deteriorate the water quality of the stream materially. Analyses of the flow of Frenchman Creek at Culbertson have been made and they are discussed under the water quality discussion for the Frenchman unit.

The analyses listed in tables 56 and 57 have been plotted on the charts, exhibits 20 and 21. These exhibits show the water in the river at Max and Trenton are of excellent quality insofar as total salts and sodium percentage are concerned.

The analyses show the boron content is never high enough to cause damage to the most sensitive crops. The highest boron content reported was 0.57 parts per million and this was only one analysis. All other analyses show a boron content of 0.30 parts per million or less.

Sodium carbonate or bicarbonate concentration of the water at Max and Trenton was studied by drawing bar graphs of chemical equivalents to show hypothetical combinations of sodium and the carbonates. Of 42 samples

CHEMICAL ANALYSIS AND RELATED PHYSICAL MEASUREMENTS OF STREAMS

IN THE

MISSOURI RIVER BASIN

REPUBLICAN RIVER AT MAX, NEBRASKA

( Chemical analysis in parts per million )

Table 56
Sheet 1 of 2

| Sample No. | Date of Collection | Mean discharge (sec.-ft.) | Temperature (°F) | pH | Specific conductance K x 10^5 at 25° C | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | | | Dissolved solids: Parts per million | Dissolved solids: Tons per acre foot | Dissolved solids: Tons per day | Hardness as $CaCO_3$: Total | Hardness as $CaCO_3$: Noncarbonate | Percent sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | Oct. 1-10, 1945 | 107 | | 8.5 | 40.7 | 49 | 0.08 | 50 | 17 | 31 | 32 | 241 | [illegible] | 6.0 | 1.1 | 1.8 | 0.04 | | | 347 | | | 198 | 0 | 25 |
| [illegible] | Oct. 11-17, 19-20 | 90 | | 8.1 | 49.8 | 50 | .02 | 51 | 17 | 30 | 18 | 242 | [illegible] | 8.5 | 1.1 | 1.1 | .06 | | | 347 | | | 197 | 0 | 24 |
| [illegible] | Oct. 21-28, 30 | 70 | | 8.0 | 50.1 | 44 | .08 | 52 | 18 | 30 | 9.0 | 244 | [illegible] | 8.8 | 1.1 | 1.5 | .08 | | | 345 | | | 200 | 0 | 24 |
| [illegible] | Oct. 31, Nov. 1-4, 5-10 | [illegible] | | 7.5 | 58.2 | 48 | .08 | 58 | 18 | 31 | 9.3 | 247 | [illegible] | 7.0 | 1.2 | 2.5 | .04 | | | [illegible] | | | 211 | [illegible] | 22 |
| [illegible] | Nov. 11-20 | [illegible] | | 7.7 | 72.2 | 47 | .08 | [illegible] | 18 | 30 | 9.4 | [illegible] | [illegible] | [illegible] | 1.1 | 2.4 | .04 | | | [illegible] | | | 211 | [illegible] | 22 |
| [illegible] | Nov. 21-30 | 220 | | [illegible] | 47.9 | 47 | .08 | [illegible] | 19 | 31 | 10 | 255 | [illegible] | 6.0 | 1.2 | 3.7 | .04 | | | [illegible] | | | 214 | [illegible] | 23 |
| [illegible] | Dec. 1, 3-4, 10 | [illegible] | | 7.7 | 56.4 | 54 | .08 | [illegible] | [illegible] | [illegible] | 9.3 | [illegible] | [illegible] | [illegible] | 1.4 | [illegible] | .08 | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Dec. 11-20 | [illegible] | | 7.7 | [illegible] | 41 | .08 | [illegible] | [illegible] | [illegible] | 10 | [illegible] | [illegible] | 7.5 | 1.4 | 4.1 | .08 | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Dec. 21-27, 29-30, 31 | [illegible] | | 7.4 | [illegible] | 46 | .06 | [illegible] | 19 | 31 | 9.2 | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | .08 | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Jan. 1-5, 7-10, 1946 | 164 | | 7.8 | 61.3 | [illegible] | .06 | [illegible] | 16 | [illegible] | 7.2 | [illegible] | [illegible] | [illegible] | 1.2 | 2.7 | .06 | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Jan. 12-18, 24-28, 30 | [illegible] | | 7.8 | [illegible] | [illegible] | .08 | [illegible] | 19 | [illegible] | 9.4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Jan. 21-31 | 135 | | [illegible] | [illegible] | [illegible] | .08 | [illegible] | 15 | [illegible] | 9.2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Feb. 1-10 | [illegible] | | 7.9 | [illegible] | [illegible] | [illegible] | [illegible] | 17 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Feb. 11-11, 18 | [illegible] | | 7.9 | [illegible] | [illegible] | .10 | [illegible] | [illegible] | 27 | 4.5 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Feb. 16-13 | [illegible] | | - | [illegible] | - | - | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.0 | [illegible] | - | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Feb. 20-28 | 147 | | [illegible] | [illegible] | [illegible] | .07 | 54 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 3.7 | .04 | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Mar. 1-10 | 115 | | [illegible] | [illegible] | 47 | [illegible] | [illegible] | [illegible] | [illegible] | 8.7 | [illegible] | [illegible] | [illegible] | 1.4 | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Mar. 11-20 | 115 | | 7.7 | [illegible] | [illegible] | .07 | [illegible] | [illegible] | [illegible] | 10 | [illegible] | [illegible] | 7.0 | [illegible] | 3.7 | [illegible] | | | [illegible] | | | [illegible] | 11 | [illegible] |
| [illegible] | Mar. 21-31 | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 11 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Apr. 1-10 | 127 | | 8.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Apr. 11-20 | 126 | | 8.1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Apr. 21-30 | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 10 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | May 1-10 | [illegible] | | 7.4 | 55.1 | [illegible] | [illegible] | [illegible] | 17 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | May 11-20 | [illegible] | | 8.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 10 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | May 21-31 | 277 | | [illegible] | [illegible] | [illegible] | [illegible] | 50 | [illegible] | [illegible] | 7.1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | June 1-10 | [illegible] | | 7.5 | [illegible] | [illegible] | [illegible] | [illegible] | 17 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | June 11-20 | [illegible] | | [illegible] | [illegible] | 67 | [illegible] | [illegible] | 17 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | June 21-23, 25-30 | 47 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | July 1, 3-10 | [illegible] | | 8.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | July 11-20 | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | July 21-31 | 116 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 7.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Aug. 1-10 | 23 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 7.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Aug. 11-20 | 8 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Aug. 21-31 | 11 | | [illegible] | 67.1 | 44 | .08 | [illegible] | 18 | [illegible] | 7.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Sept. 1-10 | [illegible] | | 7.4 | 55.7 | 48 | .08 | [illegible] | 17 | 41 | 14 | 234 | [illegible] | [illegible] | 1.6 | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Sept. 11-20 | [illegible] | | [illegible] | 57.0 | 52 | .02 | [illegible] | 16 | [illegible] | 16 | 235 | [illegible] | 7.5 | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| [illegible] | Sept. 21-30 | [illegible] | | [illegible] | 56.8 | 52 | .06 | [illegible] | 19 | [illegible] | 11 | 251 | [illegible] | 7.1 | [illegible] | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] |
| | Weighted Average | | | | | | | | | | | | | | | | | | 144 | | | | | | |

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Table 56

KS002332

Table 56
sheet 2 of 2

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY [illegible]

[illegible] River [illegible]

Mineral constituents, in parts per million, and related physical measurements, water year October, [illegible] to September, [illegible]

| Sample No. | Date of Collection | Mean discharge (second-feet) [1] | Temperature (°F) | pH | Specific conductance (micromhos at 25°C) | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | Dissolved Solids: Parts per million | Dissolved Solids: Tons per acre-foot | Dissolved Solids: Tons per day | Hardness as $CaCO_3$: Total | Hardness as $CaCO_3$: Non-carbonate | Percent sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | Oct. [illegible], 1948 | [1] --- | [illegible] | 7.8 | [illegible] | 39 | 0.06 | [illegible] | 13 | 27 | [illegible] | 338 | 80 | [illegible] | [illegible] | [illegible] | [illegible] | 349 | 0.48 | --- | 178 | [illegible] | [illegible] |
| [illegible] | [illegible] | --- | [illegible] | 7.8 | [illegible] | 44 | .08 | 55 | 16 | 32 | 11 | 268 | 66 | 6.5 | [illegible] | 7.5 | [illegible] | 354 | .48 | --- | 203 | 0 | [illegible] |
| [illegible] | [illegible] | --- | [illegible] | 7.9 | [illegible] | [illegible] | .08 | 58 | 18 | 33 | 13 | 262 | 72 | 6.7 | .9 | 1.6 | .06 | 378 | .51 | --- | 218 | 3 | 23 |
| [illegible] | Nov. [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | .02 | 56 | 18 | 32 | 12 | 267 | 75 | [illegible] | [illegible] | 1.8 | [illegible] | 365 | .50 | --- | 214 | 12 | 23 |
| [illegible] | Nov. [illegible] | --- | 42 | [illegible] | [illegible] | 42 | .03 | 61 | 19 | 35 | 9.9 | 264 | 77 | 7.0 | [illegible] | [illegible] | [illegible] | 390 | .53 | --- | [illegible] | 14 | 24 |
| [illegible] | Nov. 21-30 | --- | 53 | [illegible] | [illegible] | [illegible] | .02 | 61 | [illegible] | [illegible] | 10 | 278 | 75 | [illegible] | 1.6 | [illegible] | 11 | 398 | .54 | --- | [illegible] | 0 | 24 |
| [illegible] | Dec. [illegible] | --- | [illegible] | [illegible] | [illegible] | 51 | .08 | [illegible] | 18 | [illegible] | 6.9 | [illegible] | 68 | 6.7 | [illegible] | [illegible] | [illegible] | [illegible] | .51 | --- | [illegible] | [illegible] | [illegible] |
| [illegible] | Dec. 11-14, 18-20 | --- | 42 | 8.1 | [illegible] | 42 | .03 | 61 | 19 | [illegible] | [illegible] | [illegible] | 72 | 6.6 | 1.1 | [illegible] | [illegible] | [illegible] | .52 | --- | [illegible] | 11 | [illegible] |
| [illegible] | Dec. [illegible] | [illegible] | 36 | 7.7 | [illegible] | 47 | .04 | 64 | 19 | [illegible] | [illegible] | [illegible] | 78 | 7.9 | [illegible] | [illegible] | [illegible] | [illegible] | .56 | --- | 224 | [illegible] | 21 |

[1] No discharge available for this station.





Table 56 (cont'd)

Table 57
sheet 1 of 3

UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY Water Resources [illegible]

[illegible] River at Trenton, Nebraska

Mineral constituents, in parts per million, and related physical measurements, water year [illegible]

| Sample No. | Date of Collection | Mean discharge (second-feet) | Temperature (°F) | pH | Specific conductance (K x 10^5 at 25°C) | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | Dissolved solids: Parts per million | Dissolved solids: Tons per acre-foot | Dissolved solids: Tons per day | Hardness as $CaCO_3$: Total | Hardness as $CaCO_3$: Noncarbonate | Percent sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | Nov. 25-28, 30, 1946 | 262 | 34 | 8.2 | [illegible] | --- | --- | --- | --- | --- | --- | 277 | --- | --- | --- | --- | --- | | | | | | |
| [illegible] | Dec. 1-10 | 197 | 33 | 8.2 | [illegible] | --- | --- | --- | --- | --- | --- | 1/ 281 | --- | --- | --- | --- | --- | | | | | | |
| [illegible] | Dec. 11-16, 17-20 | 182 | 37 | 8.3 | [illegible] | --- | --- | --- | --- | --- | --- | 1/ [illegible] | --- | --- | --- | --- | --- | | | | | | |
| 443 | Jan. 2-10, 1947 | 57 | 37 | 8.0 | 55.7 | 45 | 0.05 | 79 | 47 | [illegible] | [illegible] | 333 | 100 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 444 | Jan. 11-1? | 190 | --- | 8.4 | 53.2 | 44 | .01 | 57 | 18 | 27 | | 1/ 258 | 53 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 445 | Jan. 23-29 | 249 | 33 | 8.6 | 50.0 | 33 | .05 | 56 | 18 | [illegible] | 15 | 1/ [illegible] | 59 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 446 | Feb. 10-20 | 678 | 35 | 8.5 | 47.0 | 52 | .05 | 73 | 41 | [illegible] | 17 | [illegible] | 67 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 447 | Feb. 21-28 | 175 | 37 | 8.4 | [illegible] | 45 | .07 | 62 | 21 | 22 | 19 | 251 | 70 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 448 | Mar. 3-10 | 289 | 33 | 8.7 | 57.4 | 38 | .07 | 64 | [illegible] | 24 | 18 | 278 | 72 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 449 | Mar. 11-20 | 659 | 40 | 7.8 | 50.8 | 36 | .07 | 57 | 18 | 19 | 17 | 247 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 450 | Mar. 21-31 | 353 | 47 | 8.6 | 62.5 | 33 | .07 | 57 | 25 | 28 | | 268 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 451 | Apr. 1-? | 194 | 48 | 8.4 | 55.6 | 47 | .10 | 66 | 19 | 29 | 18 | 279 | 67 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 452 | Apr. 11-20 | 201 | 56 | 8.4 | 57.1 | 43 | .07 | 62 | 20 | 28 | 19 | 281 | 74 | 7.7 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | Apr. 15 2/ | 181 | --- | 8.5 | 59.6 | 71 | .14 | [illegible] | 14 | 18 | 20 | 280 | 86 | [illegible] | [illegible] | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | Apr. 21-30 | 517 | 35 | 8.4 | 53.1 | 31 | .08 | 59 | [illegible] | 34 | | 12/ 259 | 66 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 481 | May 1-10 | 237 | 40 | 8.4 | 56.1 | 31 | .05 | 60 | 18 | 27 | 45 | 264 | 77 | 7.0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | May 15-27 | [illegible] | --- | 8.3 | 57.0 | 65 | .18 | 50 | 17 | 38 | 19 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | May 28 2/ | [illegible] | --- | 8.0 | 64.4 | 43 | .17 | 91 | 19 | 30 | 12 | 360 | [illegible] | [illegible] | [illegible] | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | May 29-30 | 1,430 | --- | 8.2 | 80.4 | 0 | .14 | 80 | 19 | 40 | | 372 | 94 | 3.0 | [illegible] | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | May 31-June 5 | 312 | --- | 8.3 | 55.2 | 40 | .15 | 50 | 14 | 22 | 14 | 7/ [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | June 6 | 3,430 | --- | 8.0 | 56.2 | 39 | .24 | 72 | 22 | 47 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | June 7-10 | 478 | --- | 8.1 | 55.4 | 67 | .47 | [illegible] | 13 | [illegible] | | 284 | 77 | 5.6 | [illegible] | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | June 12 | 1,060 | --- | 7.7 | 55.9 | 46 | .15 | 60 | 14 | 45 | | [illegible] | 83 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | June 13-23 | 280 | --- | 8.4 | 57.4 | 66 | .17 | 54 | [illegible] | [illegible] | 12 | 268 | [illegible] | [illegible] | [illegible] | [illegible] | .16 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | June 24 (6:25 p.m.) | 1,060 | --- | 8.0 | 47.1 | 27 | .10 | [illegible] | 12 | 25 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | June 24 (9:00 p.m.) 10/ | 1,080 | --- | 8.0 | 50.9 | --- | --- | --- | --- | [illegible] | --- | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | June 26-July 3, 6-16 | 166 | --- | 8.2 | 59.0 | [illegible] | .05 | 80 | 17 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | July 8 2/ | 1,090 | 47 | 8.1 | 49.9 | --- | --- | --- | --- | 17 | --- | [illegible] | --- | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | July 22 | 1,160 | --- | 9.0 | 69.5 | --- | --- | 74 | --- | | --- | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | July 23-26, Aug. 3-6 | 154 | --- | 8.0 | 50.1 | 58 | [illegible] | 62 | 14 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | Weighted Average 13/ | 312 | --- | --- | 57.1 | 42 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

1/ Includes 12 ppm Carbonate
2/ Includes 8.3 ppm Carbonate
3/ Includes [illegible] ppm Carbonate
4/ Includes [illegible] ppm Carbonate
5/ Includes 14 ppm Carbonate
6/ Includes 7.[illegible] ppm Carbonate
7/ [illegible]
8/ Includes [illegible]
9/ [illegible]

114 Table 57

UNITED STATES DEPARTMENT OF THE INTERIOR-GEOLOGICAL SURVEY-Water Resources Division

U. S. Geological Survey
[illegible] Building
Lincoln, Nebraska

Mineral constituents, in parts per million, and related physical measurements, [illegible]

| Sample No. | Date of Collection | Mean discharge (second-feet) | Temperature (°F) | pH | Specific conductance (Micromhos) | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | Dissolved solids: Parts per million | Dissolved solids: Tons per acre-foot | Dissolved solids: Tons per day | Hardness as $CaCO_3$: Total | Hardness as $CaCO_3$: Non-carbonate | Percent Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | -- | 8.[illegible] | [illegible] | 6[illegible] | .02 | 54 | 20 | 49 | 5.8 | [illegible] | [illegible] | 14 | 1.4 | [illegible] | [illegible] | 418 | 0.57 | 16 | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | -- | [illegible] | 471 | 68 | .02 | 42 | 19 | 38 | [illegible] | [illegible] | [illegible] | 9.6 | 1.5 | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 20? | -- | [illegible] | 481 | 70 | .02 | 52 | 19 | 38 | [illegible] | [illegible] | [illegible] | 7.5 | 3.[illegible] | [illegible] | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] Aug. 29, 30, [illegible] | 270 | -- | 8.3 | 559 | 60 | .02 | 61 | 18 | 31 | [illegible] | 255 | 81 | 9.[illegible] | [illegible] | [illegible] | --- | [illegible] | [illegible] | 148 | [illegible] | [illegible] | 24 |
| [illegible] | [illegible] 1, 1940 | 236 | 61 | 8.6 | 422 | --- | --- | --- | --- | 12 | --- | [illegible] | [illegible] | 6.0 | --- | --- | --- | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] 10, 17, Feb. 2 | 97 | -- | 8.4 | 456 | 74 | [illegible] | [illegible] | 21 | 4 | [illegible] | [illegible] | [illegible] | 16 | [illegible] | [illegible] | --- | [illegible] | .45 | 121 | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] 14-21 | 221 | -- | 8.4 | [illegible] | 64 | .07 | [illegible] | 17 | 38 | | [illegible] | [illegible] | 9.0 | [illegible] | [illegible] | --- | 176 | .52 | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | | 8.[illegible] | 444 | [illegible] | .06 | 62 | 16 | 48 | | [illegible] | [illegible] | 9.0 | 1.0 | [illegible] | --- | [illegible] | .53 | [illegible] | [illegible] | [illegible] | 33 |
| 4751? | Mar. 1, sta. [illegible] | [illegible] | | 7.8 | 502 | 54 | .04 | 60 | 17 | 37 | | [illegible] | [illegible] | 9.0 | --- | [illegible] | --- | [illegible] | .58 | [illegible] | [illegible] | [illegible] | 27 |
| [illegible] | Mar. 1, sta. 1[illegible] | [illegible] | [illegible] | 7.9 | [illegible] | 56 | .10 | 60 | 21 | 41 | | 270 | [illegible] | [illegible] | --- | [illegible] | --- | [illegible] | .55 | [illegible] | [illegible] | 0 | 29 |
| [illegible] | Mar. 3, sta. 150 | [illegible] | 32 | 8.3 | 336 | 60 | .12 | 60 | 17 | 43 | | 275 | 93 | [illegible] | --- | [illegible] | --- | [illegible] | .58 | 254 | [illegible] | 0 | 29 |
| [illegible] | Mar. 15-31 | [illegible] | -- | 8.6 | 527 | 54 | .06 | 55 | 17 | 35 | 5.2 | 249 | [illegible] | [illegible] | [illegible] | [illegible] | --- | [illegible] | .56 | 115 | [illegible] | 0 | 26 |
| [illegible] | [illegible] | [illegible] | 51 | 8.4 | 508 | 54 | .03 | 47 | 20 | 34 | 4.8 | 256 | [illegible] | 11 | 1.1 | [illegible] | .29 | 398 | .53 | 142 | 200 | 0 | 27 |
| [illegible] | [illegible] | [illegible] | 59 | 8.5 | 527 | 55 | .05 | 28 | 19 | 33 | 7.2 | [illegible] | [illegible] | 11 | 1.0 | [illegible] | .21 | 384 | .52 | 202 | 194 | 0 | 29 |
| [illegible] | [illegible] | [illegible] | [illegible] | 7.7 | 543 | --- | --- | --- | --- | --- | --- | 276 | [illegible] | 7.0 | --- | --- | --- | [illegible] | .57 | 800 | --- | --- | --- |
| [illegible] | [illegible] | [illegible] | 62 | 7.7 | 508 | [illegible] | .04 | 68 | 17 | 37 | | 264 | 60 | 9.0 | --- | 0.8 | --- | [illegible] | .55 | 798 | 209 | 0 | 28 |
| [illegible] | June [illegible] | 1,020? | 68 | 8.4 | [illegible] | 65 | .25 | 56 | 15 | 28 | 12 | [illegible] | [illegible] | 4.0 | 1.0 | 16 | --- | 376 | .51 | 897 | 201 | 0 | 22 |
| [illegible] | June 7, sta. 161 | [illegible] | [illegible] | 7.7 | [illegible] | 58 | [illegible] | 60 | 19 | 36 | | [illegible] | [illegible] | 16 | 1.8 | .5 | --- | 378 | .51 | 227 | 228 | 26 | 26 |
| [illegible] | June 7, sta. 1[illegible] | [illegible] | 76 | 7.9 | 550 | 64 | .16 | 60 | 22 | 33 | | [illegible] | [illegible] | 5.0 | 1.8 | .5 | --- | 410 | .56 | 216 | 240 | 33 | 22 |
| [illegible] | June 7, sta. [illegible] | [illegible] | 76 | 7.4 | 536 | 59 | .20 | 58 | 19 | 38 | | [illegible] | [illegible] | 12 | 1.4 | 1.4 | --- | 386 | .52 | 231 | 221 | 23 | 27 |
| [illegible] | June 7, bridge | [illegible] | 76 | 7.6 | 536 | 58 | .14 | 54 | 18 | [illegible] | | [illegible] | 76 | 16 | 1.4 | 1.8 | --- | 382 | .52 | 229 | 208 | 7 | 30 |
| [illegible] | July 1-31 | [illegible] | 71 | 8.4 | 638 | 59 | .05 | 60 | 16 | [illegible] | [illegible] | [illegible] | 44 | 4.0 | 1.0 | 1.2 | .29 | 408 | .55 | 180 | 216 | 13 | 26 |
| [illegible] | Aug. 1-30 | [illegible] | 70 | 7.7 | [illegible] | 56 | .07 | 58 | 14 | [illegible] | 4.8 | 238 | [illegible] | 9.0 | [illegible] | [illegible] | [illegible] | [illegible] | .52 | [illegible] | [illegible] | 0 | [illegible] |
| [illegible] | Aug. 16, daily sam. | [illegible] | 71 | 8.0 | 564 | 53 | .04 | 48 | 11 | 49 | | 252 | [illegible] | [illegible] | [illegible] | 1.6 | --- | [illegible] | .50 | [illegible] | 165 | 0 | [illegible] |
| [illegible] | Aug. 16, sta. 16 | [illegible] | 71 | 8.5 | 568 | 79 | [illegible] | 58 | 14 | 46 | | 258 | [illegible] | 7.0 | [illegible] | [illegible] | --- | [illegible] | .57 | 99 | [illegible] | 0 | 33 |
| [illegible] | Aug. 16, sta. 75 | 52 | 71 | 8.1 | 571 | 60 | .06 | 49 | 14 | [illegible] | | [illegible] | 74 | 7.4 | [illegible] | [illegible] | -- | [illegible] | .50 | 92 | [illegible] | 0 | 37 |
| [illegible] | Aug. 16, sta. 115 | 52 | 71 | 8.0 | 580 | 54 | .05 | 50 | 16 | [illegible] | | 240 | 74 | [illegible] | [illegible] | [illegible] | -- | [illegible] | .51 | 92 | [illegible] | 0 | [illegible] |
| [illegible] | Aug. 16, bridge | 53 | 71 | 8.4 | [illegible] | 72 | [illegible] | 54 | 11 | [illegible] | | 252 | 74 | [illegible] | [illegible] | [illegible] | -- | [illegible] | [illegible] | 95 | [illegible] | 0 | 35 |
| [illegible] | [illegible] 12, 17 | 1.8 | 78 | 8.1 | 507 | 60 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | 74 | [illegible] | [illegible] | 1.5 | -- | [illegible] | .51 | 1.8 | 181 | 0 | 35 |
| | Weighted average [illegible] | 250 | -- | -- | [illegible] | [illegible] | 0.15 | [illegible] | 14 | 31 | 7.7 | [illegible] | [illegible] | 7.7 | 1.0 | 9.7 | --- | 379 | [illegible] | 223 | [illegible] | 0 | [illegible] |

[illegible] Carbonate [illegible]
[illegible]

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Table 57
sheet 2 of 3

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - Water Resources Division

Mineral constituents, in parts per million, and related physical measurements, water year October, [illegible] to September, [illegible]

| Date of collection | Mean discharge (second-feet) | Temperature (°F) | pH | Specific conductance (Micromhos) | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | Dissolved Solids: Parts per million | Dissolved Solids: Tons per acre-foot | Dissolved Solids: Tons per day | Hardness as $CaCO_3$: Total | Hardness as $CaCO_3$: Non-carbonate | Percent sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | | | 8.3 | 618 | 62 | 0.05 | 33 | 18 | 63 | 10 | [illegible] | [illegible] | 9.3 | 1.2 | 0.5 | [illegible] | 432 | | | [illegible] | [illegible] | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 35 | 8.8 | [illegible] | [illegible] | 7.7 | 1.2 | 2.8 | .10 | [illegible] | | | 228 | 3 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 39 | 8.8 | [illegible] | [illegible] | 7.5 | 1.2 | [illegible] | .13 | [illegible] | | | 222 | 2 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 37 | | [illegible] | [illegible] | 8.0 | 1.2 | 3.8 | — | [illegible] | | | 227 | 17 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 9.0 | 44 | | [illegible] | [illegible] | 7.8 | 1.3 | 3.4 | — | [illegible] | | | 212 | 10 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 9.5 | 43 | | [illegible] | [illegible] | 7.0 | 1.2 | 3.7 | — | [illegible] | | | 178 | 0 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 11 | 43 | | 245 | [illegible] | 7.0 | 1.2 | 3.0 | — | 376 | | | [illegible] | [illegible] | [illegible] |
| [illegible] | | | [illegible] | [illegible] | 70 | [illegible] | [illegible] | 18 | 32 | | 255 | 80 | [illegible] | 1.2 | 1.8 | — | [illegible] | | | 218 | [illegible] | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 11 | 42 | | 265 | 80 | 5.4 | 1.2 | [illegible] | — | 396 | | | 222 | 5 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 11 | 49 | | 266 | 80 | 7.0 | 1.2 | 3.4 | — | [illegible] | | | 218 | 0 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 10 | 45 | | 277 | 76 | 7.4 | 1.2 | 2.2 | — | 412 | | | [illegible] | 0 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 37 | [illegible] | 228 | 79 | [illegible] | 1.2 | 3.2 | .30 | 390 | | | 202 | 6 | [illegible] |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 7.0 | 1.2 | 2.5 | .30 | 310 | | | [illegible] | 3 | 32 |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 8.0 | 1.2 | 2.7 | .30 | 394 | | | [illegible] | 1 | 26 |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.2 | 3.9 | .29 | 350 | | | [illegible] | 0 | 27 |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.4 | 4.5 | — | 400 | | | [illegible] | 0 | 25 |
| [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.6 | 2.3 | .57 | 414 | | | [illegible] | [illegible] | 27 |
| Apr. [illegible] | | | [illegible] | 616 | 51 | .08 | 64 | 18 | [illegible] | | [illegible] | 86 | [illegible] | 1.2 | [illegible] | — | 448 | | | 234 | 0 | 37 |
| Apr. [illegible] | | | [illegible] | 603 | 76 | .10 | 64 | 17 | [illegible] | | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | — | 448 | | | 226 | 0 | 35 |
| Apr. [illegible] | | | [illegible] | 600 | 87 | [illegible] | [illegible] | 13 | [illegible] | | [illegible] | 87 | [illegible] | 1.2 | [illegible] | — | 436 | | | 202 | 0 | [illegible] |
| Apr. [illegible] | | | [illegible] | [illegible] | 87 | [illegible] | 57 | 13 | [illegible] | | [illegible] | 90 | [illegible] | [illegible] | [illegible] | — | 446 | | | 225 | 0 | 36 |

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Table 57 (con't)

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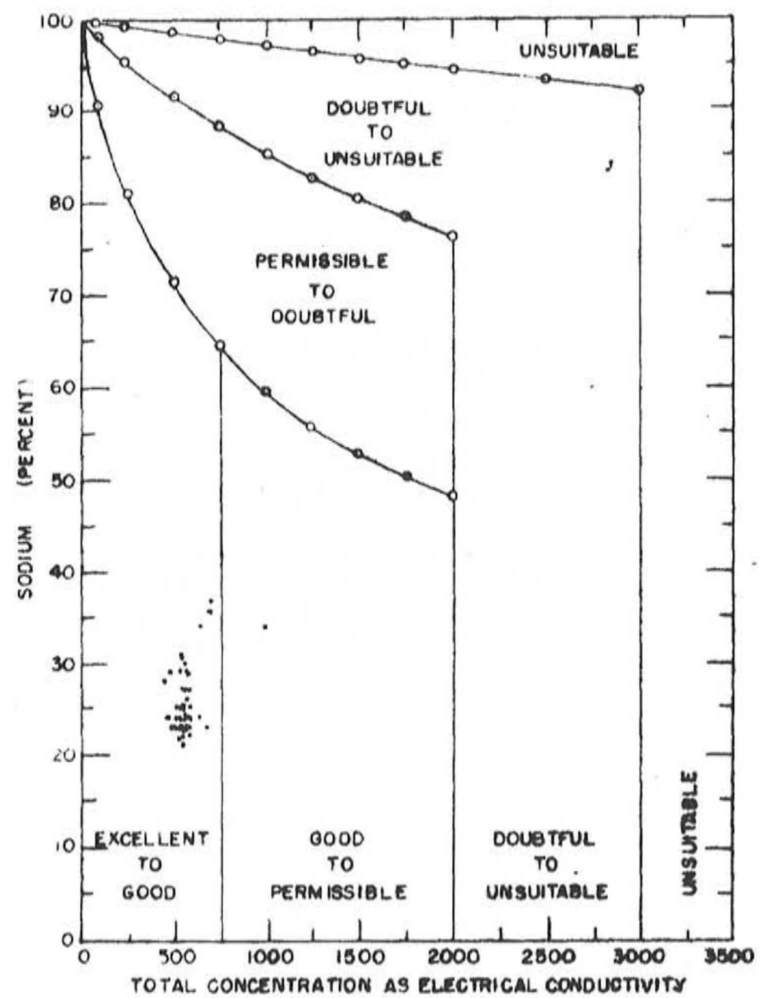
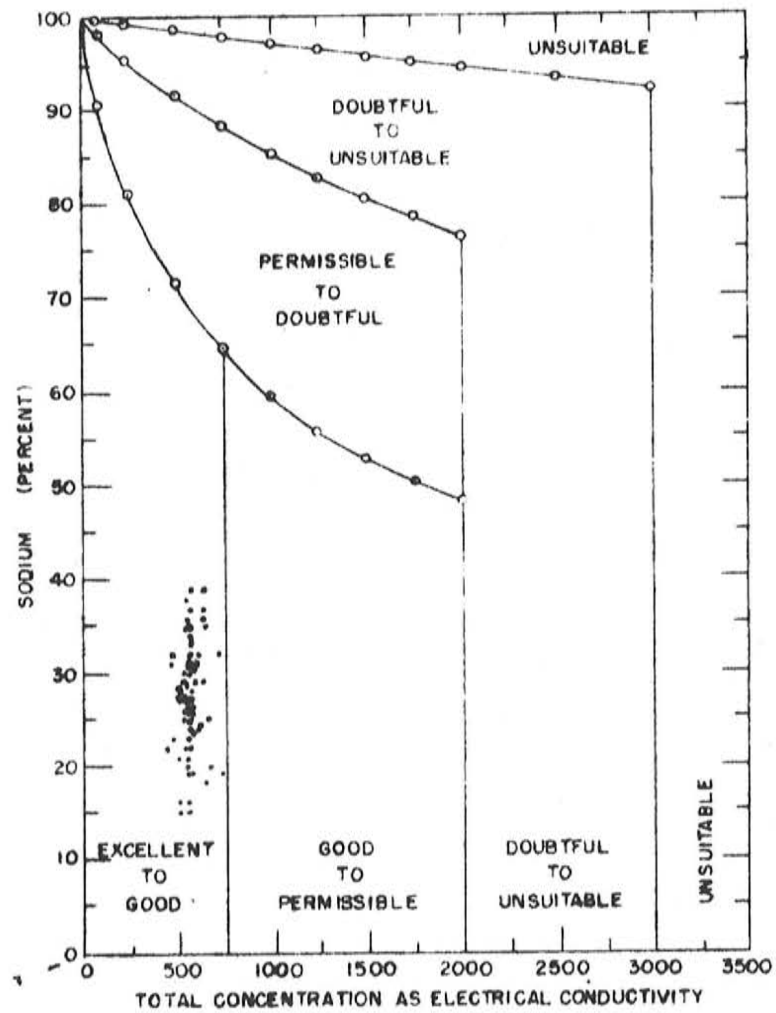
EXHIBIT 20 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF WATER SAMPLES FROM REPUBLICAN RIVER AT MAX, NEBRASKA.




USDA CIRCULAR NO. 784, MAY 1948

"EXPLANATION AND INTERPRETATION OF ANALYSIS OF IRRIGATION WATERS" L.V. WILCOX

EXHIBIT 21 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF WATER SAMPLES FROM REPUBLICAN RIVER AT TRENTON, NEBRASKA.




USDA CIRCULAR NO. 784, MAY 1948

"EXPLANATION AND INTERPRETATION OF ANALYSIS OF IRRIGATION WATERS" L.V. WILCOX

that were studied from the Max station, 18 or 43 percent showed some sodium bicarbonate could be formed. Of 76 samples from the Trenton station studied, 35 or 46 percent showed some sodium bicarbonate could be formed. Since the sodium bicarbonate concentration is never very great and because the analysis of all other factors shows the water to be of excellent quality, the quality of water that will be stored in Trenton Reservoir is considered to be satisfactory for irrigation.

A study of the quality of ground water has been made by the Geological Survey and chemical analyses to determine the mineral constituents of the ground water taken from wells at Trenton, Culbertson, McCook, and Indianola were reported in Geological Survey Circular 19. 1/ A study of these analyses has been made and was reported in a study made by the Bureau of Reclamation, Indianola office. 2/ This study shows that although the ground water has a little higher total salt concentration than the river water it is of satisfactory quality for irrigation. These analyses are not considered necessarily to reflect the quality of the return flow water.

All of the communities in the Republican River Valley use water pumped from wells for domestic water supplies and it is not anticipated any of them will wish to use project water in the future. For this reason no data is presented to show the extent of pollution of surface waters in this report.

The Public Health Service has prepared a detailed report showing the extent, types, and major sources of pollution of streams in the Kansas River Basin. 3/ Minimum stream flows necessary below reservoirs for sanitation are listed in the Public Health Service Report and are discussed in the section of this appendix discussing "Releases for Public Health Service".

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1/ United States Department of the Interior, Geological Survey, Circular 19, August 1948.

2/ Quality of Water Report, Republican River Basin by the Kansas River District, Indianola, Nebraska, March 1950.

3/ "Kansas River Basin Water Pollution Investigation", Federal Security Agency, Public Health Service, June 1949.

## Meeker-Driftwood Unit

### Water Rights

The chief existing irrigation right below Swanson Lake and above Bartley Diversion Dam is the present right of the Meeker Canal which has a provisional grant of 143 second-feet dating from December 22, 1890. All of the presently irrigated area under the Meeker Canal will be included in the Meeker-Driftwood Unit.

Claims and applications for water rights below Trenton and above Bartley Diversion Dam, as published by the Nebraska Department of Roads and Irrigation, are shown in table 58.

### Anticipated Water Use by Future Private Development

Anticipated future depletions by all development of irrigation and ponds above Benkelman Diversions have been reflected in the flow passing Benkelman Diversion, table 52. These depletions were based on the water supply studies of the Upper Republican Division. Depletions due to any future private irrigation or pond developments between Benkelman Diversion and Swanson Lake are considered negligible. Depletions due to future municipal and industrial development are also considered negligible.

### Project Water Supply

Water stored in Swanson Lake will be the only source of water for development of the Meeker-Driftwood Unit. No sectional accretions below the dam could be diverted to the unit under this proposed plan because the canal serving the unit heads at the Trenton Dam. Return flows from the unit were determined in order to be able to show the flow that will pass by the unit after development.

Depletions of stream flow due to upstream development have been determined and were discussed in the foregoing section on water resources.

Reservoir inflow.--Water available for storage (depleted inflow) in Swanson Lake, table 62, is derived from the sum of the following tables:

Table 52. Flow of Republican River passing Benkelman Diversion Dam after development of Upper Republican Division.

Table 59. Historical gain in flow of the Republican River between Benkelman Diversion and Trenton Dam. This gain is computed by subtracting the historical flow at Benkelman Diversion, table 60, from the historical flow at Trenton, table 53.

Table 61. Estimated return flow from 3,700 acres irrigated between Benkelman Diversion and Swanson Lake.

Table 58.—Claims and Applications for Water Rights Below Swanson Lake and above Bartley a/

| Source | Operator or Appropriator | Carrier | Use | Provisional Grant in c.f.s. | Location S T R | Date of Priority |
|---|---|---|---|---|---|---|
| Republican River | Ferguson and Co. | Meeker Canal | Irrigation | 143.00 | 15 3 31 | Dec. 22, 1890 |
| Republican River | Lang, Alfred E. | Pump | Irrigation | 0.42 | 14 3 27 | Feb. 16, 1937 |
| Republican River | Lang, Alfred E. | Pump | Irrigation | 0.87 | 14 3 27 | Feb. 24, 1941 |
| Republican River | Frenchman-Camb. Irrig. District | Meeker Canal | Irrigation | - | 15 3 31 | Apr. 3, 1946 |
| School Creek | Sughroue, Edward | Pump | Irrigation | 0.32 | 15 3 27 | Aug. 16, 1932 |
| *Driftwood Creek | Schmitz, Carl M. | Schmitz Canal | Irrigation | 1.50 | 12 2 30 | May 3, 1930 |
| Berger Creek | Sughroue, Edward | Pump | Irrigation | 0.64 | 15 3 27 | Aug. 16, 1932 |
| Driftwood Creek | Hesterworth, Mrs. John T. et al | Hesterworth canal | Irrigation | 1.00 | 14 2 30 | Nov. 17, 1913 |
| Driftwood Creek | Kueffer, Matties et al. | Sylvan Dell canal | Irrigation | 2.80 | 1 2 30 | Dec. 6, 1930 |
| Driftwood Creek | Hoyt, Frank | Pump | Irrigation | 0.56 | 24 2 31 | Sept. 7, 1937 |
| Driftwood Creek | Liebrandt, John C. | Pump | Irrigation | 0.67 | 14 2 30 | Sept. 5, 1939 |
| Driftwood Creek | Hoyt, Homer | Hoyt Canal | Irrigation | 0.68 | 25 2 31 | Feb. 23, 1943 |

a/ Data published by the Nebraska Department of Roads and Irrigation, Twenty-seventh Biennial Report
* Petitioned to be excluded from district.

Table 59.—Historical Pickup on Republican River between Benkelman Diversion Dam and Trenton (Trenton Dam Site)

1000 acre-feet

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | | | | | | | | | | 1.6 | 2.5 | -1.6 | 2.5 |
| 1929 | 1.6 | 1.0 | 6.0 | 6.2 | 3.3 | 0.2 | -4.0 | 0 | -0.6 | 1.1 | 4.3 | 1.8 | 20.9 |
| 1930 | 2.1 | -0.6 | 1.9 | 4.6 | 4.9 | 0.2 | -2.3 | 0.7 | 1.5 | -2.4 | 0.2 | 7.1 | 17.9 |
| 1931 | 1.2 | -0.3 | -1.4 | -2.4 | -2.0 | -0.8 | -0.1 | -1.2 | 0 | -0.5 | 1.2 | -1.8 | -8.1 |
| 1932 | -1.9 | -4.0 | -5.4 | -1.8 | -1.7 | -4.3 | 1.0 | -7.4 | -8.4 | -1.3 | -1.9 | -1.9 | -39.0 |
| 1933 | -2.1 | -2.9 | -1.2 | 0 | 3.0 | 0.6 | -10.2 | 58.2 | 19.2 | 0.2 | 0.5 | 0.2 | 65.5 |
| 1934 | -0.4 | 0.2 | -2.7 | -1.0 | -0.6 | -3.5 | -0.3 | -5.5 | -1.9 | -2.8 | -1.3 | -0.4 | -20.2 |
| 1935 | 1.2 | 1.3 | 0.8 | -0.4 | 7.6 | 46.0 | 14.4 | 5.1 | 1.9 | -0.1 | -2.5 | 0.1 | 75.4 |
| 1936 | -1.1 | 0.2 | 1.5 | 1.2 | 18.2 | 9.1 | -0.3 | 0.2 | -2.8 | -2.5 | -1.6 | -0.9 | 21.2 |
| 1937 | -2.0 | -3.0 | 0.6 | 2.9 | 11.6 | 14.8 | 0.9 | 1.2 | 0.1 | 0 | -0.4 | -2.0 | 24.7 |
| 1938 | -0.2 | 2.7 | 0.8 | -1.9 | 4.9 | 7.6 | 1.7 | -1.1 | -3.8 | -1.1 | -1.6 | -2.4 | 5.6 |
| 1939 | 1.8 | -1.8 | 8.8 | 3.4 | 0 | 19.8 | 1.5 | 3.8 | -0.7 | -2.5 | -2.0 | -1.3 | 30.8 |
| 1940 | -1.0 | 8.6 | 3.2 | -1.0 | -0.6 | 3.8 | -0.1 | -0.2 | -5.9 | -1.5 | 5.0 | 4.8 | 15.1 |
| 1941 | 8.0 | 0.7 | -1.6 | 6.4 | 2.0 | 23.2 | -0.9 | 3.1 | 0.4 | -2.0 | 0 | -1.5 | 37.8 |
| 1942 | -4.4 | 0.6 | 9.8 | -0.1 | 2.1 | 4.9 | -1.9 | 2.2 | 1.3 | -1.8 | -1.4 | 7.5 | 18.8 |
| 1943 | -2.0 | 4.0 | -2.3 | -2.3 | -0.6 | 4.1 | -0.5 | -0.3 | -1.4 | -2.8 | -3.0 | -3.8 | -10.9 |
| 1944 | 7.4 | 3.3 | 4.5 | 15.1 | 4.8 | 3.9 | 7.1 | -1.1 | -2.0 | -2.0 | -0.9 | 1.4 | 41.5 |
| 1945 | 3.7 | 2.2 | 0.1 | -0.4 | 0.9 | 1.6 | 1.5 | 0.9 | -1.5 | -0.8 | -1.1 | -3.2 | 3.9 |
| 1946 | -2.2 | -1.9 | 1.4 | -1.0 | 2.0 | 2.6 | 0.4 | -0.1 | -2.1 | 6.4 | 3.9 | 1.1 | 10.5 |
| 1947 | 0.1 | 4.8 | 4.1 | -0.6 | 0.9 | 6.1 | 1.6 | -0.4 | -1.3 | - | - | - | 15.3 |
| Total Avg. | 0.5 | 0.8 | 1.5 | 1.4 | 3.2 | 7.4 | 0.5 | 3.0 | -0.4 | -0.8 | 0 | 0.2 | 17.3 |

Table 60--Historical run-off of Republican River at Benkelman Diversion Dam a/
1000 Acre-Feet

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 6.5 | 12.1 | 7.0 | 7.4 | 5.8 | 14.6 | 10.6 | 12.4 | 8.5 | 4.4 | 3.0 | 5.7 | 98.0 |
| 1930 | 6.6 | 7.0 | 8.0 | 7.7 | 10.9 | 9.6 | 7.3 | 12.5 | 13.9 | 6.2 | 9.8 | 6.6 | 106.1 |
| 1931 | 12.0 | 8.7 | 8.0 | 9.1 | 14.5 | 13.7 | 14.6 | 8.8 | 7.5 | 0.4 | 3.0 | 0.8 | 101.1 |
| 1932 | 4.1 | 8.3 | 11.9 | 13.2 | 12.9 | 14.7 | 10.4 | 8.9 | 15.4 | 4.8 | 17.0 | 9.5 | 131.1 |
| 1933 | 5.5 | 9.2 | 11.1 | 13.1 | 12.3 | 12.0 | 7.8 | 11.3 | 2.1 | 12.7 | 19.7 | 17.5 | 134.3 |
| 1934 | 7.7 | 8.2 | 12.3 | 12.0 | 11.6 | 13.6 | 9.4 | 2.0 | 12.0 | 0.5 | 6.1 | 1.9 | 97.3 |
| 1935 | 4.0 | 6.4 | 11.2 | 10.7 | 9.1 | 12.3 | 8.3 | 226.9 | 155.2 | 8.4 | 9.3 | 7.0 | 468.8 |
| 1936 | 3.6 | 8.2 | 10.5 | 9.1 | 9.4 | 12.2 | 12.6 | 27.1 | 10.4 | 0.6 | 3.7 | 2.8 | 110.2 |
| 1937 | 6.1 | 7.2 | 8.0 | 6.2 | 12.4 | 14.3 | 7.5 | 7.2 | 6.6 | 1.7 | 0.8 | 9.3 | 87.3 |
| 1938 | 5.3 | 6.5 | 7.9 | 8.6 | 7.1 | 9.3 | 12.4 | 25.5 | 12.0 | 15.3 | 13.6 | 24.8 | 148.3 |
| 1939 | 3.7 | 6.3 | 9.4 | 8.7 | 5.1 | 11.6 | 9.2 | 3.4 | 7.5 | 4.0 | 1.6 | 0.7 | 71.2 |
| 1940 | 2.6 | 4.4 | 5.6 | 5.5 | 9.7 | 13.1 | 8.0 | 3.3 | 3.2 | 1.3 | 0.5 | 15.8 | 73.0 |
| 1941 | 4.8 | 5.8 | 7.8 | 8.2 | 8.5 | 11.5 | 14.6 | 7.8 | 25.2 | 33.6 | 18.0 | 7.1 | 152.9 |
| 1942 | 13.4 | 9.9 | 10.0 | 11.2 | 12.2 | 38.3 | 14.0 | 11.1 | 16.4 | 3.9 | 13.3 | 16.4 | 170.1 |
| 1943 | 12.8 | 11.2 | 12.6 | 11.5 | 10.2 | 10.4 | 9.5 | 8.8 | 5.1 | 0.5 | 0.3 | 1.4 | 94.3 |
| 1944 | 2.8 | 4.4 | 7.1 | 8.8 | 13.0 | 11.3 | 22.5 | 13.7 | 5.1 | 25.9 | 2.8 | 2.1 | 119.5 |
| 1945 | 5.3 | 6.7 | 8.4 | 10.2 | 10.8 | 8.6 | 12.3 | 8.6 | 20.7 | 3.8 | 5.0 | 3.0 | 103.4 |
| 1946 | 5.7 | 7.2 | 6.8 | 9.9 | 12.0 | 12.7 | 6.6 | 14.8 | 6.2 | 48.0 | 1.1 | 3.1 | 134.1 |
| 1947 | 9.2 | 12.9 | 10.1 | 9.0 | 9.9 | 18.1 | 19.0 | 19.2 | 21.4 | 8.8 | 0.5 | 1.3 | 139.4 |
| Total Avg. | 6.4 | 7.9 | 9.1 | 9.5 | 10.4 | 13.8 | 11.4 | 22.8 | 18.7 | 9.7 | 6.8 | 7.2 | 133.7 |

a/ Sum of Republican River above Benkelman and South Fork Republican River at Benkelman

Table 61--Estimated return flow - Benkelman Unit below Benkelman Diversion Dam a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.2 | 3.1 |
| 1930 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 2.0 |
| 1931 | 0.1 | 0.1 | 0.1 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 4.0 |
| 1932 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 4.5 |
| 1933 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.5 | 0.4 | 0.4 | 4.8 |
| 1934 | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.7 | 0.7 | 0.7 | 0.6 | 0.5 | 6.0 |
| 1935 | 0.4 | 0.4 | 0.4 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 4.1 |
| 1936 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.5 | 0.4 | 0.4 | 4.5 |
| 1937 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.5 | 0.4 | 0.4 | 4.8 |
| 1938 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 4.6 |
| 1939 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 4.3 |
| 1940 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | 0.4 | 5.1 |
| 1941 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 3.6 |
| 1942 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 2.7 |
| 1943 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | 0.4 | 4.8 |
| 1944 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 3.6 |
| 1945 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.2 | 3.0 |
| 1946 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 3.8 |
| 1947 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.4 | 0.3 | 0.3 | 3.7 |
| Avg. | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 4.1 |

a/ Return flow from 3700 acres

Meeker-Driftwood Unit

The reservoir inflow can be stored until the reservoir irrigation storage capacity at 58,800 acre-feet is reached.

Return flow.--The return flows available for project use in the Meeker-Driftwood Unit include all return flows from upstream development except that which may be diverted by the Benkelman Diversion Dam. Unused return flows from lands above Benkelman Diversion Dam are reflected in the depleted inflow to Swanson Lake, table 62.

Computation of return flow from lands irrigated under the Meeker-Driftwood Unit were made in the same manner as for the Frenchman Unit.

Records of the historical diversions to lands now irrigated under the Meeker Canal are available for the irrigation seasons from April 1929 through September 1942, table 63. To estimate the missing period, October 1942 through September 1947, a correlation curve, exhibit 22, was drawn by plotting concurrent diversions by Culbertson Canal against the diversions of Meeker Canal.

Return flows from the Meeker-Driftwood Unit are based only on the increased diversions over and above the historic diversions because return flows from presently irrigated lands are already reflected in stream-flow records. The return flow from the increased diversions required for full development are shown in table 64. The same method was used in determining the return flows from the additional diversions as was used in determining the return flows from the Frenchman Unit. (See Frenchman Unit return flow discussion.)

Return flows from lands irrigated in the Meeker-Driftwood Unit, listed in table 64, are not considered available for reuse in this unit. They are considered to enter the Republican River and will be available for diversion at Bartley Diversion Dam in the Red Willow Unit.

## Water Requirements

Water requirements for the Meeker-Driftwood Unit which will create a demand upon Swanson Lake include the water required for irrigating the lands in the unit, water lost due to evaporation from the reservoir, and water lost due to seepage from the reservoir. The water requirements for irrigation are dependent upon the consumptive use of water by irrigated crops, the effective precipitation in the area, transportation, and farm losses.

### Determination of diversion and irrigation requirements

The same general procedure was followed to determine the above factors required to find the diversion and irrigation requirements as was explained in the foregoing discussion on the water requirements for the Frenchman

Table 62.—Depleted inflow of Republican River into Swanson Lake a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 9.4 | 7.0 | 20.4 | 13.5 | 12.6 | 4.2 | 0 | 0 | 0 | 3.5 | 9.2 | 7.9 | 87.7 |
| 1930 | 9.2 | 10.4 | 11.0 | 8.5 | 17.4 | 10.3 | 0 | 4.2 | 3.9 | 6.9 | 8.3 | 15.0 | 105.1 |
| 1931 | 10.3 | 14.4 | 12.0 | 10.4 | 0.9 | 2.5 | 0.7 | 0 | 0.6 | 0.4 | 6.4 | 6.3 | 64.9 |
| 1932 | 6.9 | 6.4 | 6.2 | 3.9 | 0 | 6.9 | 1.8 | 1.5 | 0 | 0 | 2.5 | 7.8 | 43.9 |
| 1933 | 9.6 | 8.1 | 9.0 | 2.6 | 8.4 | 1.4 | 0 | 59.8 | 32.8 | 3.9 | 8.4 | 13.2 | 157.2 |
| 1934 | 12.1 | 12.5 | 10.9 | 1.0 | 0.2 | 0.9 | 0.6 | 0 | 0 | 0 | 0 | 4.5 | 42.7 |
| 1935 | 8.7 | 7.4 | 8.7 | 1.7 | 222.8 | 197.9 | 15.1 | 6.6 | 3.9 | 0.7 | 3.7 | 8.9 | 486.1 |
| 1936 | 6.8 | 9.3 | 13.4 | 8.5 | 44.1 | 13.6 | 0.5 | 1.1 | 0 | 0 | 0 | 4.9 | 102.2 |
| 1937 | 3.4 | 7.2 | 8.7 | 3.6 | 12.6 | 15.8 | 1.7 | 2.1 | 1.6 | 1.9 | 3.8 | 3.0 | 65.4 |
| 1938 | 5.4 | 7.8 | 6.9 | 3.8 | 26.5 | 11.9 | 8.0 | 6.0 | 12.7 | 0 | 4.2 | 6.4 | 99.6 |
| 1939 | 11.2 | 3.7 | 20.7 | 9.6 | 0.7 | 22.3 | 2.3 | 4.7 | 0.2 | 0 | 0 | 2.7 | 78.1 |
| 1940 | 3.3 | 14.1 | 11.7 | 1.4 | 0.1 | 4.6 | 0.8 | 0.8 | 4.3 | 0 | 8.0 | 8.3 | 57.4 |
| 1941 | 11.8 | 7.0 | 6.4 | 17.3 | 3.8 | 40.7 | 23.5 | 13.2 | 5.2 | 7.7 | 8.8 | 9.1 | 154.5 |
| 1942 | 7.0 | 13.2 | 47.6 | 13.6 | 9.7 | 18.6 | 0 | 4.1 | 13.5 | 8.6 | 9.4 | 20.3 | 165.6 |
| 1943 | 9.7 | 14.6 | 7.8 | 0.3 | 3.4 | 5.4 | 0.4 | 0.7 | 0 | 0 | 0 | 0 | 42.3 |
| 1944 | 10.4 | 8.4 | 12.1 | 33.8 | 16.2 | 4.7 | 28.9 | 0 | 0 | 0 | 0 | 6.4 | 120.9 |
| 1945 | 11.5 | 11.5 | 6.0 | 10.1 | 5.4 | 17.5 | 2.2 | 1.6 | 0 | 0 | 1.8 | 1.7 | 69.3 |
| 1946 | 7.0 | 9.5 | 14.2 | 0 | 13.9 | 4.3 | 39.7 | 0.7 | 0 | 10.2 | 13.3 | 8.5 | 121.3 |
| 1947 | 8.0 | 14.3 | 20.7 | 18.2 | 20.0 | 26.0 | 4.6 | 0.4 | 0 | -- | -- | -- | 112.2 |
| Average | 8.5 | 9.8 | 13.4 | 8.5 | 22.0 | 21.6 | 6.9 | 5.7 | 4.1 | 2.4 | 4.9 | 7.5 | 115.3 |

a/ Includes flow passing Benkelman Diversion plus Return Flow from 3700 ac. plus pick up between Benkelman Diversion and Trenton Dam Site.

Table 63--Historical diversions into Meeker Canal a/

(Unit - 1000 acre-feet)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0 | 0.9 | 1.2 | 2.0 | 2.0 | 1.1 | 1.2 | 0 | 8.4 |
| 1930 | 0 | 1.2 | 1.1 | 2.1 | 1.7 | 0.9 | 0.6 | 0 | 7.6 |
| 1931 | 0 | 1.0 | 1.2 | 1.7 | 1.4 | 1.2 | 1.1 | 0 | 7.6 |
| 1932 | 0.9 | 1.4 | 1.2 | 2.0 | 1.6 | 1.1 | 0 | 0 | 8.2 |
| 1933 | 0.2 | 1.1 | 1.9 | 1.9 | 1.1 | 0.3 | 0 | 0 | 6.5 |
| 1934 | 0 | 1.8 | 1.3 | 2.2 | 1.6 | 1.2 | 1.6 | 2.1 | 11.8 |
| 1935 | 1.3 | 1.8 | 0 | 0 | 0 | 0.2 | 0.5 | 0 | 3.8 |
| 1936 | 0.3 | 0.6 | 0.8 | 1.6 | 1.6 | 1.4 | 1.3 | 0.4 | 8.0 |
| 1937 | 0.3 | 1.3 | 0.6 | 1.8 | 1.7 | 1.2 | 1.7 | 1.0 | 9.6 |
| 1938 | 0.3 | 0.6 | 0.9 | 1.7 | 1.7 | 0.5 | 1.6 | 1.3 | 8.6 |
| 1939 | 0 | 1.4 | 1.0 | 1.6 | 1.6 | 1.2 | 1.6 | 1.9 | 10.3 |
| 1940 | 0 | 1.6 | 1.4 | 2.1 | 2.0 | 1.8 | 1.5 | 0.6 | 11.0 |
| 1941 | 0 | 0.2 | 0.5 | 0.9 | 1.8 | 0.9 | 0.6 | 0.3 | 5.2 |
| 1942 | 0 | 0.2 | 0.4 | 1.1 | 1.5 | 1.0 | 0.4 | 0 | 4.6 |
| 1943 | 0.2 | 1.6 | 1.0 | 1.8 | 1.8 | 1.7 | 1.3 | 0.2 | 9.6 |
| 1944 | 0 | 0.3 | 0.9 | 1.1 | 1.7 | 1.4 | 1.3 | 0.5 | 7.2 |
| 1945 | 0.1 | 1.4 | 0.6 | 1.2 | 1.5 | 1.3 | 1.0 | 0.2 | 7.3 |
| 1946 | 0.3 | 1.1 | 1.1 | 1.0 | 1.6 | 1.3 | 0.6 | 0 | 7.0 |
| 1947 | 0 | 1.0 | 0.9 | 0.6 | 1.8 | 1.2 | 0 | 0 | 5.5 |
| Avg. | 0.2 | 1.1 | 0.9 | 1.5 | 1.6 | 1.1 | 1.0 | 0.4 | 7.8 |

a/ Oct. 1942 through Sept. 1947 estimated from correlation with Culbertson Canal Diversions

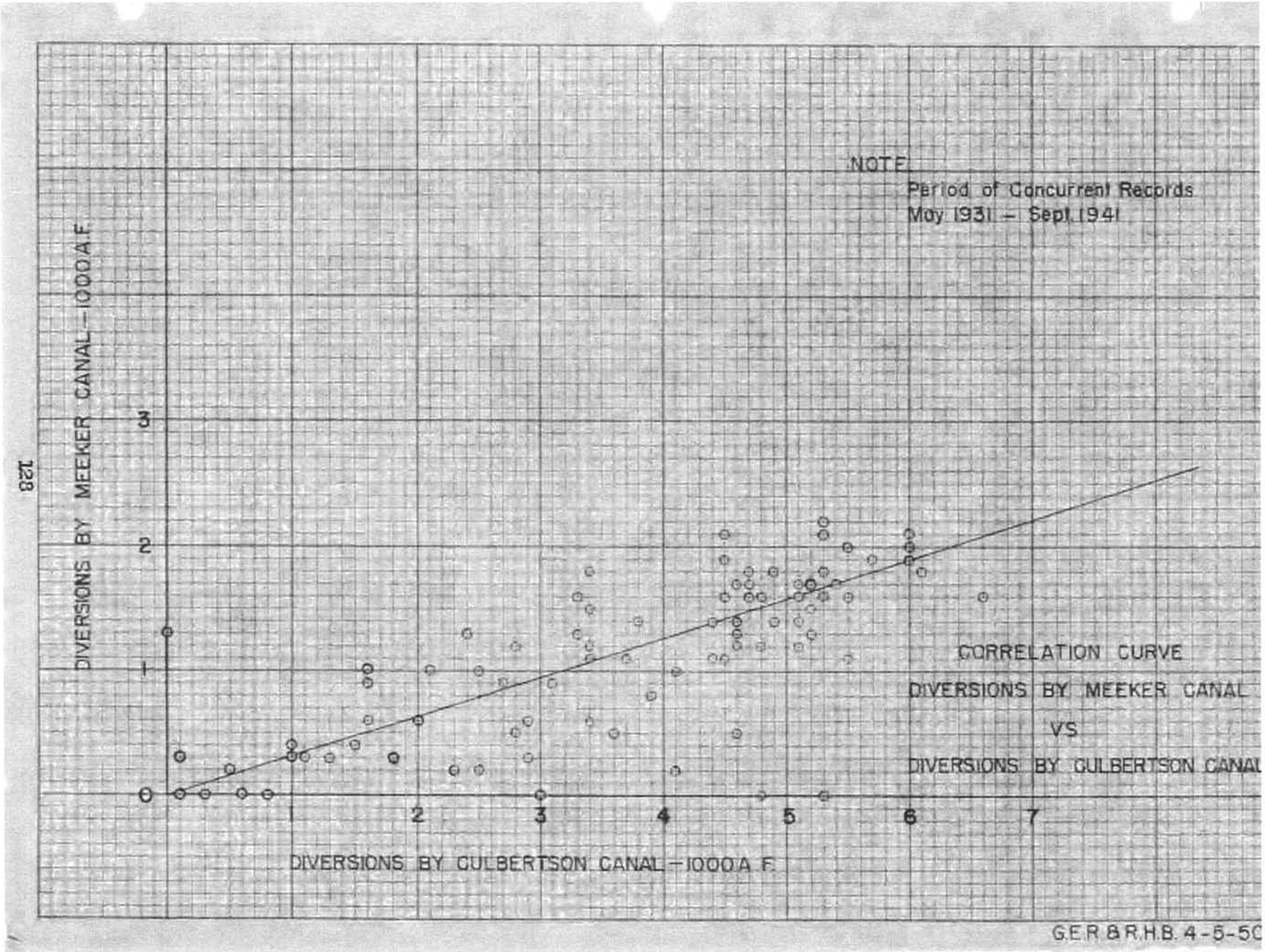
NOTE
Period of Concurrent Records
May 1931 – Sept. 1941
DIVERSIONS BY MEEKER CANAL – 1000 A.F.
DIVERSIONS BY CULBERTSON CANAL – 1000 A.F.
CORRELATION CURVE
DIVERSIONS BY MEEKER CANAL
VS
DIVERSIONS BY CULBERTSON CANAL
G.E.R. & R.H.B. 4-5-50

Table 64.--Return flow from increased diversions for full development of Meeker-Driftwood Unit

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 | 0.7 | 0.6 | [illegible].8 |
| 1930 | 0.5 | 0.5 | 0.5 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 3.3 |
| 1931 | 0.2 | 0.1 | 0.1 | 0.4 | 0.5 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.6 | 0.5 | 5.9 |
| 1932 | 0.5 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.0 | 1.0 | 0.8 | 0.7 | 8.4 |
| 1933 | 0.6 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.8 | 1.0 | 1.1 | 1.0 | 0.9 | 0.8 | 9.3 |
| 1934 | 0.7 | 0.6 | 0.6 | 0.8 | 0.9 | 1.0 | 1.2 | 1.4 | 1.6 | 1.4 | 1.2 | 1.0 | 12.4 |
| 1935 | 0.9 | 0.8 | 0.8 | 0.6 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.0 | 0.8 | 0.7 | 9.8 |
| 1936 | 0.6 | 0.6 | 0.6 | 0.8 | 1.0 | 1.1 | 1.3 | 1.6 | 1.7 | 1.6 | 1.3 | 1.1 | 13.3 |
| 1937 | 1.0 | 0.8 | 0.8 | 0.6 | 0.8 | 0.9 | 1.0 | 1.2 | 1.3 | 1.2 | 1.0 | 0.9 | 11.5 |
| 1938 | 0.8 | 0.7 | 0.6 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.0 | 0.8 | 0.7 | 9.3 |
| 1939 | 0.6 | 0.6 | 0.5 | 0.8 | 0.9 | 1.0 | 1.2 | 1.4 | 1.6 | 1.4 | 1.2 | 1.1 | 12.3 |
| 1940 | 0.9 | 0.8 | 0.8 | 0.6 | 0.8 | 0.9 | 1.0 | 1.2 | 1.3 | 1.2 | 1.0 | 0.9 | 11.4 |
| 1941 | 0.8 | 0.7 | 0.6 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 5.5 |
| 1942 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.6 | 0.5 | 0.5 | 5.5 |
| 1943 | 0.4 | 0.4 | 0.4 | 0.8 | 1.0 | 1.1 | 1.2 | 1.5 | 1.6 | 1.5 | 1.2 | 1.1 | 12.2 |
| 1944 | 1.0 | 0.8 | 0.8 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.6 | 0.5 | 0.4 | 7.0 |
| 1945 | 0.4 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.7 | 0.6 | 0.5 | 6.2 |
| 1946 | 0.5 | 0.4 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 0.8 | 0.7 | 0.6 | 7.3 |
| 1947 | 0.5 | 0.5 | 0.5 | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.6 | 0.5 | 0.5 | 6.1 |
| Avg. | 0.6 | 0.5 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.0 | 0.8 | 0.7 | 8.6 |

Unit. The consumptive use, effective precipitation, consumptive use of irrigation water, and diversion requirements for the Meeker-Driftwood Unit were found as follows:

Consumptive use.--Temperature records, table 65, collected by the Weather Bureau at Culbertson, Nebraska were used in computing effective heat and consumptive use for the Meeker-Driftwood Unit. The annual consumptive use distributed on a monthly basis is shown in table 66.

Precipitation.--Precipitation records at Culbertson, table 67, and McCook, table 68, were averaged together to determine the precipitation over the Meeker-Driftwood area, table 69. Not all precipitation falling on the project area is effective; therefore an adjustment was necessary to determine the amount that would be considered effective. These adjustments to the recorded precipitation were made in the same manner as explained in the Frenchman Unit. Effective precipitation for the Meeker-Driftwood area is shown in table 70.

Consumptive use requirements of irrigation water.--The consumptive use requirement of irrigation water is that amount not supplied by effective precipitation, as shown in table 71.

Diversion requirements.--In order to satisfy the crop irrigation requirement, it is necessary to divert sufficient additional water to overcome transportation and farm losses. For this unit, the farm losses were estimated to be 30 percent of the farm delivery requirement. Therefore the crop irrigation requirements were multiplied by 100 percent over 100 percent minus the percent of farm loss to give the farm delivery requirement.

Transportation losses in the distribution system include water consumed by evaporation, by transpiration of canal-bank vegetation, and by seepage or percolation. The estimated percentage for the total losses was based on these factors together with the length of canal. Canal losses were estimated to be 25 percent of the diversion requirement. The diversion requirement in acre-feet per acre, table 72, was computed by multiplying the farm delivery requirement by 100 percent over 100 percent minus the transportation loss percentage.

Releases will be made at Trenton Dam for the irrigation of the entire 16,440 acres, table 47, that are planned for development in the Meeker-Driftwood Unit. The diversion requirements in acre-feet, table 73, were obtained by multiplying the diversion requirements in acre-feet per acre, table 72, by 16,400 acres.

Evaporation from reservoir

The evaporation rate from Swanson Lake was determined by using the same general methods as were followed for determining the evaporation rate from Enders Reservoir.

Table 65--Effective Heat and Consumptive Use at Culbertson (day degrees)

| Year | | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | | Total | Consumptive Use in feet a/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | Mar 28 | 66 | 1086 | 1302 | 1549 | 1903 | 1968 | 1230 | 997 | - | Oct 26 | 10,121 | 2.43 |
| 1930 | Apr 2 | - | 1150 | 1271 | 1560 | 1910 | 1767 | 1491 | 850 | - | Oct 26 | 9,999 | 2.41 |
| 1931 | Apr 7 | - | 823 | 1370 | 1740 | 1934 | 1758 | 1605 | 1197 | - | Oct 28 | 10,427 | 2.47 |
| 1932 | Apr 5 | - | 982 | 1513 | 1551 | 1984 | 1820 | 1442 | 673 | - | Oct 18 | 9,965 | 2.40 |
| 1933 | Apr 2 | - | 963 | 1311 | 1914 | 1913 | 1628 | 1515 | 1228 | 61 | Nov 3 | 10,533 | 2.50 |
| 1934 | Mar 28 | 93 | 1194 | 1693 | 1779 | 2114 | 1854 | 1338 | 1286 | 290 | Nov 8 | 11,641 | 2.67 |
| 1935 | Mar 24 | 205 | 954 | 1011 | 1512 | 1987 | 1820 | 1413 | 862 | - | Oct 25 | 9,764 | 2.37 |
| 1936 | Apr 4 | - | 1065 | 1420 | 1788 | 2117 | 2055 | 1587 | 879 | - | Oct 23 | 10,911 | 2.55 |
| 1937 | Apr 9 | - | 763 | 1321 | 1551 | 2015 | 2000 | 1578 | 989 | - | Oct 29 | 10,217 | 2.44 |
| 1938 | Mar 25 | 109 | 1017 | 1286 | 1671 | 1990 | 1993 | 1584 | 1140 | - | Oct 24 | 10,790 | 2.54 |
| 1939 | Apr 9 | - | 727 | 1575 | 1774 | 2065 | 1872 | 1671 | 797 | - | Oct 19 | 10,481 | 2.49 |
| 1940 | Apr 3 | - | 864 | 1414 | 1761 | 2015 | 1798 | 1539 | 1258 | - | Oct 29 | 10,649 | 2.51 |
| 1941 | Apr 2 | - | 877 | 1472 | 1512 | 1814 | 1866 | 1422 | 1014 | - | Oct 31 | 9,977 | 2.41 |
| 1942 | Mar 29 | 48 | 1053 | 1318 | 1503 | 1956 | 1767 | 1302 | 1051 | - | Oct 28 | 9,998 | 2.41 |
| 1943 | Apr 2 | - | 1089 | 1240 | 1608 | 2009 | 2015 | 1533 | 883 | - | Oct 22 | 10,377 | 2.47 |
| 1944 | Apr 9 | - | 444 | 1463 | 1578 | 1730 | 1773 | 1539 | 1137 | - | Oct 29 | 9,664 | 2.36 |
| 1945 | Apr 6 | - | 764 | 1352 | 1347 | 1876 | 1795 | 1509 | 1045 | - | Oct 25 | 9,688 | 2.36 |
| 1946 | Mar 15 | 525 | 1335 | 1212 | 1713 | 1925 | 1758 | 1494 | 825 | - | Oct 25 | 10,787 | 2.54 |
| 1947 | Apr 10 | | 719 | 1256 | 1446 | 1792 | 2015 | 1632 | 1463 | 36 | Nov 2 | 10,359 | 2.47 |
| Total | | 1046 | 17869 | 25800 | 30877 | 37049 | 35322 | [illegible] | 19574 | 387 | | 196348 | 46.80 |
| Avg. | | 55 | 940 | 1358 | 1624 | 1950 | 1860 | 1497 | 1030 | 20 | | 10334 | 2.46 |

a/ From Lowry & Johnson curve.

Table 66.-Distribution of Consumptive Use Meeker-Driftwood Unit a/
Feet per Acre

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | .02 | .05 | .12 | .20 | .24 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.43 |
| 1930 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .15 | .07 | .05 | 2.41 |
| 1931 | .02 | .05 | .12 | .20 | .25 | .35 | .47 | .44 | .30 | .15 | .07 | .05 | 2.47 |
| 1932 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .14 | .07 | .05 | 2.40 |
| 1933 | .02 | .05 | .12 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.50 |
| 1934 | .03 | .05 | .13 | .21 | .27 | .38 | .51 | .48 | .32 | .16 | .08 | .05 | 2.67 |
| 1935 | .02 | .05 | .12 | .19 | .24 | .33 | .45 | .43 | .28 | .14 | .07 | .05 | 2.37 |
| 1936 | .02 | .05 | .13 | .20 | .26 | .36 | .48 | .46 | .31 | .15 | .08 | .05 | 2.55 |
| 1937 | .02 | .05 | .12 | .20 | .25 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.44 |
| 1938 | .03 | .05 | .13 | .20 | .25 | .36 | .48 | .46 | .30 | .15 | .08 | .05 | 2.54 |
| 1939 | .03 | .05 | .12 | .20 | .25 | .35 | .47 | .45 | .30 | .15 | .07 | .05 | 2.50 |
| 1940 | .02 | .05 | .13 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.51 |
| 1941 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .15 | .07 | .05 | 2.41 |
| 1942 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .15 | .07 | .05 | 2.41 |
| 1943 | .02 | .05 | .12 | .20 | .25 | .35 | .47 | .44 | .30 | .15 | .07 | .05 | 2.47 |
| 1944 | .02 | .05 | .12 | .19 | .24 | .33 | .45 | .42 | .28 | .14 | .07 | .05 | 2.36 |
| 1945 | .02 | .05 | .12 | .19 | .24 | .33 | .45 | .42 | .28 | .14 | .07 | .05 | 2.36 |
| 1946 | .03 | .05 | .13 | .20 | .25 | .36 | .48 | .46 | .30 | .15 | .08 | .05 | 2.54 |
| 1947 | .02 | .05 | .12 | .20 | .25 | .35 | .47 | .44 | .30 | .15 | .07 | .05 | 2.47 |
| Total Avg. | 0.02 | 0.05 | 0.12 | 0.20 | 0.25 | 0.35 | 0.47 | 0.44 | 0.29 | 0.15 | 0.07 | 0.05 | 2.46 |

a/ Use records at Culbertson, Nebr.

Table 67.—Precipitation at Culbertson, Nebraska a/
Unit - Inches

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | .10 | .51 | 1.33 | .54 | 6.68 | 7.29 | 7.75 | .50 | .66 | 2.73 | 1.20 | T | 29.29 |
| 1929 | .20 | .75 | .05 | 1.86 | 5.31 | 2.54 | 1.67 | .38 | 2.53 | 1.62 | 1.28 | 0 | 18.19 |
| 1930 | 1.00 | .46 | .67 | 3.94 | 4.44 | 2.75 | 4.78 | 2.14 | 2.38 | 4.62 | 2.03 | .53 | 29.74 |
| 1931 | 0 | 1.02 | 3.21 | 1.13 | 1.19 | 3.18 | .87 | 3.30 | .58 | .62 | 1.26 | .32 | 16.68 |
| 1932 | .60 | .50 | .20 | 2.26 | 3.40 | 3.90 | 2.62 | .51 | .38 | .64 | 0 | .15 | 15.16 |
| 1933 | .03 | .30 | 1.53 | 1.93 | 2.79 | .98 | 2.88 | 7.33 | 3.81 | 0 | .30 | .10 | 21.98 |
| 1934 | .20 | 1.56 | .07 | 1.22 | .80 | 4.81 | 1.10 | 2.01 | 2.13 | .56 | 2.00 | .75 | 17.21 |
| 1935 | .20 | .38 | .46 | 1.45 | 8.33 | 4.27 | .42 | 1.92 | 2.21 | .44 | 1.25 | .23 | 21.56 |
| 1936 | .53 | .22 | .56 | 1.17 | 4.37 | 1.20 | 1.99 | .36 | 1.17 | .10 | T | .32 | 11.99 |
| 1937 | .64 | .12 | 1.19 | .64 | 1.38 | 4.84 | 1.63 | 1.85 | .40 | 1.19 | .08 | .30 | 14.26 |
| 1938 | .24 | .14 | 1.89 | 2.32 | 7.80 | 2.05 | 3.76 | 3.35 | 1.41 | .02 | .04 | .13 | 23.15 |
| 1939 | .50 | .43 | 1.81 | 1.38 | 1.52 | 3.57 | .53 | 1.47 | .39 | .03 | T | .84 | 12.47 |
| 1940 | .91 | .19 | 2.97 | .58 | 1.87 | 1.28 | 2.31 | 1.26 | 1.54 | .52 | .45 | 1.13 | 15.01 |
| 1941 | 1.09 | .29 | .76 | 2.88 | 2.94 | 5.32 | 4.52 | 1.39 | 5.61 | 1.16 | .20 | 1.50 | 27.66 |
| 1942 | .32 | .87 | .82 | 5.82 | 1.79 | 5.72 | .94 | 1.97 | 4.61 | .61 | .54 | .39 | 24.40 |
| 1943 | .26 | .09 | .76 | 1.71 | 1.15 | 2.03 | 1.39 | 2.78 | .05 | .60 | .25 | .17 | 11.24 |
| 1944 | 1.97 | .99 | 1.71 | 7.91 | 2.53 | 1.58 | 5.88 | 1.28 | .04 | .52 | 1.02 | .33 | 25.76 |
| 1945 | .54 | .26 | .31 | 2.57 | 3.40 | 3.19 | 2.58 | 3.80 | 2.34 | .29 | .20 | .33 | 19.81 |
| 1946 | .12 | .13 | 1.74 | .15 | 4.91 | 4.40 | 3.81 | 2.27 | 2.23 | 6.06 | 2.21 | .10 | 28.13 |
| 1947 | .26 | .35 | .46 | 2.95 | 2.73 | 8.18 | 4.58 | .45 | 2.04 | .81 | 1.22 | .93 | 24.96 |
| Total Avg. | 0.51 | 0.48 | 1.11 | 2.31 | 3.30 | 3.46 | 2.54 | 2.10 | 1.89 | 1.07 | 0.75 | 0.45 | 19.97 |

a/ Data published by the U. S. Weather Bureau.

Table 68.—Precipita ion at McCook, Nebraska — Inches a/

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | .18 | 1.16 | .34 | 1.66 | 3.40 | 4.42 | 2.66 | 1.18 | 2.23 | 1.40 | 1.80 | .14 | 20.57 |
| 1930 | 1.10 | .82 | .12 | 4.43 | 4.75 | 3.77 | 8.70 | 2.22 | 2.68 | 6.66 | 2.61 | .40 | 38.26 |
| 1931 | .30 | 1.97 | 3.87 | 1.51 | 1.18 | 3.11 | 1.12 | 2.51 | .59 | .79 | 2.26 | .56 | 19.77 |
| 1932 | .80 | .84 | .37 | 1.71 | 3.12 | 3.76 | 2.48 | 1.30 | 1.21 | .66 | 0 | .18 | 16.43 |
| 1933 | 0 0 | .19 | 2.09 | 2.98 | 2.66 | 1.19 | 1.77 | 5.52 | 3.10 | 0 | .12 | 1.52 | 21.15 |
| 1934 | .32 | 1.09 | .16 | 1.46 | 1.27 | 5.19 | .45 | 1.87 | 1.90 | .16 | 1.90 | .49 | 16.26 |
| 1935 | .05 | .30 | .55 | 1.45 | 7.20 | 2.91 | 1.34 | 2.75 | 1.70 | .45 | 1.32 | .27 | 20.2[illegible] |
| 1936 | .49 | .37 | .18 | 1.02 | 5.35 | 1.50 | 2.03 | .64 | 1.26 | .12 | .07 | .67 | 13.70 |
| 1937 | .90 | .20 | 2.29 | .61 | 2.27 | 3.65 | 1.95 | 1.37 | .97 | 1.45 | .13 | .31 | 16.10 |
| 1938 | .25 | .15 | 1.51 | 2.31 | 5.54 | 1.08 | 3.12 | 3.43 | 1.54 | T | .02 | .15 | 19.10 |
| 1939 | .63 | .53 | 1.49 | 2.45 | 1.74 | 3.59 | 1.80 | 1.25 | .25 | .02 | T | .88 | 14.63 |
| 1940 | .93 | .43 | 3.99 | .29 | 1.78 | 2.14 | 2.03 | 1.79 | 1.46 | .33 | .88 | 1.20 | 17.25 |
| 1941 | 1.46 | .38 | .67 | 3.94 | 2.32 | 6.35 | 1.86 | 1.40 | 5.76 | .79 | .18 | 2.24 | 27.35 |
| 1942 | .35 | 1.35 | 1.93 | 3.52 | 2.15 | 5.38 | .82 | 1.65 | 4.69 | .45 | .60 | .47 | 23.36 |
| 1943 | .18 | .10 | .69 | 1.95 | 1.33 | 2.97 | 1.93 | 1.32 | .35 | .12 | .17 | .23 | 11.34 |
| 1944 | 2.36 | 1.78 | 2.08 | 8.22 | 1.93 | 2.75 | 7.45 | 1.14 | .07 | .91 | 1.23 | .44 | 30.36 |
| 1945 | .66 | .21 | .30 | 2.23 | 2.91 | 4.30 | 2.77 | 4.49 | 1.57 | .19 | .17 | .71 | 20.51 |
| 1946 | .15 | .04 | 2.03 | .17 | 4.48 | 2.94 | 5.30 | 3.16 | 2.49 | 7.62 | 2.61 | .05 | 31.04 |
| 1947 | .35 | .55 | .99 | 2.21 | 2.53 | 4.22 | 3.40 | .77 | 1.84 | 1.16 | 1.27 | 1.10 | 20.39 |
| Avg. | 0.61 | 0.66 | 1.35 | 2.32 | 3.05 | 3.43 | 2.79 | 2.09 | 1.88 | 1.22 | 0.91 | 0.63 | 20.94 |

a/ Data published by the U. S. Weather Bureau.

Table 69.--Precipitation--Culbertson-McCook Average a/
Inches

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 0.12 | 0.44 | 1.11 | 0.41 | 5.27 | 5.98 | 8.26 | 0.42 | 0.83 | 2.04 | 1.66 | 0 | 26.54 |
| 1929 | .19 | .96 | .20 | 1.76 | 4.36 | 3.48 | 2.16 | .78 | 2.38 | 1.51 | 1.54 | .07 | 19.39 |
| 1930 | 1.05 | .64 | .40 | 4.18 | 4.60 | 3.26 | 6.74 | 2.18 | 2.53 | 5.64 | 2.32 | .46 | 34.00 |
| 1931 | .15 | 1.50 | 3.54 | 1.32 | 1.18 | 3.14 | 1.00 | 2.90 | .58 | .70 | 1.76 | .44 | 18.21 |
| 1932 | .70 | .67 | .28 | 1.98 | 3.26 | 3.83 | 2.55 | .90 | .80 | .65 | 0 | .16 | 15.78 |
| 1933 | .02 | .24 | 1.81 | 2.46 | 2.72 | 1.08 | 2.32 | 6.42 | 3.46 | 0 | .21 | .81 | 21.55 |
| 1934 | .26 | 1.32 | .12 | 1.34 | 1.04 | 5.00 | .78 | 1.94 | 2.02 | .36 | 1.95 | .62 | 16.75 |
| 1935 | .12 | .34 | .50 | 1.45 | 7.76 | 3.59 | .88 | 2.34 | 1.96 | .44 | 1.28 | .25 | 20.91 |
| 1936 | .51 | .30 | .37 | 1.10 | 4.86 | 1.35 | 2.01 | .50 | 1.22 | .11 | .04 | .50 | 12.87 |
| 1937 | .77 | .16 | 1.74 | .62 | 1.82 | 4.24 | 1.79 | 1.61 | .68 | 1.32 | .10 | .30 | 15.15 |
| 1938 | .24 | .14 | 1.70 | 2.32 | 6.67 | 1.56 | 3.44 | 3.39 | 1.48 | .01 | .03 | .14 | 21.12 |
| 1939 | .56 | .48 | 1.65 | 1.92 | 1.63 | 3.58 | 1.16 | 1.36 | .32 | .02 | 0 | .86 | 13.54 |
| 1940 | .92 | .31 | 3.48 | .44 | 1.82 | 1.71 | 2.17 | 1.52 | 1.50 | .42 | .66 | 1.16 | 16.11 |
| 1941 | 1.28 | .34 | .72 | 3.41 | 2.63 | 5.84 | 3.19 | 1.40 | 5.68 | .98 | .19 | 1.87 | 27.53 |
| 1942 | .34 | 1.11 | 1.38 | 4.67 | 1.97 | 5.55 | .88 | 1.81 | 4.65 | .53 | .57 | .43 | 23.89 |
| 1943 | .22 | .10 | .72 | 1.83 | 1.24 | 2.50 | 1.66 | 2.05 | .20 | .36 | .21 | .20 | 11.29 |
| 1944 | 2.16 | 1.38 | 1.90 | 8.06 | 2.23 | 2.16 | 6.66 | 1.21 | .06 | .72 | 1.12 | .38 | 28.04 |
| 1945 | .60 | .24 | .30 | 2.40 | 3.16 | 3.74 | 2.68 | 4.14 | 1.96 | .24 | .18 | .52 | 20.16 |
| 1946 | .14 | .08 | 1.88 | .16 | 4.70 | 3.67 | 4.56 | 2.72 | 2.36 | 6.84 | 2.40 | .08 | 29.59 |
| 1947 | .30 | .45 | .72 | 2.58 | 2.63 | 6.20 | 3.99 | .61 | 1.94 | .98 | 1.24 | 1.02 | 22.66 |
| Total Avg. | 0.55 | 0.57 | 1.28 | 2.30 | 3.17 | 3.45 | 2.67 | 2.09 | 1.88 | 1.15 | 0.88 | 0.54 | 20.45 |

a/ Average of data published by U. S. Weather Bureau.

Table 70.--Effective Precipitation--Culbertson-McCook Average a/
Feet

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 0.01 | 0.04 | 0.09 | 0.03 | 0.32 | 0.33 | 0.34 | 0.03 | 0.07 | 0.16 | 0.13 | 0 | |
| 1929 | .02 | .08 | .02 | .14 | .29 | .25 | .17 | .06 | .18 | .12 | .12 | .01 | 1.46 |
| 1930 | .08 | .05 | .03 | .29 | .30 | .24 | .34 | .17 | .19 | .33 | .18 | .04 | 2.24 |
| 1931 | .01 | .12 | .25 | .10 | .09 | .23 | .08 | .22 | .05 | .06 | .14 | .04 | 1.39 |
| 1932 | .06 | .05 | .02 | .15 | .24 | .27 | .19 | .07 | .07 | .05 | 0 | .01 | 1.18 |
| 1933 | 0 | .02 | .14 | .19 | .20 | .09 | .18 | .34 | .25 | 0 | .02 | .07 | 1.50 |
| 1934 | .02 | .10 | .01 | .10 | .08 | .32 | .06 | .15 | .16 | .03 | .15 | .05 | 1.23 |
| 1935 | .01 | .03 | .04 | .11 | .34 | .26 | .07 | .18 | .15 | .04 | .10 | .02 | 1.35 |
| 1936 | .04 | .02 | .03 | .09 | .31 | .11 | .15 | .04 | .10 | .01 | 0 | .04 | 0.94 |
| 1937 | .06 | .01 | .13 | .05 | .15 | .29 | .14 | .13 | .05 | .10 | .01 | .02 | 1.14 |
| 1938 | .02 | .01 | .13 | .18 | .34 | .12 | .25 | .25 | .12 | 0 | 0 | .01 | 1.43 |
| 1939 | .04 | .04 | .13 | .15 | .13 | .26 | .09 | .11 | .03 | 0 | 0 | .07 | 1.05 |
| 1940 | .07 | .02 | .25 | .04 | .14 | .13 | .17 | .12 | .12 | .03 | .05 | .09 | 1.23 |
| 1941 | .10 | .03 | .06 | .25 | .20 | .33 | .23 | .11 | .33 | .08 | .02 | .14 | 1.88 |
| 1942 | .03 | .09 | .11 | .31 | .15 | .33 | .07 | .14 | .31 | .04 | .05 | .03 | 1.66 |
| 1943 | .02 | .01 | .06 | .14 | .10 | .19 | .13 | .16 | .02 | .03 | .02 | .02 | 0.90 |
| 1944 | .17 | .11 | .15 | .34 | .18 | .17 | .34 | .09 | 0 | .06 | .09 | .03 | 1.73 |
| 1945 | .05 | .02 | .02 | .19 | .23 | .26 | .20 | .28 | .15 | .02 | .01 | .04 | 1.47 |
| 1946 | .01 | .01 | .15 | .01 | .31 | .26 | .30 | .20 | .18 | .34 | .19 | .01 | 1.97 |
| 1947 | .02 | .04 | .06 | .19 | .20 | .34 | .28 | .05 | .15 | .08 | .10 | .08 | 1.59 |
| Total Avg. | 0.04 | 0.05 | 0.09 | 0.16 | 0.21 | 0.24 | 0.18 | 0.15 | 0.14 | 0.07 | 0.07 | 0.04 | 1.44 |

a/ Average of data published by U. S. Weather Bureau.

Table 71.--Consumptive Use Requirements of Irrigation Water
Meeker - Driftwood Unit

| Year | Apr.[a] | May[a] | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| | | | Feet per acre Irrigated | | | | | |
| 1929 | 0.09 | 0 | 0.07 | 0.29 | 0.38 | 0.11 | 0.03 | 0.97 |
| 1930 | 0 | 0 | 0 | .08 | .26 | .10 | 0 | .44 |
| 1931 | 0 | 0 | 0 | .30 | .22 | .25 | .09 | .86 |
| 1932 | .04 | 0 | .07 | .27 | .36 | .22 | .09 | 1.05 |
| 1933 | .08 | .12 | .26 | .30 | .11 | .05 | .15 | 1.07 |
| 1934 | .17 | .25 | .06 | .45 | .33 | .16 | .13 | 1.55 |
| 1935 | .10 | 0 | 0 | .37 | .25 | .13 | .10 | .95 |
| 1936 | .17 | 0 | .25 | .33 | .42 | .21 | .14 | 1.52 |
| 1937 | .19 | .14 | .05 | .32 | .31 | .24 | .05 | 1.30 |
| 1938 | .09 | 0 | .22 | .23 | .21 | .18 | .15 | 1.08 |
| 1939 | .11 | .17 | .09 | .38 | .34 | .27 | .15 | 1.51 |
| 1940 | .07 | .11 | .22 | .31 | .33 | .18 | .12 | 1.34 |
| 1941 | 0 | 0 | 0 | .21 | .32 | 0 | .03 | .56 |
| 1942 | 0 | 0 | 0 | .29 | .29 | 0 | .09 | .67 |
| 1943 | .13 | .22 | .16 | .34 | .28 | .28 | .12 | 1.53 |
| 1944 | 0 | 0 | 0 | .02 | .33 | .28 | .08 | .71 |
| 1945 | .05 | .06 | .07 | .25 | .14 | .13 | .12 | .82 |
| 1946 | .25 | 0 | .09 | .18 | .26 | .12 | 0 | .90 |
| 1947 | 0 | 0 | 0 | .07 | .39 | .15 | .07 | .68 |
| Average | 0.08 | 0.06 | 0.09 | 0.26 | 0.29 | 0.16 | 0.09 | 1.03 |

a/ Includes one-half of portion of Nov.-Mar. requirement not met by the effective precipitation for that period.

Table 72.—Diversion Requirements - Meeker-Driftwood Unit a/

(acre-feet per acre irrigated)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0.17 | 0 | 0.13 | 0.55 | 0.72 | 0.21 | 0.06 | 1.84 |
| 1930 | 0 | 0 | 0 | .15 | .50 | .19 | 0 | 0.84 |
| 1931 | 0 | 0 | 0 | .57 | .42 | .47 | .17 | 1.63 |
| 1932 | .08 | 0 | .13 | .51 | .68 | .42 | .17 | 1.99 |
| 1933 | .15 | .23 | .49 | .57 | .21 | .10 | .28 | 2.03 |
| 1934 | .32 | .48 | .11 | .85 | .63 | .30 | .25 | 2.94 |
| 1935 | .19 | 0 | 0 | .70 | .47 | .25 | .19 | 1.80 |
| 1936 | .32 | 0 | .47 | .63 | .80 | .40 | .27 | 2.89 |
| 1937 | .36 | .27 | .09 | .61 | .59 | .46 | .09 | 2.47 |
| 1938 | .17 | 0 | .42 | .44 | .40 | .34 | .28 | 2.05 |
| 1939 | .21 | .32 | .17 | .72 | .65 | .51 | .29 | 2.87 |
| 1940 | .13 | .21 | .42 | .59 | .63 | .34 | .23 | 2.55 |
| 1941 | 0 | 0 | 0 | .40 | .61 | 0 | .05 | 1.06 |
| 1942 | 0 | 0 | 0 | .55 | .55 | 0 | .17 | 1.27 |
| 1943 | .25 | .42 | .30 | .65 | .53 | .53 | .23 | 2.91 |
| 1944 | 0 | 0 | 0 | .04 | .63 | .53 | .15 | 1.35 |
| 1945 | .09 | .11 | .13 | .48 | .27 | .25 | .23 | 1.56 |
| 1946 | .48 | 0 | .17 | .34 | .49 | .23 | 0 | 1.71 |
| 1947 | 0 | 0 | 0 | .13 | .74 | .29 | .13 | 1.29 |
| Average | 0.15 | 0.11 | 0.16 | 0.50 | 0.55 | 0.31 | 0.17 | 1.95 |

a/ Based upon canal and farm losses of 25 and 30 percent.

Table 73.--Diversion Requirements - Meeker-Driftwood Unit - 16,440 acres

(Unit 1000 acre-feet)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 2.8 | 0 | 2.1 | 9.0 | 11.8 | 3.5 | 1.0 | 30.2 |
| 1930 | 0 | 0 | 0 | 2.5 | 8.2 | 3.1 | 0 | 13.8 |
| 1931 | 0 | 0 | 0 | 9.4 | 6.9 | 7.7 | 2.8 | 26.8 |
| 1932 | 1.3 | 0 | 2.1 | 8.4 | 11.2 | 6.9 | 2.8 | 32.7 |
| 1933 | 2.5 | 3.8 | 8.1 | 9.4 | 3.5 | 1.6 | 4.6 | 33.5 |
| 1934 | 5.3 | 7.9 | 1.8 | 14.0 | 10.4 | 4.9 | 4.1 | 48.4 |
| 1935 | 3.1 | 0 | 0 | 11.5 | 7.7 | 4.1 | 3.1 | 29.5 |
| 1936 | 5.3 | 0 | 7.7 | 10.4 | 13.2 | 6.6 | 4.4 | 47.6 |
| 1937 | 5.9 | 4.4 | 1.5 | 10.0 | 9.7 | 7.6 | 1.5 | 40.6 |
| 1938 | 2.8 | 0 | 6.9 | 7.2 | 6.6 | 5.6 | 4.6 | 33.7 |
| 1939 | 3.5 | 5.3 | 2.8 | 11.8 | 10.7 | 8.4 | 4.8 | 47.3 |
| 1940 | 2.1 | 3.5 | 6.9 | 9.7 | 10.4 | 5.6 | 3.8 | 42.0 |
| 1941 | 0 | 0 | 0 | 6.6 | 10.0 | 0 | 0.8 | 17.4 |
| 1942 | 0 | 0 | 0 | 9.0 | 9.0 | 0 | 2.8 | 20.8 |
| 1943 | 4.1 | 6.9 | 4.9 | 10.7 | 8.7 | 8.7 | 3.8 | 47.8 |
| 1944 | 0 | 0 | 0 | 0.7 | 10.4 | 8.7 | 2.5 | 22.3 |
| 1945 | 1.5 | 1.8 | 2.1 | 7.9 | 4.4 | 4.1 | 3.7 | 25.5 |
| 1946 | 7.9 | 0 | 2.8 | 5.6 | 8.1 | 3.8 | 0 | 28.2 |
| 1947 | 0 | 0 | 0 | 2.1 | 12.2 | 4.8 | 2.1 | 21.2 |
| Average | 2.5 | 1.8 | 2.6 | 8.2 | 9.1 | 5.0 | 2.8 | 32.0 |

Gross evaporation.--The evaporation records at Colby, Kansas, corrected to free water surface, table 74, were used as a basis for determining the evaporation rate at Swanson Lake for the months of April through September. A factor determined from charts published by the Minnesota Resources Commission was used to adapt the Colby, Kansas evaporation records to the Swanson Lake area. 1/ The Colby, Kansas records were multiplied by the following factors to obtain the evaporation rate for Swanson Lake.

| Month | Factor |
|---|---|
| April | 0.93 |
| May | 0.96 |
| June | 0.95 |
| July | 0.94 |
| August | 0.95 |
| September | 0.95 |

Records of evaporation are not collected in this area during the winter because of freezing weather; therefore the rates of evaporation for the winter months were used as published by the Minnesota Resources Commission. 1/

| Month | Evaporation rate in inches |
|---|---|
| October | 4.95 |
| November | 2.85 |
| December | 1.45 |
| January | 1.25 |
| February | 1.40 |
| March | 2.40 |

The gross evaporation rates determined for Swanson Lake are presented in table 75.

Precipitation over reservoir.--Precipitation data collected by the Weather Bureau at Culbertson, Nebraska, represents the precipitation falling over Swanson Lake area, and these data are presented in table 67.

Net reservoir evaporation.--The net reservoir evaporation rate is the difference between future and past consumptive uses from the reservoir area. For this study, the past consumptive use is estimated to be equal to the precipitation over the reservoir area. The net evaporation therefore is the difference between the gross evaporation rate, table 75, and the precipitation over the reservoir area, table 67. The net evaporation for Swanson Lake is shown in table 76.

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1/ "Evaporation from Lakes and Reservoir", published by Minnesota Resources Commission, June 1942.

Table 74.—Reservoir Evaporation Rates, Colby, Kansas a/

(Inches)

| Year | Apr. | May | June | July | Aug. | Sept. |
|---|---|---|---|---|---|---|
| 1929 | 5.45 | 4.79 | 6.63 | 9.38 | 7.73 | 5.43 |
| 1930 | 4.53 | 5.22 | 7.17 | 8.93 | 7.09 | 4.74 |
| 1931 | 3.75 | 5.71 | 8.37 | 9.21 | 7.53 | 7.67 |
| 1932 | 5.39 | 7.13 | 6.46 | 9.72 | 8.60 | 5.91 |
| 1933 | 5.96 | 5.50 | 9.54 | 9.16 | 6.66 | 6.15 |
| 1934 | 5.91 | 8.85 | 10.55 | 12.73 | 10.01 | 5.96 |
| 1935 | 6.51 | 5.00 | 7.20 | 11.11 | 8.79 | 5.83 |
| 1936 | 4.94 | 6.17 | 9.11 | 11.45 | 9.06 | 6.39 |
| 1937 | 5.11 | 6.47 | 6.80 | 9.68 | 9.20 | 5.61 |
| 1938 | 4.48 | 4.98 | 7.21 | 8.67 | 9.99 | 5.85 |
| 1939 | 4.20 | 7.28 | 9.22 | 10.99 | 7.99 | 8.38 |
| 1940 | 4.90 | 6.68 | 9.57 | 9.87 | 7.19 | 5.01 |
| 1941 | 3.56 | 5.96 | 6.82 | 7.20 | 7.09 | 6.35 |
| 1942 | 3.96 | 5.79 | 5.68 | 9.02 | 7.58 | 4.93 |
| 1943 | 5.32 | 4.64 | 7.76 | 9.53 | 9.04 | 6.39 |
| 1944 | 2.72 | 6.33 | 6.72 | 6.89 | 7.31 | 5.62 |
| 1945 | 3.72 | 5.56 | 5.45 | 7.89 | 7.10 | 5.76 |
| 1946 | 5.82 | 6.23 | 8.50 | 8.48 | 8.98 | 6.13 |
| 1947 | 3.88 | 4.71 | 5.68 | 7.30 | 9.20 | 7.84 |

a/ Evaporation Rate equal to 0.94 times evaporation from pan recorded by U. S. Weather Bureau at Colby, Kansas.

Table 75.—Gross Evaporation at Swanson Lake a/

(Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.25 | 1.40 | 2.40 | 5.07 | 4.60 | 6.30 | 8.82 | 7.34 | 5.16 | 4.95 | 2.85 | 1.45 | 51.59 |
| 1930 | 1.25 | 1.40 | 2.40 | 4.21 | 5.01 | 6.81 | 8.39 | 6.74 | 4.50 | 4.95 | 2.85 | 1.45 | 49.96 |
| 1931 | 1.25 | 1.40 | 2.40 | 3.49 | 5.48 | 7.95 | 8.66 | 7.15 | 7.29 | 4.95 | 2.85 | 1.45 | 54.32 |
| 1932 | 1.25 | 1.40 | 2.40 | 5.01 | 6.84 | 6.14 | 9.14 | 8.17 | 5.61 | 4.95 | 2.85 | 1.45 | 55.21 |
| 1933 | 1.25 | 1.40 | 2.40 | 5.54 | 5.28 | 9.06 | 8.61 | 6.33 | 5.84 | 4.95 | 2.85 | 1.45 | 54.96 |
| 1934 | 1.25 | 1.40 | 2.40 | 5.50 | 8.50 | 10.02 | 11.97 | 9.51 | 5.66 | 4.95 | 2.85 | 1.45 | 65.48 |
| 1935 | 1.25 | 1.40 | 2.40 | 6.05 | 4.80 | 6.84 | 10.44 | 8.35 | 5.54 | 4.95 | 2.85 | 1.45 | 56.32 |
| 1936 | 1.25 | 1.40 | 2.40 | 4.59 | 5.92 | 8.65 | 10.76 | 8.61 | 6.07 | 4.95 | 2.85 | 1.45 | 58.90 |
| 1937 | 1.25 | 1.40 | 2.40 | 4.75 | 6.21 | 6.46 | 9.10 | 8.74 | 5.33 | 4.95 | 2.85 | 1.45 | 54.89 |
| 1938 | 1.25 | 1.40 | 2.40 | 4.17 | 4.78 | 6.85 | 8.15 | 9.49 | 5.56 | 4.95 | 2.85 | 1.45 | 53.30 |
| 1939 | 1.25 | 1.40 | 2.40 | 3.91 | 6.99 | 8.76 | 10.33 | 7.59 | 7.96 | 4.95 | 2.85 | 1.45 | 59.84 |
| 1940 | 1.25 | 1.40 | 2.40 | 4.56 | 6.41 | 9.09 | 9.28 | 6.83 | 4.76 | 4.95 | 2.85 | 1.45 | 55.23 |
| 1941 | 1.25 | 1.40 | 2.40 | 3.31 | 5.72 | 6.48 | 6.77 | 6.74 | 6.03 | 4.95 | 2.85 | 1.45 | 49.35 |
| 1942 | 1.25 | 1.40 | 2.40 | 3.68 | 5.56 | 5.40 | 8.48 | 7.20 | 4.68 | 4.95 | 2.85 | 1.45 | 49.30 |
| 1943 | 1.25 | 1.40 | 2.40 | 4.95 | 4.45 | 7.37 | 8.96 | 8.59 | 6.07 | 4.95 | 2.85 | 1.45 | 54.69 |
| 1944 | 1.25 | 1.40 | 2.40 | 2.53 | 6.08 | 6.38 | 6.48 | 6.94 | 5.34 | 4.95 | 2.85 | 1.45 | 48.05 |
| 1945 | 1.25 | 1.40 | 2.40 | 3.46 | 5.34 | 5.18 | 7.42 | 6.74 | 5.47 | 4.95 | 2.85 | 1.45 | 47.91 |
| 1946 | 1.25 | 1.40 | 2.40 | 5.41 | 5.98 | 8.08 | 7.97 | 8.53 | 5.82 | 4.95 | 2.85 | 1.45 | 56.09 |
| 1947 | 1.25 | 1.40 | 2.40 | 3.61 | 4.52 | 5.40 | 6.86 | 8.74 | 7.45 | 4.95 | 2.85 | 1.45 | 50.88 |
| Total | 23.75 | 26.60 | 45.60 | 83.80 | 108.47 | 137.22 | 166.59 | 148.33 | 110.14 | 94.05 | 54.15 | 27.55 | 1026.25 |
| Average | 1.25 | 1.40 | 2.40 | 4.41 | 5.71 | 7.22 | 8.77 | 7.80 | 5.80 | 4.95 | 2.85 | 1.45 | 54.01 |

a/ Oct.-Mar. based on Meyer's maps. Apr.-Sept. based on correction factors for records at Colby, Kansas (Apr.-0.93, May-0.96, June-0.95, July-0.94, Aug.-0.95, Sept.-0.95)

Table 76.—Net evaporation rate at Swanson Lake a/

(Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.05 | 0.65 | 2.35 | 3.21 | -0.71 | 3.76 | 7.15 | 6.96 | 2.63 | 3.33 | 1.57 | 1.45 | 33.40 |
| 1930 | 0.25 | 0.94 | 1.73 | 0.27 | 0.57 | 4.06 | 3.61 | 4.60 | 2.12 | 0.33 | 0.82 | 0.92 | 20.22 |
| 1931 | 1.25 | 0.38 | -0.81 | 2.36 | 4.29 | 4.77 | 7.79 | 3.85 | 6.71 | 4.33 | 1.59 | 1.13 | 37.64 |
| 1932 | 0.65 | 0.90 | 2.20 | 2.75 | 3.44 | 2.24 | 6.52 | 7.66 | 5.23 | 4.31 | 2.85 | 1.30 | 40.05 |
| 1933 | 1.22 | 1.10 | 0.87 | 3.61 | 2.49 | 8.08 | 5.73 | -1.00 | 2.03 | 4.95 | 2.55 | 1.35 | 32.98 |
| 1934 | 1.05 | -0.16 | 2.33 | 4.28 | 7.70 | 5.21 | 10.87 | 7.50 | 3.53 | 4.39 | 0.85 | 0.70 | 48.25 |
| 1935 | 1.05 | 1.02 | 1.94 | 4.60 | -3.53 | 2.57 | 10.02 | 6.43 | 3.33 | 4.51 | 1.60 | 1.22 | 34.76 |
| 1936 | 0.72 | 1.18 | 1.84 | 3.42 | 1.55 | 7.45 | 8.77 | 8.25 | 4.90 | 4.85 | 2.85 | 1.13 | 46.91 |
| 1937 | 0.61 | 1.28 | 1.21 | 4.11 | 4.83 | 1.62 | 7.47 | 6.89 | 4.93 | 3.76 | 2.77 | 1.15 | 40.63 |
| 1938 | 1.01 | 1.26 | 0.51 | 1.85 | -3.02 | 4.80 | 4.39 | 6.14 | 4.15 | 4.93 | 2.81 | 1.32 | 30.15 |
| 1939 | 0.75 | 0.97 | 0.59 | 2.53 | 5.47 | 5.19 | 9.80 | 6.12 | 7.57 | 4.92 | 2.85 | 0.61 | 47.37 |
| 1940 | 0.34 | 1.21 | -0.57 | 3.98 | 4.54 | 7.81 | 6.97 | 5.57 | 3.22 | 4.43 | 2.40 | 0.32 | 40.22 |
| 1941 | 0.16 | 1.11 | 1.64 | 0.43 | 2.78 | 1.16 | 2.25 | 5.35 | 0.42 | 3.79 | 2.65 | -0.05 | 21.69 |
| 1942 | 0.93 | 0.53 | 1.58 | -2.14 | 3.77 | -0.32 | 7.54 | 5.23 | 0.07 | 4.34 | 2.31 | 1.06 | 24.90 |
| 1943 | 0.99 | 1.31 | 1.64 | 3.24 | 3.30 | 5.34 | 7.57 | 5.81 | 6.02 | 4.35 | 2.60 | 1.28 | 43.45 |
| 1944 | -0.72 | 0.41 | 0.69 | -5.38 | 3.55 | 4.80 | 0.60 | 5.66 | 5.30 | 4.43 | 1.83 | 1.12 | 22.29 |
| 1945 | 0.71 | 1.14 | 2.09 | 0.89 | 1.94 | 1.99 | 4.84 | 2.94 | 3.13 | 4.66 | 2.65 | 1.12 | 28.10 |
| 1946 | 1.13 | 1.27 | 0.66 | 5.26 | 1.07 | 3.68 | 4.16 | 6.26 | 3.59 | -1.11 | 0.64 | 1.35 | 27.96 |
| 1947 | 0.99 | 1.05 | 1.94 | 0.66 | 1.79 | -2.78 | 2.28 | 8.29 | 5.41 | 4.14 | 1.63 | 0.52 | 25.92 |
| Total Avg. | 0.74 | 0.92 | 1.29 | 2.10 | 2.41 | 3.76 | 6.23 | 5.71 | 3.91 | 3.88 | 2.10 | 1.00 | 34.05 |

a/ Evaporation at Colby, Kansas for summer months corrected to free water surface less rainfall recorded at Culbertson; winter months based upon A. F. Meyers' evaporation study. Negative values indicate the amount that precipitation exceeded gross evaporation.

## Meeker-Driftwood Unit

To facilitate computations necessary to determine the water lost by evaporation at different reservoir capacities in the monthly reservoir operations study, a series of curves, one for each inch of evaporation, were drawn by plotting reservoir content in 1,000 acre-feet as ordinate and evaporation loss in 1,000 acre-feet as abscissas. By entering the curve with the average reservoir content to the monthly evaporation rate in inches, the corresponding evaporation loss for any month was indicated. The reservoir's evaporation curves for Swanson Lake are shown in exhibit 23.

### Seepage

Seepage losses from the reservoir were estimated to range from 0 to 3 second-feet based on geologic and construction data. For the operation study, a constant seepage rate of 3 second-feet was used. This is equal to approximately 200 acre-feet per month.

## Water Utilization

An operation study showing the water delivery on a monthly basis has been made to determine the adequacy of the water supply available to the unit for development. The study was based upon water supply and climatic conditions existing during the period 1929 through 1947. The 10-year period 1931 through 1940 is considered to be the most critical period of water supply that has been experienced since records were first established.

### Reservoir operations

The operation study is based upon conditions expected to exist in Swanson Lake after 50 years of use. It is estimated that the storage capacity at this time will be decreased 64,000 acre-feet due to accumulation of sediment in the reservoir. The amount of water available for development of irrigation was determined after making depletions for all developments that will occur due to upstream development.

Table 77 is the operation study for the Meeker-Driftwood Unit. This is a relatively simple study because all releases for irrigation of the unit will be made at Trenton Dam. The following operation criteria were used in making the operation study:

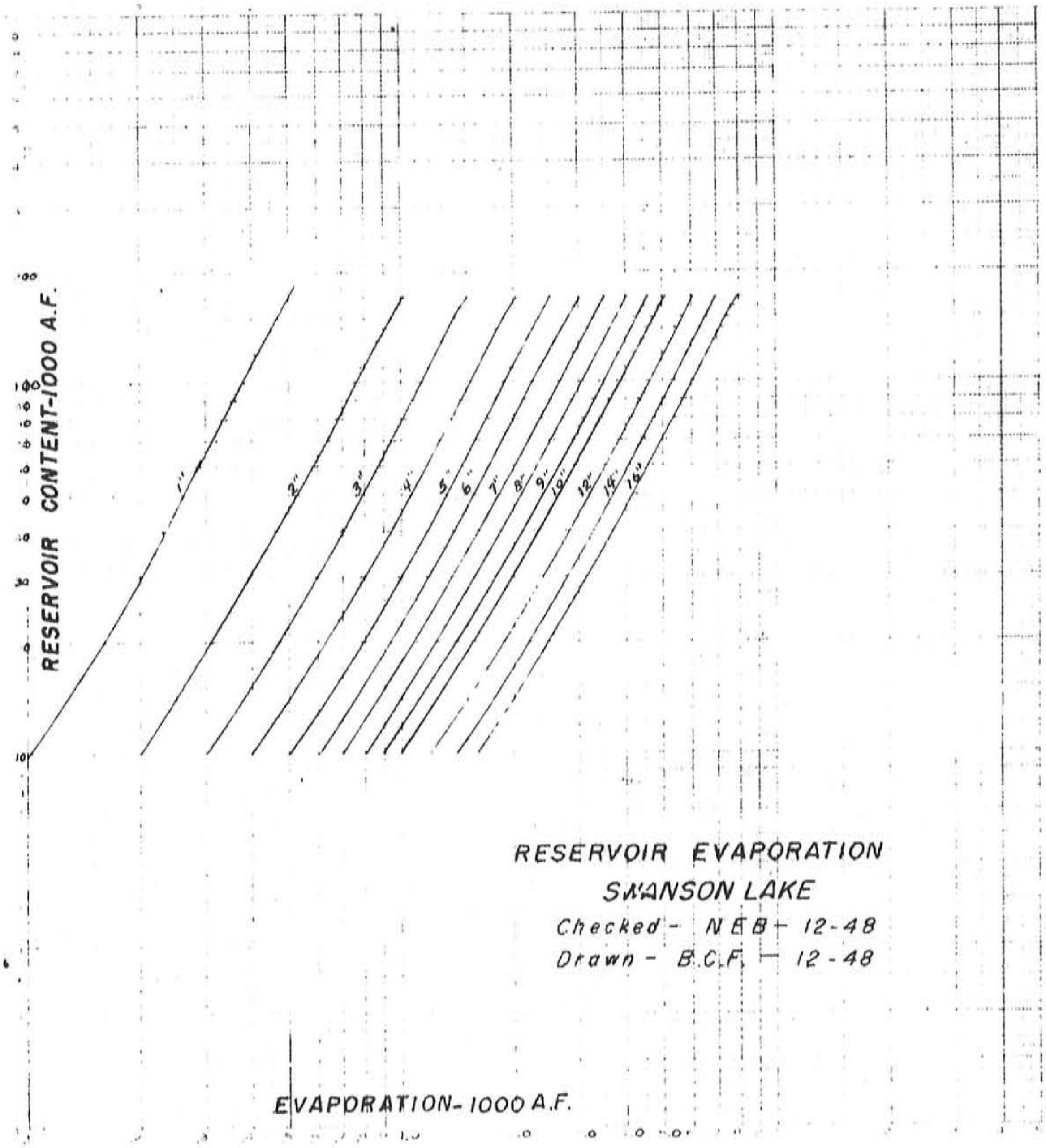
1. Method of meeting irrigation demands.

    a. All irrigation demands were met by releases from Swanson Lake at the dam site.

2. Requirements for other than irrigation demands.

    a. No releases were made from Swanson Lake to supply negative sectional gains. It was assumed that negative sectional gains which occurred historically

E[illegible]IT 23




RESERVOIR EVAPORATION
SWANSON LAKE
Checked - NEB - 12-48
Drawn - B.C.F. - 12-48

Table 77 — SWANSON LAKE OPERATION STUDY

Dead Storage 0 A.F.
Active Irrig Storage 58,800 A.F.
16,440 Acres

Values in 1000 A-F Unless Indicated Otherwise

| Year | Month | Depleted Inflow Into Reservoir | Reservoir Losses: Evap. Rate-In. | Reservoir Losses: Evap. Loss | Reservoir Losses: Seepage | Diversion Req't. | Change in Reservoir Content | Reservoir Content End of Month | Reservoir Spills | Shortage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | | |
| 1929 | Jan. | 9.4 | 1.05 | 0.3 | 0.2 | | 0 | 58.8 | 8.9 | | | |
| | Feb. | 7.0 | 0.65 | 0.2 | .2 | | 0 | 58.8 | 6.6 | | | |
| | Mar. | 20.4 | 2.35 | 0.7 | .2 | | 0 | 58.8 | 19.5 | | | |
| | Apr. | 13.5 | 3.21 | 0.9 | .2 | 2.8 | 0 | 58.8 | 9.6 | | | |
| | May | 12.6 | -0.71 | -0.2 | .2 | 0 | 0 | 58.8 | 12.6 | | | |
| | June | 4.2 | 3.76 | 1.1 | .2 | 2.1 | 0 | 58.8 | 0.8 | | | |
| | July | 0 | 7.15 | 1.9 | .2 | 9.0 | -11.1 | 47.7 | 0 | | | |
| | Aug. | 0 | 6.96 | 1.6 | .2 | 11.8 | -13.6 | 34.1 | 0 | | | |
| | Sept. | 0 | 2.63 | 0.5 | .2 | 3.5 | - 4.2 | 29.9 | 0 | | | |
| | Oct. | 3.5 | 3.33 | 0.7 | .2 | 1.0 | + 1.6 | 31.5 | 0 | | | |
| | Nov. | 9.2 | 1.57 | 0.3 | .2 | | + 8.7 | 40.2 | 0 | | | |
| | Dec. | 7.9 | 1.45 | 0.3 | .2 | | + 7.4 | 47.6 | 0 | | | |
| TOTAL | | 87.7 | 33.40 | 8.3 | 2.4 | 30.2 | | -11.2 | 58.0 | | | |
| 1930 | Jan. | 9.2 | 0.25 | 0.1 | 0.2 | | + 8.9 | 56.5 | 0 | | | |
| | Feb. | 10.4 | 0.94 | 0.3 | .2 | | + 2.3 | 58.8 | 7.6 | | | |
| | Mar. | 11.0 | 1.73 | 0.5 | .2 | | 0 | 58.8 | 10.3 | | | |
| | Apr. | 8.5 | 0.27 | 0.1 | .2 | 0 | 0 | 58.8 | 8.2 | | | |
| | May | 17.4 | 0.57 | 0.2 | .2 | 0 | 0 | 58.8 | 17.0 | | | |
| | June | 10.3 | 4.06 | 1.2 | .2 | 0 | 0 | 58.8 | 8.9 | | | |
| | July | 0 | 3.61 | 1.0 | .2 | 2.5 | - 3.7 | 55.1 | 0 | | | |
| | Aug. | 4.2 | 4.60 | 1.2 | .2 | 8.2 | - 5.4 | 49.7 | 0 | | | |
| | Sept. | 3.9 | 2.12 | 0.6 | .2 | 3.1 | 0 | 49.7 | 0 | | | |
| | Oct. | 6.9 | 0.33 | 0.1 | .2 | 0 | + 6.6 | 56.3 | 0 | | | |
| | Nov. | 8.3 | 0.82 | 0.2 | .2 | | + 2.5 | 58.8 | 5.4 | | | |
| | Dec. | 25.0 | 0.92 | 0.1 | .2 | | 0 | 58.8 | 14.5 | | | |
| TOTAL | | 105.1 | 20.22 | 5.8 | 2.4 | 13.8 | | +11.2 | 72.9 | | | |
| 1931 | Jan. | 10.3 | 1.25 | 0.4 | 0.2 | | 0 | 58.8 | 9.7 | | | |
| | Feb. | 14.4 | 0.38 | 0.1 | .2 | | 0 | 58.8 | 14.1 | | | |
| | Mar. | 12.0 | -0.81 | -0.2 | .2 | | 0 | 58.8 | 12.0 | | | |
| | Apr. | 10.4 | 2.36 | 0.7 | .2 | 0 | 0 | 58.8 | 9.5 | | | |
| | May | 0.9 | 4.29 | 1.2 | .2 | 0 | - 0.5 | 58.3 | 0 | | | |
| | June | 2.5 | 4.77 | 1.4 | .2 | 0 | + 0.5 | 58.8 | 0.4 | | | |
| | July | 0.7 | 7.79 | 2.1 | .2 | 9.4 | -11.0 | 47.8 | 0 | | | |
| | Aug. | 0 | 3.85 | 0.9 | .2 | 6.9 | - 8.0 | 39.8 | 0 | | | |
| | Sept. | 0.6 | 6.71 | 1.4 | .2 | 7.7 | - 8.7 | 31.1 | 0 | | | |
| | Oct. | 0.4 | 4.33 | 0.8 | .2 | 2.8 | - 3.5 | 27.6 | 0 | | | |
| | Nov. | 6.4 | 1.99 | 0.3 | .2 | | + 5.0 | 32.6 | 0 | | | |
| | Dec. | 6.3 | 1.13 | 0.2 | .2 | | + 5.9 | 38.4 | 0 | | | |
| TOTAL | | 64.9 | 37.64 | 9.4 | 2.4 | 26.8 | | -20.4 | 45.7 | | | |

Table 77 SWANSON LAKE OPERATION STUDY

Values in 1000 A-F Unless Indicated Otherwise — 16,440 Acres

| Year Month | Regulated Inflow into Reservoir | Reservoir Losses: Evap. Rate-In. | Evap. Loss | Seepage | Diversion Req'd. | Change in Reservoir Content | Reservoir Content End of Month | Reservoir Spills | Shortage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1932 Jan. | 6.9 | 0.66 | 0.2 | 0.2 | | + 6.5 | 46.9 | 0 | | | |
| Feb. | 6.4 | 0.[illegible] | 0.2 | .2 | | + 6.0 | 52.9 | 0 | | | |
| Mar. | 6.2 | 2.[illegible] | 0.6 | .2 | | + 5.4 | 57.3 | 0 | | | |
| Apr. | 3.9 | 2.75 | 0.7 | .2 | 1.3 | + 1.5 | [illegible] | 0.2 | | | |
| May | 0 | 3.44 | 1.0 | .2 | 0 | - 1.2 | 57.6 | 0 | | | |
| June | 6.9 | 2.24 | 0.6 | .2 | 2.1 | + 1.2 | 58.8 | 2.8 | | | |
| July | 1.8 | 6.52 | 1.8 | .2 | 8.4 | - 8.6 | 50.2 | 0 | | | |
| Aug. | 1.5 | 7.66 | 1.9 | .2 | 11.2 | - 11.8 | 38.4 | 0 | | | |
| Sept. | 0 | 5.23 | 1.1 | .2 | 6.9 | - 8.2 | 30.2 | 0 | | | |
| Oct. | 0 | 4.32 | 0.9 | .2 | 2.8 | - 3.9 | 26.3 | 0 | | | |
| Nov. | 2.5 | 2.85 | 0.5 | .2 | | + 1.8 | 28.1 | 0 | | | |
| Dec. | 7.8 | 1.30 | 0.3 | .2 | | + 7.3 | 35.4 | 0 | | | |
| TOTAL | 43.9 | 40.05 | 9.8 | 2.4 | 32.7 | | -4.0 | 3.0 | | | |
| 1933 Jan. | 9.[illegible] | 1.28 | 0.3 | 0.2 | | + 9.1 | 44.5 | 0 | | | |
| Feb. | 8.1 | 1.30 | 0.1 | .2 | | + 7.6 | 52.1 | 0 | | | |
| Mar. | 9.0 | 0.87 | 0.2 | .2 | | + 6.7 | 58.8 | 1.9 | | | |
| Apr. | 2.6 | 1.61 | 1.1 | .2 | 2.5 | - 1.2 | 57.6 | 0 | | | |
| May | 8.4 | 2.40 | 0.7 | .2 | 3.8 | + 1.2 | 58.8 | 2.5 | | | |
| June | 1.4 | 8.08 | 2.2 | .2 | 8.1 | - 9.1 | 49.7 | 0 | | | |
| July | 0 | 5.73 | 1.4 | .2 | 9.4 | - 11.0 | 38.7 | 0 | | | |
| Aug. | 59.8 | - 1.00 | - 0.1 | .2 | 3.5 | + 20.1 | 58.8 | 36.1 | | | |
| Sept. | 32.8 | 2.03 | 0.8 | .2 | 1.6 | 0 | 58.8 | 30.4 | | | |
| Oct. | 3.9 | 4.95 | 1.4 | .2 | 4.6 | - 2.3 | 56.5 | 0 | | | |
| Nov. | 8.4 | 2.55 | 0.7 | .2 | | + 2.3 | 58.8 | 5.2 | | | |
| Dec. | 23.2 | 1.35 | 0.4 | .2 | | 0 | 58.8 | 22.6 | | | |
| TOTAL | 157.2 | 32.[illegible] | 9.0 | 2.4 | 33.5 | | +23.4 | 98.9 | | | |
| 1934 Jan. | 12.1 | 1.05 | 0.3 | 0.2 | | 0 | 58.8 | 11.6 | | | |
| Feb. | 12.5 | - 0.36 | - 0.1 | .2 | | 0 | 58.8 | 12.4 | | | |
| Mar. | 10.9 | 2.33 | 0.7 | .2 | | 0 | 58.8 | 10.0 | | | |
| Apr. | 1.0 | 4.28 | 1.2 | .2 | 5.3 | - 5.7 | 53.1 | 0 | | | |
| May | 0.2 | 7.70 | 2.0 | .2 | 7.9 | - 9.9 | 43.2 | 0 | | | |
| June | 0.9 | 5.21 | 1.3 | .2 | 1.8 | - 2.4 | 40.8 | 0 | | | |
| July | 0.6 | 10.87 | 2.2 | .2 | 14.0 | - 15.8 | 25.0 | 0 | | | |
| Aug. | 0 | 7.50 | 1.1 | .2 | 10.4 | - 11.7 | 13.3 | 0 | | | |
| Sept. | 0 | 3.53 | 0.4 | .2 | 4.9 | - 5.5 | 7.8 | 0 | | | |
| Oct. | 0 | 4.39 | 0.1 | .2 | 4.1 | - 4.6 | 3.2 | 0 | | | |
| Nov. | 0 | 0.85 | 0.1 | .2 | | - 0.3 | 2.9 | 0 | | | |
| Dec. | 4.5 | 0.70 | 0.1 | .2 | | + 4.2 | 7.1 | 0 | | | |
| TOTAL | 42.7 | 48.85 | 9.6 | 2.4 | 48.4 | | -51.7 | 34.0 | | | |

Table 77 **SWANSON LAKE OPERATION STUDY**

Values in 1000 A-F Unless Indicated Otherwise 16,440 Acres

| Year Month | Regulated Inflow into Reservoir | Reservoir Losses: Evap. Rate-In. | Evap. Loss | Seepage | Diversion Req'd. | Change in Reservoir Content | Reservoir Content End of Month | Reservoir Spills | Shortage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 7.1 | | | | |
| 19[illegible] Jan. | 8.7 | 1.08 | 0.1 | 0.2 | | +8.4 | 15.8 | 0 | | | |
| Feb. | 7.4 | 2.09 | 0.1 | .2 | | +7.1 | 22.6 | 0 | | | |
| Mar. | 8.7 | 1.81 | 0.2 | .2 | | +8.2 | 30.8 | 0 | | | |
| Apr. | 1.7 | 4.09 | 0.8 | .2 | 3.1 | -2.5 | 28.3 | 0 | | | |
| May | [illegible] | -3.92 | -0.8 | .2 | 0 | +30.6 | [illegible] | 188.9 | | | |
| June | 107.9 | 2.97 | 0.7 | .2 | 0 | 0 | [illegible] | 107.0 | | | |
| July | 15.1 | 10.02 | 3.9 | .2 | 11.8 | 0 | [illegible] | 0.5 | | | |
| Aug. | 6.2 | 8.45 | 1.8 | .2 | 7.7 | -3.1 | [illegible] | 0 | | | |
| Sept. | 3.9 | 3.22 | 0.9 | .2 | 4.1 | -1.5 | [illegible] | 0 | | | |
| Oct. | 0.7 | 4.81 | 1.2 | .2 | 3.1 | -3.8 | [illegible] | 0 | | | |
| Nov. | 3.7 | 1.09 | 0.4 | .2 | | +3.1 | 23.7 | 0 | | | |
| Dec. | 8.2 | 1.23 | 0.3 | .2 | | +8.1 | [illegible] | 3.3 | | | |
| TOTAL | [illegible] | 34.76 | 8.0 | 2.4 | 29.8 | | +21.7 | 393.7 | | | |
| 1936 Jan. | [illegible] | 0.72 | 0.2 | 0.2 | | 0 | [illegible] | 6.4 | | | |
| Feb. | 8.3 | 1.26 | 0.3 | .2 | | 0 | [illegible] | 8.9 | | | |
| Mar. | 13.4 | 1.20 | 0.3 | .2 | | 0 | [illegible] | 12.7 | | | |
| Apr. | [illegible] | 3.42 | 1.0 | .2 | [illegible] | 0 | [illegible] | 2.0 | | | |
| May | [illegible] | 1.88 | 0.4 | .2 | 0 | 0 | [illegible] | [illegible] | | | |
| June | 13.4 | 7.45 | 2.1 | .2 | 7.7 | 0 | [illegible] | 3.6 | | | |
| July | 9.3 | 8.77 | 2.3 | .2 | 19.4 | -12.4 | [illegible] | 0 | | | |
| Aug. | 1.1 | [illegible] | 1.9 | .2 | 18.3 | -14.2 | [illegible] | 0 | | | |
| Sept. | 0 | [illegible] | 1.6 | .2 | 6.2 | - 7.8 | [illegible] | 0 | | | |
| Oct. | 0 | [illegible] | 0.9 | .2 | [illegible] | - 5.4 | 19.0 | 0 | | | |
| Nov. | 0 | [illegible] | 0.4 | .2 | | - 0.8 | [illegible] | 0 | | | |
| Dec. | 4.8 | 1.13 | 0.2 | .2 | | + 4.3 | 22.8 | 0 | | | |
| TOTAL | 102.3 | 46.92 | 11.1 | 2.4 | 47.6 | | [illegible] | 77.0 | | | |
| 1937 Jan. | 3.4 | 0.61 | 0.1 | 0.2 | | + 3.1 | [illegible] | 0 | | | |
| Feb. | 7.3 | 1.28 | 0.2 | .2 | | + 6.8 | [illegible] | 0 | | | |
| Mar. | 8.7 | 1.21 | 0.3 | .2 | | + 8.2 | 41.0 | 0 | | | |
| Apr. | [illegible] | 4.11 | 1.0 | .2 | [illegible] | - [illegible] | 37.5 | 0 | | | |
| May | [illegible] | [illegible] | 1.1 | .2 | 4.4 | + [illegible] | [illegible] | 0 | | | |
| June | [illegible] | 1.92 | 0.4 | .2 | 1.5 | +11.7 | [illegible] | 0 | | | |
| July | 1.7 | 7.47 | 2.0 | .2 | 10.0 | -10.5 | 47.8 | 0 | | | |
| Aug. | 2.1 | [illegible] | 1.6 | .2 | 9.7 | - [illegible] | [illegible] | 0 | | | |
| Sept. | 1.6 | 4.93 | 1.1 | .2 | 7.4 | - 7.3 | [illegible] | 0 | | | |
| Oct. | 1.0 | 5.76 | 0.8 | .2 | 1.5 | - 9.6 | [illegible] | 0 | | | |
| Nov. | [illegible] | 2.77 | 0.6 | .2 | | + 3.0 | [illegible] | 0 | | | |
| Dec. | 3.0 | 1.15 | 0.3 | .2 | | + 2.5 | [illegible] | 0 | | | |
| TOTAL | 66.4 | 40.63 | 9.5 | 2.4 | 40.6 | | [illegible] | 0 | | | |



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Table 77 SWANSON LAKE OPERATION STUDY

Values in 1000 A-F Unless Indicated Otherwise 19,440 Acres

| Year Month | [Depleted Inflow into Reservoir] | [Reservoir Losses: Evap. Depth-in.] | [Evap. A-F] | [Seepage] | [Diversion Req't.] | [Change in Reservoir Content] | [Reservoir Content End of Month] | [Reservoir Spills] | [Shortage] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | [illegible] | | | | |
| [illegible] Jan. | 5.4 | 1.[illegible] | 0.2 | 0.2 | | + [illegible] | [illegible] | 0 | | | |
| Feb. | 7.9 | 1.26 | 0.2 | .2 | | + 7.3 | 49.1 | 0 | | | |
| Mar. | [illegible] | [illegible] | 0.1 | .2 | | + [illegible] | [illegible] | 0 | | | |
| Apr. | [illegible] | 1.[illegible] | [illegible] | .2 | [illegible] | + [illegible] | [illegible] | 0 | | | |
| May | [illegible] | -[illegible] | -[illegible] | .2 | 0 | + [illegible] | [illegible] | [illegible] | | | |
| June | 11.9 | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 5.4 | | | |
| July | [illegible] | [illegible] | [illegible] | .2 | 7.3 | - [illegible] | [illegible] | 0 | | | |
| Aug. | [illegible] | [illegible] | [illegible] | .2 | [illegible] | - [illegible] | [illegible] | 0 | | | |
| Sept. | 12.7 | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | [illegible] | | | |
| Oct. | 0 | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| Nov. | [illegible] | [illegible] | [illegible] | .2 | | + [illegible] | [illegible] | 0 | | | |
| Dec. | [illegible] | 1.[illegible] | 0.4 | .2 | | + [illegible] | [illegible] | [illegible] | | | |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | |
| [illegible] Jan. | 11.[illegible] | 0.75 | 0.[illegible] | 0.2 | | 0 | [illegible] | 10.[illegible] | | | |
| Feb. | 1.7 | 0.27 | 0.1 | .2 | | 0 | [illegible] | [illegible] | | | |
| Mar. | 20.7 | [illegible] | 0.2 | .2 | | 0 | [illegible] | [illegible] | | | |
| Apr. | [illegible] | [illegible] | 0.7 | .2 | [illegible] | 0 | [illegible] | [illegible] | | | |
| May | 0.7 | [illegible].47 | 1.[illegible] | .2 | [illegible] | + [illegible] | [illegible] | 0 | | | |
| June | 23.3 | [illegible].10 | 1.4 | .2 | [illegible] | + [illegible] | [illegible] | [illegible] | | | |
| July | [illegible] | 9.20 | 2.7 | .2 | 11.[illegible] | -[illegible] | [illegible] | 0 | | | |
| Aug. | 4.7 | [illegible] | 1.[illegible] | .2 | 10.7 | - [illegible] | [illegible] | 0 | | | |
| Sept. | 0.3 | 7.57 | 1.[illegible] | .2 | [illegible] | -10.9 | [illegible] | 0 | | | |
| Oct. | 0 | 4.[illegible] | 0.[illegible] | .2 | [illegible] | - [illegible] | [illegible] | 0 | | | |
| Nov. | 0 | 2.06 | 0.5 | .2 | | - [illegible] | [illegible] | 0 | | | |
| Dec. | [illegible] | 0.[illegible] | 0.1 | .2 | | + [illegible] | [illegible] | 0 | | | |
| TOTAL | 78.1 | 47.[illegible] | 11.[illegible] | 2.4 | 47.[illegible] | | [illegible] | [illegible] | | | |
| [illegible] Jan. | 3.3 | 0.34 | 0.1 | 0.2 | | + 3.0 | 27.[illegible] | 0 | | | |
| Feb. | 14.1 | 1.21 | 0.3 | .2 | | +[illegible] | [illegible] | 0 | | | |
| Mar. | 11.7 | -0.[illegible] | -0.1 | .2 | | +11.[illegible] | [illegible] | 0 | | | |
| Apr. | 1.4 | 3.[illegible] | 1.0 | .2 | 2.1 | - 1.[illegible] | [illegible] | 0 | | | |
| May | 0.1 | 4.[illegible] | 1.[illegible] | .2 | [illegible] | - [illegible] | [illegible] | 0 | | | |
| June | 4.[illegible] | 7.[illegible] | 1.[illegible] | .2 | [illegible] | - [illegible] | [illegible] | 0 | | | |
| July | 0.[illegible] | [illegible].97 | 1.[illegible] | .2 | [illegible].7 | -10.[illegible] | [illegible] | 0 | | | |
| Aug. | 0.9 | 5.57 | 1.0 | .2 | 10.4 | -10.[illegible] | [illegible] | 0 | | | |
| Sept. | 4.[illegible] | [illegible].22 | 0.[illegible] | .2 | [illegible] | - 2.0 | 10.[illegible] | [illegible] | | | |
| Oct. | 0 | 4.43 | 0.[illegible] | .2 | [illegible] | - [illegible] | [illegible] | 0 | | | |
| Nov. | [illegible] | [illegible].40 | 0.3 | .2 | | + 7.[illegible] | 21.1 | 0 | | | |
| Dec. | [illegible].3 | 0.32 | 0.1 | .2 | | + [illegible].0 | [illegible] | 0 | | | |
| TOTAL | 57.4 | 40.22 | [illegible] | [illegible] | [illegible] | | [illegible] | 0 | | | |

Table 77 SWANSON LAKE OPERATION STUDY

Values in 1000 A-F Unless Indicated Otherwise

[illegible] Acres

| Year Month | Inflow Into Reservoir | Reservoir Losses: Evap. Rate-In. | Evap. Lost | Seepage | Diversion Req't. | Change in Reservoir Content | Reservoir Content End of Month | Reservoir Spills | Shortage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | [illegible] | | | | |
| 1941 Jan. | 11.6 | 0.16 | 0.1 | 0.2 | | [illegible] | [illegible] | 0 | | | |
| Feb. | 7.0 | 1.11 | 0.3 | .2 | | + [illegible] | [illegible] | 0 | | | |
| Mar. | 6.4 | 1.04 | 0.4 | .2 | | + [illegible] | [illegible] | 0 | | | |
| Apr. | 17.3 | 0.43 | 0.1 | .2 | 0 | + 5.9 | [illegible] | [illegible] | | | |
| May | 3.8 | 2.79 | 0.6 | .2 | 0 | 0 | [illegible] | [illegible] | | | |
| June | 40.7 | 1.16 | [illegible] | .2 | 0 | 0 | [illegible] | [illegible] | | | |
| July | 25.5 | 2.35 | 0.6 | .2 | [illegible] | 0 | [illegible] | [illegible] | | | |
| Aug. | 13.2 | 5.34 | 1.5 | .2 | 10.0 | 0 | [illegible] | [illegible] | | | |
| Sept. | 5.2 | 0.42 | 0.1 | .2 | 0 | 0 | [illegible] | [illegible] | | | |
| Oct. | 7.7 | 3.79 | 1.1 | .2 | 0.6 | 0 | [illegible] | [illegible] | | | |
| Nov. | [illegible] | 2.66 | 0.7 | .2 | | 0 | [illegible] | [illegible] | | | |
| Dec. | 9.1 | -0.66 | 0 | .2 | | 0 | [illegible] | [illegible] | | | |
| TOTAL | [illegible] | 21.60 | 6.0 | 2.4 | 17.4 | | +[illegible] | [illegible] | | | |
| 1942 Jan. | 7.0 | 0.95 | 0.3 | 0.2 | | 0 | [illegible] | [illegible] | | | |
| Feb. | [illegible] | [illegible] | [illegible] | .2 | | 0 | [illegible] | [illegible] | | | |
| Mar. | [illegible] | [illegible] | [illegible] | .2 | | 0 | [illegible] | [illegible] | | | |
| Apr. | [illegible] | -2.14 | -0.6 | .2 | 0 | 0 | [illegible] | [illegible] | | | |
| May | [illegible] | 3.77 | [illegible] | .2 | 0 | 0 | [illegible] | [illegible] | | | |
| June | [illegible] | +0.32 | -0.1 | .2 | 0 | 0 | [illegible] | [illegible] | | | |
| July | 0 | [illegible] | [illegible] | .2 | 9.0 | [illegible] | [illegible] | 0 | | | |
| Aug. | [illegible] | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| Sept. | [illegible] | [illegible] | 0 | .2 | 0 | [illegible] | [illegible] | 0 | | | |
| Oct. | [illegible] | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| Nov. | [illegible] | [illegible] | [illegible] | .2 | | 0 | [illegible] | [illegible] | | | |
| Dec. | [illegible] | [illegible] | [illegible] | .2 | | 0 | [illegible] | [illegible] | | | |
| TOTAL | [illegible] | [illegible] | [illegible] | 2.4 | [illegible] | | 0 | [illegible] | | | |
| 1943 Jan. | 9.7 | [illegible] | [illegible] | [illegible] | | 0 | [illegible] | [illegible] | | | |
| Feb. | [illegible] | [illegible] | [illegible] | .2 | | 0 | [illegible] | [illegible] | | | |
| Mar. | [illegible] | [illegible] | [illegible] | .2 | | 0 | [illegible] | [illegible] | | | |
| Apr. | [illegible] | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| May | [illegible] | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| June | [illegible] | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| July | [illegible] | 7.57 | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| Aug. | [illegible] | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| Sept. | 0 | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| Oct. | 0 | [illegible] | [illegible] | .2 | [illegible] | [illegible] | [illegible] | 0 | | | |
| Nov. | 0 | [illegible] | [illegible] | .2 | | [illegible] | [illegible] | 0 | | | |
| Dec. | 0 | [illegible] | 0.1 | .2 | | [illegible] | [illegible] | 0 | | | |
| TOTAL | [illegible] | [illegible] | [illegible] | 2.4 | 47.[illegible] | | [illegible] | [illegible] | | | |

150 Table 77 (cont)

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Table 77

## SWANSON LAKE OPERATION STUDY

Values in 1000 A-F Unless Indicated Otherwise — 16,140 Acres

| Year Month | Depleted Inflow into Reservoir | Reservoir Losses: Evap. Rate-in. | Evap. Loss | Seepage | Diversion Req'd. | Change in Reservoir Content | Reservoir Content End of Month | Reservoir Spills | Shortage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1944 Jan. | 10.4 | - 0.72 | - 0.1 | 0.2 | | + 10.3 | 31.6 | 0 | | | |
| Feb. | 8.4 | 0.42 | 0.1 | .2 | | + 8.1 | 39.7 | 0 | | | |
| Mar. | 12.1 | 0.40 | 0.2 | .2 | | + 11.7 | 51.4 | 0 | | | |
| Apr. | 33.8 | - 5.18 | - 1.4 | .2 | 0 | + 17.4 | 50.8 | 17.6 | | | |
| May | 16.2 | 3.55 | 3.0 | .2 | 0 | 0 | 50.8 | 15.0 | | | |
| June | 4.7 | 4.80 | 3.4 | .2 | 0 | 0 | 50.8 | 3.1 | | | |
| July | 30.7 | 0.60 | 0.2 | .2 | 0.7 | 0 | 50.8 | 27.6 | | | |
| Aug. | 0 | 5.46 | 3.5 | .2 | 20.4 | - 24.1 | 26.7 | 0 | | | |
| Sept. | 0 | 5.30 | 3.3 | .2 | 8.7 | - [illegible] | [illegible] | 0 | | | |
| Oct. | 0 | 4.43 | 3.0 | .2 | 2.5 | - [illegible] | [illegible] | 0 | | | |
| Nov. | 0 | 3.83 | 0.4 | .2 | | - [illegible] | [illegible] | 0 | | | |
| Dec. | 6.4 | 3.32 | 0.2 | .2 | | + [illegible] | [illegible] | 0 | | | |
| TOTAL | 130.8 | 40.29 | 5.8 | 2.4 | 32.3 | | [illegible] | [illegible] | | | |
| 1945 Jan. | 11.5 | 0.71 | 0.8 | 0.2 | | + 11.3 | [illegible] | 0 | | | |
| Feb. | 11.5 | 1.14 | 0.3 | .2 | | + 9.5 | [illegible] | [illegible] | | | |
| Mar. | 6.0 | 2.08 | 0.4 | .2 | | 0 | [illegible] | [illegible] | | | |
| Apr. | 10.1 | 0.89 | 0.1 | .2 | 1.5 | 0 | [illegible] | [illegible] | | | |
| May | 5.4 | 1.34 | 0.4 | .2 | 1.0 | 0 | [illegible] | [illegible] | | | |
| June | 17.3 | 1.99 | 0.6 | .2 | 2.1 | 0 | [illegible] | 14.6 | | | |
| July | 2.2 | 4.84 | 3.3 | .2 | 7.9 | - 7.8 | [illegible] | 0 | | | |
| Aug. | 1.6 | 2.84 | 0.8 | .2 | 4.4 | - 3.8 | 47.8 | 0 | | | |
| Sept. | 0 | 3.33 | 0.8 | .2 | 4.1 | - 5.1 | 40.7 | 0 | | | |
| Oct. | 0 | 4.66 | 3.3 | .2 | 3.7 | - 5.0 | 37.2 | 0 | | | |
| Nov. | 3.0 | 0.65 | 0.4 | .2 | | + 3.0 | 38.7 | 0 | | | |
| Dec. | 3.2 | 1.12 | 0.1 | .2 | | + 3.2 | 38.9 | 0 | | | |
| TOTAL | 60.1 | 28.30 | 7.5 | 2.4 | 25.5 | | [illegible] | 32.2 | | | |
| 1946 Jan. | 7.0 | 1.11 | 0.3 | 0.2 | | + 6.5 | 44.4 | 0 | | | |
| Feb. | 9.5 | 1.27 | 0.1 | .2 | | + 9.0 | 52.4 | 0 | | | |
| Mar. | 34.8 | 0.66 | 0.2 | .2 | | + 1.4 | [illegible] | 30.4 | | | |
| Apr. | 0 | 5.26 | 1.5 | .2 | 7.0 | - 9.6 | 48.2 | 0 | | | |
| May | 13.0 | 1.07 | 0.1 | .2 | 0 | + 9.4 | [illegible] | 3.8 | | | |
| June | 4.3 | 3.68 | 1.1 | .2 | 2.8 | 0 | [illegible] | 0.2 | | | |
| July | 30.7 | 4.26 | 1.2 | .2 | 5.4 | 0 | [illegible] | 23.7 | | | |
| Aug. | 0.7 | 6.26 | 1.7 | .2 | 8.1 | - 9.3 | 48.5 | 0 | | | |
| Sept. | 0 | 3.59 | 0.9 | .2 | 3.8 | - 4.9 | 44.6 | 0 | | | |
| Oct. | 20.8 | - 1.31 | - 0.3 | .2 | 0 | + 20.3 | 59.9 | 0 | | | |
| Nov. | 13.3 | 0.64 | 0.1 | .2 | | + 3.9 | [illegible] | 9.1 | | | |
| Dec. | 8.5 | 1.35 | 0.4 | .2 | | 0 | [illegible] | 7.9 | | | |
| TOTAL | 142.3 | 27.96 | 7.7 | 2.4 | 28.2 | | [illegible] | [illegible] | | | |

151 Table (77) cont.

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Table 77 SWANSON LAKE OPERATION STUDY

Values in 1000 A-F Unless Indicated Otherwise 16,140 Acres

| Year Month | Regulated Inflow into Reservoir | Reservoir Losses: Evap. Rate-In. | Evap. Loss | Seepage | Diversion Req't. | Change in Reservoir Content | Reservoir Content End of Month | Reservoir Spills | Shortage | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1947 Jan. | 8.0 | 0.99 | 0.1 | 0.2 | | 0 | 58.8 | 7.5 | | | |
| Feb. | 14.3 | 1.05 | 0.1 | .2 | | 0 | 58.8 | 13.8 | | | |
| Mar. | 20.7 | 1.54 | 0.4 | .2 | | 0 | 58.8 | 19.9 | | | |
| Apr. | 18.2 | 0.66 | 0.2 | .2 | 0 | 0 | 58.8 | 17.8 | | | |
| May | 20.0 | 1.79 | 0.5 | .2 | 0 | 0 | 58.8 | 19.3 | | | |
| June | 26.0 | - 2.39 | - 0.8 | .2 | 0 | 0 | 58.8 | 26.6 | | | |
| July | 4.6 | 2.28 | 0.7 | .2 | 2.1 | 0 | 58.8 | 1.6 | | | |
| Aug. | 0.4 | 8.28 | 2.3 | .2 | 12.2 | - 14.3 | 44.5 | 0 | | | |
| Sept. | 0 | 5.41 | 1.3 | .2 | 4.8 | - 6.3 | 38.2 | 0 | | | |
| Oct. | - | - | - | - | - | - | - | - | | | |
| Nov. | - | - | - | - | - | - | - | - | | | |
| Dec. | - | - | - | - | - | - | - | - | | | |
| TOTAL | 112.2 | 29.42 | 5.4 | 1.8 | 19.1 | | -20.6 | 106.5 | | | |
| 19 Jan. | | | | | | | | | | | |
| Feb. | | | | | | | | | | | |
| Mar. | | | | | | | | | | | |
| Apr. | | | | | | | | | | | |
| May | | | | | | | | | | | |
| June | | | | | | | | | | | |
| July | | | | | | | | | | | |
| Aug. | | | | | | | | | | | |
| Sept. | | | | | | | | | | | |
| Oct. | | | | | | | | | | | |
| Nov. | | | | | | | | | | | |
| Dec. | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | |
| 19 Jan. | | | | | | | | | | | |
| Feb. | | | | | | | | | | | |
| Mar. | | | | | | | | | | | |
| Apr. | | | | | | | | | | | |
| May | | | | | | | | | | | |
| June | | | | | | | | | | | |
| July | | | | | | | | | | | |
| Aug. | | | | | | | | | | | |
| Sept. | | | | | | | | | | | |
| Oct. | | | | | | | | | | | |
| Nov. | | | | | | | | | | | |
| Dec. | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | |

between Trenton Dam and Bartley would be met by return flows from the Meeker-Driftwood Unit and from the flow of Frenchman Creek. It was assumed that any negative accretions not supplied in this manner would occur below Red Willow Creek, and releases were made in the operation study of the Red Willow Unit to satisfy this demand.

b. Evaporation losses were determined in accordance with the average reservoir content determined from Column 9 of the operation study, and the net monthly evaporation rate, table 76.

c. Seepage was estimated to be 200 acre-feet per month.

3. Reservoir content

   a. The reservoir irrigation storage capacity is 58,800 acre-feet and any water available for storage after this content was reached was spilled.

   b. Releases could be made from the reservoir so that the entire 58,800 acre-feet could be released because there would be no dead storage pool at the end of 50 years of operation.

4. Integration of operation with other units.

   a. No releases from upstream reservoirs were made to help satisfy demands in this unit.

   b. No releases were made to help meet demands of other units downstream.

A column by column explanation of the operation study, table 77, follows:

1. Years. The years through which the operation study was made, 1929 through 1947, are listed in this column.

2. Months. The months for each year are listed in this column.

3. Depleted inflow into the reservoir. This column is the inflow determined in table 62.

4. Evaporation rate in inches. This column is the net evaporation rate for the reservoir area as determined in table 76.

5. Evaporation loss. This column was determined by entering the evaporation chart, exhibit 23, with the average reservoir content, determined from column 9, and reading the indicated loss.

6. Seepage. Seepage is estimated to be 3 second-feet of 200 acre-feet per month.

7. Diversion requirements. This column lists the total diversion requirements of the unit that were determined in table 73.

8. Change in reservoir content. This is obtained by subtracting the evaporation, seepage and diversions, columns 5, 6, and 7 from the reservoir inflow, column 3.

9. Reservoir content at the end of the month. This column is determined by adding algebraically the change in content, column 8, from the content at the end of the previous month.

10. Shows such spill as may be necessary to avoid showing a content at the end of any month, column 9, greater than the capacity of the irrigation pool or greater than 58,800 acre-feet.

11. Shows such shortages as may be necessary to avoid showing a content at the end of any month, column 9, less than zero acre-feet.

Table 78 is a summary of the operation study table 77. This table shows that the reservoir would spill considerable water in every year of the operation study except 1937 and 1940, when the reservoir would not have filled, and 1932 when only 3,000 acre-feet would have spilled. The study indicates there would have been no shortages during the period of study. The full diversion requirement for the unit could have been furnished every year of the study.

Exhibit 24, Reservoir operation chart, gives a graphic representation by months and years of the reservoir inflow, irrigation demands, and reservoir spills for each month, and the reservoir content at the end of each month for the period of study.

Releases for Public Health Service

Useful desirable minimum flows necessary to meet public health requirements as recommended by the Public Health Service 1/ are 4 second-feet at Culbertson, 50 second-feet at McCook, and 10 second-feet at

1/ Kansas River Basin Water Pollution Investigation - Federal Security Agency, Public Health Service, June 1949.

Table 78.—Summary of Reservoir Operations - Swanson Lake

(1000 acre-feet)

| Year | Depleted Inflow | Res. Losses Evap | Res. Losses Seepage | Diversion Requirement | Res. Content End of Year | Spills | Shortage |
|---|---|---|---|---|---|---|---|
| 1928 | - | - | - | - | 58.8 | - | - |
| 1929 | 37.7 | 8.3 | 2.4 | 30.2 | 47.6 | 58.0 | 0 |
| 1930 | 105.1 | 5.8 | 2.4 | 13.8 | 58.8 | 71.9 | 0 |
| 1931 | 64.9 | 9.4 | 2.4 | 26.8 | 39.4 | 45.7 | 0 |
| 1932 | 43.9 | 9.8 | 2.4 | 32.7 | 35.4 | 3.0 | 0 |
| 1933 | 157.2 | 9.0 | 2.4 | 33.5 | 58.8 | 88.9 | 0 |
| 1934 | 42.7 | 9.6 | 2.4 | 48.4 | 7.1 | 34.0 | 0 |
| 1935 | 486.1 | 8.8 | 2.4 | 29.5 | 58.8 | 393.7 | 0 |
| 1936 | 102.2 | 11.1 | 2.4 | 47.6 | 22.9 | 77.0 | 0 |
| 1937 | 65.4 | 9.5 | 2.4 | 40.6 | 35.8 | 0 | 0 |
| 1938 | 99.6 | 8.5 | 2.4 | 33.7 | 58.8 | 32.0 | 0 |
| 1939 | 78.1 | 11.6 | 2.4 | 47.3 | 24.5 | 51.1 | 0 |
| 1940 | 57.4 | 8.4 | 2.4 | 42.0 | 29.1 | 0 | 0 |
| 1941 | 154.5 | 6.0 | 2.4 | 17.4 | 58.8 | 99.0 | 0 |
| 1942 | 165.6 | 6.9 | 2.4 | 20.8 | 58.8 | 135.5 | 0 |
| 1943 | 42.3 | 9.3 | 2.4 | 47.8 | 11.3 | 30.3 | 0 |
| 1944 | 120.9 | 5.8 | 2.4 | 22.3 | 38.2 | 63.5 | 0 |
| 1945 | 69.3 | 7.5 | 2.4 | 25.5 | 39.9 | 32.2 | 0 |
| 1946 | 121.3 | 7.7 | 2.4 | 28.2 | 58.8 | 64.1 | 0 |
| 1947 | 112.2 | 5.4 | 1.8 | 19.1 | 38.2 | 106.5 | 0 |
| Average | 114.5 | 8.3 | 2.4 | 32.0 | 44.2 | 73.0 | 0 |

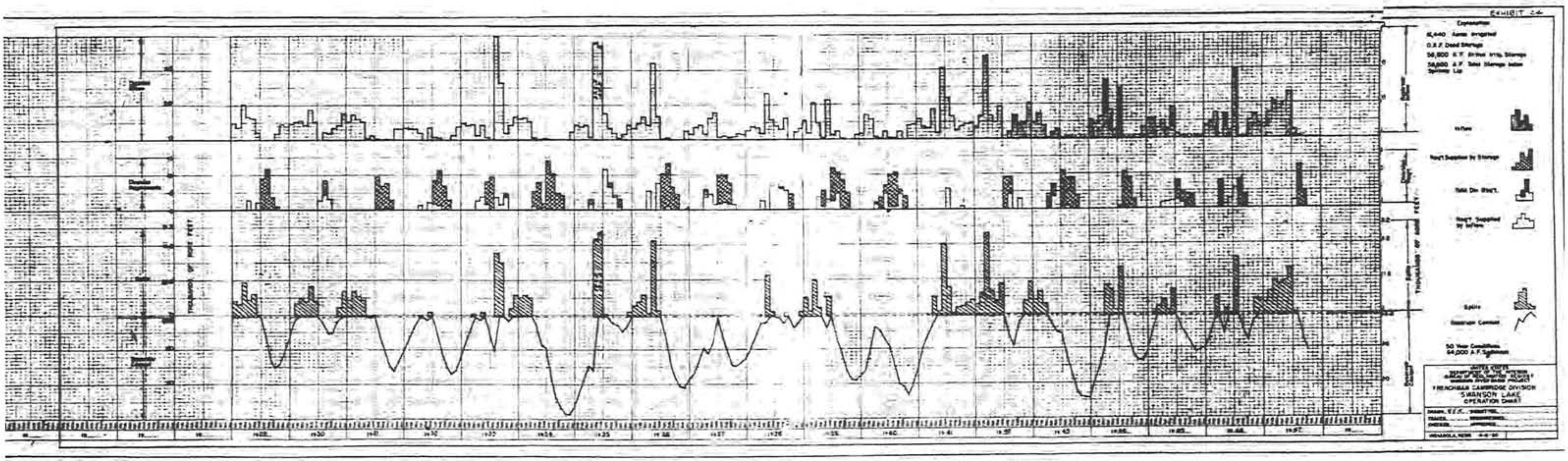


EXHIBIT 24
Explanation
Inflow
Spills
FRENCHMAN CAMBRIDGE DIVISION
SWANSON LAKE
OPERATION CHART

Indianola. The minimum flow requirement for Trenton is not listed. It has been shown in the discussion of the Frenchman Unit that the recommended minimum flow of Frenchman Creek at Culbertson will be met.

The combined flow of Frenchman creek and the Republican River after development plus the return flows from the Frenchman and Meeker-Driftwood Units, table 82, will be available at McCook to meet public health requirements. The minimum 50 second-foot flow at McCook is equal to 3,000 acre-feet per month and table 82 shows this flow would be met throughout the period of study except in September 1930 and August 1947. Because the Public Health Service shows no flow is required to prevent damage at McCook, and because the minimum monthly flow under future conditions is estimated to be greater in months of minimum flow than occurred in those months historically, it is not considered necessary to make reservoir releases to meet public health requirements at McCook.

All flows at McCook are considered to be available at Indianola; therefore there should not be any difficulty in meeting the 10 second-foot public health requirement at Indianola.

Estimated flow passing unit

The estimated flow below Trenton Dam after development is listed in table 79. This flow will result from seepage and spills from the dam. The estimated flow of the Republican River at Culbertson, plus the return flows from the Meeker-Driftwood Unit, table 81, is made up of the return flows from the Meeker-Driftwood Unit, table 64, plus the flow below the dam, table 79, plus the historical gain in flow of the Republican River between Trenton Dam and Culbertson, table 80. This flow plus the flow of Frenchman Creek at Culbertson after development, table 45, is the flow that will be available at McCook to meet public health requirements, table 82.

It is planned to build Bartley Diversion Dam on the Republican River one and one-half miles below Indianola, as a part of the development of the Red Willow Unit. It will be the first point on the Republican River below the Meeker-Driftwood Unit where future diversions are planned. Water available for diversion at this point will consist of the flows as computed in table 82 plus the sectional accretions between Culbertson and Bartley Diversion Dam as computed in the discussion of the Red Willow Unit.

Table 79.—Estimated flow of Republican River below Swanson Lake after development a/

(Unit-1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 9.1 | 6.8 | 19.7 | 9.8 | 12.8 | 1.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 60.4 |
| 1930 | 0.2 | 7.8 | 10.5 | 8.4 | 17.2 | 9.1 | 0.2 | 0.2 | 0.2 | 0.2 | 5.6 | 14.7 | 74.3 |
| 1931 | 9.9 | 11.3 | 12.2 | 9.7 | 0.2 | 0.6 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 48.1 |
| 1932 | 0.2 | 0.2 | 0.2 | 0.4 | 0.2 | 3.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 5.4 |
| 1933 | 0.2 | 0.2 | 2.1 | 0.2 | 2.7 | 0.2 | 0.2 | 36.5 | 30.6 | 0.2 | 5.4 | 12.8 | 91.3 |
| 1934 | 11.8 | 12.6 | 10.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 36.4 |
| 1935 | 0.2 | 0.2 | 0.2 | 0.2 | 193.1 | 197.2 | 0.7 | 0.2 | 0.2 | 0.2 | 0.2 | 3.5 | 396.1 |
| 1936 | 6.6 | 9.0 | 12.9 | 2.2 | 43.7 | 3.8 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 79.4 |
| 1937 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 2.4 |
| 1938 | 0.2 | 0.2 | 0.2 | 0.2 | 23.5 | 3.6 | 0.2 | 0.2 | 2.7 | 0.2 | 0.2 | 3.0 | 34.4 |
| 1939 | 11.0 | 3.4 | 20.5 | 5.4 | 0.2 | 11.8 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 53.5 |
| 1940 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 2.4 |
| 1941 | 0.2 | 0.2 | 0.2 | 11.3 | 3.0 | 40.4 | 16.3 | 1.7 | 5.1 | 5.8 | 8.1 | 9.1 | 101.4 |
| 1942 | 6.7 | 13.0 | 47.2 | 14.2 | 8.6 | 18.7 | 0.2 | 0.2 | 0.2 | 0.2 | 8.7 | 20.0 | 137.9 |
| 1943 | 9.4 | 11.2 | 7.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 32.7 |
| 1944 | 0.2 | 0.2 | 0.2 | 17.8 | 15.2 | 3.3 | 28.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 65.9 |
| 1945 | 0.2 | 1.7 | 5.4 | 8.3 | 3.0 | 14.8 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 34.6 |
| 1946 | 0.2 | 0.2 | 10.6 | 0.2 | 4.0 | 0.4 | 32.9 | 0.2 | 0.2 | 0.2 | 9.3 | 8.1 | 66.5 |
| 1947 | 7.7 | 14.0 | 20.1 | 18.0 | 19.5 | 26.8 | 1.8 | 0.2 | 0.2 | — | — | — | 108.3 |
| Average | 3.9 | 5.2 | 9.5 | 5.6 | 18.3 | 17.7 | 4.3 | 2.2 | 2.2 | 0.5 | 2.2 | 4.1 | 75.7 |

a/ Sum of Spills plus seepage

Table 80.—Historical gain inflow of Republican River between Trenton Dam and Culbertson, Nebr.

(Unit-1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.3 | 0.2 | 0.8 | 0.6 | 0.6 | 0.3 | 0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 4.2 |
| 1930 | 0.3 | 0.4 | 0.4 | 0.4 | 0.6 | 0.5 | 0.1 | 0.4 | 0.3 | 0.4 | 0.3 | 0.5 | 4.6 |
| 1931 | 0.4 | 0.5 | 0.4 | 0.4 | 0.2 | 0.2 | 0 | 0.1 | 0 | 0.1 | 0.3 | 0.4 | 3.0 |
| 1932 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.2 | 0.3 | 0 | 0.2 | 0.3 | 0.3 | 3.3 |
| 1933 | 0.4 | 0.3 | 0.4 | 0.3 | 0.5 | 0.1 | 0.1 | 2.7 | 1.3 | 0.3 | 0.3 | 0.4 | 7.1 |
| 1934 | 0.4 | 0.4 | 0.4 | 0.3 | 0.1 | 0.3 | 0 | 0 | 0 | 0 | 0.2 | 0.4 | 2.5 |
| 1935 | 0.4 | 0.4 | 0.5 | 0.3 | 8.6 | 7.2 | 0.8 | 0.5 | 0.3 | 0.1 | 0.2 | 0.4 | 19.7 |
| 1936 | 0.3 | 0.4 | 0.5 | 0.5 | 1.6 | 0.7 | 0 | 0.1 | 0 | 0.1 | 0.2 | 0.3 | 4.7 |
| 1937 | 0.2 | 0.3 | 0.5 | 0.4 | 0.7 | 0.8 | 0.1 | 0.1 | 0.3 | 0.2 | 0.2 | 0.2 | 4.0 |
| 1938 | 0.3 | 0.4 | 0.4 | 0.4 | 1.1 | 0.7 | 0.6 | 0.4 | 0.8 | 0.1 | 0.2 | 0.3 | 5.7 |
| 1939 | 0.4 | 0.1 | 0.7 | 0.4 | 0.1 | 1.0 | 0.2 | 0.2 | 0 | 0 | 0.1 | 0.2 | 3.4 |
| 1940 | 0.2 | 0.7 | 0.6 | 0.3 | 0.1 | 0.2 | 0 | 0 | 0.4 | 0.1 | 0.4 | 0.5 | 3.5 |
| 1941 | 0.6 | 0.3 | 0.4 | 0.8 | 0.3 | 1.7 | 1.2 | 0.8 | 0.3 | 0.4 | 0.4 | 0.3 | 7.5 |
| 1942 | 0.3 | 0.5 | 1.7 | 0.5 | 0.5 | 0.8 | 0.1 | 0.6 | 0.6 | 0.4 | 0.4 | 0.7 | 7.1 |
| 1943 | 0.3 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 2.2 |
| 1944 | 0.6 | 0.6 | 0.6 | 1.4 | 0.7 | 0.3 | 1.2 | 0.1 | 0 | 0.1 | 0.2 | 0.4 | 6.2 |
| 1945 | 0.5 | 0.5 | 0.3 | 0.4 | 0.3 | 0.8 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 3.8 |
| 1946 | 0.3 | 0.4 | 0.5 | 0.2 | 0.6 | 0.3 | 1.7 | 0 | 0 | 0.5 | 0.6 | 0.5 | 5.6 |
| 1947 | 2.8 | 2.6 | 1.6 | -3.6 | 0 | -3.1 | 3.4 | 0.1 | 0 | - | - | - | 3.8 |
| Avg. | 0.5 | 0.5 | 0.6 | 0.2 | 0.9 | 0.7 | 0.5 | 0.4 | 0.2 | 0.2 | 0.3 | 0.4 | 5.4 |

Table 81.—Estimated flow of Republican River at Culbertson after upstream development plus return flows from Meeker-Driftwood Unit

(unit-1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 10.0 | 7.5 | 21.0 | 10.9 | 13.9 | 1.9 | 0.9 | 1.1 | 1.3 | 1.4 | 1.3 | 1.2 | 72.4 |
| 1930 | 1.0 | 8.7 | 11.4 | 8.9 | 18.0 | 9.8 | 0.5 | 0.8 | 0.8 | 0.8 | 6.1 | 15.4 | 82.2 |
| 1931 | 10.5 | 14.9 | 12.7 | 10.5 | 0.9 | 1.3 | 0.8 | 1.1 | 1.0 | 1.1 | 1.1 | 1.1 | 57.0 |
| 1932 | 1.1 | 0.9 | 0.9 | 1.2 | 1.1 | 4.1 | 1.2 | 1.5 | 1.2 | 1.4 | 1.3 | 1.2 | 17.1 |
| 1933 | 1.2 | 1.0 | 3.0 | 1.1 | 3.9 | 1.1 | 1.1 | 40.2 | 33.0 | 1.5 | 6.6 | 14.0 | 107.7 |
| 1934 | 12.9 | 13.6 | 11.2 | 1.3 | 1.2 | 1.5 | 1.4 | 1.6 | 1.8 | 1.6 | 1.6 | 1.6 | 51.3 |
| 1935 | 1.5 | 1.4 | 1.5 | 1.1 | 202.3 | 205.1 | 2.3 | 1.7 | 1.6 | 1.3 | 1.2 | 4.6 | 425.6 |
| 1936 | 7.5 | 10.0 | 14.0 | 3.5 | 46.3 | 5.6 | 1.5 | 1.9 | 1.9 | 1.9 | 1.7 | 1.6 | 97.4 |
| 1937 | 1.4 | 1.3 | 1.5 | 1.2 | 1.7 | 1.9 | 1.3 | 1.5 | 1.8 | 1.6 | 1.4 | 1.3 | 17.9 |
| 1938 | 1.3 | 1.3 | 1.2 | 1.1 | 25.2 | 5.0 | 1.6 | 1.6 | 4.6 | 1.3 | 1.2 | 4.0 | 49.4 |
| 1939 | 12.0 | 4.1 | 21.7 | 6.6 | 1.2 | 13.8 | 1.6 | 1.8 | 1.8 | 1.6 | 1.5 | 1.5 | 69.2 |
| 1940 | 1.3 | 1.7 | 1.6 | 1.1 | 1.1 | 1.3 | 1.2 | 1.4 | 1.9 | 1.5 | 1.6 | 1.6 | 17.3 |
| 1941 | 1.6 | 1.2 | 1.2 | 12.4 | 3.6 | 42.4 | 17.8 | 3.0 | 5.9 | 6.7 | 8.9 | 9.7 | 114.4 |
| 1942 | 7.3 | 13.8 | 49.2 | 15.0 | 9.5 | 20.0 | 0.8 | 1.4 | 1.5 | 1.2 | 9.6 | 21.2 | 150.5 |
| 1943 | 10.1 | 15.1 | 8.0 | 1.3 | 1.5 | 1.6 | 1.4 | 1.7 | 1.8 | 1.7 | 1.5 | 1.4 | 47.1 |
| 1944 | 1.8 | 1.6 | 1.6 | 19.5 | 16.3 | 4.0 | 29.7 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 | 79.1 |
| 1945 | 1.1 | 2.5 | 6.0 | 9.1 | 3.7 | 16.1 | 1.0 | 1.1 | 1.1 | 1.1 | 1.0 | 0.8 | 44.6 |
| 1946 | 1.0 | 1.0 | 11.3 | 0.8 | 5.1 | 1.3 | 35.3 | 1.0 | 1.1 | 1.5 | 10.6 | 9.2 | 79.4 |
| 1947 | 11.0 | 17.1 | 22.2 | 14.7 | 19.9 | 24.2 | 5.7 | 0.9 | 0.9 | - | - | - | 116.6 |
| Avg. | 5.0 | 6.2 | 10.6 | 6.4 | 19.8 | 19.1 | 5.6 | 3.5 | 3.5 | 1.2 | 3.3 | 5.1 | 89.8 |

Table 82.—Combined Flows of Frenchman Creek and Republican River and return flows from Frenchman and Meeker-Driftwood Units after all upstream development

(Unit - 1,000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 18.6 | 17.2 | 33.3 | 16.2 | 26.2 | 6.4 | 4.0 | 3.0 | 3.5 | 6.2 | 6.5 | 8.2 | 149.3 |
| 1930 | 8.5 | 14.1 | 17.3 | 16.4 | 31.7 | 18.3 | 5.5 | 3.1 | 1.3 | 9.2 | 16.5 | 24.8 | 166.7 |
| 1931 | 19.5 | 23.5 | 21.7 | 19.1 | 9.2 | 6.7 | 3.1 | 4.1 | 3.3 | 3.9 | 5.8 | 6.2 | 126.1 |
| 1932 | 5.9 | 5.6 | 10.9 | 9.2 | 9.0 | 11.4 | 3.3 | 4.0 | 2.8 | 3.7 | 5.9 | 5.3 | 77.0 |
| 1933 | 7.1 | 7.5 | 11.9 | 4.9 | 7.1 | 2.8 | 2.8 | 43.4 | 40.5 | 4.4 | 12.2 | 24.8 | 169.4 |
| 1934 | 24.9 | 24.6 | 22.2 | 4.1 | 4.9 | 4.7 | 3.8 | 3.9 | 5.0 | 4.4 | 5.7 | 7.4 | 115.6 |
| 1935 | 8.0 | 6.7 | 8.0 | 3.6 | 234.2 | 228.5 | 5.1 | 3.8 | 4.4 | 4.0 | 5.4 | 9.7 | 521.4 |
| 1936 | 12.7 | 20.1 | 25.8 | 6.4 | 58.5 | 8.6 | 3.5 | 3.9 | 4.2 | 4.0 | 5.1 | 7.1 | 159.9 |
| 1937 | 4.9 | 6.0 | 6.6 | 3.9 | 3.8 | 8.1 | 3.5 | 3.4 | 3.9 | 3.9 | 5.7 | 6.4 | 60.1 |
| 1938 | 6.9 | 6.4 | 6.1 | 3.7 | 35.8 | 9.3 | 4.2 | 3.8 | 7.5 | 3.5 | 5.1 | 8.5 | 100.8 |
| 1939 | 17.5 | 8.8 | 31.8 | 9.8 | 3.7 | 16.8 | 4.2 | 3.9 | 4.0 | 4.0 | 5.3 | 5.0 | 114.8 |
| 1940 | 4.8 | 7.8 | 8.8 | 4.2 | 4.0 | 10.0 | 4.0 | 4.2 | 5.0 | 4.9 | 6.7 | 10.3 | 74.7 |
| 1941 | 8.4 | 7.5 | 8.0 | 23.6 | 13.3 | 54.3 | 20.2 | 4.6 | 8.8 | 11.5 | 14.1 | 19.2 | 193.5 |
| 1942 | 16.4 | 24.0 | 61.7 | 27.9 | 24.1 | 34.4 | 3.6 | 3.8 | 8.1 | 4.4 | 14.5 | 26.7 | 249.6 |
| 1943 | 19.2 | 25.1 | 18.9 | 4.3 | 4.0 | 4.7 | 3.7 | 4.0 | 4.2 | 4.9 | 6.2 | 6.5 | 105.7 |
| 1944 | 6.5 | 7.8 | 8.7 | 30.1 | 29.1 | 15.3 | 35.0 | 3.0 | 3.0 | 3.6 | 6.1 | 6.0 | 154.2 |
| 1945 | 5.8 | 8.3 | 15.4 | 15.6 | 10.8 | 24.6 | 3.6 | 3.6 | 3.9 | 4.0 | 6.1 | 8.9 | 110.6 |
| 1946 | 11.1 | 10.4 | 22.0 | 3.5 | 10.3 | 6.2 | 38.2 | 3.0 | 4.2 | 11.3 | 17.7 | 19.7 | 157.6 |
| 1947 | 21.2 | 27.0 | 33.1 | 24.8 | 30.8 | 38.4 | 13.9 | 2.7 | 3.0 | - | - | - | 194.9 |
| Avg. | 22.8 | 13.6 | 19.6 | 12.2 | 29.0 | 26.8 | 8.7 | 5.7 | 6.3 | 5.3 | 8.4 | 11.7 | 159.3 |

Meeker-Driftwood Unit

Requirements for fish and wildlife

No water releases from the reservoirs for requirements of fish have been made in this study. In the past the Republican River has dried up during extremely dry seasons. Seepage from the dams and return flows from irrigated lands are expected to establish a live stream at all times. It is anticipated that the minimum flow requirements for public health will be sufficient for fish habitat requirements.

Summary

Reservoir operation studies for the period 1929-1947 in this Appendix indicate that the water supply would have been adequate to irrigate 16,400 acres in the Meeker-Driftwood Unit by use of Swanson Lake. Spills would have occurred every year except 1937 and 1940. There would have been no shortages.

CHAPTER IV

# R E D W I L L O W U N I T

## General Plan for Development

The Red Willow Unit, comprising 11,990 acres of irrigable lands, is outlined in exhibit 2. This unit lies along Red Willow Creek and the section of the Republican River between the confluence of Red Willow Creek and Cambridge Diversion Dam east of Cambridge, Nebraska. Irrigation development will be accomplished by using water stored during winter and spring behind Red Willow Dam and by using the summer flow available from the Red Willow Creek and the Republican River. It is planned that the Corps of Engineers will construct the Red Willow Dam.

The plan for delivery of irrigation water to this area calls for construction of 2 diversion dams. The Red Willow Creek Diversion Dam would be constructed on Red Willow Creek at a point approximately 5 miles above the confluence of the creek and the Republican River. Bartley Diversion Dam would be constructed on the Republican River approximately 1½ miles east of Indianola. The Red Willow Creek Diversion Dam will divert water into the McCook Canal which will serve a small area on the west side of Red Willow Creek and also divert water into the Red Willow Canal which will serve the area east of the creek and north of the Republican River as far east as Cambridge. Bartley Diversion Dam would divert water into Bartley Canal which will serve the area on the south side of the Republican River.

Table 83. Capacity and length of canals in the Red Willow Unit

| Name | Initial capacity cfs | Length miles |
|---|---|---|
| McCook Canal | 18 | 5.3 |
| Red Willow Canal | 100 | 21.7 |
| Bartley Canal | 130 | 19.8 |

### Reservoir capacity

Water supply studies presented in this Appendix were based upon an active irrigation storage capacity in Red Willow Reservoir of 18,000 acre-feet. This is the size of the irrigation pool at the end of 50 years of operation when 8,500 acre-feet of sediment would be accumulated. Table 84 lists the distribution of the storage capacity in the reservoir for initial 50-year and 100-year conditions that would result from the accumulation of sediment.

### Areas served

There are 11,990 acres in the Red Willow Unit which would be served water under this plan of development. There are 823 acres which are presently irrigated from wells. There are an additional

Table 84.—Red Willow Reservoir Storage Capacities

| Storage Distribution | Elev. Ft. | Initial conditions acre-feet | | 50-year conditions (8,500 ac-ft Sediment) acre-feet | | 100-year conditions (17,000 ac-ft Sediment) acre-feet | |
|---|---|---|---|---|---|---|---|
| | | Accumulative | Allocated | Accumulative | Allocated | Accumulative | Allocated |
| Dead storage | | | 300 | | 0 | | 0 |
| Canal outlet | | 300 | | 0 | | 0 | |
| Active irrigation storage | | | 26,200 | | 18,000 | | 9,500 |
| Irrigation storage pool top | 2,544.5 | 26,500 | | 18,000 | | 9,500 | |
| Flood control storage | | | 22,000 | | 22,000 | | 22,000 |
| Top of flood control pool | 2,559.0 | 48,500 | | 40,000 | | 31,500 | |
| Total capacity | | | 48,500 | | 40,000 | | 31,500 |

2,101 acres which are or can be irrigated from existing wells which have not been included in the area to be served because they have petitioned to be excluded from the Frenchman-Cambridge Irrigation District. The irrigable area to be served in the Red Willow Unit has been determined from land classification surveys. The acreages under the McCook Canal and under the upper portion of the Red Willow Canal were determined by a reconnaissance survey. Acreages to be served by the lower portion of the Red Willow Canal and by the Bartley Canal were determined from detailed land classification maps.

Table 85. Acreages to be served by canals in the Red Willow Unit

| Name | Acres presently irrigated | New lands | Total |
|---|---|---|---|
| McCook Canal | | 600 | 600 |
| Red Willow Canal | 384 | 3,976 | 4,360 |
| Bartley Canal | 439 | 6,591 | 7,030 |
| Total | 823 | 11,167 | 11,990 |

## Water Resources

Water stored in Red Willow Reservoir would be the main source of water for development of irrigation in this unit under this proposed plan for development. No use of ground water is planned to carry out this proposed development. The accretion in flow of Red Willow Creek between the reservoir site and Red Willow Creek Diversion Dam would be available for diversion at the Red Willow Creek Diversion Dam during the irrigation season. On the Republican River the water passing Culbertson including return flows from the development of the Meeker-Driftwood Unit and the Frenchman Unit as indicated in table 82 would be available for diversion at the proposed Bartley Diversion Dam during the irrigation season. In addition there will be divertable at the Bartley Diversion Dam the historic accretions in flows of the Republican River between Culbertson and Bartley Diversion Dam plus the return flows from 2,610 acres in the Red Willow Unit.

### Available stream-flow records

The following historic records of flow were used in computing the water available at the various points in the unit or in extending the flow records at stations where records were not available for the complete period of study: Red Willow Creek north of McCook at Red Willow Dam Site, Red Willow Creek at the mouth, Medicine Creek at the mouth, Frenchman Creek at the mouth, Republican River at Culbertson and Republican River at Cambridge. The period of record for these stations is shown graphically on exhibit 3. The period of record, type of gage, average flow, and other pertinent data are listed for these stations in table 1.

## Red Willow Unit

### Stream-flow correlation and estimates

Historical records of stream flow at the Red Willow Dam Site, table 86, are available for the period October 1940 through May 1947. The flows for the period October 1928 through September 1931; October 1939 through September 1940; and for June 1947 through September 1947 are estimated flows based upon a correlation with Red Willow Creek near Red Willow, exhibit 25. The historical flows of Red Willow Creek near Red Willow are listed in table 87. Flows for the period October 1931 through September 1936 are estimates based upon a correlation, exhibit 26, with the historical flow of Frenchman Creek at Culbertson, table 7. Flows for the period October 1936 through September 1939 are estimates based upon a correlation, exhibit 27, with historical flows of Medicine Creek at Cambridge, table 123. The runoff of Red Willow Creek near Red Willow (at the mouth), table 87, is based upon historical records except for the period October 1931 through September 1939. Flows for the period October 1931 through September 1936 are estimated flows based upon a correlation, exhibit 28, estimated virgin flows of Frenchman Creek at Culbertson, table 122. Flows for the period October 1936 through September 1939 are based upon a correlation, exhibit 29, with historic flows of Medicine Creek at Cambridge, table 123.

Historical records of the flow of Frenchman Creek at Culbertson, table 7, are available for the entire period of study, and historical records of the Republican River at Cambridge, table 125, are available from 1942 with missing periods being filled in by correlation with Republican River at Bloomington less flows of Sappa and Prairie Dog Creeks. This correlation is described in the Cambridge Unit discussion.

### Ground water

Information supplied in the Nebraska Water Resources Survey Water Supply Paper 1, part III, indicates that the ground-water conditions for the Red Willow Unit area are similar to those described for the area of the Meeker-Driftwood Unit.

The water table in the valley of the Republican River is at a relatively shallow depth, ranging from about 4 to 20 feet below the surface of the ground. Conditions in the valley are favorable for direct recharge to the ground-water reservoir from stream flow; however ground-water supplies in the areas north and south of the Republican River Valley are not considered adequate for extensive irrigation pumping developments.

A profile of a stream section of Red Willow Creek is shown in exhibit 19. A profile of the Republican River at Bartley, Nebraska, is shown in exhibit 30. There are a total of 81 existing ground-water observation wells in the irrigable lands of the Red Willow Unit. In May and June of 1950, 59 of these wells were added by the Geological Survey at the request of the Bureau of Reclamation. Eight

Table 86.--Historical runoff of Red Willow Creek North of McCook at Red Willow Dam Site a/

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Discharge in 1,000 acre-feet | | | | | | | |
| 1929 | 1.0 | 1.1 | 1.2 | 0.9 | 0.6 | 1.6 | 1.6 | 1.9 | 2.4 | 1.0 | 0.2 | 0.5 | 14.0 |
| 1930 | 0.6 | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.9 | 2.6 | 1.6 | 1.9 | 1.1 | 0.9 | 16.6 |
| 1931 | 2.4 | 2.3 | 1.4 | 1.9 | 1.6 | 1.9 | 1.8 | 1.4 | 1.1 | 1.1 | 1.9 | 0.5 | 19.3 |
| 1932 | 0.8 | 1.4 | 1.5 | 1.5 | 1.6 | 2.4 | 1.4 | 2.3 | 3.2 | 1.2 | 1.6 | 0.5 | 19.4 |
| 1933 | 0.7 | 1.0 | 1.3 | 1.9 | 1.9 | 2.2 | 1.3 | 2.6 | 0.6 | 0.6 | 3.2 | 4.3 | 21.6 |
| 1934 | 1.1 | 1.0 | 2.1 | 2.0 | 1.8 | 1.8 | 1.2 | 0.8 | 3.7 | 1.0 | 0.7 | 1.8 | 19.0 |
| 1935 | 0.7 | 0.8 | 1.6 | 1.8 | 1.5 | 1.9 | 1.1 | 5.5 | 5.3 | 2.9 | 0.9 | 2.3 | 26.3 |
| 1936 | 0.8 | 1.2 | 1.5 | 1.6 | 1.7 | 2.0 | 1.3 | 3.6 | 2.7 | 0.7 | 0.5 | 0.7 | 18.3 |
| 1937 | 0.8 | 0.9 | 0.8 | 0.8 | 0.9 | 1.2 | 0.9 | 0.9 | 2.1 | 1.4 | 1.8 | 0.9 | 13.4 |
| 1938 | 0.8 | 0.9 | 0.9 | 0.9 | 0.9 | 1.2 | 1.2 | 2.3 | 1.3 | 2.6 | 0.8 | 0.8 | 14.6 |
| 1939 | 0.6 | 0.7 | 0.7 | 0.8 | 0.7 | 1.2 | 1.6 | 0.9 | 3.1 | 1.1 | 0.9 | 0.4 | 12.7 |
| 1940 | 0.6 | 0.8 | 0.8 | 0.7 | 0.9 | 1.6 | 1.6 | 1.1 | 3.3 | 1.0 | 0.8 | 1.0 | 14.2 |
| 1941 | 0.8 | 1.0 | 1.3 | 1.6 | 1.4 | 1.5 | 1.7 | 2.2 | 7.5 | 2.6 | 0.8 | 3.5 | 25.9 |
| 1942 | 1.7 | 1.4 | 1.3 | 1.4 | 1.5 | 3.2 | 4.7 | 2.7 | 5.0 | 1.2 | 1.0 | 4.1 | 29.2 |
| 1943 | 1.2 | 1.3 | 1.6 | 1.4 | 1.4 | 1.6 | 1.7 | 1.3 | 1.5 | 0.9 | 0.5 | 0.4 | 14.8 |
| 1944 | 0.8 | 1.2 | 1.1 | 1.2 | 1.6 | 2.2 | 4.1 | 2.2 | 2.2 | 5.0 | 2.8 | 0.8 | 25.2 |
| 1945 | 0.8 | 1.2 | 1.5 | 1.4 | 1.8 | 1.6 | 1.6 | 2.4 | 6.1 | 0.8 | 1.8 | 2.1 | 23.1 |
| 1946 | 1.2 | 1.2 | 1.1 | 0.9 | 1.1 | 2.0 | 1.3 | 3.4 | 1.9 | 1.4 | 0.9 | 1.9 | 18.3 |
| 1947 | 5.3 | 1.8 | 1.5 | 1.5 | 1.6 | 1.8 | 2.1 | 1.5 | 10.2 | 2.0 | 0.8 | 0.7 | 30.8 |
| Total Avg. | 1.2 | 1.2 | 1.3 | 1.3 | 1.4 | 1.8 | 1.8 | 2.2 | 3.4 | 1.6 | 1.2 | 1.5 | 19.9 |

a/ October 1928 through September 1931; October 1939 through September 1940 and June through September 1947 based on correlation with Red Willow Creek near Red Willow. October 1931 through September 1936 based on correlation with Frenchman Creek at Culbertson. October 1936 through September 1939 based on correlation with Medicine Creek at Cambridge. October 1940 through May 1947 are records.

Table 87.--Historical Run-off of Red Willow Creek near Red Willow at Mouth. a/ Discharge in 1,000 acre-feet.

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.2 | 1.4 | 1.5 | 1.1 | 0.6 | 2.0 | 2.0 | 2.4 | 3.2 | 1.2 | 0.1 | 0.5 | 17.2 |
| 1930 | 0.7 | 1.1 | 1.2 | 1.4 | 1.6 | 1.8 | 2.4 | 3.5 | 2.1 | 2.5 | 1.7 | 1.1 | 21.1 |
| 1931 | 3.1 | 3.0 | 1.8 | 2.5 | 2.1 | 2.5 | 2.3 | 1.8 | 1.3 | 1.4 | 2.4 | 0.5 | 24.7 |
| 1932 | 1.3 | 2.2 | 2.3 | 2.4 | 2.5 | 3.2 | 2.3 | 1.4 | 2.2 | 1.3 | 1.8 | 0.9 | 23.8 |
| 1933 | 1.0 | 1.5 | 2.0 | 2.8 | 2.8 | 3.1 | 2.3 | 1.8 | 1.0 | 1.0 | 2.3 | 3.2 | 24.8 |
| 1934 | 2.1 | 1.4 | 3.0 | 2.9 | 2.7 | 2.7 | 1.9 | 1.2 | 2.6 | 1.3 | 1.1 | 1.4 | 24.3 |
| 1935 | 1.0 | 1.0 | 2.5 | 2.7 | 2.3 | 2.8 | 2.0 | 7.5 | 5.7 | 2.4 | 1.2 | 1.5 | 32.6 |
| 1936 | 1.3 | 2.0 | 2.4 | 2.5 | 2.6 | 2.9 | 2.4 | 2.5 | 2.1 | 1.0 | 1.0 | 1.0 | 23.7 |
| 1937 | 1.0 | 1.2 | 1.0 | 0.9 | 1.2 | 1.7 | 1.2 | 1.2 | 2.8 | 2.0 | 2.4 | 1.1 | 17.7 |
| 1938 | 1.0 | 1.3 | 1.3 | 1.1 | 1.2 | 1.7 | 1.7 | 3.2 | 1.7 | 3.5 | 1.1 | 1.0 | 19.8 |
| 1939 | 0.6 | 0.9 | 0.8 | 1.0 | 0.9 | 1.7 | 2.2 | 1.2 | 4.2 | 1.5 | 1.2 | 0.3 | 16.5 |
| 1940 | 0.6 | 0.9 | 0.9 | 0.8 | 1.0 | 2.0 | 2.1 | 1.4 | 4.5 | 1.2 | 0.9 | 1.2 | 17.5 |
| 1941 | 1.0 | 1.2 | 1.6 | 2.9 | 1.7 | 1.8 | 2.3 | 2.9 | 10.2 | 3.1 | 1.2 | 6.2 | 36.1 |
| 1942 | 2.9 | 1.6 | 1.7 | 1.8 | 1.9 | 3.9 | 5.6 | 3.4 | 6.6 | 1.6 | 1.4 | 4.7 | 37.1 |
| 1943 | 1.5 | 1.6 | 1.9 | 1.7 | 1.7 | 1.9 | 2.0 | 1.5 | 1.9 | 1.4 | 1.4 | 0.5 | 19.0 |
| 1944 | 1.0 | 1.4 | 1.1 | 1.4 | 1.8 | 2.4 | 5.4 | 3.2 | 2.9 | 6.3 | 3.7 | 1.0 | 31.6 |
| 1945 | 1.1 | 1.5 | 1.8 | 1.8 | 2.1 | 1.9 | 1.8 | 3.9 | 8.8 | 1.2 | 3.4 | 3.4 | 32.7 |
| 1946 | 1.5 | 1.5 | 1.5 | 1.4 | 1.3 | 2.4 | 1.6 | 3.9 | 2.7 | 2.2 | 1.2 | 2.3 | 23.5 |
| 1947 | 9.6 | 2.3 | 1.8 | 1.6 | 1.8 | 2.1 | 2.4 | 1.8 | 13.6 | 2.7 | 1.1 | 0.9 | 41.7 |
| Avg. 1929-47 | 1.8 | 1.5 | 1.7 | 1.8 | 1.8 | 2.3 | 2.4 | 2.6 | 4.2 | 2.1 | 1.6 | 1.7 | 25.5 |

a/ October 1928 through September 1931; October 1939 through September 1947 are records.
October 1932 through September 1936 based on a correlation with Frenchman Creek at Culbertson.
October 1936 through September 1939 based on a correlation with Medicine Creek at Cambridge.

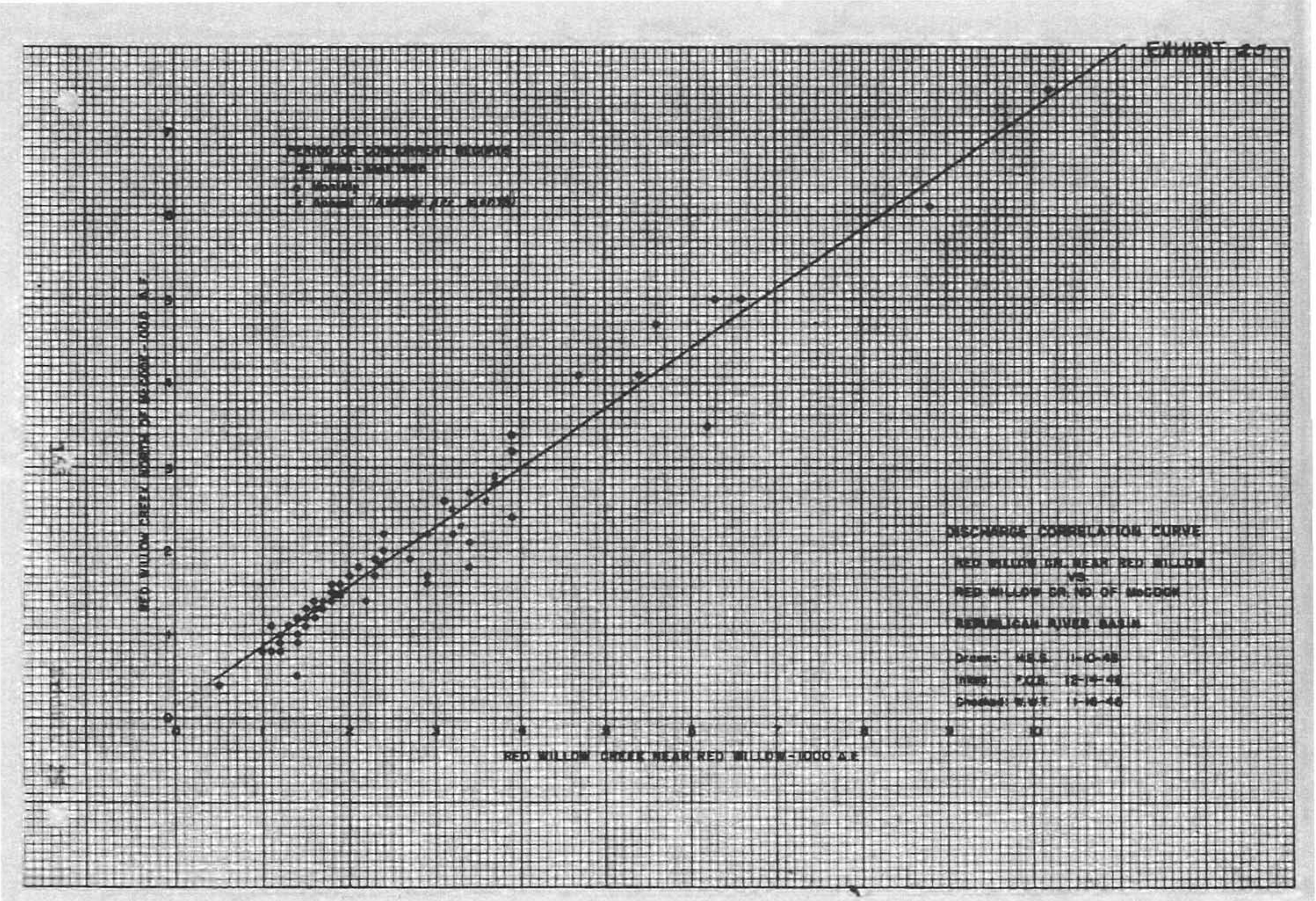


EXHIBIT 25
PERIOD OF CONCURRENT RECORDS
Monthly
Annual
DISCHARGE CORRELATION CURVE
RED WILLOW CR. NEAR RED WILLOW
VS.
RED WILLOW CR. NO OF McCOOK
REPUBLICAN RIVER BASIN
Drawn: M.E.S. 11-10-48
Traced: P.O.S. 12-14-48
Checked: W.W.T. 11-16-48
RED WILLOW CREEK NEAR RED WILLOW-1000 A.F.
RED WILLOW CREEK NORTH OF McCOOK-1000 A.F.

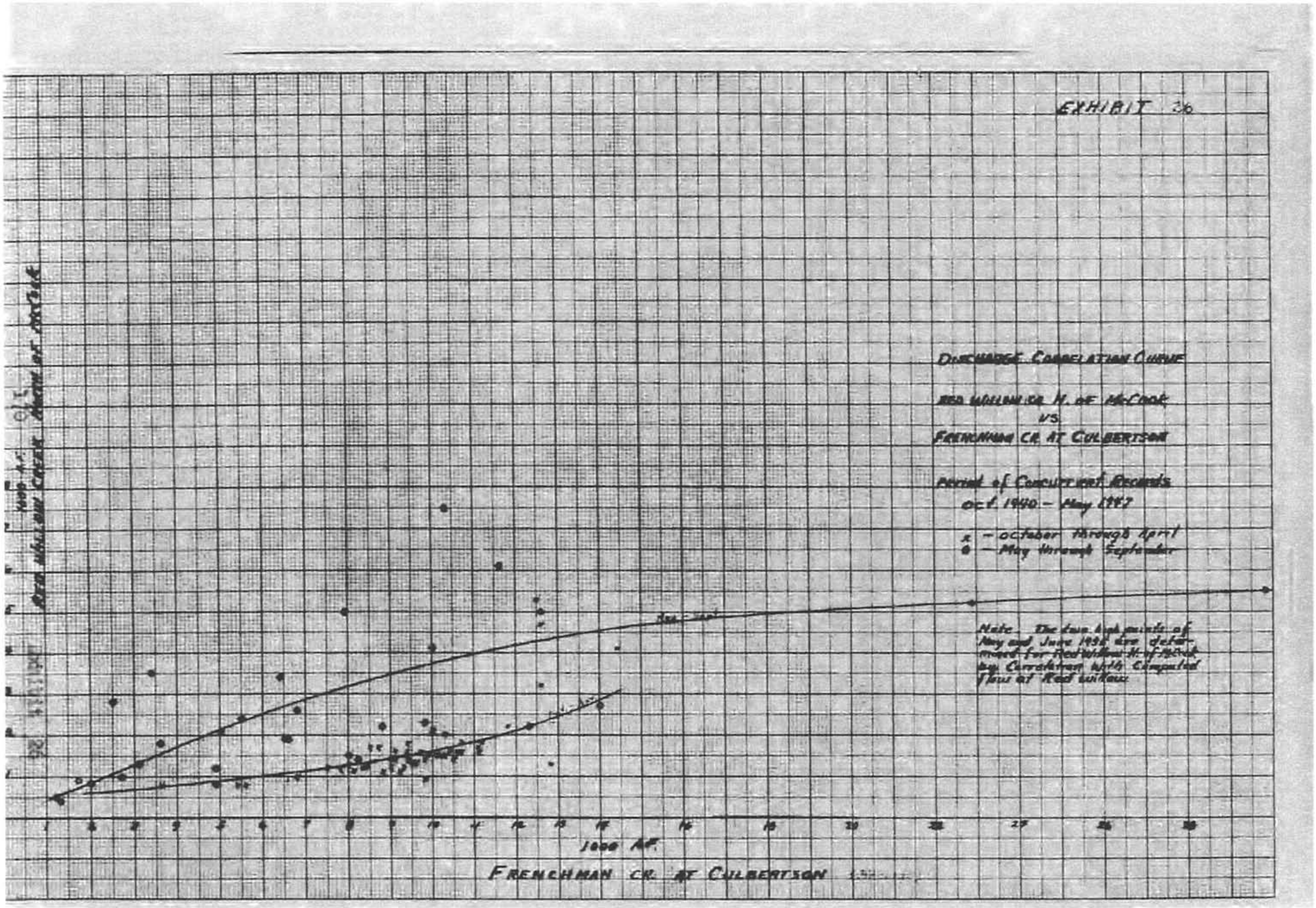
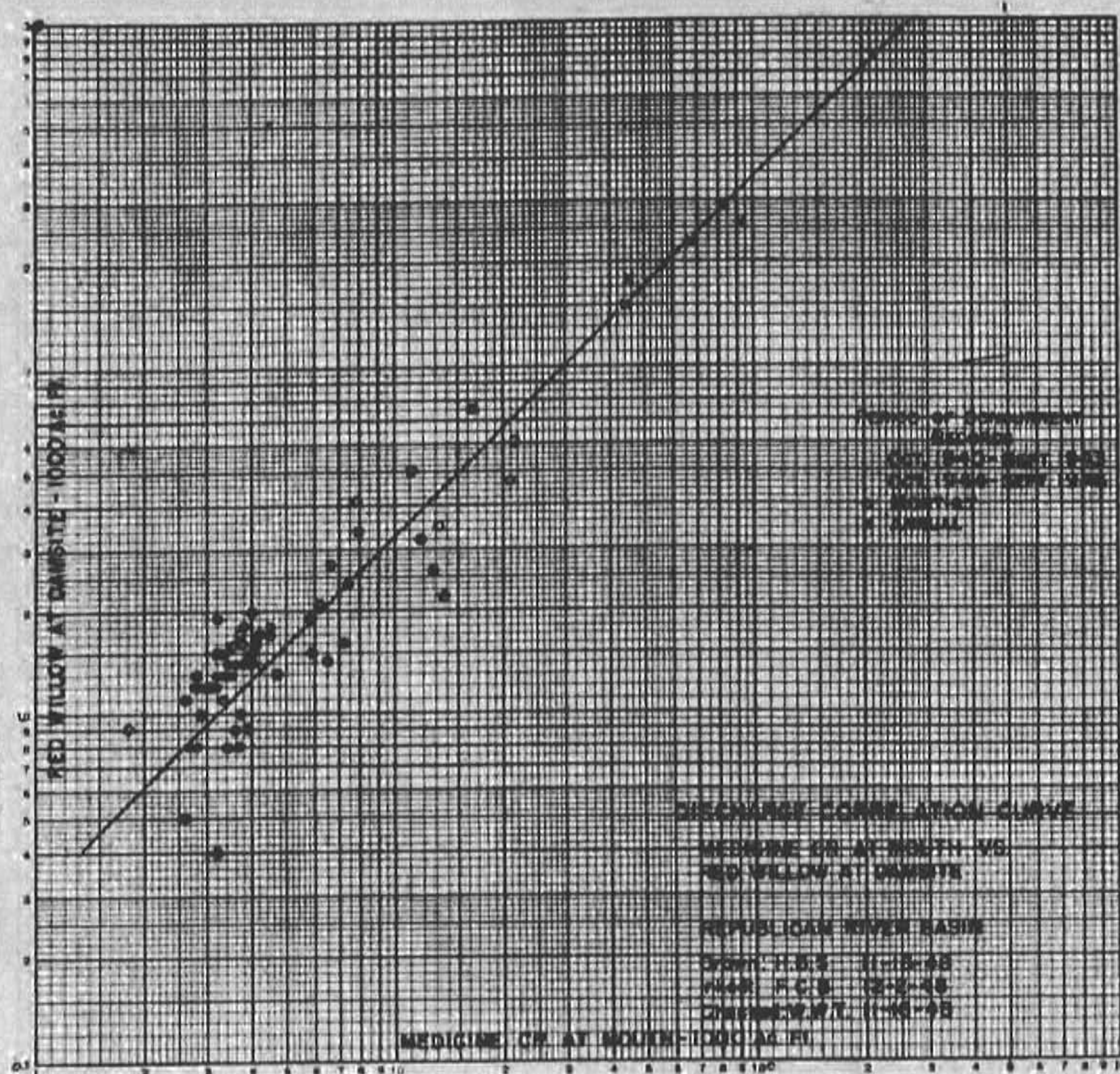


EXHIBIT 36
DISCHARGE CORRELATION CURVE
RED WILLOW CR. N. OF McCOOK
VS.
FRENCHMAN CR. AT CULBERTSON
Period of Concurrent Records
Oct. 1940 – May 1947
x – October through April
● – May through September
Note. The two high points of May and June 1938 are determined for Red Willow N. of McCook by Correlation with Computed flow at Red Willow
1000 AF.
FRENCHMAN CR. AT CULBERTSON

EXHIBIT 27


RED WILLOW AT DAMSITE - 1000 AC. FT.
DISCHARGE CORRELATION CURVE
MEDICINE CR. AT MOUTH VS.
RED WILLOW AT DAMSITE
REPUBLICAN RIVER BASIN
MEDICINE CR. AT MOUTH - 1000 AC. FT.

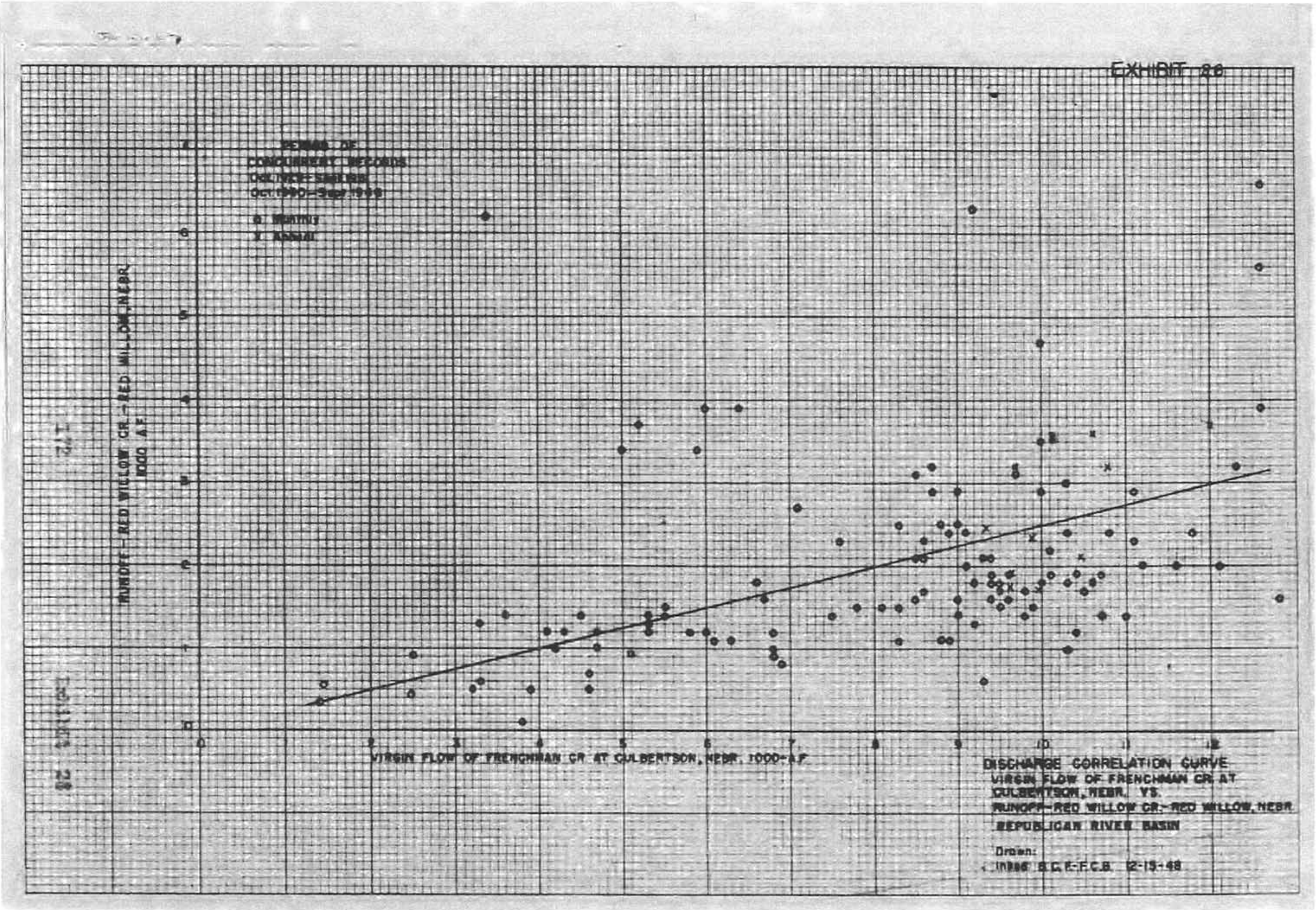
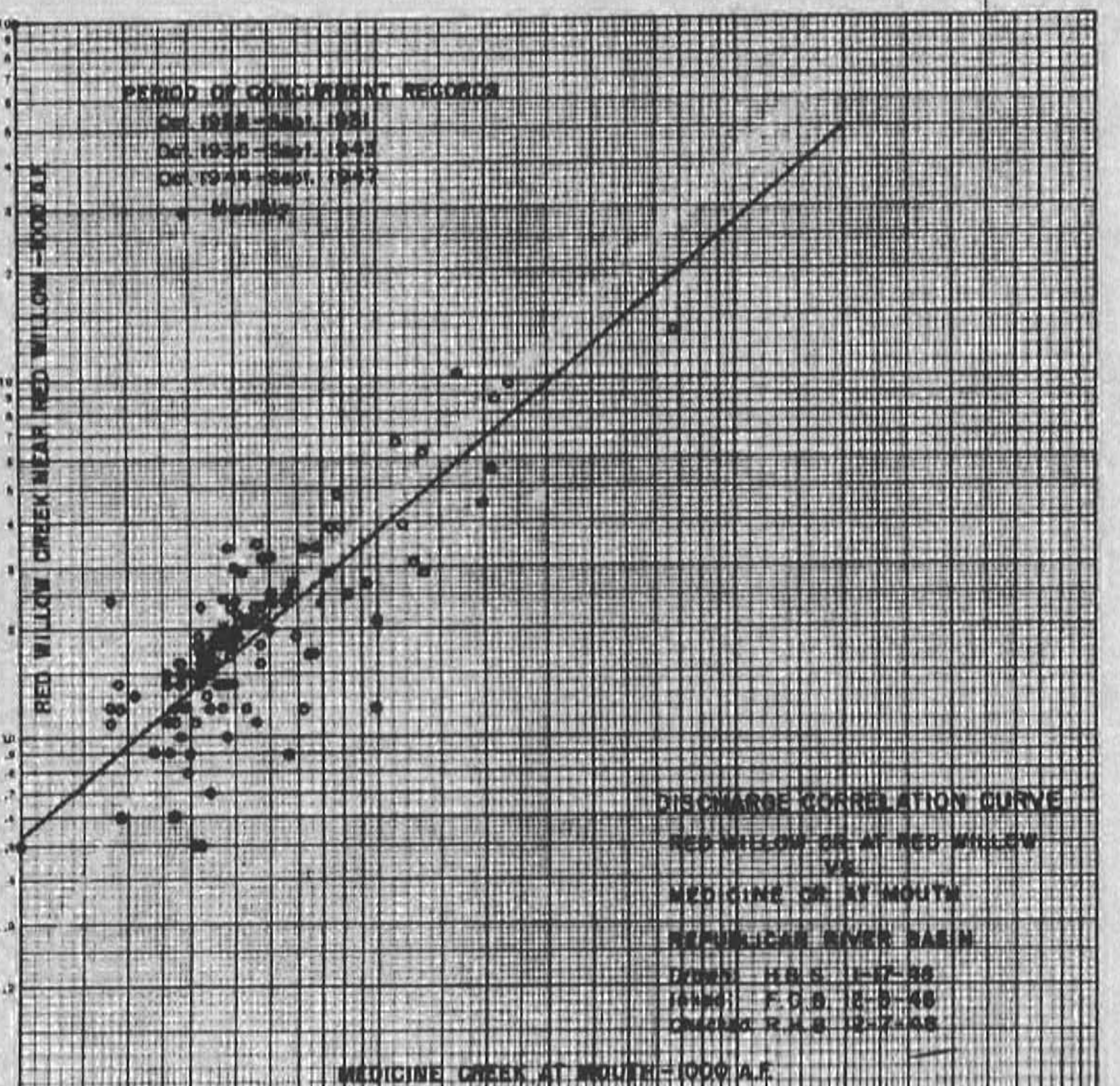
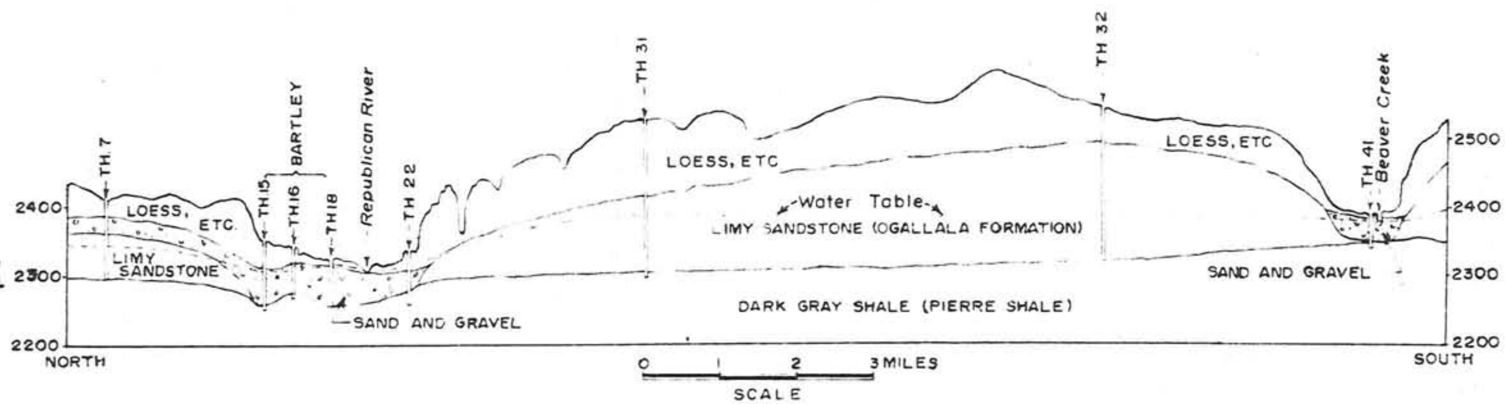


EXHIBIT 26
PERIOD OF
CONCURRENT RECORDS
o Monthly
x Annual
RUNOFF – RED WILLOW CR. – RED WILLOW, NEBR. 1000 A.F.
VIRGIN FLOW OF FRENCHMAN CR AT CULBERTSON, NEBR. 1000-A.F.
DISCHARGE CORRELATION CURVE
VIRGIN FLOW OF FRENCHMAN CR. AT
CULBERTSON, NEBR. VS.
RUNOFF–RED WILLOW CR.–RED WILLOW, NEBR.
REPUBLICAN RIVER BASIN
Drawn:
12-15-48


KS002392

EXHIBIT 29


PERIOD OF CONCURRENT RECORDS
Monthly
RED WILLOW CREEK NEAR RED WILLOW - 1000 A.F.
MEDICINE CREEK AT MOUTH - 1000 A.F.
DISCHARGE CORRELATION CURVE
VS.
REPUBLICAN RIVER BASIN




This section is located about one-half mile east of B[illegible]ley and extends in a north-south direction from a point [illegible] miles south of the Frontier County line (L) to a point 2.5 miles north of the Nebraska-Kansas state line. (Nebraska Water Resources Survey, Water Supply Paper 1, Part III)

EXHIBIT 30

of the wells added to the observation program for the first time are existing irrigation wells. The additional 51 new wells were drilled with the jetting method. The Geological Survey will furnish depth to water and ground-water contour maps by December 1, 1950 as requested by the Bureau of Reclamation.

Quality of water

No chemical analysis of the mineral constituents of Red Willow Creek water has been made to date for determining the quality of the water in Red Willow Creek for irrigation. Requests have been made to the Geological Survey that such analysis be made. The geological formation of the area drained by Red Willow Creek is practically identical to the area drained by Medicine Creek, and the analysis of the water is expected to show it to have the same quality. Analyses of the Medicine Creek water presented in the discussion of the Cambridge Unit, show it to be of excellent quality for irrigation.

Analyses of the mineral constituents of the water of Frenchman Creek at Culbertson and of the Republican River at Trenton and Cambridge indicate the water at these points is of satisfactory quality for irrigation. Because the quality of water above and below Bartley is satisfactory for irrigation the water at Bartley is also considered to be satisfactory. In the future return flows from irrigation development above this point could cause some deterioration to the quality of the Republican River water divertable at Bartley. Since return flows represent only a small portion of the total water divertable at Bartley it is not expected that deterioration in water quality due to return flows will be excessive.

It is not anticipated that any of the communities in the Red Willow Unit will wish to use surface water for domestic use. For this reason no analysis of the extent of pollution of surface waters is included in this report. The Public Health Service has made a detailed study of the pollution of streams in the Kansas River Basin and have recommended minimum flows necessary for public health. These flow requirements are shown in a seperate section of this Appendix.

Water Rights

Provisional grants by the state for the use of water for irrigation by private appropriators from Red Willow Creek and from the Republican River in the Red Willow Unit have been listed in the following tables. Table 88 lists the provisional grants totaling 4.60 second-feet made above the proposed Red Willow Reservoir. Table 89 lists a provisional grant for 0.76 second-feet made on Red Willow Creek between Red Willow Reservoir and Red Willow Creek Diversion Dam. Table 90 lists provisional grants totaling 11.13 second-feet made between Red Willow Creek Diversion Dam and Cambridge, Nebraska. Grants listed in these tables are as published in the Biennial Reports of the Nebraska Department of Roads and Irrigation.

Table 88.--Active Provisional Grants above Red Willow Reservoir

| Carrier | Doc. or Applic. No. | Date of Priority | Location | | | Provisional Grant | | |
|---|---|---|---|---|---|---|---|---|
| | | | S | T | R | Use | Acres | C. F. S. |
| Elmer Fitzgerald | 2447 | 7/27/34 | 21 | 8 | 32 | Irrigation | - | 0.57 |
| William Bortner a/ | 2938 | 7/21/39 | 28 | 5 | 30 | Irrigation | - | 0.57 |
| Charles Walker | 3037 | 12/6/39 | 9 | 6 | 31 | Irrigation | - | 0.81 |
| A. P. McKillip | 3111 | 3/9/40 | 22 | 6 | 31 | Irrigation | - | 0.97 |
| William Bortner a/ | 3114 | 3/12/40 | 21 | 5 | 30 | Irrigation | - | 0.18 |
| Howard W. Hill | 3124 | 3/28/40 | 27 | 6 | 31 | Irrigation | - | 0.23 |
| H. E. Little | 3508 | 9/20/41 | 2 | 5 | 31 | Irrigation | - | 0.42 |
| | 3609 | 4/30/43 | 2 | 5 | 31 | Irrigation | - | 0.26 |
| George Beebe | 3631 | 8/16/43 | 35 | 6 | 31 | Irrigation | - | 0.59 |
| Total | | | | | | | | 4.60 |

a/ Located in Red Willow Reservoir area.

Table 89.—Active Provisional Grants between Red Willow Reservoir and Red Willow Creek Diversion Dam

| Carrier | Doc. or Applic. No. | Date of Priority | Location S | Location T | Location R | Provisional Grant Use | Provisional Grant Acres | Provisional Grant c.f.s. |
|---|---|---|---|---|---|---|---|---|
| Merritt W. Quick | 3082 | 1/22/40 | 31 | 5 | 29 | Irrigation | - | 0.76 |
| Total | | | | | | | | 0.76 |

Table 90.--Active Provisional Grants between Red Willow Creek Diversion Dam and Cambridge, Nebraska

| Carrier | Doc. or Applic. No. | Date of Priority | Location S | Location T | Location R | Provisional Grants Use | Provisional Grants Acres | Provisional Grants c.f.s. |
|---|---|---|---|---|---|---|---|---|
| Alfred E. Lang | 2698 | 2/16/37 | 14 | 3 | 27 | Irrigation | - | 0.42 |
| | 3401 | 2/24/41 | 14 | 3 | 27 | Irrigation | - | 0.87 |
| Frenchman-Cambridge Irrig. District | 3869 c | 1/22/46 | 16 | 3 | 28 | Irrigation | - | - |
| | 3869 d | 1/22/46 | 16 | 3 | 28 | Irrigation | - | - |
| Lowell Ruggles | 1964 | 10/22/27 | 16 | 3 | 28 | Irrigation | - | 8.43 |
| Deines, Frantz | 1042 | 12/ 5/10 | 8 | 3 | 28 | Irrigation | - | 0.93 |
| Deines, Frantz C., et. al | 3623 | 7/12/43 | 8 | 3 | 28 | Irrigation | - | 0.48 |
| Total | | | | | | | | 11.13 |

## Red Willow Unit

Most of the water rights listed in tables 88, 89, and 90 were granted during the period of study, therefore, depletions were made in the water supply studies for these rights. An exception to this is the 0.76 second-foot water right below Red Willow Dam which was considered reflected in historical records. Diversions made historically under these rights were not added to the historical flows because there were no historical records of them and they were considered negligible. The lands irrigated by the water rights listed in table 88 are included in the 500 acres for which depletions of the inflow to the reservoir were made. The land irrigated by water rights listed in table 90 are included in the 11,990 acres which were furnished a water supply in this study. This was done because it is expected the owners of water rights below Red Willow Creek Diversion Dam in the Red Willow Unit will choose to receive water from the district rather than to exercise their water rights. In the past there has not always been water in the river during the entire season for irrigation. These lands were included in the Frenchman-Cambridge Irrigation District at the time the district was formed and they did not petition to be excluded from the district.

### Anticipated Water Use by Future Private Development

It can be anticipated that water supply available for the Red Willow Unit could be depleted slightly by development of irrigation in the area above Red Willow Reservoir and by the development of farm ponds throughout the water shed.

#### Water use by development of private irrigation and ponds

A reconnaissance soil survey of the area above the reservoir site shows there is a possibility for the development of irrigation of not more than 500 acres (including the areas for which the water rights have been listed in table 88.) This development could be accomplished by pumping from the creek or by development of irrigation wells. Table 91 lists the depletions that could be caused by private development of irrigation and ponds above Red Willow Reservoir table 111. Consumptive use requirements of irrigation water in the Red Willow Unit was used as the basis for determining these depletions by irrigation. Pond depletions were estimated to be 100 acre-feet per year. These depletions were treated as if they would all be diversions from the streams because this assumption would impose the most severe conditions on the available stream flows.

#### Municipal and industrial requirements

No allowance was made for increased use of water for municipal and industrial development because all municipal water supplies in this area are pumped from ground water and any increase in the use of water by the towns of the area is not considered to materially effect the water supply of the division.

Table 91.--Depletions from Possible Future Private Development of Irrigation and Ponds Above Red Willow Dam a/

1,000 acre-feet

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0 | 0 | 0 | 0 | 0 | 0.1 | 0.1 | 0.2 | 0.1 | 0 | 0 | 0 | 0.5 |
| 1930 | 0 | 0 | 0 | 0 | 0 | .1 | 0 | .1 | .1 | 0 | 0 | 0 | .3 |
| 1931 | 0 | 0 | 0 | 0 | 0 | .1 | .1 | .1 | .1 | .1 | 0 | 0 | .5 |
| 1932 | 0 | 0 | 0 | 0 | 0 | .1 | .1 | .2 | .1 | .1 | 0 | 0 | .6 |
| 1933 | 0 | 0 | 0 | 0 | 0 | .2 | .2 | 0 | .1 | .1 | 0 | 0 | .6 |
| 1934 | 0 | 0 | 0 | .1 | .1 | .1 | .2 | .2 | .1 | .1 | 0 | 0 | .9 |
| 1935 | 0 | 0 | 0 | .1 | 0 | .1 | .2 | .1 | .1 | 0 | 0 | 0 | .6 |
| 1936 | 0 | 0 | 0 | .1 | 0 | .2 | .2 | .2 | .1 | .1 | 0 | 0 | .9 |
| 1937 | 0 | 0 | 0 | .1 | .1 | .1 | .1 | .1 | .1 | 0 | 0 | 0 | .6 |
| 1938 | 0 | 0 | 0 | .1 | 0 | .2 | .1 | .1 | .1 | .1 | 0 | 0 | .7 |
| 1939 | 0 | 0 | 0 | 0 | .1 | .1 | .2 | .2 | .1 | .1 | 0 | 0 | .8 |
| 1940 | 0 | 0 | 0 | .1 | 0 | .2 | .2 | .2 | .1 | 0 | 0 | 0 | .8 |
| 1941 | 0 | 0 | 0 | 0 | 0 | .1 | .1 | .2 | 0 | 0 | 0 | 0 | .4 |
| 1942 | 0 | 0 | 0 | 0 | 0 | .1 | .1 | .1 | 0 | .1 | 0 | 0 | .4 |
| 1943 | 0 | 0 | 0 | 0 | .1 | .2 | .1 | .1 | .1 | .1 | 0 | 0 | .7 |
| 1944 | 0 | 0 | 0 | 0 | 0 | .1 | 0 | 0 | .1 | .1 | 0 | 0 | .3 |
| 1945 | 0 | 0 | 0 | 0 | 0 | .1 | .1 | .1 | .1 | .1 | 0 | 0 | .5 |
| 1946 | 0 | 0 | 0 | .1 | 0 | .2 | .1 | .1 | 0 | 0 | 0 | 0 | .5 |
| 1947 | 0 | 0 | 0 | 0 | 0 | 0 | .1 | 0 | .2 | .1 | 0 | 0 | .4 |
| Avg. | 0 | 0 | 0 | .1 | 0 | .1 | .1 | .1 | .1 | .1 | 0 | 0 | .6 |

a/ Includes irrigation requirements for 500 acres and 100 acre-feet per year for ponds

## Red Willow Unit

### Project Water Supply

Water available for development of this unit will be the water stored in Red Willow Reservoir, sectional accretions between the reservoir and Red Willow Creek Diversion Dam, sectional accretions on the Republican River between Culbertson and Bartley Diversion Dams, return flows from the Frenchman and Meeker-Driftwood Units, and return flows from 2,610 acres in the Red Willow Unit that are above Bartley Diversion Dam.

#### Reservoir Inflow

Water available for storage in Red Willow Reservoir is the historical runoff at the dam site, table 86, less the water required for possible future private development above the dam listed in table 91. This depleted inflow is listed in table 92.

#### Stream-flow sectional accretions

Table 93, the inflow of Red Willow Creek between Red Willow Dam and the mouth of Red Willow Creek is obtained by subtracting table 86, the historical runoff of Red Willow Creek north of McCook at Red Willow Dam from table 87, the runoff of Red Willow Creek near its mouth.

Because the drainage area between Red Willow Creek Diversion Dam and the mouth of the creek is small in comparison to the drainage area between the reservoir and the diversion dam, the total accretion, table 93, of Red Willow Creek between Red Willow Dam and the mouth of Red Willow Creek is estimated to be available for diversion at Red Willow Creek Diversion Dam.

Table 94 is the sum of the flows of Frenchman Creek at the mouth, table 7, the Republican River at Culbertson, table 54, Red Willow at the mouth, table 87, and Medicine Creek at the mouth, table 123. The flow of the Republican River at Cambridge, table 125, less the above table 94, is the accretion in flow, table 95, of the main stem of the Republican River between Culbertson and Cambridge without the Red Willow and Medicine Creek flows. Eighty-three and five tenths percent of this flow is the estimated historical accretion in flow of the Republican River table 96 between Culbertson and Bartley Diversion Dam without the flow of Red Willow Creek. The 83.5 percent used above is based upon the proportion of the drainage area above Bartley to the total between Culbertson and Cambridge when the drainage areas of Red Willow and Medicine Creeks are deleted. The remaining 16.5 percent of the accretion in flow of the Republican River is the estimated historical accretion in flow, table 97, between Bartley Diversion Dam and Cambridge, Nebraska.

The estimated historical flow of the Republican River at Bartley Diversion Dam, table 99, was obtained by adding table 96, the estimated historical accretion in flow of the Republican River between

Table 92.--Depleted Inflow of Red Willow Creek at Red Willow Dam Site

1000 acre-feet

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | | | | | | | | | | 0.9 | 1.1 | 1.2 | 3.2 |
| 1929 | 0.9 | 0.6 | 1.6 | 1.6 | 1.9 | 2.3 | 0.9 | 0 | 0.4 | 0.6 | 0.9 | 1.0 | 12.7 |
| 1930 | 1.1 | 1.3 | 1.4 | 1.9 | 2.6 | 1.5 | 1.9 | 1.3 | 0.8 | 2.4 | 2.3 | 1.4 | 19.9 |
| 1931 | 1.9 | 1.6 | 1.9 | 1.8 | 1.4 | 1.0 | 1.0 | 1.8 | 0.4 | 0.7 | 1.4 | 1.5 | 16.4 |
| 1932 | 1.5 | 1.6 | 2.4 | 1.4 | 2.3 | 3.1 | 1.1 | 1.4 | 0.5 | 0.6 | 1.0 | 1.3 | 18.2 |
| 1933 | 1.9 | 1.9 | 2.2 | 1.3 | 2.6 | 0.4 | 0.4 | 3.2 | 4.2 | 1.0 | 1.0 | 2.1 | 22.2 |
| 1934 | 2.0 | 1.8 | 1.8 | 1.1 | 0.7 | 3.6 | 0.8 | 0.5 | 1.7 | 0.6 | 0.8 | 1.6 | 17.0 |
| 1935 | 1.8 | 1.5 | 1.9 | 1.0 | 5.5 | 5.2 | 2.7 | 0.8 | 2.2 | 0.8 | 1.2 | 1.5 | 26.1 |
| 1936 | 1.6 | 1.7 | 2.0 | 1.2 | 3.6 | 2.5 | 0.5 | 0.3 | 0.6 | 0.7 | 0.9 | 0.8 | 16.4 |
| 1937 | 0.8 | 0.9 | 1.2 | 0.8 | 0.8 | 2.0 | 1.3 | 1.7 | 0.8 | 0.8 | 0.9 | 0.9 | 12.9 |
| 1938 | 0.9 | 0.9 | 1.2 | 1.1 | 2.3 | 1.1 | 2.5 | 0.7 | 0.7 | 0.5 | 0.7 | 0.7 | 13.3 |
| 1939 | 0.8 | 0.7 | 1.2 | 1.6 | 0.8 | 3.0 | 0.9 | 0.7 | 0.3 | 0.5 | 0.8 | 0.8 | 12.1 |
| 1940 | 0.7 | 0.9 | 1.6 | 1.5 | 1.1 | 3.1 | 0.8 | 0.6 | 0.9 | 0.8 | 1.0 | 1.3 | 14.3 |
| 1941 | 1.6 | 1.4 | 1.5 | 1.7 | 2.2 | 7.4 | 2.5 | 0.6 | 3.5 | 1.7 | 1.4 | 1.3 | 26.8 |
| 1942 | 1.4 | 1.5 | 3.2 | 4.7 | 2.7 | 4.9 | 1.1 | 0.9 | 4.1 | 1.1 | 1.3 | 1.6 | 28.5 |
| 1943 | 1.4 | 1.4 | 1.6 | 1.7 | 1.2 | 1.3 | 0.8 | 0.4 | 0.3 | 0.7 | 1.2 | 1.1 | 13.1 |
| 1944 | 1.2 | 1.6 | 2.2 | 4.1 | 2.2 | 2.1 | 5.0 | 2.8 | 0.7 | 0.7 | 1.3 | 1.5 | 25.4 |
| 1945 | 1.4 | 1.8 | 1.6 | 1.5 | 2.4 | 6.0 | 0.7 | 1.7 | 2.0 | 1.1 | 1.2 | 1.1 | 22.5 |
| 1946 | 0.9 | 1.1 | 2.0 | 1.2 | 3.4 | 1.7 | 1.3 | 0.8 | 1.9 | 5.3 | 1.8 | 1.5 | 22.9 |
| 1947 | 1.5 | 1.6 | 1.8 | 2.1 | 1.5 | 10.2 | 1.9 | 0.8 | 0.5 | - | - | - | 21.9 |
| Total Average | 1.3 | 1.4 | 1.8 | 1.7 | 2.2 | 3.3 | 1.5 | 1.1 | 1.4 | 1.1 | 1.2 | 1.3 | 19.3 |

Table 93.--Inflow of Red Willow Creek between Red Willow Dam Site and the Mouth of Red Willow Creek

1000 acre-feet

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.2 | 0.3 | 0.3 | 0.2 | 0 | 0.4 | 0.4 | 0.5 | 0.8 | 0.2 | -0.1 | 0 | 3.2 |
| 1930 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.9 | 0.5 | 0.6 | 0.3 | 0.2 | 4.5 |
| 1931 | 0.7 | 0.7 | 0.4 | 0.6 | 0.5 | 0.6 | 0.5 | 0.4 | 0.2 | 0.3 | 0.5 | 0 | 5.4 |
| 1932 | 0.5 | 0.8 | 0.8 | 0.9 | 0.9 | 0.8 | 0.9 | -0.9 | -1.0 | 0.1 | 0.2 | 0.4 | 4.4 |
| 1933 | 0.3 | 0.5 | 0.7 | 0.9 | 0.9 | 0.9 | 1.0 | -0.8 | 0.4 | 0.4 | -0.9 | -1.1 | 3.2 |
| 1934 | 1.0 | 0.4 | 0.9 | 0.9 | 0.9 | 0.9 | 0.7 | 0.4 | -1.1 | 0.3 | 0.4 | -0.4 | 5.3 |
| 1935 | 0.3 | 0.2 | 0.9 | 0.9 | 0.8 | 0.9 | 0.9 | 2.0 | 0.4 | -0.5 | -0.3 | -0.8 | 5.7 |
| 1936 | 0.5 | 0.8 | 0.9 | 0.9 | 0.9 | 0.9 | 1.1 | -1.1 | -0.6 | 0.3 | 0.5 | 0.3 | 5.4 |
| 1937 | 0.2 | 0.3 | 0.2 | 0.1 | 0.3 | 0.5 | 0.3 | 0.3 | 0.7 | 0.6 | 0.2 | 0.2 | 3.9 |
| 1938 | 0.2 | 0.4 | 0.4 | 0.2 | 0.3 | 0.5 | 0.5 | 0.9 | 0.4 | 0.9 | 0.3 | 0.2 | 5.2 |
| 1939 | 0 | 0.2 | 0.1 | 0.2 | 0.2 | 0.5 | 0.6 | 0.3 | 1.1 | 0.4 | 0.3 | -0.1 | 3.8 |
| 1940 | 0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.4 | 0.5 | 0.3 | 1.2 | 0.2 | 0.1 | 0.2 | 3.3 |
| 1941 | 0.2 | 0.2 | 0.3 | 1.3 | 0.3 | 0.3 | 0.6 | 0.7 | 2.7 | 0.5 | 0.4 | 2.7 | 10.2 |
| 1942 | 1.2 | 0.2 | 0.4 | 0.4 | 0.4 | 0.7 | 0.9 | 0.7 | 1.6 | 0.4 | 0.4 | 0.6 | 7.9 |
| 1943 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.4 | 0.5 | 0.9 | 0.1 | 4.2 |
| 1944 | 0.2 | 0.2 | 0 | 0.2 | 0.2 | 0.2 | 1.3 | 1.0 | 0.7 | 1.3 | 0.9 | 0.2 | 6.4 |
| 1945 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.2 | 1.5 | 2.7 | 0.4 | 1.6 | 1.3 | 9.6 |
| 1946 | 0.3 | 0.3 | 0.4 | 0.5 | 0.2 | 0.4 | 0.3 | 0.5 | 0.8 | 0.8 | 0.3 | 0.4 | 5.2 |
| 1947 | 4.3 | 0.5 | 0.3 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 3.4 | 0.7 | 0.3 | 0.2 | 10.9 |
| Total Avg. | 0.6 | 0.4 | 0.4 | 0.5 | 0.4 | 0.5 | 0.6 | 0.4 | 0.8 | 0.4 | 0.3 | 0.2 | 5.5 |

Table 94.--Sum of historical flows of Frenchman Creek at mouth, Republican River at Culbertson, Red Willow at the mouth and Medicine Creek at mouth

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 17.3 | 30.3 | 19.8 | 21.3 | 19.6 | 39.5 | 35.6 | 35.0 | 24.6 | 6.9 | 5.2 | 11.2 | 266.3 |
| 1930 | 16.5 | 26.3 | 26.1 | 26.0 | 25.2 | 27.7 | 28.5 | 35.9 | 34.1 | 21.0 | 25.7 | 16.1 | 309.1 |
| 1931 | 27.2 | 26.5 | 31.6 | 27.0 | 30.2 | 29.8 | 28.2 | 20.1 | 13.2 | 6.5 | 13.2 | 4.6 | 258.1 |
| 1932 | 12.7 | 24.0 | 25.6 | 27.4 | 25.4 | 30.5 | 26.3 | 17.8 | 27.9 | 13.6 | 20.2 | 5.6 | 257.0 |
| 1933 | 11.0 | 17.6 | 22.9 | 29.7 | 28.0 | 31.3 | 24.7 | 27.5 | 8.0 | 7.8 | 97.3 | 62.3 | 368.1 |
| 1934 | 22.9 | 18.2 | 32.6 | 31.2 | 29.9 | 29.2 | 23.3 | 7.6 | 28.4 | 7.2 | 6.3 | 9.4 | 246.2 |
| 1935 | 8.0 | 11.9 | 27.7 | 30.1 | 25.9 | 31.9 | 22.3 | 301.4 | 253.0 | 39.7 | 21.5 | 20.1 | 793.5 |
| 1936 | 12.6 | 18.8 | 26.9 | 24.8 | 27.0 | 33.4 | 31.1 | 65.6 | 34.6 | 5.5 | 8.9 | 5.2 | 294.4 |
| 1937 | 8.6 | 15.8 | 20.3 | 14.8 | 22.8 | 30.7 | 21.6 | 26.1 | 41.3 | 11.9 | 11.5 | 15.5 | 240.9 |
| 1938 | 11.3 | 16.0 | 19.5 | 22.4 | 23.4 | 25.1 | 24.8 | 50.8 | 36.1 | 33.4 | 19.0 | 30.6 | 312.4 |
| 1939 | 7.7 | 12.6 | 18.5 | 24.3 | 14.8 | 36.6 | 30.0 | 11.2 | 47.9 | 13.6 | 11.1 | 2.9 | 231.2 |
| 1940 | 4.5 | 8.3 | 14.8 | 15.3 | 34.1 | 34.5 | 23.0 | 11.7 | 54.2 | 15.3 | 9.2 | 20.7 | 245.6 |
| 1941 | 12.8 | 22.1 | 32.2 | 38.0 | 28.2 | 26.4 | 39.7 | 35.4 | 87.3 | 56.6 | 28.8 | 30.5 | 438.0 |
| 1942 | 27.4 | 24.3 | 23.2 | 21.6 | 28.5 | 78.1 | 53.6 | 37.8 | 52.5 | 11.4 | 23.9 | 40.8 | 423.1 |
| 1943 | 25.2 | 24.9 | 37.2 | 24.7 | 30.1 | 24.6 | 21.9 | 16.4 | 25.3 | 7.0 | 5.2 | 5.0 | 247.5 |
| 1944 | 6.7 | 13.6 | 15.7 | 30.4 | 33.5 | 36.6 | 74.0 | 43.0 | 29.4 | 66.6 | 17.8 | 5.2 | 372.5 |
| 1945 | 12.6 | 18.7 | 24.6 | 29.4 | 29.5 | 24.0 | 26.5 | 26.6 | 65.0 | 15.0 | 16.9 | 16.2 | 305.0 |
| 1946 | 18.2 | 19.2 | 15.9 | 22.8 | 24.3 | 31.3 | 18.2 | 35.6 | 24.2 | 64.5 | 5.7 | 13.0 | 292.9 |
| 1947 | 61.2 | 34.8 | 27.2 | 26.7 | 32.6 | 40.9 | 30.9 | 33.4 | 116.5 | 35.2 | 6.5 | 6.7 | 452.6 |
| Total Avg. | 17.1 | 20.2 | 24.3 | 25.7 | 27.0 | 33.8 | 30.7 | 44.2 | 52.8 | 23.1 | 18.6 | 16.9 | 334.4 |

Table 95.--Historical accretion of Republican River between Culbertson and Cambridge less Red Willow and Medicine Creek flow a/

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 2.2 | -9.3 | -0.3 | -4.3 | -6.6 | 5.6 | 3.5 | 7.0 | 53.0 | 39.2 | 3.6 | -4.0 | 89.6 |
| 1930 | -5.5 | -4.1 | -3.0 | -6.4 | -5.6 | -0.1 | 12.5 | 27.1 | 41.9 | 0.4 | -4.3 | 18.9 | 71.8 |
| 1931 | 32.6 | 15.6 | -0.6 | 1.5 | 4.5 | 7.7 | 12.4 | 13.7 | 20.6 | 1.5 | -12.0 | -2.3 | 95.2 |
| 1932 | -10.1 | -13.9 | -15.6 | -14.6 | 9.0 | 7.5 | -0.3 | 2.0 | 43.1 | 1.1 | 2.0 | 8.8 | 19.0 |
| 1933 | -5.9 | -9.4 | -3.5 | -6.2 | -8.2 | -2.8 | 22.3 | 23.4 | 2.5 | -0.7 | -52.3 | 3.3 | -37.5 |
| 1934 | -5.4 | -0.7 | -2.6 | -3.8 | -6.3 | -0.6 | -0.8 | -0.4 | 19.5 | -2.8 | -3.7 | 8.1 | 0.5 |
| 1935 | -3.2 | -1.8 | -13.2 | -5.9 | -5.1 | -4.9 | 0.8 | -79.0 | 194.9 | 1.3 | 25.3 | 28.5 | 137.7 |
| 1936 | 2.2 | 1.8 | -4.4 | -6.3 | -13.6 | 2.6 | -7.4 | 19.0 | 5.2 | -2.4 | -7.3 | 0.8 | -9.8 |
| 1937 | -6.2 | -4.3 | -3.9 | -6.0 | 4.7 | -0.8 | -2.6 | -6.5 | 5.7 | 15.1 | 16.0 | 1.5 | 12.7 |
| 1938 | -4.9 | -4.3 | -6.0 | 1.9 | -1.2 | 4.1 | 6.7 | 0.6 | 10.6 | 10.2 | 14.0 | 6.2 | 37.9 |
| 1939 | -1.6 | -3.4 | -3.0 | -7.5 | -0.7 | -3.9 | 2.4 | 16.0 | 16.6 | 12.1 | 8.5 | -2.0 | 33.5 |
| 1940 | -3.7 | -4.1 | -3.4 | -7.4 | -20.0 | 2.3 | -0.3 | 5.0 | 2.8 | 0.2 | 2.7 | -13.7 | -39.6 |
| 1941 | 3.6 | -11.0 | -17.3 | -16.8 | 1.0 | 4.4 | -6.2 | 10.9 | 16.7 | 23.4 | 22.7 | 15.9 | 47.3 |
| 1942 | 3.1 | -0.1 | -0.8 | -1.6 | 1.5 | -22.0 | 3.6 | 11.0 | -2.7 | 2.4 | -5.2 | -6.8 | -17.6 |
| 1943 | 0.8 | 2.1 | -8.7 | -6.7 | 1.1 | 6.8 | 6.2 | 2.8 | -0.2 | -1.1 | -0.7 | 0.2 | 2.6 |
| 1944 | -3.3 | -5.6 | -4.7 | -14.3 | -5.0 | -1.6 | 2.0 | 15.9 | 25.2 | 31.6 | 7.1 | -0.9 | 46.4 |
| 1945 | -0.2 | -2.3 | -3.8 | -4.0 | -1.4 | 1.2 | 5.7 | 3.4 | 37.6 | 7.1 | -1.7 | -2.6 | 39.0 |
| 1946 | -0.2 | -0.5 | -0.5 | 2.0 | 2.7 | 0.2 | 0.2 | 2.8 | 4.1 | 5.6 | -0.1 | 1.2 | 17.5 |
| 1947 | 40.9 | 6.2 | 1.4 | -4.0 | -6.1 | -1.8 | 5.6 | 2.6 | 40.9 | 2.9 | -1.4 | -3.0 | 84.2 |
| Total Average | 1.8 | -2.6 | -4.9 | -5.8 | -2.9 | 0.2 | 3.5 | 4.1 | 28.3 | 7.7 | 0.7 | 3.1 | 33.2 |

a/ Excludes the flows of Medicine and Red Willow Creeks

Table 96.--Estimated historical accretion in flow of Republican River between Culbertson and Bartley Diversion Dam, less Red Willow Creek flow a/

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.8 | -7.8 | -0.2 | -3.6 | -5.5 | 4.7 | 2.9 | 5.8 | 44.3 | 32.7 | 3.0 | -3.3 | 74.8 |
| 1930 | -4.6 | -3.4 | -2.5 | -5.3 | -4.7 | -0.1 | 10.4 | 22.6 | 35.0 | 0.3 | -3.6 | 15.8 | 59.9 |
| 1931 | 27.2 | 13.0 | -0.5 | 1.3 | 3.8 | 6.4 | 10.4 | 11.4 | 17.2 | 1.3 | -10.0 | -1.9 | 79.6 |
| 1932 | -8.4 | -11.6 | -13.0 | -12.2 | 7.5 | 6.3 | -0.2 | 1.7 | 36.0 | 0.9 | 1.7 | 7.3 | 16.0 |
| 1933 | -4.9 | -7.8 | -2.9 | -5.2 | -6.8 | -2.3 | 18.6 | 19.5 | 2.1 | -0.6 | -43.7 | 2.8 | -31.2 |
| 1934 | -4.5 | -0.6 | -2.2 | -3.2 | -5.3 | -0.5 | -0.7 | -0.3 | 16.3 | -2.3 | -3.1 | 6.8 | 0.4 |
| 1935 | -2.7 | -1.5 | -11.0 | -4.9 | -4.3 | -4.1 | 0.7 | -66.0 | 162.7 | 1.1 | 21.1 | 23.8 | 114.9 |
| 1936 | 1.8 | 1.5 | -3.7 | -5.3 | -11.4 | 2.2 | -6.2 | 15.7 | 4.3 | -2.0 | -6.1 | 0.7 | -8.5 |
| 1937 | -5.2 | -3.6 | -3.3 | -5.0 | 3.9 | -0.7 | -2.2 | -5.4 | 4.8 | 12.6 | 13.4 | 1.3 | 10.6 |
| 1938 | -4.1 | -3.6 | -5.0 | 1.6 | -1.0 | 3.4 | 5.6 | 0.5 | 8.9 | 8.5 | 11.7 | 5.2 | 31.7 |
| 1939 | -1.3 | -2.8 | -2.5 | -6.3 | -0.6 | -3.3 | 2.0 | 13.4 | 13.9 | 10.1 | 7.1 | -1.7 | 28.0 |
| 1940 | -3.1 | -3.4 | -2.8 | -6.2 | -16.7 | 1.9 | -0.2 | 4.2 | 2.3 | 0.2 | 2.3 | -11.4 | -32.9 |
| 1941 | 3.0 | -9.2 | -14.4 | -14.0 | 0.8 | 3.7 | -5.2 | 9.1 | 13.9 | 19.5 | 19.0 | 13.3 | 39.5 |
| 1942 | 2.6 | -0.1 | -0.7 | -1.3 | 1.3 | -18.4 | 3.0 | 9.2 | -2.3 | 2.0 | -4.3 | -5.7 | -14.7 |
| 1943 | 0.7 | 1.8 | -7.3 | -5.6 | 0.9 | 5.7 | 5.2 | 2.3 | -0.2 | -0.9 | -0.6 | 0.2 | 2.2 |
| 1944 | -2.8 | -4.7 | -3.9 | -11.9 | -4.2 | -1.3 | 1.7 | 13.3 | 21.0 | 26.4 | 5.9 | -0.8 | 38.7 |
| 1945 | -0.2 | -1.9 | -3.2 | -3.3 | -1.2 | 1.0 | 4.8 | 2.8 | 31.4 | 5.9 | -1.4 | -2.2 | 32.5 |
| 1946 | -0.2 | -0.4 | -0.4 | 1.7 | 2.3 | 0.2 | 0.2 | 2.3 | 3.4 | 4.7 | -0.1 | 1.0 | 14.7 |
| 1947 | 34.2 | 5.2 | 1.2 | -3.3 | -5.1 | -1.5 | 4.7 | 2.2 | 34.2 | 2.4 | -1.2 | -2.5 | 70.5 |
| Total Average | 1.5 | -2.2 | -4.1 | -4.8 | -2.4 | 0.2 | 2.9 | 3.4 | 23.6 | 6.5 | 0.6 | 2.5 | 27.7 |

a/ Estimated to be 83.5% of the gain between Culbertson and Cambridge

Table 97.—Increase in Historical Flow of Republican River between Bartley Diversion and Cambridge Diversion a/

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.4 | -1.5 | -0.1 | -0.7 | -1.1 | 0.9 | 0.6 | 1.2 | 8.7 | 6.5 | 0.6 | -0.7 | 14.8 |
| 1930 | -0.9 | -0.7 | -0.5 | -1.1 | -0.9 | 0 | 2.1 | 4.5 | 6.9 | 0.1 | -0.7 | 3.1 | 11.9 |
| 1931 | 5.4 | 2.6 | -0.1 | 0.2 | 0.7 | 1.3 | 2.0 | 2.3 | 3.4 | 0.2 | -2.0 | -0.4 | 15.6 |
| 1932 | -1.7 | -2.3 | -2.6 | -2.4 | 1.5 | 1.2 | -0.1 | 0.3 | 7.1 | 0.2 | 0.3 | 1.5 | 3.0 |
| 1933 | -1.0 | -1.6 | -0.6 | -1.0 | -1.4 | -0.5 | 3.7 | 3.9 | 0.4 | -0.1 | -8.6 | 0.5 | -6.3 |
| 1934 | -0.9 | -0.1 | -0.4 | -0.6 | -1.0 | -0.1 | -0.1 | -0.1 | 3.2 | -0.5 | -0.6 | 1.3 | 0.1 |
| 1935 | -0.5 | -0.3 | -2.2 | -1.0 | -0.8 | -0.8 | 0.1 | -13.0 | 32.2 | 0.2 | 4.2 | 4.7 | 22.8 |
| 1936 | 0.4 | 0.3 | -0.7 | -1.0 | -2.2 | 0.4 | -1.2 | 3.3 | 0.9 | -0.4 | -1.2 | 0.1 | -1.3 |
| 1937 | -1.0 | -0.7 | -0.6 | -1.0 | 0.8 | -0.1 | -0.4 | -1.1 | 0.9 | 2.5 | 2.6 | 0.2 | 2.1 |
| 1938 | -0.8 | -0.7 | -1.0 | 0.3 | -0.2 | 0.7 | 1.1 | 0.1 | 1.7 | 1.7 | 2.3 | 1.0 | 6.2 |
| 1939 | -0.3 | -0.6 | -0.5 | -1.2 | -0.1 | -0.6 | 0.4 | 2.6 | 2.7 | 2.0 | 1.4 | -0.3 | 5.5 |
| 1940 | -0.6 | -0.7 | -0.6 | -1.2 | -3.3 | 0.4 | -0.1 | 0.8 | 0.5 | 0 | 0.4 | -2.3 | -6.7 |
| 1941 | 0.6 | -1.8 | -2.9 | -2.8 | 0.2 | 0.7 | -1.0 | 1.8 | 2.8 | 3.9 | 3.7 | 2.6 | 7.8 |
| 1942 | 0.5 | 0 | -0.1 | -0.3 | 0.2 | -3.6 | 0.6 | 1.8 | -0.4 | 0.4 | -0.9 | -1.1 | -2.9 |
| 1943 | 0.1 | 0.3 | -1.4 | -1.1 | 0.2 | 1.1 | 1.0 | 0.5 | 0 | -0.2 | -0.1 | 0 | 0.4 |
| 1944 | -0.5 | -0.9 | -0.8 | -2.4 | -0.8 | -0.3 | 0.3 | 2.6 | 4.2 | 5.2 | 1.2 | -0.1 | 7.7 |
| 1945 | 0 | -0.4 | -0.6 | -0.7 | -0.2 | 0.2 | 0.9 | 0.6 | 6.2 | 1.2 | -0.3 | -0.4 | 6.5 |
| 1946 | 0 | -0.1 | -0.1 | 0.3 | 0.4 | 0 | 0 | 0.5 | 0.7 | 0.9 | 0 | 0.2 | 2.8 |
| 1947 | 6.7 | 1.0 | 0.2 | -0.7 | -1.0 | -0.3 | 0.9 | 0.4 | 6.7 | 0.5 | -0.2 | -0.5 | 13.7 |
| Avg. | 0.3 | -0.4 | -0.8 | -1.0 | -0.5 | 0 | 0.6 | 0.7 | 4.7 | 1.3 | 0.1 | 0.5 | 5.5 |

a/ Excluding flow of Medicine Creek.

Culbertson and Bartley Diversion Dam less the Red Willow Creek flow, and table 98, the sum of the flows of Frenchman Creek at the mouth, the Republican River at Culbertson, and Red Willow Creek at the mouth.

The depleted flow of the Republican River available for use at Bartley Diversion Dam is listed in table 104. The flow available for use at Bartley is the sum of table 82, the combined flows of Frenchman Creek and the Republican River and return flows from the Frenchman and Meeker-Driftwood Units, and table 96, the estimated historical accretions in flow between Culbertson and Bartley. Table 105 is the same table with the negatives in the winter months carried over to the next month. This is the flow used in the operation study. Winter negative flows were satisfied in this way and negative flows occurring during the irrigation season were met by reservoir releases.

Return flow

Return flows available for use in the Red Willow Unit consist of the return flows from the Frenchman and Meeker-Driftwood Units and return flows from 2,610 acres irrigated by the McCook and the Red Willow Canals above Bartley Diversion Dam. The return flows from the Frenchman and Meeker-Driftwood Units were computed in the discussion of the Meeker-Driftwood Unit and are part of the flows listed in table 82, the combined flows of Frenchman Creek and Republican River and return flows from Frenchman and Meeker-Driftwood Units after all upstream development. The return flows from the 2,610 acres irrigated in the Red Willow Unit and available for use at Bartley Diversion Dam are listed in table 101.

There are 4,960 acres to be irrigated by the McCook and Red Willow Canals. The return flows from this area are listed in table 100. Return flows from the 2,350 acres served by Red Willow Canal below Bartley Diversion Dam, table 102, were considered available for diversion at Cambridge Diversion Dam. Return flows from the 7,030 acres irrigated by the Bartley Canal, table 103, were also considered available at Cambridge Diversion Dam.

Return flows from the Red Willow Unit were computed on the basis that 75 percent of the canal and farm losses would return to the stream and be available for reuse. The monthly distribution of return flows used is the same as was used for the Frenchman Unit.

## Water Requirements

Factors studied in determining the water required for irrigation in the Red Willow Unit include: (1) The consumptive use of water by crops, (2) total precipitation and the precipitation that can be used by crops, (3) consumptive use requirements of irrigated crops, (4) farm delivery requirements, (5) and diversion requirements.

Table 98.--Sum of flows of Frenchman Creek at mouth, plus Republican River at Culbertson, plus Red Willow Creek at mouth a/

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 15.6 | 27.5 | 17.0 | 18.7 | 16.9 | 35.5 | 30.6 | 29.5 | 19.8 | 4.2 | 4.1 | 8.1 | 227.5 |
| 1930 | 13.1 | 21.7 | 21.8 | 22.2 | 21.7 | 23.7 | 23.5 | 31.3 | 24.1 | 12.8 | 19.3 | 14.3 | 249.5 |
| 1931 | 22.2 | 22.5 | 26.9 | 22.0 | 25.4 | 24.2 | 23.5 | 15.4 | 11.1 | 4.6 | 11.4 | 3.6 | 212.8 |
| 1932 | 9.3 | 20.6 | 22.0 | 23.6 | 21.5 | 25.5 | 20.0 | 14.2 | 21.9 | 10.1 | 15.5 | 3.2 | 207.4 |
| 1933 | 8.4 | 15.2 | 19.7 | 25.3 | 23.6 | 26.5 | 18.5 | 22.7 | 5.3 | 5.1 | 91.1 | 53.6 | 315.0 |
| 1934 | 17.3 | 16.0 | 27.9 | 26.6 | 25.6 | 24.9 | 18.2 | 4.6 | 21.2 | 3.9 | 3.4 | 5.6 | 195.2 |
| 1935 | 5.3 | 10.3 | 23.8 | 25.8 | 22.3 | 27.5 | 17.1 | 280.4 | 237.0 | 33.2 | 18.3 | 16.0 | 717.0 |
| 1936 | 9.2 | 15.7 | 23.1 | 20.9 | 22.9 | 28.8 | 24.7 | 59.0 | 28.9 | 2.9 | 6.3 | 2.7 | 245.1 |
| 1937 | 6.1 | 12.9 | 17.7 | 12.4 | 19.9 | 26.8 | 18.6 | 23.3 | 34.9 | 7.4 | 6.0 | 12.7 | 198.7 |
| 1938 | 8.8 | 13.0 | 16.5 | 19.6 | 20.5 | 21.3 | 20.9 | 43.5 | 32.0 | 25.4 | 16.3 | 28.0 | 265.8 |
| 1939 | 5.8 | 10.2 | 16.3 | 21.7 | 12.4 | 32.7 | 25.1 | 8.2 | 38.3 | 10.1 | 8.2 | 1.7 | 190.7 |
| 1940 | 2.6 | 5.9 | 12.2 | 12.4 | 30.3 | 30.5 | 18.5 | 8.5 | 34.4 | 5.4 | 3.6 | 14.5 | 178.8 |
| 1941 | 10.0 | 19.2 | 27.5 | 30.8 | 21.7 | 22.4 | 35.2 | 21.8 | 70.6 | 43.8 | 25.1 | 17.4 | 345.5 |
| 1942 | 23.2 | 20.9 | 20.0 | 18.0 | 25.3 | 66.3 | 32.6 | 31.1 | 41.3 | 8.6 | 20.2 | 33.0 | 340.5 |
| 1943 | 22.2 | 21.4 | 33.1 | 21.3 | 26.2 | 21.0 | 18.2 | 13.1 | 19.4 | 3.1 | 2.6 | 1.8 | 203.4 |
| 1944 | 4.6 | 10.4 | 13.3 | 27.2 | 29.3 | 30.6 | 58.8 | 34.7 | 22.0 | 48.4 | 8.0 | 3.1 | 290.4 |
| 1945 | 9.9 | 15.3 | 21.4 | 25.6 | 25.0 | 20.3 | 23.2 | 19.2 | 43.5 | 11.6 | 13.1 | 10.0 | 238.1 |
| 1946 | 15.0 | 16.1 | 13.3 | 19.2 | 21.0 | 27.3 | 15.4 | 27.7 | 18.4 | 60.5 | 3.9 | 9.8 | 247.6 |
| 1947 | 38.2 | 30.9 | 23.7 | 23.4 | 28.8 | 36.6 | 27.2 | 29.9 | 49.4 | 26.0 | 3.4 | 3.7 | 321.2 |
| Total Average | 13.0 | 17.1 | 20.9 | 21.9 | 23.2 | 29.1 | 24.7 | 37.8 | 40.7 | 17.2 | 14.7 | 12.8 | 273.1 |

a/ Table used to compute flow of Republican River at Bartley Diversion Dam.

Table 99.--Estimated historical flow of Republican River at Bartley Diversion Dam

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 17.4 | 19.7 | 16.8 | 15.1 | 11.4 | 40.2 | 33.5 | 35.3 | 64.1 | 36.9 | 7.1 | 4.8 | 302.3 |
| 1930 | 8.5 | 18.3 | 19.3 | 16.9 | 17.0 | 23.6 | 33.9 | 53.9 | 59.1 | 13.1 | 15.7 | 30.1 | 309.4 |
| 1931 | 49.4 | 35.5 | 26.4 | 23.3 | 29.2 | 30.6 | 33.9 | 26.8 | 28.3 | 5.9 | 1.4 | 1.7 | 292.4 |
| 1932 | 0.9 | 9.0 | 9.0 | 11.4 | 14.0 | 19.2 | 19.8 | 15.9 | 57.9 | 11.0 | 17.2 | 10.5 | 223.4 |
| 1933 | 3.5 | 7.4 | 16.8 | 20.1 | 16.8 | 24.2 | 37.1 | 42.2 | 7.4 | 4.5 | 47.4 | 56.4 | 283.8 |
| 1934 | 12.8 | 15.4 | 25.7 | 23.4 | 20.3 | 24.4 | 17.5 | 4.3 | 37.5 | 1.6 | 0.3 | 12.4 | 195.6 |
| 1935 | 2.6 | 8.8 | 12.8 | 20.9 | 18.0 | 23.4 | 17.8 | 214.4 | 399.7 | 34.3 | 39.4 | 39.8 | 831.9 |
| 1936 | 11.0 | 17.2 | 19.4 | 15.6 | 11.5 | 31.0 | 18.5 | 74.7 | 33.2 | 0.9 | 0.2 | 2.0 | 236.6 |
| 1937 | 0.9 | 9.3 | 14.4 | 7.4 | 23.8 | 26.1 | 16.4 | 17.9 | 39.7 | 20.0 | 19.4 | 14.0 | 209.3 |
| 1938 | 4.7 | 9.4 | 11.5 | 21.2 | 19.5 | 24.7 | 26.5 | 44.0 | 40.9 | 33.9 | 28.0 | 33.2 | 297.5 |
| 1939 | 4.5 | 7.4 | 13.8 | 15.4 | 11.8 | 29.4 | 27.1 | 21.6 | 52.2 | 20.2 | 15.3 | 0 | 218.7 |
| 1940 | 0 | 2.5 | 9.4 | 6.2 | 13.6 | 32.4 | 18.3 | 12.7 | 36.7 | 5.6 | 5.9 | 3.1 | 146.4 |
| 1941 | 13.0 | 10.0 | 13.1 | 16.8 | 22.5 | 26.1 | 30.0 | 30.9 | 84.5 | 63.3 | 44.1 | 30.7 | 385.0 |
| 1942 | 25.8 | 20.8 | 19.3 | 16.7 | 26.6 | 47.9 | 35.6 | 40.3 | 39.0 | 10.6 | 15.9 | 27.3 | 325.8 |
| 1943 | 22.9 | 23.2 | 25.8 | 15.7 | 27.1 | 26.7 | 23.4 | 15.4 | 19.2 | 2.2 | 2.0 | 2.0 | 205.6 |
| 1944 | 1.8 | 5.7 | 9.4 | 15.3 | 25.1 | 29.3 | 60.5 | 48.0 | 43.0 | 74.8 | 13.9 | 2.3 | 329.1 |
| 1945 | 9.7 | 13.4 | 18.2 | 22.3 | 23.8 | 21.3 | 28.0 | 22.0 | 74.9 | 17.5 | 11.7 | 7.8 | 270.6 |
| 1946 | 14.8 | 15.7 | 12.9 | 20.9 | 23.3 | 27.5 | 15.6 | 30.0 | 21.8 | 65.2 | 3.8 | 10.8 | 262.3 |
| 1947 | 72.4 | 36.1 | 24.9 | 20.1 | 23.7 | 35.1 | 31.9 | 32.1 | 83.6 | 28.4 | 2.2 | 1.2 | 391.7 |
| Total Average | 14.6 | 15.0 | 16.8 | 17.1 | 20.7 | 29.2 | 27.6 | 41.2 | 64.4 | 23.7 | 15.3 | 15.3 | 300.9 |

Table 100.—Return flow from 4960 acres irrigated by Red Willow Canal

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.2 | 3.0 |
| 1930 | .2 | .2 | .2 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | 2.1 |
| 1931 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .3 | .3 | .3 | .2 | .2 | 2.4 |
| 1932 | .2 | .2 | .2 | .2 | .3 | .3 | .3 | .4 | .4 | .4 | .3 | .3 | 3.5 |
| 1933 | .3 | .2 | .2 | .2 | .2 | .3 | .3 | .4 | .4 | .4 | .3 | .3 | 3.5 |
| 1934 | .3 | .2 | .2 | .3 | .3 | .4 | .5 | .6 | .6 | .6 | .5 | .4 | 4.9 |
| 1935 | .4 | .3 | .3 | .2 | .2 | .3 | .3 | .4 | .4 | .4 | .3 | .3 | 3.8 |
| 1936 | .2 | .2 | .2 | .3 | .3 | .4 | .4 | .6 | .6 | .6 | .4 | .4 | 4.6 |
| 1937 | .4 | .3 | .3 | .2 | .2 | .3 | .3 | .4 | .4 | .4 | .3 | .3 | 3.8 |
| 1938 | .3 | .2 | .2 | .3 | .3 | .3 | .4 | .5 | .5 | .5 | .4 | .3 | 4.2 |
| 1939 | .3 | .3 | .3 | .3 | .3 | .4 | .4 | .5 | .5 | .5 | .4 | .4 | 4.6 |
| 1940 | .3 | .3 | .3 | .3 | .3 | .4 | .4 | .5 | .6 | .5 | .4 | .4 | 4.7 |
| 1941 | .3 | .3 | .3 | .1 | .2 | .2 | .2 | .2 | .3 | .3 | .2 | .2 | 2.8 |
| 1942 | .2 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .3 | .2 | .2 | .2 | 2.1 |
| 1943 | .2 | .1 | .1 | .2 | .2 | .2 | .3 | .3 | .4 | .3 | .3 | .3 | 2.9 |
| 1944 | .2 | .2 | .2 | 0 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | 1.4 |
| 1945 | .1 | .1 | 0 | .2 | .2 | .2 | .3 | .3 | .4 | .3 | .3 | .2 | 2.6 |
| 1946 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .3 | .3 | .2 | 2.8 |
| 1947 | .2 | .2 | .2 | .1 | .1 | .2 | .2 | .2 | .3 | .2 | .2 | .2 | 2.3 |
| Total Average | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .3 | .4 | .4 | .3 | .3 | 3.3 |

Table 101.—Return flow from 2610 acres irrigated by Red Willow Canal and available for use at Bartley Diversion Dam

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 1.6 |
| 1930 | .1 | 0 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | 1.1 |
| 1931 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .1 | .1 | .1 | 1.3 |
| 1932 | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | 1.8 |
| 1933 | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | 1.8 |
| 1934 | .2 | .1 | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .3 | .2 | .2 | 2.6 |
| 1935 | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .3 | .2 | .2 | .2 | 2.0 |
| 1936 | .2 | .1 | .1 | .1 | .2 | .2 | .2 | .3 | .3 | .3 | .2 | .2 | 2.4 |
| 1937 | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .3 | .2 | .2 | .2 | 2.0 |
| 1938 | .2 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .3 | .2 | .2 | .2 | 2.2 |
| 1939 | .2 | .1 | .1 | .1 | .2 | .2 | .2 | .3 | .3 | .3 | .2 | .2 | 2.4 |
| 1940 | .2 | .1 | .1 | .2 | .2 | .2 | .2 | .3 | .3 | .3 | .2 | .2 | 2.5 |
| 1941 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .1 | .1 | 1.5 |
| 1942 | .1 | 0 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | 1.1 |
| 1943 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .1 | .1 | 1.5 |
| 1944 | .1 | 0 | 0 | 0 | .1 | 0 | .1 | .1 | .1 | .1 | .1 | 0 | 0.7 |
| 1945 | .1 | .1 | 0 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .1 | .1 | 1.4 |
| 1946 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .1 | .1 | 1.5 |
| 1947 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | 1.2 |
| Total Average | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .2 | .2 | .2 | .2 | .1 | 1.7 |

Table 102.--Return flow from 2350 acres irrigated by Red Willow Canal and available for use at Cambridge Diversion Dam a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 1.4 |
| 1930 | .1 | .2 | .1 | 0 | 0 | 0 | .1 | .1 | .1 | .1 | .1 | .1 | 1.0 |
| 1931 | 0 | 0 | 0 | .1 | .1 | .1 | .1 | .2 | .1 | .2 | .1 | .1 | 1.1 |
| 1932 | .1 | .1 | .1 | .1 | .2 | .2 | .1 | .2 | .2 | .2 | .1 | .1 | 1.7 |
| 1933 | .2 | .1 | .1 | .1 | .1 | .2 | .1 | .2 | .2 | .2 | .1 | .1 | 1.7 |
| 1934 | .1 | .1 | 0 | .1 | .1 | .2 | .3 | .3 | .3 | .3 | .3 | .2 | 2.3 |
| 1935 | .3 | .2 | .2 | .1 | .1 | .1 | .1 | .2 | .1 | .2 | .1 | .1 | 1.8 |
| 1936 | 0 | .1 | .1 | .2 | .1 | .2 | .2 | .3 | .3 | .3 | .2 | .2 | 2.2 |
| 1937 | .3 | .2 | .2 | .1 | .1 | .1 | .1 | .1 | .2 | .1 | .1 | .2 | 1.8 |
| 1938 | .1 | .1 | .1 | .2 | .1 | .1 | .2 | .3 | .2 | .3 | .2 | .1 | 2.0 |
| 1939 | .1 | .2 | .2 | .2 | .1 | .2 | .2 | .2 | .2 | .2 | .2 | .2 | 2.2 |
| 1940 | .1 | .2 | .2 | .1 | .1 | .2 | .2 | .2 | .3 | .2 | .2 | .2 | 2.2 |
| 1941 | .2 | .2 | .2 | 0 | .1 | .1 | .1 | 0 | .1 | .1 | .1 | .1 | 1.3 |
| 1942 | .1 | .1 | 0 | 0 | 0 | .1 | .1 | .1 | .2 | .1 | .1 | .1 | 1.0 |
| 1943 | .1 | 0 | 0 | .1 | .1 | .1 | .2 | .1 | .1 | .2 | .2 | .2 | 1.4 |
| 1944 | .1 | .2 | .2 | 0 | 0 | .1 | 0 | 0 | 0 | 0 | 0 | .1 | 0.7 |
| 1945 | 0 | 0 | 0 | .1 | .1 | .1 | .2 | .1 | .2 | .1 | .2 | .1 | 1.2 |
| 1946 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .1 | .2 | .1 | 1.3 |
| 1947 | .1 | .1 | .1 | 0 | 0 | .1 | .1 | .1 | .2 | .1 | .1 | .1 | 1.1 |
| Total Avg. | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 1.5 |

a/ Return flows from 4,960 acres irrigated by 4,960 acres by the Red Willow Canal, Red Willow Unit, less return flow from 2,610 acres considered available at Bartley Diversion Dam.

Table 103.—Return flow from 7030 acres under Bartley Canal

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 4.3 |
| 1930 | .3 | .3 | .3 | .1 | .2 | .2 | .2 | .3 | .3 | .3 | .2 | .2 | 2.9 |
| 1931 | .2 | .2 | .1 | .2 | .3 | .3 | .4 | .4 | .5 | .4 | .4 | .3 | 3.7 |
| 1932 | .3 | .2 | .2 | .3 | .4 | .4 | .5 | .6 | .6 | .6 | .5 | .4 | 5.0 |
| 1933 | .4 | .3 | .3 | .3 | .3 | .4 | .5 | .6 | .6 | .6 | .5 | .4 | 5.2 |
| 1934 | .4 | .3 | .3 | .4 | .5 | .6 | .7 | .8 | .9 | .8 | .7 | .6 | 7.0 |
| 1935 | .5 | .5 | .5 | .3 | .4 | .4 | .4 | .5 | .6 | .5 | .4 | .4 | 5.4 |
| 1936 | .4 | .3 | .3 | .4 | .5 | .6 | .6 | .8 | .9 | .8 | .6 | .6 | 6.8 |
| 1937 | .5 | .4 | .4 | .3 | .3 | .4 | .4 | .6 | .6 | .6 | .4 | .4 | 5.3 |
| 1938 | .4 | .3 | .3 | .4 | .4 | .5 | .5 | .7 | .7 | .7 | .6 | .5 | 6.0 |
| 1939 | .4 | .4 | .4 | .4 | .5 | .5 | .6 | .7 | .8 | .7 | .6 | .5 | 6.5 |
| 1940 | .4 | .4 | .4 | .4 | .5 | .5 | .6 | .7 | .8 | .7 | .6 | .6 | 6.6 |
| 1941 | .5 | 4 | .4 | .2 | .2 | .2 | .3 | .4 | .4 | .4 | .3 | .3 | 4.0 |
| 1942 | .2 | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .4 | .3 | .3 | .3 | 3.1 |
| 1943 | .2 | .2 | .2 | .3 | .3 | .3 | .4 | .5 | .5 | .5 | .4 | .3 | 4.1 |
| 1944 | .3 | .3 | .3 | .1 | .1 | .1 | .1 | .2 | .2 | .1 | .1 | .1 | 2.0 |
| 1945 | .1 | .1 | .1 | .2 | .3 | .3 | .4 | .5 | .5 | .5 | .4 | .3 | 3.7 |
| 1946 | .3 | .3 | .3 | .2 | .3 | .3 | .4 | .5 | .5 | .4 | .4 | .3 | 4.2 |
| 1947 | .3 | .2 | .2 | .2 | .2 | .2 | .3 | .3 | .4 | — | — | — | 2.3 |
| Avg. | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.5 | 0.4 | 0.4 | 4.7 |

Table 104.—Depleted flows of Republican River available for use at Bartley Diversion Dam a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 15.0 | 11.7 | 38.0 | 19.1 | 32.0 | 50.7 | 36.7 | 6.0 | 0.2 | 1.6 | 3.1 | 5.7 | 219.8 |
| 1930 | 3.2 | 9.4 | 17.2 | 26.8 | 54.3 | 53.3 | 5.8 | -0.5 | 17.1 | 36.4 | 29.5 | 24.3 | 276.8 |
| 1931 | 20.8 | 27.3 | 28.1 | 29.5 | 20.6 | 23.9 | 4.4 | -5.9 | 1.4 | -4.5 | -5.8 | -6.8 | 133.0 |
| 1932 | -6.3 | 13.1 | 17.2 | 9.0 | 10.7 | 47.4 | 4.2 | 5.7 | 10.1 | -1.2 | -1.9 | 2.4 | 110.4 |
| 1933 | 1.9 | 0.7 | 9.6 | 23.5 | 26.6 | 4.9 | 2.2 | -0.3 | 43.3 | -0.1 | 11.6 | 22.6 | 146.5 |
| 1934 | 21.7 | 19.3 | 21.7 | 3.4 | 4.6 | 21.0 | 1.5 | 0.8 | 11.8 | 1.7 | 4.2 | -3.6 | 108.1 |
| 1935 | 3.1 | 2.4 | 3.9 | 4.3 | 168.2 | 391.2 | 6.2 | 24.9 | 28.2 | 5.8 | 6.9 | 6.0 | 651.1 |
| 1936 | 7.4 | 8.7 | 28.0 | 0.2 | 74.2 | 12.9 | 1.5 | -2.2 | 4.9 | -1.2 | 1.5 | 3.8 | 139.7 |
| 1937 | -0.1 | 9.9 | 5.9 | 1.7 | -1.6 | 12.9 | 16.1 | 16.8 | 5.2 | -0.2 | 2.1 | 1.4 | 70.1 |
| 1938 | 8.5 | 5.4 | 9.5 | 9.3 | 36.3 | 18.2 | 12.7 | 15.5 | 12.7 | 2.2 | 2.3 | 6.0 | 138.6 |
| 1939 | 11.2 | 8.2 | 28.5 | 11.8 | 17.1 | 30.7 | 14.3 | 11.0 | 2.3 | 0.9 | 1.9 | 2.2 | 140.1 |
| 1940 | -1.4 | -8.9 | 10.7 | 4.0 | 8.2 | 12.3 | 4.2 | 6.5 | -6.4 | 7.9 | -2.5 | -4.1 | 30.5 |
| 1941 | -5.6 | 8.3 | 11.7 | 18.4 | 22.4 | 68.2 | 39.7 | 23.6 | 22.1 | 14.1 | 14.0 | 18.5 | 255.4 |
| 1942 | 15.1 | 25.3 | 43.3 | 30.9 | 33.3 | 32.1 | 5.6 | -0.5 | 2.4 | 5.1 | 16.3 | 19.4 | 228.3 |
| 1943 | 13.6 | 26.0 | 24.6 | 9.5 | 6.3 | 4.5 | 2.8 | 3.4 | 4.4 | 2.1 | 1.5 | 2.6 | 101.3 |
| 1944 | -5.4 | 3.6 | 7.4 | 31.8 | 42.4 | 36.3 | 61.4 | 8.9 | 2.2 | 3.4 | 4.2 | 2.8 | 199.0 |
| 1945 | 2.5 | 7.1 | 16.4 | 20.4 | 13.6 | 56.0 | 9.5 | 2.2 | 1.7 | 3.8 | 5.7 | 8.5 | 147.4 |
| 1946 | 12.8 | 12.7 | 22.2 | 3.7 | 12.6 | 9.6 | 42.9 | 2.9 | 5.2 | 45.5 | 22.9 | 20.9 | 213.9 |
| 1947 | 17.9 | 21.9 | 31.6 | 29.5 | 33.0 | 72.6 | 16.3 | 1.5 | 0.5 | -- | -- | — | 224.8 |
| Total Average | 7.2 | 11.2 | 19.8 | 15.1 | 32.4 | 50.4 | 15.2 | 6.3 | 8.9 | 6.8 | 6.5 | 7.4 | 187.2 |

a/ Computed as combined flows of Frenchman + Republican at Culbertson after upstream development + gain in flow between that point and Bartley Diversion.

Table 105.—Depleted flow of Republican River available for use at Bartley Diversion Dam with winter flows adjusted a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 15.0 | 11.7 | 38.0 | 19.1 | 32.0 | 50.7 | 36.7 | 6.0 | 0.2 | 1.6 | 3.1 | 5.7 | 219.8 |
| 1930 | 3.2 | 9.4 | 17.2 | 26.8 | 54.3 | 53.3 | 5.8 | -0.5 | 17.1 | 36.4 | 29.5 | 24.3 | 276.8 |
| 1931 | 20.8 | 27.3 | 28.1 | 29.5 | 20.6 | 23.9 | 4.4 | -5.9 | 1.4 | -4.5 | 0 | 0 | 145.6 |
| 1932 | 0 | 0 | 11.4 | 9.0 | 10.7 | 47.4 | 4.2 | 5.7 | 10.1 | -1.2 | 0 | 0.5 | 97.8 |
| 1933 | 1.9 | 0.7 | 9.6 | 23.5 | 26.6 | 4.9 | 2.2 | -0.3 | 43.3 | -0.1 | 11.6 | 22.6 | 146.5 |
| 1934 | 21.7 | 19.3 | 21.7 | 3.4 | 4.6 | 21.0 | 1.5 | 0.8 | 11.8 | 1.7 | 4.2 | 0 | 111.7 |
| 1935 | 0 | 1.9 | 3.9 | 4.3 | 168.2 | 391.2 | 6.2 | 24.9 | 28.2 | 5.8 | 6.9 | 6.0 | 647.5 |
| 1936 | 7.4 | 8.7 | 28.0 | 0.2 | 74.2 | 12.9 | 1.5 | -2.2 | 4.9 | -1.2 | 1.5 | 3.8 | 139.7 |
| 1937 | 0 | 9.8 | 5.9 | 1.7 | -1.6 | 12.9 | 16.1 | 16.8 | 5.2 | -0.2 | 2.1 | 1.4 | 70.1 |
| 1938 | 8.5 | 5.4 | 9.5 | 9.3 | 36.3 | 18.2 | 12.7 | 15.5 | 12.7 | 2.2 | 2.3 | 6.0 | 138.6 |
| 1939 | 11.2 | 8.2 | 28.5 | 11.8 | 17.1 | 30.7 | 14.3 | 11.0 | 2.3 | 0.9 | 1.9 | 2.2 | 140.1 |
| 1940 | 0 | 0 | 0.4 | 4.0 | 8.2 | 12.3 | 4.2 | 6.5 | -6.4 | 7.9 | 0 | 0 | 37.1 |
| 1941 | 0 | 0 | 7.8 | 18.4 | 22.4 | 68.2 | 39.7 | 23.6 | 22.1 | 14.1 | 14.0 | 18.5 | 248.8 |
| 1942 | 15.1 | 25.3 | 43.3 | 30.9 | 33.3 | 32.1 | 5.6 | -0.5 | 2.4 | 5.1 | 16.3 | 19.4 | 228.3 |
| 1943 | 13.6 | 26.0 | 24.6 | 9.5 | 6.3 | 4.5 | 2.8 | 3.4 | 4.4 | 2.1 | 1.5 | 2.6 | 101.3 |
| 1944 | 0 | 0 | 5.6 | 31.8 | 42.4 | 36.3 | 61.4 | 8.9 | 2.2 | 3.4 | 4.2 | 2.8 | 199.0 |
| 1945 | 2.5 | 7.1 | 16.4 | 20.4 | 13.6 | 56.0 | 9.5 | 2.2 | 1.7 | 3.8 | 5.7 | 8.5 | 147.4 |
| 1946 | 12.8 | 12.7 | 22.2 | 3.7 | 12.6 | 9.6 | 42.9 | 2.9 | 5.2 | 45.5 | 22.9 | 20.9 | 213.9 |
| 1947 | 17.9 | 21.9 | 31.6 | 29.5 | 33.0 | 72.6 | 16.3 | 1.5 | 0.5 | — | — | — | 224.8 |
| Avg. | 8.0 | 10.3 | 18.6 | 15.1 | 32.4 | 50.4 | 15.2 | 6.3 | 8.9 | 6.8 | 7.1 | 8.0 | 187.1 |

a/ Computed as combined flows of Frenchman + Republican at Culbertson after upstream development + gain in flow between that point and Bartley Diversion. Negatives in winter months carried over to next months.

## Red Willow Unit

### Consumptive use

The Lowry-Johnson method was used in determining the consumptive use requirements for the Red Willow Unit. This method and the determination of the consumptive use monthly distribution percentages are discussed under the consumptive use determination for the Frenchman Unit. The annual consumptive use has been determined from the effective heat based upon the temperatures recorded by the Weather Bureau at Curtis, Nebraska. This computation is shown in table 106. The annual consumptive use has also been determined for Culbertson based upon temperatures recorded there. This computation is shown in table 65. The average of the consumptive use for these two stations was used for the consumptive use for the Red Willow Unit. The monthly distribution and annual consumptive use for the Red Willow Unit are shown in table 107.

### Precipitation over project area

Precipitation data used to determine the effective precipitation for the Red Willow Unit were determined from the average of precipitation recorded by the Weather Bureau at McCook and Cambridge, Nebraska. The precipitation recorded at these two stations is listed in tables 68 and 143.

Not all precipitation falling on the project area is effective; therefore an adjustment was necessary to determine the amount that would be considered effective. These adjustments to the recorded precipitation were made in the same manner as explained for the Frenchman Unit. Effective precipitation at McCook, is shown in table 108 and the effective precipitation at Cambridge, is shown in table 109. The effective precipitation for the Red Willow Unit is the average of these two tables and is shown in table 110.

### Consumptive use requirements of irrigation water

The consumptive use requirements of irrigation water is the amount not supplied by effective precipitation. The monthly consumptive use requirements of irrigation water for the Red Willow Unit, table 111, were determined by subtracting the monthly effective precipitation, table 110, plus any precipitation carry-over of the previous month from the monthly values of consumptive use shown in table 107. The soil reservoir was considered to be able to hold 6 inches, or 0.5 feet of water and this was the maximum carry over used.

### Diversion requirement

In order to satisfy the crop irrigation requirements it is necessary to divert sufficient additional water to overcome transportations and farm losses. The farm losses were estimated to be 30 percent of the farm delivery requirements. Therefore the crop irrigation requirement is multiplied by the ratio of 100 over 100 minus the 30 percent farm loss to give the farm delivery requirement.

Table 106.—Computation of Effective Heat and Consumptive Use at Curtis, Nebraska

(Day Degrees)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total day deg. | Consumptive use in ft. depth a/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | - | - | - | 995 | 1,246 | 1,551 | 1,882 | 1,882 | 1,260 | 1,018 | - | - | 9,834 | 2.38 |
| 1930 | - | - | - | 952 | 1,252 | 1,503 | 1,876 | 1,724 | 1,503 | 979 | - | - | 9,789 | 2.38 |
| 1931 | - | - | - | 639 | 1,367 | 1,743 | 1,900 | 1,727 | 1,686 | 1,218 | - | - | 10,280 | 2.46 |
| 1932 | - | - | - | 862 | 1,488 | 1,560 | 1,944 | 1,835 | 1,476 | 653 | - | - | 9,818 | 2.38 |
| 1933 | - | - | - | 902 | 1,296 | 1,854 | 1,934 | 1,677 | 1,635 | 902 | - | - | 10,200 | 2.44 |
| 1934 | - | - | - | 1,057 | 1,686 | 1,803 | 2,114 | 1,900 | 1,395 | 1,392 | 56 | - | 11,403 | 2.63 |
| 1935 | - | - | 120 | 864 | 980 | 1,503 | 1,993 | 1,841 | 1,449 | 919 | - | - | 9,669 | 2.36 |
| 1936 | - | - | - | 385 | 1,442 | 1,710 | 2,092 | 2,000 | 1,581 | 842 | - | - | 10,052 | 2.42 |
| 1937 | - | - | - | 812 | 1,479 | 1,599 | 2,065 | 2,071 | 1,617 | 956 | - | - | 10,599 | 2.51 |
| 1938 | - | - | 287 | 1,071 | 1,293 | 1,680 | 1,941 | 2,012 | 1,575 | 1,344 | - | - | 11,203 | 2.60 |
| 1939 b/ | - | - | - | 965 | 1,411 | 1,650 | 2,049 | 1,866 | 1,680 | 1,047 | - | - | 10,668 | 2.52 |
| 1940 | - | - | - | 902 | 1,451 | 1,782 | 2,018 | 1,807 | 1,593 | 1,196 | - | - | 10,749 | 2.53 |
| 1941 | - | - | - | 937 | 1,476 | 1,524 | 1,869 | 1,876 | 1,485 | 1,001 | 27 | - | 10,195 | 2.44 |
| 1942 | - | - | 59 | 1,104 | 1,296 | 1,518 | 1,938 | 1,770 | 1,266 | 1,054 | - | - | 10,005 | 2.41 |
| 1943 | - | - | - | 942 | 1,228 | 1,569 | 1,972 | 1,950 | 1,482 | 628 | - | - | 9,771 | 2.37 |
| 1944 | - | - | - | 459 | 1,404 | 1,494 | 1,662 | 1,733 | 1,536 | 942 | - | - | 9,230 | 2.29 |
| 1945 b/ | - | - | - | 767 | 1,352 | 1,344 | 1,798 | 1,786 | 1,458 | 941 | - | - | 9,446 | 2.32 |
| 1946 b/ | - | - | 556 | 1,161 | 1,107 | 1,572 | 1,739 | 1,596 | 1,311 | 852 | - | - | 9,894 | 2.39 |
| 1947 b/ | - | - | - | 689 | 1,175 | 1,347 | 1,634 | 1,916 | 1,479 | 1,355 | 114 | - | 9,709 | 2.36 |
| Total | | | | | | | | | | | | | | |
| Avg. | | | | | | | | | | | | | 10,132 | 2.43 |

a/ From Lowry-Johnson curve.
b/ Records for Lexington used when Curtis records were incomplete.

Table 107.—Distribution of Consumptive Use--Red Willow Unit a/

(Feet per acre)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.42 |
| 1930 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.42 |
| 1931 | .03 | .05 | .12 | .20 | .25 | .35 | .47 | .45 | .30 | .15 | .07 | .05 | 2.49 |
| 1932 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .15 | .07 | .05 | 2.41 |
| 1933 | .02 | .05 | .12 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.50 |
| 1934 | .03 | .05 | .13 | .22 | .27 | .38 | .51 | .48 | .32 | .16 | .08 | .05 | 2.68 |
| 1935 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .14 | .07 | .05 | 2.40 |
| 1936 | .02 | .05 | .13 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.51 |
| 1937 | .02 | .05 | .13 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.51 |
| 1938 | .03 | .05 | .13 | .21 | .26 | .36 | .50 | .47 | .31 | .16 | .08 | .05 | 2.61 |
| 1939 | .03 | .05 | .13 | .20 | .25 | .36 | .48 | .46 | .30 | .15 | .08 | .05 | 2.54 |
| 1940 | .03 | .05 | .13 | .20 | .26 | .36 | .48 | .46 | .31 | .15 | .08 | .05 | 2.56 |
| 1941 | .02 | .05 | .12 | .20 | .25 | .34 | .47 | .44 | .29 | .15 | .07 | .05 | 2.45 |
| 1942 | .02 | .05 | .12 | .20 | .25 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.44 |
| 1943 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.42 |
| 1944 | .02 | .05 | .12 | .19 | .23 | .33 | .45 | .42 | .28 | .14 | .07 | .05 | 2.35 |
| 1945 | .02 | .05 | .12 | .19 | .24 | .33 | .45 | .43 | .28 | .14 | .07 | .05 | 2.37 |
| 1946 | .02 | .05 | .13 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.51 |
| 1947 | .02 | .05 | .12 | .20 | .25 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.44 |
| Total Avg. | .02 | .05 | .12 | .20 | .25 | .35 | .47 | .45 | .30 | .15 | .07 | .05 | 2.48 |

a/ Use mean of records at Culbertson, Curtis, and Alma.

Table 108.--Effective precipitation at McCook, Nebraska a/

(Feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | 0.01 | 0.03 | 0.07 | 0.02 | 0.27 | 0.31 | 0.34 | 0.03 | 0.08 | 0.11 | 0.16 | 0 | 1.43 |
| 1929 | .01 | .09 | .03 | .13 | .25 | .30 | .20 | .09 | .18 | .11 | .14 | .01 | 1.54 |
| 1930 | .09 | .07 | .01 | .30 | .31 | .27 | .34 | .18 | .20 | .34 | .20 | .03 | 2.34 |
| 1931 | .02 | .15 | .27 | .12 | .09 | .23 | .09 | .19 | .05 | .06 | .18 | .04 | 1.49 |
| 1932 | .07 | .07 | .03 | .13 | .23 | .27 | .19 | .10 | .09 | .05 | 0 | .01 | 1.24 |
| 1933 | 0 | .02 | .16 | .22 | .20 | .09 | .14 | .33 | .23 | 0 | .01 | .12 | 1.52 |
| 1934 | .03 | .09 | .01 | .11 | .10 | .32 | .04 | .14 | .15 | .01 | .15 | .04 | 1.19 |
| 1935 | 0 | .02 | .04 | .11 | .34 | .22 | .10 | .21 | .13 | .04 | .10 | .02 | 1.33 |
| 1936 | .04 | .03 | .01 | .08 | .33 | .12 | .16 | .05 | .10 | .01 | .01 | .05 | 0.99 |
| 1937 | .07 | .02 | .18 | .05 | .18 | .26 | .15 | .11 | .08 | .11 | .01 | .02 | 1.24 |
| 1938 | .02 | .01 | .12 | .18 | .33 | .09 | .23 | .25 | .12 | 0 | 0 | .01 | 1.36 |
| 1939 | .05 | .04 | .12 | .19 | .13 | .26 | .14 | .10 | .02 | 0 | 0 | .07 | 1.12 |
| 1940 | .07 | .03 | .28 | .02 | .14 | .16 | .16 | .14 | .11 | .03 | .07 | .09 | 1.30 |
| 1941 | .11 | .03 | .05 | .27 | .18 | .34 | .14 | .11 | .33 | .06 | .01 | .18 | 1.81 |
| 1942 | .03 | .11 | .15 | .25 | .16 | .33 | .07 | .13 | .31 | .04 | .05 | .04 | 1.67 |
| 1943 | .01 | .01 | .05 | .15 | .10 | .22 | .15 | .10 | .03 | .01 | .01 | .02 | 0.86 |
| 1944 | .18 | .14 | .16 | .34 | .15 | .21 | .34 | .09 | .01 | .07 | .10 | .04 | 1.83 |
| 1945 | .05 | .02 | .02 | .18 | .22 | .29 | .21 | .30 | .12 | .02 | .01 | .06 | 1.50 |
| 1946 | .01 | 0 | .16 | .01 | .30 | .22 | .32 | .23 | .19 | .34 | .20 | 0 | 1.98 |
| 1947 | .03 | .04 | .08 | .18 | .19 | .29 | .25 | .06 | .14 | .09 | .10 | .09 | 1.54 |
| Total Average | .05 | .05 | .10 | .16 | .21 | .18 | .18 | .15 | .14 | .07 | .07 | .05 | 1.41 |

a/ Based upon rainfall recorded at McCook, Nebraska.

Table 109.--Effective Precipitation at Cambridge, Nebraska

(Feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1928 | | | | | | | | | | | 0.17 | 0 | |
| 1929 | 0.03 | 0.15 | 0 | 0.20 | 0.32 | 0.20 | 0.12 | 0.04 | 0.14 | 0.19 | 0.12 | 0 | 1.51 |
| 1930 | .06 | .06 | .02 | .34 | .31 | .30 | .24 | .15 | .10 | .28 | .19 | .02 | 2.07 |
| 1931 | .01 | .07 | .24 | .11 | .16 | .24 | .14 | .22 | .07 | .07 | .20 | .01 | 1.54 |
| 1932 | .07 | .04 | .04 | .08 | .12 | .33 | .22 | .02 | .13 | .04 | .01 | .03 | 1.13 |
| 1933 | 0 | .02 | .12 | .29 | .22 | .11 | .16 | .34 | .10 | 0 | 0 | .10 | 1.46 |
| 1934 | 0 | .07 | 0 | .07 | .13 | .25 | .09 | .10 | .24 | .07 | .22 | .04 | 1.28 |
| 1935 | 0 | .04 | .07 | .05 | .34 | .18 | 0 | .26 | .15 | .02 | .08 | .01 | 1.20 |
| 1936 | .04 | .02 a/ | .01 | .08 | .34 | .09 | .11 | .07 | .14 | .01 | 0 | .05 | 0.96 |
| 1937 | .04 | .01 | .13 | .05 | .16 | .24 | .19 | .31 | .16 | .11 | .01 | .01 | 1.42 |
| 1938 | .02 | .01 | .10 | .16 | .31 | .09 | .29 | .20 | .10 | 0 | 0 | .01 | 1.29 |
| 1939 | .06 | .04 | .09 | .09 | .23 | .33 | .15 | .13 | .03 | 0 | 0 | .07 | 1.22 |
| 1940 | .06 | .04 | .19 | .03 | .18 | .15 | .15 | .04 | .17 | .07 | .06 | .08 | 1.22 |
| 1941 | .08 | .04 | .03 | .33 | .24 | .34 | .18 | .05 | .29 | .04 | .04 | .12 | 1.78 |
| 1942 | .04 | .08 | .06 | .26 | .18 | .32 | .15 | .22 | .26 | .07 | .05 | .04 | 1.73 |
| 1943 | .03 | .03 | .06 | .31 | .05 | .22 | .19 | .22 | .25 | .04 | .01 | .01 | 1.42 |
| 1944 | .17 | .10 | .18 | .34 | .30 | .34 | .34 | .22 | 0 | .04 | .16 | .02 | 2.21 |
| 1945 | .05 | .03 | .03 | .20 | .21 | .27 | .07 | .22 | .18 | .02 | .03 | .07 | 1.38 |
| 1946 | .01 | 0 | .14 | .01 | .33 | .25 | .28 | .15 | .24 | .34 | .22 | .01 | 1.98 |
| 1947 | .05 | .04 | .06 | .18 | .18 | .34 | .21 | .05 | .22 | .05 | .10 | .04 | 1.52 |
| Total Avg. | 0.04 | 0.5 | 0.8 | 1.7 | 2.3 | 2.4 | 1.7 | 1.6 | 1.6 | 0.8 | 0.8 | 0.4 | 1.50 |

a/ Feb. - Aug. 1936 are average precipitation records of McCook, Gosper, and Beaver City.

Table 110.--Average of effective precipitation of Cambridge and McCook (Red Willow) a/

(Feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.02 | 0.12 | 0.01 | 0.16 | 0.29 | 0.25 | 0.16 | 0.07 | 0.15 | 0.15 | 0.13 | 0.01 | 1.52 |
| 1930 | .07 | .06 | .01 | .33 | .31 | .29 | .34 | .16 | .15 | .33 | .19 | .03 | 2.27 |
| 1931 | .02 | .11 | .26 | .11 | .13 | .23 | .11 | .20 | .06 | .07 | .19 | .03 | 1.52 |
| 1932 | .07 | .05 | .03 | .11 | .18 | .31 | .21 | .06 | .11 | .04 | .01 | .02 | 1.20 |
| 1933 | 0 | .02 | .14 | .26 | .21 | .10 | .15 | .34 | .17 | 0 | 0 | .11 | 1.50 |
| 1934 | .01 | .07 | .01 | .09 | .11 | .29 | .07 | .12 | .19 | .04 | .19 | .04 | 1.23 |
| 1935 | 0 | .03 | .06 | .08 | .34 | .19 | .05 | .24 | .14 | .03 | .09 | .02 | 1.27 |
| 1936 | .04 | .02 a/ | .01 | .08 | .34 | .09 | .11 | .07 | .12 | .01 | 0 | .05 | 0.94 |
| 1937 | .06 | .01 | .15 | .05 | .17 | .31 | .17 | .23 | .12 | .11 | .01 | .02 | 1.41 |
| 1938 | .02 | .01 | .11 | .18 | .32 | .09 | .26 | .22 | .11 | 0 | 0 | .01 | 1.33 |
| 1939 | .05 | .04 | .10 | .14 | .19 | .30 | .14 | .11 | .03 | 0 | 0 | .07 | 1.17 |
| 1940 | .07 | .04 | .23 | .03 | .16 | .16 | .15 | .09 | .14 | .05 | .07 | .09 | 1.28 |
| 1941 | .10 | .04 | .04 | .31 | .21 | .34 | .16 | .08 | .32 | .05 | .03 | .15 | 1.83 |
| 1942 | .03 | .09 | .11 | .26 | .18 | .33 | .11 | .18 | .29 | .05 | .05 | .04 | 1.72 |
| 1943 | .02 | .02 | .06 | .24 | .08 | .22 | .17 | .16 | .15 | .02 | .01 | .01 | 1.16 |
| 1944 | .18 | .12 | .18 | .34 | .24 | .31 | .34 | .16 | 0 | .06 | .13 | .03 | 2.09 |
| 1945 | .05 | .02 | .03 | .19 | .22 | .28 | .14 | .26 | .15 | .02 | .02 | .07 | 1.45 |
| 1946 | .01 | 0 | .15 | .01 | .32 | .23 | .31 | .19 | .22 | .34 | .21 | .01 | 2.00 |
| 1947 | .04 | .04 | .07 | .18 | .19 | .32 | .23 | .06 | .18 | .07 | .10 | .06 | 1.54 |
| Total Avg. | .04 | .05 | .09 | .17 | .22 | .24 | .18 | .16 | .15 | .08 | .07 | .05 | 1.50 |

a/ February - July 1936 are precipitation records from the average of McCook, Gosper, and Beaver City.

Table 114--Consumptive Use Requirements of Irrigation Water
Red Willow Unit

Feet per acre irrigated

| Year | Apr. a/ | May a/ | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0 | 0 | 0.01 | 0.34 | 0.40 | 0.15 | 0 | 0.90 |
| 1930 | 0 | 0 | 0 | .05 | .29 | .19 | 0 | .53 |
| 1931 | 0 | 0 | 0 | .28 | .23 | .23 | .08 | .82 |
| 1932 | .06 | .12 | .01 | .24 | .41 | .16 | .11 | 1.11 |
| 1933 | 0 | .07 | .24 | .32 | .11 | .20 | .15 | 1.09 |
| 1934 | .24 | .22 | .13 | .42 | .38 | .08 | .09 | 1.56 |
| 1935 | .09 | 0 | .06 | .46 | .17 | .14 | .12 | 1.04 |
| 1936 | .20 | 0 | .25 | .37 | .38 | .16 | .14 | 1.50 |
| 1937 | .20 | .14 | .11 | .29 | .14 | .14 | .04 | 1.06 |
| 1938 | .15 | .04 | .27 | .21 | .27 | .21 | .16 | 1.31 |
| 1939 | .18 | .09 | .03 | .33 | .33 | .27 | .15 | 1.38 |
| 1940 | .15 | .08 | .21 | .33 | .42 | .14 | .08 | 1.41 |
| 1941 | 0 | 0 | 0 | .20 | .39 | 0 | .11 | .70 |
| 1942 | 0 | 0 | 0 | .31 | .22 | .03 | .08 | .64 |
| 1943 | 0 | .17 | .12 | .27 | .22 | .04 | .11 | .93 |
| 1944 | 0 | 0 | 0 | 0 | 0 | .20 | .10 | .30 |
| 1945 | 0 | .04 | .06 | .38 | .21 | .10 | .12 | .91 |
| 1946 | .23 | 0 | .05 | .20 | .30 | .06 | 0 | .84 |
| 1947 | 0 | 0 | 0 | .09 | .39 | .07 | .10 | .65 |
| Average | 0.08 | 0.05 | 0.08 | 0.27 | 0.28 | 0.13 | 0.09 | 0.98 |

a/ Includes one-half of portion of Nov.-Mar. requirement not met by the effective precipitation for that period.

Transportation losses in the distribution system include water consumed by evaporation, transpiration by the canal-bank vegetation and seepage or percolation. The estimated percentage for the canal losses was based upon these factors together with the length of the canal. Canal losses were estimated to be 25 percent of the diversion requirements. Table 112 lists the diversion requirements determined for the Red Willow Unit in acre-feet per acre by multiplying the ratio of 100 over 100 minus 25 percent by the farm delivery requirement. The diversion requirements for the 4,960 acres under the McCook and Red Willow Canals are listed in table 113 and the diversion requirements for the 7,030 acres under the Bartley Canal are listed in table 114.

Evaporation from reservoir

The evaporation rate from Red Willow Reservoir was determined by using the same general procedure as was used for determining the evaporation rates from Enders Reservoir.

Gross evaporation.--The records of evaporation rates of North Platte, Nebraska were used in determining the evaporation rates from Red Willow Reservoir through the period from April through September. The actual records were converted to evaporation rates from a free water surface, table 115, by multiplying the actual readings by a coefficient of 0.94. These converted records are moved to the Red Willow Reservoir area by factors determined from Adolph F. Meyer's Charts.1/

| Month | Factor |
|---|---|
| April | 1.06 |
| May | 1.05 |
| June | 1.03 |
| July | 1.06 |
| August | 1.03 |
| September | 1.05 |

Records of evaporation are not collected during the winter because of freezing weather; therefore the rates of evaporation for the winter months are based upon studies by Adolph F. Meyer.1/

| Month | Evaporation rate in inches |
|---|---|
| October | 4.85 |
| November | 2.75 |
| December | 1.35 |
| January | 1.05 |
| February | 1.30 |
| March | 2.35 |

The gross evaporation at Red Willow Reservoir is contained in table 116.

1/ Adolph F. Meyer, "Evaporation from Lakes and Reservoirs," published by Minnesota Reservoirs Commission, June 1942.

Table 112.--Diversion Requirements--Red Willow Unit

(acre-feet per acre irrigated)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0.00 | 0.00 | 0.02 | 0.65 | 0.76 | 0.28 | 0.00 | 1.71 |
| 1930 | .00 | .00 | .00 | .10 | .55 | .36 | .00 | 1.01 |
| 1931 | .00 | .00 | .00 | .53 | .44 | .44 | .15 | 1.56 |
| 1932 | .11 | .23 | .02 | .46 | .78 | .30 | .21 | 2.11 |
| 1933 | .00 | .13 | .46 | .61 | .21 | .38 | .28 | 2.07 |
| 1934 | .45 | .42 | .25 | .80 | .72 | .15 | .17 | 2.96 |
| 1935 | .17 | .00 | .12 | .87 | .32 | .27 | .23 | 1.98 |
| 1936 | .38 | .00 | .48 | .70 | .72 | .30 | .27 | 2.85 |
| 1937 | .38 | .26 | .21 | .55 | .26 | .27 | .08 | 2.01 |
| 1938 | .29 | .08 | .51 | .40 | .51 | .40 | .30 | 2.49 |
| 1939 | .34 | .17 | .06 | .63 | .63 | .51 | .28 | 2.62 |
| 1940 | .28 | .15 | .40 | .63 | .80 | .27 | .15 | 2.68 |
| 1941 | .00 | .00 | .00 | .38 | .74 | .00 | .21 | 1.33 |
| 1942 | .00 | .00 | .00 | .59 | .42 | .06 | .15 | 1.22 |
| 1943 | .00 | .32 | .23 | .51 | .42 | .08 | .21 | 1.77 |
| 1944 | .00 | .00 | .00 | .00 | .00 | .38 | .19 | .57 |
| 1945 | .00 | .08 | .11 | .72 | .40 | .19 | .23 | 1.73 |
| 1946 | .44 | .00 | .10 | .38 | .57 | .11 | .00 | 1.60 |
| 1947 | .00 | .00 | .00 | .17 | .74 | .13 | .19 | 1.23 |
| Total Avg. | 0.15 | 0.10 | 0.16 | 0.51 | 0.52 | 0.26 | 0.17 | 1.87 |

Table 113—Diversion requirements for 4,960 Acres under Red Willow Creek Canal.

(Unit - 1,000 acre-feet)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0 | 0 | 0.1 | 3.2 | 3.8 | 1.4 | 0 | 8.5 |
| 1930 | 0 | 0 | 0 | 0.5 | 2.7 | 1.8 | 0 | 5.0 |
| 1931 | 0 | 0 | 0 | 2.6 | 2.2 | 2.2 | 0.7 | 7.7 |
| 1932 | 0.5 | 1.1 | 0.1 | 2.3 | 3.9 | 1.5 | 1.0 | 10.4 |
| 1933 | 0 | 0.6 | 2.3 | 3.0 | 1.0 | 1.9 | 1.4 | 10.2 |
| 1934 | 2.2 | 2.1 | 1.2 | 4.0 | 3.6 | 0.7 | 0.8 | 14.6 |
| 1935 | 0.8 | 0 | 0.6 | 4.3 | 1.6 | 1.3 | 1.1 | 9.7 |
| 1936 | 1.9 | 0 | 2.4 | 3.5 | 3.6 | 1.5 | 1.3 | 14.2 |
| 1937 | 1.9 | 1.3 | 1.0 | 2.7 | 1.3 | 1.3 | 0.4 | 9.9 |
| 1938 | 1.4 | 0.4 | 2.5 | 2.0 | 2.5 | 2.0 | 1.5 | 12.3 |
| 1939 | 1.7 | 0.8 | 0.3 | 3.1 | 3.1 | 2.5 | 1.4 | 12.9 |
| 1940 | 1.4 | 0.7 | 2.0 | 3.1 | 4.0 | 1.3 | 0.7 | 13.2 |
| 1941 | 0 | 0 | 0 | 1.9 | 3.7 | 0 | 1.0 | 6.6 |
| 1942 | 0 | 0 | 0 | 2.9 | 2.1 | 0.3 | 0.7 | 6.0 |
| 1943 | 0 | 1.6 | 1.1 | 2.5 | 2.1 | 0.4 | 1.0 | 8.7 |
| 1944 | 0 | 0 | 0 | 0 | 0 | 1.9 | 0.9 | 2.8 |
| 1945 | 0 | 0.4 | 0.5 | 3.6 | 2.0 | 0.9 | 1.1 | 8.5 |
| 1946 | 2.2 | 0 | 0.5 | 1.9 | 2.8 | 0.5 | 0 | 7.9 |
| 1947 | 0 | 0 | 0 | 0.8 | 3.7 | 0.6 | 0.9 | 6.0 |
| Total Average | 0.7 | 0.5 | 0.8 | 2.5 | 2.6 | 1.3 | 0.8 | 9.2 |

Table 114.--Diversion requirements for 7030 Acres under Bartley Canal.

(Unit - 1000 acre-feet)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0 | 0 | 0.1 | 4.6 | 5.3 | 2.0 | 0 | 12.0 |
| 1930 | 0 | 0 | 0 | 0.7 | 3.9 | 2.5 | 0 | 7.1 |
| 1931 | 0 | 0 | 0 | 3.7 | 3.1 | 3.1 | 1.1 | 11.0 |
| 1932 | 0.8 | 1.6 | 0.1 | 3.2 | 5.5 | 2.1 | 1.5 | 14.8 |
| 1933 | 0 | 0.9 | 3.2 | 4.3 | 1.5 | 2.7 | 2.0 | 14.6 |
| 1934 | 3.2 | 3.0 | 1.8 | 5.6 | 5.1 | 1.1 | 1.2 | 21.0 |
| 1935 | 1.2 | 0 | 0.8 | 6.1 | 2.2 | 1.9 | 1.6 | 13.8 |
| 1936 | 2.7 | 0 | 3.4 | 4.9 | 5.1 | 2.1 | 1.9 | 20.1 |
| 1937 | 2.7 | 1.8 | 1.5 | 3.9 | 1.8 | 1.9 | 0.6 | 14.2 |
| 1938 | 2.0 | 0.6 | 3.6 | 2.8 | 3.6 | 2.8 | 2.1 | 17.5 |
| 1939 | 2.4 | 1.2 | 0.4 | 4.4 | 4.4 | 3.6 | 2.0 | 18.4 |
| 1940 | 2.0 | 1.1 | 2.8 | 4.4 | 5.6 | 2.0 | 1.1 | 19.0 |
| 1941 | 0 | 0 | 0 | 2.7 | 5.2 | 0 | 1.5 | 9.4 |
| 1942 | 0 | 0 | 0 | 4.1 | 3.0 | 0.4 | 1.1 | 8.6 |
| 1943 | 0 | 2.2 | 1.6 | 3.6 | 3.0 | 0.6 | 1.5 | 12.5 |
| 1944 | 0 | 0 | 0 | 0 | 0 | 2.7 | 1.3 | 4.0 |
| 1945 | 0 | 0.6 | 0.8 | 5.1 | 2.8 | 1.3 | 1.6 | 12.2 |
| 1946 | 3.1 | 0 | 0.7 | 2.7 | 4.0 | 0.8 | 0 | 11.3 |
| 1947 | 0 | 0 | 0 | 1.2 | 5.2 | 0.9 | 1.3 | 8.6 |
| Total Average | 1.7 | 0.7 | 1.1 | 3.6 | 3.7 | 1.8 | 1.2 | 13.2 |

Table 115.--Reservoir Evaporation - North Platte. a/

(Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | | | | 5.04 | 5.18 | 6.19 | 8.40 | 7.61 | 3.92 | | | | |
| 1930 | | | | 4.05 | 5.39 | 5.81 | 7.67 | 6.19 | 4.52 | | | | |
| 1931 | | | | 4.30 | 6.39 | 7.71 | 9.65 | 8.07 | 7.19 | | | | |
| 1932 | | | | 5.12 | 7.24 | 6.57 | 8.07 | 7.74 | 5.89 | | | | |
| 1933 | | | | 5.82 | 5.54 | 9.11 | 10.02 | 5.57 | 6.24 | | | | |
| 1934 | | | | 5.95 | 9.02 | 9.95 | 12.50 | 9.06 | 5.25 | | | | |
| 1935 | | | | 4.63 | 4.03 | 5.54 | 9.21 | 8.05 | 4.94 | | | | |
| 1936 | | | | 4.99 | 5.60 | 8.56 | 10.99 | 8.85 | 6.76 | | | | |
| 1937 | | | | 4.74 | 6.19 | 6.44 | 8.98 | 8.52 | 6.19 | | | | |
| 1938 | | | | 4.17 | 5.11 | 7.40 | 9.45 | 9.87 | 4.99 | | | | |
| 1939 | | | | 4.57 | 6.88 | 8.84 | 10.82 | 8.55 | 8.46 | | | | |
| 1940 | | | | 4.52 | 7.41 | 9.38 | 9.89 | 7.76 | 6.15 | | | | |
| 1941 | | | | 3.74 | 6.03 | 6.03 | 7.54 | 7.34 | 5.98 | | | | |
| 1942 | | | | 3.75 | 5.69 | 5.56 | 7.38 | 6.58 | 3.97 | | | | |
| 1943 | | | | 5.40 | 4.37 | 6.56 | 8.25 | 7.31 | 6.15 | | | | |
| 1944 | | | | 2.89 | 6.38 | 6.76 | 7.17 | 7.03 | 5.36 | | | | |
| 1945 | | | | 3.72 | 5.04 | 5.35 | 6.48 | 6.09 | 5.60 | | | | |
| 1946 | | | | 5.29 | 5.56 | 7.08 | 7.93 | 7.01 | 5.50 | | | | |
| 1947 | | | | 3.17 | 4.55 | 5.66 | 6.61 | 7.75 | 5.83 | | | | |
| Avg. | | | | 4.51 | 6.10 | 7.02 | 8.79 | 7.61 | 5.70 | | | | |

a/ 0.94 x actual readings

Table 116.--Gross Evaporation at Red Willow Reservoir a/

(inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.05 | 1.30 | 2.35 | 5.34 | 5.44 | 6.38 | 8.90 | 7.84 | 4.12 | 4.85 | 2.75 | 1.35 | 51.67 |
| 1930 | 1.05 | 1.30 | 2.35 | 4.29 | 5.66 | 5.98 | 8.13 | 6.38 | 4.75 | 4.85 | 2.75 | 1.35 | 48.84 |
| 1931 | 1.05 | 1.30 | 2.35 | 4.56 | 6.71 | 7.94 | 10.23 | 8.31 | 7.55 | 4.85 | 2.75 | 1.35 | 58.95 |
| 1932 | 1.05 | 1.30 | 2.35 | 5.43 | 7.60 | 6.77 | 8.55 | 7.97 | 6.18 | 4.85 | 2.75 | 1.35 | 56.15 |
| 1933 | 1.05 | 1.30 | 2.35 | 6.17 | 5.82 | 9.38 | 10.62 | 5.74 | 6.55 | 4.85 | 2.75 | 1.35 | 57.93 |
| 1934 | 1.05 | 1.30 | 2.35 | 6.31 | 9.47 | 10.25 | 13.25 | 9.33 | 5.51 | 4.85 | 2.75 | 1.35 | 67.77 |
| 1935 | 1.05 | 1.30 | 2.35 | 4.91 | 4.23 | 5.71 | 9.76 | 8.29 | 5.19 | 4.85 | 2.75 | 1.35 | 51.74 |
| 1936 | 1.05 | 1.30 | 2.35 | 5.29 | 5.88 | 8.82 | 11.65 | 9.12 | 7.10 | 5.85 | 2.75 | 1.35 | 61.51 |
| 1937 | 1.00 | 1.30 | 2.35 | 5.02 | 6.50 | 6.63 | 9.52 | 8.78 | 6.50 | 4.85 | 2.75 | 1.35 | 56.60 |
| 1938 | 1.05 | 1.30 | 2.35 | 4.42 | 5.37 | 7.62 | 10.02 | 10.17 | 5.24 | 4.85 | 2.75 | 1.35 | 56.49 |
| 1939 | 1.05 | 1.30 | 2.35 | 4.84 | 7.22 | 9.11 | 11.47 | 8.81 | 8.88 | 4.85 | 2.75 | 1.35 | 63.98 |
| 1940 | 1.05 | 1.30 | 2.35 | 4.79 | 7.78 | 9.66 | 10.48 | 7.99 | 6.46 | 4.85 | 2.75 | 1.35 | 60.81 |
| 1941 | 1.05 | 1.30 | 2.35 | 3.96 | 6.33 | 6.21 | 7.99 | 7.56 | 6.28 | 4.85 | 2.75 | 1.35 | 51.98 |
| 1942 | 1.05 | 1.30 | 2.35 | 3.98 | 5.97 | 5.73 | 7.82 | 6.78 | 4.17 | 4.85 | 2.75 | 1.35 | 48.10 |
| 1943 | 1.05 | 1.30 | 2.35 | 5.72 | 4.59 | 6.76 | 8.74 | 7.53 | 6.46 | 4.85 | 2.75 | 1.35 | 53.45 |
| 1944 | 1.05 | 1.30 | 2.35 | 3.06 | 6.70 | 6.96 | 7.60 | 7.24 | 5.63 | 4.85 | 2.75 | 1.35 | 50.84 |
| 1945 | 1.05 | 1.30 | 2.35 | 3.94 | 5.29 | 5.51 | 6.87 | 6.27 | 5.88 | 4.85 | 2.75 | 1.35 | 47.41 |
| 1946 | 1.05 | 1.30 | 2.35 | 5.61 | 5.84 | 7.29 | 8.41 | 7.22 | 5.30 | 4.85 | 2.75 | 1.35 | 53.32 |
| 1947 | 1.05 | 1.30 | 2.35 | 3.36 | 4.78 | 5.83 | 7.01 | 7.98 | 6.12 | 4.85 | 2.75 | 1.35 | 48.73 |
| Total Average | 1.05 | 1.30 | 2.35 | 4.79 | 6.17 | 7.29 | 9.32 | 7.86 | 5.99 | 4.85 | 2.75 | 1.35 | 55.07 |

a/ Oct. through Mar. estimated from Meyer's maps. Other months based on correction factors for records at North Platte, Nebr. (1.06 for Apr., 1.05 for May, 1.03 for June, 1.06 for July, 1.03 for Aug. and 1.05 for Sept.)

Precipitation over reservoir area.--The records of precipitation at McCook, table 68, are assumed to represent the precipitation over the Red Willow Reservoir area.

Net reservoir evaporation.--The net evaporation from Red Willow Reservoir, table 117, is the gross evaporation, table 116, less the precipitation over the reservoir area, table 68.

The amount of water that is lost by evaporation from the reservoir surface may be obtained from the Reservoir evaporation chart, exhibit 31. This chart shows the evaporation loss in 1,000 acre-feet for various reservoir capacities between 0 and 18,000 acre-feet and for various evaporation rates between 1 and 16 inches.

Seepage

From geologic data taken at the dam site the seepage from Red Willow Reservoir was estimated to range from 0 to 8 second-feet. Although losses from the reservoir to the abutment may occur in some such variable fashion, it is believed that outflow from the abutment to the stream would remain practically constant throughout the year, providing that the reservoir filled at least once during the year.

In this study the seepage was held constant at approximately 5 second-feet, which amounts to approximately 300 acre-feet per month.

## Water Utilization

An operation study showing the water delivery on a monthly basis for the irrigation of 11,990 acres has been made to determine the adequacy of the water supply available for development of the Red Willow Unit.

Reservoir operations

The operations study, table 118, is based upon conditions expected to exist in Red Willow Reservoir after 50 years of operation. The initial active irrigation storage capacity of 26,500 acre-feet has been reduced by 8,500 acre-feet of sediment to the 18,000 acre-feet which was used in this study. The amount of water assumed to be available for development of irrigation in the unit was determined after allowing for all water use that will occur because of future developments above the Reservoir on Red Willow Creek and above Bartley Diversion Dam on the Republican River.

Table 118, shows the computations made in the operations study for the Red Willow Unit. The following operation criteria were used in making the operation study.

1. Method of meeting irrigation demands

Table 117.--Net Evaporation at Red Willow Reservoir a/

(Inches)

| Year | Jan | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.87 | 0.14 | 2.01 | 3.68 | 2.04 | 1.96 | 6.24 | 6.66 | 1.89 | 3.45 | 0.95 | 1.21 | 31.10 |
| 1930 | -0.05 | 0.48 | 2.23 | -0.14 | 0.91 | 2.21 | -0.57 | 4.16 | 2.07 | -1.81 | 0.14 | 0.95 | 10.58 |
| 1931 | 0.75 | -0.67 | -1.52 | 3.05 | 5.53 | 4.83 | 9.11 | 5.80 | 6.96 | 4.06 | 0.49 | 0.79 | 39.18 |
| 1932 | 0.25 | 0.46 | 1.98 | 3.72 | 4.48 | 3.01 | 6.07 | 6.67 | 4.97 | 4.19 | 2.75 | 1.17 | 39.72 |
| 1933 | 1.05 | 1.11 | 0.26 | 3.19 | 3.16 | 8.19 | 8.85 | 0.22 | 3.45 | 4.85 | 2.63 | -0.17 | 36.79 |
| 1934 | 0.73 | 0.21 | 2.19 | 4.85 | 8.20 | 5.06 | 12.80 | 7.46 | 3.61 | 4.69 | 0.85 | 0.86 | 51.51 |
| 1935 | 1.00 | 1.00 | 1.80 | 3.46 | -2.97 | 2.80 | 8.42 | 5.54 | 3.49 | 4.40 | 1.43 | 1.08 | 31.45 |
| 1936 | 0.56 | 0.93 | 2.17 | 4.27 | 0.53 | 7.32 | 9.62 | 8.48 | 5.84 | 4.73 | 2.68 | 0.68 | 47.81 |
| 1937 | 0.15 | 1.10 | 0.06 | 4.41 | 4.23 | 2.98 | 7.57 | 7.41 | 5.53 | 3.40 | 2.62 | 1.04 | 40.50 |
| 1938 | 0.80 | 1.15 | 0.84 | 2.11 | -0.17 | 6.54 | 6.90 | 6.74 | 3.70 | 4.85 | 2.73 | 1.20 | 37.39 |
| 1939 | 0.42 | 0.77 | 0.86 | 2.39 | 5.48 | 5.52 | 9.67 | 7.56 | 8.63 | 4.83 | 2.75 | 0.47 | 49.35 |
| 1940 | 0.12 | 0.87 | -1.64 | 4.50 | 6.00 | 7.52 | 8.45 | 6.20 | 5.00 | 4.52 | 1.87 | 0.15 | 43.56 |
| 1941 | -0.41 | 0.92 | 1.68 | 0.02 | 4.01 | -0.14 | 6.13 | 6.16 | 0.52 | 4.06 | 2.57 | -0.89 | 24.63 |
| 1942 | 0.70 | -0.05 | 0.42 | 0.46 | 3.82 | 0.35 | 7.00 | 5.13 | -0.52 | 4.40 | 2.15 | 0.88 | 24.74 |
| 1943 | 0.87 | 1.20 | 1.66 | 3.77 | 3.26 | 3.79 | 6.81 | 6.21 | 6.11 | 4.73 | 2.58 | 1.12 | 42.11 |
| 1944 | -1.31 | -0.48 | 0.27 | -5.16 | 4.77 | 4.21 | 0.15 | 6.10 | 5.56 | 3.94 | 1.52 | 0.91 | 20.48 |
| 1945 | 0.39 | 1.09 | 2.05 | 1.71 | 2.38 | 1.21 | 4.10 | 1.78 | 4.31 | 4.66 | 2.58 | 0.64 | 26.90 |
| 1946 | 0.90 | 1.26 | 0.32 | 5.44 | 1.36 | 4.35 | 3.11 | 4.06 | 2.81 | -2.77 | 0.14 | 1.30 | 22.28 |
| 1947 | 0.70 | 0.75 | 1.36 | 1.15 | 2.25 | 1.61 | 3.61 | 7.21 | 4.28 | 3.69 | 1.48 | 0.25 | 28.34 |
| Total Average | 0.45 | 0.64 | 1.00 | 2.46 | 3.12 | 3.85 | 6.51 | 5.76 | 4.12 | 3.62 | 1.87 | 0.72 | 34.12 |

a/ Gross evaporation less precipitation at McCook, Nebraska.

Negative values indicate the amount that precipitation exceeded gross evaporation.

EXHIBIT 31


RESERVOIR EVAPORATION
RED WILLOW RESERVOIR
Drawn - B.C.F. - 12-48
Checked - N.E.B. - 12-48

Red Willow Canal 4,000 Ac.
Bartley Canal 7,000 Ac.
Total 11,900 Ac.

Table 17. MONTHLY RESERVOIR OPERATION STUDY - RED WILLOW RESERVOIR

Values in 1000 Acre-feet unless indicated otherwise

[illegible]

1/ Includes flow of Indian Creek

2/ Includes seepage & spills

KS002433

[illegible] Canal 900 Ac.
Red Willow Canal 4,580 Ac.
Bartley Canal 7,030 Ac.
Total 12,[illegible] Ac.

Table C MONTHLY RESERVOIR OPERATION STUDY - RED WILLOW RESERVOIR
Values in 1000 Acre-feet unless indicated otherwise

0 A.F. Dead Storage
18,000 A.F. Active Irrig. Storage

| Year & Month | Depleted Inflow into Red Willow Res. | Reservoir Losses: Evap. Rate Inches | Reservoir Losses: Evap. Loss 1000 A.F. | Reservoir Losses: Seepage | Additional Gain, Red Willow Dam to R.W.C. Diversion | Irrig. Demand for 4360 Ac. | Dem. to be Met by Res. Releases | Water Passing R.W. Creek Diversion | Return Flow from 2610 Ac. | Depleted Flow of Rep. Riv. at Bartley Diversion | Avail. Flow at Bartley Diversion | Irrig. Demand for 7030 Ac. | Demand to be Met by Res. Releases | Water Passing Bartley Diversion | Total Dem. to be Met by Res. Releases | Change in Res. Content | Res. Content at end of Month | Spills | Shortage | Flow Below Bartley Div. a/ | Return Flow from 2380 A. R.W. Canal | Return Flow from 7080 A. Bart. Canal | Gain Bart. Div. to Cambridge 1/ | Flow at Camb. Diversion 1/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) |
| 1935 JAN. | 1.8 | 1.00 | 0 | 0.3 | 0.8 | | | 0.8 | 0.1 | 0 | 1.0 | | | 1.0 | | +1.8 | 3.4 | | | 1.3 | 0.3 | 0.3 | -1.0 | 1.1 |
| FEB. | 1.5 | 1.00 | 0 | .3 | 0.8 | | | 0.8 | .1 | 1.8 | 2.8 | | | 2.8 | | +1.2 | 5.6 | | | 3.1 | .2 | .3 | -0.8 | 3.0 |
| MAR. | 1.5 | 1.80 | 0.1 | .1 | 0.9 | | | 0.9 | .1 | 3.9 | 4.8 | | | 4.8 | | +1.5 | 6.1 | | | 5.2 | .2 | .3 | -0.8 | 2.1 |
| APR. | 1.9 | 3.48 | 0.1 | .3 | 0.9 | 0.8 | 0 | 0.1 | .1 | 4.3 | 4.3 | 1.3 | 0 | 3.3 | 0 | +0.6 | 6.7 | | | 3.6 | .1 | .3 | 0.1 | 4.1 |
| MAY | 5.5 | -3.37 | -0.1 | .2 | 2.0 | 0 | 0 | 2.0 | .1 | 168.1 | 170.8 | 0 | 0 | 170.8 | 0 | +5.3 | 12.0 | | | 172.8 | .1 | .4 | -15.0 | 158.1 |
| JUNE | 5.7 | 8.80 | 0.8 | .3 | 0.4 | 0.9 | 2.2 | 0 | .2 | 301.2 | 301.4 | 0.8 | 0 | 300.6 | 0.2 | +6.5 | 18.3 | | | 300.9 | .1 | .4 | 32.2 | 433.8 |
| JULY | 3.7 | 9.46 | 0.4 | .1 | -0.3 | 4.3 | 4.3 | 0 | .3 | 4.2 | 6.6 | 5.1 | 0 | 0.4 | 4.8 | -2.8 | 15.6 | | | 0.6 | .2 | .3 | 0.2 | 1.3 |
| AUG. | 0.6 | 5.86 | 0.2 | .2 | -0.5 | 1.8 | 1.3 | 0 | .2 | 26.9 | 28.1 | 2.2 | 0 | 22.9 | 1.8 | -3.7 | 11.9 | | | 21.7 | .1 | .4 | 9.2 | 28.1 |
| SEPT. | 4.2 | 3.42 | 0.2 | .1 | -0.8 | 2.2 | 4.1 | 0 | .3 | 28.7 | 28.8 | 1.7 | 0 | 28.2 | 2.1 | -0.4 | 11.5 | | | 28.2 | .1 | .4 | 4.7 | 32.7 |
| OCT. | 0.8 | 4.40 | 0.2 | .3 | 0.4 | 1.1 | 0.6 | 0 | .3 | 5.8 | 9.0 | 1.8 | 0 | 4.6 | 0.6 | -0.3 | 11.2 | | | 4.7 | .2 | .3 | 0.4 | 5.6 |
| NOV. | 1.2 | 1.43 | 0.1 | .2 | 0.8 | | | 0.6 | .2 | 6.2 | 7.0 | | | 7.8 | | +0.8 | 12.0 | | | 8.1 | .1 | .3 | 0.2 | 9.0 |
| DEC. | 1.3 | 1.08 | 0.1 | .2 | 0.2 | | | 0.2 | .2 | 6.0 | 7.1 | | | 7.1 | | +1.1 | 13.1 | | | 7.4 | .1 | .4 | -0.7 | 7.3 |
| TOTAL | 28.1 | 51.43 | 1.7 | 2.8 | 4.8 | 8.7 | 2.6 | 5.6 | 2.0 | 547.5 | 580.7 | 13.2 | 0 | 542.1 | 8.6 | | +11.1 | | | 548.7 | 1.8 | 3.6 | 28.8 | 875.7 |
| 1936 JAN. | 1.8 | 0.98 | 0 | 0.3 | 0.9 | | | 0.9 | 0.2 | 7.4 | 8.3 | | | 8.3 | | +1.2 | 14.4 | | | 8.8 | 0 | 0.4 | -1.0 | 8.2 |
| FEB. | 1.7 | 0.33 | 0.1 | .3 | 0.3 | | | .3 | .1 | 8.7 | 8.7 | | | 8.7 | | +1.3 | 15.7 | | | 10.0 | .1 | .3 | -3.2 | 8.3 |
| MAR. | 2.0 | 2.37 | 0.1 | .3 | 0.9 | | | .3 | .1 | 29.0 | 29.0 | | | 29.0 | | +1.8 | 17.3 | | | 29.3 | .1 | .3 | 0.4 | 30.1 |
| APR. | 1.3 | 4.27 | 0.3 | .3 | 1.1 | 1.8 | 0.8 | 0 | .1 | 0.6 | 0.5 | 2.7 | 2.6 | 0 | 3.7 | -0.6 | 16.7 | | | 0.3 | .2 | .4 | -1.2 | 0 |
| MAY | 3.6 | 0.53 | 0 | .2 | -1.1 | 0 | 1.1 | 0 | .2 | 74.2 | 76.6 | 0 | 0 | 76.6 | 1.1 | +2.2 | 18.9 | | | 74.7 | .1 | .4 | 3.3 | 78.3 |
| JUNE | 3.8 | 7.48 | 0.4 | .2 | -0.6 | 2.6 | 3.0 | 0 | .2 | 12.9 | 15.1 | 3.9 | 0 | 9.7 | 3.0 | -1.2 | 16.7 | | | 10.0 | .2 | .4 | 0.8 | 11.7 |
| JULY | 0.4 | 8.62 | 0.2 | .3 | 0.3 | 3.8 | 3.2 | 0 | .2 | 1.3 | 1.2 | 4.3 | 2.2 | 0 | 5.6 | -8.7 | 8.0 | | | 0.3 | .2 | .4 | -0.6 | 0.7 |
| AUG. | 2.3 | 8.48 | 0.3 | .3 | 2.1 | 3.8 | 4.1 | 0 | .3 | -2.8 | -1.8 | 3.1 | 7.0 | 0 | 10.1 | -8.0 | 0 | | 1.4 | 0.8 | .3 | .4 | -1.2 | 0.2 |
| SEPT. | 0.9 | 3.86 | 0 | .2 | 0.8 | 1.8 | 1.2 | 0 | .2 | 4.3 | 6.2 | 2.1 | 0 | 3.1 | 1.2 | 0 | 0 | | 0.9 | 2.4 | .3 | .2 | 0.1 | 4.7 |
| OCT. | 0.7 | 4.73 | 0 | .2 | 0.2 | 1.3 | 1.2 | 0 | .2 | -1.2 | -0.9 | 1.8 | 2.9 | 0 | 3.9 | 0 | 0 | | 3.3 | 0.3 | .2 | .8 | -1.0 | 0.6 |
| NOV. | 0.7 | 2.48 | 0 | .3 | 0.3 | | | .2 | .2 | 1.8 | 2.0 | | | 2.0 | | +0.6 | 0.6 | | | 2.3 | .2 | .4 | +0.7 | 3.6 |
| DEC. | 0.8 | 0.84 | 0 | .3 | 0.2 | | | .2 | .3 | 8.8 | 9.2 | | | 9.2 | | +0.8 | 1.1 | | | 4.3 | .2 | .4 | -0.8 | 4.7 |
| TOTAL | 18.4 | 47.82 | 1.7 | 3.6 | 3.6 | 14.8 | 15.2 | 2.2 | 2.4 | 128.7 | 148.8 | 20.1 | 16.4 | 140.4 | 33.9 | | -12.0 | | 5.6 | 144.1 | 2.2 | 4.8 | -8.6 | 149.8 |
| 1937 JAN. | 0.8 | 0.38 | 0 | 0.3 | 0.1 | | | 0.1 | 0.1 | 0 | 0.2 | | | 0.2 | | +0.8 | 1.8 | | | 0.4 | 0.3 | 0.3 | -1.0 | 0.5 |
| FEB. | 0.8 | 1.10 | 0 | .3 | .3 | | | .3 | .1 | 9.6 | 10.2 | | | 10.2 | | +0.6 | 2.2 | | | 10.5 | .2 | .4 | 0.8 | 11.9 |
| MAR. | 1.2 | 0.06 | 0 | .3 | .6 | | | .6 | .1 | 5.9 | 6.4 | | | 6.3 | | +0.8 | 3.1 | | | 6.6 | .2 | .4 | -0.1 | 7.2 |
| APR. | 0.4 | 4.41 | 0.1 | .4 | .3 | 1.8 | 1.6 | 0 | .1 | 1.7 | 1.9 | 2.2 | 0.6 | 0 | 2.6 | -2.1 | 1.0 | | | 0.3 | .1 | .2 | -0.4 | 0.3 |
| MAY | 0.8 | 4.13 | 0 | .2 | .3 | 1.3 | 1.0 | 0 | .1 | -1.6 | -1.8 | 1.8 | 1.8 | 0 | 4.2 | -2.0 | 0 | | 2.8 | 0.2 | .1 | .2 | -1.1 | 0 |
| JUNE | 3.0 | 2.08 | 0.1 | .2 | .7 | 1.0 | 0.6 | 0 | .2 | 12.9 | 13.1 | 3.5 | 0 | 11.6 | 0.6 | +1.5 | 1.8 | | | 11.6 | .1 | .4 | 0.8 | 12.9 |
| JULY | 1.8 | 7.97 | 0.1 | .3 | .6 | 3.7 | 3.2 | 0 | .3 | 16.1 | 18.3 | 3.8 | 0 | 15.4 | 3.1 | -1.2 | 0.1 | | | 15.7 | .1 | .4 | 2.3 | 18.7 |
| AUG. | 1.7 | 7.41 | 0 | .2 | .7 | 1.9 | 1.1 | 0 | .2 | 19.3 | 17.0 | 1.8 | 0 | 19.2 | 1.1 | +0.3 | 0.6 | | | 18.2 | .1 | .4 | 2.6 | 19.8 |
| SEPT. | 0.6 | 3.53 | 0 | .8 | .2 | 1.7 | 1.1 | 0 | .2 | 5.2 | 9.5 | 1.9 | 0 | 3.3 | 1.1 | -0.6 | 0 | | 0.7 | 3.3 | .2 | .4 | 0.2 | 4.5 |
| OCT. | 0.2 | 3.60 | 0 | .2 | .2 | 0.6 | 0.2 | 0 | .2 | -0.2 | 0 | 0.8 | 0.8 | 0 | 0.8 | 0 | 0 | | 0.3 | 0.3 | .1 | .4 | -0.8 | 0.2 |
| NOV. | 0.3 | 2.46 | 0 | .4 | .4 | | | .4 | .2 | 2.1 | 3.7 | | | 3.7 | | +0.8 | 0.8 | | | 3.0 | .2 | .4 | -0.7 | 2.8 |
| DEC. | 0.7 | 1.06 | 0 | .3 | .4 | | | .4 | .2 | 1.4 | 2.0 | | | 2.0 | | +0.6 | 1.2 | | | 2.3 | .2 | .4 | -1.0 | 1.9 |
| TOTAL | 12.3 | 40.30 | 0.3 | 3.8 | 4.2 | 9.2 | 7.6 | 1.7 | 2.0 | 70.1 | 78.8 | 16.2 | 5.2 | 80.6 | 12.8 | | +0.1 | | 3.3 | 88.0 | 1.8 | 5.5 | 1.7 | 77.0 |

1/ Includes flow of Medicine Creek

a/ Includes seepage & spills

| Year & Month | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1938 JAN. | 0.8 | 0.80 | 0 | 0.3 | 0.1 | | | 0.2 | 0.2 | 8.2 | 8.8 | | | 8.7 | | +0.7 | 3.8 | 0 | | 9.2 | 0.1 | 0.4 | 0.5 | 10.0 |
| FEB. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| MAR. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| APR. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| AUG. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| SEPT. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| OCT. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| NOV. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DEC. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1939 JAN. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| FEB. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| MAR. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| APR. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| AUG. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| SEPT. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| OCT. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| NOV. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DEC. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1940 JAN. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| FEB. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| MAR. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| APR. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| AUG. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| SEPT. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| OCT. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| NOV. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DEC. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

1/ Includes flow of Medicine Creek

a/ Includes seepage & spills

[illegible] Canal [illegible] Ac.
Red Willow Canal 4,560 Ac.
Bartley Canal 7,030 Ac.
Total 11,[illegible] Ac.

Table __ MONTHLY RESERVOIR OPERATION STUDY - RED WILLOW RESERVOIR

Values in 1000 Acre-Feet unless indicated otherwise

0 A.F. Dead Storage
18,000 A.F. Active Irrig. Storage

| Year & Month | Depleted Inflow into Red Willow Res. | Reservoir Losses: Evap. Rate inches | Reservoir Losses: Evap. Loss 1000 A.F. | Reservoir Losses: Seepage | [illegible] Red Willow Can. Diversion | Irrig. Demand for [illegible] Ac. | Dem. to be Met by Releases | Water Passing [illegible] Diversion | Return Flow from 2610 Ac. | Depleted Flow at Bartley Diversion | Avail. Flow at Bartley Diversion | Irrig. Demand for 7030 Ac. | Demand to be Met by Res. Releases | Water Passing Bartley Diversion | Total Dem. to be Met by Res. Releases | Change in Res. Content | Res. Content at end of Month | Spills | Shortage | Flow below Bartley Div. a/ | Return Flow from 2500 A. R.W. Canal | Return Flow from 7030 A. Bart. Canal | Seepage Gain Bart.-Camb. 1/ | Flow at Camb. Diversion 1/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) |
| 1942 JAN. | 1.6 | -0.41 | 0 | 0.5 | 1.3 | | | 1.3 | 0.1 | 0 | 1.6 | | | 1.6 | | +1.9 | 4.0 | | | 1.7 | 0.2 | 0.2 | -2.3 | 0 |
| FEB. | 1.4 | 0.88 | 0 | .3 | 0.3 | | | 0.3 | .1 | 0 | 0.4 | | | 0.4 | | +1.1 | 4.1 | | | 0.7 | 0.2 | .4 | -0.8 | 0 |
| MAR. | 1.6 | 1.48 | 0.1 | .3 | 0.3 | | | 0.3 | .1 | 7.8 | 8.2 | | | 8.2 | | +1.2 | 5.3 | | | 9.4 | 0.2 | .4 | 0.7 | 9.8 |
| APR. | 1.7 | 0.88 | 0 | .3 | 0.4 | 0 | 0 | 0.4 | .1 | 18.6 | 19.1 | 0 | 0 | 19.1 | 0 | +1.6 | 6.8 | | | 18.4 | 0 | .2 | -1.0 | 18.8 |
| MAY | 2.3 | 6.01 | 0.2 | .3 | 0.7 | 0 | 0 | 0.7 | .1 | 38.6 | 33.2 | 0 | 0 | 43.3 | 0 | +1.7 | 8.8 | | | 43.3 | 0.1 | .2 | 1.6 | 33.0 |
| JUNE | 7.4 | -0.14 | 0 | .3 | 2.7 | 0 | 0 | 2.7 | .1 | 88.3 | 71.0 | 0 | 0 | 71.0 | 0 | +7.1 | 18.8 | | | 71.8 | 0.1 | .2 | 2.8 | 74.6 |
| JULY | 2.8 | 8.15 | 0.6 | .3 | 0.5 | 1.8 | 1.4 | 0 | .1 | 38.7 | 38.8 | 2.7 | 0 | 37.1 | 1.4 | -0.4 | 18.8 | | | 37.4 | 0.1 | .2 | 4.9 | 41.7 |
| AUG. | 0.8 | 8.18 | 0.3 | .3 | 0.4 | 3.7 | 1.3 | 0 | .1 | 33.6 | 23.3 | 8.3 | 0 | 18.6 | 8.3 | -3.3 | 12.3 | | | 18.9 | 0 | .4 | 3.2 | 23.0 |
| SEPT. | 3.3 | 0.88 | 0 | .3 | 2.7 | 0 | 0 | 2.7 | .1 | 88.1 | 88.0 | 0 | 0 | 88.0 | 0 | +2.2 | 14.7 | | | 88.2 | 0.1 | .4 | 2.8 | 88.4 |
| OCT. | 1.7 | 4.08 | 0.2 | .3 | 1.8 | 1.8 | 0 | 0.2 | .1 | 16.1 | 16.8 | 1.8 | 0 | 15.0 | 0 | +1.3 | 16.3 | | | 13.2 | 0.1 | .4 | 0.8 | 14.3 |
| NOV. | 1.4 | 2.87 | 0.2 | .3 | 0.3 | | | 0.2 | .1 | 14.0 | 14.2 | | | 14.3 | | +0.9 | 17.6 | | | 14.5 | 0.1 | .3 | 0 | 15.0 |
| DEC. | 1.3 | -0.88 | 0 | .3 | 0.4 | | | 0.4 | .1 | 18.8 | 19.0 | | | 19.0 | | +0.3 | 18.0 | 0.2 | | 20.1 | 0.1 | .3 | -0.1 | 20.4 |
| TOTAL | 28.8 | 86.85 | 1.4 | 3.6 | 11.5 | 8.8 | 4.7 | 8.4 | 1.2 | 368.8 | 368.7 | 9.6 | 0 | 330.3 | 4.7 | | +14.3 | 8.8 | | 334.7 | 1.2 | 4.8 | 13.3 | 370.7 |
| 1943 JAN. | 1.4 | 0.70 | 0 | 0.3 | 0.1 | | | 9.6 | 0.1 | 18.1 | 18.8 | | | 18.8 | | 0 | 18.0 | 1.1 | | 17.0 | 0.1 | 0.2 | -0.9 | 17.0 |
| FEB. | 1.3 | -0.08 | 0 | .3 | 0.6 | | | 0.4 | 0 | 25.2 | 25.7 | | | 25.7 | | 0 | 18.0 | 1.8 | | 27.2 | 0.1 | .2 | 0.2 | 27.2 |
| MAR. | 3.3 | 0.42 | 0 | .3 | 0.7 | | | 0.7 | .1 | 43.3 | 44.1 | | | 44.1 | | 0 | 18.0 | 3.3 | | 47.3 | 0 | .2 | -2.4 | 42.2 |
| APR. | 6.7 | 0.46 | 0 | .3 | 0.9 | 0 | 0 | 0.8 | .1 | 30.8 | 31.8 | 0 | 0 | 31.8 | 0 | 0 | 18.0 | 4.8 | | 38.4 | 0 | .2 | 0.4 | 37.4 |
| MAY | 2.7 | 5.48 | 0.2 | .2 | 0.7 | 0 | 0 | 0.7 | .1 | 43.3 | 38.1 | 0 | 0 | 38.1 | 0 | 0 | 18.0 | 3.2 | | 39.4 | 0 | .2 | 1.0 | 38.4 |
| JUNE | 4.9 | 0.08 | 0 | .4 | 1.8 | 0 | 0 | 1.8 | .1 | 38.1 | 38.8 | 0 | 0 | 38.6 | 0 | 0 | 18.0 | 4.8 | | 38.7 | 0.1 | .2 | -0.4 | 38.6 |
| JULY | 1.1 | 7.00 | 0.6 | .3 | 0.4 | 2.9 | 2.6 | 0 | .1 | 9.6 | 6.7 | 4.1 | 0 | 1.8 | 2.6 | -2.1 | 15.9 | 0 | | 1.2 | 0.1 | .2 | 0.6 | 2.7 |
| AUG. | 0.9 | 6.13 | 0.5 | .3 | 0.6 | 3.1 | 1.7 | 0 | .1 | -0.6 | -0.6 | 3.0 | 2.6 | 0 | 3.1 | -5.8 | 11.1 | 0 | | 0.2 | 0.1 | .2 | -0.8 | 0 |
| SEPT. | 4.1 | -0.88 | 0 | .3 | 0.6 | 0.3 | 0 | 0.3 | .1 | 6.6 | 3.3 | 0.4 | 0 | 3.6 | 0 | +3.8 | 14.9 | 0 | | 2.7 | 0.2 | .4 | -1.1 | 3.2 |
| OCT. | 1.1 | 4.40 | 0.2 | .3 | 0.8 | 0.7 | 0.4 | 0 | .1 | 8.1 | 8.3 | 1.1 | 0 | 4.1 | 0.4 | +0.2 | 18.1 | 0 | | 4.4 | 0.1 | .3 | 0.1 | 4.8 |
| NOV. | 1.3 | 2.13 | 0.1 | .3 | 0.3 | | | 0.2 | .1 | 16.3 | 16.7 | | 0 | 16.7 | | +0.3 | 18.0 | 0 | | 17.0 | 0.1 | .3 | 0.3 | 17.7 |
| DEC. | 1.8 | 0.80 | 0.1 | .3 | 0.3 | | | 0.3 | .1 | 19.6 | 19.8 | | | 19.8 | | +1.2 | 17.8 | 0 | | 20.1 | 0.1 | .2 | -1.4 | 19.1 |
| TOTAL | 30.8 | 34.76 | 1.8 | 3.6 | 7.0 | 8.0 | 4.6 | 9.8 | 1.1 | 328.3 | 330.0 | 8.8 | 2.6 | 323.8 | 8.0 | | -0.3 | 16.4 | | 342.8 | 1.0 | 3.1 | -4.3 | 342.8 |
| [illegible] JAN. | 1.6 | 0.87 | 0.1 | 0.3 | 0.3 | | | 0.3 | 0.1 | 14.8 | 14.0 | | | 14.0 | | +0.8 | 18.0 | 0.3 | | 14.3 | 0.1 | .2 | -1.1 | 13.7 |
| FEB. | 1.4 | 1.80 | 0.1 | .3 | .3 | | | 0.3 | .1 | 28.0 | 28.4 | | | 28.4 | | 0 | 18.0 | 1.8 | | 27.7 | 0 | .2 | 0.3 | 28.1 |
| MAR. | 1.3 | 1.08 | 0.1 | .3 | .3 | | | 0.3 | .1 | 38.8 | 38.0 | | | 38.0 | | 0 | 18.0 | 1.2 | | 38.1 | 0 | .2 | 1.1 | 47.0 |
| APR. | 1.7 | 3.77 | 0.2 | .3 | .2 | 0 | 0 | 0.3 | .1 | 3.3 | 3.3 | 0 | 0 | 3.3 | 0 | 0 | 18.0 | 1.8 | | 11.4 | 0.1 | .2 | 1.0 | 14.6 |
| MAY | 1.2 | 3.38 | 0.2 | .3 | .2 | 1.8 | 1.6 | 0 | .1 | 3.3 | 4.4 | 2.2 | 0 | 4.2 | 1.6 | -0.7 | 17.3 | 0 | | 4.8 | 0.1 | .2 | 0.3 | 5.6 |
| JUNE | 1.8 | 20.79 | 0.2 | .3 | .4 | 1.1 | 0.7 | 0 | .1 | 3.8 | 4.2 | 1.8 | 0 | 3.8 | 0.7 | +0.1 | 17.4 | 0 | | 3.3 | 0.1 | .2 | 0 | 3.7 |
| JULY | 0.9 | 6.81 | 0.6 | .3 | .3 | 2.3 | 2.0 | 0 | .1 | 3.8 | 2.2 | 4.2 | 0.7 | 0 | 2.7 | -2.6 | 14.8 | 0 | | 0.3 | 0.2 | .4 | -0.2 | 0.7 |
| AUG. | 0.4 | 6.21 | 0.3 | .3 | .2 | 2.1 | 1.2 | 0 | .1 | 3.6 | 3.6 | 3.0 | 0 | 0.8 | 1.3 | -1.6 | 13.4 | 0 | | 0.8 | 0.1 | .3 | -0.3 | 1.6 |
| SEPT. | 0.3 | 6.11 | 0.3 | .3 | .1 | 0.4 | 0.3 | 0 | .1 | 3.6 | 3.8 | 0.8 | 0 | 3.8 | 0.3 | -0.8 | 12.8 | 0 | | 4.3 | 0.1 | .3 | 0 | 4.9 |
| OCT. | 0.7 | 4.73 | 0.2 | .3 | .2 | 1.6 | 0.8 | 0 | .1 | 2.1 | 2.2 | 1.6 | 0 | 0.8 | 0.8 | -0.6 | 12.2 | 0 | | 1.1 | 0.2 | .3 | -0.3 | 1.3 |
| NOV. | 1.2 | 2.38 | 0.1 | .3 | .2 | | | 0.2 | .1 | 1.8 | 1.8 | | | 1.8 | | +0.8 | 12.8 | 0 | | 2.1 | 0.2 | .4 | -0.2 | 1.8 |
| DEC. | 1.3 | 1.18 | 0.1 | .3 | 0 | | | 0 | .1 | 2.8 | 2.7 | | | 2.7 | | +0.7 | 13.7 | 0 | | 3.0 | 0.2 | .3 | -0.3 | 2.7 |
| TOTAL | 13.1 | 48.11 | 2.3 | 3.6 | 2.7 | 8.7 | 6.6 | 1.6 | 1.2 | 108.8 | 108.2 | 13.3 | 0.7 | 88.6 | 7.1 | | -2.6 | 3.8 | | 99.6 | 1.6 | 4.1 | -0.8 | 108.3 |

1/ Excludes flow of Medicine Creek

a/ Includes seepage & spills

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1944 JAN. | 1.2 | -1.31 | -0.1 | 0.3 | 0.2 | | | 0.2 | 0.1 | 0 | 0.3 | | | 0.3 | | +1.0 | 16.7 | 0 | | 0.6 | 0.1 | 0.2 | -2.4 | 0 |
| FEB. | 1.9 | -2.48 | 0 | .3 | 0.2 | | | 0.2 | 0 | 0 | 0.2 | | | 0.2 | | +1.3 | 18.0 | 0 | | 0.6 | 0.2 | .2 | -0.8 | 0 |
| MAR. | 1.2 | 0.27 | 0 | .3 | 0.2 | | | 0.2 | 0 | 3.6 | 3.8 | | | 3.8 | | +1.3 | 17.9 | 0 | | 8.1 | 0.2 | .2 | -0.8 | 3.1 |
| APR. | 4.1 | -0.18 | -0.2 | .3 | 1.3 | 0 | 0 | 1.3 | 0 | 31.8 | 33.1 | 0 | 0 | 33.1 | 0 | +0.1 | 18.0 | 4.0 | | 37.6 | 0 | .1 | 0.3 | 37.8 |
| MAY | 2.2 | 4.77 | 0.3 | .3 | 1.0 | 0 | 0 | 1.0 | .1 | 42.4 | 43.3 | 0 | 0 | 43.3 | 0 | 0 | 18.0 | 1.8 | | 46.4 | 0 | .1 | 2.8 | 48.1 |
| JUNE | 5.1 | 4.81 | 0.3 | .3 | 0.7 | 0 | 0 | 0.7 | 0 | 36.3 | 37.0 | 0 | 0 | 37.0 | 0 | 0 | 18.0 | 1.2 | | 38.8 | 0.1 | .1 | 4.3 | 43.2 |
| JULY | 6.0 | 9.18 | 0 | .3 | 1.2 | 0 | 0 | 1.2 | .1 | 61.6 | 62.8 | 0 | 0 | 62.8 | 0 | 0 | 18.0 | 4.7 | | 67.2 | 0 | .1 | 9.7 | 73.1 |
| AUG. | 2.6 | 9.30 | 0.4 | .3 | 0.3 | 0 | 0 | 2.8 | .1 | 8.3 | 9.8 | 0 | 0 | 8.8 | 0 | 0 | 18.0 | 2.1 | | 12.3 | 0 | .2 | 1.2 | 13.7 |
| SEPT. | 0.7 | 8.96 | 0.2 | .2 | 0.1 | 1.8 | 1.7 | 0 | .1 | 7.2 | 7.2 | 2.7 | 0.4 | 0 | 2.1 | -2.0 | 16.0 | 0 | | 0.3 | 0 | .2 | -0.1 | 0.6 |
| OCT. | 0.7 | 3.96 | 0.2 | .3 | 0.2 | 0.8 | 0.8 | 0 | .1 | 3.6 | 3.9 | 1.3 | 0 | 3.2 | 0.6 | -0.4 | 15.6 | 0 | | 3.2 | 0 | .1 | 0 | 2.8 |
| NOV. | 1.3 | 1.82 | 0.1 | .3 | 0.2 | | | 0.2 | .1 | 4.2 | 4.8 | | | 4.8 | | +0.3 | 15.9 | 0 | | 4.7 | 0 | .1 | -0.4 | 5.2 |
| DEC. | 1.3 | 0.81 | 0.1 | .3 | 0.3 | | | 0.2 | 0 | 2.8 | 3.1 | | | 3.1 | | +1.1 | 17.4 | 0 | | 3.6 | 0.1 | .1 | -0.6 | 5.0 |
| TOTAL | 28.4 | 40.68 | 1.3 | 3.4 | 6.2 | 2.7 | 2.8 | 6.9 | 0.7 | 198.0 | 206.1 | 4.0 | 0.4 | 202.6 | 2.7 | | -1.9 | 13.8 | | 220.0 | 0.7 | 2.0 | 8.9 | 281.8 |
| 1945 JAN. | 1.6 | 0.38 | 0 | 0.3 | 0.6 | | | 2.6 | 0.1 | 2.8 | 3.0 | | | 3.0 | | +0.4 | 18.0 | 0.7 | | 4.0 | 0 | 0.1 | -0.7 | 3.4 |
| FEB. | 1.3 | 1.06 | .1 | .3 | 0.4 | | | 0.3 | .1 | 7.1 | 7.3 | | | 7.3 | | 0 | 18.0 | 1.4 | | 8.2 | 0 | .1 | -0.2 | 8.1 |
| MAR. | 1.3 | 2.05 | .1 | .3 | 0.3 | | | 0.3 | 0 | 18.6 | 18.7 | | | 18.7 | | 0 | 18.0 | 1.2 | | 18.2 | 0 | .1 | 0.2 | 18.3 |
| APR. | 1.3 | 1.71 | .1 | .3 | 0.6 | 0 | 0 | 0.6 | .1 | 20.6 | 20.7 | 0 | 0 | 20.7 | 0 | 0 | 18.0 | 1.1 | | 22.1 | 0.1 | .2 | 0.9 | 23.3 |
| MAY | 2.3 | 2.88 | .1 | .3 | 1.1 | 0.4 | 0 | 1.1 | .1 | 15.8 | 16.8 | 0.4 | 0 | 16.8 | 0 | 0 | 18.0 | 2.0 | | 16.3 | 0.1 | .2 | 0.4 | 17.3 |
| JUNE | 9.6 | 1.31 | .1 | .3 | 2.7 | 0.3 | 0 | 2.2 | .1 | 86.0 | 88.3 | 0.3 | 0 | 87.3 | 0 | 0 | 18.0 | 2.6 | | 83.4 | 0.1 | .3 | 8.6 | 70.0 |
| JULY | 0.7 | 4.10 | .2 | .3 | 0.6 | 3.6 | 3.2 | 0 | .1 | 2.8 | 3.8 | 3.1 | 0 | 5.3 | 3.2 | -2.0 | 16.0 | 0 | | 4.2 | 0.2 | .4 | 1.7 | 6.6 |
| AUG. | 1.7 | 1.78 | .1 | .3 | 1.8 | 2.0 | 0.6 | 0 | .2 | 3.2 | 2.4 | 2.8 | 0.4 | 0 | 0.8 | +0.3 | 15.5 | 0 | | 0.2 | 0.1 | .2 | -0.2 | 0.8 |
| SEPT. | 2.0 | 4.31 | .2 | .2 | 1.3 | 0.9 | 0 | 0.4 | .2 | 1.7 | 2.3 | 1.3 | 0 | 1.0 | 0 | +1.4 | 16.8 | 0 | | 1.1 | 0.2 | .4 | -0.4 | 1.2 |
| OCT. | 1.1 | 4.86 | .2 | .2 | 0.3 | 1.1 | 0.8 | 0 | .2 | 3.8 | 4.0 | 1.2 | 0 | 3.6 | 0.8 | -0.3 | 16.8 | 0 | | 2.7 | 0.1 | .4 | 0 | 3.3 |
| NOV. | 1.3 | 2.38 | .2 | .1 | 0.3 | | | 0.3 | .1 | 8.7 | 8.1 | | | 8.1 | | +0.7 | 17.3 | 0 | | 8.4 | 0.2 | .4 | -0.1 | 8.7 |
| DEC. | 1.1 | 0.84 | 0 | .3 | 0.4 | | | 0.6 | .1 | 9.2 | 9.0 | | | 8.0 | | +0.7 | 18.0 | 0.1 | | 8.4 | 0.1 | .2 | -0.1 | 8.7 |

Red Willow Canal 4,300 Ac.
Bartley Canal 7,030 Ac.
Total 11,930 Ac.

Table 11C MONTHLY RESERVOIR OPERATION STUDY - RED WILLOW RESERVOIR

Values in 1000 Acre-feet unless indicated otherwise

0 A.F. Dead Storage
18,000 A.F. Active Irrig. Storage

| Year & Month | Depleted Inflow into Red Willow Res. | Reservoir Losses: Evap. Rate Inches | Evap. Loss 1000 A.F. | Seepage | Additional Gain, Red Willow Dam to R.W. Cr. Diversion | Irrig. Demand for 4900 Ac. | Dem. to be Met by Res. Releases | Water Passing R.W. Creek Diversion | Return Flow from 2810 Ac. | Depleted Flow of Rep. Riv. at Bartley Diversion | Avail. Flow at Bartley Diversion | Irrig. Demand for 7030 Ac. | Demand to be Met by Res. Releases | Water Passing Bartley Diversion | Total Dem. to be Met by Res. Releases | Change in Res. Contents | Res. Content at end of Month | Spills | Shortage | Flow Below Bartley Div. a/ | Return Flow from 2360 A. R.W. Canal | Return Flow from 7030 A. Bart. Canal | Gain Bart. Div. to Cambridge 1/ | Flow at Camb. Diversion 1/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) |
| 1947 JAN. | 1.3 | 0.70 | 0 | 0.2 | 0.1 | - | - | 0.1 | 0.1 | 17.2 | 18.1 | - | - | 18.1 | | 0 | 18.0 | 1.2 | | 18.8 | 0.1 | 0.2 | -0.7 | 19.3 |
| FEB. | 1.4 | 0.73 | 0.1 | .2 | 0.2 | - | | 0.2 | .1 | 21.9 | 22.2 | | - | 22.2 | | 0 | 18.0 | 1.2 | | 22.7 | 0.1 | 0.2 | -1.0 | 22.0 |
| MAR. | 1.3 | 1.38 | 0.1 | .2 | 0.2 | - | - | 0.2 | .1 | 31.6 | 32.0 | - | - | 32.0 | | 0 | 18.0 | 1.4 | | 32.7 | 0.1 | 0.2 | -0.3 | 32.7 |
| APR. | 2.1 | 1.13 | 0.1 | .2 | 0.3 | 0 | 0 | 0.3 | .1 | 28.8 | 29.2 | 0 | 0 | 29.2 | 0 | 0 | 18.0 | 1.7 | | 31.2 | 0 | 0.2 | 0.7 | 32.0 |
| MAY | 1.4 | 2.29 | 0.1 | .2 | 0.3 | 0 | 0 | 0.3 | .1 | 33.0 | 33.4 | 0 | 0 | 33.4 | 0 | 0 | 18.0 | 1.1 | | 34.8 | 0 | 0.2 | 0.6 | 36.4 |
| JUNE | 10.3 | 1.41 | 0.1 | .2 | 3.6 | 0 | 0 | 3.6 | .1 | 75.8 | 76.1 | 0 | 0 | 76.1 | 0 | 0 | 18.0 | 8.8 | | 88.7 | 0.1 | 0.2 | 4.7 | 90.2 |
| JULY | 1.3 | 3.81 | 0.3 | .2 | 0.7 | 0.8 | 0.1 | 0 | .1 | 16.3 | 16.4 | 1.2 | 0 | 15.2 | 0.1 | 0 | 18.0 | 1.3 | | 16.8 | 0.1 | 0.2 | 0.8 | 17.7 |
| AUG. | 0.2 | 7.21 | 0.4 | .2 | 0.3 | 3.7 | 3.4 | 0 | .1 | 1.8 | 1.6 | 4.2 | 3.6 | 0 | 7.0 | -6.9 | 11.1 | 0 | | 0.3 | 0.1 | 0.3 | -0.2 | 0.8 |
| SEPT. | 0.1 | 4.29 | 0.3 | .2 | 0.2 | 0.8 | 0.6 | 0 | .1 | 0.5 | 0.6 | 0.9 | 0.3 | 0 | 0.7 | -0.7 | 10.4 | 0 | | 0.3 | 0.2 | 0.4 | -0.5 | 0.4 |
| OCT. | - | - | | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | | - | - | - | - | - |
| NOV. | - | - | | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | | - | - | - | - | - |
| DEC. | - | - | | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | | - | - | - | - | - |
| TOTAL | 21.2 | 32.88 | 1.1 | 2.7 | 5.8 | 5.1 | 3.9 | 4.8 | 0.9 | 326.8 | 330.2 | 7.3 | 3.9 | 326.9 | 7.8 | | -7.6 | 17.7 | | 347.3 | 0.8 | 2.2 | 5.8 | 356.2 |
| 19 JAN. | 7 | | | | | | | | | | | | | | | | | | | | | | | |
| FEB. | | | | | | | | | | | | | | | | | | | | | | | | |
| MAR. | | | | | | | | | | | | | | | | | | | | | | | | |
| APR. | | | | | | | | | | | | | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | | | | | | | | | | | | | |
| JUNE | | | | | | | | | | | | | | | | | | | | | | | | |
| JULY | | | | | | | | | | | | | | | | | | | | | | | | |
| AUG. | | | | | | | | | | | | | | | | | | | | | | | | |
| SEPT. | | | | | | | | | | | | | | | | | | | | | | | | |
| OCT. | | | | | | | | | | | | | | | | | | | | | | | | |
| NOV. | | | | | | | | | | | | | | | | | | | | | | | | |
| DEC. | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 JAN. | | | | | | | | | | | | | | | | | | | | | | | | |
| FEB. | | | | | | | | | | | | | | | | | | | | | | | | |
| MAR. | | | | | | | | | | | | | | | | | | | | | | | | |
| APR. | | | | | | | | | | | | | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | | | | | | | | | | | | | |
| JUNE | | | | | | | | | | | | | | | | | | | | | | | | |
| JULY | | | | | | | | | | | | | | | | | | | | | | | | |
| AUG. | | | | | | | | | | | | | | | | | | | | | | | | |
| SEPT. | | | | | | | | | | | | | | | | | | | | | | | | |
| OCT. | | | | | | | | | | | | | | | | | | | | | | | | |
| NOV. | | | | | | | | | | | | | | | | | | | | | | | | |
| DEC. | | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | | |

1/ Excludes flow of Medicine Creek

a/ Includes seepage & spills

Red Willow Unit

a. Sectional gains between Red Willow Dam and mouth of Red Willow Creek were supplemented by releases from the reservoir to meet the irrigation demand for 600 acres served by the McCook Canal and 4,360 acres served by the Red Willow Canal. Return flow, wastes, and sectional gains from upstream units that are available for diversion at the Bartley Diversion Dam are supplemented by releases from Red Willow Reservoir to meet the irrigation demand for 7,030 acres served by the Bartley Canal.

2. Requirements for other than irrigation demands

   a. When the sectional gain between the reservoir and the diversion dam is negative, or when the depleted flow of the Republican River at Bartley Diversion Dam is negative, releases from Red Willow Reservoir were made in order to satisfy these negative flows during the irrigation season.

   b. Evaporation losses were determined in accordance with the reservoir content and the monthly net evaporation rate.

   c. Seepage was estimated to be 300 acre-feet per month.

3. Reservoir content

   a. The reservoir irrigation pool becomes full when the capacity reaches 18,000 acre-feet. Any inflow into the reservoir at this capacity was allowed to spill.

   b. Releases can be made from the reservoir until it becomes empty, since there is no space allocated to conservation storage.

4. Integration of operation with other units

   a. No releases from upstream reservoirs were made to help satisfy demands in this unit.

   b. No releases from Red Willow Reservoir were made to help meet demands in downstream units.

An explanation of the different columns in the operation study, ıble 118, is offered as follows:

1. Years and months which the operation study was made. (Jan. 1929 through Sept. 1947)

2. The depleted inflow, table 92, is the historical flow at Red Willow Dam site less the estimated future depletions above the reservoir. This represents the water available for storage or regulation.

3. Evaporation rate in inches, table 117, is the net rate of evaporation from the reservoir.

4. Reservoir evaporation loss in acre-feet is obtained by entering the "Reservoir Evaporation" chart, exhibit 31, with the average of the reservoir content for the month concerned, and with the monthly evaporation rate in inches.

5. Seepage is estimated to be 300 acre-feet per month and is allowed to pass downstream without satisfying any demands in this unit.

6. Sectional gain in historical stream-flow records between Red Willow Reservoir and the mouth of Red Willow Creek is contained in table 93.

7. Irrigation demand for 4,960 acres served by McCook Canal and Red Willow Canal is shown in table 113.

8. Demand on the reservoir is that portion of the irrigation demand, Col. 7, which is not satisfied by the sectional gain between the Reservoir and Red Willow Creek Diversion Dam.

9. Wastes passing Red Willow Creek Diversion Dam is that portion of the sectional gain between the Reservoir and the Diversion Dam which is not diverted to satisfy irrigation demands.

10. Return flow from 2,610 acres, table 101, served by the McCook Canal and Red Willow Canal. Of the 4,960 acres served by these two canals, 2,610 acres are above the Bartley Diversion Dam.

11. Depleted flows of Republican River at Bartley Diversion Dam, table 105, are the combined flows of Frenchman Creek and Republican River at Culbertson after upstream developments plus the gain in flow between Culbertson and Bartley Diversion Dam. Negative flows that occur during the winter are carried over into the following months until satisfied.

12. Flow at Bartley Diversion Dam available for diversion is the sum of Cols. 9, 10, and 11.

13. Irrigation demand for 7,030 acres served by the Bartley Canal is shown in table 114.

14. Demand to be met by releases from Red Willow Reservoir is the positive figure obtained by algebraically subtracting Col. 12 from Col. 13.

15. Waste water passing Bartley Diversion Dam is Col. 12 less Col. 13.

16. Total demand to be met by releases from Red Willow Reservoir is the sum of Cols. 8 and 14.

17. An increase in the content of the reservoir at the end of the current month over the content at the end of the preceding month is indicated by a plus sign; a decrease is indicated by a minus sign, and no change in reservoir content is represented by a zero. Col. 17 = Cols. (2+6+10+11+20) - Cols. (4+5+7+13+15+19).

18. The content of the reservoir at the end of the month equals the content at the end of the previous month corrected by the change in content as shown by Col. 17.

19. Shows the amount of water which must be spilled to avoid showing a content at the end of any month in excess of the active irrigation storage capacity which is 18,000 acre-feet. Col. 19 = Cols. (2+6+10+11+20) - Cols. (4+5+7+13+15+17).

20. Represents the demand on the reservoir which was not met due to an insufficient supply. Col. 20 = 16 - 2 + (4+5).

21. The flow below Bartley Diversion Dam is that which is in excess of the irrigation demands of lands which are served by the Bartley Canal. The flow includes seepage and spills from Red Willow Reservoir plus return flow from 2,610 acres which are located upstream from Bartley Diversion Dam. Col. 21 = 5+15+19.

22. Shows the return flow from 2,350 acres table 102 which is the remainder of the 4,960 acres served by the McCook and Bartley Canals. These 2,350 acres are located downstream from the Bartley Diversion.

23. Return flows from 7,030 acres irrigated by the Bartley Canal are contained in table 103.

24. The sectional gain in stream flow between Bartley Diversion Dam and Cambridge Diversion is shown in table 97. The flow of Medicine Creek is excluded.

25. The flow of the Republican River at Cambridge Diversion Dam after upstream developments and excluding the flow of Medicine Creek, is shown in table 136. Col. 25 = Cols. (21+22+23+24) unless their sum is negative, in which case it is carried over into the following months as zero until a positive answer is obtained.

## Red Willow Unit

Table 119 is a summary sheet of the Red Willow Reservoir operations study by years. This table shows that the shortage during the critical 1930-1940 period does not exceed the maximum permissible shortage as described in Vol. IV, Chapter 5.3 of the Reclamation Manual.

Exhibit 32 is a graphic chart which shows the proposed operation of Red Willow Reservoir. There are three hydrographs shown on this chart. The hydrograph at the top of the chart represents the estimated depleted inflow into the reservoir during the period of study.

The second hydrograph shows the irrigation requirements which were supplied by natural flows, the requirement met by storage releases from the reservoir, the total diversion requirements, and the amount which was shorted.

The third hydrograph shows the reservoir content and the spills during the period of study.

### Releases for Public Health Service

Studies made by the Public Health Service indicate that during the months of June through September the minimum desirable flow of the Republican River at Indianola is 10 second-feet. 1/ The desirable flow throughout the year as a percent of the June through September minimum flow is shown below:

| Month | Percent of summer flow | Min. desirable flow (cfs) |
|---|---|---|
| Jan. | 20 | 2 |
| Feb. | 20 | 2 |
| Mar. | 25 | 2.5 |
| Apr. | 40 | 4 |
| May | 60 | 6 |
| June | 100 | 10 |
| July | 100 | 10 |
| Aug. | 100 | 10 |
| Sept. | 100 | 10 |
| Oct. | 45 | 4.5 |
| Nov. | 30 | 3 |
| Dec. | 20 | 2 |

The Public Health Service requirements were adequately met by the normal operation of the Red Willow Reservoir operation study. The flow passing Indianola may be found by subtracting column 20 from the sum of columns 21 and 13 of the operation study, table 118.

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1/ "Kansas River Basin Water Pollution Investigation" Public Health Service, June 1949, p. 121.

Table 118

11,930 Acres Irrigated
18,000 A.F. Active Storage

Table 118. Reservoir Operation Summary
Red Willow Reservoir

Table 118

| Year | Depleted Inflow Red Willow Res. | Evap. A.F. | Seepage | Sectional Gain A.F. | Irrig. Demand 4000 ac. | Demand to be met by Release | System Passing A.F. | Ret. Flow From 4000 acres | Depleted Flow of Rep. Riv. at Bartley | Available at Bartley Diversion | Irrig. Demand for 7930 ac. | Demand to be met by releases | System passing Bartley Diver. | Total dem. to be made Reservoir Releases | Change in Rest. for year | Res. Cont. End Year | Spills | Shortage | Percent Shortage | Flow below Bartley | R.F. 2350 A | R.F. 7930 A | Sect. Gain to ... | Flow at ... Riv. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | 18.0 | | | | | | | | |
| 1929 | 17.7 | 1.6 | 3.6 | 7.9 | 8.4 | 8.3 | 8.7 | 1.6 | 453.8 | 389.1 | 12.0 | 1.6 | 813.1 | 8.3 | -8.9 | 9.1 | 4.5 | 0 | 0 | 383.8 | 1.4 | 4.3 | 13.9 | 393.4 |
| 1930 | 19.9 | 0.6 | 3.6 | 7.8 | 5.0 | 4.0 | 4.8 | 1.1 | 376.8 | 388.7 | 7.1 | 4.3 | 875.9 | 8.3 | +7.0 | 16.1 | 0.4 | 0 | 0 | 883.9 | 1.0 | 8.9 | 15.9 | 399.7 |
| 1931 | 16.4 | 1.9 | 3.6 | 5.7 | 7.7 | 6.4 | 4.4 | 1.3 | 105.6 | 151.3 | 11.0 | 15.9 | 146.8 | 20.3 | -13.0 | 8.3 | 5.6 | 3.7 | 4.8 | 180.9 | 1.1 | 3.7 | 1.1 | 173.8 |
| 1932 | 16.2 | 1.3 | 3.6 | 3.8 | 10.4 | 10.6 | 4.2 | 1.6 | 97.6 | 103.8 | 19.6 | 8.3 | 95.5 | 13.3 | 0 | 8.3 | 0 | 0 | 0 | 95.1 | 1.7 | 5.0 | 6.8 | 105.8 |
| 1933 | 20.7 | 1.0 | 3.6 | 4.0 | 20.8 | 11.8 | 9.0 | 1.8 | 146.5 | 113.3 | 14.6 | 5.4 | 156.1 | 16.6 | -2.0 | 3.3 | 0 | 0 | 0 | 147.8 | 1.7 | 5.2 | -4.9 | 150.1 |
| 1934 | 17.0 | 1.2 | 3.6 | 8.4 | 19.6 | 14.9 | 3.8 | 8.4 | 112.7 | 118.1 | 21.0 | 7.9 | 105.0 | 23.4 | -1.6 | 1.7 | 0 | 6.3 | 13.66 | 100.6 | 8.3 | 7.9 | -1.9 | 114.9 |
| 1935 | 86.1 | 1.7 | 3.6 | 6.5 | 9.7 | 9.6 | 6.4 | 8.8 | 697.5 | 695.9 | 13.8 | 0 | 680.1 | 9.6 | +11.7 | 13.1 | 0 | 0 | 0 | 645.7 | 1.8 | 5.9 | 29.8 | 628.7 |
| 1936 | 16.4 | 1.7 | 3.6 | 3.9 | 14.2 | 13.4 | 3.8 | 8.4 | 120.7 | 145.3 | 20.1 | 15.6 | 146.6 | 28.9 | -18.0 | 1.1 | 0 | 5.8 | 10.28 | 144.8 | 2.2 | 6.8 | -7.6 | 138.6 |
| 1937 | 12.9 | 0.3 | 3.6 | 3.8 | 3.9 | 7.5 | 1.7 | 8.8 | 70.1 | 73.8 | 19.2 | 4.6 | 80.4 | 16.2 | -0.1 | 1.0 | 0 | 3.3 | 5.00 | 60.0 | 1.8 | 5.3 | 1.9 | 77.0 |
| 1938 | 11.3 | 0.9 | 3.6 | 9.7 | 10.3 | 9.6 | 1.6 | 7.8 | 130.6 | 142.6 | 17.5 | 0 | 135.1 | 9.6 | -0.4 | 0.8 | 0 | 0.9 | 0.78 | 180.7 | 2.0 | 6.0 | 7.3 | 144.0 |
| 1939 | 12.1 | 0.9 | 3.6 | 3.7 | 12.9 | 11.1 | 1.9 | 8.4 | 100.1 | 166.6 | 16.6 | 1.8 | 187.0 | 17.9 | -0.2 | 1.0 | 0 | 2.5 | 9.46 | 151.6 | 2.2 | 6.5 | 3.0 | 165.1 |
| 1940 | 14.3 | 1.1 | 3.6 | 3.8 | 13.8 | 10.5 | 1.1 | 9.5 | 57.1 | 90.7 | 19.0 | 0.6 | 95.3 | 13.1 | -0.7 | 1.7 | 0 | 4.8 | 7.09 | 87.9 | 2.8 | 6.0 | -4.9 | 89.4 |
| 1941 | 34.8 | 1.4 | 3.6 | 11.3 | 6.6 | 4.7 | 9.4 | 1.5 | 496.0 | 499.7 | 9.4 | 0 | 498.3 | 4.7 | +16.3 | 18.0 | 0.2 | 0 | 0 | 494.7 | 1.3 | 4.0 | 12.3 | 496.1 |
| 1942 | 88.4 | 1.3 | 3.6 | 7.0 | 6.0 | 4.6 | 5.6 | 1.1 | 488.3 | 435.0 | 6.6 | 3.4 | 486.0 | 6.0 | -0.8 | 17.2 | 16.4 | 0 | 0 | 489.0 | 1.0 | 3.1 | -4.3 | 489.6 |
| 1943 | 33.1 | 2.3 | 3.6 | 3.7 | 8.7 | 6.4 | 1.4 | 1.9 | 140.3 | 109.8 | 18.4 | 8.7 | 98.4 | 7.1 | -3.5 | 13.7 | 3.6 | 0 | 0 | 99.6 | 1.4 | 6.1 | -0.8 | 104.2 |
| 1944 | 29.4 | 1.3 | 3.6 | 4.9 | 8.6 | 8.3 | 6.6 | 0.7 | 339.0 | 406.1 | 9.0 | 0.6 | 308.5 | 8.7 | +3.7 | 17.4 | 13.9 | 0 | 0 | 400.0 | 0.7 | 8.0 | 7.5 | 411.6 |
| 1945 | 20.4 | 1.6 | 3.6 | 9.7 | 8.5 | 8.4 | 5.6 | 1.8 | 147.4 | 174.6 | 12.8 | 0.4 | 192.6 | 4.8 | +0.6 | 18.0 | 58.1 | 0 | 0 | 158.3 | 1.8 | 3.7 | 7.3 | 170.5 |
| 1946 | 20.9 | 1.4 | 3.6 | 9.3 | 7.9 | 5.4 | 7.0 | 1.5 | 453.5 | 282.4 | 11.3 | 0.9 | 452.0 | 4.7 | 0 | 18.0 | 11.4 | 0 | 0 | 377.0 | 1.3 | 4.2 | 10.5 | 395.4 |
| 1947 | 25.9 | 1.3 | 2.7 | 5.8 | 5.3 | 3.9 | 4.6 | 0.9 | 384.8 | 450.3 | 7.3 | 3.9 | 886.9 | 7.9 | -7.6 | 10.4 | 17.7 | 0 | 0 | 891.3 | 0.8 | 8.3 | 5.8 | 396.8 |
| Average | 18.8 | 1.3 | 3.6 | 5.8 | 9.4 | 8.0 | 4.7 | 1.7 | 180.9 | 186.8 | 13.6 | 3.8 | 180.3 | 12.8 | | | 3.8 | 1.7 | | 187.8 | 1.8 | 4.3 | 4.8 | 190.6 |



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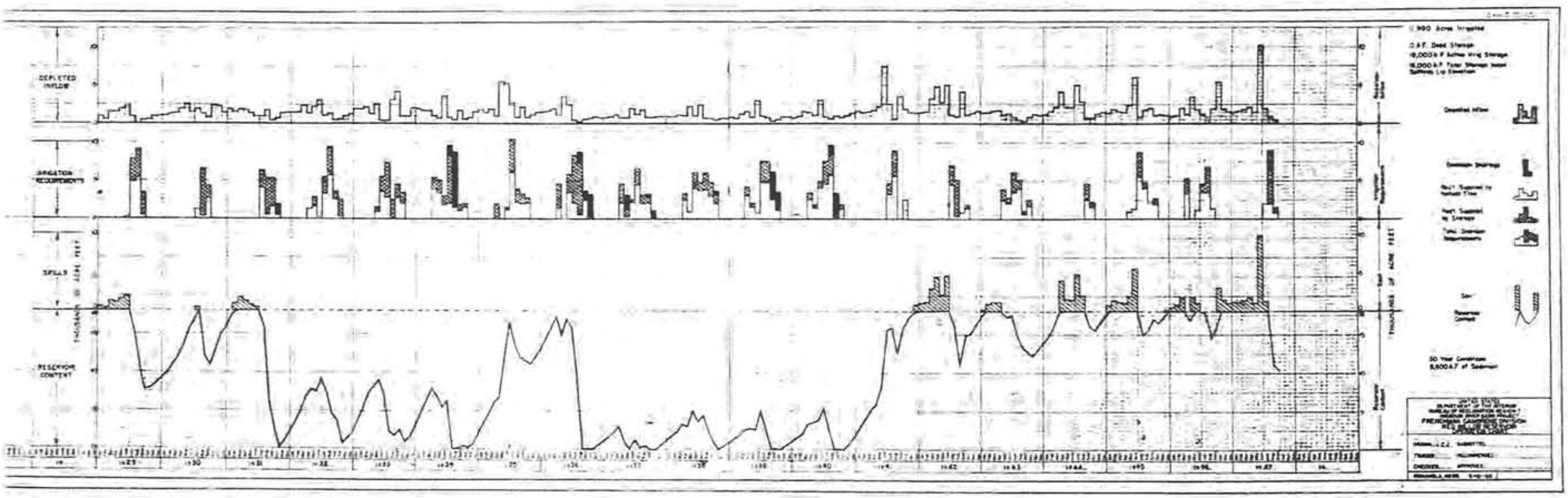

DEPLETED INFLOW
IRRIGATION REQUIREMENTS
SPILLS
RESERVOIR CONTENT
THOUSANDS OF ACRE FEET
Depleted Inflow
Reservoir Content
30 Year Conditions
UNITED STATES
FRENCHMAN CAMBRIDGE DIVISION

## Red Willow Unit

### Requirements for fish and wildlife

No water releases from the reservoirs for requirements of fish have been made in this study. In the past the Republican River has dried up during extremely dry seasons. Seepage from the dams and return flows from irrigated lands are expected to establish a live stream at all times. It is anticipated that the minimum flow requirements for public health will be sufficient for fish habitat requirements.

### Water passing the unit after development

The estimated flow of the Republican River passing the Red Willow Unit is the Republican River flow at Cambridge Diversion Dam and is shown under column 25 in the operations study and also in table 136. This flow consists of spills and seepage from Red Willow Reservoir, sectional gain in flow between Red Willow Reservoir and mouth of Red Willow Creek that was not diverted by either the Red Willow or the Bartley Diversion Dam, return flow from 2,610 acres that was not divertable by Bartley Diversion Dam, return flow from 9,380 acres below Bartley Diversion Dam, depleted flow of Republican River at Bartley Diversion Dam that was not diverted, and the sectional gain between Bartley Diversion Dam and Cambridge Diversion Dam. Flows from Medicine Creek were not included in table 136 as they are treated separately in the operation of Medicine Creek Reservoir.

### Summary

The water supply studies as presented herein indicate that the supply of water available is sufficient to serve the 11,990 acres in the unit, with the exception of a few small shortages which occurred during the critical 1930-1940 period. The maximum shortage occurred in the year 1934. This shortage amounted to 13.6 percent of the consumptive use requirements.

CHAPTER V

# C A M B R I D G E   U N I T

## General Plan of Development

The Cambridge Unit is comprised of 17,230 acres of irrigable land in the Republican River Valley between Cambridge and Alma, Nebraska. The water supply for the unit under this plan would be obtained from stored water in Medicine Creek Reservoir and from water that would be available for diversion from the Republican River at Cambridge Diversion Dam about 2 miles east of Cambridge, Nebraska.

Construction on Medicine Creek Dam was started March 3, 1948, and completed December 9, 1949. Closure was made at the dam and the storage of water was commenced on August 8, 1949.

Construction on Cambridge Diversion Dam was started November 17, 1947, and completed in December 1948. Work on the Cambridge Canal system was commenced June 12, 1948. The section between the diversion dam and Arapahoe which is about 12 miles long has been completed and an 8 mile section between Arapahoe and Edison is now under construction.

### Reservoir capacities

A total storage capacity of 92,300 acre-feet in Medicine Creek Reservoir is allocated as indicated in table 120.

The water supply study presented in this report has been worked out on the basis that there will be 15,000 acre-feet of sedimentation in the first 50 years of operation. This estimate of 15,000 acre-feet was based on very limited data. Recent studies using subsequent records of sediment on Medicine Creek indicate that sedimentation may be approximately 46,000 acre-feet in the first 50-year period.

Table 120.--Storage allocation in Medicine Creek Reservoir

| | Elev. (ft.) | Initial condition | | 50-Year conditions 15,000 ac-ft sediment | | 100-Year conditions 30,000 ac-ft sediment | |
|---|---|---|---|---|---|---|---|
| | | Accum. | Alloc. | Accum. | Alloc. | Accum. | Alloc. |
| Dead storage | | | 6,000 | | 800 | | 0 |
| Canal outlet | 2335.0 | 6,000 | | 800 | | 0 | |
| Active irrig. storage | | | 34,000 | | 24,200 | | 10,000 |
| Irrig. storage pool top | 2366.1 | 40,000 | | 25,000 | | 10,000 | |
| Flood control storage | | | 52,300 | | 52,300 | | 52,300 |
| Top flood control pool | 2386.2 | 92,300 | | 77,300 | | 62,300 | |
| Total capacity | | | 92,300 | | 77,300 | | 62,300 |

Cambridge Unit

If the results of studies in the future substantiate the conclusion that the original capacity for sediment storage was underestimated, present plans for increasing the storage capacity available for irrigation may have to be carried out. This may call for allocating the present water surcharge storage space to flood control storage and redesigning the present spillway section to pass the maximum design flood.

At the present time, a proposed plan is being initiated to develop a watershed treatment plan on the Medicine Creek watershed which would serve to reduce the sources of sediment and debris inflow to the reservoir. This would be a cooperative program between the Soil Conservation Service and the Bureau of Reclamation. Previous survey experience of the Soil Conservation Service in an adjacent watershed indicates that such a program would be very beneficial.

If the plans for redesigning the spillway section cannot be confirmed, it may become necessary to release irrigation water from other reservoirs to satisfy irrigation demands under the Cambridge Unit.

Finally, reference is made to the operating agreement between the Bureau of Reclamation and the Corps of Engineers wherein the loss of reservoir capacity, exceeding 10 percent of the present allocation for either irrigation or flood control is to be redistributed accordingly.

The method of distributing sediment in the reservoir was described under the Frenchman Unit. Operation studies were based on conditions assumed to exist in the reservoir at the end of 50 years.

Areas served

Cambridge Diversion Dam, near Cambridge, Nebraska, will be used to divert water from the Republican River to 17,230 acres including about 1,655 acres presently irrigated by pumps in the Cambridge Unit. There are 665 acres of irrigable lands in the Cambridge Unit which have been excluded from the Frenchman-Cambridge Irrigation District and are also excluded from the area furnished water in this study because they are or can be irrigated from existing wells. At the time the Frenchman-Cambridge Irrigation District was formed the owners of these lands petitioned to be excluded from the District.

Detailed land classification surveys show there are 15,630 acres to be served by the Cambridge Canal, which is now under construction, on the north side of the Republican River between Cambridge Diversion Dam and Alma, Nebraska. This canal will be approximately 47 miles long and will have an initial capacity of 325 second-feet. The Holbrook Canal, 17 miles long, and with an initial capacity of 36 second-feet, will be constructed to serve 1600 acres. This acreage was determined by land classification surveys which were complete except for detailed topography. The Holbrook canal is located on the south side of the Republican River between Cambridge Diversion Dam and Holbrook, Nebraska. The areas to be served under the Cambridge Unit are shown in exhibit 2.

Table 121.--Areas served under the Cambridge Unit.

| Canal | Presently irrigated (acres) | New lands (acres) | Total (acres) |
|---|---|---|---|
| Cambridge | 1,348 | 14,282 | 15,630 |
| Holbrook | 307 | 1,293 | 1,600 |
| Total | 1,655 | 15,575 | 17,230 |

## Water Resources

Medicine Creek rises in a sand-hill area in the south central part of Lincoln County, Nebraska, and flows southeastward about 70 miles to its confluence with the Republican River near the town of Cambridge, Nebraska. The contributing drainage areas above the near Cambridge gaging station and above Medicine Creek Dam are 687 square miles and 656 square miles, respectively. This does not include approximately 150 square miles of sand-hill area drainage which does not contribute to flood runoff; however, the sand-hill drainage contributes much to a sustained base flow of from 15 to 50 second-feet throughout the year in Medicine Creek. Summer flows are characterized by occasional large flows due to summer storms. Melting snow contributes little to surface runoff.

### Available stream-flow records

Stream-flow records of Medicine Creek near Cambridge and the Republican River near Cambridge have been used in determining the water supply which will be available to serve the Cambridge Unit. The periods of historical record are indicated in table 1, and exhibit 3. The locations of the stations used in the study are shown on exhibit 4.

Records of the flow of Medicine Creek near Cambridge prior to October 1940 are based upon staff-gage readings and they are only considered to be fair records. Flow records since October 1940 are based upon water stage recorders and they are considered to be good records except for periods of ice effect when all records are considered to be poor.

Cambridge Unit

The records of the flow of the Republican River near Cambridge are all based upon staff-gage readings. They were read twice daily and are considered to be fair records except for periods of ice effect when they are considered poor.

Stream flow correlations and estimates

Historical records of stream flow on Medicine Creek and on the Republican River near Cambridge are not available for the entire period of the water supply study, 1929-47, therefore, the use of correlations with available records at other stations was necessary in order to complete the records for use in the operation studies.

Concurrent historical records of Medicine Creek near Cambridge were correlated with records of Frenchman Creek flow at the mouth near Culbertson, adjusted to virgin flow, table 122, and by use of a curve, exhibit 33. The missing period was completed as shown in table 123. The virgin flow was computed by adding consumptive use of irrigation water by lands irrigated historically under Culbertson Canal. Portions of the period in this table were also completed by use of records of Red Willow Creek near Red Willow, table 87, and a correlation curve, exhibit 29, showing values of concurrent records of Medicine Creek and Red Willow Creek near Red Willow.

No records of historical runoff of Medicine Creek at Medicine Creek Dam were available for this study. Estimates of this historical runoff at Medicine Creek Dam, table 124, were computed by multiplying the estimated flow of Medicine Creek near Cambridge, table 123, by the ratio of the respective drainage area of the two points. The drainage area at the dam site is 656 square miles and the drainage area at Cambridge is 687 square miles. The drainage area above the dam is thus 95.5 percent of the Cambridge drainage area. The missing period of flow records of the Republican River near Cambridge, Nebraska, were estimated by correlating with adjusted records near Bloomington, Nebraska. Historical run-off records collected near Bloomington, table 128, were adjusted by subtracting table 127, the sum of the flows of Sappa Creek near Stamford, Nebraska, and Prairie Dog Creek near Woodruff, Kansas. This adjustment was necessary to eliminate any flood flows that occurred in the drainage area above Stamford and Woodruff. The adjusted flows near Bloomington shown in table 126, were then used in establishing the correlation curve presented in exhibit 34. Flows for the missing period of record of the Republican River near Cambridge, Nebraska, table 125, were estimated by entering this curve with the adjusted records near Bloomington, Nebraska, table 128.

Ground water

The information on ground water as presented in this discussion was obtained from Parts I and II of Water Supply Paper I, which is a

Table 122.—Virgin Flow of Frenchman Creek at Culbertson, Nebraska (at Mouth) a/

(1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 7.0 | 11.0 | 9.9 | 8.3 | 9.3 | 12.1 | 11.2 | 10.8 | 8.8 | 5.3 | 3.8 | 3.2 | 100.7 |
| 1930 | 4.6 | 8.9 | 10.4 | 10.7 | 9.4 | 10.0 | 8.8 | 9.8 | 7.7 | 7.7 | 8.6 | 6.1 | 102.7 |
| 1931 | 9.1 | 10.3 | 9.5 | 8.8 | 8.6 | 9.0 | 8.6 | 6.6 | 3.3 | 5.5 | 8.9 | 4.6 | 92.8 |
| 1932 | 5.2 | 8.6 | 9.2 | 9.5 | 9.8 | 12.7 | 9.3 | 5.5 | 8.9 | 5.3 | 7.1 | 3.7 | 94.8 |
| 1933 | 3.9 | 6.1 | 8.2 | 11.1 | 11.1 | 12.2 | 9.2 | 7.2 | 4.1 | 4.1 | 9.2 | 12.7 | 99.1 |
| 1934 | 8.4 | 5.6 | 12.0 | 11.7 | 10.7 | 10.9 | 7.6 | 4.6 | 10.5 | 5.0 | 4.4 | 5.7 | 97.1 |
| 1935 | 4.2 | 4.0 | 10.1 | 10.8 | 9.2 | 11.1 | 7.8 | 29.8 | 22.9 | 9.6 | 4.8 | 6.2 | 130.5 |
| 1936 | 5.2 | 7.8 | 9.7 | 10.1 | 10.3 | 11.7 | 9.4 | 9.8 | 8.5 | 3.9 | 3.9 | 3.8 | 94.1 |
| 1937 | 2.7 | 5.9 | 9.3 | 7.1 | 9.0 | 9.7 | 7.5 | 4.6 | 10.2 | 5.3 | 4.2 | 4.3 | 79.8 |
| 1938 | 2.9 | 5.4 | 9.1 | 9.8 | 9.1 | 9.1 | 8.9 | 8.8 | 11.6 | 6.3 | 4.4 | 7.0 | 92.4 |
| 1939 | 3.9 | 4.4 | 8.2 | 9.8 | 8.1 | 9.9 | 9.9 | 5.2 | 6.6 | 5.3 | 4.2 | 3.8 | 79.3 |
| 1940 | 3.3 | 2.5 | 6.8 | 6.9 | 10.3 | 11.6 | 9.3 | 5.3 | 24.6 | 5.8 | 5.1 | 4.7 | 96.2 |
| 1941 | 6.6 | 6.8 | 12.8 | 11.1 | 10.5 | 10.3 | 11.1 | 9.0 | 10.4 | 8.5 | 4.3 | 3.4 | 104.8 |
| 1942 | 8.7 | 9.0 | 9.5 | 9.1 | 10.1 | 12.6 | 12.6 | 14.0 | 12.6 | 6.7 | 5.3 | 10.0 | 120.2 |
| 1943 | 9.9 | 9.6 | 10.4 | 9.8 | 9.8 | 10.7 | 9.1 | 5.5 | 9.6 | 4.5 | 3.6 | 3.9 | 96.4 |
| 1944 | 4.7 | 7.5 | 8.8 | 9.0 | 10.6 | 11.8 | 14.4 | 12.3 | 10.0 | 9.2 | 5.2 | 4.2 | 107.7 |
| 1945 | 6.3 | 7.8 | 9.4 | 9.4 | 9.4 | 9.4 | 9.2 | 6.0 | 12.5 | 6.8 | 5.0 | 5.9 | 97.1 |
| 1946 | 9.5 | 8.3 | 8.1 | 9.8 | 9.2 | 10.3 | 8.5 | 6.4 | 7.1 | 10.1 | 4.1 | 7.6 | 99.0 |
| 1947 | 12.5 | 11.2 | 10.2 | 9.9 | 9.7 | 10.7 | 10.0 | 8.0 | 11.4 | 10.1 | 5.8 | 4.1 | 113.6 |
| Total Avg. | 6.2 | 7.4 | 9.6 | 9.6 | 9.7 | 10.8 | 9.6 | 8.9 | 10.7 | 6.6 | 5.4 | 5.5 | 100.0 |

a/ Computed by adding consumptive use of irrigation water by lands irrigated historically under Culbertson Canal.

EXHIBIT 33

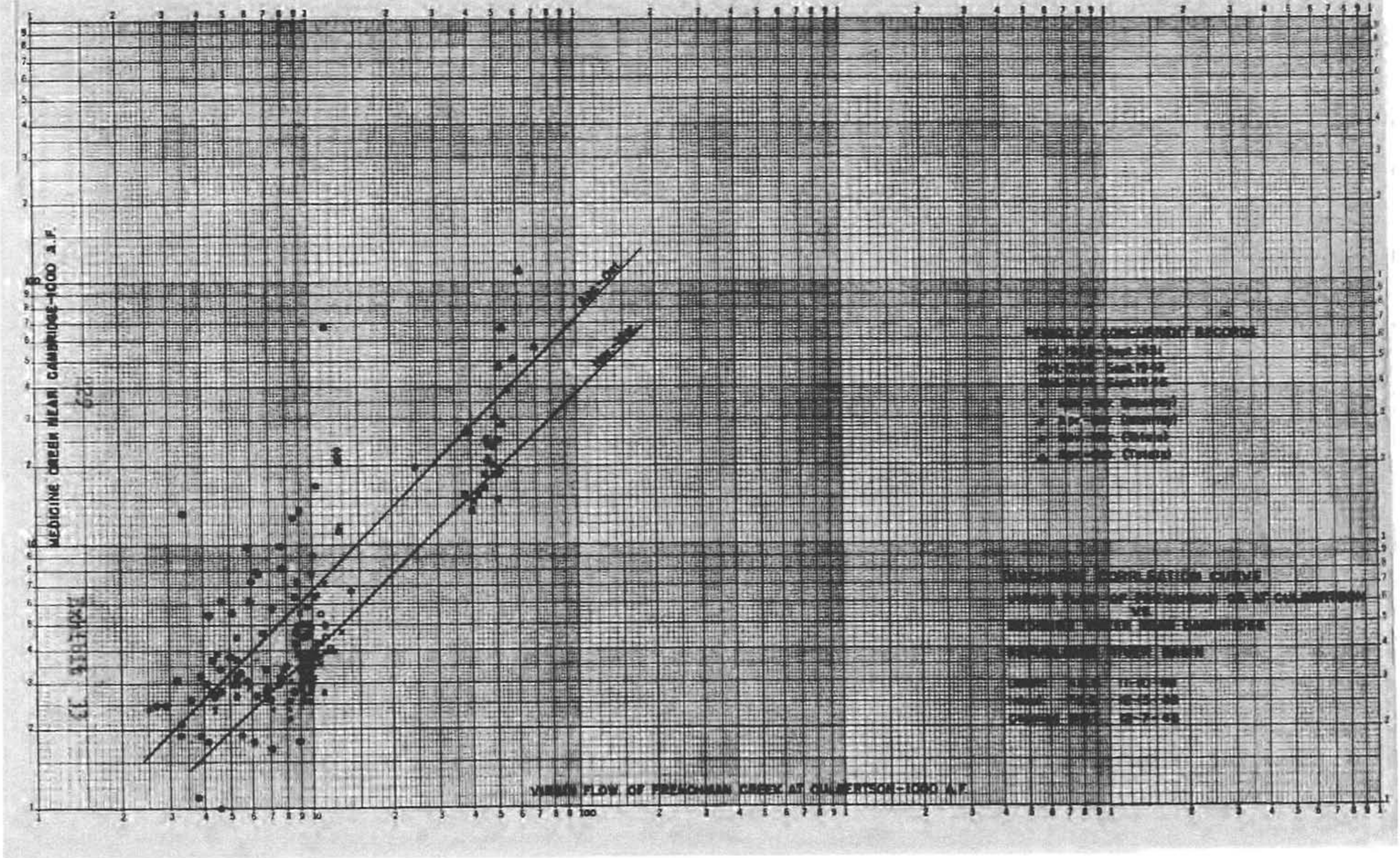


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Table 123.--Historical Runoff of Medicine Creek near Cambridge at Mouth. a/ Discharge in 1,000 acre-feet.

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.7 | 2.8 | 2.8 | 2.6 | 2.7 | 4.0 | 5.0 | 5.5 | 4.8 | 2.7 | 1.1 | 3.1 | 38.8 |
| 1930 | 3.4 | 4.6 | 4.3 | 3.8 | 3.5 | 4.0 | 5.0 | 4.6 | 10.0 | 8.2 | 6.4 | 1.8 | 59.6 |
| 1931 | 5.0 | 4.0 | 4.7 | 5.0 | 4.8 | 5.6 | 4.7 | 4.7 | 2.1 | 1.9 | 1.8 | 1.0 | 45.3 |
| 1932 | 3.4 | 3.4 | 3.6 | 3.8 | 3.9 | 5.0 | 6.3 | 3.6 | 6.0 | 3.5 | 4.7 | 2.4 | 49.6 |
| 1933 | 2.6 | 2.4 | 3.2 | 4.4 | 4.4 | 4.8 | 6.2 | 4.8 | 2.7 | 2.7 | 6.2 | 8.7 | 53.1 |
| 1934 | 5.6 | 2.2 | 4.7 | 4.6 | 4.3 | 4.3 | 5.1 | 3.0 | 7.2 | 3.3 | 2.9 | 3.8 | 51.0 |
| 1935 | 2.7 | 1.6 | 3.9 | 4.3 | 3.6 | 4.4 | 5.2 | 21.0 | 16.0 | 6.5 | 3.2 | 4.1 | 76.5 |
| 1936 | 3.4 | 3.1 | 3.8 | 3.9 | 4.1 | 4.6 | 6.4 | 6.6 | 5.7 | 2.6 | 2.6 | 2.5 | 49.3 |
| 1937 | 2.5 | 2.9 | 2.6 | 2.4 | 2.9 | 3.9 | 3.0 | 2.8 | 6.4 | 4.5 | 5.5 | 2.8 | 42.2 |
| 1938 | 2.5 | 3.0 | 3.0 | 2.8 | 2.9 | 3.8 | 3.9 | 7.3 | 4.1 | 8.0 | 2.7 | 2.6 | 46.6 |
| 1939 | 1.9 | 2.4 | 2.2 | 2.6 | 2.4 | 3.9 | 4.9 | 3.0 | 9.6 | 3.5 | 2.9 | 1.2 | 40.5 |
| 1940 | 1.9 | 2.4 | 2.6 | 2.9 | 3.8 | 4.0 | 4.5 | 3.2 | 19.8 | 9.9 | 5.6 | 6.2 | 66.8 |
| 1941 | 2.8 | 2.9 | 4.7 | 7.2 | 6.5 | 4.0 | 4.5 | 13.6 | 16.7 | 12.8 | 3.7 | 13.1 | 92.5 |
| 1942 | 4.2 | 3.4 | 3.2 | 3.6 | 3.2 | 11.8 | 21.0 | 6.7 | 11.2 | 2.8 | 3.7 | 7.8 | 82.6 |
| 1943 | 3.0 | 3.5 | 4.1 | 3.4 | 3.9 | 3.6 | 3.7 | 3.3 | 5.9 | 3.9 | 2.6 | 3.2 | 44.1 |
| 1944 | 2.1 | 3.2 | 2.4 | 3.2 | 4.2 | 6.0 | 15.2 | 8.3 | 7.4 | 18.2 | 9.8 | 2.1 | 82.1 |
| 1945 | 2.7 | 3.4 | 3.2 | 3.8 | 4.5 | 3.7 | 3.3 | 7.4 | 21.5 | 3.4 | 3.8 | 6.2 | 66.9 |
| 1946 | 3.2 | 3.1 | 2.6 | 3.6 | 3.3 | 4.0 | 2.8 | 7.9 | 5.8 | 4.0 | 1.8 | 3.2 | 45.3 |
| 1947 | 23.0 | 3.9 | 3.5 | 3.3 | 3.8 | 4.3 | 3.7 | 3.5 | 67.1 | 9.2 | 3.1 | 3.0 | 131.4 |
| Av. 1929-47 | 4.1 | 3.1 | 3.4 | 3.7 | 3.8 | 4.7 | 6.0 | 6.4 | 12.1 | 5.9 | 3.9 | 4.2 | 61.3 |

a/ Periods Oct. 1931 through Sept. 1936 based on correlation of Medicine Creek at mouth with Frenchman Creek (virgin flow) at mouth. (On Nov. - Mar. basis and Apr. - Oct. basis.)
Oct. 1928 through Sept. 1931; Oct. 1936 through Sept. 1943; and Oct. 1944 through Sept. 1947 are records.
Oct. 1943 through Sept. 1944 based on correlation of Medicine Creek with Red Willow Creek near Red Willow.

Table 124.—Estimated Historical Runoff of Medicine Creek at Medicine Creek Dam Site a/

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.6 | 2.7 | 2.7 | 2.5 | 2.6 | 3.8 | 4.8 | 5.3 | 4.6 | 2.6 | 1.0 | 3.0 | 37.2 |
| 1930 | 3.2 | 4.4 | 4.1 | 3.6 | 3.3 | 3.8 | 4.8 | 4.4 | 9.6 | 7.8 | 6.1 | 1.7 | 56.8 |
| 1931 | 4.8 | 3.8 | 4.5 | 4.8 | 4.6 | 5.4 | 4.5 | 4.5 | 2.0 | 1.8 | 1.7 | 1.0 | 43.4 |
| 1932 | 3.2 | 3.2 | 3.4 | 3.6 | 3.7 | 4.8 | 6.0 | 3.4 | 5.7 | 3.3 | 4.5 | 2.3 | 47.1 |
| 1933 | 2.5 | 2.3 | 3.1 | 4.2 | 4.2 | 4.6 | 5.9 | 4.6 | 2.6 | 2.6 | 5.9 | 8.3 | 50.8 |
| 1934 | 5.3 | 2.1 | 4.5 | 4.4 | 4.1 | 4.1 | 4.9 | 2.9 | 6.9 | 3.2 | 2.8 | 3.6 | 48.8 |
| 1935 | 2.6 | 1.5 | 3.7 | 4.1 | 3.4 | 4.2 | 5.0 | 20.1 | 15.3 | 6.2 | 3.1 | 3.9 | 73.1 |
| 1936 | 3.2 | 3.0 | 3.6 | 3.7 | 3.9 | 4.4 | 6.1 | 6.3 | 5.4 | 2.5 | 2.5 | 2.4 | 47.0 |
| 1937 | 2.4 | 2.8 | 2.5 | 2.3 | 2.8 | 3.7 | 2.9 | 2.7 | 6.1 | 4.3 | 5.3 | 2.7 | 40.5 |
| 1938 | 2.4 | 2.9 | 2.9 | 2.7 | 2.8 | 3.6 | 3.7 | 7.0 | 3.9 | 7.6 | 2.6 | 2.5 | 44.6 |
| 1939 | 1.8 | 2.3 | 2.1 | 2.5 | 2.3 | 3.7 | 4.7 | 2.9 | 9.2 | 3.3 | 2.8 | 1.1 | 38.7 |
| 1940 | 1.8 | 2.3 | 2.5 | 2.8 | 3.6 | 3.8 | 4.3 | 3.1 | 18.9 | 9.5 | 5.3 | 5.9 | 63.8 |
| 1941 | 2.7 | 2.8 | 4.5 | 6.9 | 6.2 | 3.8 | 4.3 | 13.0 | 15.9 | 12.2 | 3.5 | 12.5 | 88.3 |
| 1942 | 4.0 | 3.2 | 3.1 | 3.4 | 3.1 | 11.3 | 20.0 | 6.4 | 10.7 | 2.7 | 3.5 | 7.4 | 78.8 |
| 1943 | 2.9 | 3.3 | 3.9 | 3.2 | 3.7 | 3.4 | 3.5 | 3.2 | 5.6 | 3.7 | 2.5 | 3.1 | 42.0 |
| 1944 | 2.0 | 3.1 | 2.3 | 3.1 | 4.0 | 5.7 | 14.5 | 7.9 | 7.1 | 17.4 | 9.4 | 2.0 | 78.5 |
| 1945 | 2.6 | 3.2 | 3.1 | 3.6 | 4.3 | 3.5 | 3.2 | 7.1 | 20.5 | 3.2 | 3.6 | 5.9 | 63.8 |
| 1946 | 3.1 | 3.0 | 2.5 | 3.4 | 3.2 | 3.8 | 2.7 | 7.5 | 5.5 | 3.8 | 1.7 | 3.1 | 43.3 |
| 1947 | 22.0 | 3.7 | 3.3 | 3.2 | 3.6 | 4.1 | 3.5 | 3.3 | 64.1 | 8.8 | 3.0 | 2.9 | 125.5 |
| Total | | | | | | | | | | | | | |
| Average | 3.9 | 2.9 | 3.3 | 3.6 | 3.6 | 4.5 | 5.8 | 6.1 | 11.5 | 5.6 | 3.7 | 4.0 | 58.5 |

a/ Est. to be 95.5% of the flow at the mouth. Drainage area ratio $(\frac{656}{687})$



KS002451

Table 125.—Historical Runoff of Republican River at Cambridge, Nebraska (Cambridge Diversion Dam) a/

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 19.5 | 21.0 | 19.5 | 17.0 | 13.0 | 45.1 | 39.1 | 42.0 | 77.6 | 46.1 | 8.8 | 7.2 | 355.9 |
| 1930 | 11.0 | 22.2 | 23.1 | 19.6 | 19.6 | 27.6 | 41.0 | 63.0 | 76.0 | 21.4 | 21.4 | 35.0 | 380.9 |
| 1931 | 59.8 | 42.1 | 31.0 | 28.5 | 34.7 | 37.5 | 40.6 | 33.8 | 33.8 | 8.0 | 1.2 | 2.3 | 353.3 |
| 1932 | 2.6 | 10.1 | 10.0 | 12.8 | 34.4 | 38.0 | 26.0 | 19.8 | 71.0 | 14.7 | 22.2 | 14.4 | 276.0 |
| 1933 | 5.1 | 8.2 | 19.4 | 23.5 | 19.8 | 28.5 | 47.0 | 50.9 | 10.5 | 7.1 | 45.0 | 65.6 | 330.6 |
| 1934 | 17.5 | 17.5 | 30.0 | 27.4 | 23.6 | 28.6 | 22.5 | 7.2 | 47.9 | 4.4 | 2.6 | 17.5 | 246.7 |
| 1935 | 4.8 | 10.1 | 14.5 | 24.2 | 20.8 | 27.0 | 23.1 | 222.4 | 447.9 | 41.0 | 46.8 | 48.6 | 931.2 |
| 1936 | 14.8 | 20.6 | 22.5 | 18.5 | 13.4 | 36.0 | 23.7 | 84.6 | 39.8 | 3.1 | 1.6 | 6.0 | 284.6 |
| 1937 | 2.4 | 11.5 | 16.4 | 8.8 | 27.5 | 29.9 | 19.0 | 19.6 | 47.0 | 27.0 | 27.5 | 17.0 | 253.6 |
| 1938 | 6.4 | 11.7 | 13.5 | 24.3 | 22.2 | 29.2 | 31.5 | 51.4 | 46.7 | 43.6 | 33.0 | 36.8 | 350.3 |
| 1939 | 6.1 | 9.2 | 15.5 | 16.8 | 14.1 | 32.7 | 32.4 | 27.2 | 64.5 | 25.7 | 19.6 | 0.9 | 264.7 |
| 1940 | 0.8 | 4.2 | 11.4 | 7.9 | 14.1 | 36.8 | 22.7 | 16.7 | 57.0 | 15.5 | 11.9 | 7.0 | 206.0 |
| 1941 | 16.4 | 11.1 | 14.9 | 21.2 | 29.2 | 30.8 | 33.5 | 46.3 | 104.0 | 80.0 | 51.5 | 46.4 | 485.3 |
| 1942 | 30.5 | 24.2 | 22.4 | 20.0 | 30.0 | 56.1 | 57.2 | 48.8 | 49.8 | 13.8 | 18.7 | 34.0 | 405.5 |
| 1943 | 26.0 | 27.0 | 28.5 | 18.0 | 31.2 | 31.4 | 28.1 | 19.2 | 25.1 | 5.9 | 4.5 | 5.2 | 250.1 |
| 1944 | 3.4 | 8.0 | 11.0 | 16.1 | 28.5 | 35.0 | 76.0 | 58.9 | 54.6 | 98.2 | 24.9 | 4.3 | 418.9 |
| 1945 | 12.4 | 16.4 | 20.8 | 25.4 | 28.1 | 25.2 | 32.2 | 30.0 | 102.6 | 22.1 | 15.2 | 13.6 | 344.0 |
| 1946 | 18.0 | 18.7 | 15.4 | 24.8 | 27.0 | 31.5 | 18.4 | 38.4 | 28.3 | 70.1 | 5.6 | 14.2 | 310.4 |
| 1947 | 102.1 | 41.0 | 28.6 | 22.7 | 26.5 | 39.1 | 36.5 | 36.0 | 157.4 | 38.1 | 5.1 | 3.7 | 536.8 |
| Total Average | 18.9 | 17.6 | 19.4 | 19.8 | 24.1 | 34.0 | 34.2 | 48.2 | 81.1 | 30.8 | 19.3 | 20.0 | 367.6 |

a/- Records are as follows:
June through Oct. 1942; Apr. through Oct. 1943; Apr. through Oct. 1944; and Oct. 1945 through Sept. 1947. All other months, with the exception of May and June 1935, based on a correlation with the Republican River at Bloomington, Nebraska less Sappa Creek near Stamford and Prairie Dog Creek near Woodruff. May and June 1935 based on adjusting the pickup between Culbertson and Bloomington by river mileage basis.

Table 126.—Runoff of Republican River at Bloomington minus runoff of Sappa and Prairie Dog Creeks

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 20.5 | 22.0 | 20.6 | 18.2 | 13.7 | 49.9 | 42.0 | 45.8 | 92.8 | 51.0 | 9.0 | 7.4 | 392.9 |
| 1930 | 11.7 | 23.5 | 24.1 | 20.8 | 20.7 | 28.7 | 44.4 | 76.4 | 99.5 | 22.3 | 22.5 | 37.5 | 432.1 |
| 1931 | 70.6 | 45.9 | 32.8 | 29.8 | 36.9 | 40.0 | 45.7 | 35.7 | 35.6 | 8.3 | 1.2 | 2.4 | 384.9 |
| 1932 | 2.7 | 10.8 | 10.3 | 13.3 | 36.6 | 40.4 | 27.0 | 20.9 | 90.0 | 15.5 | 23.3 | 15.0 | 305.8 |
| 1933 | 5.3 | 8.8 | 20.2 | 24.8 | 20.9 | 29.3 | 52.0 | 57.5 | 11.0 | 7.3 | 49.6 | 80.9 | 367.6 |
| 1934 | 18.5 | 18.6 | 31.6 | 28.6 | 24.6 | 30.0 | 23.6 | 7.5 | 53.3 | 4.6 | 2.6 | 18.5 | 262.0 |
| 1935 | 4.9 | 10.9 | 15.1 | 25.3 | 21.8 | 28.0 | 24.1 | 79.6 | 526.2 | 44.2 | 51.8 | 54.7 | 886.6 |
| 1936 | 15.6 | 21.4 | 23.6 | 19.4 | 14.3 | 38.5 | 24.8 | 115.6 | 44.7 | 3.2 | 1.7 | 6.2 | 329.0 |
| 1937 | 2.5 | 12.0 | 17.5 | 9.0 | 28.8 | 31.3 | 20.0 | 20.8 | 52.0 | 28.0 | 28.7 | 18.0 | 268.6 |
| 1938 | 6.7 | 12.1 | 14.1 | 25.5 | 23.4 | 30.4 | 33.1 | 58.5 | 51.6 | 47.8 | 35.0 | 39.0 | 377.2 |
| 1939 | 6.3 | 9.7 | 16.9 | 17.9 | 15.1 | 34.6 | 34.3 | 28.4 | 78.7 | 26.9 | 20.8 | 0.9 | 290.5 |
| 1940 | 0.8 | 4.3 | 12.0 | 8.1 | 15.0 | 39.0 | 23.9 | 17.8 | 66.8 | 16.7 | 12.4 | 8.7 | 225.5 |
| 1941 | 17.5 | 11.8 | 15.5 | 22.4 | 30.6 | 32.6 | 35.5 | 51.3 | 155.7 | 106.7 | 58.6 | 51.2 | 589.4 |
| 1942 | 32.3 | 25.5 | 23.6 | 21.1 | 31.6 | 65.2 | 67.3 | 54.8 | 109.1 | 22.2 | 31.1 | 71.2 | 555.0 |
| 1943 | 24.3 | 28.0 | 30.0 | 19.0 | 33.1 | 33.9 | 53.3 | 21.4 | 50.7 | 12.1 | 1.6 | 2.2 | 309.6 |
| 1944 | 1.3 | 8.2 | 11.5 | 17.2 | 30.0 | 37.2 | 103.7 | 63.6 | 100.4 | 75.3 | 34.0 | 6.6 | 489.0 |
| 1945 | 9.8 | 17.6 | 21.9 | 26.7 | 29.3 | 26.6 | 34.1 | 31.7 | 152.2 | 23.1 | 16.1 | 14.4 | 403.5 |
| 1946 | 17.9 | 17.5 | 10.8 | 21.3 | 29.7 | 33.1 | 19.9 | 38.7 | 29.5 | 65.6 | 16.8 | 43.8 | 344.6 |
| 1947 | 192.7 | 48.2 | 34.5 | 20.5 | 28.5 | 45.7 | 37.1 | 40.4 | 275.7 | 61.8 | 10.2 | 5.8 | 801.1 |
| Average | 24.3 | 18.8 | 20.4 | 20.4 | 25.4 | 36.4 | 39.2 | 45.6 | 109.0 | 33.8 | 22.4 | 25.4 | 421.1 |

Table 127.--Run-off of Sappa Creek at the mouth plus Prairie Dog Creek at the mouth

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 2.4 | 0 | 2.8 | 0.3 | 0 | 9.6 | 4.3 | 10.9 | 16.2 | 19.1 | 3.0 | 1.2 | 69.8 |
| 1930 | 4.9 | 0.4 | 0.4 | 0.6 | 5.1 | 1.7 | 4.3 | 8.4 | 36.5 | 4.3 | 9.3 | 8.8 | 84.7 |
| 1931 | 28.4 | 8.0 | 5.5 | 4.3 | 3.9 | 5.9 | 9.6 | 6.1 | 5.6 | 1.2 | 23.8 | 2.2 | 104.5 |
| 1932 | 1.3 | 1.6 | 1.6 | 1.5 | 18.7 | 2.5 | 2.8 | 6.2 | 8.2 | 2.5 | 3.6 | 4.9 | 55.4 |
| 1933 | 0 | 0 | 1.3 | 1.3 | 0 | 3.3 | 14.6 | 15.1 | 2.5 | 1.1 | 0 | 12.5 | 51.7 |
| 1934 | 1.1 | 2.3 | 3.8 | 2.8 | 0.9 | 4.4 | 2.7 | 1.4 | 14.1 | 0.7 | 0.1 | 5.7 | 40.0 |
| 1935 | 0.3 | 0.9 | 0 | 1.1 | 0.9 | 1.8 | 3.4 | 41.7 | 29.7 | 5.2 | 14.1 | 16.6 | 115.7 |
| 1936 | 2.9 | 4.4 | 1.5 | 0.5 | 0 | 7.2 | 0.8 | 24.9 | 7.0 | 0.4 | 0 | 1.7 | 51.3 |
| 1937 | 0 | 0.1 | 0.4 | 0 | 5.9 | 3.5 | 0.9 | 3.5 | 48.9 | 5.0 | 19.4 | 7.7 | 95.3 |
| 1938 | 0.3 | 0 | 0 | 0.3 | 0.4 | 1.1 | 3.6 | 13.9 | 31.5 | 10.8 | 3.1 | 1.7 | 66.7 |
| 1939 | 0 | 0 | 0.1 | 0 | 0 | 0.9 | 1.4 | 11.3 | 30.2 | 6.5 | 1.9 | 0 | 52.3 |
| 1940 | 0 | 0 | 0 | 0. | 0.4 | 0.4 | 0 | 3.3 | 3.9 | 25.3 | 11.7 | 12.7 | 57.7 |
| 1941 | 1.7 | 0 | 0.3 | 0.4 | 1.5 | 0.5 | 8.3 | 9.7 | 102.5 | 42.9 | 19.8 | 46.5 | 234.1 |
| 1942 | 5.9 | 2.9 | 2.7 | 2.2 | 2.9 | 3.7 | 20.2 | 11.4 | 51.7 | 18.8 | 29.0 | 9.2 | 160.6 |
| 1943 | 2.4 | 1.7 | 2.3 | 2.3 | 2.7 | 2.7 | 4.8 | 1.9 | 17.2 | 2.0 | 1.6 | 4.2 | 45.8 |
| 1944 | 0 | 0.3 | 0.3 | 1.3 | 1.0 | 1.5 | 11.4 | 25.5 | 20.7 | 113.9 | 30.0 | 4.7 | 210.6 |
| 1945 | 2.7 | 2.4 | 2.5 | 2.3 | 2.4 | 3.3 | 3.7 | 3.7 | 15.0 | 26.0 | 3.6 | 0.4 | 68.0 |
| 1946 | 0.2 | 0.4 | 0.5 | 0.5 | 0.7 | 2.3 | 0.7 | 9.3 | 6.4 | 19.6 | 1.1 | 6.5 | 48.2 |
| 1947 | 88.6 | 11.9 | 7.1 | 4.9 | 4.6 | 10.9 | 5.1 | 5.4 | 121.0 | 19.6 | 5.6 | 1.6 | 286.3 |
| Average | 7.5 | 2.0 | 1.7 | 1.4 | 2.7 | 3.5 | 5.6 | 11.2 | 30.0 | 17.1 | 9.5 | 7.8 | 99.8 |

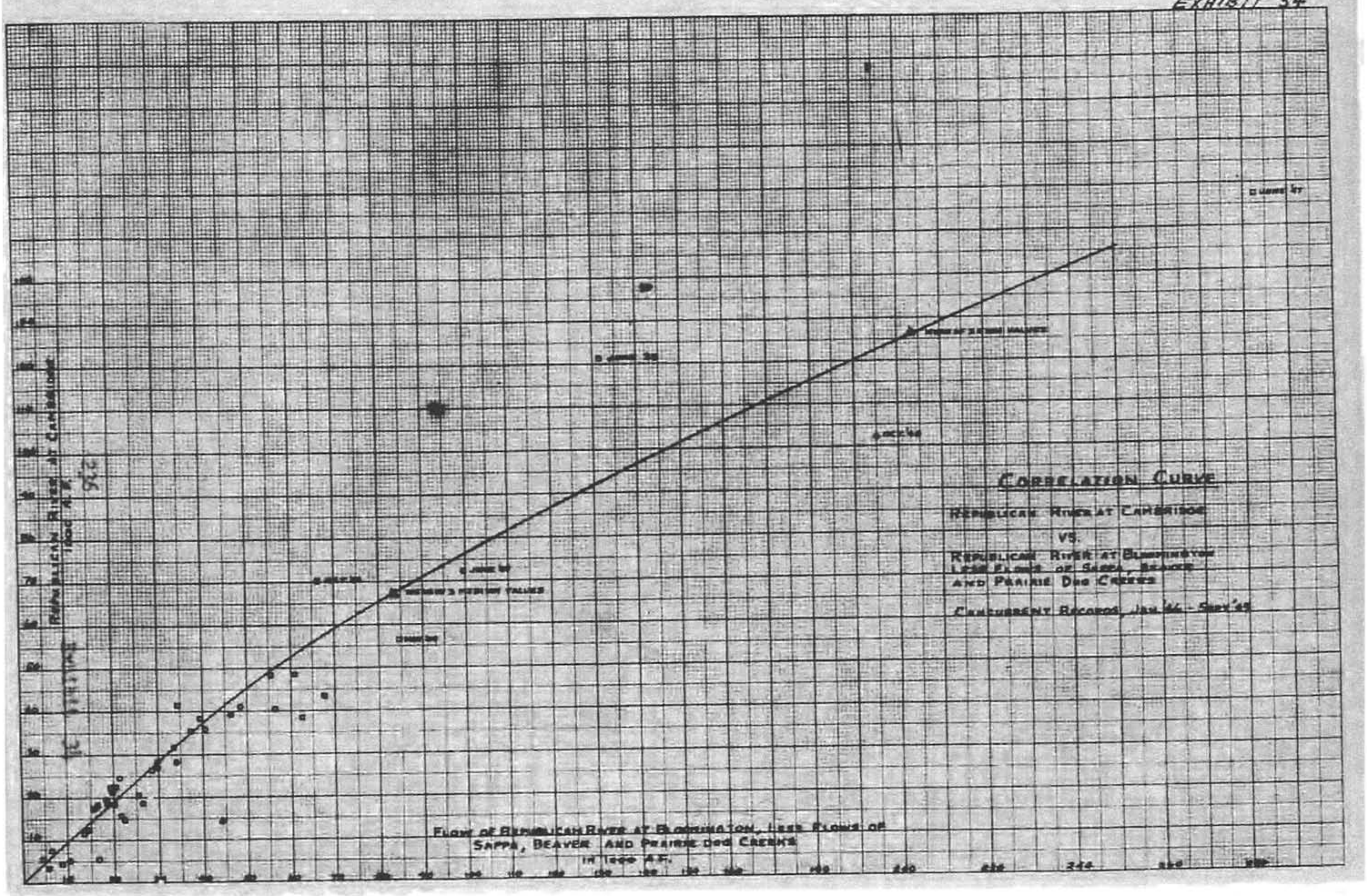
Table 128.—Historical flow Republican River near Bloomington a/

1000 acre-feet

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 22.9 | 22.0 | 23.4 | 18.5 | 13.7 | 59.5 | 46.3 | 56.7 | 109.0 | 70.1 | 12.0 | 8.6 | 462.7 |
| 1930 | 16.6 | 23.9 | 24.5 | 21.4 | 25.8 | 30.4 | 48.7 | 84.8 | 136.0 | 26.6 | 31.8 | 46.3 | 516.8 |
| 1931 | 99.0 | 53.9 | 38.3 | 34.1 | 40.8 | 45.9 | 55.3 | 41.8 | 41.2 | 9.5 | 25.0 | 4.6 | 489.4 |
| 1932 | 4.0 | 12.4 | 11.9 | 14.8 | 55.3 | 42.9 | 29.8 | 27.1 | 98.2 | 18.0 | 26.9 | 19.9 | 361.2 |
| 1933 | 5.3 | 8.8 | 21.5 | 26.1 | 20.9 | 32.6 | 66.6 | 72.6 | 13.5 | 8.4 | 49.6 | 93.4 | 419.3 |
| 1934 | 19.6 | 20.9 | 35.4 | 31.4 | 25.5 | 34.4 | 26.3 | 8.9 | 67.4 | 5.3 | 2.7 | 24.2 | 302.0 |
| 1935 | 5.2 | 11.8 | 15.1 | 26.4 | 22.7 | 29.8 | 27.5 | 121.3 | 555.9 | 49.4 | 65.9 | 71.3 | 1002.3 |
| 1936 | 18.5 | 25.8 | 25.1 | 19.9 | 14.3 | 45.7 | 25.6 | 140.5 | 51.7 | 3.6 | 1.7 | 7.9 | 380.3 |
| 1937 | 2.5 | 12.1 | 17.9 | 9.0 | 34.7 | 34.8 | 20.9 | 24.3 | 100.9 | 33.0 | 48.1 | 25.7 | 363.9 |
| 1938 | 7.0 | 12.1 | 14.1 | 25.8 | 23.8 | 31.5 | 36.7 | 72.4 | 83.1 | 58.6 | 38.1 | 40.7 | 443.9 |
| 1939 | 6.3 | 9.7 | 17.0 | 17.9 | 15.1 | 35.5 | 35.7 | 39.7 | 108.9 | 33.4 | 22.7 | 0.9 | 342.8 |
| 1940 | 0.8 | 4.3 | 12.0 | 8.1 | 15.4 | 39.4 | 23.9 | 21.1 | 70.7 | 42.0 | 24.1 | 21.4 | 283.2 |
| 1941 | 19.2 | 11.8 | 15.8 | 22.8 | 32.1 | 33.1 | 43.8 | 61.0 | 258.2 | 149.6 | 78.4 | 97.7 | 823.5 |
| 1942 | 38.2 | 28.4 | 26.3 | 23.3 | 34.5 | 68.9 | 87.5 | 66.2 | 160.8 | 41.0 | 60.1 | 80.4 | 715.6 |
| 1943 | 26.7 | 29.7 | 32.3 | 21.3 | 35.8 | 36.6 | 58.1 | 23.3 | 67.9 | 14.1 | 3.2 | 6.4 | 355.4 |
| 1944 | 1.3 | 8.5 | 11.8 | 18.5 | 31.0 | 38.7 | 115.1 | 89.1 | 121.1 | 189.2 | 64.0 | 11.3 | 699.6 |
| 1945 | 12.5 | 20.0 | 24.4 | 29.0 | 31.7 | 29.9 | 37.8 | 35.4 | 167.2 | 49.1 | 19.7 | 14.8 | 471.5 |
| 1946 | 18.1 | 17.9 | 11.3 | 21.8 | 30.4 | 35.4 | 20.6 | 48.0 | 35.9 | 85.2 | 17.9 | 50.3 | 392.8 |
| 1947 | 281.3 | 60.1 | 41.6 | 25.4 | 33.1 | 56.6 | 42.2 | 45.8 | 396.7 | 81.4 | 15.8 | 7.4 | 1087.4 |
| Total | 605.0 | 394.1 | 419.7 | 415.5 | 536.6 | 761.6 | 848.4 | 1080.0 | 2644.3 | 967.5 | 607.7 | 633.2 | 9913.6 |
| Avg. | 31.8 | 20.8 | 22.1 | 21.9 | 28.2 | 40.1 | 44.7 | 56.8 | 139.2 | 50.9 | 32.0 | 33.3 | 521.8 |

a/ Oct. 1928 - Apr. 1929 based on yearly discharge correlation with Hardy, Nebr. Other values are records.

EXHIBIT 34




KS002456

publication of the Nebraska Water Resources Survey, and from informal talks with farmers throughout the region. 1/

The Republican River Valley has an average width of about two miles in the Cambridge Unit area. The valley is characterized by a buried channel with relatively low bedrock and comparatively thick overlying deposits of water-bearing sand and gravel. Both north and south of the valley the sand and gravel deposits are capped by a relatively thick mantle of loess except where streams tributary to the Republican River have cut through the loess cap. As a result, recharge of the underlying ground-water reservoir from local precipitation is limited. It is believed that, because of these circumstances, the intensive development of large ground-water supplies in the areas north and south of the Republican Valley will necessarily be restricted. However, within the valley optimum conditions prevail for the infiltration of precipitation that falls in the region, because the valley soils are permeable, thus allowing percolation to the underlying sands and gravels. Conditions are likewise favorable in the valley region for direct recharge to the ground-water reservoir from stream flow. In addition, the ground water in the Republican Valley region receives steady contributions from upland areas north of it in the form of water moving in toward the valley. Since the soils in the valley are generally permeable, it is expected that most of the return flow waters, resulting from irrigation developments, will seep to the ground water and then return to the river. Return flow waters should increase the ground-water supply and make it possible to obtain a larger and more dependable yield from the ground water than is possible at present.

Profiles of the Republican River near Arapahoe and near Alma are shown in exhibits 35 and 36. The water-table ranges from about 4 feet to 20 feet below the surface of the ground.

Although the profiles show that the water-bearing layer of sand and gravel is relatively uniform in thickness, informal talks with farmers about farm wells reveal that it varies considerably in thickness throughout the region. In many locations it is too thin to yield a sufficient quantity of water. In other locations it is sometimes difficult to obtain a sufficient yield because the fine-grained sands too greatly restrict the flow of water into the well, even though there may be a good supply of water contained in the water-bearing layer. The better producing wells are predominantly on the south side of the river, because here the impervious chalky shale

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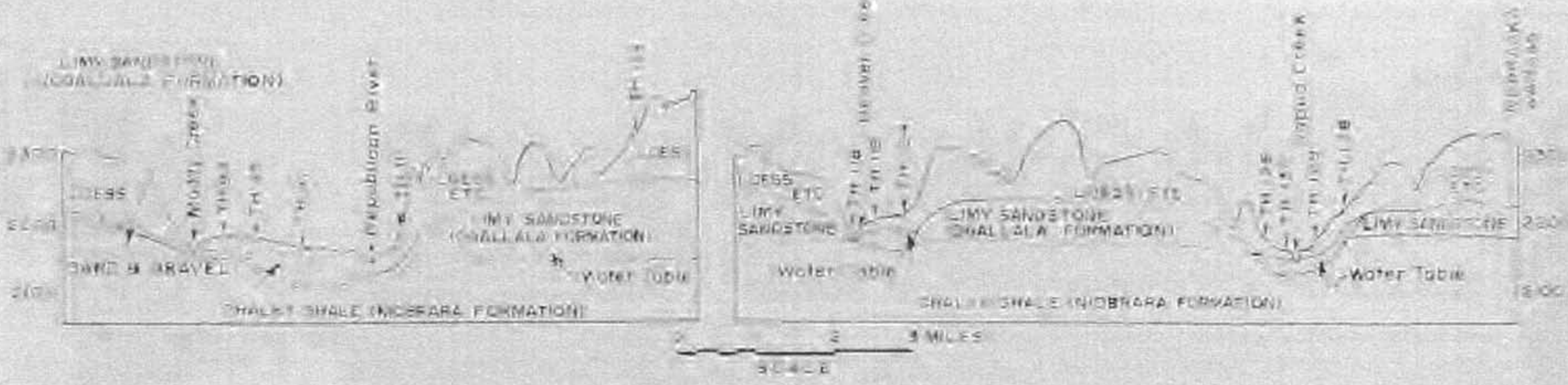
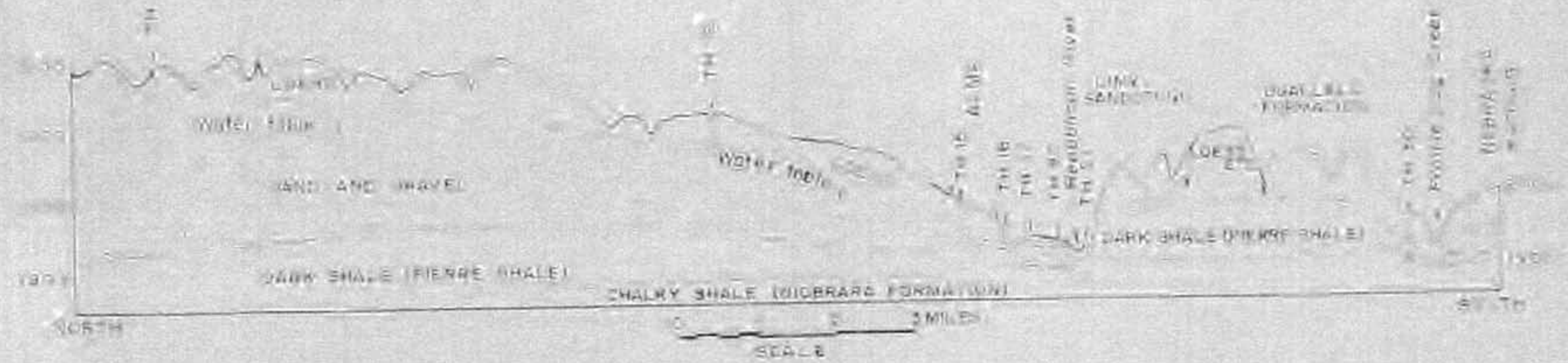
1/ Ground water in the Republican River Basin in Nebraska, Part I Nuckolls, Webster, Franklin, and Harlan Counties, and Part II Furnas County, by H. A. Waite, E. C. Reed, and D. S. Jones Jr., Published by the University of Nebraska, Conservation and Survey Division.


LIMY SANDSTONE (OGALLALA FORMATION)
LOESS
Republican River
SAND & GRAVEL
LOESS ETC.
LIMY SANDSTONE (OGALLALA FORMATION)
Water Table
CHALKY SHALE (NIOBRARA FORMATION)
LOESS ETC.
LIMY SANDSTONE
Water Table
LIMY SANDSTONE (OGALLALA FORMATION)
LIMY SANDSTONE
Water Table
CHALKY SHALE (NIOBRARA FORMATION)
0 1 2 3 MILES
SCALE


Water table
Water table
SAND AND GRAVEL
DARK SHALE (PIERRE SHALE)
CHALKY SHALE (NIOBRARA FORMATION)
DARK SHALE (PIERRE SHALE)
NORTH
SOUTH
3 MILES
SCALE

bedrock has been scoured out more deeply and there is generally a greater thickness of water-bearing sand and gravel overlying the shale than is generally found on the north side. The maximum thickness of saturated water-bearing material occurs in a narrow band extending from a point about 2 miles southwest of Holbrook to the Red Willow-Furnas county line west of Cambridge.

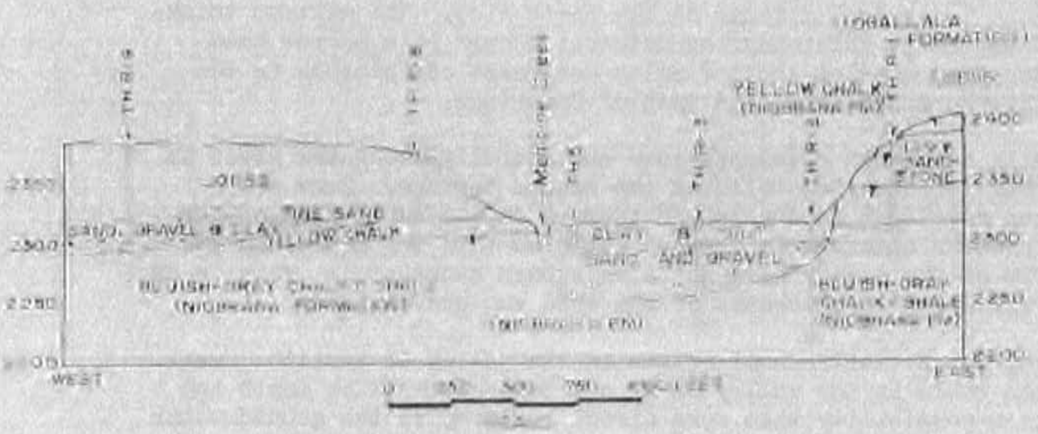
Wells have been developed more successfully along the river on the bottom terrace than wells on the second terrace. Some wells have been developed on the second terrace on the south side of the river; however attempts to develop wells on this terrace along the outer rim of the valley have not always been successful. This is due to the variation in thickness of the sand and gravel layer.

A narrow buried channel exists in the valley of Medicine Creek. The water table in the valley is at a relatively shallow depth and there is a possibility that some direct recharge to the ground-water reservoir from the stream flow occurs. There are possibilities of developing small water supplies in places where there is sufficient thickness of underlying saturated water-bearing material. A profile of Medicine Creek about 2 miles north of the Frontier-Red Willow County line is shown in exhibit 37.

It is not expected that extensive development of ground water will take place after a gravity system for irrigation is installed, because of the capital investment, heavy depreciation, scarcity of well locations, and upkeep costs necessary to maintain and operate the wells and pumps.

A cooperative program between the Bureau of Reclamation and the Geological Survey has been established for the study of the ground water in the Republican River Valley. This program will establish a history of the conditions which will be used as a basis for observing ground-water changes resulting from irrigation.

There are 27 observation wells located in the Cambridge Unit on the north side of the river and 6 wells located on the south side that are being read monthly by the Geological Survey. Thirty-one of these wells were jetted by the Geological Survey during May and June 1950 and were added to the observation program. The Bureau of Reclamation has requested the Geological Survey to prepare depth to ground water and water table contour maps of this area on the north side of the river by December 31, 1950, and July 1, 1951, respectively. The Bureau has also requested the Geological Survey to drill 25 additional observation wells on the south side of the river under the Holbrook Canal and add them to the observation program for minimum coverage. They were also requested to prepare depth to ground water and table contour maps of the area by October 1, 1951.


OGALLALA FORMATION
YELLOW CHALK
LOESS
FINE SAND
YELLOW CHALK
SAND, GRAVEL & CLAY
BLUISH-GRAY CHALKY SHALE (NIOBRARA FORMATION)
SAND AND GRAVEL
BLUISH-GRAY CHALKY SHALE (NIOBRARA FM)
2400
2350
2300
2250
2200
WEST
EAST
0 250 500 750 1000 FEET

## Cambridge Unit

### Quality of water

The criteria used in determining the quality of water permissable for use in irrigation are described under the discussion of quality of water for the Frenchman Unit.

Analyses of the mineral constituents of Medicine Creek near Cambridge and of the Republican River near Cambridge have been made by the Geological Survey. These analyses, taken during 1947 through 1949 are listed in tables 129 and 130. Table 131 lists analyses of ground water taken from wells at Cambridge, Arapahoe, Oxford, Orleans, and Alma.

Total salt concentration and sodium percentage of the water listed in tables 129 and 130 are plotted on charts, exhibits 38 and 39. These exhibits indicate that the stream flows of Medicine Creek and of the Republican River are of excellent quality for irrigation with respect to total salts and percent sodium. The boron concentration of these waters is low enough for the water to be classified as excellent or good for growing crops classified as sensitive to boron.

Hypothetical chemical combinations were made by drawing bar graphs of chemical equivalents showing the relationship of the carbonates and bicarbonates to the calcium, magnesium, sodium, and potassium. These bar graphs indicate that in two samples out of seven on Medicine Creek and eight samples out of the fourteen taken on the Republican River there were some concentrations of sodium carbonate or bicarbonate.

Analyses of ground-water samples taken from city wells at Cambridge, Arapahoe, Oxford, Orleans, and Alma have been made and are listed in table 131. These wells ranged in depth from 40 feet at Oxford to 72 feet at Arapahoe. Exhibit 40 indicates that the ground water in the unit is satisfactory for irrigation insofar as percentage of sodium and total salts are concerned. The largest amount of boron reported in any of the samples analyzed is 0.14 p.p.m. which is not enough to cause damage to the plants most sensitive to boron. A study of the sodium carbonate or bicarbonate concentration indicates there is no damaging concentration of these salts in the ground water of this area.

All of the communities in the Republican River Valley use water pumped from wells for domestic water supplies and it is not anticipated any of them will wish to use project water in the future. For this reason no data is presented to show the extent of pollution of surface waters in this report.

The Public Health Service has prepared a detailed report showing the extent, types, and major sources of pollution of streams in the Kansas River Basin. 1/ Minimum stream flows necessary below

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1/ "Kansas River Basin Water Pollution Investigation," Federal Security Agency, Public Health Service, June 1949.

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UNITED STATES DEPARTMENT OF THE INTERIOR—GEOLOGICAL SURVEY—Water Resources Division

Medicine [illegible] Creek [illegible] near Cambridge, Nebr.

Mineral constituents, in parts per million, and related physical measurements, water year October, 1946, to September, ___

| Date of Collection | Discharge (second-feet) | Temperature (°F) | pH | Specific conductance (K x $10^5$ at 25°C) | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | Dissolved Solids: Parts per million | Dissolved Solids: Tons per acre-foot | Dissolved Solids: Tons per day | Hardness as $CaCO_3$: Total | Hardness as $CaCO_3$: Non-carbonate | Percent Sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1947 | | | | | | | | | | | | | | | | | | | | | | |
| Mar. 30 | [illegible] | - - - | 8.7 | 46.5 | 56 | 0.05 | 60 | 12 | 10 | | 257 | 17 | 3.5 | 0.3 | 6.0 | 0.36 | 300 | 0.41 | - - - | 217 | 6 | 9 |
| May 1 | [illegible] | - - - | 8.7 | 45.4 | 60 | .05 | 64 | 15 | 11 | | 266 | 19 | 3.0 | .4 | 5.0 | .36 | 310 | .42 | - - - | 221 | 5 | 10 |
| May 30 | [illegible] | - - - | 7.6 | 46.0 | 46 | .05 | 63 | 15 | 11 | | 261 | 17 | 3.2 | .6 | 6.0 | .33 | 309 | .42 | - - - | 219 | 5 | 10 |
| Sept. 26 | [illegible] | - - - | 8.5 | [illegible] | 35 | .48 | [illegible] | 18 | 7.4 | | [illegible] | 21 | 2.6 | .5 | 4.2 | .17 | 330 | .45 | - - - | 245 | 16 | 6 |
| | | | | (Micromhos) | | | | | | | | | | | | | | | | | | |
| June 27, 1948 | [illegible] | - - - | 7.4 | [illegible] | 16 | 0.15 | 35 | 6.6 | 12 | | 146 | [illegible] | [illegible] | [illegible] | .4 | [illegible] | 149 | 0.27 | - - - | 116 | [illegible] | 19 |
| 1948 | | | | | | | | | | | | | | | | | | | | | | |
| Oct. 1 | | - - - | 7.1 | 415 | 48 | 0.02 | 55 | 12 | 22 | | 260 | 2.4 | 3.0 | [illegible] | 4.3 | [illegible] | 300 | | - - - | 182 | 0 | [illegible] |
| Apr. 26, 1949 | | | 7.1 | 499 | 48 | .02 | 60 | 15 | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | -- | [illegible] | | | 213 | 3 | [illegible] |

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TABLE 129

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - Water Resources Division

U. S. Geological Survey

Lincoln, Nebraska

*Table 130*

Preliminary Records

Drainage area _______ square miles

Mineral constituents, in parts per million, and related physical measurements, water year October, ____ to September, ____

| Sample No. | Date of Collection | Mean discharge (second-feet) | Temperature (°F) | pH | Specific conductance (micromhos, K x 10⁵ at 25°C) | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | Dissolved Solids: Parts per million | Dissolved Solids: Tons per acre-foot | Dissolved Solids: Tons per day | Hardness as $CaCO_3$: Total | Hardness as $CaCO_3$: Non-carbonate | Percent sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3380 | May 20, 1947 | 1,010 | --- | 8.0 | 14.5 | 55 | 0.05 | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | 7.5 | .7 | [illegible] | [illegible] | [illegible] | [illegible] | --- | [illegible] | [illegible] | 11 |
| 3389 | July 1 --- | 108 | --- | 8.3 | 42.9 | 44 | .08 | 58 | [illegible] | [illegible] | | 312 | [illegible] | [illegible] | [illegible] | 5.8 | [illegible] | [illegible] | [illegible] | --- | [illegible] | [illegible] | 11 |
| 3390 | Aug. 30 --- | 1,650 | --- | 7.7 | 50.7 | 47 | .05 | 46 | 19 | [illegible] | | 290 | [illegible] | 6.0 | .7 | [illegible] | .00 | 270 | .72 | --- | [illegible] | [illegible] | 17 |
| 3581 | Aug. 29 --- | 46 | --- | 7.8 | 43.0 | 60 | .06 | [illegible] | [illegible] | 12 | | 298 | 19 | 5.8 | .0 | [illegible] | [illegible] | 320 | .44 | --- | [illegible] | 1 | 21 |
| 3584 | Sept. 26 --- | 40 | --- | 7.8 | 45.1 | 65 | .14 | 80 | [illegible] | 17 | | 380 | 19 | 6.0 | .6 | [illegible] | [illegible] | [illegible] | .119 | --- | [illegible] | 0 | 11 |
| 6860 | June 17, 1948 | 1,340 | | 7.5 | 447 | 48 | 0.00 | 65 | 17 | 30 | | 264 | [illegible] | 5.0 | 0.6 | [illegible] | 0.20 | 266 | 0.36 | --- | 192 | 0 | 26 |
| 7889 | Sept. 1 --- | 46 | | 7.8 | 471 | [illegible] | .00 | 66 | 13 | [illegible] | | 270 | 22 | 7.0 | .6 | 4.7 | [illegible] | 320 | .44 | --- | 214 | 0 | 34 |
| | 1948 | | | | | | | | | | | | | | | | | | | | | | |
| 9431 | Oct. 1 --- | | | 7.9 | 437 | 56 | 0.03 | 57 | 22 | 27 | | 271 | 5.6 | 4.9 | 0.5 | 4.9 | 0.00 | 314 | 0.43 | --- | 177 | 0 | 25 |
| | 1949 | | | | | | | | | | | | | | | | | | | | | | |
| 11362 | [illegible]. 28 --- | | -- | 7.6 | 409 | 32 | .05 | 44 | [illegible] | [illegible] | | 198 | 45 | 5.5 | .7 | 3.2 | .03 | 274 | | | 155 | 0 | 30 |
| 11364 | [illegible]. 31 --- | | -- | 7.9 | 451 | 34 | .04 | 57 | [illegible] | [illegible] | | 246 | 32 | 8.0 | .6 | 4.1 | .08 | 308 | | | 198 | 0 | 20 |
| [illegible] | [illegible]. 28 --- | | | 7.1 | [illegible] | 40 | .13 | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | 7.0 | .9 | [illegible] | — | [illegible] | | | 190 | [illegible] | 32 |
| [illegible] | [illegible] --- | | | 7.1 | [illegible] | 37 | .00 | [illegible] | [illegible] | [illegible] | | [illegible] | 40 | [illegible] | .7 | 4.1 | .11 | 304 | | | 182 | [illegible] | 22 |
| [illegible] | [illegible] --- | | | 7.3 | 523 | 41 | .03 | 53 | [illegible] | [illegible] | | 262 | [illegible] | 5.0 | .8 | 4.7 | — | 368 | | | [illegible] | [illegible] | 32 |
| [illegible] | [illegible]. 24 --- | | | 7.3 | 533 | 34 | .02 | [illegible] | 14 | [illegible] | | [illegible] | [illegible] | 9.1 | .5 | 3.9 | — | 318 | | | 195 | [illegible] | 31 |

214

Table 130

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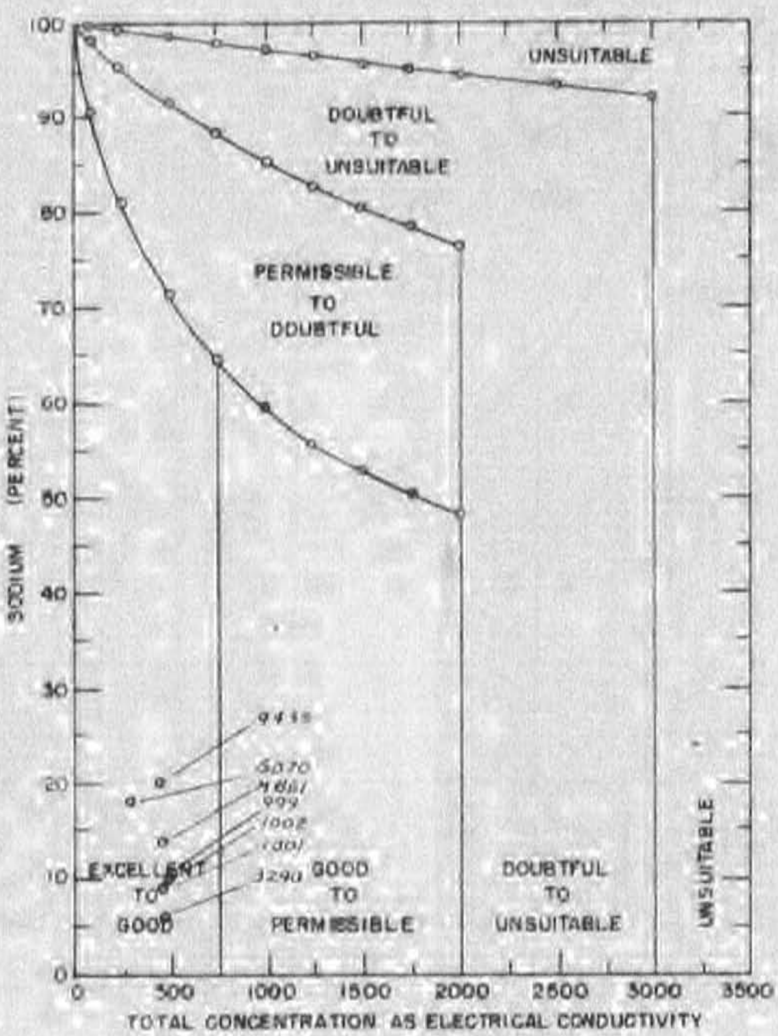
Table 131

Table 131. Mineral constituents, in parts per million, and related physical measurements of wells in the Cambridge Unit Area

| Analysis number | Owner and well number | Date of collection | Depth (feet) Well | Depth (feet) To water surface | Diameter (inches) | Discharge (g.p.m.) | Temperature (°F) | pH | Specific conductance $K \times 10^5$ at 25° C | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Boron (B) | Manganese (Mn) | Dissolved solids | Hardness as $CaCO_3$ Total | Hardness as $CaCO_3$ Noncarbonate | Percent sodium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 508 | City of Cambridge 4-26-36 abl | 5/22/47 | 52 | 15 | 22 | 350 | 55 | 8.4 | 49.9 | 54 | .00 | 78 | 17 | | 8.4 | 302 | 17 | 6.0 | 0.5 | 10 | .03 | 0 | 354 | 265 | 17 | 7 |
| 509 | City of Arapahoe 4-23-23 bb2 | 5/21/47 | 72 | 38 | 24 | 350 | 56 | 8.3 | 78.2 | 34 | .00 | 101 | 26 | 29 | 23 | 396 | 77 | 88 | 0.6 | 6.0 | .08 | 0 | 538 | 357 | 32 | 14 |
| 510 | City of Oxford 3-21-12 aa1 | 5/24/47 | 40 | 17 | 18 | 300 | 56 | 8.4 | 76.6 | 51 | .00 | 105 | 24 | 21 | 18 | 388 | 56 | 32 | 0.4 | 8.0 | .09 | 0 | 524 | 361 | 43 | 11 |
| 511 | City of Orleans 2-19-21 dal | 5/24/47 | 45 | 34 | 24 | 100 | 55 | 8.3 | 95.8 | 40 | .00 | 144 | 89 | 30. | | 430 | 105 | 55 | 0.2 | 6.0 | .10 | .1 | 711 | 379 | 26 | 12 |
| 512 | City of Alma 2-18-33 aa | 5/29/47 | 52 | 11 | 24 | 150 | 56 | 8.4 | 66.6 | 53 | .00 | 102 | 19 | 17. | | 362 | 33 | 28 | 0.8 | 10 | .14 | 0 | 477 | 333 | 36 | 12 |

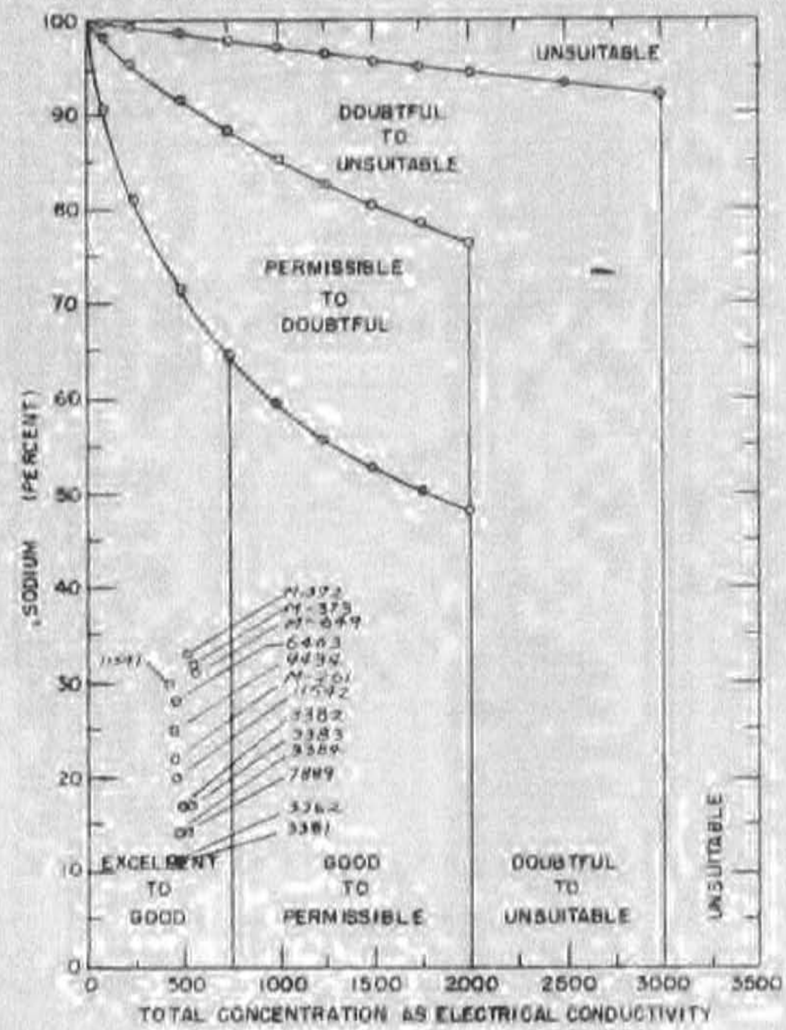
EXHIBIT 3 - DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS
OF WATER SAMPLES FROM
MEDICINE CREEK NEAR CAMBRIDGE, NEBRASKA




USDA CIRCULAR NO. 784, MAY 1948

"EXPLANATION AND INTERPRETATION OF ANALYSIS OF IRRIGATION WATERS" L.V. WILCOX

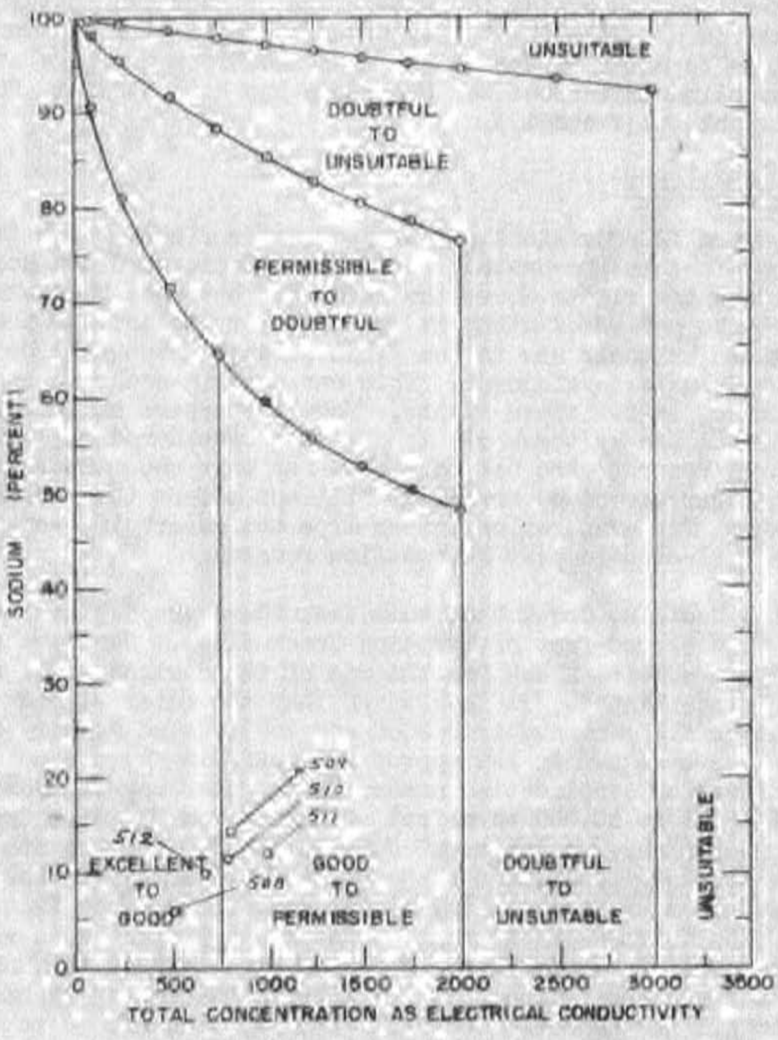
EXHIBIT -? DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF WATER SAMPLES FROM REPUBLICAN RIVER NEAR CAMBRIDGE, NEBRASKA




USDA CIRCULAR NO. 784, MAY 1948

"EXPLANATION AND INTERPRETATION OF ANALYSIS OF IRRIGATION WATERS" L.V. WILCOX

EXHIBIT 4 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS OF WATER SAMPLES FROM WELLS IN CAMBRIDGE UNIT AREA




USDA CIRCULAR NO. 784, MAY 1948

"EXPLANATION AND INTERPRETATION OF ANALYSIS OF IRRIGATION WATERS" L.V WILCOX reservoirs for sanitation are listed in the Public Health Service Report and are discussed in the section of this appendix discussing releases for Public Health Service.

## Water Rights

Information concerning the water laws of Nebraska appears under the discussion of water rights for the Frenchman Unit. Claims and applications to water rights in the Medicine Creek drainage area and on the Republican River between Cambridge and Harlan County Reservoir appear in tables 132 and 133.

### Active water rights

There are 12 provisional grants for water rights which total 6.78 second-feet in the drainage area above Medicine Creek Reservoir. Because the water rights above the reservoir have not been exercised throughout the period of study it was necessary to include the acreage irrigated by their use in the 1,650 acreage which will be developed by private development. This was done in order to insure a full water supply for these rights. For the purpose of this study the historical use by these rights has been considered negligible and the historic records were not corrected for this use. Storage at Wellfleet Reservoir of 80 acre-feet will not affect the project water supply except for evaporation losses from the reservoir, which would have been reflected in past stream-flow records.

In the Medicine Creek Reservoir area there are 5 claims to a total of 2.96 second-feet of Medicine Creek flows. Due to the construction of Medicine Creek Dam the use of these rights will necessarily be discontinued. It is assumed that the water rights under appropriation filings numbered 2686 and 2687, dated January 27, 1937, will be assigned to the appropriation filing by the United States of America, application number 3900, dated May 1, 1946, for for right to store 40,000 acre-feet of water from Medicine Creek for irrigation purposes. A letter of July 16, 1941, from the State Engineer, Nebraska Department of Roads and Irrigation, to the Chief Engineer, Bureau of Reclamation, states that there is on file in the office of the Nebraska Department of Roads and Irrigation a resolution, dated July 5, 1941, by the Board of Directors of the United Public Power and Irrigation District stating that water rights claimed in filings numbered 2686 and 2687 may be assigned to the organization designated to build the Cambridge project. The Cambridge Unit will include the same areas which were planned to be served under the water rights claimed in filings numbered 2686 and 2687.

Between Medicine Creek Dam and Cambridge, there are 6 provisional grants with a total right of 71.10 second-feet, however, 68.0 second-feet out of the 71.10 second-feet are rights claimed by the Cambridge Mill at Cambridge.

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Table 132

Table [illegible]. Claims and Applications of Water Rights in Medicine Creek Drainage Area

| Appropriator or Operator | Post Office | Carrier | Use to which applied | Provisional grant in Sec.-Ft. | Location of Diversion or Dam S | T | R | County | Date of Priority Mo. | Day | Year | Dec. No. | App. No. | Date Discontinued Mo. | Day | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Above Reservoir Area | | | | | | | | | | | | | | | | |
| Young, Lee | Maywood | Young Canal | Irrigation | .20 | 33 | 8 | 28 | Frontier | Apr. | 8 | 1927 | | 1931 | | | |
| Nelson, R. O. & H. L. | Curtis | Nelson Pump | Irrigation | .27 | 34 | 8 | 28 | Frontier | Apr. | 18 | 1927 | | 1927 | | | |
| Reed, Martha | Stockville | Sanders Canal | Irrigation | .16 | 27 | 7 | 27 | Frontier | Feb. | 8 | 1898 | 93, 3040 1/ | | | | |
| Crete Mills | Curtis | Curtis Lake | Power | | 32 | 8 | 28 | Frontier | | | | | | | | |
| Maywood Mill Co. | Maywood | Maywood Mills | Power | 11.88 | 18 | 8 | 28 | Frontier | May | 4 | 1907 | | 488 | Jan. | 31 | 1946 |
| Borah, Burdette C. | Maywood | Nelson Pump | Irrigation | .81 | 21 | 8 | 28 | Frontier | Oct. | 2 | 1938 | | 1888 | Jan. | 31 | 1948 |
| Game Forestation & Parks Commission | Lincoln | Wellfleet Lake | Resort | 80 A. F. | 18 | 9 | 30 | Lincoln | June | 18 | 1931 | | 2210 | | | |
| Schick, Wm. | Curtis | Schick Pump | Irrigation | .43 | 1 | 8 | 28 | Frontier | May | 18 | 1940 | | 3161 | | | |
| Kaldeen, Chris | Curtis | Kaldeen Pump | Irrigation | .26 | 4 | 8 | 28 | Frontier | May | 16 | 1940 | | 3168 | | | |
| Towne, W. E. | Maywood | Towne Pump | Irrigation | .99 | 36 | 9 | 28 | Frontier | Feb. | 6 | 1950 | | 3098 | | | |
| Towne, W. E. | Maywood | Towne Pump | Irrigation | .28 | 26 | 8 | 28 | Frontier | July | 11 | 1940 | | 3197 | | | |
| Russell, O. E. | Maywood | Russell Pump | Irrigation | 1.30 | 28 | 8 | 28 | Frontier | Oct. | 31 | 1940 | | 3218 | | | |
| Schmelzer, Albert | Maywood | Schmelzer-Pump | Irrigation | .82 | 8 | 8 | 28 | Frontier | Oct. | 31 | 1940 | | 3218 | | | |
| Baker, Jay D. | Curtis | Pump | Irrigation | 1.00 | 7 | 7 | 27 | Frontier | May | 18 | 1948 | | 3486 | | | |
| | | | | | 18 | 7 | 27 | | | | | | | | | |
| Wood, Donald | Stockville | Pump | Irrigation | | 1 | 6 | 27 | Frontier | Feb. | 27 | 1948 | | 4283 | | | |
| Busher, Guy J. | Stockville | Pump | Irrigation | .33 | 12 | 6 | 27 | Frontier | Oct. | 8 | 1940 | | 3287 | | | |
| Pursel, Orie O. | Curtis | Pursel Pump | Irrigation | 1.17 | 1 | 7 | 28 | Frontier | Sep. | 13 | 1948 | | 4394 | | | |
| Bessmever & Sanders | Denver | Sander Pump | Irrigation | | 36 | 10 | 31 | Lincoln | Jan. | 4 | 1949 | | 4414 1/ | | | |
| Total Active | | | | 6.78 | | | | | | | | | | | | |
| Total Inactive or Cancelled | | | | 13.40 | | | | | | | | | | | | |
| In Reservoir Area | | | | | | | | | | | | | | | | |
| Tridle, Ralph D. | Freedom | Tridle Pump | Irrigation | | 36 | 6 | 28 | Frontier | Apr. | 26 | 1937 | | 2736 | June | 28 | 1940 |
| Compton, J. H. | Cambridge | Compton Pump | Irrigation | .67 | 24 | 5 | 28 | Frontier | May | 14 | 1940 | | 3158 | | | |
| Baker, J. G. | Freedom | Baker Pump | Irrigation | .38 | 18 | 6 | 26 | Frontier | Oct. | 8 | 1940 | | 3235 | | | |
| Compton, C. H. | Cambridge | Compton Pump | Irrigation | .04 | 24 | 5 | 28 | Frontier | Dec. | 12 | 1940 | | 3260 | | | |
| Smith, Luther L. | Indianola | Pumps | Irrigation | .70 | 36 | 6 | 28 | Frontier | June | 4 | 1940 | | 3173 | | | |
| | | | | | 2 | 5 | 28 | Frontier | June | 4 | 1940 | | 3178 | | | |
| U. S. of America | Denver, Colo. | Med. Cr. Res. | Storage | 60,000 A. F. | 24 | 6 | 28 | Frontier | May | 1 | 1946 | | 3800 | | | |
| | | | | | 25 | 5 | 28 | Frontier | May | 1 | 1946 | | 3900 | | | |
| Wolf and Staley | Bartley | Pump | Irrigation | .36 | 20 | 4 | 28 | Frontier | Apr. | 28 | 1947 | | 4090 | | | |
| Total Active | | | | 2.08 | | | | | | | | | | | | |
| Total Inactive or Cancelled | | | | | | | | | | | | | | | | |
| Below Reservoir Area | | | | | | | | | | | | | | | | |
| Gold Gain Mills | Cambridge | Cambridge Mill | Power | 88.00 | 28 | 4 | 25 | Furnas | Dec. | 31 | 1878 | 42-43 | | | | |
| Cambridge-Arapahoe Irrigation & Improvement Co. | Arapahoe | Cambridge Arapahoe Canal | Irrigation | 170.00 | 26 | 4 | 25 | Furnas | Aug. | 28 | 1891 | 59 | | July | 8 | 1947 |
| United Public Power and Irrigation District | Cambridge | Med. Cr. Canal | Irrigation | | 20 | 4 | 23 | Furnas | Jan. | 27 | 1937 | | 2600 1/ | | | |
| United Public Power and Irrigation District | Cambridge | Med. Cr. Canal | Irrig. & Power | | 26 | 6 | 28 | Frontier | Jan. | 27 | 1937 | | 2601 1/ | | | |
| Mousel, George A. | Cambridge | Mousel Pump | Irrigation | 1.38 | 31 | 6 | 25 | Frontier | Apr. | 8 | 1943 | | 3606 | | | |
| Mousel, George A. | Cambridge | Mousel Pump | Irrigation | .18 | 5 | 4 | 26 | Red Willow | Apr. | 20 | 1943 | | 3608 | | | |
| Mousel, Robert, Jr. | Cambridge | Mousel Pumps | Irrigation | .90 | 29-30 | 5 | 26 | Frontier | June | 8 | 1943 | | 3614 | | | |
| Harding, Ernest L. | Cambridge | Harding Pump | Irrigation | .28 | 7 | 4 | 25 | Furnas | Aug. | 31 | 1943 | | 3652 | | | |
| Babcock, Mrs. Fannie | Cambridge | Babcock Pump | Irrigation | .18 | 18 | 4 | 25 | Furnas | Mar. | 22 | 1944 | | 3701 | | | |
| Bellamy, Guy | Cambridge | Bellamy Pump | Irrigation | | 29 | 4 | 25 | Furnas | Feb. | 5 | 1949 | | 4427 1/ | | | |
| Total Active | | | | 71.10 | | | | | | | | | | | | |
| Total Inactive or Cancelled | | | | 170.00 | | | | | | | | | | | | |

1/ Pending

Note: Data taken from report of The Department of Roads and Irrigation, Vol. II Bureau of Irrigation Water Power and Drainage. Data for 1948 are unpublished records of Nebraska Department of Roads and Irrigation.

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Table 133

Table 133. Claims and Applications of Water Rights on Republican River between Cambridge and Harlan County Reservoir Area 1/

| Appropriator or Operator | Post Office | Carrier | Use to which Applied | Provisional Grant in Sec. Ft. | Location of Diversion or Dam S | T | R | County | Date of Priority Mo. | Day | Year | Doc. No. | App. No. | Date Discontinued Mo. | Day | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Busch and Murdoch | Orleans | Pumps | Irrig. | 4.29 | 22 | 3 | 20 | Harlan | Sept. | 18 | 1939 | | 2029 | | | |
| | | | | | 27 | 3 | 20 | Harlan | Sept. | 18 | 1939 | | 2030 | | | |
| Best, John | Oxford | Pump | Irrig. | 2.60 | 36 | 5 | 22 | Furnas | Nov. | 9 | 1934 | | 2482 | | | |
| Fisher, Marshall | Edison | Pump | Irrig. | .32 | 30 | 4 | 22 | Furnas | June | 25 | 1936 | | 2383 | | | |
| French, J. A. | Edison | Pump | Irrig. | .89 | 9 | 3 | 21 | Furnas | Feb. | 20 | 1937 | | 2702 | | | |
| Andrews, Donald | Cambridge | Pump | Irrig. | .86 | 25 | 4 | 24 | Furnas | Apr. | 29 | 1938 | | 2907 | | | |
| Tietze, Ernest E. et. al. | Fremont | Pumps | Irrig. | .33 | 28 | 4 | 24 | Furnas | Oct. | 16 | 1940 | | 3230 | | | |
| | | | | | 28 | 4 | 24 | Furnas | Oct. | 16 | 1940 | | [illegible] | | | |
| McCann, Howard | Edison | Pump | Irrig. | .04 | 30 | 4 | 22 | Furnas | May | 2 | 1941 | | 3430 | | | |
| Olsen, Wendell | Orleans | Pump | Irrig. | 1.00 | 30 | 5 | 20 | Harlan | Aug. | 5 | 1943 | | 3623 | | | |
| Frenchman-Cambridge Irrigation District | McCook | Camb. Oxford - Orleans Canal | Irrig. | | 27 | 4 | 20 | Furnas | Jan. | 12 | 1946 | | 3848a | | | |
| Peterson, Ben E. | Orleans | Pump | Irrig. | .23 | 1 | 3 | 20 | Harlan | Mar. | 5 | 1947 | | 4042 | | | |
| Ballard, Henry L. | Oxford | Ballard Canal | Irrig. | 6.00 | 8 | 3 | 21 | Furnas | June | 6 | 1894 | 91 | - | Jan. | 22 | 1943 |
| Consumers Public Power Dist. | Columbus | Arapahoe Star Mills | Power | 100.00 | 27 | 4 | 23 | Furnas | July | 24 | 1879 | 1029 | - | Jan. | 22 | 1943 |
| Olson, Oliver | Orleans | Rep. Valley Pump | Irrig. | 2.09 | 27 | 3 | 20 | Harlan | June | 18 | 1928 | | 1041 | July | 2 | 1943 |
| Olson, L. | Orleans | Lake View Project | Irrig. | 1.15 | 27 | 3 | 20 | Harlan | June | 20 | 1924 | | 1084 | July | 2 | 1943 |
| Shaffery, C. E. | Oxford | Shaffery Pump | Irrig. | 1.86 | 16 | 3 | 20 | Harlan | Feb. | [illegible] | [illegible] | | [illegible] | Jan. | 7 | 1943 |
| Best, John W. | Oxford | Best Pump | Irrig. | 1.41 | 27 | 3 | 20 | Harlan | June | 30 | 1927 | | 1988 | Jan. | 7 | 1943 |
| Hill, Roy E. | Edison | Hill Pump | Irrig. | 1.86 | 33 | 4 | 25 | Furnas | Mar. | 29 | 1932 | | 2314 | Feb. | 12 | 1943 |
| Hall, Dorothy A. | Hastings | Sherwood Pump | Irrig. | .87 | 12 | 3 | 21 | Furnas | July | 19 | 1933 | | 2343 | July | 3 | 1943 |
| Fritser, H. E. | Edison | Fritser Pump | Irrig. | 1.29 | 33 | 4 | 25 | Furnas | Aug. | 3 | 1932 | | 2360 | Feb. | 12 | 1943 |
| Mayfield, L. L. | Edison | Mayfield Pump | Irrig. | 1.17 | 28 | 4 | 25 | Furnas | June | 8 | 1934 | | 2606 | Mar. | 28 | 1943 |
| Warner, George | Edison | Warner Pumps | Irrig. | .07 | 3 | 5 | 25 | Furnas | Jan. | 06 | 1938 | | 2830 | Mar. | 26 | 1943 |
| | | | | | 06 | 4 | 22 | | | | | | | | | |
| Brooker, A.F. | Edison | Brooker Pump | Irrig. | .67 | 33 | 4 | 22 | Furnas | July | 12 | 1933 | | 2862 | May | 22 | 1946 |
| Total Active | | | | 6.48 | | | | | | | | | | | | |
| Total Inactive or Cancelled | | | | 118.80 | | | | | | | | | | | | |

1/ Taken from the Department of Roads and Irrigation, Volume II, Bureau of Irrigation, Water Power and Drainage.

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Cambridge Unit

Cambridge Mill was diverting as much as 68 second-feet from Medicine Creek in the period immediately prior to its destruction by flood in April 1943. The floods for June 1947 and June 1948 also caused much damage to portions of the mill remaining after the flood of 1943. The mill has not been operated since April 1943. In operating the mill, the wheel was rope-connected to the milling machinery. Since most of the Medicine Creek nonirrigation season flow will be stored for project use before reaching the mill site, it will not be possible to operate the mill during winter with water power after development of the project.

The owner of the mill has indicated that he is willing to subordinate his right to the proposed irrigation project during 7 months of the year for a consideration, however, the Bureau of Reclamation is negotiating to have the right cancelled because of nonuse.

The water supply studies presented herein have subordinated the right of the mill to those of the Cambridge Unit.

There are 9 provisional grants with a total right of 9.88 second-feet on the Republican River between Cambridge and Harlan County Reservoir. Most of these water rights were granted during the period of study, therefore, the historical records do not reflect depletions for irrigating these lands throughout the entire period of study. The lands irrigated under all but one of these rights have been included in the 17,230 acres in the Cambridge Unit for which a water supply has been determined in this study because they were included in the Frenchman-Cambridge Irrigation District. Only one farmer with a provisional grant of 0.73 second-feet has petitioned to be excluded from the district. The historical records have not been corrected for the water used by these lands because there is no record of diversion or of acreages irrigated on which to base a correction. The water use under these rights has been considered negligible because the lands irrigated by their use have not received a full water supply during the entire period of study. It is expected that those who did not petition to be excluded from the district will receive water from the district and will not choose to exercise their water rights.

Inactive water rights

Information presented in tables 132 and 133 also includes water rights cancelled during and after the period of operation study for the Cambridge Unit water supply.

Rights which have been cancelled are as follows: 12.49 second-feet above Medicine Creek Reservoir, 170.00 second-feet on Medicine Creek between Medicine Creek Dam and Cambridge, and 215.90 second-feet on the Republican River between Cambridge and Harlan County Reservoir.

Cambridge Unit

## Anticipated Use by Future Private Development

It is anticipated that in the future there will be additional depletions to the water supply for the Cambridge Unit. Other depletions considered in this study are water used by private irrigation development, water used by development of ponds, and water used for municipal and industrial requirements.

### Water use for private irrigation and pond development

Field reconnaissance and informal talks with state and county agents were the basis for determining the estimated maximum probable future irrigation and pond development. The estimated effect of future use by pond development is considered to be very small, averaging 100 acre-feet in May and 100 acre-feet in June, or 200 acre-feet per year.

Above Medicine Creek Reservoir it was estimated that 1,650 acres will be developed for irrigation including the land that is presently irrigated. This irrigable area is based upon land classification maps prepared by the Bureau of Agricultural Economics. Development is dependent upon private initiative which may be accomplished with the aid of the Water Facilities program of the Department of Agriculture. On March 20, 1942, H. P. Burleigh, representing the Bureau of Agricultural Economics and C. T. Judah, representing the Bureau of Reclamation recommended that the development in this area be limited to 1,400 acres. An estimated 250 acres of presently irrigated land was added to the 1,400 acres to obtain the total area for private depletions above Medicine Creek Dam. The use of water expected by this new area was computed by multiplying 1,650 acres times the consumptive use of irrigation water requirements shown in table 147.

This private development could result from pumping from the stream or from well development; however all expected future use was depleted from the stream flow in order to impose the most severe demand on the stream flow during the irrigation season. The average annual depletion, table 134, for both irrigation and ponds is 1,700 acre-feet.

Past and present use of water above Medicine Creek Reservoir is, for the most part, already reflected in stream-flow records. Future use for irrigation of an estimated 200 acres between Medicine Creek Dam and Cambridge is shown in table 135. Future development of ponds in this reach is considered to be negligible.

### Water use for municipal and industrial requirements

No allowance was made for future municipal or industrial development above or below Medicine Creek Reservoir. At the present time all of the communities in the Cambridge Unit area obtain their water supply from wells.

Table 134.—Depletions from Possible Future Private Development of Irrigation and Ponds Above Medicine Creek Dam. a/

1,000 acre-feet

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0 | 0 | 0 | 0 | 0.2 | 0.4 | 0.5 | 0.6 | 0.2 | 0 | 0 | 0 | 1.9 |
| 1930 | 0 | 0 | 0 | 0 | .1 | .1 | .1 | .3 | .4 | 0 | 0 | 0 | 1.0 |
| 1931 | 0 | 0 | 0 | 0 | .1 | .1 | .3 | .3 | .3 | .1 | 0 | 0 | 1.2 |
| 1932 | 0 | 0 | 0 | 0 | .1 | .1 | .5 | .6 | .2 | .2 | 0 | 0 | 1.7 |
| 1933 | 0 | 0 | 0 | 0 | .2 | .5 | .6 | .2 | .2 | .2 | 0 | 0 | 1.9 |
| 1934 | 0 | 0 | 0 | .3 | .4 | .3 | .7 | .6 | .2 | .2 | 0 | 0 | 2.7 |
| 1935 | 0 | 0 | 0 | .2 | .1 | .1 | .7 | .3 | .2 | .1 | 0 | 0 | 1.7 |
| 1936 | 0 | 0 | 0 | .4 | .1 | .5 | .7 | .6 | .1 | .2 | 0 | 0 | 2.6 |
| 1937 | 0 | 0 | 0 | .3 | .2 | .3 | .5 | .3 | .2 | .1 | 0 | 0 | 1.9 |
| 1938 | 0 | 0 | 0 | .2 | .1 | .5 | .5 | .4 | .3 | .3 | 0 | 0 | 2.3 |
| 1939 | 0 | 0 | 0 | .2 | .3 | .2 | .6 | .5 | .4 | .2 | 0 | 0 | 2.4 |
| 1940 | 0 | 0 | 0 | .3 | .1 | .5 | .4 | .7 | .2 | .1 | 0 | 0 | 2.3 |
| 1941 | 0 | 0 | 0 | 0 | .1 | .1 | .1 | .3 | .1 | .2 | 0 | 0 | 0.9 |
| 1942 | 0 | 0 | 0 | 0 | .1 | .1 | .6 | .3 | 0 | .1 | 0 | 0 | 1.2 |
| 1943 | 0 | 0 | 0 | 0 | .3 | .3 | .5 | .4 | .2 | .2 | 0 | 0 | 1.8 |
| 1944 | 0 | 0 | 0 | 0 | .1 | .1 | 0 | .2 | .4 | .1 | 0 | 0 | 0.9 |
| 1945 | 0 | 0 | 0 | 0 | .1 | .2 | .6 | .4 | .2 | .2 | 0 | 0 | 1.7 |
| 1946 | 0 | 0 | 0 | .4 | .1 | .3 | .4 | .3 | 0 | 0 | 0 | 0 | 1.5 |
| 1947 | 0 | 0 | 0 | 0 | .1 | .1 | .4 | .6 | .2 | .1 | 0 | 0 | 1.5 |
| Avg. | 0 | 0 | 0 | .1 | .2 | .2 | .5 | .4 | .2 | .1 | 0 | 0 | 1.7 |

a/ Depletions were made for the private development of 1,650 acres and 300 acre-feet per year for depletions due to pond development.

Table 135.--Medicine Creek--depletions for future private irrigation between dam site and mouth

| Year | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|
| 1929 | | | | 0.1 | 0.1 | | 0.2 |
| 1930 | | | | | | 0.1 | 0.1 |
| 1931 | | | | 0.1 | | | 0.1 |
| 1932 | | | | 0.1 | 0.1 | | 0.2 |
| 1933 | | | 0.1 | 0.1 | | | 0.2 |
| 1934 | | 0.1 | 0 | 0.1 | 0.1 | | 0.3 |
| 1935 | | | | 0.1 | 0.1 | | 0.2 |
| 1936 | | | 0.1 | 0.1 | 0.1 | | 0.3 |
| 1937 | | | | 0.1 | 0.1 | | 0.2 |
| 1938 | | | 0.1 | 0.1 | | | 0.2 |
| 1939 | | | | 0.1 | 0.1 | 0.1 | 0.3 |
| 1940 | | | 0.1 | 0.1 | 0.1 | | 0.3 |
| 1941 | | | | | 0.1 | | 0.1 |
| 1942 | | | | 0.1 | | | 0.1 |
| 1943 | | | | 0.1 | 0.1 | | 0.2 |
| 1944 | | | | | | 0.1 | 0.1 |
| 1945 | | | | 0.1 | 0.1 | | 0.2 |
| 1946 | 0.1 | | | 0.1 | | | 0.2 |
| 1947 | | | | 0.1 | 0.1 | | 0.2 |
| Total Avg. | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.2 |

Note: Depletion for 200 acres of private development.

## Cambridge Unit

### Project Water Supply

The principal source of water that will be used in developing the Cambridge Unit will be water stored in Medicine Creek Reservoir. In addition, stream-flow accretions in Medicine Creek between Medicine Creek Dam and Cambridge and in the Republican River between Bartley Diversion Dam will be used to serve the area. The accretions in the Republican River upstream from the Cambridge Diversion Dam will include wastes and return flow from upstream units which will be used to serve the area. The Republican River flow at Cambridge Diversion Dam after upstream development less flows that will be contributed by Medicine Creek are shown in table 136.

#### Reservoir inflow

The only historical records of Medicine Creek flow are flows recorded near Cambridge. The flow at Medicine Creek Dam was estimated to be 95.5 percent of the flow at Cambridge. This percentage is based upon the ratio of the drainage area above the dam to the drainage area above Cambridge. The drainage area above Medicine Creek Dam is 656 square miles and the drainage area above Cambridge is 687 square miles. Table 124 is the estimated historical flow of Medicine Creek determined as described above.

The depleted inflow at Medicine Creek Dam, table 137, was computed by subtracting the depletions which would be caused by future private development of irrigation and ponds, table 134, from the estimated historical flow at Medicine Creek Dam. Water can be stored in the reservoir for irrigation until the irrigation storage capacity of 24,200 acre-feet, assumed as the effective storage content at the end of 50 years of operation, is filled.

#### Stream-flow sectional accretions

The gain in flow of Medicine Creek between Medicine Creek Dam and Cambridge is estimated to be 4.5 percent of the flow near Cambridge. This percentage was based upon the ratio of drainage areas as explained in the foregoing discussion in reservoir inflow. The sectional gain in stream flow of Medicine Creek between the Dam and the mouth of the Creek (near Cambridge) is listed in table 138. This natural gain was depleted by the estimated future use for private development in this reach, table 135, and the result is shown in table 139. The depleted sectional gain, table 139, is the natural flow water that will be available for diversion at Cambridge Diversion Dam.

#### Return flow

Return flow from 17,230 acres in the Cambridge Unit, table 140, was computed as described in the discussion of return flow under the Frenchman Unit. The distribution of return flow is the same as used in the Frenchman Unit. The return flows from the Cambridge Unit will not be available for reuse by this unit. They were determined in order to show the water that will pass the unit after development.

Table 136.—Flow of Republican River at Cambridge Diversion Dam after upstream development. a/

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 15.8 | 11.7 | 41.3 | 21.9 | 36.0 | 62.7 | 39.6 | 2.4 | 0.3 | 1.9 | 3.6 | 6.2 | 243.4 |
| 1930 | 3.2 | 9.6 | 18.4 | 29.9 | 60.3 | 61.3 | 6.4 | 0 | 18.5 | 43.3 | 33.5 | 25.3 | 309.7 |
| 1931 | 22.2 | 30.0 | 32.2 | 34.0 | 24.9 | 28.7 | 1.8 | 0 | 0 | 0 | 0 | 0 | 173.8 |
| 1932 | 0 | 0 | 13.5 | 9.3 | 10.4 | 55.4 | 2.3 | 1.8 | 10.8 | 0.1 | 0 | 1.6 | 105.2 |
| 1933 | 2.8 | 1.0 | 10.8 | 29.0 | 30.4 | 3.1 | 0.8 | 0 | 34.9 | 0.2 | 13.0 | 24.1 | 150.1 |
| 1934 | 23.0 | 20.0 | 23.3 | 1.1 | 2.6 | 23.7 | 0.8 | 0.8 | 13.8 | 1.7 | 5.6 | 0 | 116.4 |
| 1935 | 1.1 | 3.0 | 5.1 | 4.1 | 158.1 | 423.6 | 1.3 | 28.1 | 32.3 | 5.8 | 9.0 | 7.2 | 678.7 |
| 1936 | 8.2 | 8.2 | 30.1 | 0 | 78.3 | 11.7 | 0.7 | 0.2 | 4.7 | 0.4 | 2.4 | 4.7 | 149.6 |
| 1937 | 0.3 | 11.9 | 7.3 | 0.3 | 0 | 12.9 | 15.7 | 18.8 | 4.9 | 0.2 | 2.8 | 1.9 | 77.0 |
| 1938 | 10.0 | 6.3 | 11.5 | 9.4 | 37.3 | 17.4 | 12.8 | 15.7 | 12.4 | 1.3 | 3.2 | 6.7 | 144.0 |
| 1939 | 11.2 | 9.3 | 29.4 | 10.8 | 19.6 | 35.0 | 13.2 | 9.5 | 1.0 | 0.6 | 2.6 | 2.9 | 145.1 |
| 1940 | 0 | 0 | 0 | 2.8 | 9.0 | 11.2 | 1.1 | 2.8 | 0 | 2.5 | 0 | 0 | 29.4 |
| 1941 | 0 | 0 | 9.3 | 18.6 | 25.6 | 74.4 | 41.7 | 23.0 | 28.4 | 14.3 | 15.0 | 20.4 | 270.7 |
| 1942 | 17.0 | 27.7 | 43.9 | 37.4 | 38.6 | 38.6 | 2.7 | 0 | 2.0 | 4.9 | 17.7 | 19.1 | 249.6 |
| 1943 | 13.7 | 28.1 | 27.8 | 12.8 | 5.4 | 3.7 | 0.7 | 1.4 | 4.9 | 1.3 | 1.8 | 2.7 | 104.3 |
| 1944 | 0 | 0 | 5.1 | 37.8 | 48.1 | 43.2 | 73.1 | 13.7 | 0.4 | 2.6 | 4.6 | 3.0 | 231.6 |
| 1945 | 3.4 | 9.1 | 18.5 | 23.3 | 17.5 | 70.0 | 6.6 | 0.6 | 1.6 | 3.3 | 6.9 | 9.7 | 170.5 |
| 1946 | 14.9 | 14.8 | 25.1 | 1.3 | 16.1 | 11.8 | 42.0 | 0.9 | 5.7 | 60.6 | 26.9 | 23.3 | 243.4 |
| 1947 | 19.3 | 23.0 | 33.7 | 33.0 | 35.4 | 93.2 | 17.7 | 0.5 | 0.4 | | | | 256.2 |
| Total Average | 8.8 | 11.2 | 20.3 | 16.7 | 34.4 | 57.0 | 14.8 | 6.3 | 9.3 | 8.1 | 8.3 | 8.8 | 204.0 |

a/ Excluding flow of Medicine Creek.

Table 137.—Depleted Inflow of Medicine Creek at Medicine Creek Dam Site

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 2.5 | 2.6 | 3.8 | 4.8 | 5.1 | 4.2 | 2.1 | 0.4 | 2.8 | 3.2 | 4.4 | 4.1 | 40.0 |
| 1930 | 3.6 | 3.3 | 3.8 | 4.8 | 4.3 | 9.5 | 7.7 | 5.8 | 1.3 | 4.8 | 3.8 | 4.5 | 57.2 |
| 1931 | 4.8 | 4.6 | 5.4 | 4.5 | 4.4 | 1.9 | 1.5 | 1.4 | 0.7 | 3.1 | 3.2 | 3.4 | 38.9 |
| 1932 | 3.6 | 3.7 | 4.8 | 6.0 | 3.3 | 5.6 | 2.8 | 3.9 | 2.1 | 2.3 | 2.3 | 3.1 | 43.5 |
| 1933 | 4.2 | 4.2 | 4.6 | 5.9 | 4.4 | 2.1 | 2.0 | 5.7 | 8.1 | 5.1 | 2.1 | 4.5 | 52.9 |
| 1934 | 4.4 | 4.1 | 4.1 | 4.6 | 2.5 | 6.6 | 2.5 | 2.2 | 3.4 | 2.4 | 1.5 | 3.7 | 42.0 |
| 1935 | 4.1 | 3.4 | 4.2 | 4.8 | 20.0 | 15.2 | 5.5 | 2.8 | 3.7 | 3.1 | 3.0 | 3.6 | 73.4 |
| 1936 | 3.7 | 3.9 | 4.4 | 5.7 | 6.2 | 4.9 | 1.8 | 1.9 | 2.3 | 2.2 | 2.8 | 2.5 | 42.3 |
| 1937 | 2.3 | 2.8 | 3.7 | 2.6 | 2.5 | 5.8 | 3.8 | 5.0 | 2.5 | 2.3 | 2.9 | 2.9 | 39.1 |
| 1938 | 2.7 | 2.8 | 3.6 | 3.5 | 6.9 | 3.4 | 7.1 | 2.2 | 2.2 | 1.5 | 2.3 | 2.1 | 40.3 |
| 1939 | 2.5 | 2.3 | 3.7 | 4.5 | 2.6 | 9.0 | 2.7 | 2.3 | 0.7 | 1.6 | 2.3 | 2.5 | 36.7 |
| 1940 | 2.8 | 3.6 | 3.8 | 4.0 | 3.0 | 18.4 | 9.1 | 4.6 | 5.7 | 2.6 | 2.8 | 4.5 | 64.9 |
| 1941 | 6.9 | 6.2 | 3.8 | 4.3 | 12.9 | 15.8 | 12.1 | 3.2 | 12.4 | 3.8 | 3.2 | 3.1 | 87.7 |
| 1942 | 3.4 | 3.1 | 11.3 | 20.0 | 6.3 | 10.6 | 2.1 | 3.2 | 7.4 | 2.8 | 3.3 | 3.9 | 77.4 |
| 1943 | 3.2 | 3.7 | 3.4 | 3.5 | 2.9 | 5.4 | 3.2 | 2.1 | 2.9 | 1.8 | 3.1 | 2.3 | 37.5 |
| 1944 | 3.1 | 4.0 | 5.7 | 14.5 | 7.8 | 7.0 | 17.4 | 9.2 | 1.6 | 2.5 | 3.2 | 3.1 | 79.1 |
| 1945 | 3.6 | 4.3 | 3.5 | 3.2 | 7.0 | 20.3 | 2.6 | 3.2 | 5.7 | 2.9 | 3.0 | 2.5 | 61.8 |
| 1946 | 3.4 | 3.2 | 3.8 | 2.3 | 7.4 | 5.2 | 3.4 | 1.4 | 3.1 | 22.0 | 3.7 | 3.3 | 62.2 |
| 1947 | 3.2 | 3.6 | 4.1 | 3.5 | 3.2 | 64.0 | 8.4 | 2.4 | 2.7 | - | - | - | 95.1 |
| Total Average | 3.6 | 3.6 | 4.5 | 5.6 | 5.9 | 11.3 | 5.1 | 3.3 | 3.8 | 3.9 | 2.9 | 3.3 | 56.8 |

Table 138.—Sectional Gain in Streamflow of Medicine Creek between Dam Site and the Mouth

(Unit - 1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 1.6 |
| 1930 | 0.2 | .2 | .2 | .2 | .2 | .2 | 0.2 | .2 | 0.4 | .4 | .3 | .1 | 2.8 |
| 1931 | 0.2 | .2 | .2 | .2 | .2 | .2 | 0.2 | .2 | 0.1 | .1 | .1 | 0 | 1.9 |
| 1932 | 0.2 | .2 | .2 | .2 | .2 | .2 | 0.3 | .2 | 0.3 | .2 | .2 | .1 | 2.5 |
| 1933 | 0.1 | .1 | .1 | .2 | .2 | .2 | 0.3 | .2 | 0.1 | .1 | .3 | .4 | 2.3 |
| 1934 | 0.3 | .1 | .2 | .2 | .2 | .2 | 0.2 | .1 | 0.3 | .1 | .1 | .2 | 2.2 |
| 1935 | 0.1 | .1 | .2 | .2 | .2 | .2 | 0.2 | .9 | 0.7 | .3 | .1 | .2 | 3.4 |
| 1936 | 0.2 | .1 | .2 | .2 | .2 | .2 | 0.3 | .3 | 0.3 | .1 | .1 | .1 | 2.3 |
| 1937 | 0.1 | .1 | .1 | .1 | .1 | .2 | 0.1 | .1 | 0.3 | .2 | .2 | .1 | 1.7 |
| 1938 | 0.1 | .1 | .1 | .1 | .1 | .2 | 0.2 | .3 | 0.2 | .4 | .1 | .1 | 2.0 |
| 1939 | 0.1 | .1 | .1 | .1 | .1 | .2 | 0.2 | .1 | 0.4 | .2 | .1 | .1 | 1.8 |
| 1940 | 0.1 | .1 | .1 | .1 | .2 | .2 | 0.2 | .1 | 0.9 | .4 | .3 | .3 | 3.0 |
| 1941 | 0.1 | .1 | .2 | .3 | .3 | .2 | 0.2 | .6 | 0.8 | .6 | .2 | .6 | 4.2 |
| 1942 | 0.2 | .2 | .1 | .2 | .1 | .5 | 1.0 | .3 | 0.5 | .1 | .2 | .4 | 3.8 |
| 1943 | 0.1 | 2 | .2 | .2 | .2 | .2 | 0.2 | .1 | 0.3 | .2 | .1 | .1 | 2.1 |
| 1944 | 0.1 | .1 | .1 | .1 | .2 | .3 | 0.7 | .4 | 0.3 | .8 | .4 | .1 | 3.6 |
| 1945 | 0.1 | .2 | .1 | .2 | .2 | .2 | 0.1 | .3 | 1.0 | .2 | .2 | .3 | 3.1 |
| 1946 | 0.1 | .1 | .1 | .2 | .1 | .2 | 0.1 | .4 | 0.3 | .2 | .1 | .1 | 2.0 |
| 1947 | 1.0 | .2 | .2 | .1 | .2 | .2 | 0.2 | .2 | 3.0 | .4 | .1 | .1 | 5.9 |
| Total | | | | | | | | | | | | | |
| Average | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 | 0.2 | 2.8 |

Table 139.--Depleted Sectional Gain of Medicine Creek between the Dam Site and the Mouth

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 1.7 |
| 1930 | .2 | .2 | .2 | .2 | .2 | .4 | .4 | .3 | 0 | .2 | .2 | .2 | 2.7 |
| 1931 | .2 | .2 | .2 | .2 | .2 | .1 | 0 | .1 | 0 | .2 | .2 | .2 | 1.8 |
| 1932 | .2 | .2 | .2 | .3 | .2 | .3 | .1 | .1 | .1 | .1 | .1 | .1 | 2.0 |
| 1933 | .2 | .2 | .2 | .3 | .2 | 0 | 0 | .3 | .4 | .3 | .1 | .2 | 2.4 |
| 1934 | .2 | .2 | .2 | .2 | 0 | .3 | 0 | 0 | .2 | .1 | .1 | .2 | 1.7 |
| 1935 | .2 | .2 | .2 | .2 | .9 | .7 | .2 | 0 | .2 | .2 | .1 | .2 | 3.3 |
| 1936 | .2 | .2 | .2 | .3 | .3 | .2 | 0 | 0 | .1 | .1 | .1 | .1 | 1.8 |
| 1937 | .1 | .1 | .2 | .1 | .1 | .3 | .1 | .1 | .1 | .1 | .1 | .1 | 1.5 |
| 1938 | .1 | .1 | .2 | .2 | .3 | .1 | .3 | .1 | .1 | .1 | .1 | .1 | 1.8 |
| 1939 | .1 | .1 | .2 | .2 | .1 | .4 | .1 | 0 | 0 | .1 | .1 | .1 | 1.5 |
| 1940 | .1 | .2 | .2 | .2 | .1 | .8 | .3 | .2 | .3 | .1 | .1 | .2 | 2.8 |
| 1941 | .3 | .3 | .2 | .2 | .6 | .8 | .6 | .1 | .6 | .2 | .2 | .1 | 4.2 |
| 1942 | .2 | .1 | .5 | 1.0 | .3 | .5 | 0 | .2 | .4 | .1 | .2 | .2 | 3.7 |
| 1943 | .2 | .2 | .2 | .2 | .1 | .3 | .1 | 0 | .1 | .1 | .1 | .1 | 1.7 |
| 1944 | .1 | .2 | .3 | .7 | .4 | .3 | .8 | .4 | 0 | .1 | .2 | .1 | 3.6 |
| 1945 | .2 | .2 | .2 | .1 | .3 | 1.0 | .1 | .1 | .3 | .1 | .1 | .1 | 2.8 |
| 1946 | .2 | .1 | .2 | 0 | .4 | .3 | .1 | .1 | .1 | 1.0 | .2 | .2 | 2.9 |
| 1947 | .1 | .2 | .2 | .2 | .2 | 3.0 | .3 | 0 | .1 | - | - | - | 4.3 |
| Avg. | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.5 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 2.7 |

Table 140.--Return Flow from 17,230 Acres Irrigated - Cambridge Unit

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.7 | 0.7 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.3 | 1.4 | 1.3 | 1.1 | 1.0 | 11.7 |
| 1930 | 0.8 | 0.7 | 0.7 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | 0.4 | 6.5 |
| 1931 | 0.4 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 0.8 | 0.6 | 0.6 | 6.9 |
| 1932 | 0.5 | 0.4 | 0.4 | 0.6 | 0.7 | 0.8 | 0.9 | 1.2 | 1.2 | 1.2 | 0.9 | 0.8 | 9.6 |
| 1933 | 0.7 | 0.6 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.3 | 1.5 | 1.3 | 1.1 | 1.0 | 11.8 |
| 1934 | 0.9 | 0.7 | 0.7 | 1.1 | 1.2 | 1.4 | 1.6 | 1.9 | 2.1 | 1.9 | 1.6 | 1.4 | 16.5 |
| 1935 | 1.2 | 1.1 | 1.0 | 0.6 | 0.7 | 0.9 | 1.0 | 1.2 | 1.3 | 1.2 | 1.0 | 0.8 | 12.0 |
| 1936 | 0.7 | 0.6 | 0.6 | 1.0 | 1.2 | 1.3 | 1.5 | 1.9 | 2.0 | 1.9 | 1.5 | 1.3 | 15.5 |
| 1937 | 1.2 | 1.0 | 1.0 | 0.7 | 0.8 | 1.0 | 1.1 | 1.3 | 1.5 | 1.3 | 1.1 | 1.0 | 13.0 |
| 1938 | 0.8 | 0.7 | 0.7 | 0.9 | 1.0 | 1.1 | 1.3 | 1.6 | 1.7 | 1.6 | 1.3 | 1.1 | 13.8 |
| 1939 | 1.0 | 0.9 | 0.9 | 0.9 | 1.1 | 1.3 | 1.4 | 1.7 | 1.9 | 1.7 | 1.4 | 1.3 | 15.5 |
| 1940 | 1.1 | 1.0 | 0.9 | 0.9 | 1.0 | 1.2 | 1.4 | 1.7 | 1.8 | 1.7 | 1.4 | 1.2 | 15.3 |
| 1941 | 1.0 | 0.9 | 0.9 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | 0.4 | 7.0 |
| 1942 | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 0.8 | 0.6 | 0.6 | 6.8 |
| 1943 | 0.5 | 0.4 | 0.4 | 0.7 | 0.8 | 0.9 | 1.0 | 1.3 | 1.4 | 1.3 | 1.0 | 0.9 | 10.6 |
| 1944 | 0.8 | 0.7 | 0.7 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | 0.4 | 6.5 |
| 1945 | 0.4 | 0.3 | 0.3 | 0.6 | 0.8 | 0.9 | 1.0 | 1.2 | 1.3 | 1.2 | 1.0 | 0.9 | 9.9 |
| 1946 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.8 | 1.0 | 1.1 | 1.0 | 0.8 | 0.7 | 9.2 |
| 1947 | 0.6 | 0.6 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 1.0 | 1.1 | 1.0 | 0.8 | 0.7 | 9.2 |
| Total Average | 0.7 | 0.7 | 0.6 | 0.6 | 0.8 | 0.9 | 1.0 | 1.2 | 1.3 | 1.2 | 1.0 | 0.9 | 10.9 |

## Water Requirements

Water requirements for the Cambridge Unit that will create a demand on Medicine Creek Reservoir include water required for irrigating lands in the unit, water lost due to evaporation from the reservoir, and water lost as seepage from the reservoir.

### Determination of irrigation and diversion requirements

The diversion requirement for irrigation is based upon the consumptive use of water by crops, the effective precipitation in the area, and transportation and farm losses. These values were computed as described under discussion of the Frenchman Unit.

Consumptive use.--The Lowry-Johnson method as described under the Frenchman Unit was used in determining the consumptive use of water by crops. Effective heat data used in determining consumptive use for the Cambridge Unit was the mean of three stations as indicated below:

Records at Culbertson, Nebr.--Table 30 under Meeker-Driftwood Unit

Records at Curtis, Nebr.--Table 106 under Red Willow Unit

Records at Beaver City and Alma, Nebr.--Table 141 under the Cambridge Unit

The distribution of consumptive use, using an annual total based on average of the above tables is shown in table 142.

Precipitation over project area.--An average of the precipitation records at Cambridge, Nebraska, table 143, and Orleans, Nebraska, table 144, were used for the precipitation over the Cambridge Unit, table 145. Not all precipitation falling on the project area is effective for use by growing crops, therefore, an adjustment was necessary to determine that which would be considered effective. These adjustments to the recorded precipitation were made in the same manner as explained under the discussion of the Frenchman Unit. The computed effective precipitation for the Cambridge Unit is shown in table 146.

Consumptive use requirements of irrigation water.--The consumptive use requirements of irrigation water is the amount of the consumptive use requirements not supplied by effective precipitation. Consumptive use requirements of irrigation water for the Cambridge Unit are shown in table 147.

Diversion requirements.--In order to satisfy the crop irrigation requirement it is necessary to divert sufficient additional water to overcome transportation and farm losses. Operations specialists of the Regional Office have estimated that the transportation losses

Table 141.--Computations of Effective Heat and Consumptive Use at Beaver City and Alma, Nebraska

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total | Consumptive Use in Ft. Depth a/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Day Degrees | | | | | | | |
| 1929b/ | - | - | 27 | 1,086 | 1,274 | 1,611 | 1,885 | 1,968 | 1,353 | 1,082 | - | - | 10,286 | 2.46 |
| 1930 | - | - | 54 | 1,146 | 1,224 | 1,563 | 2,037 | 1,786 | 1,485 | 1,032 | 163 | - | 10,490 | 2.49 |
| 1931 | - | - | - | 932 | 1,305 | 1,803 | 1,953 | 1,755 | 1,734 | 1,243 | 108 | - | 10,833 | 2.54 |
| 1932 | - | - | - | 1,128 | 1,476 | 1,572 | 1,962 | 1,798 | 1,449 | 976 | - | - | 10,361 | 2.54 |
| 1933 | - | - | 120 | 990 | 1,252 | 1,932 | 1,959 | 1,717 | 1,629 | 1,190 | 74 | - | 10,863 | 2.55 |
| 1934 | - | - | - | 1,128 | 1,628 | 1,845 | 2,201 | 1,962 | 1,425 | 1,383 | 476 | - | 12,048 | 2.73 |
| 1935 | - | - | 548 | 909 | 1,011 | 1,398 | 2,074 | 1,838 | 1,443 | 1,032 | 31 | - | 10,284 | 2.46 |
| 1936 | - | - | - | 961 | 1,414 | 1,776 | 2,207 | 2,083 | 1,542 | 988 | - | - | 10,971 | 2.56 |
| 1937 | - | - | - | 984 | 1,500 | 1,644 | 2,003 | 2,080 | 1,668 | 1,153 | - | - | 11,032 | 2.57 |
| 1938c/ | - | - | 548 | 1,038 | 1,308 | 1,632 | 1,987 | 2,024 | 1,629 | 1,534 | 93 | - | 11,793 | 2.69 |
| 1939 | - | - | 72 | 1,008 | 1,628 | 1,692 | 2,052 | 1,844 | 1,773 | 1,260 | - | - | 11,329 | 2.62 |
| 1940 | - | - | 225 | 1,095 | 1,463 | 1,746 | 2,021 | 1,789 | 1,584 | 1,432 | 115 | - | 11,470 | 2.64 |
| 1941 | - | - | 164 | 1,014 | 1,454 | 1,497 | 1,860 | 1,835 | 1,491 | 1,132 | 87 | - | 10,534 | 2.50 |
| 1942 | - | - | 172 | 1,173 | 1,355 | 1,518 | 1,959 | 1,767 | 1,374 | 1,243 | - | - | 10,561 | 2.50 |
| 1943 | - | - | - | 1,047 | 1,271 | 1,563 | 1,938 | 1,990 | 1,500 | 827 | - | - | 10,136 | 2.43 |
| 1944 | - | - | - | 475 | 1,454 | 1,587 | 1,733 | 1,773 | 1,536 | 1,318 | 113 | - | 9,989 | 2.41 |
| 1945 | - | - | 46 | 990 | 1,296d/ | 1,395 | 1,835 | 1,885 | 1,578 | 1,157 | - | - | 10,182 | 2.44 |
| 1946 | - | - | 626 | 1,332 | 1,234 | 1,719 | 1,897 | 1,761 | 1,464 | 1,104 | 76 | - | 11,213 | 2.60 |
| 1947 | - | - | - | 844 | 1,330 | 1,464 | 1,773 | 2,003 | 1,569 | 1,380 | 178 | - | 10,541 | 2.50 |
| Total | | | 2,602 | 19,280 | 25,877 | 30,957 | 37,336 | 35,658 | 29,226 | 22,466 | 1,514 | | 204,916 | 48.16 |
| Avg. | | | 137 | 1,014 | 1,361 | 1,629 | 1,965 | 1,877 | 1,540 | 1,182 | 80 | | 10,785 | 2.53 |

a/ From Lowry-Johnson Curve.
b/ Records from 1931-1937 taken at Alma, Nebraska
c/ Records from 1938-1946 taken at Beaver City, Nebraska.
d/ Record for Norton Kansas, used.

Table 142.—Distribution of Consumptive Use - Cambridge Unit a/
acre-feet per acre

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.02 | 0.05 | 0.12 | 0.19 | 0.24 | 0.34 | 0.46 | 0.44 | 0.29 | 0.15 | 0.07 | 0.05 | 2.42 |
| 1930 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.42 |
| 1931 | .03 | .05 | .12 | .20 | .25 | .35 | .47 | .45 | .30 | .15 | .07 | .05 | 2.49 |
| 1932 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .15 | .07 | .05 | 2.41 |
| 1933 | .02 | .05 | .12 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.50 |
| 1934 | .03 | .05 | .13 | .22 | .27 | .38 | .51 | .48 | .32 | .16 | .08 | .05 | 2.68 |
| 1935 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .43 | .29 | .14 | .07 | .05 | 2.40 |
| 1936 | .02 | .05 | .13 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.51 |
| 1937 | .02 | .05 | .13 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.51 |
| 1938 | .03 | .05 | .13 | .21 | .26 | .36 | .50 | .47 | .31 | .16 | .08 | .05 | 2.61 |
| 1939 | .03 | .05 | .13 | .20 | .25 | .36 | .48 | .46 | .30 | .15 | .08 | .05 | 2.54 |
| 1940 | .03 | .05 | .13 | .20 | .26 | .36 | .48 | .46 | .31 | .15 | .08 | .05 | 2.56 |
| 1941 | .02 | .05 | .12 | .20 | .25 | .34 | .47 | .44 | .29 | .15 | .07 | .05 | 2.45 |
| 1942 | .02 | .05 | .12 | .20 | .25 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.44 |
| 1943 | .02 | .05 | .12 | .19 | .24 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.42 |
| 1944 | .02 | .05 | .12 | .19 | .23 | .33 | .45 | .42 | .28 | .14 | .07 | .05 | 2.35 |
| 1945 | .02 | .05 | .12 | .19 | .24 | .33 | .45 | .43 | .28 | .14 | .07 | .05 | 2.37 |
| 1946 | .02 | .05 | .13 | .20 | .25 | .35 | .48 | .45 | .30 | .15 | .08 | .05 | 2.51 |
| 1947 | .02 | .05 | .12 | .20 | .25 | .34 | .46 | .44 | .29 | .15 | .07 | .05 | 2.44 |
| Total Avg. | 0.02 | 0.05 | 0.12 | 0.20 | 0.25 | 0.35 | 0.47 | 0.45 | 0.30 | 0.15 | 0.07 | 0.05 | 2.48 |

a/ Use mean of records at Culbertson, Curtis, and Alma in Nebraska.

Table 143.--Precipitation at Cambridge, Nebraska--Inches 1/

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.40 | 2.00 | 0.01 | 2.61 | 5.13 | 2.68 | 1.53 | 0.44 | 1.76 | 2.46 | 1.50 | 0 | 20.52 |
| 1930 | 0.75 | 0.76 | 0.20 | 7.31 | 4.76 | 4.55 | 3.29 | 1.97 | 1.24 | 4.06 | 2.50 | 0.30 | 31.69 |
| 1931 | 0.10 | 0.90 | 3.30 | 1.40 | 2.04 | 3.27 | 1.77 | 2.96 | 0.90 | 0.86 | 2.60 | 0.10 | 20.20 |
| 1932 | 0.80 | 0.50 | 0.45 | 1.02 | 1.55 | 5.50 | 3.05 | 0.25 | 1.66 | 0.45 | 0.16 | 0.38 | 15.77 |
| 1933 | 0 | 0.20 | 1.58 | 4.24 | 2.94 | 1.36 | 2.12 | 7.93 | 1.26 | 0 | T | 1.26 | 22.89 |
| 1934 | 0 | 0.80 | 0 | 0.80 | 1.62 | 3.50 | 1.20 | 1.26 | 3.22 | 0.88 | 2.92 | 0.45 | 16.65 |
| 1935 | 0 | 0.45 | 0.86 | 0.62 | 10.16 | 2.21 | T | 3.72 | 1.99 | 0.24 | 1.04 | 0.15 | 21.44 |
| 1936 | 0.45 | 0.23a/ | 0.10a/ | 0.97a/ | 6.62a/ | 1.18a/ | 1.41a/ | 0.94a/ | 1.83 | 0.14 | T | 0.59 | 14.46 |
| 1937 | 0.50 | 0.15 | 1.69 | 0.63 | 2.09 | 3.25 | 2.42 | 4.79 | 2.12 | 1.41 | 0.10 | 0.17 | 19.32 |
| 1938 | 0.27 | 0.18 | 1.33 | 2.09 | 4.85 | 1.10 | 4.30 | 2.62 | 1.30 | 0.06 | 0.05 | 0.12 | 18.27 |
| 1939 | 0.72 | 0.47 | 1.09 | 1.11 | 3.14 | 5.47 | 1.91 | 1.61 | 0.43 | 0.02 | 0 | 0.91 | 16.88 |
| 1940 | 0.72 | 0.48 | 2.40 | 0.37 | 2.39 | 1.91 | 1.94 | 0.48 | 2.16 | 0.92 | 0.71 | 1.04 | 15.52 |
| 1941 | 1.02 | 0.50 | 0.35 | 5.33 | 3.38 | 7.41 | 2.26 | 0.66 | 4.24 | 0.45 | 0.54 | 1.59 | 27.73 |
| 1942 | 0.45 | 1.02 | 0.79 | 3.61 | 2.29 | 5.25 | 1.96 | 2.92 | 3.68 | 0.84 | 0.66 | 0.50 | 23.97 |
| 1943 | 0.35 | 0.38 | 0.76 | 4.69 | 0.68 | 3.05 | 2.43 | 2.97 | 3.40 | 0.48 | 0.13 | 0.10 | 19.42 |
| 1944 | 2.16 | 1.31 | 2.31 | 8.09 | 4.62 | 6.79 | 7.29 | 2.90 | 0.01 | 0.50 | 2.04 | 0.29 | 38.31 |
| 1945 | 0.67 | 0.40 | 0.38 | 2.62 | 2.88 | 3.92 | 0.89 | 2.95 | 2.36 | 0.29 | 0.33 | 0.91 | 18.60 |
| 1946 | 0.08 | 0.04 | 1.84 | 0.10 | 5.40 | 3.43 | 4.04 | 1.89 | 3.34 | 8.88 | 2.98 | 0.11 | 32.13 |
| 1947 | 0.65 | 0.53 | 0.70 | 2.27 | 2.38 | 6.03 | 2.76 | 0.64 | 2.93 | 0.68 | 1.24 | 0.48 | 21.29 |
| Avg. | 0.52 | 0.60 | 1.08 | 2.65 | 3.70 | 3.66 | 2.43 | 2.40 | 2.05 | 1.27 | 1.02 | 0.50 | 21.88 |

1/ Records published by U. S. Weather Bureau.
a/ Average of McCook, Gosper, Beaver City.

Table 144.—Precipitation at Orleans, Nebraska 1/

(Unit - Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0 | 0.60 | T | 3.48 | 1.74 | 1.36 | 3.13 | 0.80 | 2.05 | 4.71 | 1.65 | 0 | 19.52 |
| 1930 | 0.80 | 0.25 | 0 | 5.66 | 4.23 | 4.40 | 2.05 | 5.05 | 0.79 | 5.84 | 2.97 | 0 | 32.04 |
| 1931 | 0 | 2.10 | 1.90 | 3.22 | 1.96 | 1.32 | 2.79 | 4.46 | 1.83 | 1.90 | 2.60 | 0.35 | 24.43 |
| 1932 | 1.90 | 1.90 | 0.60 | 1.81 | 2.70 | 4.10 | 1.55 | 1.43 | 3.41 | 0.77 | 0 | 0.40 | 20.57 |
| 1933 | 0 | 0.40 | 1.50 | 5.65 | 2.98 | 0.83 | 1.33 | 4.71 | 2.81 | 0 | 0.90 | 1.45 | 22.56 |
| 1934 | 0.10 | 1.35 | 0.65 | 1.10 | 1.07 | 5.13 | 1.31 | 1.43 | 1.38 | 0.37 | 1.80 | 0.80 | 16.49 |
| 1935 | 0.25 | 0.50 | 0.50 | 1.13 | 7.29 | 4.52 | 0.77 | 3.85 | 2.68 | 0.75 | 1.50 | 0 | 23.74 |
| 1936 | 0.10 | 0.45 | 0.25 | 0.74 | 6.43 | 1.00 | 0.92 | 0.86 | 3.97 | 0 | 0.05 | 0.80 | 15.57 |
| 1937 | 1.20 | 0.70 | 1.92 | 0.41 | 2.84 | 3.27 | 2.46 | 2.96 | 1.60 | 1.53 | 0.10 | 0.05 | 19.04 |
| 1938 | 0.25 | 0.55 | 1.27 | 2.91 | 4.78 | 1.61 | 1.59 | 3.59 | 2.44 | 0 | 0 | 0.10 | 19.09 |
| 1939 | 0.70 | 0.95 | 1.12 | 1.99 | 2.93 | 5.39 | 0.98 | 2.45 | 0.38 | 0 | 0 | 0.50 | 17.39 |
| 1940 | 1.00 | 0.50 | 1.32 | 0.89 | 4.12 | 1.30 | 4.59 | 0.89 | 1.71 | 1.63 | 1.10 | 0.70 | 19.75 |
| 1941 | 1.20 | 0.70 | 0.70 | 4.87 | 2.41 | 10.18 | 6.46 | 5.99 | 2.52 | 0.90 | 1.07 | 1.00 | 38.00 |
| 1942 | 0.35 | 0.55 | 1.88 | 3.19 | 1.87 | 6.20 | 0.43 | 4.39 | 6.27 | 0.31 | 0.65 | 0.90 | 26.99 |
| 1943 | 0.10 | 0.60 | 0.70 | 5.10 | 0.62 | 5.81 | 2.24 | 1.77 | 0.71 | 0.12 | 0.28 | 0.10 | 18.15 |
| 1944a/ | 1.37 | 0.92 | 1.50 | 7.22 | 1.71 | 2.39 | 6.12 | 2.38 | 0.48 | 1.09 | 1.36 | 0.26 | 26.70 |
| 1945a/ | 0.64 | 0.36 | 0.30 | 4.85 | 2.83 | 4.31 | 1.40 | 1.38 | 1.28 | 0.34 | 0 | 0.81 | 18.50 |
| 1946a/ | 0.35 | 0.10 | 1.57 | T | 5.15 | 2.14 | 3.27 | 5.41 | 4.74 | 5.58 | 1.62 | T | 29.93 |
| 1947a/ | 0.19 | 0.24 | 0.42 | 1.98 | 2.70 | 8.30 | 2.30 | 1.25 | 0.60 | 1.71 | 1.42 | 0.79 | 21.90 |
| Avg. | 0.55 | 0.72 | 0.95 | 2.96 | 3.18 | 3.87 | 2.40 | 2.90 | 2.19 | 1.45 | 1.00 | 0.47 | 22.64 |

a/ Alma Records

1/ Data published by U. S. Weather Bureau.

Table 145.—Average of Precipitation at Cambridge and Orleans, Nebraska

(Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.20 | 1.30 | 0.01 | 3.04 | 3.44 | 2.02 | 2.33 | 0.62 | 1.90 | 3.59 | 1.57 | 0 | 20.02 |
| 1930 | 0.77 | .51 | .10 | 6.48 | 4.50 | 4.47 | 2.67 | 3.51 | 1.02 | 4.95 | 2.73 | 0.15 | 31.86 |
| 1931 | 0.05 | 1.50 | 2.60 | 2.31 | 2.00 | 2.29 | 2.28 | 3.71 | 1.37 | 1.38 | 2.60 | 0.23 | 22.32 |
| 1932 | 1.35 | 1.20 | 0.53 | 1.41 | 2.12 | 4.80 | 2.30 | .84 | 2.53 | 0.61 | 0.08 | 0.39 | 18.16 |
| 1933 | 0 | 0.30 | 1.54 | 4.94 | 2.96 | 1.09 | 1.73 | 6.32 | 2.04 | 0 | 0.45 | 1.36 | 22.73 |
| 1934 | 0.05 | 1.08 | 0.32 | 0.95 | 1.34 | 4.32 | 1.25 | 1.35 | 2.30 | 0.62 | 2.36 | 0.63 | 16.57 |
| 1935 | 0.12 | 0.48 | 0.68 | 0.87 | 8.73 | 3.37 | 0.38 | 3.78 | 2.33 | 0.50 | 1.27 | 0.08 | 22.59 |
| 1936 | 0.37 | 0.34 | 0.18 | 0.85 | 6.52 | 1.09 | 1.17 | .90 | 2.90 | 0.07 | 0.03 | 0.69 | 15.01 |
| 1937 | 0.85 | 0.43 | 1.80 | 0.52 | 2.47 | 3.26 | 2.44 | 3.87 | 1.86 | 1.47 | 0.10 | 0.11 | 19.18 |
| 1938 | 0.26 | 0.36 | 1.30 | 2.50 | 4.82 | 1.35 | 2.95 | 3.10 | 1.87 | 0.03 | 0.03 | 0.11 | 18.68 |
| 1939 | 0.71 | 0.71 | 1.10 | 1.55 | 3.03 | 5.43 | 1.44 | 2.03 | .41 | 0.01 | 0 | 0.71 | 17.13 |
| 1940 | 0.86 | 0.49 | 1.86 | 0.63 | 3.25 | 1.61 | 3.26 | .69 | 1.93 | 1.28 | 0.90 | 0.87 | 17.63 |
| 1941 | 1.11 | 0.60 | 0.52 | 5.10 | 2.89 | 8.80 | 4.36 | 3.33 | 3.38 | 0.67 | 0.81 | 1.29 | 32.86 |
| 1942 | 0.40 | 0.78 | 1.33 | 3.40 | 2.08 | 5.72 | 1.20 | 3.65 | 4.98 | 0.57 | 0.66 | 0.70 | 25.47 |
| 1943 | 0.22 | 0.49 | 0.73 | 4.90 | 0.65 | 4.43 | 2.34 | 2.37 | 2.05 | 0.30 | 0.20 | 0.10 | 18.78 |
| 1944 | 1.76 | 1.12 | 1.90 | 7.66 | 3.16 | 4.59 | 6.71 | 2.59 | .24 | 0.80 | 1.70 | 0.27 | 32.50 |
| 1945 | 0.65 | 0.38 | 0.34 | 3.74 | 2.85 | 4.12 | 1.15 | 2.15 | 1.82 | 0.32 | 0.17 | 0.86 | 18.55 |
| 1946 | 0.21 | 0.07 | 1.71 | 0.05 | 5.27 | 2.79 | 3.66 | 3.65 | 4.04 | 7.23 | 2.30 | 0.05 | 31.03 |
| 1947 | 0.42 | 0.38 | 0.56 | 2.13 | 2.54 | 7.16 | 2.53 | .95 | 1.76 | 1.20 | 1.33 | 0.63 | 21.59 |
| Avg. | 0.54 | 0.66 | 1.00 | 2.79 | 3.40 | 3.83 | 2.43 | 2.60 | 2.14 | 1.35 | 1.02 | 0.49 | 22.25 |

Table 146.—Effective Average Precipitation of Cambridge and Orleans (Cambridge Unit)

(Unit - Feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.02 | 0.10 | 0 | 0.22 | 0.25 | 0.16 | 0.18 | 0.05 | 0.15 | 0.26 | 0.12 | 0 | 1.51 |
| 1930 | .06 | .04 | .01 | .34 | .30 | .30 | .20 | .25 | .08 | .32 | .20 | .01 | 2.11 |
| 1931 | 0 | .12 | .20 | .18 | .15 | .18 | .18 | .26 | .11 | .11 | .20 | .02 | 1.71 |
| 1932 | .11 | .09 | .04 | .11 | .16 | .31 | .18 | .07 | .19 | .05 | .01 | .03 | 1.35 |
| 1933 | 0 | .02 | .12 | .32 | .22 | .09 | .13 | .34 | .16 | 0 | .04 | .11 | 1.55 |
| 1934 | 0 | .09 | .03 | .08 | .10 | .29 | .10 | .10 | .18 | .05 | .18 | .05 | 1.25 |
| 1935 | .01 | .04 | .05 | .07 | .34 | .24 | .03 | .27 | .18 | .04 | .10 | .01 | 1.38 |
| 1936 | .02 | .03 | .01 | .07 | .34 | .09 | .09 | .07 | .22 | .01 | 0 | .06 | 1.01 |
| 1937 | .07 | .03 | .14 | .04 | .19 | .24 | .19 | .27 | .14 | .11 | .01 | .01 | 1.44 |
| 1938 | .02 | .03 | .10 | .19 | .31 | .11 | .22 | .23 | .14 | 0 | 0 | .01 | 1.36 |
| 1939 | .06 | .06 | .09 | .12 | .22 | .33 | .11 | .16 | .03 | 0 | 0 | .06 | 1.24 |
| 1940 | .07 | .04 | .14 | .05 | .24 | .12 | .24 | .05 | .15 | .10 | .07 | .07 | 1.34 |
| 1941 | .09 | .05 | .04 | .32 | .22 | .34 | .29 | .24 | .24 | .05 | .07 | .10 | 2.05 |
| 1942 | .03 | .06 | .10 | .25 | .16 | .33 | .09 | .26 | .32 | .05 | .05 | .06 | 1.76 |
| 1943 | .02 | .04 | .06 | .31 | .05 | .30 | .18 | .18 | .16 | .02 | .02 | .01 | 1.35 |
| 1944a/ | .14 | .09 | .15 | .34 | .23 | .30 | .34 | .19 | .02 | .07 | .13 | .02 | 2.02 |
| 1945a/ | .05 | .03 | .03 | .26 | .21 | .28 | .09 | .17 | .14 | .03 | .01 | .07 | 1.37 |
| 1946a/ | .02 | .01 | .13 | 0 | .32 | .21 | .26 | .26 | .28 | .34 | .18 | 0 | 2.01 |
| 1947a/ | .03 | .03 | .04 | .16 | .19 | .34 | .19 | .08 | .14 | .09 | .10 | .05 | 1.44 |
| Total Avg. | 0.04 | 0.05 | 0.08 | 0.18 | 0.22 | 0.24 | 0.17 | 0.19 | 0.16 | 0.09 | 0.08 | 0.04 | 1.54 |

a/ Precipitation records average of Alma and Cambridge.

Table 147.--Consumptive Use Requirements of Irrigation Water
Cambridge Unit

(Feet per acre irrigated)

| Year | Apr.a/ | May a/ | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | .01 | .02 | .18 | .28 | .39 | .14 | 0 | 1.02 |
| 1930 | 0 | 0 | 0 | .06 | .19 | .21 | 0 | .46 |
| 1931 | 0 | 0 | 0 | .20 | .19 | .19 | .04 | .62 |
| 1932 | 0 | .01 | .03 | .28 | .36 | .10 | .10 | .88 |
| 1933 | 0 | .04 | .26 | .35 | .11 | .14 | .15 | 1.05 |
| 1934 | .18 | .20 | .09 | .41 | .38 | .14 | .11 | 1.51 |
| 1935 | .11 | 0 | 0 | .43 | .16 | .11 | .10 | .91 |
| 1936 | .21 | 0 | .24 | .39 | .38 | .08 | .14 | 1.44 |
| 1937 | .18 | .07 | .11 | .29 | .18 | .16 | .04 | 1.03 |
| 1938 | .11 | .03 | .25 | .28 | .24 | .17 | .16 | 1.24 |
| 1939 | .14 | .09 | .03 | .37 | .30 | .27 | .15 | 1.35 |
| 1940 | .17 | .03 | .24 | .24 | .41 | .16 | .05 | 1.30 |
| 1941 | 0 | 0 | 0 | .09 | .20 | .05 | .10 | .44 |
| 1942 | 0 | 0 | 0 | .37 | .18 | 0 | .07 | .62 |
| 1943 | 0 | .15 | .04 | .28 | .26 | .13 | .13 | .99 |
| 1944 | 0 | 0 | 0 | 0 | .12 | .26 | .07 | .45 |
| 1945 | 0 | .01 | .05 | .36 | .26 | .14 | .11 | .93 |
| 1946 | .24 | 0 | .11 | .22 | .19 | .02 | 0 | .78 |
| 1947 | 0 | 0 | 0 | .22 | .36 | .15 | .06 | .79 |
| Average | .07 | .03 | .09 | .27 | .26 | .14 | .08 | .94 |

a/ Includes one-half of portion of Nov.-Mar. requirement not met by the precipitation for that period.

will be 25 percent of the diversions at the head of the canal and the farm losses will be 30 percent of the amount delivered to the farm turn-out. The consumptive use requirement of irrigation water was multiplied by 100 percent over 100 percent less 30 percent for the farm loss to determine the farm delivery requirement.

Transportation losses in the distribution system include water consumed by evaporation, transpiration by plants growing along the canal, and seepage or percolation. The diversion requirements in acre-feet per acre, table 148, were computed by multiplying the farm delivery requirement by 100 percent over 100 percent less the 25 percent transportation loss.

Diversions will be made at Cambridge Diversion Dam for the irrigation of the entire area of 17,230 acres under the Cambridge Unit. The diversion requirements in 1,000 acre-feet, table 149, were obtained by multiplying 17,230 times the diversion requirement in acre-feet per acre, table 148.

Evaporation from reservoir

The evaporation rate from Medicine Creek Reservoir was determined by using the same general procedure as was used for determining the evaporation rate from Enders Reservoir.

Gross evaporation.--The evaporation records at North Platte, Nebraska, corrected to free water surface, table 37, were used as a basis for determining the evaporation rate at Medicine Creek Reservoir for the months of April through September. A factor determined from charts published by the Minnesota Resources Commission was used to adapt the North Platte, Nebraska, evaporations records to the Medicine Creek Reservoir area. 1/ The North Platte records were multiplied by the following factors to obtain the evaporation rate from Medicine Creek Reservoir:

| Month | Factor |
|---|---|
| April | 1.04 |
| May | 1.04 |
| June | 1.04 |
| July | 1.05 |
| August | 1.03 |
| September | 1.05 |

1/ "Evaporation from Lakes and Reservoirs," published by Minnesota Reservoirs Commission, June 1942.

Table 148.--Diversion Requirements Cambridge Unit
Acre-feet per acre irrigated

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0.02 | 0.04 | 0.34 | 0.53 | 0.74 | 0.27 | 0 | 1.94 |
| 1930 | 0 | 0 | 0 | .11 | .36 | .40 | 0 | 0.87 |
| 1931 | 0 | 0 | 0 | .38 | .36 | .36 | .08 | 1.18 |
| 1932 | 0 | .02 | .06 | .53 | .68 | .19 | .19 | 1.67 |
| 1933 | 0 | .08 | .49 | .67 | .21 | .27 | .28 | 2.00 |
| 1934 | .34 | .38 | .17 | .78 | .72 | .27 | .21 | 2.87 |
| 1935 | .21 | 0 | 0 | .82 | .30 | .21 | .19 | 1.73 |
| 1936 | .40 | 0 | .46 | .74 | .72 | .15 | .27 | 2.74 |
| 1937 | .34 | .13 | .21 | .55 | .34 | .31 | .08 | 1.96 |
| 1938 | .21 | .06 | .48 | .53 | .46 | .32 | .30 | 2.36 |
| 1939 | .27 | .17 | .06 | .70 | .57 | .51 | .28 | 2.56 |
| 1940 | .32 | .06 | .46 | .46 | .78 | .30 | .09 | 2.47 |
| 1941 | 0 | 0 | 0 | .17 | .38 | .10 | .19 | 0.84 |
| 1942 | 0 | 0 | 0 | .71 | .34 | 0 | .13 | 1.18 |
| 1943 | 0 | .28 | .08 | .53 | .49 | .25 | .25 | 1.88 |
| 1944 | 0 | 0 | 0 | 0 | .23 | .50 | .13 | 0.86 |
| 1945 | 0 | .02 | .10 | .68 | .49 | .27 | .21 | 1.77 |
| 1946 | .45 | 0 | .21 | .42 | .36 | .04 | 0 | 1.48 |
| 1947 | 0 | 0 | 0 | .42 | .68 | .29 | .11 | 1.50 |
| Total Avg. | 0.13 | 0.07 | 0.16 | 0.51 | 0.49 | 0.26 | 0.16 | 1.78 |



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Table 149.--Diversion Requirements for 17,230 Acres - Cambridge Unit

(Unit - 1000 acre-feet)

| Year | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| 1929 | 0.3 | 0.7 | 5.9 | 9.1 | 12.8 | 4.6 | 0 | 33.4 |
| 1930 | 0 | 0 | 0 | 1.9 | 6.2 | 6.9 | 0 | 15.0 |
| 1931 | 0 | 0 | 0 | 6.5 | 6.2 | 6.2 | 1.4 | 20.3 |
| 1932 | 0 | 0.4 | 1.0 | 9.1 | 11.7 | 3.3 | 3.3 | 28.8 |
| 1933 | 0 | 1.4 | 8.4 | 11.6 | 3.6 | 4.7 | 4.8 | 34.5 |
| 1934 | 5.9 | 6.5 | 2.9 | 13.4 | 12.4 | 4.7 | 3.6 | 49.4 |
| 1935 | 3.6 | 0 | 0 | 14.1 | 5.2 | 3.6 | 3.3 | 29.8 |
| 1936 | 6.9 | 0 | 7.9 | 12.7 | 12.4 | 2.6 | 4.7 | 47.2 |
| 1937 | 5.9 | 2.2 | 3.6 | 9.5 | 5.9 | 5.3 | 1.4 | 33.8 |
| 1938 | 3.6 | 1.0 | 8.3 | 9.1 | 7.9 | 5.5 | 5.2 | 40.6 |
| 1939 | 4.7 | 2.9 | 1.0 | 12.1 | 9.8 | 8.8 | 4.8 | 44.1 |
| 1940 | 5.5 | 1.0 | 7.9 | 7.9 | 13.4 | 5.2 | 1.6 | 42.5 |
| 1941 | 0 | 0 | 0 | 2.9 | 6.6 | 1.7 | 3.3 | 14.5 |
| 1942 | 0 | 0 | 0 | 12.2 | 5.9 | 0 | 2.2 | 20.3 |
| 1943 | 0 | 4.8 | 1.4 | 9.1 | 8.5 | 4.3 | 4.3 | 32.4 |
| 1944 | 0 | 0 | 0 | 0 | 4.0 | 8.6 | 2.2 | 14.8 |
| 1945 | 0 | 0.3 | 1.7 | 11.7 | 8.5 | 4.7 | 3.6 | 30.5 |
| 1946 | 7.8 | 0 | 3.6 | 7.2 | 6.2 | 0.7 | 0 | 25.5 |
| 1947 | 0 | 0 | 0 | 7.2 | 11.7 | 5.0 | 1.9 | 25.8 |
| Average | 2.3 | 1.1 | 2.8 | 8.8 | 8.4 | 4.6 | 2.7 | 30.7 |

Cambridge Unit

Records of evaporation are not collected in this area during the winter because of freezing weather; therefore the rates of evaporation for the winter months were used as determined from the Minnesota Resources Commission charts. 1/ These rates are as follows:

| Month | Evaporation rate in inches |
|---|---|
| October | 4.80 |
| November | 2.70 |
| December | 1.25 |
| January | 1.00 |
| February | 1.25 |
| March | 2.25 |

The gross evaporation rates computed for Medicine Creek Reservoir are shown in table 150.

Precipitation over reservoir area.--Precipitation data collected by the Weather Bureau at Cambridge, Nebraska, table 143, represents the precipitation falling over Medicine Creek Reservoir.

Net reservoir evaporation.--The net reservoir evaporation is the difference between future and past consumptive uses from the reservoir area. For this study the past consumptive use is estimated to be equal to the precipitation over the reservoir area. The net evaporation over the reservoir area, table 151, is the difference between the gross evaporation rate, table 150, and the precipitation over the reservoir area, table 143. The water loss from the reservoir through evaporation is considered to take place at the same rate as the net reservoir evaporation.

To facilitate computations necessary to determine the amount of water lost by evaporation at different reservoir capacities and at different evaporation rates in the monthly reservoir operations, a chart, exhibit 41, showing evaporation losses at various reservoir contents and various evaporation rates was used.

Seepage

Seepage losses from the reservoir were estimated by geologists of the Regional Office of Region 7 and of the Kansas River District to range from 0 to 3 second-feet. This estimate was based on geologic and construction data. For the operation study a constant rate of 3 second-feet was used. This amounts to about 200 acre-feet per month.

## Water Utilization

An operation study showing the water delivery on a monthly basis has been made to determine the adequacy of the water supply available for development of the Cambridge Unit. The operation study was

1/ Ibid

Table 150.--Gross Evaporation at Medicine Creek Reservoir a/ (Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.00 | 1.25 | 2.25 | 5.24 | 5.39 | 6.44 | 8.82 | 7.84 | 4.12 | 4.80 | 2.70 | 1.25 | 51.10 |
| 1930 | 1.00 | 1.25 | 2.25 | 4.21 | 5.61 | 6.04 | 8.05 | 6.38 | 4.75 | 4.80 | 2.70 | 1.25 | 48.29 |
| 1931 | 1.00 | 1.25 | 2.25 | 4.47 | 6.65 | 8.02 | 10.13 | 8.31 | 7.55 | 4.80 | 2.70 | 1.25 | 58.38 |
| 1932 | 1.00 | 1.25 | 2.25 | 5.32 | 7.53 | 6.83 | 8.47 | 7.97 | 6.18 | 4.80 | 2.70 | 1.25 | 55.55 |
| 1933 | 1.00 | 1.25 | 2.25 | 6.05 | 5.76 | 9.47 | 10.52 | 5.74 | 6.55 | 4.80 | 2.70 | 1.25 | 57.34 |
| 1934 | 1.00 | 1.25 | 2.25 | 6.19 | 9.38 | 10.35 | 13.12 | 9.33 | 5.51 | 4.80 | 2.70 | 1.25 | 67.13 |
| 1935 | 1.00 | 1.25 | 2.25 | 4.82 | 4.19 | 5.76 | 9.67 | 8.29 | 5.19 | 4.80 | 2.70 | 1.25 | 51.17 |
| 1936 | 1.00 | 1.25 | 2.25 | 5.19 | 5.82 | 8.90 | 11.54 | 9.12 | 7.10 | 4.80 | 2.70 | 1.25 | 60.92 |
| 1937 | 1.00 | 1.25 | 2.25 | 4.93 | 6.44 | 6.70 | 9.43 | 8.78 | 6.50 | 4.80 | 2.70 | 1.25 | 56.03 |
| 1938 | 1.00 | 1.25 | 2.25 | 4.34 | 5.31 | 7.70 | 9.92 | 10.17 | 5.24 | 4.80 | 2.70 | 1.25 | 55.93 |
| 1939 | 1.00 | 1.25 | 2.25 | 4.75 | 7.16 | 9.19 | 11.36 | 8.81 | 8.88 | 4.80 | 2.70 | 1.25 | 63.40 |
| 1940 | 1.00 | 1.25 | 2.25 | 4.70 | 7.71 | 9.76 | 10.38 | 7.99 | 6.46 | 4.80 | 2.70 | 1.25 | 60.25 |
| 1941 | 1.00 | 1.25 | 2.25 | 3.89 | 6.27 | 6.27 | 7.92 | 7.56 | 6.28 | 4.80 | 2.70 | 1.25 | 51.44 |
| 1942 | 1.00 | 1.25 | 2.25 | 3.90 | 5.92 | 5.78 | 7.75 | 6.78 | 4.17 | 4.80 | 2.70 | 1.25 | 47.55 |
| 1943 | 1.00 | 1.25 | 2.25 | 5.62 | 4.54 | 6.82 | 8.66 | 7.53 | 6.46 | 4.80 | 2.70 | 1.25 | 52.88 |
| 1944 | 1.00 | 1.25 | 2.25 | 3.01 | 6.64 | 7.03 | 7.53 | 7.24 | 5.63 | 4.80 | 2.70 | 1.25 | 50.33 |
| 1945 | 1.00 | 1.25 | 2.25 | 3.87 | 5.24 | 5.56 | 6.80 | 6.27 | 5.88 | 4.80 | 2.70 | 1.25 | 46.87 |
| 1946 | 1.00 | 1.25 | 2.25 | 5.50 | 5.78 | 7.36 | 8.33 | 7.22 | 5.30 | 4.80 | 2.70 | 1.25 | 52.74 |
| 1947 | 1.00 | 1.25 | 2.25 | 3.30 | 4.73 | 5.89 | 6.94 | 7.98 | 6.12 | 4.80 | 2.70 | 1.25 | 48.21 |
| Total Average | 1.00 | 1.25 | 2.25 | 4.70 | 6.11 | 7.36 | 9.23 | 7.86 | 5.99 | 4.80 | 2.70 | 1.25 | 59.50 |

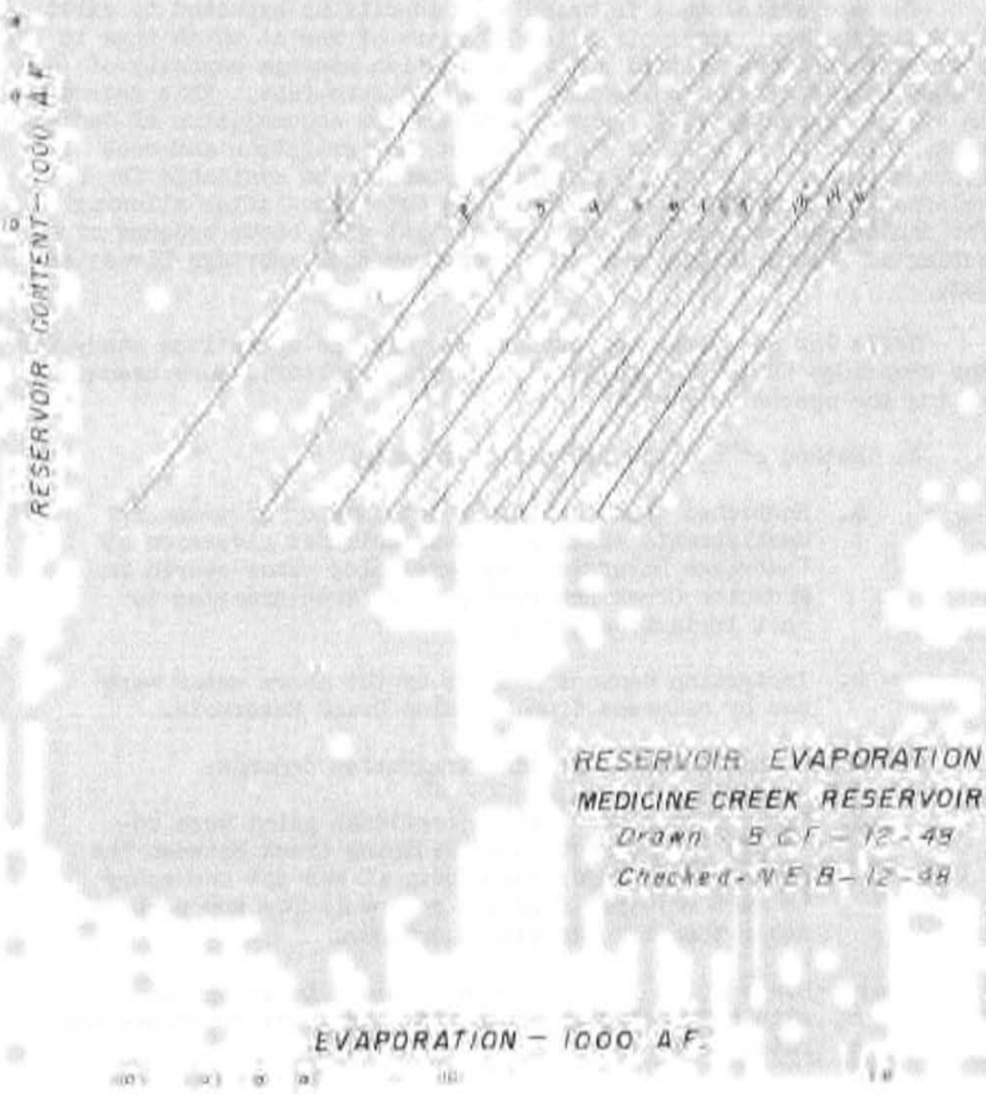
a/ Oct. - Mar. estimated from Meyer's maps. Other months based on correction factors for records at North Platte, Nebr. (1.04 for Apr., 1.04 for May, 1.04 for June, 1.05 for July, 1,03 for Aug., and 105 for Sept.)

Table 151. Net Evaporation at Medicine Creek Reservoir a/
(Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.60 | -0.75 | 2.24 | 2.63 | 0.26 | 3.76 | 7.29 | 7.40 | 2.36 | 2.34 | 1.20 | 1.25 | 30.58 |
| 1930 | 0.25 | 0.49 | 2.05 | -3.10 | 0.85 | 1.49 | 4.76 | 4.41 | 3.51 | 0.74 | 0.20 | 0.95 | 16.60 |
| 1931 | 0.90 | 0.35 | -1.05 | 3.07 | 4.61 | 4.75 | 8.36 | 5.35 | 6.65 | 3.94 | 0.10 | 1.15 | 38.18 |
| 1932 | 0.20 | 0.75 | 1.80 | 4.30 | 5.98 | 1.33 | 5.42 | 7.72 | 4.52 | 4.35 | 2.54 | 0.87 | 39.78 |
| 1933 | 1.00 | 1.05 | 0.67 | 1.81 | 2.82 | 8.11 | 8.40 | -2.19 | 5.29 | 4.80 | 2.70 | -0.01 | 34.45 |
| 1934 | 1.00 | 0.45 | 2.25 | 5.39 | 7.76 | 6.85 | 11.92 | 8.07 | 2.29 | 3.92 | -0.22 | 0.80 | 50.48 |
| 1935 | 1.00 | 0.80 | 1.39 | 4.20 | -5.97 | 3.55 | 9.67 | 4.57 | 3.20 | 4.56 | 1.66 | 1.10 | 29.73 |
| 1936 | 0.55 | 1.02 | 2.15 | 4.22 | -0.80 | 7.72 | 10.13 | 8.18 | 5.27 | 4.66 | 2.70 | 0.66 | 46.46 |
| 1937 | 0.50 | 1.10 | 0.56 | 4.30 | 4.35 | 3.45 | 7.01 | 3.99 | 4.38 | 3.39 | 2.60 | 1.08 | 36.71 |
| 1938 | 0.73 | 1.07 | 0.92 | 2.25 | 0.46 | 6.60 | 5.62 | 7.55 | 3.94 | 4.74 | 2.65 | 1.13 | 37.66 |
| 1939 | 0.28 | 0.78 | 1.16 | 3.64 | 4.02 | 3.72 | 9.45 | 7.20 | 8.45 | 4.78 | 2.70 | 0.34 | 46.52 |
| 1940 | 0.28 | 0.77 | -0.15 | 4.33 | 5.32 | 7.85 | 8.44 | 7.51 | 4.30 | 3.88 | 1.99 | 0.21 | 44.73 |
| 1941 | -0.02 | 0.75 | 1.90 | -1.44 | 2.89 | -1.14 | 5.66 | 6.90 | 2.04 | 4.35 | 2.16 | -0.34 | 23.71 |
| 1942 | 0.55 | 0.23 | 1.46 | 0.29 | 3.63 | 0.53 | 5.79 | 3.86 | 0.49 | 3.96 | 2.04 | 0.75 | 23.58 |
| 1943 | 0.65 | 0.87 | 1.49 | 0.93 | 3.86 | 3.77 | 6.23 | 4.56 | 3.06 | 4.32 | 2.57 | 1.15 | 33.46 |
| 1944 | -1.16 | -0.06 | -0.06 | -5.08 | 2.02 | 0.24 | 0.24 | 4.34 | 5.62 | 4.30 | 0.66 | 0.96 | 12.02 |
| 1945 | 0.33 | 0.85 | 1.87 | 1.25 | 2.36 | 1.64 | 5.91 | 3.32 | 3.52 | 4.51 | 2.37 | 0.34 | 28.27 |
| 1946 | 0.92 | 1.21 | 0.41 | 5.40 | 0.38 | 3.93 | 4.29 | 5.33 | 1.96 | -4.08 | -0.28 | 1.14 | 20.61 |
| 1947 | 0.35 | 0.72 | 1.55 | 1.03 | 2.35 | -0.14 | 4.18 | 7.34 | 3.19 | 4.12 | 1.46 | 0.77 | 26.92 |
| Total Avg. | 0.47 | 0.66 | 1.19 | 2.07 | 2.48 | 3.58 | 6.78 | 5.55 | 3.90 | 3.56 | 1.67 | 0.75 | 32.66 |

a/ Gross evaporation less precipitation at Cambridge, Nebraska.
Negative values indicate the amount that precipitation exceeded gross evaporation.

EXHIBIT 41




RESERVOIR EVAPORATION
MEDICINE CREEK RESERVOIR
Drawn - B.C.F. - 12-48
Checked - N.E.B. - 12-48



KS002496

based upon water supply and climatic conditions existing during the period 1929 through 1947. This period includes the 10-year period, which is considered to be the most critical period, with respect to water supply, that has been experienced since records were first established for this area.

Reservoir operations

The operation study is based upon conditions expected to exist in Medicine Creek Reservoir after 50 years of use at which time it is estimated that the initial active irrigation storage capacity of 34,000 acre-feet will be reduced to 24,200 acre-feet. This decrease in storage capacity will occur because of the accumulation of sediment, 15,000 acre-feet for 50 years, in the irrigation and dead storage pools. The amount of water assumed to be available for development of irrigation in the unit was determined after allowing for depletions caused by all water use that will occur because of estimated future developments upstream from the Cambridge Diversion Dam.

Table 152 shows the computation made in the operations study for the Cambridge Unit. The following operation criteria were used in making the operation study:

1. Method of meeting irrigation demands.

   a. Sectional gains and water not used by upstream developments which were available for diversion at Cambridge Diversion Dam, excluding water stored in Medicine Creek Reservoir, were first diverted to meet irrigation demands.

   b. Irrigation demands not met by the above water were met by releases from Medicine Creek Reservoir.

2. Requirements for other than irrigation demands.

   a. Historically no negative sectional gains were recorded in the section of Medicine Creek between the dam and Cambridge; therefore, it was not necessary to make releases from the reservoir for any purpose other than for irrigation demands.

   b. Evaporation losses were determined in accordance with the reservoir content and the monthly evaporation rate.

   c. Seepage was estimated to be 200 acre-feet per month.

Cambridge Canal 15,630 ac.
Bellrose Canal 1,632 ac.
Total 17,2?? ac.

Table 152 Monthly Reservoir Operation Study - Medicine Creek Reservoir

500 A.F. Dead Storage
24,200 A.F. Active Irrig. Storage

Values in 1000 acre-feet unless indicated otherwise

| Year & Month | Depleted Inflow into Reservoir | Reservoir Losses: Evap. Rate (Inches) | Reservoir Losses: Evap. Loss | Reservoir Losses: Seepage | Depleted Gain of Med. Cr. Damsite to Mouth | Avail. Flow of Rep. R. at Cambridge Div. Dam | Total Avail. Flow at Cambridge Div. Dam | Irrigation Demand for 17,2?? Ac. | Demand to be met by Res. Releases | Change in Reservoir Content | Reservoir Content End of Month | Spills | Shortage | Water Passing Cambridge Div. Dam | Flow Below Cambridge Div. Dam 1/ | Return Flow from 17,2?? Ac. | Gain of Rep. R. between Camb. Div. & Bar-Cam Dam 2/ | Flow of Rep. R. below Camb. | Avail. Flow of Sappa at Mouth | Total Flow at Rep.-Sappa Junction | Req. Rel. to meet P.R.B. Min. Flow | Flow of Prairie Dog Creek at Mouth | Depleted Flow of Rep. R. at Harlan Dam |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) |
| 1929 JAN | 2.5 | 0.50 | 0.1 | 0.2 | 0.1 | 15.8 | 15.9 | | | 0 | 25.0 | 2.2 | | 15.9 | 18.1 | 0.7 | 0.8 | 19.8 | 0.5 | 20.3 | | 0.5 | 20.8 |
| FEB | 2.6 | -0.75 | -0.1 | .2 | .1 | 11.7 | 11.8 | | | 0 | 25.0 | 2.5 | | 11.8 | 14.3 | .7 | 0.4 | 15.6 | 0.4 | 16.0 | | 0.4 | 16.4 |
| MAR | 3.8 | 2.09 | 0.2 | .2 | .2 | 41.3 | 41.5 | | | 0 | 25.0 | 3.4 | | 41.5 | 45.1 | .6 | 3.6 | 49.3 | 5.6 | 54.9 | | 2.0 | 56.9 |
| APR | 4.7 | 2.63 | 0.3 | .2 | .2 | 23.9 | 24.1 | 0.3 | 0 | 0 | 25.0 | 4.1 | 0 | 21.8 | 25.9 | .7 | 2.0 | 29.0 | 2.7 | 31.7 | | 0.8 | 32.5 |
| MAY | 5.3 | 0.26 | 0 | .2 | .2 | 36.0 | 36.2 | 0.7 | 0 | 0 | 25.0 | 4.9 | | 35.5 | 40.6 | .8 | 2.7 | 44.1 | 7.8 | 52.3 | | 1.2 | 53.5 |
| JUNE | 4.2 | 3.35 | 0.4 | .2 | .3 | 62.7 | 62.8 | 5.5 | 0 | 0 | 25.0 | 3.6 | | 56.3 | 60.7 | 1.0 | 11.0 | 72.7 | 7.8 | 80.5 | | 2.9 | 83.4 |
| JULY | 2.1 | 7.25 | 0.8 | .2 | 0 | 35.6 | 35.4 | 3.1 | 0 | 0 | 25.0 | 1.1 | | 30.5 | 31.6 | 1.1 | 3.3 | 36.3 | 2.1 | 38.4 | | 13.3 | 51.7 |
| AUG | 0.4 | 7.80 | 0.7 | .2 | .1 | 2.4 | 0.5 | 12.8 | 10.3 | -10.8 | 14.2 | 0 | | 0 | 0.2 | 1.1 | 0 | 1.3 | 0.1 | 1.6 | | 3.4 | 5.0 |
| SEPT | 2.8 | 2.36 | 0.2 | .2 | .1 | 0.3 | 0.4 | 4.6 | 4.2 | -1.8 | 12.4 | 0 | | 0 | 0.2 | 1.4 | 0 | 1.6 | 0.4 | 2.0 | | 0.9 | 2.9 |
| OCT | 3.2 | 2.38 | 0.2 | .2 | .2 | 1.9 | 2.1 | 0 | 0 | +2.8 | 15.2 | 0 | 0 | 2.1 | 2.3 | 1.3 | 0.4 | 4.0 | 0.2 | 4.2 | | 1.6 | 5.8 |
| NOV | 4.4 | 1.20 | 0.1 | .2 | .2 | 3.6 | 3.8 | | | +4.1 | 19.3 | 0 | | 3.8 | 4.0 | 1.1 | 0.8 | 5.9 | 0.2 | 6.1 | | 0.6 | 6.7 |
| DEC | 4.1 | 1.25 | 0.1 | .2 | .2 | 6.2 | 6.4 | | | +3.8 | 23.1 | 0 | | 6.4 | 6.6 | 1.0 | 0.5 | 8.1 | 0.2 | 8.3 | | 0.6 | 8.9 |
| TOTAL | 40.0 | 30.54 | 3.0 | 2.4 | 1.7 | 243.6 | 245.1 | 33.4 | 14.5 | | -2.9 | 22.0 | 0 | 226.2 | 250.4 | 12.7 | 27.4 | 289.3 | 27.4 | 317.3 | | 37.2 | 354.5 |
| 1930 JAN | 3.6 | 0.25 | 0 | 0.2 | 0.2 | 3.2 | 3.4 | | | +1.9 | 25.0 | 1.5 | | 3.4 | 5.1 | 0.8 | 0.8 | 6.7 | 0.2 | 6.9 | | 0.5 | 7.4 |
| FEB | 3.3 | 0.50 | 0 | .2 | .2 | 9.6 | 9.8 | | | 0 | 25.0 | 3.1 | | 9.8 | 13.3 | .7 | 0.6 | 14.4 | 2.5 | 16.8 | | 0.8 | 17.7 |
| MAR | 3.8 | 2.05 | 0.2 | .2 | .2 | 18.4 | 18.6 | | | 0 | 25.0 | 3.4 | | 18.6 | 22.0 | .7 | 0.5 | 23.4 | 0.6 | 24.0 | | 0.7 | 24.7 |
| APR | 4.8 | -3.30 | -0.1 | .2 | .2 | 29.9 | 30.1 | 0 | 0 | 0 | 25.0 | 4.8 | | 30.1 | 35.2 | .5 | 2.4 | 37.9 | 0.4 | 38.3 | | 1.4 | 39.7 |
| MAY | 4.5 | 0.85 | 0.1 | .2 | .2 | 60.3 | 60.5 | 0 | 0 | 0 | 25.0 | 4.0 | | 60.5 | 64.7 | .6 | 11.7 | 76.8 | 3.1 | 79.9 | | 3.3 | 83.2 |
| JUNE | 5.5 | 1.95 | 0.2 | .2 | .4 | 61.3 | 61.7 | 0 | 0 | 0 | 25.0 | 5.1 | | 61.7 | 71.0 | .6 | 20.7 | 92.1 | 17.2 | 109.3 | | 12.5 | 121.8 |
| JULY | 7.7 | 4.75 | 0.5 | .2 | .4 | 6.4 | 6.8 | 1.9 | 0 | 0 | 25.0 | 7.0 | | 4.9 | 12.1 | .5 | 0.4 | 13.0 | 0.7 | 13.7 | | 0.9 | 14.6 |
| AUG | 5.6 | 4.41 | 0.5 | .2 | .1 | 0 | 0.3 | 5.2 | 5.3 | -0.8 | 24.2 | 0 | | 0 | 0.2 | .6 | 0.3 | 1.1 | 2.5 | 3.6 | | 1.9 | 5.7 |
| SEPT | 1.3 | 3.5 | 0.4 | .2 | 0 | 18.5 | 18.5 | 6.9 | 0 | +0.7 | 24.9 | 0 | | 11.6 | 11.8 | .6 | 1.6 | 14.0 | 2.4 | 16.4 | | 1.8 | 18.2 |
| OCT | 4.8 | 0.79 | 0.1 | .2 | .2 | 43.3 | 43.5 | 0 | 0 | +0.1 | 25.0 | 4.4 | | 41.5 | 46.1 | .6 | 8.8 | 57.5 | 13.9 | 71.4 | | 10.3 | 81.7 |
| NOV | 5.2 | 0.80 | 0 | .2 | .2 | 33.3 | 33.5 | | | 0 | 25.0 | 3.6 | | 33.7 | 37.5 | .5 | 2.7 | 40.7 | 4.2 | 44.9 | | 4.0 | 48.9 |
| DEC | 4.5 | 0.55 | 0.1 | .2 | .2 | 25.3 | 25.5 | | | 0 | 25.0 | 4.7 | | 25.5 | 29.9 | .4 | 1.0 | 31.3 | 3.7 | 35.0 | | 1.7 | 36.7 |
| TOTAL | 51.7 | 16.50 | 1.8 | 2.4 | 2.7 | 309.7 | 312.4 | 15.0 | 5.3 | | +1.9 | 45.2 | 0 | 303.3 | 350.1 | 6.5 | 51.7 | 409.1 | 51.4 | 460.5 | | 39.8 | 500.7 |
| 1931 JAN | 5.6 | 0.50 | 0.1 | 0.2 | 0.2 | 22.2 | 22.4 | | | 0 | 25.0 | 4.5 | | 22.4 | 27.1 | 0.4 | -0.6 | 28.1 | 2.4 | 30.5 | | 1.7 | 32.2 |
| FEB | 4.6 | 0.57 | 0 | .2 | .2 | 30.0 | 30.2 | | | 0 | 25.0 | 4.6 | | 30.2 | 34.8 | .3 | 1.4 | 36.5 | 2.7 | 39.2 | | 1.2 | 40.4 |
| MAR | 5.5 | -1.05 | -0.1 | .2 | .2 | 32.2 | 32.4 | | | 0 | 25.0 | 5.3 | | 32.4 | 37.6 | .3 | 1.4 | 39.8 | 4.7 | 44.5 | | 1.3 | 45.8 |
| APR | 4.5 | 3.07 | 0.3 | .2 | .2 | 34.0 | 34.2 | 0 | 0 | 0 | 25.0 | 4.0 | | 34.2 | 38.4 | .4 | 4.0 | 42.8 | 2.0 | 44.8 | | 1.8 | 46.6 |
| MAY | 4.4 | 4.43 | 0.5 | .2 | .2 | 24.9 | 25.1 | 0 | 0 | 0 | 25.0 | 3.7 | | 25.1 | 28.8 | .5 | 2.1 | 30.4 | 3.8 | 34.2 | | 1.2 | 35.4 |
| JUNE | 1.9 | 4.79 | 0.5 | .2 | .1 | 28.7 | 28.8 | 0 | 0 | 0 | 25.0 | 1.2 | | 28.8 | 30.0 | .6 | 0.1 | 30.9 | 1.4 | 32.3 | | 0.9 | 33.2 |
| JULY | 1.5 | 6.36 | 0.8 | .2 | 0 | 1.8 | 1.8 | 6.5 | 4.7 | -3.8 | 21.2 | 0 | | 0 | 0.2 | .7 | -0.5 | 0.4 | 0.1 | 0.5 | 1.0 | 0.7 | 2.2 |
| AUG | 1.4 | 5.35 | 0.6 | .2 | .1 | 0 | 0.1 | 6.8 | 6.7 | -6.7 | 14.5 | 0 | | 0 | 0.2 | .8 | 0 | 1.0 | 8.5 | 9.5 | | 4.0 | 13.5 |
| SEPT | 0.7 | 3.85 | 0.4 | .2 | 0 | 0 | 0 | 6.6 | 6.2 | -6.1 | 8.4 | 0 | | 0 | 0.2 | .8 | 0 | 1.1 | 0.3 | 1.4 | | 1.0 | 2.4 |
| OCT | 3.3 | 3.38 | 0.2 | .2 | .2 | 0 | 0.2 | 1.4 | 1.2 | +1.5 | 9.9 | 0 | | 0 | 0.2 | .8 | -0.4 | 1.6 | 0.4 | 1.9 | | 0.8 | 2.7 |
| NOV | 3.7 | 0.50 | 0 | .2 | .2 | 0 | 0.2 | | | +3.0 | 12.9 | 0 | | -0.2 | 0.4 | .6 | -0.1 | 1.1 | 1.2 | 2.3 | | 0.7 | 3.0 |
| DEC | 3.4 | 1.15 | 0.1 | .2 | .2 | 0 | 0.2 | | | +3.1 | 16.0 | 0 | | -0.2 | 0.4 | .6 | 0.2 | 1.2 | 1.2 | 2.4 | | 0.7 | 3.1 |
| TOTAL | 38.4 | 38.18 | 3.2 | 2.4 | 1.8 | 173.8 | 175.6 | 20.1 | 18.8 | | -9.0 | 21.1 | 0 | 171.5 | 196.0 | 6.9 | 9.5 | 214.5 | 31.6 | 246.5 | | 16.1 | [illegible] |

1/ Includes seepage, spills and excess. 2/ Excludes Sappa, Beaver, and Prairie Dog Cr.

| Year & Month | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1932 JAN | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| FEB | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| APR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| AUG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| SEPT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| OCT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| NOV | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| DEC | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| 1933 JAN | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| FEB | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| APR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| AUG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| SEPT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| OCT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| NOV | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| DEC | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| 1934 JAN | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| FEB | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| APR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| AUG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| SEPT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| OCT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| NOV | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| DEC | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
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1/ Includes seepage, spills and excess. 2/ Excludes Sappa, Beaver, and Prairie Dog Cr.

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Cambridge Canal [illegible] ac.
[illegible] Canal 1,[illegible] ac.
Total [illegible] ac.

Table [illegible] Monthly Reservoir Operation Study – [illegible] Creek Reservoir

Values in 1000 acre-feet unless indicated otherwise

[illegible] A.F. Dead Storage
[illegible] A.F. Active Irrig. Storage

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) |
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| 1955 JAN | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
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1/ Includes seepage, spills and waste. 2/ Excludes Sappa, Beaver, and Prairie Dog Cr.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) |
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| APR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| AUG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| SEPT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| OCT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| NOV | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| DEC | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| 1960 JAN | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| FEB | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| APR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| AUG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| SEPT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| OCT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| NOV | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| DEC | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |

1/ Includes seepage, spills and waste. 2/ Excludes Sappa, Beaver, and Prairie Dog Cr.

Table [illegible]

Cambridge Canal 15,530 Ac.
Bellbrook Canal 1,800 Ac.
Total 17,330 Ac.

Table ___ Monthly Reservoir Operation Study – Medicine Creek Reservoir

Values in 1000 acre-feet unless indicated otherwise

800 A.F. Dead Storage
24,200 A.F. Active Irrig. Storage

| Year & Month | Depleted Inflow into Reservoir | Reservoir Losses: Evap. Rate (inches) | Evap. Loss | Seepage | Depleted Gain of Med. Cr. Damsite to Mouth | Unreg. Flow of Rep. R. at Cambridge Div. Dam | Total Avail. Flow at Cambridge Div. Dam | Irrigation Demand for 17330 Ac. | Demand to be met by Res. Releases | Change in Reservoir Content | Reservoir Content End of Month | Spills | Shortage | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) |
| 1941 Jan. | 5.9 | -0.08 | 0 | 0.2 | 0.1 | 0 | 0.3 | | | 0 | 25.0 | 5.7 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Feb. | 5.7 | 0.79 | 0.1 | .2 | .3 | 0 | 0.3 | | | 0 | 25.0 | 5.2 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Mar. | 5.6 | 1.90 | 0.2 | .2 | .2 | 8.3 | 8.5 | | | 0 | 25.0 | 5.1 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Apr. | 4.9 | -1.09 | +0.1 | .2 | .2 | 18.8 | 18.9 | 0 | 0 | 0 | 25.0 | 4.7 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| May | 11.7 | 1.62 | 0.2 | .2 | .2 | 25.8 | 26.2 | 0 | 0 | 0 | 25.0 | 11.4 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| June | 15.8 | -1.14 | +0.1 | .2 | .3 | 74.4 | 75.2 | 0 | 0 | 0 | 25.0 | 16.7 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| July | 32.1 | 5.88 | 0.4 | .2 | .4 | 41.7 | 42.5 | 2.9 | 0 | 0 | 25.0 | 31.3 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Aug. | 3.3 | [illegible] | 0.7 | .2 | .1 | 22.0 | 23.3 | 8.8 | 0 | 0 | 25.0 | 2.3 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Sept. | 32.4 | 1.06 | 0.2 | .2 | .2 | 28.4 | 28.0 | 1.7 | 0 | 0 | 25.0 | 32.0 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Oct. | 5.2 | 5.38 | 0.4 | .2 | .2 | 14.3 | 14.5 | 3.1 | 0 | 0 | 25.0 | 5.1 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Nov. | 5.2 | 3.18 | 0.2 | .2 | .2 | 18.0 | 18.2 | | | 0 | 25.0 | 5.8 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Dec. | 5.3 | -0.36 | 0 | .2 | .1 | 20.4 | 20.8 | | | 0 | 25.0 | 5.7 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| TOTAL | 87.7 | 23.71 | 2.4 | 2.4 | 4.2 | 270.3 | 276.2 | 16.4 | 0 | | ±0 | 80.7 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| 1942 Jan. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Feb. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Mar. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Apr. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| June | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Aug. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Sept. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Oct. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Nov. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Dec. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| 1943 Jan. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Feb. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Mar. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Apr. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| June | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Aug. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Sept. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Oct. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Nov. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Dec. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

1/ Includes seepage, spills and wastes. 2/ Includes Cambr., Beaver, and Prairie Dog Cr.

| Year & Month | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1944 Jan. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
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| Mar. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Apr. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| June | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
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| Mar. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Apr. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| June | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Aug. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Sept. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Oct. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Nov. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Dec. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
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| 1946 Jan. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
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| Apr. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| May | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| June | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| July | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Aug. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Sept. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
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| Nov. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| Dec. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] |

1/ Includes seepage, spills and wastes. 2/ Includes Cambr., Beaver, and Prairie Dog Cr.

Cambridge Canal 16,650 Ac.
[illegible] Canal 600 Ac.
Total 17,250 Ac.

Table 52 Monthly Reservoir Operation Study - Medicine Creek Reservoir

Values in 1000 acre-feet unless indicated otherwise

800 A.F. Dead Storage
16,200 A.F. Active Irrig. Storage

| Year & Month | Depleted Inflow into Reservoir | Reservoir Losses: Evap. Rate (Inches) | Reservoir Losses: Evap. Loss | Reservoir Losses: Seepage | Depleted Gain of Med. Cr. Damsite to Mouth | Avail. Flow of Rep. R. at Cambridge Div. Dam | Total Avail. Flow at Cambridge Div. Dam | Irrigation Demand for 17,250 Ac. | Demand to be met by Res. Release | Change in Reservoir Content | Reservoir Content End of Month | Spills | Shortage | Surplus Passing Cambridge Div. Dam | Flow below Cambridge Div. Dam 1/ | Return Flow from 17,250 Ac. | Gain of Rep. R. between Camb. Div. & Harlan Dam 2/ | Flow of Rep. R. below Camb. Unit | Avail. Flow of Sappa at Mouth | Total Flow at Rep.-Sappa Junction | Req. Bal. to meet P.D.C. Min. Flow | Flow of Prairie Dog Creek at Mouth | Depleted Flow of Rep. R. at Harlan Dam |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) |
| 19[illegible] JAN | 3.2 | 0.36 | 0 | 0.2 | 0.1 | 18.3 | 18.4 | | | 0 | 25.0 | 3.0 | | 19.4 | 22.6 | 0.6 | -2.7 | 20.3 | 3.7 | 24.7 | - | 1.6 | 22.6 |
| FEB | 3.9 | 0.77 | 0.1 | .2 | .2 | 23.0 | 27.3 | | | 0 | 25.0 | 3.3 | | 23.7 | 25.7 | 0.6 | 1.3 | 26.4 | 7.9 | 31.6 | | 1.8 | 33.3 |
| MAR | 4.1 | 1.63 | 0.1 | .2 | .2 | 32.7 | 33.9 | | | 0 | 25.0 | 3.6 | | 28.2 | 37.2 | 0.8 | 3.4 | 40.9 | 6.9 | 49.8 | | 4.8 | 34.6 |
| APR | 3.8 | 1.03 | 0.1 | .2 | .7 | 32.0 | 32.8 | 0 | 0 | 0 | 25.0 | 3.7 | | 28.7 | 30.8 | 0.8 | -0.3 | 37.0 | 3.1 | 40.1 | | 1.4 | 41.9 |
| MAY | 3.2 | 2.35 | 0.2 | .2 | .2 | 36.4 | 38.4 | 0 | 0 | 0 | 25.0 | 2.6 | | 35.4 | 38.4 | 0.7 | 3.6 | 42.6 | 3.3 | 46.1 | | 1.8 | 47.9 |
| JUNE | 24.0 | -2.34 | 0 | .2 | 3.0 | 35.2 | 38.2 | 0 | 0 | 0 | 25.0 | 33.6 | | 35.2 | 100.1 | 0.7 | 110.6 | 171.3 | 81.8 | 257.9 | | 69.3 | 305.1 |
| JULY | 4.8 | 4.18 | 0.6 | .2 | .3 | 17.7 | 18.0 | 7.2 | 0 | 0 | 25.0 | 7.9 | | 10.8 | 18.7 | 0.8 | 27.1 | 41.6 | 11.0 | 52.6 | | 3.1 | 30.7 |
| AUG | 2.6 | 7.36 | 0.7 | .2 | 0 | 0.8 | 0.3 | 11.7 | 11.2 | -8.7 | 16.3 | 0 | | 0 | 0.2 | 1.0 | 4.3 | 6.0 | 1.2 | 7.2 | | 1.8 | 8.8 |
| SEPT | 2.7 | 3.19 | 0.2 | .2 | .1 | 0.4 | 0.5 | 9.0 | 4.3 | -2.7 | 13.1 | 0 | | 0 | 0.8 | 1.1 | 2.0 | 3.8 | 0.8 | 4.2 | | 0.6 | 4.9 |
| OCT | — | — | | — | — | | | — | | | | | | | | — | — | — | — | — | | — | — |
| NOV | — | — | | — | — | | | — | | | | | | | | — | — | — | — | — | | — | — |
| DEC | — | — | | — | — | | | — | | | | | | | | — | — | — | — | — | | — | — |
| TOTAL | 96.1 | 23.57 | 1.9 | 1.8 | 4.3 | 226.2 | 240.5 | 23.3 | 15.7 | | Δ=-11.9 | 87.6 | | 181.3 | 341.7 | 8.7 | 146.8 | 496.0 | 55.2 | 578.4 | | 88.9 | 604.3 |
| 19 JAN | | | | | | | | | | | | | | | | | | | | | | | |
| FEB | | | | | | | | | | | | | | | | | | | | | | | |
| MAR | | | | | | | | | | | | | | | | | | | | | | | |
| APR | | | | | | | | | | | | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | | | | | | | | | | | | |
| JUNE | | | | | | | | | | | | | | | | | | | | | | | |
| JULY | | | | | | | | | | | | | | | | | | | | | | | |
| AUG | | | | | | | | | | | | | | | | | | | | | | | |
| SEPT | | | | | | | | | | | | | | | | | | | | | | | |
| OCT | | | | | | | | | | | | | | | | | | | | | | | |
| NOV | | | | | | | | | | | | | | | | | | | | | | | |
| DEC | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | |
| 19 JAN | | | | | | | | | | | | | | | | | | | | | | | |
| FEB | | | | | | | | | | | | | | | | | | | | | | | |
| MAR | | | | | | | | | | | | | | | | | | | | | | | |
| APR | | | | | | | | | | | | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | | | | | | | | | | | | |
| JUNE | | | | | | | | | | | | | | | | | | | | | | | |
| JULY | | | | | | | | | | | | | | | | | | | | | | | |
| AUG | | | | | | | | | | | | | | | | | | | | | | | |
| SEPT | | | | | | | | | | | | | | | | | | | | | | | |
| OCT | | | | | | | | | | | | | | | | | | | | | | | |
| NOV | | | | | | | | | | | | | | | | | | | | | | | |
| DEC | | | | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | | |

1/ Includes seepage, spills and wastes.
2/ Excludes Sappa, Beaver, and Prairie Dog Cr.

Table 52

KS002501

3. Reservoir content.

   a. The reservoir irrigation pool is full when the reservoir reaches a content of 25,000 acre-feet. Any water available for storage after this content was reached was spilled.

   b. No release could be made from the reservoir when it was drawn down to a content of 800 acre-feet.

4. Integration of operation with other units.

   a. No releases from upstream reservoirs were made to help satisfy demands in this unit.

   b. No releases were made to help meet irrigation demands in the Bostwick Division.

A column-by-column explanation of the operation study, table 152 follows:

1. Years and months through which the operation study was made (January 1929 through September 1947.)

2. The depleted inflow, table 137, is the historic flow at Medicine Creek Dam less the anticipated depletion by future development above the reservoir. This represents the water available for storage or regulation.

3. Evaporation rate in inches, table 151, is the net reservoir evaporation rate.

4. Evaporation loss is obtained by entering the evaporation chart, exhibit 41, with an average reservoir content determined from column 12 and computing the loss therefrom.

5. Seepage is estimated to be 3 second-feet, 200 acre-feet per month, and was allowed to pass downstream and was used in meeting public health and fish requirements.

6. Depleted inflow of Medicine Creek sectional gain, between Medicine Creek Dam and Cambridge, table 139.

7. Flow of Republican River at Cambridge Diversion Dam, excluding flow of Medicine Creek, after development of upstream units, table 136.

8. Col. 6 plus Col. 7.

9. Total diversion requirements for 17,230 acres in the Cambridge Unit. See table 149.

10. Demand on the reservoir is that portion of the diversion requirements, Col. 9, not met by Col. 8.

11. Change in reservoir content is computed as follows: Col. 2 - (Col. 4 ≠ Col. 5 ≠ Col. 10) - (Col. 13 ≠ Col. 14).

12. The content at the end of the month equals the content at the end of the previous month corrected by the change in content as computed in Col. 11.

13. Shows such spill as may be necessary to avoid showing a content at the end of any month (Col. 12) greater than the sum of irrigation and dead storage, or 25,000 acre-feet.

14. Shows such shortage (diversion requirements not met in Col. 9) as may be necessary to avoid showing a content at the end of any month (Col. 12) less than the capacity of the dead storage of 800 acre-feet.

15. Waste is that part of Col. 7 not diverted (excluding seepage from the dam).

16. Includes seepage (Col. 5), wastes (Col. 15), and reservoir spills (Col. 13).

17. Return flow computed for 17,230 acres in Cambridge Unit. See table 140.

18. Historical runoff of Republican River at Harlan County Dam less historical flows of Prairie Dog Creek near Woodruff, Sappa Creek (including Beaver Creek) at mouth, and Republican River at Cambridge. See table 158.

19. Flow passing Cambridge Unit. Col. 16 plus Col. 17 plus Col. 18.

20. Flow of Sappa Creek and Beaver Creek depleted for estimated upstream developments.

21. Col. 19 plus Col. 20.

22. Releases required to meet minimum flow at Orleans as determined by Public Health Service.

23. Flow of Prairie Dog Creek depleted for estimated upstream developments.

24. Col. 21 plus Col. 22 plus Col. 23.

## Cambridge Unit

Table 153 summarizes the Medicine Creek Reservoir Operation study by years. This table shows that there would have been spills in every year of operation with an average spill of 32,800 acre-feet.

Exhibit 42 is a graphic chart showing the proposed operation of Medicine Creek Reservoir. Three hydrographs are shown on this chart. The hydrograph at the top of the chart shows the water that will flow into the reservoir.

The second hydrograph shows the total diversion that must be made to meet all irrigation demands. The demands that are supplied by reservoir storage releases and by natural flow are also shown.

The third hydrograph on this exhibit shows the reservoir content and the spills from the reservoir.

Releases for Public Health Service.--Studies made by the Public Health Service indicate that during the months of June through September there is a required flow of 3 second-feet on Medicine Creek near Cambridge, Nebraska, and 25 second-feet at a point about 3 miles below the junction of Sappa Creek with the Republican River, near Orleans, Nebraska. 1/ The allowance of 3 second-feet for seepage will meet the requirement on Medicine Creek. In order to maintain a flow of 25 second-feet, (1,500 acre-feet per month) at Orleans, releases were made from Medicine Creek Reservoir in the operation study in August, 1931, August, September, and October in 1943, and October 1944.

### Requirements for fish and wildlife

No water releases from the reservoirs for requirements of fish have been made in this study. In the past the Republican River has dried up during extremely dry seasons. Seepage from the dams and return flows from irrigated lands are expected to establish a live stream at all times. It is anticipated that the minimum flow requirements for public health will be sufficient for fish habitat requirements.

### Water passing the unit after development

The estimated flow of the Republican River passing the Cambridge Unit after development is shown in table 158. This flow consists of wastes from Cambridge Diversion Dam, seepage and spills from Medicine Creek Reservoir, return flow from 17,230 acres in the Cambridge Unit, and the increase in stream flow on the Republican River, between Cambridge and Harlan County Dam, table 157, (excluding flows of Prairie Dog Creek, table 156, and Sappa Creek and Beaver Creek, table 155.) Historical flow of the Republican River at Harlan County Dam site is shown in table 154.

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1/ "Kansas River Basin Water Pollution Investigation." Public Health Service, June 1949, p.121.

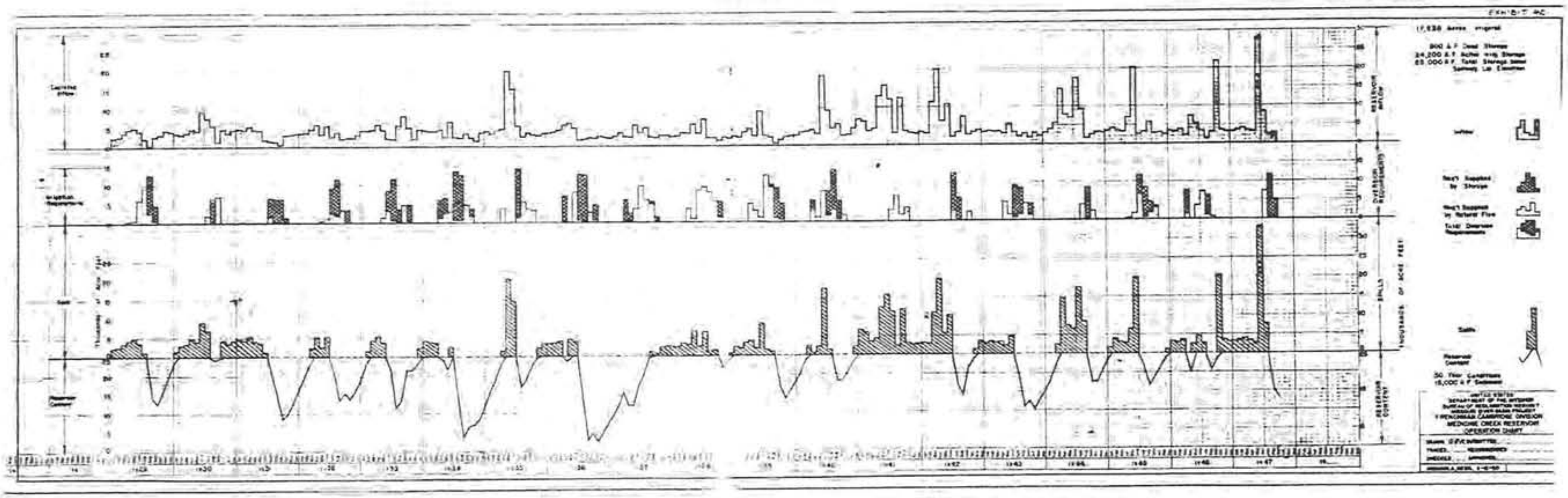
Table 183. Reservoir Operation Summary Medicine Creek Reservoir

14,830 Acres Cambridge Canal
2,400 Acres Holbrook Canal
17,230 Acres Total

24,000 Ac. Ft. Active Irrig. Stor.
800 Ac. Ft. Dead Storage
13,000 Ac. Ft. Silt Storage
37,300

(Unit - 1000 acre-feet)

| Year | Depleted Inflow | Res. Losses Evap. | Res. Losses Seepage | Sectional Gain Below Res. | Available Flow Res. & at Camb. | Total Avail. Flow at Camb. Div. Dam | Irrig. Dem. for 17,230 A. | Demand to be met by Reservoir Releases | Res. Cont. End Month | Spills | Shortage | Waste water passing Camb. Div. | Flow below Cambr. Div. Dam | Return Flow from 17,230 Acres | Sec. Gain between Camb. & Harlan Co. Reservoir | Flow at Orleans | Sappa at mouth | Total flow at Rep. Sappa Junction | P.S.L. Releases | Prairie Dog at mouth | Total Depl. Flow of Rep. River at Harlan Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 25.0 | | | | | | | | | | | | |
| 1929 | 40.0 | 3.0 | 2.4 | 1.7 | 243.4 | 245.1 | 33.4 | 14.5 | 23.1 | 22.0 | 0 | 226.2 | 250.6 | 11.7 | 27.6 | 289.9 | 47.4 | 317.3 | | 27.2 | 344.5 |
| 1930 | 47.2 | 3.4 | 2.4 | 2.7 | 309.7 | 312.4 | 15.0 | 5.9 | 25.0 | 46.8 | 0 | 303.3 | 350.9 | 6.5 | 71.7 | 409.1 | 51.4 | 460.5 | | 39.8 | 500.3 |
| 1931 | 38.9 | 3.2 | 2.4 | 1.8 | 173.8 | 175.6 | 20.3 | 18.8 | 16.0 | 23.1 | 0 | 173.5 | 199.0 | 4.9 | 9.0 | 214.9 | 33.6 | 248.5 | 1.0 | 16.1 | 265.6 |
| 1932 | 63.5 | 3.4 | 2.4 | 2.0 | 107.2 | 107.2 | 28.4 | 19.6 | 18.7 | 15.3 | 0 | 98.0 | 135.7 | 9.6 | 28.8 | 148.1 | 10.0 | 158.1 | | 21.2 | 179.3 |
| 1933 | 42.9 | 3.0 | 2.4 | 2.4 | 190.1 | 192.5 | 34.3 | 23.7 | 25.0 | 17.5 | 0 | 141.7 | 161.6 | 11.8 | 29.8 | 203.2 | 21.9 | 225.1 | | 13.3 | 238.4 |
| 1934 | 40.0 | 4.2 | 2.4 | 1.7 | 116.4 | 118.1 | 59.4 | 38.9 | 11.7 | 14.2 | 0 | 103.2 | 119.8 | 16.5 | 7.9 | 144.2 | 12.4 | 156.6 | | 8.0 | 164.6 |
| 1935 | 73.4 | 3.0 | 2.4 | 3.3 | 578.7 | 582.0 | 29.8 | 12.6 | 25.0 | 42.1 | 0 | 664.8 | 709.3 | 12.0 | -64.4 | 646.9 | 47.9 | 704.4 | | 19.7 | 724.1 |
| 1936 | 47.3 | 3.1 | 2.4 | 1.8 | 149.6 | 151.4 | 47.2 | 35.0 | 7.3 | 22.5 | 0 | 139.2 | 161.1 | 13.5 | 36.3 | 212.9 | 20.3 | 233.2 | | 12.5 | 245.7 |
| 1937 | 36.1 | 3.3 | 2.4 | 1.5 | 77.0 | 78.5 | 33.8 | 8.0 | 25.0 | 5.7 | 0 | 53.7 | 62.8 | 13.0 | 7.3 | 83.1 | 31.9 | 115.0 | | 21.6 | 136.6 |
| 1938 | 40.3 | 3.9 | 2.4 | 1.8 | 144.0 | 145.8 | 40.5 | 3.8 | 25.0 | 32.2 | 0 | 109.0 | 141.6 | 13.8 | 18.7 | 174.1 | 24.9 | 199.0 | | 16.6 | 215.6 |
| 1939 | 36.7 | 4.6 | 2.4 | 1.5 | 145.1 | 146.6 | 44.1 | 12.8 | 18.0 | 24.9 | 0 | 116.7 | 141.6 | 15.5 | 17.7 | 174.8 | 17.5 | 192.3 | | 13.9 | 206.2 |
| 1940 | 44.9 | 4.9 | 2.4 | 2.8 | 29.4 | 32.2 | 42.9 | 24.3 | 25.0 | 26.7 | 0 | 14.0 | 43.1 | 15.3 | 14.9 | 73.3 | 18.5 | 91.8 | | 14.7 | 106.5 |
| 1941 | 87.7 | 2.0 | 2.4 | 4.2 | 270.7 | 274.9 | 14.4 | 0 | 25.0 | 62.7 | 0 | 260.4 | 345.5 | 7.0 | 88.4 | 440.9 | 99.0 | 539.9 | | 66.6 | 606.5 |
| 1942 | 77.4 | 2.0 | 2.4 | 3.7 | 289.6 | 293.3 | 20.5 | 15.2 | 25.0 | 57.8 | 0 | 278.2 | 308.4 | 6.8 | 131.6 | 446.8 | 83.1 | 529.9 | | 53.1 | 583.0 |
| 1943 | 37.5 | 3.0 | 2.4 | 1.7 | 104.3 | 106.0 | 32.4 | 18.3 | 15.0 | 19.7 | 0 | 91.3 | 114.0 | 10.6 | 51.5 | 176.1 | 17.7 | 193.8 | 4.1 | 14.0 | 211.9 |
| 1944 | 79.1 | 1.2 | 2.4 | 3.6 | 231.6 | 235.7 | 14.8 | 6.2 | 23.3 | 57.0 | 0 | 228.6 | 288.3 | 6.5 | 56.3 | 351.1 | 107.3 | 458.4 | 2.0 | 67.5 | 527.9 |
| 1945 | 61.8 | 2.6 | 2.4 | 2.8 | 170.5 | 173.3 | 30.5 | 15.4 | 25.0 | 39.3 | 0 | 158.6 | 200.0 | 5.5 | 44.6 | 254.5 | 28.7 | 283.2 | | 20.9 | 304.1 |
| 1946 | 62.2 | 2.0 | 2.4 | 2.9 | 243.4 | 246.3 | 17.5 | 11.7 | 25.0 | 46.1 | 0 | 232.4 | 281.0 | 9.2 | 129.1 | 415.3 | 71.6 | 491.9 | | 36.2 | 527.1 |
| 1947 | 95.1 | 1.9 | 1.8 | 4.3 | 256.2 | 260.5 | 23.9 | 15.7 | 13.2 | 87.6 | 0 | 252.3 | 340.7 | 4.7 | 146.6 | 495.0 | 83.3 | 578.3 | | 85.9 | 664.2 |
| Average | 56.3 | 3.0 | 2.4 | 2.6 | 186.8 | 200.0 | 31.0 | 16.7 | – | 38.8 | 0 | 186.7 | 221.0 | 11.0 | 37.8 | 270.7 | 40.3 | 311.0 | 0.4 | 27.0 | 338.8 |


Inflow
Spills
RESERVOIR INFLOW
DIVERSION REQUIREMENTS
RESERVOIR CONTENT
THOUSANDS OF ACRE FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
FRENCHMAN CAMBRIDGE DIVISION
MEDICINE CREEK RESERVOIR
OPERATION CHART

KS002506

Table 154.--Republican River at Harlan County Dam Site a/
1000 acre-feet

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 22.4 | 21.6 | 22.9 | 18.1 | 13.4 | 58.3 | 45.4 | 55.6 | 106.8 | 68.6 | 11.8 | 8.4 | 453.3 |
| 1930 | 16.3 | 23.4 | 24.0 | 21.0 | 25.3 | 29.8 | 47.7 | 83.1 | 133.2 | 26.1 | 31.2 | 45.4 | 506.5 |
| 1931 | 97.0 | 52.8 | 37.5 | 33.4 | 40.0 | 45.0 | 54.2 | 41.0 | 40.4 | 9.3 | 24.5 | 4.5 | 479.6 |
| 1932 | 3.9 | 12.1 | 11.7 | 14.5 | 54.2 | 42.0 | 29.2 | 26.5 | 96.2 | 17.6 | 26.4 | 19.5 | 353.8 |
| 1933 | 5.2 | 8.6 | 21.1 | 25.6 | 20.5 | 31.9 | 65.3 | 71.1 | 13.2 | 8.2 | 48.6 | 91.5 | 410.8 |
| 1934 | 19.2 | 20.5 | 34.7 | 30.8 | 25.0 | 33.7 | 25.8 | 8.7 | 66.0 | 5.2 | 2.6 | 23.7 | 295.9 |
| 1935 | 5.1 | 11.6 | 14.8 | 25.9 | 22.2 | 29.2 | 26.9 | 118.8 | 544.8 | 48.4 | 64.6 | 69.8 | 982.1 |
| 1936 | 18.1 | 25.3 | 24.6 | 19.5 | 14.0 | 44.8 | 25.1 | 137.6 | 50.6 | 3.5 | 1.7 | 7.7 | 372.5 |
| 1937 | 2.4 | 11.9 | 17.5 | 8.8 | 34.0 | 34.1 | 20.5 | 23.8 | 98.9 | 32.3 | 47.1 | 25.2 | 356.5 |
| 1938 | 6.9 | 11.9 | 13.8 | 25.3 | 23.3 | 30.8 | 36.0 | 71.0 | 81.4 | 57.4 | 37.3 | 39.9 | 435.0 |
| 1939 | 6.2 | 9.5 | 16.6 | 17.5 | 14.8 | 34.8 | 35.0 | 38.9 | 106.6 | 32.7 | 22.2 | 0.9 | 335.7 |
| 1940 | 0.8 | 4.2 | 11.8 | 7.9 | 15.1 | 38.6 | 23.4 | 20.7 | 69.2 | 41.2 | 23.6 | 21.0 | 277.5 |
| 1941 | 18.8 | 11.6 | 15.5 | 22.3 | 31.5 | 32.4 | 42.9 | 59.8 | 253.0 | 146.6 | 76.8 | 95.7 | 806.9 |
| 1942 | 37.4 | 27.8 | 25.8 | 22.8 | 33.8 | 67.5 | 85.7 | 64.8 | 157.5 | 40.2 | 58.9 | 78.8 | 701.0 |
| 1943 | 26.2 | 29.1 | 31.7 | 20.9 | 35.1 | 35.9 | 56.9 | 22.8 | 66.5 | 13.8 | 3.1 | 6.3 | 348.3 |
| 1944 | 1.3 | 8.3 | 11.6 | 18.1 | 30.4 | 37.9 | 112.8 | 87.3 | 118.6 | 185.4 | 62.7 | 11.1 | 685.5 |
| 1945 | 12.2 | 19.6 | 23.9 | 28.4 | 31.1 | 29.3 | 37.0 | 34.7 | 163.9 | 48.1 | 19.3 | 14.5 | 462.0 |
| 1946 | 17.7 | 17.5 | 11.1 | 21.4 | 29.8 | 34.7 | 20.2 | 47.0 | 35.2 | 83.4 | 17.5 | 49.3 | 384.8 |
| 1947 | 275.6 | 58.9 | 40.8 | 24.9 | 32.4 | 55.4 | 41.4 | 44.9 | 388.8 | 79.8 | 15.5 | 7.3 | 1065.7 |
| Total | 592.7 | 386.2 | 411.4 | 407.1 | 525.9 | 746.1 | 831.4 | 1058.1 | 2590.8 | 947.8 | 595.4 | 620.5 | 9713.4 |
| Avg. | 31.2 | 20.3 | 21.7 | 21.4 | 27.7 | 39.3 | 43.7 | 55.7 | 136.4 | 49.9 | 31.3 | 32.7 | 511.3 |

a/ Runoff at Harlan County Dam Site estimated as 98% of the runoff at Bloomington.

Table 155.—Historical runoff at mouth of Sappa Creek near Stamford, Nebraska a/
Discharge in 1,000 acre-feet

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total | Less Beaver Cr. at Mouth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 1.6 | 0 | 2.1 | 0.2 | 0 | 7.0 | 3.0 | 8.7 | 10.2 | 4.2 | 0.6 | 0.3 | 37.9 | 14.7 |
| 1930 | 0 | 0 | 0 | 0.3 | 3.9 | 0.9 | 2.4 | 5.1 | 23.7 | 2.7 | 5.4 | 5.1 | 49.5 | 25.4 |
| 1931 | 15.6 | 4.2 | 3.9 | 2.7 | 2.7 | 4.8 | 7.8 | 4.5 | 4.2 | 0.6 | 14.7 | 0.9 | 66.6 | 41.5 |
| 1932 | 0.3 | 0.9 | 0.9 | 0.9 | 3.9 | 1.2 | 1.8 | 3.0 | 4.5 | 1.7 | 2.4 | 3.2 | 24.7 | 7.7 |
| 1933 | 0 | 0 | 1.0 | 1.0 | 0 | 2.5 | 9.2 | 9.5 | 1.7 | 0.8 | 0 | 7.9 | 33.6 | 19.0 |
| 1934 | 0.8 | 1.7 | 2.8 | 2.1 | 0.7 | 3.3 | 1.8 | 1.0 | 8.9 | 0.5 | 0.1 | 3.7 | 27.4 | 16.5 |
| 1935 | 0.2 | 0.7 | 0 | 0.9 | 0.7 | 1.4 | 2.3 | 28.0 | 19.3 | 3.4 | 8.9 | 10.4 | 76.2 | 46.3 |
| 1936 | 1.9 | 3.3 | 1.2 | 0.4 | 0 | 5.3 | 0.6 | 15.4 | 4.6 | 0.3 | 0 | 1.1 | 34.1 | 20.1 |
| 1937 | 0 | 0.1 | 0.3 | 0 | 4.3 | 2.6 | 0.6 | 2.8 | 25.4 | 3.3 | 11.6 | 4.1 | 55.1 | 38.0 |
| 1938 | 0.1 | 0 | 0 | 0.1 | 0.2 | 0.7 | 2.0 | 8.2 | 19.1 | 7.1 | 2.4 | 0.9 | 40.8 | 22.9 |
| 1939 | 0 | 0 | 0.1 | 0 | 0 | 0.6 | 1.2 | 5.9 | 18.3 | 4.7 | 1.2 | 0 | 32.0 | 18.2 |
| 1940 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0 | 1.7 | 3.1 | 13.1 | 6.4 | 7.6 | 32.3 | 22.5 |
| 1941 | 1.4 | 0 | 0.1 | 0.2 | 0.9 | 0.3 | 6.1 | 5.4 | 56.9 | 21.6 | 11.6 | 24.4 | 128.9 | 90.6 |
| 1942 | 3.9 | 1.8 | 1.7 | 1.3 | 2.0 | 2.6 | 12.3 | 7.5 | 32.8 | 10.7 | 17.0 | 6.0 | 99.6 | 55.4 |
| 1943 | 1.4 | 1.0 | 1.5 | 1.4 | 1.8 | 1.8 | 3.2 | 1.3 | 9.3 | 1.2 | 0.8 | 2.6 | 27.3 | 16.5 |
| 1944 | 0 | 0.1 | 0.1 | 0.6 | 0.6 | 0.8 | 6.8 | 11.4 | 13.5 | 73.4 | 18.3 | 2.8 | 128.4 | 78.3 |
| 1945 | 1.6 | 1.5 | 1.6 | 1.4 | 1.5 | 2.4 | 2.6 | 2.5 | 6.9 | 15.5 | 3.0 | 0.3 | 40.8 | 22.0 |
| 1946 | 0.1 | 0.2 | 0.3 | 0.2 | 0.3 | 1.4 | 0.4 | 3.2 | 3.2 | 12.3 | 0.7 | 4.3 | 26.6 | 17.3 |
| 1947 | 59.3 | 8.6 | 5.3 | 3.6 | 2.9 | 6.2 | 3.8 | 3.8 | 52.3 | 13.6 | 3.2 | 1.0 | 163.6 | 96.6 |
| Av. 1929-47 | 4.6 | 1.3 | 1.2 | 0.9 | 1.4 | 2.4 | 3.6 | 6.8 | 16.7 | 10.0 | 5.7 | 4.6 | 59.2 | 35.2 |

a/ October 1928 through March 1929 and July 1932 through April 1937 (except May and June 1935) based on correlation with increased discharge of Frenchman and Republican Rivers at Culbertson and Republican River near Bloomington. May and June 1935 based on rainfall correlation.
April 1929 through June 1932 based on correlation with Beaver Creek at Ludell and Sappa Creek near Oberlin.
May 1937 through December 1945 based on correlation with Sappa and Beaver Creek near Beaver City.
Other values are records.

Table 156.—Historical Run-off at Mouth of Prairie Dog Creek. a/ Discharge in 1,000 acre-feet.

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.8 | 0 | 0.7 | 0.1 | 0 | 2.6 | 1.3 | 2.2 | 6.0 | 14.9 | 2.4 | 0.9 | 31.9 |
| 1930 | 4.9 | 0.4 | 0.4 | 0.3 | 1.2 | 0.8 | 1.9 | 3.3 | 12.8 | 1.6 | 3.9 | 3.7 | 35.2 |
| 1931 | 12.8 | 3.8 | 1.6 | 1.6 | 1.2 | 1.1 | 1.8 | 1.6 | 1.4 | 0.6 | 9.1 | 1.3 | 37.9 |
| 1932 | 1.0 | 0.7 | 0.7 | 0.6 | 14.8 | 1.3 | 1.0 | 3.2 | 3.7 | 0.8 | 1.2 | 1.7 | 30.7 |
| 1933 | 0 | 0 | 0.3 | 0.3 | 0 | 0.8 | 5.4 | 5.6 | 0.8 | 0.3 | 0 | 4.6 | 18.1 |
| 1934 | 0.3 | 0.6 | 1.0 | 0.7 | 0.2 | 1.1 | 0.9 | 0.4 | 5.2 | 0.2 | 0 | 2.0 | 12.6 |
| 1935 | 0.1 | 0.2 | 0 | 0.2 | 0.2 | 0.4 | 1.1 | 13.7 | 10.4 | 1.8 | 5.2 | 6.2 | 39.5 |
| 1936 | 1.0 | 1.1 | 0.3 | 0.1 | 0 | 1.9 | 0.2 | 9.5 | 2.4 | 0.1 | 0 | 0.6 | 17.2 |
| 1937 | 0 | 0 | 0.1 | 0 | 1.6 | 0.9 | 0.3 | 0.7 | 23.5 | 1.7 | 7.8 | 3.6 | 40.2 |
| 1938 | 0.2 | 0 | 0 | 0.2 | 0.2 | 0.4 | 1.6 | 5.7 | 12.4 | 3.7 | 0.7 | 0.8 | 25.9 |
| 1939 | 0 | 0 | 0 | 0 | 0 | 0.3 | 0.2 | 5.4 | 11.9 | 1.8 | 0.7 | 0 | 20.3 |
| 1940 | 0 | 0 | 0 | 0 | 0.2 | 0.2 | 0 | 1.6 | 0.8 | 12.2 | 5.3 | 5.1 | 25.4 |
| 1941 | 0.3 | 0 | 0.2 | 0.2 | 0.6 | 0.2 | 2.2 | 4.3 | 45.6 | 21.3 | 8.2 | 22.1 | 105.2 |
| 1942 | 2.0 | 1.1 | 1.0 | 0.9 | 0.9 | 1.1 | 7.9 | 3.9 | 18.9 | 8.1 | 12.0 | 3.2 | 61.0 |
| 1943 | 1.0 | 0.7 | 0.8 | 0.9 | 0.9 | 0.9 | 1.6 | 0.6 | 7.9 | 0.8 | 0.8 | 1.6 | 18.5 |
| 1944 | 0 | 0.2 | 0.2 | 0.7 | 0.4 | 0.7 | 4.6 | 14.1 | 7.2 | 40.5 | 11.7 | 1.9 | 82.2 |
| 1945 | 1.1 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 1.1 | 1.2 | 8.1 | 10.5 | 0.6 | 0.1 | 27.2 |
| 1946 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.9 | 0.3 | 6.1 | 3.2 | 7.3 | 0.4 | 2.2 | 21.6 |
| 1947 | 29.3 | 3.3 | 1.8 | 1.3 | 1.7 | 4.7 | 1.3 | 1.6 | 68.7 | 6.0 | 2.4 | 0.6 | 122.7 |
| Av. 1929-47 | 2.9 | 0.7 | 0.5 | 0.5 | 1.1 | 1.1 | 1.8 | 4.5 | 13.2 | 7.1 | 3.8 | 3.3 | 40.7 |

a/ Based on drainage are relationship with State Line. $\left(\frac{1138}{1028} = 111\%\right)$

Table 157.—Increase in historical flow of Republican River Between Cambridge Diversion Dam and Harlan County Dam Site a/

(Unit-1000 acre-feet)

| Year | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 0.5 | 0.6 | 0.6 | 0.8 | 0.4 | 3.6 | 2.0 | 2.7 | 13.0 | 3.4 | 0 | 0 | 27.6 |
| 1930 | 0.4 | 0.8 | 0.5 | 0.8 | 0.6 | 0.5 | 2.4 | 11.7 | 20.7 | 0.4 | 0.5 | 1.6 | 40.9 |
| 1931 | 8.8 | 2.7 | 1.0 | 0.6 | 1.4 | 1.6 | 4.0 | 1.1 | 1.0 | 0.1 | -0.5 | 0 | 21.8 |
| 1932 | 0 | 0.4 | 0.1 | 0.2 | 1.1 | 1.5 | 0.4 | 0.5 | 17.0 | 0.4 | 0.6 | 0.2 | 22.4 |
| 1933 | 0.1 | 0.4 | 0.4 | 0.8 | 0.7 | 0.1 | 3.7 | 5.1 | 0.2 | 0 | 3.6 | 13.4 | 28.5 |
| 1934 | 0.6 | 0.7 | 0.9 | 0.6 | 0.5 | 0.7 | 0.6 | 0.1 | 4.0 | 0.1 | -0.1 | 0.5 | 9.2 |
| 1935 | 0 | 0.6 | 0.3 | 0.6 | 0.5 | 0.4 | 0.4 | -145.3 | 67.2 | 2.2 | 3.7 | 4.6 | -64.8 |
| 1936 | 0.4 | 0.3 | 0.6 | 0.5 | 0.6 | 1.6 | 0.6 | 28.1 | 3.8 | 0 | 0.1 | 0 | 36.6 |
| 1937 | 0 | 0.3 | 0.7 | 0 | 0.6 | 0.7 | 0.6 | 0.7 | 3.0 | 0.3 | 0.2 | 0.5 | 7.6 |
| 1938 | 0.2 | 0.2 | 0.3 | 0.7 | 0.7 | 0.5 | 0.9 | 5.7 | 3.2 | 3.0 | 1.2 | 1.4 | 18.0 |
| 1939 | 0.1 | 0.3 | 1.0 | 0.7 | 0.7 | 1.2 | 1.2 | 0.4 | 11.9 | 0.5 | 0.7 | 0 | 18.7 |
| 1940 | 0 | 0 | 0.4 | 0 | 0.6 | 1.4 | 0.7 | 0.7 | 8.3 | 0.4 | 0 | 1.3 | 13.8 |
| 1941 | 0.7 | 0.5 | 0.3 | 0.7 | 0.8 | 1.1 | 1.1 | 3.8 | 46.5 | 23.7 | 5.5 | 2.8 | 87.5 |
| 1942 | 1.0 | 0.7 | 0.7 | 0.6 | 0.9 | 7.7 | 8.3 | 4.6 | 56.0 | 7.6 | 11.2 | 35.6 | 134.9 |
| 1943 | -2.2 | 0.4 | 0.9 | 0.6 | 1.2 | 1.8 | 24.0 | 1.7 | 24.2 | 5.9 | -3.0 | -3.1 | 52.4 |
| 1944 | -2.1 | 0 | 0.3 | 0.7 | 0.9 | 1.4 | 25.4 | 2.9 | 43.3 | -26.7 | 7.8 | 2.1 | 56.0 |
| 1945 | -2.9 | 0.8 | 0.6 | 0.7 | 0.6 | 0.8 | 1.1 | 1.0 | 46.3 | 0 | 0.5 | 0.5 | 50.0 |
| 1946 | -0.5 | -1.6 | -4.8 | -3.9 | 2.1 | 0.9 | 1.1 | -0.7 | 0.5 | -6.3 | 10.8 | 28.6 | 26.2 |
| 1947 | 84.9 | 6.0 | 5.1 | -2.7 | 1.3 | 5.4 | -0.2 | 3.5 | 110.4 | 22.1 | 4.8 | 2.0 | 242.6 |
| Avg. | 4.7 | 0.7 | 0.5 | 0.2 | 0.9 | 1.7 | 4.1 | -3.8 | 25.3 | 2.0 | 2.5 | 4.9 | 43.7 |

a/ Does not include any flow of Sapa, Beaver or Prairie Dog Creeks

Table 158.--Computed flow of Republican River passing Cambridge Unit after development of proposed upstream units

(Unit - 1000 acre-feet)

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1929 | 19.8 | 15.6 | 49.3 | 29.0 | 44.1 | 74.7 | 36.3 | 1.5 | 1.6 | 4.0 | 5.9 | 8.1 | 289.9 |
| 1930 | 6.7 | 14.4 | 23.4 | 37.9 | 76.8 | 92.1 | 13.0 | 1.3 | 14.0 | 57.5 | 40.7 | 31.3 | 409.1 |
| 1931 | 28.1 | 36.5 | 39.8 | 42.8 | 30.6 | 30.9 | 0.4 | 1.0 | 1.1 | 1.4 | 1.1 | 1.2 | 214.9 |
| 1932 | 1.1 | 1.9 | 18.0 | 16.1 | 14.1 | 78.0 | 1.5 | 2.0 | 9.2 | 1.5 | 1.6 | 3.1 | 148.1 |
| 1933 | 4.7 | 4.2 | 16.2 | 39.4 | 39.3 | 1.4 | 1.3 | 5.1 | 45.7 | 2.1 | 15.1 | 28.7 | 203.2 |
| 1934 | 29.0 | 25.5 | 28.8 | 1.9 | 1.5 | 29.2 | 1.9 | 2.0 | 12.1 | 2.1 | 8.1 | 2.1 | 144.2 |
| 1935 | 3.3 | 5.0 | 6.9 | 3.5 | 35.0 | 507.2 | 3.4 | 28.0 | 35.0 | 4.5 | 12.8 | 12.3 | 656.9 |
| 1936 | 13.2 | 13.4 | 36.7 | 1.8 | 112.7 | 13.2 | 1.7 | 2.2 | 4.4 | 2.1 | 4.5 | 7.0 | 212.9 |
| 1937 | 1.8 | 13.8 | 9.4 | 1.5 | 1.7 | 13.8 | 7.9 | 14.7 | 3.3 | 2.3 | 6.8 | 6.1 | 83.1 |
| 1938 | 14.2 | 10.5 | 16.4 | 11.1 | 50.2 | 16.2 | 14.8 | 12.1 | 11.9 | 1.9 | 5.1 | 9.7 | 174.1 |
| 1939 | 15.5 | 13.2 | 35.3 | 12.5 | 20.5 | 56.2 | 4.8 | 3.6 | 2.1 | 1.9 | 4.3 | 4.9 | 174.8 |
| 1940 | 1.4 | 2.0 | 5.2 | 2.6 | 12.2 | 31.2 | 3.5 | 1.9 | 3.3 | 3.6 | 2.2 | 4.2 | 73.3 |
| 1941 | 8.9 | 8.1 | 15.1 | 24.6 | 42.9 | 138.0 | 75.1 | 25.1 | 42.9 | 16.1 | 19.4 | 24.7 | 440.9 |
| 1942 | 21.4 | 32.1 | 63.6 | 67.1 | 49.9 | 106.2 | 8.5 | 12.2 | 39.1 | 1.6 | 20.5 | 24.6 | 446.8 |
| 1943 | 18.1 | 33.5 | 33.5 | 41.1 | 5.7 | 32.7 | 7.1 | 0 | 0 | 0 | 0.2 | 4.2 | 176.1 |
| 1944 | 1.8 | 2.0 | 10.0 | 79.2 | 59.4 | 94.2 | 65.1 | 27.2 | 2.9 | 0 | 4.7 | 4.6 | 351.1 |
| 1945 | 6.3 | 14.4 | 23.1 | 28.2 | 26.1 | 136.6 | 1.2 | 1.9 | 2.0 | 0.9 | 6.6 | 7.2 | 254.5 |
| 1946 | 15.2 | 20.7 | 30.6 | 1.9 | 18.9 | 14.5 | 32.3 | 12.0 | 35.0 | 168.1 | 37.6 | 32.5 | 419.3 |
| 1947 | 20.5 | 28.6 | 43.9 | 37.0 | 42.8 | 271.3 | 41.6 | 6.0 | 3.3 | — | — | — | 495.0 |
| Avg. | 12.2 | 15.5 | 26.6 | 25.2 | 36.0 | 91.5 | 16.9 | 8.4 | 14.1 | 15.1 | 11.0 | 12.0 | 284.5 |

## Cambridge Unit

### Summary

The water supply studies presented herein indicate that there is a sufficient water supply to serve the 17,230 acres proposed to be served in the Cambridge Unit. No shortages are expected and it is likely that spills will occur from the reservoir in practically every year of operation.

## CHAPTER VI

## EFFECTS OF DIVISION DEVELOPMENT IN THE KANSAS RIVER DRAINAGE AREA

### Depletions

Table 159 summarizes the depletions in the Frenchman-Cambridge Division. This table shows an increase in the use of water by 68,570 acres amounting to an average of 84,500 acre-feet annually. The total average annual use, including both Bureau of Reclamation project lands and private development averages 94,600 acre-feet annually.

This consumptive use of irrigation water is accomplished through the use of 130,000 acre-feet of irrigation storage capacity in the Division. This compares with 436,500 acre-feet of irrigation storage capacity required to irrigate a total of 188,360 acres included in the Bureau of Reclamation plan for development in the drainage area of the Republican River.

### Effect of Development on Bostwick Division

The development of the Frenchman-Cambridge Division as presented in the plan of development would not cause intolerable shortages in the potential units of the Bostwick Division. The operation study for Harlan County and Lovewell Reservoirs is made up in two parts. Table 161 shows the computations to determine the total demand to be met by Harlan County Reservoir and table 160 is the operation study of Harlan County and Lovewell Reservoirs. The operation study for the Bostwick Division is based upon the depleted inflow to Harlan County Reservoir allowing for development of the Upper Republican and Frenchman-Cambridge Division on the Republican River plus development of the Kanaska Division on Sappa, Beaver, and Prairie Dog Creeks. The average annual depletions that will be incurred by development of the Kanaska Division are listed in table 162. Table 163 is a summary showing annual depletions that will be incurred by development of the Bostwick Division.

Storage allocations in the proposed reservoirs of the Kanaska and Bostwick Divisions are shown in table 164. The potential project areas in the Kanaska and Bostwick Division are listed in table 165.

### Discussion of general plan of operation

The rights for the use of water by various canals and reservoirs proposed by the Bureau of Reclamation in the Frenchman-Cambridge Division have been protected by appropriation filings with the Nebraska Bureau of Roads and Irrigation. The existing water rights and their dates of filing for features that propose to receive water from the Bureau of Reclamation development in the Republican River drainage are shown in table 166.

TABLE OF SUMMARY OF ANNUAL DEPLETIONS IN FRENCHMAN-CAMBRIDGE DIVISION

1000 ACRE-FEET

| Year | Frenchman Unit (Private Depletions, Irrigation & Ponds; Bureau Planned Depletions) | Meeker-Driftwood Unit (Bureau Planned Depletions) | Red Willow Unit (Private Depletions; Bureau Planned Depletions) | Cambridge Unit (Private Depletions, Irrigation & Ponds; Bureau Planned Depletions) | Depletions for Division: Private Ponds & Irrig. | Bureau Irrig. | Evap. Reservoirs | Total Depletions |
|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 10.4 | 72.0 | 15.6 | 97.8 |
| 1930 | [illegible] | [illegible] | [illegible] | [illegible] | 8.8 | 26.0 | 10.2 | [illegible] |
| 1931 | [illegible] | [illegible] | [illegible] | [illegible] | 9.2 | 57.9 | 14.7 | 88.4 |
| 1932 | [illegible] | [illegible] | [illegible] | [illegible] | 10.9 | 88.6 | 16.2 | [illegible] |
| 1933 | [illegible] | [illegible] | [illegible] | [illegible] | 10.2 | 73.0 | 16.8 | 100.1 |
| 1934 | [illegible] | [illegible] | [illegible] | [illegible] | 19.7 | 108.1 | 14.1 | [illegible] |
| 1935 | [illegible] | [illegible] | [illegible] | [illegible] | 9.2 | 41.2 | 10.3 | [illegible] |
| 1936 | [illegible] | [illegible] | [illegible] | [illegible] | 16.8 | 110.8 | 13.5 | [illegible] |
| 1937 | [illegible] | [illegible] | [illegible] | [illegible] | 12.6 | 76.1 | 13.8 | [illegible] |
| 1938 | [illegible] | [illegible] | [illegible] | [illegible] | 10.6 | [illegible] | [illegible] | [illegible] |
| 1939 | [illegible] | [illegible] | [illegible] | [illegible] | 16.8 | 98.6 | 21.2 | [illegible] |
| 1940 | [illegible] | [illegible] | [illegible] | [illegible] | 12.0 | [illegible] | 16.3 | [illegible] |
| 1941 | [illegible] | [illegible] | [illegible] | [illegible] | 8.3 | 31.2 | 15.7 | 50.2 |
| 1942 | [illegible] | [illegible] | [illegible] | [illegible] | 7.1 | 57.9 | 12.2 | [illegible] |
| 1943 | [illegible] | [illegible] | [illegible] | [illegible] | 13.3 | 90.8 | 17.5 | [illegible] |
| 1944 | [illegible] | [illegible] | [illegible] | [illegible] | 7.8 | 38.1 | 11.8 | 56.7 |
| 1945 | [illegible] | [illegible] | [illegible] | [illegible] | 8.8 | 63.0 | 14.3 | [illegible] |
| 1946 | [illegible] | [illegible] | [illegible] | [illegible] | 9.8 | 61.1 | 14.2 | [illegible] |
| 1947 | [illegible] | [illegible] | [illegible] | [illegible] | 7.0 | 46.7 | 12.2 | [illegible] |
| Total | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1303.7 | 300.2 | [illegible] |
| Average | [illegible] | [illegible] | [illegible] | [illegible] | 10.7 | 68.6 | 15.8 | [illegible] |
| % of total | | | | | 10.7 | 72.6 | 16.8 | 100.0 |
| Depth in feet per acre | | | | | 1.30 | [illegible] | | |

107.9 or 106.0

234

KS002514

COMPUTATIONS TO DETERMINE THE TOTAL DEMAND TO BE MET BY HARLAN COUNTY RESERVOIR - BOSTWICK DIVISION

[illegible]



TABLE 16D

COMPUTATIONS TO DETERMINE THE TOTAL DEMAND TO BE MET BY HARLAN COUNTY RESERVOIR - BOSTWICK DIVISION

[illegible]

COMPUTATIONS TO DETERMINE THE TOTAL DEMAND TO BE MET BY HARLAN COUNTY RESERVOIR - BOSTWICK DIVISION

KS002517

COMPUTATIONS TO DETERMINE THE TOTAL DEMAND TO BE MET BY HARLAN COUNTY RESERVOIR - BOSTWICK DIVISION

BOSTWICK UNIT
31,230 ACRES

TABLE [illegible] RESERVOIR OPERATIONS - HARLAN COUNTY AND LOVEWELL RESERVOIRS
( 1,000 Acre Feet unless indicated otherwise )

HARLAN CO. 75,000 A.F. DEAD STORAGE, 75,000 ACTIVE IRRIGATION
LOVEWELL 4,200 A.F. DEAD STORAGE, 24,200 ACTIVE IRRIGATION

| | HARLAN COUNTY RESERVOIR | | | | | | | | | LOVEWELL RESERVOIR | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year and Month | Depleted Res. Inflow | Res. Evap. Rate (In.) | Reservoir Evaporation | Seepage | Demand on Reservoir | Change in Res. Content | Res. Content at End of Month | Spills | Shortage | Inflow Excl. Harlan Co Spills | Storage Spills from Harlan Co | Total Inflow | Res. Evap. Rate (In.) | Reservoir Evaporation | Seepage | Irrigation Demand | Change in Res. Content | Res. Content at End of Month | Spills | Shortage |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 1949 JAN | [illegible] | 1.00 | [illegible] | 0.1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| FEB | [illegible] | [illegible] | [illegible] | 0.1 | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| MAR | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| APR | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| MAY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| JUNE | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| JULY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| AUG | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| SEPT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| OCT | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | |
| NOV | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | |
| DEC | [illegible] | [illegible] | | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| TOTAL | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | 2.8 | [illegible] | [illegible] | | [illegible] | [illegible] | |
| 1950 JAN | [illegible] | [illegible] | [illegible] | 0.1 | [illegible] | [illegible] | 194.7 | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| FEB | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| MAR | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| APR | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | 250.0 | 8.2 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| MAY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| JUNE | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| JULY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| AUG | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| SEPT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| OCT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| NOV | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| DEC | [illegible] | [illegible] | | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| TOTAL | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | |
| 1951 JAN | [illegible] | [illegible] | [illegible] | 0.1 | | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | | [illegible] | |
| FEB | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | |
| MAR | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| APR | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| MAY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| JUNE | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| JULY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| AUG | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| SEPT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| OCT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | |
| NOV | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| DEC | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| TOTAL | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | |
| 19__ JAN | | | | | | | | | | | | | | | | | | | | |
| FEB | | | | | | | | | | | | | | | | | | | | |
| MAR | | | | | | | | | | | | | | | | | | | | |
| APR | | | | | | | | | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | | | | | | | | | |
| JUNE | | | | | | | | | | | | | | | | | | | | |
| JULY | | | | | | | | | | | | | | | | | | | | |
| AUG | | | | | | | | | | | | | | | | | | | | |
| SEPT | | | | | | | | | | | | | | | | | | | | |
| OCT | | | | | | | | | | | | | | | | | | | | |
| NOV | | | | | | | | | | | | | | | | | | | | |
| DEC | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | |
| 19__ JAN | | | | | | | | | | | | | | | | | | | | |
| FEB | | | | | | | | | | | | | | | | | | | | |
| MAR | | | | | | | | | | | | | | | | | | | | |
| APR | | | | | | | | | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | | | | | | | | | |
| JUNE | | | | | | | | | | | | | | | | | | | | |
| JULY | | | | | | | | | | | | | | | | | | | | |
| AUG | | | | | | | | | | | | | | | | | | | | |
| SEPT | | | | | | | | | | | | | | | | | | | | |
| OCT | | | | | | | | | | | | | | | | | | | | |
| NOV | | | | | | | | | | | | | | | | | | | | |
| DEC | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | |
| 19__ JAN | | | | | | | | | | | | | | | | | | | | |
| FEB | | | | | | | | | | | | | | | | | | | | |
| MAR | | | | | | | | | | | | | | | | | | | | |
| APR | | | | | | | | | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | | | | | | | | | |
| JUNE | | | | | | | | | | | | | | | | | | | | |
| JULY | | | | | | | | | | | | | | | | | | | | |
| AUG | | | | | | | | | | | | | | | | | | | | |
| SEPT | | | | | | | | | | | | | | | | | | | | |
| OCT | | | | | | | | | | | | | | | | | | | | |
| NOV | | | | | | | | | | | | | | | | | | | | |
| DEC | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | |



KS002519

BOSTWICK UNIT
______ ACRES

TABLE 161 RESERVOIR OPERATIONS – HARLAN COUNTY AND LOVEWELL RESERVOIRS
(1,000 Acre-feet unless indicated otherwise)

HARLAN CO. ______ A.F. DEAD STORAGE, ______ ACTIVE IRRIGATION
LOVEWELL ______ A.F. DEAD STORAGE, ______ ACTIVE IRRIGATION

| Year and Month | HARLAN COUNTY RESERVOIR: Depleted Res. Inflow | Res. Evap Rate (in.) | Reservoir Evaporation | Seepage | Demand on Reservoir | | Change in Res. Content | Res. Content at End of Month | Spills | Shortage | LOVEWELL RESERVOIR: Inflow Excl. Harlan Co. Spills | Storable Spills from Harlan Co. | Total Inflow | Res. Evap Rate (in.) | Reservoir Evaporation | Seepage | Irrigation Demand | Change in Res. Content | Res. Content at End of Month | Spills | Shortage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19[illegible] JAN | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | |
| FEB | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| MAR | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| APR | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| MAY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| JUNE | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| JULY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| AUG | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| SEPT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| OCT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| NOV | [illegible] | [illegible] | [illegible] | .1 | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| DEC | [illegible] | [illegible] | [illegible] | .1 | | | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| TOTAL | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | | [illegible] | | |
| 19[illegible] JAN | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | | |
| FEB | [illegible] | [illegible] | [illegible] | .1 | | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| MAR | [illegible] | [illegible] | [illegible] | .1 | | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| APR | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| MAY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| JUNE | [illegible] | [illegible] | | .1 | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| JULY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| AUG | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | | | |
| SEPT | [illegible] | [illegible] | [illegible] | .1 | | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | | | |
| OCT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | .1 | [illegible] | [illegible] | [illegible] | | |
| NOV | [illegible] | [illegible] | [illegible] | .1 | | | | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | | |
| DEC | [illegible] | [illegible] | [illegible] | .1 | | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | [illegible] | |
| TOTAL | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | 1.2 | [illegible] | | [illegible] | | |
| 19[illegible] JAN | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | [illegible] | | | | | |
| FEB | [illegible] | [illegible] | [illegible] | .1 | | | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | .1 | | [illegible] | | | |
| MAR | [illegible] | [illegible] | [illegible] | .1 | | | | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | .1 | | [illegible] | [illegible] | | |
| APR | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | | | |
| MAY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | | | |
| JUNE | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | | | |
| JULY | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | | | | |
| AUG | [illegible] | 8.24 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | |
| SEPT | [illegible] | 2.53 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| OCT | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | .1 | [illegible] | | [illegible] | | |
| NOV | [illegible] | [illegible] | [illegible] | .1 | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | | .1 | | [illegible] | [illegible] | | |
| DEC | [illegible] | [illegible] | [illegible] | .1 | | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | .1 | | [illegible] | [illegible] | [illegible] | |
| TOTAL | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.2 | [illegible] | | [illegible] | [illegible] | |
| 19[illegible] JAN | [illegible] | [illegible] | [illegible] | [illegible] | Canal Demand | [illegible] Loss | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | |
| FEB | | [illegible] | [illegible] | | 0 | | | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | | [illegible] | [illegible] | | |
| MAR | | [illegible] | [illegible] | | 0 | | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | |
| APR | | [illegible] | | [illegible] | 14.1 | | | [illegible] | | | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | |
| MAY | [illegible] | [illegible] | | [illegible] | 0 | | | [illegible] | | | [illegible] | | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | | |
| JUNE | [illegible] | [illegible] | [illegible] | | 7.4 | | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | |
| JULY | [illegible] | [illegible] | [illegible] | | 25.9 | | [illegible] | [illegible] | | | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | |
| AUG | [illegible] | [illegible] | [illegible] | [illegible] | 17.4 | 11.5 | [illegible] | [illegible] | | | [illegible] | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | |
| SEPT | [illegible] | [illegible] | [illegible] | [illegible] | 3.8 | 4.1 | | [illegible] | | | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | |
| OCT | | [illegible] | [illegible] | | 10.8 | 8.4 | | [illegible] | | | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | |
| NOV | [illegible] | [illegible] | | [illegible] | 0 | | [illegible] | [illegible] | | | | | | [illegible] | | [illegible] | | [illegible] | [illegible] | | |
| DEC | [illegible] | [illegible] | [illegible] | [illegible] | 0.1 | | [illegible] | [illegible] | | | [illegible] | | | [illegible] | | [illegible] | | [illegible] | [illegible] | | |
| TOTAL | [illegible] | [illegible] | [illegible] | [illegible] | 79.5 | 24.0 | | [illegible] | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | |
| 19[illegible] JAN | [illegible] | [illegible] | [illegible] | .1 | 0 | | | | | | [illegible] | | | [illegible] | | [illegible] | | | | | |
| FEB | [illegible] | [illegible] | | .1 | 0 | | | | | | | | | [illegible] | | .1 | | | | | |
| MAR | [illegible] | [illegible] | | [illegible] | 0 | | | | | | [illegible] | | | [illegible] | | .1 | | [illegible] | | | |
| APR | [illegible] | [illegible] | [illegible] | .1 | 4.9 | | | | | | [illegible] | | [illegible] | [illegible] | [illegible] | .1 | [illegible] | [illegible] | [illegible] | | |
| MAY | [illegible] | [illegible] | | .1 | 7.1 | | | | [illegible] | | [illegible] | | [illegible] | [illegible] | | .1 | [illegible] | [illegible] | [illegible] | | |
| JUNE | [illegible] | [illegible] | [illegible] | .1 | 1.1 | | | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | .1 | | [illegible] | [illegible] | | |
| JULY | [illegible] | [illegible] | | .1 | 33.7 | | | | | | [illegible] | | | [illegible] | | .1 | [illegible] | [illegible] | [illegible] | | |
| AUG | [illegible] | [illegible] | | [illegible] | 13.9 | | | | | | [illegible] | | | [illegible] | | .1 | [illegible] | [illegible] | [illegible] | | |
| SEPT | | [illegible] | | | 35.5 | 17.5 | | [illegible] | | | | | | [illegible] | | .1 | [illegible] | | [illegible] | | |
| OCT | | [illegible] | | [illegible] | 10.0 | 8.2 | [illegible] | | | | | | | [illegible] | | .1 | [illegible] | | | | |
| NOV | | [illegible] | | | 0 | | | | | | [illegible] | | | [illegible] | | .1 | | | [illegible] | | |
| DEC | | [illegible] | | | 1.2 | | | | | | [illegible] | | | [illegible] | | .1 | | | [illegible] | | |
| TOTAL | | [illegible] | | | 106.4 | 25.7 | | | [illegible] | | | | [illegible] | [illegible] | | [illegible] | [illegible] | | | | |
| 19[illegible] JAN | | | | [illegible] | 0 | | | | | | [illegible] | | | [illegible] | | [illegible] | | | [illegible] | | |
| FEB | | [illegible] | | | 1.6 | | | | | | | | | [illegible] | | | | | [illegible] | | |
| MAR | | [illegible] | | | 0 | | | | | | | | | [illegible] | | | | | | | |
| APR | | [illegible] | | | 4.4 | | | | | | | | | [illegible] | | | | | [illegible] | | |
| MAY | | [illegible] | | | 2.2 | | | | | | | | | [illegible] | | | | | [illegible] | | |
| JUNE | | [illegible] | | | 11.2 | 3.5 | | | | | | | | [illegible] | | .1 | [illegible] | | | | |
| JULY | | | | | 52.4 | 22.9 | | | | | | | | [illegible] | | | [illegible] | | | | |
| AUG | | | | | 19.6 | 14.6 | | | | | | | | [illegible] | | | [illegible] | | [illegible] | | |
| SEPT | | [illegible] | | | 30.7 | 11.8 | | | | | | | | [illegible] | | | [illegible] | | | | |
| OCT | | | | | 4.4 | 3.3 | | | | | | | | | | | [illegible] | | [illegible] | | |
| NOV | | | | | 0 | | | | | | | | | | | | | [illegible] | [illegible] | | |
| DEC | | | | | 0 | | | | | | | | | | | | | [illegible] | [illegible] | | |
| TOTAL | | | | | 124.5 | 57.1 | | | | | | | | | | | | | [illegible] | | |

KS002520

BOSTWICK UNIT
ACRES

TABLE 26L RESERVOIR OPERATIONS - HARLAN COUNTY AND LOVEWELL RESERVOIRS
(1,000 Acre-feet unless indicated otherwise)

HARLAN CO. [illegible] AF DEAD STORAGE, [illegible] ACTIVE IRRIGATION
LOVEWELL [illegible] AF DEAD STORAGE, [illegible] ACTIVE IRRIGATION

Table (6)

| Year and Month | HARLAN COUNTY RESERVOIR: Depleted Res. Inflow | Res. Evap. Rate (In.) | Reservoir Evaporation | Seepage | Demand at Reservoir | | Change in Res. Content | Res. Content at End of Month | Spills | Shortage | LOVEWELL RESERVOIR: Inflow Excl. Harlan Co. Spills | Useable Spills from Harlan Co. | Total Inflow | Res. Evap. Rate (In.) | Reservoir Evaporation | Seepage | Irrigation Demand | Change in Res. Content | Res. Content at End of Month | Spills | Shortage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1941 JAN | 9.9 | -0.80 | -0.1 | [illegible] | | | +9.9 | 93.6 | | | 0 | 0 | 0 | 0.00 | 0 | 0.1 | | -0.1 | 18.4 | | |
| FEB | 9.4 | 0.50 | 0.2 | | | | +9.0 | 101.5 | | | 0 | 0 | 0 | 0.67 | 0.1 | 0.1 | | -0.2 | 18.2 | | |
| MAR | 19.8 | 1.50 | 0.8 | | | | +14.9 | 116.4 | | | 38 2.1 | 0 | 2.1 | 1.83 | 0.1 | 0.1 | | +1.9 | 20.1 | | |
| APR | 38.0 | -0.96 | -0.5 | 0.1 | 0 | 0 | +38.4 | 146.8 | | | 0.2 | 0 | 0.2 | -0.47 | 0.1 | 0.1 | | | 17.1 | | |
| MAY | 47.9 | 3.89 | 2.6 | 0.1 | 0 | 0 | +45.2 | 192.0 | | | 0.3 | 0 | 0.3 | 3.61 | 0.4 | 0.1 | | -0.3 | 13.9 | | |
| JUNE | 211.9 | -9.55 | -7.2 | 0.1 | 0 | 0 | +57.9 | 250.0 | 154.9 | | 17.4 | 9.1 | 22.5 | -5.11 | -0.8 | 0.1 | | +22.8 | 36.0 | | |
| JULY | 117.6 | 7.46 | 2.8 | [illegible] | 48.4 | 0 | 0 | 250.0 | 64.1 | | 1.4 | 12.0 | 14.4 | 5.71 | 1.3 | 0.1 | 17.2 | 0 | 36.0 | | |
| AUG | 31.8 | 1.97 | 1.6 | [illegible] | 45.0 | 0 | -16.9 | 239.1 | | | 2.5 | 0 | 2.5 | 0.74 | 1.1 | 0.1 | 20.4 | -19.1 | 16.9 | | |
| SEPT | 92.8 | 4.58 | 4.1 | [illegible] | 6.6 | 0 | +10.9 | 250.0 | 79.7 | | 2.4 | 16.6 | 19.0 | -1.33 | -0.2 | 0 | 0 | +19.1 | 36.0 | | |
| OCT | 17.5 | 1.96 | 1.8 | 0.1 | 0 | 0 | 0 | 250.0 | 15.6 | | 17.3 | 0 | 17.3 | -0.48 | -0.1 | 0.1 | 0 | 0 | 36.0 | 17.3 | |
| NOV | 26.1 | 1.57 | 1.4 | 0.1 | | | 0 | 250.0 | 24.6 | | 58 3.3 | 0 | 3.3 | 2.19 | 0.3 | 0.1 | | 0 | 36.0 | 6.9 | |
| DEC | 27.5 | 0.36 | 0.2 | 0.1 | | | 0 | 250.0 | 27.2 | | 24 5.8 | 0 | 5.8 | -1.04 | -0.2 | 0.1 | | 0 | 36.0 | 5.9 | |
| TOTAL | 626.5 | 17.39 | 11.1 | 1.2 | 938 | 0 | | Δ = +162.6 | 399.8 | | 45.0 | 38.7 | 87.7 | [illegible] | 3.1 | [illegible] | 37.6 | | Δ = +25.5 | 35.5 | |
| 1942 JAN | 29.6 | 0.65 | 2.6 | [illegible] | | | 0 | 250.0 | 29.9 | | 6.8 | 0 | 2.3 | 0.80 | 0.2 | 0.1 | | 0 | 36.0 | 6.6 | |
| FEB | 34.9 | 0.55 | 0.5 | 0.1 | | | 0 | 250.0 | 34.3 | | 6.5 | 0 | 6.5 | 0.47 | 0.1 | 0.1 | | 0 | 36.0 | 6.3 | |
| MAR | 57.1 | 0.38 | 0.3 | 0.1 | | | 0 | 250.0 | 56.7 | | 45 5.5 | 0 | 5.5 | 0.42 | 0.3 | 0.1 | | 0 | 36.0 | 5.3 | |
| APR | 87.0 | 1.07 | 1.8 | 0.1 | 0 | 0 | 0 | 250.0 | 85.9 | | 0 | 0.5 | 0.5 | 1.97 | 0.4 | 0.1 | | 0 | 36.0 | 0 | |
| MAY | 58.8 | 4.92 | 4.4 | 0.1 | 0 | 0 | 0 | 250.0 | 54.3 | | 1.2 | 0 | 1.2 | 2.46 | 0.5 | 0.1 | | 0 | 36.0 | 0.6 | |
| JUNE | 156.5 | -0.27 | -0.2 | 0.1 | 0 | 0 | 0 | 250.0 | 156.6 | | 6.8 | 0 | 6.8 | -1.17 | -0.3 | 0.1 | | 0 | 36.0 | 7.0 | |
| JULY | 19.1 | 9.66 | 8.7 | 0.1 | 6.8 | 0 | 0 | 250.0 | 3.5 | | 1.9 | 3.5 | 5.4 | 4.36 | 0.9 | 0.1 | 7.2 | -3.7 | 32.3 | 0 | |
| AUG | 36.2 | 2.42 | 2.1 | 0.1 | 9.8 | 0 | 0 | 250.0 | 24.2 | | 1.3 | 4.4 | 5.7 | 1.49 | 0.3 | 0.1 | 1.5 | +3.7 | 36.0 | 0 | |
| SEPT | 47.7 | -1.33 | -1.2 | 0.1 | 0 | 0 | 0 | 250.0 | 48.8 | | 5.4 | 0 | 5.4 | -2.04 | -0.4 | 0.1 | | 0 | 36.0 | 5.7 | |
| OCT | 3.5 | 9.42 | 3.1 | 0.1 | 2.5 | 0 | -2.2 | 247.8 | 0 | | 0.5 | 0 | 0.5 | 2.07 | 0.5 | 0.1 | 3.4 | -3.5 | 32.5 | 0 | |
| NOV | 23.3 | 2.00 | 1.8 | 0.1 | 0 | 0 | +2.2 | 250.0 | 19.2 | | 41 4.3 | 0 | 4.3 | 2.30 | 0.5 | 0.1 | | +3.5 | 36.0 | 0.2 | |
| DEC | 26.4 | 0.30 | 0.3 | 0.1 | .5 | 0 | 0 | 250.0 | 25.5 | | 8.1 | 0 | 8.1 | -0.86 | -0.1 | 0.1 | | 0 | 36.0 | 8.1 | |
| TOTAL | 557.0 | 24.81 | 23.5 | 1.2 | 19.8 | 0 | | Δ = 0 | 539.5 | | 25.3 | 8.4 | 34.7 | [illegible] | 2.8 | | | | Δ = 0 | 19.6 | |
| 1943 JAN | 20.0 | 0.90 | 0.8 | 0.1 | | | 0 | 250.0 | 19.1 | | 4.1 | 4.2 | 8.3 | 0.87 | 0.2 | | | | 36.0 | | |
| FEB | 35.6 | 0.45 | 0.6 | 0.1 | | | 0 | 250.0 | 34.9 | | 6.7 | 0 | 6.7 | 0.86 | 0 | 0.1 | | 0 | 36.0 | 6.6 | |
| MAR | 35.6 | 1.57 | 1.2 | 0.1 | | | 0 | 250.0 | 34.4 | | 27 3.1 | 0 | 3.1 | 1.84 | 0.4 | | | 0 | 36.0 | 2.6 | |
| APR | 45.6 | 1.78 | 1.2 | 0.1 | 0 | 0 | 0 | 250.0 | 44.3 | | 1.0 | 0 | 1.0 | 2.00 | 0.5 | | | 0 | 36.0 | 0.4 | |
| MAY | 2.9 | 5.80 | 2.8 | 0.1 | 6.3 | 0 | -6.3 | 245.7 | 0 | | 2.3 | 0 | 2.3 | 3.94 | 0.8 | | | 0 | 36.0 | 1.6 | |
| JUNE | 42.9 | 4.31 | 3.9 | 0.1 | 0 | 0 | +4.3 | 250.0 | 34.6 | | 24.3 | 0 | 24.3 | -1.82 | -0.3 | | | 0 | 36.0 | 24.6 | |
| JULY | 8.4 | 8.10 | 7.4 | 0.1 | 22.9 | 0 | -22.0 | 227.8 | 0 | | 1.2 | 0 | 1.2 | 4.90 | 0.9 | | | -16.8 | 19.2 | 0 | |
| AUG | 2.4 | 8.64 | 7.6 | 0.1 | 35.9 | 0 | -39.1 | 187.9 | 0 | | 0.5 | 0 | 0.5 | 4.16 | 0.4 | | 17.6 | -17.0 | 2.2 | 0 | |
| SEPT | 3.9 | 5.84 | 3.9 | 0.1 | 26.6 | 15.4 | -41.7 | 145.2 | 0 | | 0 | 0 | 0 | 3.52 | 0.1 | | 15.0 | -0.2 | 2.0 | 0 | |
| OCT | 1.4 | 4.11 | 2.6 | 0.1 | 9.3 | 3.6 | -12.2 | 132.0 | 0 | | 0.1 | 0 | 0.1 | 2.00 | 0.1 | | [illegible] | -0.1 | [illegible] | 0 | |
| NOV | 4.5 | 2.37 | 1.4 | 0.1 | | | +3.0 | 136.0 | 0 | | 27 2.3 | 0 | 2.3 | 2.31 | 0.1 | 0.1 | | +2.1 | 4.1 | 0 | |
| DEC | 5.5 | 1.10 | 0.7 | 0.1 | | | +4.7 | 140.7 | 0 | | 19 1.9 | 0 | 1.9 | 0.94 | 0 | 0.1 | | +1.8 | 5.9 | 0 | |
| TOTAL | 216.9 | 43.88 | 36.2 | 1.2 | 999 | 286 | | Δ = -115.3 | 167.7 | | 37.4 | 4.2 | 37.6 | 24.92 | 2.9 | 1.2 | [illegible] | | Δ = -30.1 | 29.7 | |
| 1945 JAN | 2.6 | -0.97 | -0.3 | 0.1 | | | +3.6 | 139.9 | | | 0 | 0 | 0 | -0.26 | 0 | 0.1 | | -0.1 | 5.7 | | |
| FEB | 7.4 | 0.20 | 0.2 | 0.1 | | | +7.1 | 141.4 | | | 0 | 0 | 0 | 2.37 | 0 | 0.1 | | -0.1 | 5.6 | | |
| MAR | 11.6 | 0.74 | 0.4 | 0.1 | | | +11.1 | 151.5 | | | 80 8.7 | 0 | 8.7 | -1.56 | -0.1 | 0.1 | | +8.7 | 14.3 | | |
| APR | 35.0 | -4.19 | -3.3 | 0.1 | [illegible] | | +72.4 | 221.9 | | | 3.1 | 0 | 3.1 | -1.92 | -0.4 | 0.1 | 0 | +3.4 | 16.7 | | |
| MAY | 71.6 | 4.07 | 3.7 | 0.1 | | | +18.1 | 250.0 | 49.7 | | 6.7 | 12.8 | 17.7 | 1.88 | 0.3 | 0.1 | 0 | +19.3 | 36.0 | | |
| JUNE | 109.7 | 6.07 | 5.5 | 0.1 | | | 0 | 250.0 | 104.1 | | 2.7 | 0 | 2.7 | 1.64 | 0.7 | 0.1 | 0 | 0 | 36.0 | 2.9 | |
| JULY | 170.2 | 1.82 | 1.6 | 0.1 | [illegible] | | 0 | 250.0 | 163.5 | | 1.3 | 0 | 1.3 | 2.44 | 2.4 | 0.1 | 0 | 0 | 36.0 | 4.6 | |
| AUG | 49.6 | 4.71 | 4.2 | 0.1 | [illegible] | | 0 | 250.0 | 41.2 | | 4.3 | 0 | 4.3 | 0.16 | 0 | 0.1 | 0 | 0 | 36.0 | 4.2 | |
| SEPT | 5.2 | 4.92 | 4.4 | 0.1 | [illegible] | | -4.1 | 240.9 | | | 3.2 | 0 | 3.2 | 2.95 | 0.6 | 0.1 | 6.6 | -4.1 | 31.9 | | |
| OCT | 2.7 | 2.32 | 2.1 | 0.1 | [illegible] | | -11.0 | 229.9 | | | 2.4 | 0 | 2.4 | 1.15 | 2.2 | 0.1 | 4.2 | -4.1 | 27.8 | | |
| NOV | 7.4 | 1.39 | 1.1 | 0.1 | [illegible] | | +7.2 | 247.1 | | | 27 3.1 | 0 | 3.1 | 0.57 | 0.1 | 0.1 | | +2.8 | 30.6 | | |
| DEC | 6.4 | 1.14 | 0.8 | 0.1 | [illegible] | | +2.9 | 250.0 | 1.6 | | [illegible] | 1.4 | 1.8 | -0.93 | 0.1 | 0.1 | | +1.6 | 32.2 | | |
| TOTAL | 505.9 | 32.73 | 24.4 | 1.2 | 37.4 | | | Δ = +115.3 | 360.1 | | 36.8 | 15.8 | 56.6 | 8.03 | 1.7 | 1.2 | 10.8 | | Δ = +26.4 | 12 | |
| 1945 JAN | 9.1 | 0.36 | 0.7 | 0.1 | | | 0 | 250.0 | 7.7 | | 6.1 | 2.9 | 9.0 | 0.50 | 0.1 | 0.1 | | +3.8 | 36.0 | 0 | |
| FEB | 14.7 | 0.24 | 0.2 | 0.1 | | | 0 | 250.0 | 18.5 | | 4.5 | 0 | 4.5 | 0.37 | 0.1 | 0.1 | | 0 | 36.0 | [illegible] | |
| MAR | 25.9 | 1.91 | 1.7 | 0.1 | | | 0 | 250.0 | 24.1 | | 57 3.3 | 0 | 7.3 | 1.15 | 0.3 | 0.1 | | 0 | 36.0 | [illegible] | |
| APR | 31.4 | -1.52 | -1.2 | 0.1 | | | 0 | 250.0 | 31.5 | | 6.2 | 0 | 6.2 | -1.45 | -0.3 | 0.1 | | 0 | 36.0 | [illegible] | |
| MAY | 27.8 | 5.87 | 2.4 | 0.1 | | | 0 | 250.0 | 25.1 | | 38.3 | 0 | 38.3 | -7.00 | -1.4 | 0.1 | 0 | 0 | 36.0 | [illegible] | |
| JUNE | 148.5 | 1.43 | 3.9 | 0.1 | [illegible] | | 0 | 250.0 | 134.9 | | 5.5 | 0 | 5.5 | 4.27 | 0.2 | 0.1 | 0 | 0 | 36.0 | [illegible] | |
| JULY | 20.8 | 7.19 | 6.5 | 0.1 | [illegible] | 0 | 0 | 250.0 | 9.8 | | 18.7 | 0 | 18.7 | 2.04 | 2.5 | 0.1 | 0 | 0 | 36.0 | [illegible] | |
| AUG | 9.1 | 4.40 | 7.9 | 0.1 | 26.3 | | -26.3 | 223.7 | 0 | | 1.1 | 0 | 1.1 | 4.32 | 2.8 | [illegible] | 16.5 | [illegible] | 27.0 | | |
| SEPT | 3.0 | 5.18 | 4.6 | 0.1 | [illegible] | | -17.2 | 206.4 | 0 | | 0.4 | 0 | 0.4 | 3.34 | 1.5 | [illegible] | 4.5 | [illegible] | [illegible] | | |
| OCT | 3.0 | 3.53 | 2.8 | 0.1 | [illegible] | | -5.1 | 198.3 | 0 | | 0.3 | 0 | 0.3 | 2.10 | 1.7 | [illegible] | 7.6 | -0.7 | [illegible] | | |
| NOV | 7.9 | 2.65 | 2.1 | 0.1 | [illegible] | | +5.5 | 204.8 | 0 | | 15 1.5 | 0 | 1.5 | 2.51 | 0.3 | [illegible] | | [illegible] | [illegible] | | |
| DEC | 8.4 | 0.87 | 5.4 | 0.1 | | | +7.9 | 211.7 | 0 | | 27 2.9 | 0 | 2.9 | -0.77 | 0 | [illegible] | | +2.7 | [illegible] | | |
| TOTAL | 309.1 | 30.92 | 27.4 | 1.2 | [illegible] | | | Δ = -38.3 | 245.2 | | 97.7 | 2.9 | [illegible] | 19.93 | 7.4 | 1.2 | 44.0 | | | | |
| 1946 JAN | 16.9 | [illegible] | [illegible] | 2.1 | | | [illegible] | [illegible] | | | 0 | | | 0.33 | | | | | | | |
| FEB | 2.7 | [illegible] | | [illegible] | | | [illegible] | [illegible] | | | 0 | | | [illegible] | | | | | | | |
| MAR | 32.8 | 1.63 | | [illegible] | | | [illegible] | [illegible] | | | 27 2.7 | | [illegible] | 2.31 | | | | [illegible] | [illegible] | | |
| APR | 3.5 | 1.82 | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | 2.5 | | | 4.76 | | [illegible] | 6.4 | | [illegible] | | |
| MAY | 26.6 | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | | | 0 | | | [illegible] | | [illegible] | 3.4 | | | | |
| JUNE | 7.8 | 5.41 | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | | [illegible] | | [illegible] | 2.38 | | | | | | | |
| JULY | 32.6 | [illegible] | | [illegible] | [illegible] | | | | [illegible] | | [illegible] | | | [illegible] | | | | | | | |
| AUG | [illegible] | [illegible] | | [illegible] | [illegible] | | | | | | [illegible] | | | [illegible] | | | [illegible] | | | | |
| SEPT | [illegible] | [illegible] | | | | | | [illegible] | [illegible] | | [illegible] | | | [illegible] | | | | | | | |
| OCT | [illegible] | [illegible] | | | | | | | [illegible] | | [illegible] | | | [illegible] | | | | | | | |
| NOV | [illegible] | [illegible] | | | | | | | | | [illegible] | | | [illegible] | | | | | | | |
| DEC | [illegible] | [illegible] | | | | | | | | | | | | [illegible] | | | | | | | |
| TOTAL | [illegible] | [illegible] | | [illegible] | | | | | [illegible] | | [illegible] | | | [illegible] | | | | | | | |

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BOSTWICK UNIT
_______ ACRES

TABLE [illegible] RESERVOIR OPERATIONS - HARLAN COUNTY AND LOVEWELL RESERVOIRS
(1,000 Acre-feet unless indicated otherwise)

HARLAN CO. _______ A.F. DEAD STORAGE, _______ ACTIVE IRRIGATION
LOVEWELL _______ A.F. DEAD STORAGE, _______ ACTIVE IRRIGATION

Table 101

| Year and Month | HARLAN COUNTY RESERVOIR | | | | | | | | | LOVEWELL RESERVOIR | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Depleted Res. Inflow | Res. Evap Rate (in.) | Reservoir Evaporation | Seepage | Demand at Reservoir | Change in Res. Content | Res. Content at End of Month | Spills | Shortage | Inflow Excl. Harlan Co. Spills | Spills from Harlan Co. | Total Inflow | Res. Evap Rate (in.) | Reservoir Evaporation | Seepage | Irrigation Demand | Change in Res. Content | Res. Content at End of Month | Spills | Shortage |
| 19__ JAN | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | |
| FEB | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | |
| MAR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | |
| APR | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | |
| MAY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | |
| JUNE | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | |
| JULY | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | [illegible] | |
| AUG | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | | |
| SEPT | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | | |
| OCT | | | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | | | | | [illegible] | | | | | |
| NOV | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | | | [illegible] | | [illegible] | [illegible] | | | | |
| DEC | | | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | | | [illegible] | | [illegible] | | [illegible] | | | |
| TOTAL | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | |
| 19__ JAN | | | | | | | | | | | | | | | | | | | | |
| FEB | | | | | | | | | | | | | | | | | | | | |
| MAR | | | | | | | | | | | | | | | | | | | | |
| APR | | | | | | | | | | | | | | | | | | | | |
| MAY | | | | | | | | | | | | | | | | | | | | |
| JUNE | | | | | | | | | | | | | | | | | | | | |
| JULY | | | | | | | | | | | | | | | | | | | | |
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| DEC | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | |
| 19__ JAN | | | | | | | | | | | | | | | | | | | | |
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| AUG | | | | | | | | | | | | | | | | | | | | |
| SEPT | | | | | | | | | | | | | | | | | | | | |
| OCT | | | | | | | | | | | | | | | | | | | | |
| NOV | | | | | | | | | | | | | | | | | | | | |
| DEC | | | | | | | | | | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | | | | | | | | | |

Table /AD. - SUMMARY OF ANNUAL DEPLETIONS from FUTURE DEVELOPMENT AT [illegible] DIVISION - 1000 Acre-Feet

Beaver Creek

| Year | Private Depletions: Irrigation Above Beaver C. | Private Depletions: Irrigation Below Beaver C. | Private Depletions: Ponds | Total Private Depletions | Bureau Planned Depletions: Amount Diverted | Bureau Planned Depletions: Return Flow | Bureau Planned Depletions: Depletion for Irrig. | Bureau Planned Depletions: Evap. from Res. | Total Depletion on Beaver Creek |
|---|---|---|---|---|---|---|---|---|---|
| 1929 | [illegible] | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1930 | [illegible] | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1931 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1932 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1933 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1934 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 11.1 |
| 1935 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1936 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 11.9 |
| 1937 | [illegible] | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1938 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1939 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1940 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1941 | [illegible] | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1942 | [illegible] | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1943 | [illegible] | 0.1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1944 | [illegible] | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1945 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1946 | [illegible] | .1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1947 | [illegible] | 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Average | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

Sappa Creek

| Year | Private Depletions: Irrig. Above Oberlin | Private Depletions: Irrig. Below Oberlin | Private Depletions: Ponds | Total Private Depletions | Bureau Planned Depletions: Amount Diverted | Bureau Planned Depletions: Return Flow | Bureau Planned Depletions: Depletion for Irrig. | Bureau Planned Depletions: Evap. from Res. | Total Depletion on Sappa Creek |
|---|---|---|---|---|---|---|---|---|---|
| 1929 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1930 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1931 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1932 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1933 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1934 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1935 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1936 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1937 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1938 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1939 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1940 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1941 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1942 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1943 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1944 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1945 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1946 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1947 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Average | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

Prairie Dog Creek

| Year | Private Depletions: Irrig. Above Norton | Private Depletions: Irrig. Below Norton | Private Depletions: Ponds | Total Private Depletions | Bureau Planned Depletions: Amount Diverted | Bureau Planned Depletions: Return Flow | Bureau Planned Depletions: Depletion for Irrig. | Bureau Planned Depletions: Evap. from Res. | Total Depletion on Prairie Dog. Cr. |
|---|---|---|---|---|---|---|---|---|---|
| 1929 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1930 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1931 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1932 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1933 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1934 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1935 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1936 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1937 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1938 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1939 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1940 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1941 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1942 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1943 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1944 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1945 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1946 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1947 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Average | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| % of Total | | | | | | | | [illegible] | |
| Depl. in acre-ft. per acre | | | | | | | | [illegible] | |

Depletions for Division

| Year | Private: Irrigation [illegible] Ac. | Private: Ponds | Bureau: Irrigation [illegible] Ac. | Bureau: Res. Evap. | Total Depletions |
|---|---|---|---|---|---|
| 1929 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1930 | [illegible] | [illegible] | [illegible] | [illegible] | 17.0 |
| 1931 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1932 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1933 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1934 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1935 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1936 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1937 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1938 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1939 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1940 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1941 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1942 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1943 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1944 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1945 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1946 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1947 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Average | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| % of Total | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Depl. in acre-ft. per acre | [illegible] | - | [illegible] | - | - |

304.0
11
or
27.6

Table 163. Summary of Annual Depletions from Future Development of the Bostwick Division
1,000 Acre-feet

| | Franklin Unit | | | [illegible] Unit | | | Superior-Courtland Unit: Superior Canal | | | Superior-Courtland Unit: Courtland Canal | | | | | | [illegible] Unit | | | [illegible] Unit | | | Evaporation | | Total | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Irrig. Demand | Return Flow | Depletion For Unit | Irrig. Demand | Return Flow | Depletion For Unit | Irrig. Demand | Return Flow | Depletion | Deb. | Demand Above Lovewell | Demand Below Lovewell | Total | Return Flow | Depletion | Irrig. Demand | Return Flow | Depletion | Irrig. Demand | Return Flow | Depletion | Harlan County Res. | Lovewell Res. | Depletion for Bureau Irrigation | Depletion for Private Development | Depletion for Basin Division |
| 1929 | 40.2 | 17.2 | 23.0 | 3.2 | 1.2 | 2.0 | 15.9 | 8.8 | 6.5 | 6.3 | 32.5 | 44.1 | 77.8 | 28.7 | 49.1 | 16.6 | 6.1 | 10.5 | 19.7 | 7.5 | 12.2 | 20.7 | 2.6 | 106.4 | 2.7 | 137.4 |
| 1930 | 32.7 | 14.9 | 17.8 | 2.7 | 1.2 | 1.5 | 13.6 | 5.8 | 7.2 | 5.2 | 20.3 | 46.0 | 71.1 | 28.3 | 46.2 | 15.8 | 6.9 | 9.6 | 20.0 | 7.4 | 12.6 | 13.0 | 5.9 | 95.7 | 2.2 | 118.8 |
| 1931 | 32.0 | 14.2 | 18.8 | 2.7 | 1.0 | 1.7 | 15.9 | 6.3 | 9.6 | 6.7 | 26.0 | 62.1 | 88.2 | 33.7 | 52.6 | 17.3 | 6.6 | 10.9 | 16.6 | 6.5 | 10.1 | 28.7 | 4.5 | 104.8 | 4.1 | 140.1 |
| 1932 | 40.0 | 16.2 | 26.8 | 3.8 | 1.1 | 2.2 | 15.0 | 5.6 | 9.4 | 2.7 | 24.2 | 63.3 | 86.1 | 30.5 | 58.6 | 10.6 | 4.6 | 6.0 | 10.8 | 4.2 | 6.7 | 27.0 | 4.7 | 104.5 | 2.9 | 138.1 |
| 1933 | 36.6 | 22.7 | 31.7 | 6.6 | 1.7 | 2.7 | 22.0 | 8.6 | 15.4 | 8.2 | 30.1 | 78.3 | 118.2 | 39.6 | 75.6 | 22.4 | 7.7 | 14.7 | 30.6 | 11.7 | 18.9 | 21.6 | 2.6 | 138.6 | 3.8 | 180.0 |
| 1934 | 60.6 | 20.3 | 30.8 | 5.2 | 2.1 | 3.2 | 30.7 | 15.0 | 15.7 | 12.3 | 60.6 | 105.0 | 161.4 | 56.6 | 105.0 | 35.9 | 11.7 | 22.2 | 42.6 | 16.2 | 30.2 | 37.6 | 3.6 | 213.0 | 4.7 | 260.0 |
| 1935 | 32.9 | 17.0 | 15.9 | 2.7 | 1.2 | 1.8 | 15.2 | 7.5 | 8.3 | 6.8 | 24.7 | 56.4 | 85.9 | 38.2 | 48.7 | 12.3 | 7.8 | 5.8 | 15.7 | 6.8 | 8.7 | 27.1 | 2.7 | 82.8 | 2.8 | 138.0 |
| 1936 | 55.2 | 23.2 | 32.0 | 4.6 | 1.8 | 3.0 | 22.8 | 8.8 | 13.7 | 9.6 | 33.5 | 78.8 | 117.1 | 40.2 | 78.9 | 23.2 | 8.1 | 16.1 | 30.6 | 14.6 | 22.0 | 37.2 | 4.5 | 165.6 | 3.8 | 210.2 |
| 1937 | 48.7 | 20.3 | 28.0 | 3.7 | 1.6 | 2.3 | 15.7 | 7.6 | 9.2 | 7.0 | 28.2 | 86.0 | 88.3 | 34.2 | 56.1 | 14.2 | 6.0 | 8.2 | 28.2 | 10.6 | 17.6 | 29.1 | 0.9 | 114.2 | 3.1 | 149.3 |
| 1938 | 41.9 | 18.6 | 23.6 | 3.6 | 1.3 | 2.1 | 16.6 | 8.1 | 8.3 | 6.0 | 21.7 | 47.3 | 73.0 | 29.2 | 47.6 | 14.7 | 9.6 | 9.1 | 28.3 | 10.3 | 16.6 | 34.3 | 1.1 | 107.1 | 2.9 | 148.6 |
| 1939 | 48.6 | 20.6 | 27.9 | 3.9 | 1.5 | 2.4 | 22.0 | 8.3 | 13.3 | 9.1 | 28.3 | 78.3 | 112.3 | 39.2 | 70.1 | 20.7 | 7.2 | 12.6 | 30.8 | 11.8 | 19.0 | 43.3 | 2.0 | 152.2 | 2.8 | 203.9 |
| 1940 | 46.9 | 20.3 | 26.6 | 3.3 | 1.6 | 2.5 | 20.7 | 8.3 | 11.9 | 8.3 | 22.1 | 50.5 | 108.2 | 59.7 | 66.6 | 18.1 | 5.6 | 0.5 | 35.7 | 12.6 | 22.1 | 21.7 | 0.6 | 140.7 | 3.2 | 194.2 |
| 1941 | 16.8 | 8.9 | 6.7 | 1.2 | 0.8 | 0.6 | 10.1 | 3.0 | 0.1 | 6.2 | 15.2 | 33.6 | 42.9 | 13.0 | 19.8 | 3.4 | 4.1 | 3.3 | 16.4 | 6.8 | 10.1 | 11.1 | 2.1 | 36.4 | 1.0 | 70.4 |
| 1942 | 18.3 | 7.5 | 10.8 | 1.4 | 0.5 | 0.6 | 3.6 | 2.8 | 3.0 | 2.4 | 5.7 | 19.2 | 30.5 | 12.6 | 17.8 | 0 | 0.7 | -0.7 | 7.7 | 2.9 | 4.8 | 23.5 | 2.6 | 38.6 | 1.2 | 63.4 |
| 1943 | 46.6 | 16.6 | 36.2 | 3.2 | 1.0 | 2.5 | 17.8 | 6.4 | 11.4 | 7.4 | 27.0 | 89.6 | 96.0 | 30.0 | 64.0 | 16.5 | 5.1 | 11.6 | 31.7 | 8.2 | 13.4 | 36.2 | 2.8 | 135.9 | 3.0 | 191.0 |
| 1944 | 21.0 | 10.8 | 10.2 | 1.7 | 1.0 | 0.7 | 5.6 | 2.1 | 3.0 | 2.1 | 7.8 | 16.0 | 26.5 | 16.7 | 11.2 | 7.5 | 2.0 | 0.5 | 5.1 | 1.2 | 1.3 | 20.6 | 1.7 | 27.1 | 1.6 | 50.9 |
| 1945 | 30.1 | 10.7 | 14.6 | 2.0 | 0.6 | 1.2 | 6.1 | 3.8 | 6.9 | 2.6 | 12.2 | 28.9 | 42.9 | 16.2 | 28.6 | 5.3 | 2.0 | 6.8 | 16.3 | 5.2 | 8.6 | 27.4 | 2.6 | 62.1 | 1.7 | 94.5 |
| 1946 | 29.8 | 12.3 | 17.2 | 2.6 | 0.8 | 1.6 | 18.2 | 5.1 | 13.0 | 5.0 | 21.0 | 67.1 | 74.2 | 26.7 | 49.6 | 13.0 | 4.6 | 8.6 | 21.7 | 8.1 | 13.6 | 16.7 | 2.0 | 101.6 | 2.1 | 133.2 |
| 1947 | 28.1 | 9.2 | 18.8 | 2.0 | 0.5 | 1.6 | 15.2 | 6.0 | 10.3 | 6.4 | 13.2 | 61.8 | 60.9 | 22.8 | 38.1 | 8.7 | 6.0 | 2.7 | 29.9 | 9.9 | 16.0 | 26.7 | 2.6 | 106.4 | 2.1 | 138.6 |
| Total | 712.6 | 309.9 | 418.7 | 57.2 | 22.2 | 36.2 | 306.7 | 123.2 | 179.9 | 106.1 | 456.9 | 1,068.8 | 1,886.9 | 670.2 | 1,016.7 | 278.5 | 107.2 | 168.4 | 422.0 | 161.7 | 261.3 | 538.2 | 53.8 | 2,069.2 | 48.9 | 2,709.9 |
| Avg. | 37.6 | 16.1 | 21.6 | 3.1 | 1.2 | 1.8 | 16.0 | 6.3 | 9.3 | 5.6 | 24.0 | 52.6 | 63.2 | 30.0 | 53.2 | 14.6 | 5.7 | 8.8 | 22.2 | 8.5 | 13.7 | 28.2 | 2.8 | 108.7 | 2.6 | 142.3 |
| | | | | | | | | | | | | | | | | | | | | | % of Total | 19.2 | 2.0 | 76.6 | 1.8 | 100.0 |
| | | | | | | | | | | | | | | | | | | | | | Depl. in Ac-ft. per Ac. | - | - | 1.19 | 1.00 | - |

1853.4
11
= 168.2

Table 163

Table 164. Reservoir storage capacities for Reservoirs in Kanaska and Bostwick Divisions

| Reservoir | Storage in acre-feet | | | | |
|---|---|---|---|---|---|
| | Conservation or Dead at end of first 50 years | 50-years Sediment | Active irrigation at end of first 50 years | Flood Control | Total |
| Beaver City | 0 | 9,000 | 11,700 | 20,000 | 40,700 |
| Oberlin | 0 | 8,000 | 14,800 | 20,000 | 42,800 |
| Norton | 0 | 9,000 | 20,000 | 20,000 | 49,000 |
| Harlan County a/ | 75,000 | 100,000 | 175,000 | 500,000 | 850,000 |
| Lovewell | 2,000 | 8,000 | 34,000 | 39,000 b/ | 83,000 |

a/ Being constructed by Corps of Engineers

b/ Corps of Engineers tentative allocation

Table 165.--Potential Project Lands in the Kanaska and Bostwick Divisions

| Unit | Colorado New Lands | Colorado Presently Irrigated | Kansas New Lands | Kansas Presently Irrigated | Nebraska New Lands | Nebraska Presently Irrigated | Total New Lands | Total Presently Irrigated | Total to be Irrigated |
|---|---|---|---|---|---|---|---|---|---|
| Beaver City | 0 | 0 | 0 | 0 | 1,200 | 0 | 1,200 | 0 | 1,200 |
| Oberlin | 0 | 0 | 1,500 | 0 | 0 | 0 | 1,500 | 0 | 1,500 |
| Almena | 0 | 0 | 5,000 | 0 | 0 | 0 | 5,000 | 0 | 5,000 |
| Franklin Unit | | | | | | | | | |
| Franklin Canal | 0 | 0 | 0 | 0 | 12,400 | 0 | 12,400 | 0 | 12,400 |
| Naponee Canal | 0 | 0 | 0 | 0 | 1,360 | 0 | 1,360 | | 1,360 |
| Franklin So. Side Canal | | | | | 2,090 | 0 | 2,090 | | 2,090 |
| Total | | | | | 15,850 | | 15,850 | | 15,850 |
| Red Cloud | 0 | 0 | 0 | 0 | 1,480 | | 1,480 | 0 | 1,480 |
| Superior-Courtland Unit | | | | | | | | | |
| Superior Canal | 0 | 0 | 0 | 0 | 7,400 | 0 | 7,400 | 0 | 7,400 |
| Courtland Canal | 0 | 0 | 12,870 | 0 | 3,560 | 0 | 16,430 | 0 | 16,430 |
| Total | | | 12,870 | | 10,960 | | 23,830 | | 23,830 |
| Republic | | | | | | | | | |
| East Side Canal | 0 | 0 | 7,650 | | 0 | 0 | 7,650 | 0 | 7,650 |
| West Side Canal | 0 | 0 | 1,500 | | | | 1,500 | | 1,500 |
| Total | | | 9,150 | | | | 9,150 | | 9,150 |
| Scandia | | | | | | | | | |
| East Side Canal | 0 | 0 | 12,700 | | 0 | 0 | 12,700 | 0 | 12,700 |
| Courtland Canal below Lovewell | 0 | 0 | 28,280 | 0 | 0 | 0 | 28,280 | | 28,280 |

Table 166

Water Rights for features planned to be used by Bureau of Reclamation for Irrigation development in the Republican River Basin 1/

| Source | Agency Filing | Post Office | Carrier | Use to which applied | Provisional Grant c.f.s. | Location of Diversion or Dam S | T | R | County | Date of Priority Mo. | Day | Year | Dec. No. | Applic. No. | Unit in which right is to be used |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Buffalo Creek | So. Rep. Irrig. Dist. | McCook | Buffalo Creek Canal | Irrigation | | 20 | 1 | 40 | Dundy | Jan. | 22 | 1946 | | 3846c 3/ | Benkelman |
| Frenchman River | Green, Jas. S. et. al. | Culbertson | Farmers Canal | Irrigation | 11.00 5/ | 11 | 3 | 32 | Hitchcock | Dec. | 13 | 1893 | 19 | | Frenchman |
| Frenchman River | Riverside Irrig. Co. | Culbertson | Riverside Canal | Irrigation | 12.01 5/ | 33 | 4 | 32 | Hitchcock | July | 28 | 1894 | 16 | | Frenchman |
| Frenchman River | Riverside Ditch Co. | Culbertson | Riverside Canal | Irrigation | 2.90 5/ | 33 | 4 | 32 | Hitchcock | July | 5 | 1922 | | 1674 | Frenchman |
| Frenchman River | Frenchman-Cambridge Irrig. Dist. | McCook | Farmers Canal | Irrigation | - | 34 | 4 | 32 | Hitchcock | Jan. | 22 | 1946 | | 3849a | Frenchman |
| Frenchman River | Frenchman-Cambridge Irrig. Dist. | McCook | Riverside Canal | Irrigation | - | 34 | 4 | 32 | Hitchcock | Apr. | 3 | 1946 | | 3887a | Frenchman |
| Frenchman River | Frenchman-Cambridge Irrig. Dist. | McCook | Farmers Canal | Irrigation | - | 34 | 4 | 32 | Hitchcock | Apr. | 3 | 1946 | | 3887b | Frenchman |
| Frenchman River | U. S. of America | Denver, Colo. | Enders Reservoir | Storage | 44,089 A.F. | 4-5 | 5 | 37 | Chase | May | 1 | 1946 | | 3899 | Frenchman |
| Medicine Creek | U. S. of America | Denver, Colo. | Medicine Creek Reserv. | Storage | 40,000 A.F. | 28 | 5 | 26 | Frontier | May | 1 | 1946 | | 3900 | Cambridge |
| | | | | | | 24 | 5 | 26 | Frontier | May | 1 | 1946 | | 3900 | Cambridge |
| Rep. Riv. No. F. | So. Rep. Irrig. Dist. | McCook | Upper Haigler Canal | Irrigation | - | 13 | 1 | 42 | Dundy | Jan. | 22 | 1946 | | 3846a 3/ | So. Republican |
| Rock Creek | So. Rep. Irrig. Dist. | McCook | Rock Creek Canal | Irrigation | - | 21 | 1 | 38 | Dundy | Jan. | 22 | 1946 | | 3846d 3/ | Benkelman |
| Rep. River So. F. | Roscoe Hutton & Others | Hale, Colo. | Hale Ditch | Irrigation | 23.[illegible] | 21 | 5 | 43 | Yuma, Colo | Jan. | 17 | 1906 | | | St. Francis |
| Rep. River So. F. | Roscoe Hutton & Others | Hale, Colo. | Hale Ditch | Irrigation | 3.0 | 21 | 4 | 43 | Yuma, Colo | May | 17 | 1908 | | | St. Francis |
| Rep. River So. F. | Roscoe Hutton & Others | Hale, Colo. | Hale Ditch | Irrigation | 8.5 | 21 | 4 | 43 | Yuma, Colo | Nov. | 20 | 1932 | | | St. Francis |
| Republican River | Pioneer Irrig. Co. | Haigler | Haigler Canal | Irrigation | 24.39 | 2 | 1 | 43 | Yuma, Colo. | Apr. | 4 | 1890 | 1025 | | So. Republican |
| Republican River | Pioneer Irrig. Dist. | Haigler | Haigler Canal | Irrigation | 40.00 4/ | 2 | 1 | 43 | Yuma, Colo. | Apr. | 4 | 1890 | 1025 | | So. Republican |
| Republican River | Ferguson and Company | Lincoln | Meeker Canal | Irrigation | 143.00 5/ | 15 | 3 | 31 | Hitchcock | Dec. | 22 | 1890 | 4-9 5-7 | | Meeker-Driftwood |
| Republican River | Pringle, Geo. E. | Parks | Parks Canal | Irrigation | 15.00 | 20 | 1 | 39 | Dundy | June | 18 | 1912 | | 1202 | Benkelman |
| Republican River | Pringle, Geo. E. | Parks | Parks Canal | Irrigation | 2.00 | 20 | 1 | 39 | Dundy | Dec. | 31 | 1915 | | 1444 | Benkelman |
| Republican River | Pringle, Geo. E. | Parks | Parks Canal | Irrigation | 1.14 | 20 | 1 | 39 | Dundy | Sept. | 5 | 1919 | | 1545 | Benkelman |
| Republican River | So. Rep. Irrig. Dist | McCook | Lower Haigler Canal | Irrigation | - | 21 | 1 | 40 | Dundy | Jan. | 22 | 1946 | | 3868b 3/ | So. Republican |
| Republican River | So. Rep. Irrig. Dist | McCook | Benkelman Canal | Irrigation | - | 24 | 1 | 38 | Dundy | Jan. | 22 | 1946 | | 3868a 3/ | Benkelman |
| Republican River | Frenchman-Cambridge Irrig. Dist | McCook | Meeker Canal | Irrigation | - | 15 | 3 | 31 | Hitchcock | Jan. | 22 | 1946 | | 3869b | Meeker-Driftwood |
| Republican River | Frenchman-Cambridge Irrig. Dist | McCook | No. Red Willow Canal | Irrigation | - | 16 | 3 | 28 | Red Willow | Jan. | 22 | 1946 | | 3869c | Red Willow |
| Republican River | Frenchman-Cambridge Irrig. Dist | McCook | So. Red Willow Canal | Irrigation | - | 16 | 3 | 28 | Red Willow | Jan. | 22 | 1946 | | 3869d | Red Willow |
| Republican River | Frenchman-Cambridge Irrig. Dist | McCook | Camb-Oxford-Orleans Canal | Irrigation | - | 27 | 4 | 25 | Furnas | Jan. | 22 | 1946 | | 3869e | Cambridge |
| Republican River | Frenchman-Cambridge Irrig. Dist | McCook | Meeker Canal | Irrigation | - | 15 | 3 | 31 | Hitchcock | Apr. | 3 | 1946 | | 3887c | Meeker-Driftwood |
| Republican River | United States of America | Denver, Colo. | Harlan County Reserv. | Storage | 850,000 A.F. | 2 | 1 | 17 | Harlan | Jan. | 26 | 1948 | | 4190 | Bostwick Division |
| Republican River | Bostwick Irrig. Dist | Red Cloud | Franklin Canal | Irrigation | - | 11 | 1 | 17 | Harlan | Feb. | 26 | 1948 | | 4216 3/ | Franklin |
| Republican River | Bostwick Irrig. Dist. | Red Cloud | Superior Canal | Irrigation | - | 14 | 1 | 17 | Harlan | Feb. | 26 | 1948 | | 4217 3/ | Franklin |
| Republican River | Bostwick Irrig. Dist. | Red Cloud | Red Cloud No. 1 Pump Cn. | Irrigation | - | 1 | 1 | 12 | Webster | Feb. | 26 | 1948 | | 4218 3/ | Red Cloud |
| Republican River | Bostwick Irrig. Dist. | Red Cloud | Red Cloud No. 2 Pump Cn. | Irrigation | - | 2 | 1 | 12 | Webster | Feb. | 26 | 1948 | | 4219 3/ | Red Cloud |
| Republican River | Bostwick Irrig. Dist. | Red Cloud | Red Cloud No. 3 Pump Cn. | Irrigation | - | 6 | 1 | 11 | Webster | Feb. | 26 | 1948 | | 4220 3/ | Red Cloud |
| Republican River | Bostwick Irrig. Dist. | Red Cloud | Superior Canal | Irrigation | - | 7 | 1 | 9 | Webster | Feb. | 26 | 1948 | | 4221 3/ | Sup.-Ctland |
| Republican River | Bostwick Irrig. Dist. | Red Cloud | Courtland Canal | Irrigation | - | 7 | 1 | 9 | Webster | Feb. | 26 | 1948 | | 4222 3/ | Sup.-Ctland |
| Republican River | Bostwick Irrig. Dist. | Red Cloud | Franklin Canal | Irrigation | - | 6 | 1 | 14 | Franklin | Feb. | 26 | 1948 | | 4227 3/ | Franklin |

1/ Data taken from the (1947-1948) Biennial Report of the Nebraska Department of Roads and Irrigation, Bureau of Irrigation, Water Power, and Drainage except when indicated otherwise.
2/ [illegible] second-feet for Nebraska and [illegible] second-feet for Colorado.
3/ Denotes application Pending, or Claim not adjudicated.
4/ From records of 1938 adjudication procedure - filed at courthouse at Burlington, Colorado.
5/ Part of appropriation subject to cancellation because of non-use.

## Effects of Division Development

This table shows that the priorities were essentially established in two blocks with the priorities of the Frenchman-Cambridge Division senior to the Bostwick Division and to Harlan County Reservoir. No filings are listed for Swanson Lake and Red Willow Reservoir in table 166 because appropriations for the storage of irrigation water have not yet been requested for these two reservoirs, hence they will have priorities junior to the priority of the Harlan County Reservoir.

The storage of water in Enders and Medicine Creek Reservoirs and the diversion of natural flow by the canals of the Frenchman-Cambridge Division as presented in this report were made in strict compliance with priorities shown in table 166.

Swanson Lake and Red Willow Reservoir were operated in this study without regard to the senior appropriation of Harlan County Reservoir. These operation studies prove that storage of water could be made in these reservoirs without violating priority laws in all years of the operation study, 1929-1947, except 1940. Shortages occurred at the Harlan County Reservoir during 1934 and 1940. However, in June of 1934 the Harlan County Reservoir spilled, therefore the water stored in Swanson Lake and Red Willow Reservoir that year could not be classed as Harlan County Reservoir water. The plan of operation of the reservoirs in the Republican River Basin requires that water will be stored first in upstream reservoirs and released to share shortages in downstream reservoirs as required. The capacity of Swanson Lake was designed with excess capacity to regulate surplus waters. The Bureau of Reclamation's plan of operation is based upon the concept that the Federal Government will retain control of the stored water to the extent that such storage can be administered to supplement natural flow so that all areas will share the supply. Following this plan of operation with all upstream reservoirs storing all of the water reaching those reservoirs, a shortage of 52,400 acre-feet occurred in the year 1940 for the Harlan County Reservoir and the land of the Bostwick Irrigation District. During the 1939-40 storage season 33,200 acre-feet of water was stored in Swanson Lake and 5,400 acre-feet of water was stored in Red Willow Reservoir which might have been identified as belonging to Harlan County Reservoir because of its higher priority. This water released from these 2 reservoirs would have reduced the shortage for the Bostwick Division lands from 10.8 to 2.8 percent of the consumptive use requirement, and would have only increased the shortage for the Meeker-Driftwood and Red Willow Project lands to 18.3 and 16.4 percent respectively for these two areas. These shortages would still have been within the tolerable limits. Following the rule of sharing shortages, the shortage for all lands in the 3 areas would have been approximately 5 percent of the consumptive use requirement.

The irrigation storage space in Red Willow Reservoir and Swanson Lake was designed to irrigate Nebraska lands with water allocated to Nebraska by the terms of the Republican River Compact. The plan for development provides sufficient storage in Nebraska to irrigate all of the irrigable land in the valley floor of the Republican River plus a considerable area of table land, however the plan has not provided sufficient storage space or land to use all of the water allocated to Nebraska under the terms of the compact. The development has been restricted due to economic reasons.

Nebraska irrigation laws require that secondary appropriation be filed for the use of storage water from reservoirs and the lands on which the water will be used must be specified. These secondary filings have not been made to date, however, in this report the reservoirs were operated on the basis that the appropriations for the use of storage will be made to use the water from any one reservoir on the lands of just one unit.

The maximum utilization of the reservoir storage capacity for irrigation purposes in the Republican River system to meet irrigation shortages where they exist requires that some flexibility be permitted in the use of storage water.

Secondary use filings for storage water, in accordance with Nebraska irrigation law, will be made for each of the reservoirs which will permit the flexibility in the use of storage water to share shortages.

During the first 50 years of operation there will actually be extra storage space which will not have been assigned for irrigation use. The space reserved in each reservoir for sediment will be usable until such space is filled with sediment. The priorities for the canal systems do not need to be changed for the situation is preferable as it exists. The senior priorities for use of natural flow by canal systems should remain in the upstream area, for the diversion of natural flow waters will permit the greatest reuse and provide the greatest amount of return flow thus having a tendency to stabilize the flow of the Republican River.

The annual shortages experienced by the reservoirs in the Republican River drainage as taken from the operation studies for these reservoirs are shown in table 167. This table shows that at times downstream reservoirs were experiencing shortages, while upstream reservoirs had only minor shortages. The greatest use of water would be made if all the reservoirs were to be used to adjust or meet shortages where they exist. Some of the water which was shown to have spilled would have been made usable. Table 168 lists the spills which occurred in reservoirs of the Republican River drainage when the units are operated independently. Small amounts of this spilled water could be made available for irrigation through an integrated scheme of operation. Such a scheme of operation has not been included in this report. Integrated operation would not make it possible to irrigate any more land or to change the balance of acreage as shown for the plans of operation which are proposed. The principal benefit to be obtained from integrated operation would be to adjust the shortages so that some shortages for the over-all scheme would be reduced and the severity of shortage for any one area would be minimized.

Table 167. Shortages occurring for Reservoirs in Republican River Drainage Area when units are operated independently (1929-1947). (Shortages indicated in 1,000 acre-feet and percent of consumptive use.)

| YEAR | RESERVOIR | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Upper Republican Division | | | | | | | | Frenchman-Cambridge Division | | | | | | | | | | Kanaska Division | | | | | | | | Bostwick Division | |
| | Pioneer | | Wray-Haigler | | Parks | | Bonny | | Enders | | Swanson Lake | | Red Willow | | Medicine Creek | | Beaver City | | Oberlin | | Norton | | | | | | Harlan County and Lovewell | |
| | A.F. | % | A.F. | % | A.F. | % | A.F. | % | A.F. | % | A.F. | % | A.F. | % | A.F. | % | A.F. | % | A.F. | % | A.F. | % | | | | | A.F. | % |
| 1931 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.7 | 4.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 | 0 |
| 1934 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9.1 | 7.9 | 0 | 0 | 8.3 | 13.6 | 0 | 0 | 0 | 0 | 3.3 | 42.1 | 10.2 | 36.4 | | | | | 54.1 | 10.4 a/ |
| 1935 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.7 | 9.8 | 1.3 | 5.1 | | | | | 1.2 | .1 |
| 1936 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14.8 | 13.3 | 0 | 0 | 5.8 | 10.1 | 0 | 0 | 0 | 0 | 0.1 | 1.4 | 0 | 0 | | | | | 0 | 0 |
| 1937 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11.4 | 10.7 | 0 | 0 | 3.3 | 5.8 | 0 | 0 | 0 | 0 | 1.3 | 29.1 | 1.9 | 7.2 | | | | | 0 | 0 |
| 1938 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .4 | .7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 | 0 |
| 1939 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12.3 | 11.2 | 0 | 0 | 5.5 | 9.6 | 0 | 0 | 0 | 0 | 2.9 | 38.9 | 3.6 | 13.5 | | | | | 0 | 0 |
| 1940 | 0 | 0 | 0 | 0 | 1.8 | 6.6 | 0 | 0 | 0 | 0 | 0 | 0 b/ | 4.2 | 7.2 c/ | 0 | 0 | 0 | 0 | 2.1 | 28.5 | 5.3 | 20.1 | | | | | 52.4 | 10.8 d/ |
| 1943 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.4 | 6.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | 0 | 0 |

a/ No demand could be made on upstream reservoirs for additional water.

b/ If water stored out of priority were released to the Harlan County Reservoir, it would cause a consumptive use requirement shortage of 14,300 acre-feet or 18.3 percent on the lands served by Swanson Lake.

c/ If water stored out of priority were released to the Harlan County Reservoir, it would cause a consumptive use requirement shortage of 9,600 acre-feet or 16.4 percent on the lands served by Red Willow Reservoir.

d/ If water stored out of priority in Swanson Lake and Red Willow Res. were released and used in the Bostwick Division, the consumptive use requirement shortage would have been 13,800 acre-feet or 2.8 percent.

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Table 168. Spills occurring in Reservoirs of Republican River Drainage Area when units are operated independently (1929-1947).

(1000 acre-feet)

| YEAR | Upper Republican Division | | | Frenchman-Cambridge Division | | | | Kanaska Division | | | Bostwick Division | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wray | Parks | Bonny | Enders | Swanson Lake | Red Willow | Medicine Creek | Beaver City | Oberlin | Norton | Harlan County | Lovewell |
| 1929 | 8.2 | 7.5 | 11.5 | 21.0 | 58.0 | 6.5 | 22.0 | 14.8 | 1.8 | 8.2 | 238.0 | 12.1 |
| 1930 | 10.5 | 12.5 | 12.0 | 23.6 | 71.9 | 0.4 | 45.2 | 19.9 | 6.3 | 15.9 | 268.4 | 0.3 |
| 1931 | 4.5 | 7.6 | 11.4 | 27.5 | 45.7 | 5.1 | 23.1 | 7.1 | 2.6 | 2.7 | 202.3 | 3.2 |
| 1932 | 8.5 | 3.2 | 1.8 | 13.9 | 3.0 | 0 | 15.3 | 2.3 | 0 | 4.1 | 67.6 | 0 |
| 1933 | 8.3 | 10.7 | 12.4 | 6.7 | 88.9 | 0 | 17.5 | .9 | 0 | 0 | 34.7 | 0 |
| 1934 | 4.4 | 4.7 | 7.8 | 15.9 | 34.0 | 0 | 14.2 | 0 | 0 | 0 | 57.3 | 1.5 |
| 1935 | 6.2 | 1.1 | 115.8 | 12.8 | 393.7 | 0 | 42.1 | 6.8 | 0 | 0 | 438.8 | 6.8 |
| 1936 | 6.4 | 8.1 | 12.1 | 15.7 | 77.0 | 0 | 19.5 | 5.1 | 0 | 0 | 164.0 | 1.7 |
| 1937 | 3.6 | 0 | 0 | 0 | 0 | 0 | 6.7 | 0 | 0 | 0 | 0 | 0 |
| 1938 | 8.7 | 6.0 | 9.7 | 4.1 | 32.0 | 0 | 30.2 | 3.8 | 0 | 0 | 0 | 0 |
| 1939 | 4.5 | 3.7 | 5.3 | 4.9 | 51.1 | 0 | 24.5 | 1.3 | 0 | 0 | 80.6 | 0 |
| 1940 | 1.5 | 0 | 0 | 2.5 | 0 | 0 | 26.7 | 0 | 0 | 0 | 0 | 0 |
| 1941 | 9.8 | 6.0 | 2.7 | 20.7 | 99.0 | 0.8 | 82.7 | 19.2 | 4.4 | 37.9 | 353.0 | 25.5 |
| 1942 | 8.7 | 8.8 | 25.4 | 32.1 | 135.5 | 16.4 | 57.8 | 30.8 | 6.3 | 25.8 | 540.5 | 19.6 |
| 1943 | 4.9 | 5.4 | 8.4 | 13.4 | 30.3 | 3.6 | 19.7 | 2.5 | 0 | 1.6 | 167.3 | 29.7 |
| 1944 | 4.5 | 1.3 | 4.7 | 13.0 | 63.5 | 13.9 | 57.0 | 33.1 | 31.4 | 27.8 | 360.1 | 12.1 |
| 1945 | 7.3 | 1.4 | 6.5 | 22.1 | 32.2 | 12.1 | 39.3 | 6.6 | 0 | 1.0 | 245.2 | 70.5 |
| 1946 | 5.2 | 3.4 | 10.0 | 21.4 | 64.1 | 11.4 | 46.1 | 22.4 | 13.4 | 19.6 | 378.2 | 34.4 |
| a/1947 | 7.1 | 3.9 | 16.0 | 33.1 | 106.5 | 17.7 | 87.6 | 26.1 | 5.1 | 28.0 | 593.4 | 36.6 |
| Average | 6.5 | 5.0 | 14.4 | 16.2 | 73.0 | 3.9 | 36.1 | 10.7 | 3.8 | 9.2 | 199.8 | 12.1 |

a/ Jan.-Sept.

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Table 168

## Effects of Division Development

The change in the delivery of storage water to share shortages, which might be affected through an integrated scheme of operation of the reservoirs would not effect the delivery of natural flow that was assumed in these studies.

The studies herein included demonstrate that an adequate supply of water is available to develop the Meeker-Driftwood Unit of the Frenchman-Cambridge Division. It has been determined in a separate study that the storage space in Swanson Lake and Enders Reservoir, originally allocated for sediment may be too large and may be usable to offset the sedimentation of irrigation space in Medicine Creek Reservoir. During this initial period of operation there is also available for storage the space in Swanson Lake and Enders and Harlan County Reservoirs which has been allocated for sedimentation which will be usable to store water to meet irrigation demands. This amounts to 107,800 acre-feet in Harlan County Reservoir, 7,000 acre-feet in Enders Reservoir, and 59,300 acre-feet in Swanson Lake, of space which has not been used in the studies to meet irrigation demands. This storage space will be usable to aid in meeting irrigation requirements during the period that return flows from the irrigated lands would be developing.

In view of these facts the construction of canals and distribution systems in the Frenchman-Cambridge Division should be completed as soon as possible. The sedimentation rate of some of the reservoirs in the Republican Drainage is high, therefore the canal distribution systems to acquire storage water should be ready to divert it as soon as the reservoirs are completed if the maximum use is to be made of the storage capacity provided.

## Sedimentation of Reservoirs

Engineering studies are now being made to increase our knowledge regarding the probable sedimentation of the reservoirs in the Kansas River Basin and to improve our estimates of the sedimentation which will take place in the proposed reservoirs. These studies are not yet final and are not included with this Appendix. The results of their findings will appear in a separate sedimentation appendix to the Kansas River Basin Report which will be submitted at a later date. Studies accomplished up to the present time indicate some disagreement with the original estimates of sedimentation in the reservoirs proposed for use by the Frenchman-Cambridge Division. Results of these studies will have to be borne out by additional information and definite answers will not be available until the report is submitted. However, these studies do indicate that a considerable greater quantity of sediment will be deposited in the Medicine Creek Reservoir than was originally indicated. According to these recent estimates irrigation space in the Medicine Creek Reservoir may be completely filled at the end of the fifty-year period. If the indications of these studies are borne out, adjustments will be necessary in the allocations of space for the various uses in the reservoir.

## Effects of Division Development

The field working agreement between the Bureau of Reclamation and the Corps of Engineers regarding the operation of the Medicine Creek Dam and Reservoir provides that "the District Manager shall at reasonable intervals make necessary field surveys and office studies to prepare estimates of the volume and location of sediment deposits in the reservoir. If the results of these studies show that the storage available for flood control and irrigation is reduced by an amount exceeding 10 percent of allocation for either purpose, the operating agreement plan described herein with respect to the elevation limits of storage allocations shall be reviewed with the view of equitable distribution loss of reservoir capacity between the primary reservoir uses."

While the present studies indicate more sediment for the Medicine Creek Reservoir than the original estimates, the present study shows less sediment will be deposited in Swanson Lake and Enders Reservoir than originally estimated. According to the most recent study, 50,000 acre-feet of sediment will be deposited in Swanson Lake after 50 years as compared with the original estimate of 64,000 acre-feet. For the Enders Reservoir the new estimate indicates 2,000 acre-feet of sediment will be deposited at the end of 50 years as compared with the original estimate of 10,000 acre-feet. These two reservoirs are upstream from the Cambridge Canal lands which are shown in this study to be served from the Medicine Creek Reservoir. Therefore, the additional storage space in these two reservoirs could be used to offset the reduction in space due to the accumulation of sediment in the Medicine Creek Reservoir.

Studies are now under way to devise means of reducing the sediment rate of the Medicine Creek Reservoir either by retention dams upstream or by soil erosion control in the Basin above the reservoir. Such control may be obtained which will materially reduce present indicated rates of sedimentation.

## Effects of Division Development

### Republican River Compact

The drainage basin of the Republican River lies in the three state: Colorado, Kansas, and Nebraska. An agreement known as the Republican River Compact was entered into by these three states in order "..... to provide for the most efficient use of the waters of the Republican Rive Basin for multiple purposes; to provide for an equitable division of su waters; to remove all causes present and future, which might lead to co versies, should promote interstate commity; to recognize that the most efficient utilization of waters within the basin is for beneficial cons tive use;..."1/. Under this agreement specific allocations in acre-feet per acre were made to each state. These allocations were derived from computed average annual virgin water supply originating in designated drainage basin or, parts thereof, of the Republican River Drainage Basi Under terms of the compact a total of 57,400 acre-feet was allocated to Colorado, 234,500 acre-feet was allocated to Nebraska, and 190,300 acre feet was allocated to Kansas.

The plan for development of the entire Republican River Basin prov sufficient storage in Nebraska to irrigate all of the irrigable land in the valley floor of the Republican River plus a considerable area of ta land, but the plan has not provided sufficient storage space or land to use all of the water allocated to Nebraska under the terms of the compa

1/ From Article I, Republican River Compact.