

BOSTWICK
Definite Plan Report
1953

Water Supply, Flood Control & Sediment

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UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

BUREAU OF RECLAMATION
Fred G. Aandahl
Assistant Secretary - Water and Power

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

Definite Plan Report
Bostwick Division
Nebraska - Kansas

Volume 1
General Plan of Development

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

Appendix II - Water Supply
Appendix III - Flood Control
Appendix IV - Sedimentation

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Part 3 of 4

June 1953

Copy No. 6

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

Bostwick Division, Kansas River District Missouri River Basin Project

LOCATION: South Central Nebraska and North Central Kansas on the Republican River extending from Orleans, Nebraska, to Concordia, Kansas

AUTHORIZED: December 22, 1944, by Act of Congress (Public Law 534, 78th Congress, 2nd Session) Senate Document 247, 78th Congress, 2nd Session, 1944.

PLAN

The Bostwick Division is being developed along the Republican River in Nebraska and Kansas. The division plan provides for regulation of stream runoff for flood and sediment control, and for ultimate irrigation of 90,000 acres in Harlan, Franklin, Webster and Nuckolls Counties in Nebraska and Jewell, Republic and Cloud Counties in Kansas. The two major features of the plan are Harlan County Reservoir, constructed on Republican River by the Corps of Engineers, and the potential Lovewell Reservoir on White Rock Creek, a tributary to the Republican River. Lovewell Reservoir could also provide a source of supplemental water supply for three municipalities in Kansas. Complete distribution and drainage systems will enable the irrigation of 86,240 acres, of which 24,240 acres are in Nebraska and 62,000 acres are in Kansas. The supply works and major distribution works features, however, are being constructed with sufficient capacity to normally provide water for an additional 3,760 acres of potential irrigable lands in Nebraska. Project lands will be served by six main canals. Two of the canals will divert from outlets in Harlan County Dam; three will divert from two diversion dams on Republican River; and one canal, Franklin South Side, derives its water supply by a pump diversion from Republican River. No power will be developed initially in the division although provisions have been made during construction of Harlan County Dam to facilitate future installation of a power penstock. Substantial annual benefits will accrue from irrigation, flood control, fish and wildlife conservation, and recreational facilities provided by the division plan.

DEFINITE PLAN REPORTS

Vol. 1 ... General Plan of Development for Bostwick Division
Subsequent design volumes will be prepared in the order determined by construction schedules.

COSTS

\$99,010,000

Harlan County Dam and Reservoir	\$45,917,000
Lovewell Dam and Reservoir	10,450,000
Superior-Courtland Diversion Dam	1,903,000
Scandia Diversion Dam	2,880,000
Pumping Plants	470,000
Canals	22,217,000
Laterals	6,852,000
Drainage System	6,530,000
Floodway Channels (non-reimbursable) . . .	790,000
General Property (excl.coop.development) .	203,000
Farm Unit Development	81,000
Distribution Lines and Substations	223,000
Fish and Wildlife	82,000
Recreation	412,000

BENEFITS, ALLOCATIONS AND REPAYMENTAnnual Benefits

\$ 4,657,000

Flood Control:

Reservoirs	\$2,035,000
Floodway Channels	117,900 a/
Irrigation	2,368,800
Fish and Wildlife	34,400
Recreation	100,900

Allocation of Costs and Repayment

Nonreimbursable - flood control . . .	\$46,287,000
Reimbursable:	
Irrigation, recreation, fish	
and wildlife	\$52,723,000
Irrigation repayment 40-year period .	14,131,000 b/
Balance to be repaid by extension	
of repayment period or Missouri	
River Basin Project power revenues	38,592,000

BENEFIT - COST RATIO

1.5 to 1.0

a/ Net benefits after deduction of private costs.

b/ Includes cost of drains to be constructed by irrigation districts.

IRRIGATION

Classification of Irrigable Land

Units	Class 1 (acres)	Class 2 (acres)	Class 3 (acres)	Class 4h (acres)	Total (acres)
Nebraska					
Franklin-Red Cloud	3,439	8,102	3,172	888	15,601
Superior-Courtland	3,965	3,090	949	638	8,642
Subtotals (Rounded)	7,400	11,190	4,120	1,530	24,240
Kansas					
Courtland	3,147	42,438	3,415	--	49,000
Scandia	5,740	7,260	--	--	13,000
Subtotals (Rounded)	8,890	49,700	3,410	--	62,000
Totals (Rounded)	16,290	60,890	7,530	1,530	86,240

Amortization Data Bostwick Division

	Nebraska portion	Kansas portion
Payment Capacity/ac/yr	\$8.60	\$9.10
O&M & Replacements/ac/yr	3.38	2.67
Amortization Capacity/ac/yr	5.22	6.43

Number of Farm Operating Units:

Present	789
Anticipated	1,109

Growing season: 155 days at Red Cloud, Nebr., 191 days at Concordia, Kansas

Elevation of project area: msl 1,380 to 1,900 ft.

Requirements of Irrigation Water

Unit and Canal	Consumptive use requirement av.ann. ft.	Effective precipitation av. ann. ft.	Diversion requirement av. ann. ft.
Franklin-Red Cloud Unit			
Franklin	2.54	1.53	2.39
Naponee	2.54	1.53	2.39
Franklin South Side	2.54	1.53	2.39
Superior-Courtland Unit			
Superior	2.56	1.60	2.16
Courtland(Nebraska)	2.56	1.60	1.88
Courtland Unit			
Courtland (Kansas)	2.56	1.60	1.88
Scandia Unit			
Scandia	2.57	1.69	1.76

Canal Data

Canals	Length (miles)	Initial Capacity (cfs)	First water to be applied	All project lands to be irrigated
Franklin	54.0	230	April 1954	Mar. 1958
Naponee	9.6	36	Nov. 1954	Jan. 1959
Franklin South				
Side Pump	4.9	42	April 1953	Mar. 1957
Superior	33.1	139	Mar. 1953	Mar. 1959
Courtland, Nebr.	16.1	751	Jan. 1954	Mar. 1960
Courtland, Kansas, above				
Lovewell Res.	18.3	685	Oct. 1954	April 1961
Pump Area No. 1	5.0	36	----	----
North	6.2	50	----	----
Ridge	6.0	90	----	----
Courtland, Lovewell Res.				
to Courtland West	8.9	634	Jan. 1957	Jan. 1958
White Rock	7.6	50	----	----
Pump Area No. 2	6.1	42	----	----
Miller	8.4	120	----	----
Courtland, below				
Courtland West	14.8	340	Jan. 1958	Jan. 1958
Pump Area No. 3	2.3	30	----	----
Courtland West	10.2	280	April 1958	April 1959
Courtland West Ext.	15.2	120	April 1959	April 1960
Pump Area No. 4	3.5	42	----	----
Scandia	18.3	230	April 1959	April 1959

MUNICIPAL WATER

None

POWER

None

STORAGE DAMS

Location

Harlan Co. (USCE): On Republican River 12 miles west of Franklin, Nebraska

Lovewell: On White Rock Creek 3 miles northwest of Lovewell, Kansas

Type	Harlan Co. (USCE)	Lovewell
	Earth-fill	Earth-fill
Hydraulic height, feet	107	85
Volume, cu. yds.	13,400,000	2,150,000
Spillway capacity, cfs	431,000	68,400

RESERVOIRSHarlan Co. (USCE)Lovewell

Elevation at maximum controlled storage, msl	1,973.5	1,595.3
Active storage, ac-ft initial conditions	752,800	75,200
Capacity below bottom irriga- tion outlets, ac-ft, initial conditions	97,200	3,800
Storage capacities after 50 years of operation: (acre-feet)		(acre-feet)
100,000 ac-ft. sediment	8,000	ac-ft. sediment
Conservation	75,000	12,000
Irrigation	175,000	24,000
Flood control	500,000	50,000
Total	750,000	86,000

DIVERSION DAMS

Type	Superior- Courtland Concrete	Scandia Concrete
Height above old stream bed, ft.	7	10
Initial canal capacity, cfs	751 & 139	230
Design floods, cfs	42,000	70,500

PUMPING PLANTS

River Pumps:

Number of units	Franklin South Side
Type	3
Capacity, cfs (per unit)	Electric
Horsepower (per unit)	15.9
Lift, feet	44
	18.74

Courtland Canal Pumps:

	No. 1	No. 2	No. 3	No. 4
Type	Electric	Electric	Electric	Electric
Capacity (c.f.s.)	30	36	30	42
Horsepower	230	190	100 ✓	180 ✓
Total head in feet	48	32	20	26

HYDROLOGY

	Harlan Co. (USCE)	Lovewell
Net Contributing drainage area, sq. mi.	14,127	354
Average annual depleted inflow, ac-ft (1929-1947)	356,400	17,700 a/
Maximum annual depleted inflow, ac-ft	724,100	43,900
	(1935) b/	(1949)
Minimum annual depleted inflow, ac-ft	106,500	1,300
	(1940)	(Est. 1934)
Peak discharge of record, cfs	260,000	23,300
	(June 1935)	(July 1950)
Minimum discharge of record, cfs	6.8	0
	(Oct. 1937)	(Intermittently)
Inflow design flood, ac-ft	3,085,000	173,000
	Vol. 11 1/2 days	Vol. 72 hours
Inflow design flood peak discharge, cfs	485,000	115,000

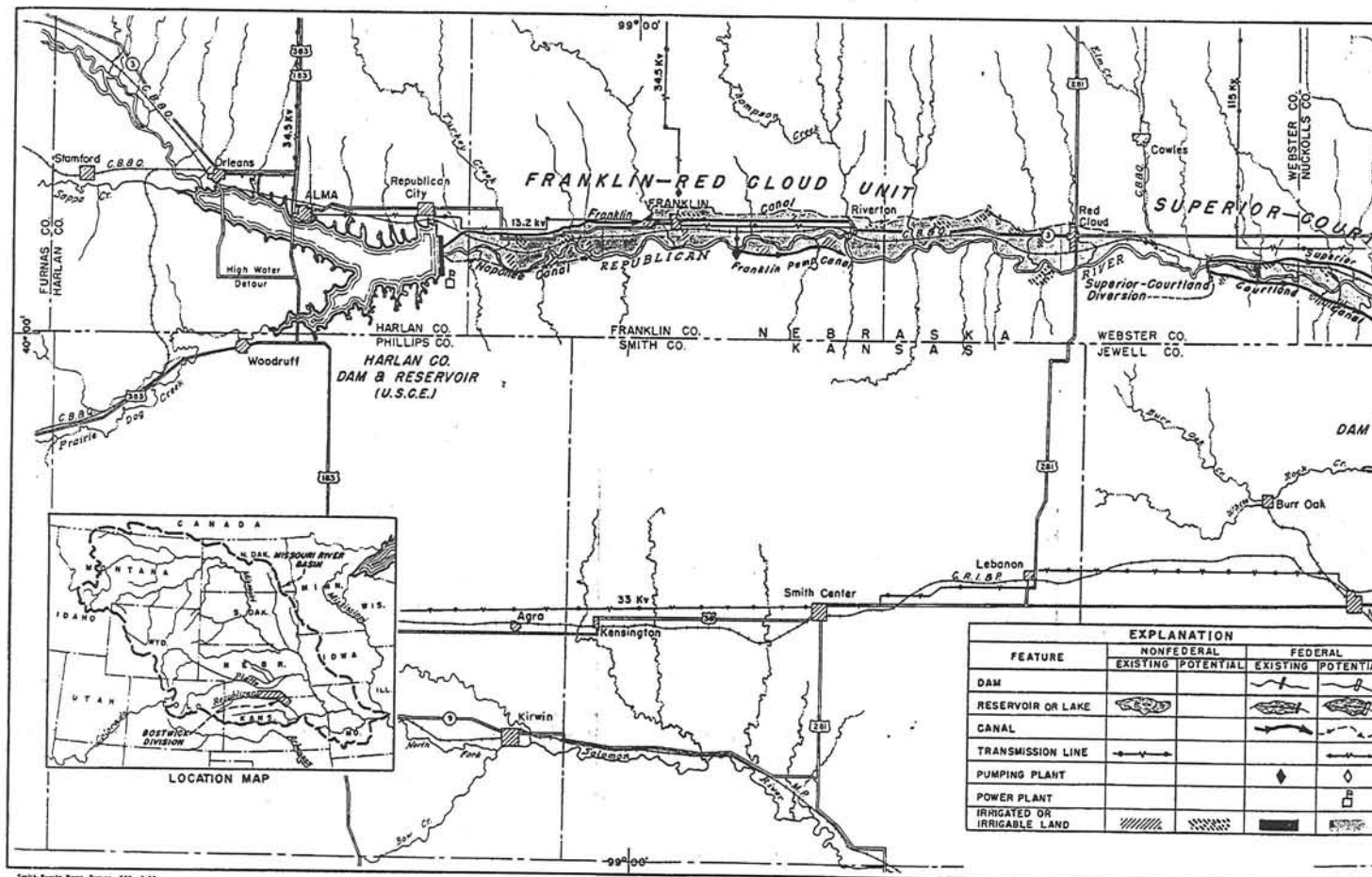
a/ An additional 19,400 ac-ft of storable inflow from the Republican River will enter Lovewell Reservoir by way of the Superior-Courtland diversion and the Courtland Canal.

b/ Depleted inflow for 1947 somewhat larger but has not been computed for the full calendar year.

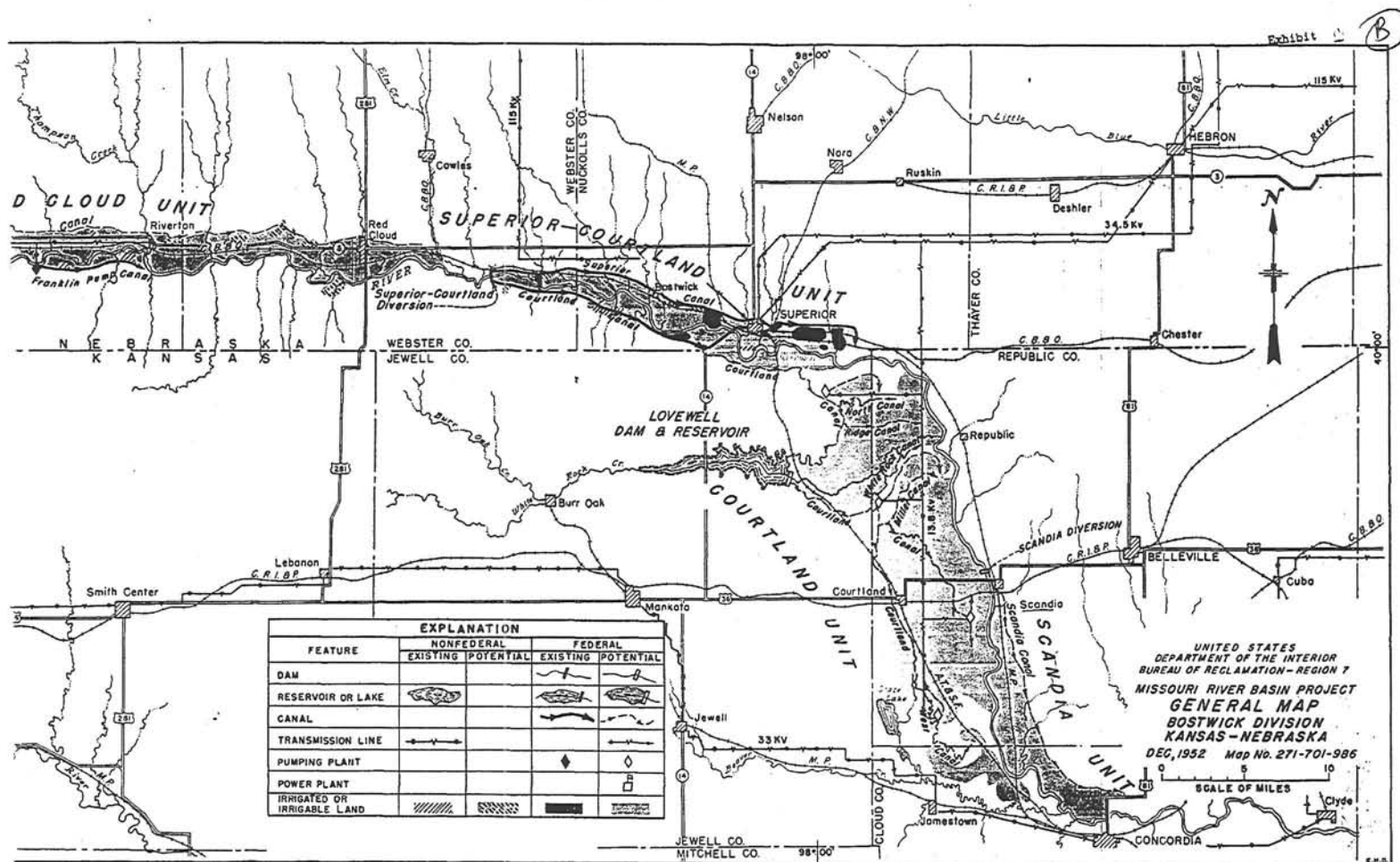
REMARKS

The Nebraska Bostwick Irrigation District, organized in April 1948, negotiated a repayment contract with the United States in February 1949. The Kansas Bostwick Irrigation District was organized in December 1948 and a repayment contract with the United States was negotiated in March 1951. Both contracts were confirmed by state courts. The irrigation district in Kansas did not include 13,000 arable acres in the Scandia Unit.

Detailed investigations resulted in suggested substitutions of some of the original acreages in both irrigation districts. Other lands found feasible of irrigation by investigations and the 13,000 arable acres in the Scandia Unit may be included in the two irrigation districts by revising district boundaries and renegotiating repayment contracts.



KS001922



KS001923

Bestwick Division Definite Plan Report

Missouri River Basin Project

Part 1 General Plan of Development

Appendixes

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APPENDIX II

WATER SUPPLY

Introduction

Summary and conclusions

The Bureau of Reclamation general plan of development for the Bostwick Division presented in this report will assure a realization of the greatest public benefit with a plan of operation sufficiently comprehensive to permit the maximum integration of the needs of other uses consistent with the primary purpose of irrigation. The factors which make up the total use of water are the Bureau of Reclamation planned increase in irrigation, private irrigation existing and potential, flood control, farm ponds, sediment control, public health requirements, stream pollution abatement requirements, wildlife preservation, recreation, and municipal, domestic and industrial requirements.

The Bostwick Division including all the lands in the Republican drainage between Harlan County Reservoir and a north-south line through Concordia, Kansas, is one of five divisions into which the Republican drainage has been divided for Bureau of Reclamation investigations. This division is the fourth division in downstream order.

The Bureau plan of irrigation development for the Bostwick Division provides for the irrigation of 90,000 acres in Nebraska and Kansas. This expansion in irrigation will be accomplished by using the regulated supply of water provided by Harlan County and Lovewell Reservoirs. The initial storage capacity of these reservoirs for irrigation purposes will be 252,800 acre-feet for Harlan County Reservoir and 40,200 acre-feet for Lovewell Reservoir. Under normal operating conditions only 25,200 acre-feet of the irrigation storage in Lovewell would be used. The remaining space would be evacuated only in extreme dry periods.

Water Supply

The water supply considered to be available for development of the Bostwick Division is the water remaining after making allowances for past uses and future potential uses including Bureau of Reclamation proposed plan of development in the Upper Republican, Frenchman-Cambridge and Kanaska Divisions. The acreage of land to be irrigated has been based on the water supply remaining after making allowances for use of complete allocations of the Republican River Compact in upstream states. The use of water is based on 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 irrigation expansion in the Bostwick Division by the Bureau of Reclamation, as proposed, is to be accomplished entirely with river waters. This proposed plan does not contemplate pumping from the ground water for any irrigation development. It is anticipated, though, that some of the probable development will be accomplished by developing wells.

Water requirements for municipal, domestic, and industrial uses were studied and it is considered that these requirements in the Republican River Valley will be adequately supplied from ground waters. These uses are presently satisfied from wells, and it is expected that improved ground-water supplies due to percolating water from irrigation will provide an adequate supply for municipal wells.

Stream pollution abatement has been studied by the Public Health Service and they have recommended minimum flows at critical points along the river. Releases of water were made from Harlan County Reservoir to adequately meet minimum flow requirements for public health when return flows, local supplies and releases for irrigation were not adequate to serve this purpose. Downstream requirements below Concordia, Kansas, will be adequately met by return flows from the Bostwick Division.

All surface waters in the Bostwick Division have been analyzed for mineral constituents and have been found to be satisfactory for irrigation use. Water from wells has been found to be satisfactory for irrigation use between Harlan County Reservoir and Scandia, Kansas. Only one well near Hardy, Nebraska, showed any possibility of formation of sodium carbonates or bicarbonates. All municipal supplies are from ground water and tests show these waters to be suitable for domestic consumption. The ground water is hard and requires large amounts of soap when the water is used for washing. The quality of the ground water in Cloud County, Kansas, is questionable for irrigation.

There are no established prior rights for gravity irrigation canals in the Bostwick Division diverting from the Republican River. There are a few rights for pumping from the streams, but it is anticipated that the owners will choose to obtain water from canals provided in the Bureau plan of development. A supply of water for these lands has been provided and the lands are included in the acreage for which storage supplies have been determined.

All irrigation requirements are based on 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.

Continuous stream-flow records are not available at all stations for the entire period of study and it has been necessary to extend records by correlation with existing records at nearby stations. The stream-flow estimates are all considered to be reasonable.

Monthly operation studies were made for Harlan County and Lovewell Reservoirs. These studies were made using the stream-flow and weather conditions existing during the period 1929 through 1947. This period contains the years 1931 through 1940, which is the longest known sustained drought and includes the 1930-40 period used to base the allocations of water made in the Republican River Compact. The studies were made with Harlan County Reservoir storing all of the water flowing into it, allowing water to spill when the irrigation storage space was filled. Releases from Harlan County Reservoir for irrigation purposes were made only after local supplies, including return-flow waters, were inadequate to meet the demands. The studies for Lovewell Reservoir were made storing all the flow of White Rock Creek plus divertible quantities of the accretion in flow between Harlan County Dam and the Superior-Courtland Diversion Dam including spills from Harlan County Reservoir not required for irrigation on the land served by the Courtland Canal above Lovewell Reservoir. No diversion was made for Lovewell Reservoir at the Superior-Courtland Diversion Dam during January and February because of icing conditions. These operation studies show that there is an adequate supply of water to meet all requirements within the limits of tolerable shortages for irrigation.

The Harlan County Reservoir operation study presented in this report was operated without the use of storage from upstream reservoirs. An analysis was made of the shortages of all the projects in the Republican drainage to determine the effect of enforcing

priorities of storage rights. There was only one year when the water stored upstream out of priority was enough to be beneficial to the Bostwick Division materially. The enforcement of the priorities of the Bostwick Division canals against upstream junior canals would not cause intolerable shortages on lands served from upstream reservoirs, however, such enforcement of priorities is not necessary to insure a firm water supply to the Bostwick Division.

This report contains a summary of the Republican River "Compact Study" and a comparison of water uses made in the "Compact Study" with Bureau Practical Plan of Development Study for the entire river basin. This summary demonstrates that the use of water in the Bureau Plan of Development is in all cases within the limits of the allocations of water reserved for each state in the Compact and that there is an adequate supply of water, after upstream compact depletions, for all of the uses contemplated in the Practical Plan of Development. The distribution of water 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.

This concept of use assumes a system operation of the reservoirs. An integrated plan of operation of the reservoirs has not been made. System operation will consist essentially of sharing of shortage in extreme dry years and capturing wastes and return flows from upstream canals and reservoirs in normal water years. In years when the water supply is normal, or better than normal, shortages will not exist but the principle of keeping the stored waters as far upstream as possible at all times should be followed. The proportions of the lands to be irrigated in any unit have been so designed that each reservoir, and the land which the reservoir is intended to serve, will operate as units without intolerable shortages. This method of operation can only be improved by sharing of shortages through system operation in extremely dry years.

The water supply of the Republican drainage is, to a great extent, dependent on rainfall, most of which falls in thunderstorms. The headwaters of the tributaries do not originate in the mountains and hence have no flows which can be estimated from snow melt. Some of the tributaries originate in the sand hills and have small base flows. This sand-hill flow, plus developed return flows, will be the dependable water supply of the basin which can be more or less accurately computed, but the portion of the supply due to

rainfall will not be subject to close estimates. Therefore, stored water should not be passed promiscuously from one reservoir to another in anticipation of expected river flows except to alleviate floods.

Plan of development

The Bostwick Division is made up of lands along the Republican River in Kansas and Nebraska between Harlan County Reservoir, and Concordia, Kansas. It is a portion of the Kansas River Basin Development, (see exhibits 1 & 2,) which was authorized by Congress as part of the Missouri Basin Project in Senate Documents 191 and 247. Funds were appropriated by Congress for the construction of Harlan County Dam by the Corps of Engineers in Public Law 228, 77th Congress, First Session, and Public Law 534, 78th Congress, Second Session. The construction of Harlan County Dam was commenced August 1, 1946 and was completed in the fall of 1952. Public Law 534, 78th Congress, Second Session, appropriated money for the construction of the Superior Canal, the Courtland Canal in Nebraska, and the Superior-Courtland Diversion Dam. These features were completed in the fall of 1950. Exhibit 1 is a map of the Bostwick Division outlining the proposed features required for the development of this Division.

The water supply study presented herein shows an adequate supply of water can be provided for the irrigation of 90,000 acres of irrigable land in the division, after making allowances of water for all upstream development in the Republican River Basin. The Bostwick Division, consisting of 28,000 acres in Nebraska and 62,000 acres in Kansas, has been divided into four units, as follows: the Franklin-Red Cloud Unit, the Superior-Courtland Unit, the Courtland Unit, and the Scandia Unit. Acreages of the various units as well as of the constituent canal service areas are shown on Table 1, which also reconciles water supply acreages with acreages being presented elsewhere in this report. The acreages forming the basis for the water supply studies conforms with the acreage breakdown used in repayment contract negotiations; whereas acreage data presented in other Chapters and Appendixes of the Bostwick Division Definite Plan Report are based on later refinements to the division land classification. Any error accruing to the water supply study by virtue of these minor differences is considered to be within the allowable limits of error for such studies.

The acreages used in the water supply studies were determined from semi-detailed or detailed land classifications. Those lands within the organized irrigation district boundaries have received the detailed classification. Unorganized lands in the plan of development include the Scandia Unit and certain lands in the Courtland Unit, namely, the four pump lift areas and the gravity areas near Kackley and along Buffalo Creek.

It is proposed that the Bostwick Division will receive storage water from the Harlan County Reservoir and from Lovewell Reservoir. The Harlan County Reservoir, located on the Republican River near Republican City, Nebraska, will provide an initial irrigation storage capacity of 252,800 acre-feet for irrigation purposes. The Lovewell Reservoir, located on White Rock Creek about three miles above the town of Lovewell, Kansas, will store the waters of White Rock Creek plus spills from Harlan County Reservoir which will be diverted at the Superior-Courtland Diversion Dam and delivered to Lovewell Reservoir through the Courtland Supply Canal. A portion of the natural flow occurring in the Republican River between Harlan County Dam and the Superior-Courtland Diversion Dam during March through December will also be diverted and stored in Lovewell Reservoir. The Lovewell Reservoir has an initial storage capacity for irrigation purposes of 40,200 acre-feet. Under normal operating conditions, only 25,200 acre-feet of irrigation storage would be used. The remaining space would be evacuated only in extreme dry periods.

The Franklin-Red Cloud Unit is to be supplied with water from three canals; the Franklin Canal will divert directly from Harlan County Reservoir to serve an area on the north side of the Republican River between the Harlan County Reservoir and the Superior-Courtland Diversion Dam. The Naponee Canal, which also originates at the Harlan County Dam, will supply water to the Franklin Unit on the south side of the Republican River between the Harlan County Dam and Bloomington, Nebraska. The third canal, called the Franklin South Side Canal, will divert water from the Republican River by the means of pumps to serve lands on the south side of the Republican River between Franklin and Riverton, Nebraska.

The Superior-Courtland Unit which is in Nebraska will be supplied water through two supply canals beginning at the Superior-Courtland Diversion Dam near Guide Rock, Nebraska. The Superior Canal will serve the area in Nebraska on the north side of the Republican River and the Courtland Canal will serve the area south of the river in Nebraska. The Courtland Unit in Kansas will be served by the Courtland Canal, which will carry water to the Lovewell Reservoir and serve the lands in Kansas above Lovewell. It will also serve the lands below Lovewell Reservoir. It is proposed to build Lovewell Reservoir on White Rock Creek to provide regulation for the Courtland Canal and to provide storage space for White Rock Creek flows and spills and pickup below Harlan County Dam that can

Water Supply

be diverted at the Superior-Courtland Diversion Dam. This dam will also eliminate the necessity of constructing a costly siphon across White Rock Creek. Main canals for the Superior Canal and the Courtland Canal areas in Nebraska have been constructed and the distribution systems are under construction.

The Scandia Diversion Dam on the Republican River just above Scandia, Kansas will divert water to the Scandia Unit. The lands of the Scandia Unit all lie east of the Republican River between Scandia and Concordia, Kansas.

Water Resources

Reservoirs

Full irrigation development in this area is dependent upon providing storage reservoirs to regulate the erratic flow of the river. Winter flows and flood flows would then be held until required for irrigation. Harlan County Reservoir and Lovewell Reservoir will provide the required storage space.

The initial storage space for irrigation water in Harlan County and Lovewell Reservoir will total 293,000 acre-feet. Harlan County Reservoir on the Republican River will have an initial irrigation storage capacity of 252,800 acre-feet. Lovewell Reservoir on White Rock Creek will have an initial storage capacity of 40,200 acre-feet.

An allocation for flood control of 500,000 acre-feet of space in the Harlan County Reservoir has been made for the life of the Reservoir. It is estimated that 100,000 acre-feet of sediment will be accumulated in 50 years of operation. ~~It is expected that part of the sediment will accumulate in the flood storage pool.~~ Therefore in order to maintain the set size of the flood control pool the elevation of the irrigation pool at the end of 50 years must be changed. The elevation and size of the dead storage, irrigation, and flood control pool in Harlan County Reservoir under initial, 50-year and 100-year conditions are listed in table 2.

An allocation of 50,000 acre-feet of space has been made in Lovewell Reservoir for flood control. It is estimated that 8,000 acre-feet of sediment will be deposited in Lovewell in the first 50 years of operation. Table 2 also lists allocations of storage space for flood control, irrigation and dead storage under initial, 50-year and 100-year conditions for Lovewell Reservoir.

Operation studies were based upon conditions expected to exist in the reservoirs at the end of 50 years. The irrigation storage available at that time will be 175,000 acre-feet in Harlan County Reservoir and 35,000 acre-feet in Lovewell Reservoir. Some additional water can reasonably be expected to be stored in the reservoir areas as bank storage. The effect of bank storage would be to increase the storage capacity of the reservoirs. The increased storage that could 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 banks has not been established.

Surface water supply

Water stored in Harlan County Reservoir will come from the flow of the Republican River, Prairie Dog Creek and Sappa Creek, which includes Beaver Creek. Water stored in Lovewell Reservoir will come from White Rock Creek and spill water from Harlan County Reservoir which can be diverted into the Lovewell Reservoir. Natural flow originating between Harlan County Reservoir and the Superior-Courtland Diversion Dam during March through December will also be diverted into Lovewell Reservoir. These streams all have erratic flow characteristics due to the summer rainstorms that occur in the area causing heavy runoff. The flow of streams varies as the rainfall. The winter precipitation is low and the runoff is correspondingly low. The runoff from snow melt is usually very small. Rainfall is heaviest from March to July, however, extended dry periods thirty to sixty days in length during the June to September period have occurred. Table 7 shows the annual flow of the Republican River at Bloomington during the period of study, 1929-1947. The maximum annual flow at this station was 1,087,400 acre-feet in 1947. The minimum annual flow was 283,200 acre-feet in 1940. This great difference in the annual flow is characteristic of all streams in this area.

Period of Operation Study -- Exhibit 3 presents graphs of historical precipitation over the Bostwick Division. The graphs of rainfall for the Franklin-Red Cloud Unit are based upon the rainfall recorded at Red Cloud, Nebraska. The Superior-Courtland Unit and Courtland Unit annual rainfall variation is shown by plotting rainfall recorded at Superior, Nebraska. The third graph shows the annual rainfall recorded at Republic, Kansas, prior to 1935. After 1935 the rainfall recorded at Belleville, Kansas, is shown. The annual rainfall recorded at Concordia, Kansas, has been plotted to show the precipitation in the Scandia Unit.

These graphs do not necessarily show all periods of drought because even in a year of normal or above normal rainfall prolonged dry periods, which reduce crop yields, are common. Because these periods tend to be more severe in years with less than normal rainfall, the graphs of exhibit 3 are used to indicate periods of critical water shortage. The average annual rainfall is greater in the eastern part of the division than it is in the western part.

The period of operation 1929-1947 was chosen because this period includes the most severe drought period (1931-1940) in history. It is considered that there is a sufficient water supply if it can be shown that there is water enough to irrigate without intolerable shortages during such a period as 1931 through 1940.

Analysis of rainfall and stream flow data of upstream stations show there would have been sufficient water supply to fill all reservoirs prior to 1929, therefore, the Harlan County and Lovewell Reservoirs have been considered to be full at the beginning of the operation studies.

Water rights.--Development of the Bostwick Division must be in compliance with the laws of Nebraska and Kansas and with the Republican River Compact. A brief summary of the state laws and of the Republican River Compact follows:

Nebraska water laws --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 therefor 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."

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 State of Nebraska's Department of Roads and Irrigation has large discretion in granting a right to make an appropriation. It is an administrative body having quasi-judicial 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.

The following statute taken from the Revised Statutes of Nebraska, 1943, governs the use of water in Nebraska for direct flow and storage rights. Chap. 46-231 provides:

"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.
* * * No allotment from the Natural flow of the streams for irrigation shall exceed 1 cu. ft. per second of time for each 70 acres of land nor 3 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 water; * * *"

However, in Chap. 46-242 the following appears:

"* * * No appropriation of stored water for irrigation shall exceed 3 acre-feet during any calendar year for each acre of land for which such appropriation may be made."

In Chap. 46-241, there are certain limitations placed on filling reservoirs.

"* * * The owners or possessors of reservoirs shall not have the right to impound any water whatsoever in such reservoirs during the time that such water is required in ditches for direct irrigation or for reservoirs holding senior rights. * * *"

Water appropriations in Nebraska.--Table 4 lists appropriation rights for the beneficial use of water that have been granted by the State of Nebraska for diversion of water from the Republican River and from tributary streams at points that will be inundated by Harlan County Reservoir. ^{1/} This table shows irrigators hold grants for a total of 26.72 second-feet of water in this area. Table 5 lists the appropriation rights on the Republican River between Harlan County Dam and the Nebraska-Kansas state line. ^{1/} The irrigators on the Republican River in Nebraska, below Harlan County Dam are shown to have irrigation rights totaling 39.14 second-feet. One power right held by the Consumers Public Power District is listed and shows a right for the use of 400 second-feet of water.

The Consumers Public Power Plant has been purchased by the Bureau of Reclamation, and this power right subordinated to uses for irrigation purposes. The plant was shut down by the Bureau of Reclamation February 1, 1952, and the power canal filled in with earth. The diversion dam will be removed.

^{1/} Data published in the Twenty-seventh Biennial Report of the Department of Roads and Irrigation, Nebraska.

Kansas Water Laws—The Irrigation District Act (42-700, G. S. Kansas) and the Water Appropriation Act (82a-700, G. S. Kansas) have comparatively recently revised the Kansas water laws. The constitutional validity was upheld in a decision of the Kansas Supreme Court on June 11, 1949.

1945 Water Appropriation Act—On June 28, 1945, this act gave to the Division of Water Resources, State Board of Agriculture, authority to regulate and allocate surface and ground water for beneficial use in accordance with the doctrine of appropriation under the rule of priority of rights. The law recognizes two classes of water rights, (1) vested rights and (2) appropriation rights. The use of water for domestic use for family and livestock are recognized and are exempt from state regulations. Water users who were using water at the time the law went into effect, or had used water within a three-year period previous to that date, retained their appropriations under vested rights. The water right of the appropriator may be terminated when he ceases to use his rights over a period of three years or more. However, the termination of rights for nonuse is subject to the discretion of the Chief Engineer of the Division of Water Resources who makes a study of the conditions causing nonuse of water rights, and he may decide whether or not the rights should be terminated. The decision of the Chief Engineer may be appealed to the District Court of the county in which the point of diversion for the appropriation is situated. The law states that, where appropriation of water for different purposes conflict, they shall take precedence in the following order: domestic, municipal, irrigation, industrial, recreational and water power. In disputes as between appropriation, the first in time is the first in right. No limitation upon the amount or rate of use of water that can be diverted is defined by Kansas law. The quantity of a water right is left to the Senior Engineer, Division of Water Resources to set for each application for use of water. No provision is made by the law for the storage of water for future use. For this reason it may be possible for a downstream user to demand natural flow if one year's water supply is held in storage. Studies in this report assume that this will not be possible. //

Water appropriations in Kansas—The Kansas State Division of Water Resources was requested by the Bureau of Reclamation to furnish information regarding water rights in Kansas on the Republican River above Concordia, Kansas, and on White Rock Creek. A tabulation dated August 5, 1950, including all applications for permit to appropriate water as well as vested right claims for the use of water in the basin of the Republican River and its tributaries upstream from Concordia, Kansas, was received. The vested right claims listed were

Water Supply

all for the use of well water and most of them were for uses of water by municipalities or industries. One of the appropriation applications was for use of water from White Rock Creek. The land on which the appropriated White Rock Creek water is to be used is in the reservoir site, therefore, the water use under this application would be eliminated under the proposed plan of development. The remaining appropriation applications were for use of water from wells or for the use of water from Prairie Dog, Sappa and Beaver Creek. The water rights on these creeks are in the Kanaska Division and are considered in the water supply study of that unit.

It was pointed out by officials of the Kansas State Division of Water Resources that final determination has not been made of vested rights in this area. The information forwarded to the Bureau is based on the applications which have been filed and on claims for vested rights. Although the information regarding water rights in Kansas is incomplete it is concluded that water rights unaccounted for will not affect the water supply study presented in this report.

Depletions for use of water from wells are considered to be reflected in historical records and no special depletions to the water supply was made for these uses.

The extent of vested rights downstream from the Bostwick Division has not been determined. Mr. R. V. Smrha, Senior Engineer of the Kansas Division of Water Resources, pointed out in a letter dated January 14, 1949, to Mr. H. E. Robinson, District Manager, Kansas River District, the principal vested rights to be expected. He also listed appropriation rights below the Bostwick Division.

".....I believe that the principal uses for which vested rights will be found are those for municipal purposes, particularly at Topeka and Lawrence. There are some industrial uses such as the Kansas Power and Light Company plant at Tecumseh, the Bowersock Mill at Lawrence and very likely to some extent in the vicinity of Kansas City. There will be, perhaps, also some very limited use of water for irrigation by an occasional individual land owner along the river

"As to appropriation rights, a certificate of appropriation has been issued to the Sunflower Ordnance Works for use of water from the Kansas River for industrial purposes to the extent of 93 second feet and from wells in the valley to the extent of 15.5 second feet. There are two applications pending

for appropriation of water for irrigation purposes from the Republican River in Geary County which are prior to the application of the Kansas Bostwick Irrigation District No. 2. These applications involve a quantity of eight (8) second feet and a total annual volume of 280 acre feet. There are also pending applications for appropriation of water from White Rock Creek in Jewell County, prior to the Bostwick project, involving the diversion of three and one-half (3 1/2) second feet to the extent of 200 acre-feet from wells and two (2) second feet to the extent of 35 acre-feet from the stream."

It is shown in the discussion of estimated downstream water need that there will be sufficient natural flow water for these rights. The report of the Kansas State Board of Agriculture for 1950 containing a list of the Status of Water Appropriations shows that the Kansas Bostwick Irrigation District has an approved application for 130,000 acre-feet annually with a priority date of July 16, 1948.

No application has been filed for the use of White Rock Creek water on the Courtland Unit. Before Lovewell Reservoir is completed the Kansas Bostwick District should file an application to use White Rock Creek water.

Republican River Compact -- The Republican River Compact is an agreement between the States of Colorado, Nebraska, and Kansas for setting limits for the beneficial consumptive use of the Republican River Basin water in the respective states. This compact was authorized by the Act of Congress, August 4, 1942, (Public Law No. 696, 77th Congress, Chapter 545, 2nd Session.)

The compact allocated for beneficial consumptive use from streams in Colorado, annually, 54,100 acre-feet of water. A total of 234,500 acre-feet of water was allocated annually for beneficial consumptive use in Nebraska, 132,000 acre-feet of which was from the main stem of the Republican River. Kansas was allocated a total of 190,300 acre-feet of water annually for beneficial use. Fifty-two thousand three hundred acre-feet of this water was allocated on tributaries of the Republican River originating in or flowing through Kansas; the remainder or 138,000 acre-feet of water was the allocation of main stem of the Republican River. The state of Kansas was also granted the right to divert all or any portion of the 138,000 acre-feet allocation at or near the town of Guide Rock, Nebraska. In addition, the compact allocated to Kansas the entire water supply originating in the basin below the Nebraska-Kansas state line. All allocations are subject to the allocated quantity being physically available.

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The above-mentioned allocations were to be made from the virgin water supply of the Republican River and the virgin water supplies of all the major tributaries of the Republican River as estimated by the Commissioners of the Compact. The Compact provides that if the future computed virgin water supply varies from the quantity as estimated in the compact more than 10%, the allocations should be increased or decreased in the relative proportions that the future computed virgin water supply of such source bears to the virgin water supply as estimated in the compact.

The average annual flow assumed in the Compact for each of the main streams in the basin and the allocation to each state are listed in table 3.

Estimation of historical depletions -- There are no irrigation districts in the Bostwick Division that have used water historically for irrigation. A few farmers, mostly in Nebraska, have irrigated their land by pumping from wells and a few have established rights for the use of river water and have irrigated by pumping from the river. Water pumped from wells has not been sufficient to affect the historical stream flows. The water rights listed in tables 4 and 5 can be used to indicate the maximum use of water from the river. These tables show the use of water has increased during the period of study. No records of exact diversions have been made and there is no record of the acres irrigated. In the past, few if any irrigators have used their full water right in every year of operation. In years of short water supply, water was not available to give all a full supply and in years of plentiful water supply it was not necessary to use the full water right. Due to the lack of data and because water used from the stream has been small, no determination of historical depletions has been made.

Historical records corrected for expected future development are considered to reflect the local supply available for development in the Bostwick Division. The historical depletions have been shown in the foregoing paragraph to be small. Due to the lack of records of actual historical uses in the Bostwick Division and because the data upon which estimates of actual uses could be made is meager, the accuracy of the study would not be greatly improved by attempting to correct flow records for historical uses. Since the historical river flows have not been corrected for the past historical uses of water in the Bostwick Division, water shown to be available for development of the Division is conservative to the extent of past uses because the appropriative rights submerged by the Harlan County and Lovewell Reservoirs will be eliminated and because the lands with water rights below Harlan County Dam have been included with lands to be supplied with water under the planned development.

Stream-flow correlations and estimates -- Exhibit 4 is a bar graph listing the stream gaging stations. The period of record available for all stations below Harlan County Reservoir used in determining the water available for development of the Bostwick Division is also shown. Exhibit 5 is a location map of these stations. Pertinent data describing these stations, such as the type of gage, period of record, and the source of data are listed in table 6. Historical records of the flow at Bloomington and Hardy, Nebraska, and Scandia and Clay Center, Kansas, were used in determining the accretion in flow available at diversion dams on the Republican River. Other records listed were used in determining the flow into Lovewell Reservoir.

Bloomington -- Historical records of the flow of the Republican River near Bloomington are available for the period from April 1929 to October 1947. Historical and estimated flows at this station are listed in table 7. The records prior to November 18, 1938, were made by use of a chain gage and the records since that date were made by use of a water-stage recorder. All records at this station are rated as good by the Geological Survey, except for periods of ice effect when the records are considered to be only fair. The average daily discharge at this station for the 18-year period of record ending in September 1947 was 724 second-feet. The average annual flow was 521,800 acre-feet. A maximum instantaneous discharge of 260,000 second-feet was recorded June 1, 1935 and a minimum mean daily discharge of 6.8 second-feet was recorded October 6, 7, 1936. The flow for the seven months prior to May 1929 was estimated by use of the flow determined for Hardy, Nebraska. By using the ratio of the average annual discharge at the two stations for the period of common record, the flow at Bloomington was estimated to be 87.7 percent of the flow at Hardy.

Hardy -- Historical records of the flow of the Republican River near Hardy, Nebraska are available for the period, June 1932 through September 1947. The historical and estimated flows for this station are listed in table 8. The average daily discharge at this station for the 15-year period of record was 836 second-feet. The average annual flow was 581,300 acre-feet. A maximum instantaneous discharge of 225,000 second-feet was recorded June 2, 1935 and a minimum mean daily discharge of zero flow occurred August 9-19, 1934. The records at this station were obtained by use of a water-stage recorder and are rated as good records by the Geological Survey, except for periods of ice effect when they are considered to be fair. Flows for the period of October 1928 through May 1932 were estimated by correlating the flow of the river at Hardy, Nebraska and the flow at Scandia, Kansas for the period of concurrent record, see exhibit 6.

This correlation shows the flow at Hardy to be 92 percent of the flow at Scandia.

Scandia -- Historical records of the flow of the Republican River at Scandia, Kansas, see table 9, are available for the period from August 27, 1919 to July 2, 1925 and from August 14, 1928 through September 1944. The historical flows and the estimated flows of the river at this station for the 20-year period of record average 820 second-feet. The average annual flow is 664,000 acre-feet. The maximum instantaneous discharge observed at this station was 215,000 second-feet recorded June 2, 1935 and a minimum mean daily discharge of zero flow was recorded from August 9-21, 1934. The records at this station prior to July 2, 1925 were obtained by the use of a staff gage and are not used in this report since they are prior to the period of the operation studies and the station was not rated. The records for the period August 1928 through September 1935 were made by use of a chain gage, and flows recorded after October 1, 1935 were obtained by use of a wire weight gage. These records are rated by the Geological Survey as good records except for periods of ice effect when they are considered to be fair.

The flow for the period of October 1944 through September 1947 was obtained by estimating the inflow between Hardy and Scandia and adding this inflow to the flow recorded at Hardy. This was done by determining the average monthly accretion between Hardy, Nebraska and Scandia, Kansas and between Hardy and Clay Center, Kansas for the period of concurrent records, October 1935 through October 1943. These accretions are listed in tables 10 and 11. The average monthly accretion between Hardy and Scandia was then determined in percent of the total accretion between Hardy and Clay Center and the percentage was then used with the inflow between Hardy and Clay Center to obtain the inflow between Hardy and Scandia for the October 1944 through September 1947 period.

Clay Center -- Historical records of the flow of the Republican River at Clay Center, Kansas are available as early as August 1, 1904. The complete period during which records have been made at this station is shown in exhibit 4 and table 6. Historical records of the flow at Clay Center are listed in table 12.

The average discharge at this station for the 30-year period of record was 1,093 second-feet. A maximum peak discharge of 195,000 second-feet occurred June 3, 1935. Zero flow was recorded August 6, 7, and 9 to September 8, 1934. The records made at this station from February 8, 1934 to date coincide with the period of this study. All records of flow at this station since February 8, 1934, were

made by use of a water-stage recorder except for the period of January 3, 1935 to May 6, 1935 when a chain gage was used. The historical records of flow at this station used in this study are rated as good records by the Geological Survey, except for the period of ice effect when they are considered to be fair.

The flow for the period October 1928 through January 1934 was estimated by plotting the flows at Scandia and flows at Clay Center for the concurrent period, October 1935 through October 1943, and drawing the correlation curves as shown in exhibit 7.

White Rock Creek at Lovewell Dam site -- Historical records of the flow of White Rock Creek near Lovewell, Kansas have been made since June 1946 and they are listed in table 13. The remainder of the flows in this table are estimated flows. Historical records at this station were obtained by use of a water-stage recorder and are considered to be good records except for periods of ice effect when they are considered to be fair. The maximum historical discharge for White Rock Creek occurred on July 10, 1950. A peak flow of 23,300 second-feet was measured. Zero flows for over a month at a time have occurred.

The historical accretions in flow between Hardy and Clay Center, table 11, were plotted against the historical flows of White Rock Creek, in exhibit 8 and the correlation curve was drawn. This curve was then used to determine the estimated flows of White Rock Creek for the period October 1928 through April 1929 and February 1934 through May 1946.

The historical flows of White Rock Creek, at Lovewell Dam site, table 13, were plotted against the historical flows of Solomon River at Beloit, Kansas, see table 14, in exhibit 9 and the correlation curve was drawn through the resulting points. This curve was used as a basis for estimating the White Rock Creek flows for May 1929 through January 1934.

Harlan County Dam site. The historical flow at Harlan County Dam site which is about 9 miles above Bloomington, Nebraska, was estimated to be 98 percent of the historical flow at Bloomington. This percentage is based upon relationship of the drainage area at the two places which is 14,405 square miles above Bloomington and 14,127 square miles above Harlan County Dam site. The historical flow of the Republican River at Harlan County Dam site is listed in table 15.

Superior-Courtland Diversion Dam--The nearest gaging station to the Superior-Courtland Diversion Dam is at Hardy, Nebraska which is about 27 river miles downstream from the diversion dam. The historical flow of the Republican River at the Superior-Courtland Diversion Dam was estimated by determining the accretion in the flow between Bloomington, Nebraska and the diversion dam and adding the accretion to the historical flow at Bloomington. This accretion was estimated to be 69.8 percent of the accretion between Bloomington and Hardy. The percent of accretion was based upon the relationship of the drainage areas above each station. Table 16 lists the accretion of the Republican River between Bloomington and Hardy, and Table 17 lists the accretion between Bloomington and the Superior-Courtland Diversion Dam. Table 18 lists the determined historical flow at the Superior-Courtland Diversion Dam. Table 19 lists the accretion between Harlan County Dam and the Superior-Courtland Diversion Dam. The accretion in the flow between the Superior-Courtland Diversion Dam and the state line is listed in table 20.

Scandia Diversion Dam--The proposed site for the Scandia Diversion Dam is a point approximately one mile above the Scandia gaging station. There is no important inflow between the proposed site and the gaging station. Therefore, the historical flow at the proposed diversion dam is considered to be the same as the flow recorded at the Scandia gaging station.

The historical accretion between the state line and the Scandia Diversion Dam is the historical accretion between Hardy, Nebraska, and Scandia, Kansas which was presented in table 10. The building of Lovewell Reservoir will eliminate most of the accretion contributed by White Rock Creek in this section, therefore, the historical accretion of the Republican River between the state line and Scandia Diversion Dam less the flow of White Rock Creek was determined and is listed in table 21.

Estimation of future depletions to project inflow--Development of the Bostwick Division is based upon the water supply that will be left to the division after all probable upstream development takes place. Upstream development has been divided into three divisions, the Frenchman-Cambridge, the Upper Republican and the Kanaska Division.

Frenchman-Cambridge Division--The Frenchman-Cambridge Division covers the drainage area on the Republican River between Trenton Reservoir and Harlan County Reservoir. Frenchman Creek, Red Willow Creek and Medicine Creek are the main tributaries to the

stream in this area. Water requirements for this division were determined in a Water Supply Appendix for the Definite Plan Report for the Frenchman-Cambridge Division, dated February 1951.

Depletions for the Frenchman-Cambridge Division were made for the irrigation of 68,570 acres by Bureau planned development and 8,950 acres by private development. The average depletion for the 19-year period of operation was 94,600 acre-feet per year. Development of this division would be accomplished by using water stored in 4 reservoirs. Trenton Reservoir is under construction on the Republican River near Trenton, Nebraska. Closure was made on Enders Dam on Frenchman Creek October 23, 1950. Storage in Harry Strunk Lake began upon closure of Medicine Creek Dam August 8, 1949. Red Willow Reservoir on Red Willow Creek is planned for future construction by the Corps of Engineers. The capacities of these reservoirs are listed in table 22. The acreages of the various units in the division are listed in table 23. Table 24 is a summary table of the annual depletions for the 19-year period of study that will be caused by the development of the Frenchman-Cambridge Division.

The operation study of the Frenchman-Cambridge Division shows the lands to be served from the Enders and Red Willow Reservoirs would incur moderate shortages at times. Lands served by Enders Dam had shortages in 5 years out of the 19 years studied. The largest shortage was 13.3 percent of the consumptive use requirement and the lands served by the Red Willow Dam had shortage in seven years during the period of study. The largest shortage for these lands was a shortage of 13.6 percent of the consumptive use requirements.

The flow of the Republican River, excluding tributaries in the Kanaska Division, into the Harlan County Reservoir after all proposed upstream developments determined in the Frenchman-Cambridge Definite Plan Report is listed in table 25. The upstream depletions on the Republican River result from the above-summarized development of the Frenchman-Cambridge Division and the Upper Republican Division.

Upper Republican Division -- The Upper Republican Division covers the drainage area above Trenton Reservoir. Part of the states of Colorado, Kansas and Nebraska are included in the Division. The main streams of the area are the North Fork Republican, Arikaree, South Fork of the Republican and the Republican River. Depletions were made in the water supply study of this division for irrigation of 6,700 acres by private means and for the irrigation of 13,800 acres by Bureau planned development. A breakdown of the acreages

used in the water supply study of this area is shown in tables 26 and 27.

The plan for development of the Upper Republican Division calls for building 4 reservoirs. Wray Reservoir on the North Fork of the Republican River would store water for development of the North Republican Unit. The Pioneer Reservoir on the Arikaree River, above the North Republican Unit would regulate flood flows. Bonny Reservoir on the South Fork Republican River would store water for the development of the St. Francis Unit. Rock Creek Reservoir on Rock Creek would store water for the development of the Benkelman Unit. Storage allocations for the reservoirs of the Upper Republican Division are listed in table 22.

Table 28 is a summary of the annual depletions for the development of the Upper Republican Division. This table shows the average annual depletion for the 19-year period of operation was 35,700 acre-feet. The operation study of this unit shows there is an adequate water supply for the planned development in this division. The only shortage in the division for the entire period of study was a shortage for lands served by Rock Creek Reservoir of 1,800 acre-feet in 1940. This was equal to 6.6 percent of the consumptive use requirement.

Kansaka Division -- The Kansaka Division includes the drainage areas of Sappa, Beaver and Prairie Dog Creeks in Kansas, Nebraska and Colorado. The plan of development for the division calls for construction of three reservoirs which would store water for irrigation of 7,700 acres. It is expected that ultimate development of private irrigation in the division by use of pumps or stream diversions may reach 7,400 acres and that development of farm ponds may cause an additional depletion of 1,400 acre-feet per year.

The Nelson Buck Reservoir on Beaver Creek, near Cedar Bluffs, Kansas, with an active irrigation storage capacity of 11,700 acre-feet will store water for the irrigation of 1,200 acres in Nebraska. Private irrigation development above the reservoir may reach a maximum of 3,450 acres, and below the project area 50 acres may be developed by private irrigators. Future depletions to the flow of Beaver Creek caused by development of farm ponds are expected to average 800 acre-feet per year.

Oberlin reservoir, on Sappa Creek near Oberlin, Kansas, will use an active storage capacity of 14,800 acre-feet for irrigation of 1,500 acres in Kansas. Future private irrigation development on the stream is estimated at 750 acres above and 2,250 acres below the unit area. Future depletions due to private pond development will average 400 acre-feet per year.

The Norton Reservoir on Prairie Dog Creek is near Norton, Kansas. It will have an irrigation storage capacity of 20,000 acre-feet and will supply water for irrigation of 5,000 acres in the Almena Unit in Kansas. Ultimate private irrigation development is estimated at 500 acres above the reservoir and 400 acres below the unit area. Future private pond development will use an average of 200 acre-feet per year.

Storage allocations for the three reservoirs in the division are shown in table 29, and proposed project acreages appear in table 30.

Table 31 summarizes the depletions to the water supply resulting from complete development of the Kanaska Division. The average annual depletion would be 25,800 acre-feet per year.

Operation studies for the reservoirs in the division show that the Nelson Buck unit would have had a full water supply for the entire 19-year period of study. The Oberlin unit would have experienced shortages in six years of the period, the three largest being 3,300 acre-feet in 1934, 2,900 acre-feet in 1939 and 2,100 in 1950. These shortages represent consumptive use shortages of 42.1, 38.8, and 28.4 percent respectively. The Almena Unit would have been shorted in 5 years of the period, the greatest shortage being 10,200 acre-feet in 1934, or a consumptive use shortage of 36.4 percent.

Although the present operation studies for the Kanaska Division would seem to indicate some of the projects to be infeasible, it is realized that much of the criteria used may be revised in the light of further studies and extended records. It is believed likely that more complete geologic information might result in lower estimated seepage rates for the dams. There is also a possibility that alternate sites might be used. Since a definite plan report on the Kanaska Division is not yet scheduled, the present operation studies are considered adequate for determining the effects of development upon the Bostwick water supply.

Table 32, which shows the shortages occurring in the reservoirs in the Republican River drainage area when operated independently, gives an indication of the shortages incurred in the Kanaska Division.

The depleted inflow from the Kanaska Division into Harlan County Reservoir, after upstream development, has been determined from the operation studies of the reservoirs in the division. Table 33 lists the flow at the mouth of Prairie Dog Creek after development of the Almena Unit. Table 34 lists the flow of Sappa Creek after

development of the Oberlin Unit near Stamford less Beaver Creek, and table 35 lists the flow at the mouth of Beaver Creek near Stamford after development of the Beaver City Unit. Table 36 is a summary table showing the depleted inflow into Harlan County Reservoir after all upstream development. This is the sum of tables 25, 33, 34, and 35.

Private development — The use of water in Kansas River Basin due to future private development of irrigation is an important part of the future depletions in the basin. Depletions for future private development above Harlan County Reservoir have been made in the water supply studies for the Frenchman-Cambridge, Upper Republican and Kanaska Divisions. It is considered that there will be 2,600 acres of future private development in the Bostwick Division between Harlan County Dam and Superior Courtland Diversion. Depletions for this development are listed in table 37. It was considered that there would be no important depletions due to development of farm ponds in these river sections, therefore, the above tables do not include any depletions for pond development.

Not all of the historical accretions between Harlan County Dam and the Superior-Courtland Diversion Dam will be available for diversion, due to depletions for private development above this area. The depleted inflow for this reach of the river has been computed in table 38.

Quality of surface water — The quality of the water in the Republican River, originating above the mouth of Sappa Creek, has been discussed in detail in the Definite Plan Report for the Frenchman-Cambridge Division. Detailed analyses were made by the U. S. Geological Survey of samples taken from Frenchman Creek at Enders and at Culbertson; from the Republican River at Max, Trenton, and Cambridge and from Medicine Creek at Cambridge. Analyses also were made of samples from wells in the project areas. All samples of surface and ground water indicated excellent to good quality for irrigation purposes with respect to total dissolved salts and percent sodium. Boron concentration was shown to be low enough for the water to be classified as excellent to good for crops sensitive to boron.

Detailed chemical analyses have been made in the Bostwick Division, by the Geological Survey, of water taken from the Republican River at Orleans, at Bloomington, and near Hardy; and from Sappa Creek near Stamford, and Prairie Dog Creek at Norton. These analyses have been used in studying the quality of water in the Bostwick Division. These analyses are listed in tables 39 through 43.

Consideration was made of the following factors in determining the suitability of water for irrigation.

1. Total salt concentration
2. Percent sodium
3. Boron concentration
4. Sodium carbonate or bicarbonate concentration

Permissible limits of total salt concentration, percentage of sodium and boron concentration are described by L. V. Wilcox, agronomist, Bureau of Plant Industry. ^{1/} Total salt concentration and percentage of sodium of the samples were plotted on charts, exhibits 10 through 14. These exhibits show that all samples analyzed fall in the classification of excellent to good for irrigation purposes with respect to total dissolved salts and sodium percentage. The chemical analyses show the boron concentration is very low and the water is of excellent to good quality for use by plants sensitive to boron.

A graph was drawn for each water sample analyzed showing the relationship of the carbonates and bicarbonates to the calcium, magnesium, sodium and potassium, expressed in equivalent parts per million. These graphs indicate possibility in some cases, of a concentration of sodium carbonate. Since the total of dissolved salts in all cases is very small, the water is considered to be satisfactory for irrigation.

Ground water

There are two areas with aquifers suitable for irrigation well development of upstream units. Any development by pumping from ground water in the river alluvium of the Bostwick Division or in the Platte-Republican divide area would affect the water supply of the Bostwick Division. Other areas surrounding the Bostwick Division are underlain with formations that will yield only small quantities of water. The potential depletion to the Bostwick water supply from ground-water development is discussed in the following paragraphs.

^{1/} "Quality of Water for Irrigation Use" U. S. Department of Agriculture, Technical Bulletin 962.

Ground water in the river alluvium — Prior to the recent irrigation development that has been made under the Superior Canal and Superior-Courtland Canal, only 3,361 acres were reported to be irrigated in the Bostwick Division. This irrigation was all in Nebraska. The water was obtained by pumping from wells.

The most important use of ground water from the river alluvium is for supplying the municipal and domestic needs which are met entirely from ground water. No special determination of these uses has been made. Past uses are considered to be reflected in historic records and no significant changes are anticipated in future uses.

Future irrigation development by pumping from the aquifer of the river alluvium is not anticipated because the irrigable land along the river will be served by canals from Harlan County Dam. Several factors have contributed to the fact that little irrigation development has been made along the river by use of ground water. The alluvium has a great deal of very fine sand in it and wells must be drilled in an area where there is considerable saturated thickness (estimated minimum - 40 feet) in order to yield sufficient water for irrigation. The alluvium with sufficient saturated thickness is usually found only in the area close to the stream and this area is often subject to flooding. The alluvium in Kansas has sufficient saturated thickness for irrigation wells, however, many of the soils in this area are too heavy for successful irrigation. The University of Kansas publication Bulletin 73 ^{2/} indicates the yield of wells in the area between the Nebraska-Kansas state line and Scandia, Kansas would be too small for extensive irrigation development. In the area below Scandia, wells yielding 1,000 gallons per minute could be developed, however, the quality of the water from wells south of the Republic-Cloud County line is questionable.

Two bulletins have been published which give data on ground water in the Bostwick Division. The Nebraska Bostwick data is published in a Water Supply Paper published by the University of Nebraska, Conservation and Survey Division. ^{1/} And the Kansas Bostwick ground-water data is published in Bulletin 73, University of Kansas Publications. ^{2/}

^{1/} Nebraska Water Resources Survey Water Supply Paper 1, "Ground Water in the Republican River Basin in Nebraska" by H. A. Waite, E. C. Reid and D. S. Jones, Jr.

^{2/} Ground Water Resources of Republic County and Northern Cloud County, Kansas, by V. C. Fishel.

Exhibits 15, 16 and 17 are profiles of the Republican River Valley near Franklin, Red Cloud and Bostwick, Nebraska. They are of interest because they show the general geologic formation in this section of the Division.

Exhibits 18 and 19 show the location of observation wells and contours of the Bostwick Division. These are the maps taken from the state publications referred to previously. The maps give the general picture of the water table. It has been anticipated that drainage problems would occur in places due to the planned irrigation development and the existing wells would not give the required control on changes in the water levels. The Geological Survey drilled some additional wells in 1950 and prepared a depth to water and a water level contour map based on the data available at that time. These maps are available at the Bureau of Reclamation Kansas River District Headquarters. The Drainage section of the Bureau of Reclamation took over the entire observation well program in the Bostwick Division during 1950 and installed 52 wells in Nebraska. In 1951, 53 additional wells were added in Nebraska and 51 wells were added in Kansas. One Hundred sixty-one wells in Nebraska and 97 wells in Kansas were being observed in 1952. These wells were being observed monthly except for December and February when they were not read. Certain wells along the canals were read bi-monthly during the irrigation season.

Ground water, Platte-Republican Divide area -- The following computations have been made for the purpose of showing the effect of potential ground-water irrigation development in the Platte-Republican Divide area upon the Bostwick Division water supply. The computations are based upon data given on maps obtained from the University of Nebraska Conservation and Survey Division. The maps are not included as part of this report because they are as yet unpublished and are subject to minor revision. They do represent the latest and most complete data available, however, and are suitable for this analysis. The maps obtained from the University of Nebraska Conservation and Survey Division include:

1. A water table contour map of South Central Nebraska.
2. A map showing saturated thickness of Pleistocene material.
3. A Pre-Cenozoic Topographic and Geologic Bedrock Map.
4. A map indicating the depth of the water table below the surface.

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The saturated thickness map indicates the water table is within 200 feet of the surface in all but a few small areas of the Platte-Republican Divide. Any area with sufficient saturated material to supply an irrigation well was considered a potential area for well development. The area where potential development will affect the Republican River flow narrowed down to the area of Pleistocene material shown on exhibit 20. Some future development may result from pumping from the Ogallala formation in Phelps, Gosper and Frontier Counties, however, available data indicates that only the northern portion of the counties have sufficient saturated thickness for irrigation well development in the Ogallala material. Exhibit 2 shows the location of the counties in this discussion. Computations presented in a Definite Plan Report for the Kirwin Unit in Kansas indicate that pumping from wells 15 miles or more from a stream will not cause material stream depletions during the first 50 years of pumping. The Ogallala area of potential development is over 15 miles removed from the stream and is therefore not considered to affect the Bostwick water supply. It is also likely that any depletion due to pumping in this area will be at least partially offset by return flows from irrigation under Tri-County canals.

The area that could be irrigated by pump development has been estimated by use of Nebraska County Soil Survey maps. The estimated potential area for each township is noted on exhibit 20. A total area of 54,000 acres is indicated.

The depletion to the Republican River has been computed by drawing a line (see the dotted line parallel to the River, exhibit 20) through the points where stream flow begins in the streams north of the river and computing the depletion in ground-water flow across this line due to the potential development. The location of the points where flow begins is taken from Water Supply Paper 779 published by the U. S. Geological Survey. The points where flow begins on Thompson and Turkey Creeks were checked in the field on October 28, 1952.

The impermeable Niobrara formation forces the water to the surface along this line, therefore, it is a natural line for springs to appear and start the streams flowing. Levels of ground water will be maintained at or near the present elevation, due to the geologic characteristics. For this reason the water table along this line can be treated the same as a stream that will maintain a constant water level.

The depletion to ground-water flow across this line is considered to be equal to the depletion to the river because most of the streams

Water Supply

begin their flow at or near this line. By making this assumption it is not necessary to break down the computations and determine the depletion to each stream separately.

The method outlined by Mr. R. E. Glover in his memorandum to the Hydrology Division, Branch of Project Planning, dated July 11, 1951, is used in the following computations to determine the potential depletion to the Bostwick water supply. The method is based on the following formula developed for computing the river depletion as a function of time, caused by pumping from a well near a river:

$$q = \frac{2 F}{\sqrt{\pi}} \frac{\int_0^{\infty} e^{-v^2} dv}{\frac{x}{\sqrt{4 h^2 t}}}$$

where F = flow from the well

V = ratio of volume of water drained
from a sand to total volume
of the sand

t = time since pumping began

$$h^2 = \frac{KD}{V}$$

K = permeability of the aquifer

D = saturated thickness of aquifer

q = flow from stream to well, or
in this case, depletion to
aquifer outflow by the well,
at time t

Table 44 has been compiled to show the computation of the potential depletion that would result from the possible development after 50 years. The average values for Pleistocene material have been used for the permeability and yield of the aquifer. A value of 0.00155 feet per second is used for K, the permeability, V, the ratio of voids to the total volume is estimated to be .20. A column by column explanation of the table follows. Column one identifies each township of potential depletion in the depletion study and column two lists the acreage of potential development in each township.

D, the average depth of the aquifer, is listed in column 3. Column 4 is h^2 which is equal to KD/V . Column 5 lists the value of x_1 , the distance from the center of the township or pumping area to the dotted line on exhibit 20. Columns 6 through 10 list the value of the quantity $\frac{x_1^2}{4h^2t}$ for 10, 20, 30, 40 and 50-year periods. The t

in this quantity is the pumping time in seconds. The values in these columns are used with probability integral tables to determine the values listed in columns 11 through 15. The values in columns 11 - 15 are deducted from 1 to obtain Q as posted in columns 16 - 20. Values of Q for a well operated for any part of the fifty years (say 40 years, Col. 19) are multiplied by acre-feet per annum depletion on the acreage which came into irrigation during the initial years for that land (in this case the 10th year to the 20th year, Col. 22). The product is 50th-year depletion in acre-feet by such land (Col. 27), as effected at the dotted line, Exh. 20.

It is expected that irrigation development in the area will necessarily occur over a considerable period of time. An estimate of this development period has not been made. Therefore, the rate of development curve, exhibit 21 determined for the Ladder Creek area in Kansas has been used for this area. Since little development has been made to date in this area, it is probable that the rate of development will be somewhat slower than in the Ladder Creek area where considerable development already exists. Exhibit 21 indicates that 7%, 13%, 12%, 10% and 3% of the total potential area would be developed in the succeeding incremental 10-year period during the first 50 years of development. The acreage that would be developed in each township according to this curve is listed in columns 21 - 25.

The average consumptive use of irrigation water under the Franklin Canal is 1.0 acre-foot per acre. One acre-foot per acre multiplied by the area developed, Col. 21 - 25, gives the consumptive use from water pumped. These columns, therefore, represent consumption from the water pumped. The rate of depletion for 50 years is multiplied by the acreage developed during the first 10 years and the depletion rate for 40 years is multiplied by the acreage developed during the second 10-year period, etc. Column 31, is the sum of columns 26-30. The total depletion for the 50th year is shown to be 6,560 acre-feet.

Depletions for private development in the Platte-Republican Divide area are determined on table 37 and discussed in the foregoing section, "Private Development." The discussion shows that depletions were made for development of only 2,600 acres and they would cause an average depletion of 2,600 acre-feet per acre per

year instead of the 6,560 acre-feet per acre indicated by the above computation. The 2,600 acre-feet depletion is considered to be the probable depletion for this area during the first 40 years, which is the repayment period of the contract. The rate of development curve used to obtain the 6,560 acre-feet depletion is based on the Ladder Creek area in Kansas where considerable development has been made. It is not believed that development will take place as fast in this area as it will in the Ladder Creek area.

Quality of ground water— The quality of ground water in Nebraska has been studied by Herbert A. Swenson and is reported in the United States Department of Interior, Geological Survey Circular 19. ^{1/} Table 45 lists the mineral constituents of wells in the Bostwick Division as published in the above report. The total salt and sodium percentages listed in this table have been plotted on exhibit 22. This exhibit indicates the ground water in the Nebraska portion of the division is of excellent quality insofar as these two factors are concerned. Analysis No. 3169, U. S. Geological Survey, Well No. 1-5-31 CC, indicates the water from this well has a little heavier salt concentration and a higher sodium percentage than any of the other wells listed. The water from this well, however, is quite satisfactory for irrigation purposes. Bar graphs showing the anions and cations in solution in equivalent parts per million were drawn to study the possibility of formation of sodium carbonates or bicarbonates. The above-mentioned analysis No. 3169, see table 45, was the only well that had water which indicated any possibility of formation of sodium carbonates. This well is located near Hardy, Nebraska.

The quality of ground water in the Kansas portion of the Bostwick Division is discussed by V. C. Fishel in the above-mentioned University of Kansas Publications Bulletin 73. The report indicates the aquifer in the region between the Nebraska-Kansas state line and Scandia is too thin for development of large quantities of water and the quality of water in this region is not reported. The aquifer in the region between Scandia and Concordia is adequate for development of irrigation wells. The water from the wells in the area between Scandia and the Republic County line is thought to be suitable for irrigation. The quality of the ground water in the area in Cloud County is questionable.

^{1/} Progress Report on the Ground-Water Hydrology of the Republican and Frenchman River Valleys by Herbert A. Waite and others with a section on the chemical quality of the ground water by Herbert A. Swenson.

Estimation of Downstream Water NeedPast Use

Water uses downstream from the Bostwick Division are largely confined to municipal, domestic and industrial uses. Municipal and domestic rights are all supplied from wells. A certificate of appropriation has been issued to the Sunflower Ordinance Works for the use of Kansas River water near Lawrence, Kansas to the extent of 93 second-feet. Vested rights for the use of natural flow are held by the Kansas Power and Light Company plant at Tecumseh, Kansas and the Bowersock mill at Lawrence, Kansas. According to information obtained from the office of the Kansas Division of Water Resources, the Kansas Power and Light Company right at Tecumseh is for use of 73.44 million gallons per day. This is approximately 114 cubic feet per second.

The amount of water that the Bowersock mill at Lawrence, Kansas is entitled to use has not been determined by the Division of Water Resources. The original grant was made by the City of Lawrence to Orlando Darling on September 30, 1872. The power has been used for various purposes since the right was first established. Power has been furnished to a paper plant and an ice plant for about 20 years. Excess power is sold to the Kansas Power and Light Company. The power plant consists of seven generators that will produce a total peak load of 2,000 kilowatts. It is estimated that 1850 cubic feet per second is required to produce the maximum load. This estimate is based upon an overall efficiency of 75% and an operating head of 17 feet. Historical periods of low flow have occurred which prevent maximum power production. Periods of high flow also prevent maximum power generation because high tail water causes loss of head.

The effect of development of the Bostwick Division upon the power rights on the Kansas River has not been finally determined. Return flows are expected to improve the flow and will be of benefit to the power rights during low flow periods. The reservoirs will also be beneficial to power rights because of the regulation that will be given to flood flows. The water supply studies show that development in Colorado and Nebraska will be within the terms of the Republican River Compact, therefore only diversions or storage in Kansas are considered to cause possible depletions which would affect the power rights on the Kansas River. If diversions at Scandia and storage in Lovewell adversely affect the downstream power development during initial phases of development, water can be released from storage to correct the condition. Further study is planned for determining the effect of all basin development upon the Kansas River power rights. It is anticipated that a system operation of all Federal reservoirs in the Kansas River Basin will be coordinated to provide compensating replacement flows from downstream reservoirs to allow for adverse effects created by required operation of upstream reservoirs.

Expected future Requirements

The Lower Republican Division below Concordia, Kansas, is outlined as an area for future irrigation development in the Kansas River Basin. There is very little interest in irrigation in this area at the present time because the rainfall is sufficient for the type of agriculture now practiced. Because of the lack of interest in irrigation in the area there is no immediate plan for development of the area. If at some future date an interest in irrigation is developed, the amount of development will necessarily be limited to the available water supply at that time.

Water Requirements for the Bostwick Division

Water requirements that will create a demand on Harlan County and Lovewell Reservoirs will include water required for irrigating lands in the Bostwick Division, water lost by evaporation from the reservoirs, and water lost due to seepage from the reservoirs. In addition, releases must be made to meet minimum Public Health Service recommendations and to counteract historical stream losses in order to maintain a live stream.

Water requirements for irrigation of crops are dependent upon the consumptive use of water by the irrigated crops, the effective precipitation in the area, and transportation and farm losses.

Irrigation water requirements

Weather Bureau stations from which data were used in computing consumptive use and effective precipitation for the units in the Bostwick Division were as follows:

Weather Bureau records used for Bostwick Division		
Unit	Temperature Records	Precipitation Records
Franklin-Red Cloud Courtland	Red Cloud, Nebraska Average of Red Cloud, Nebr. Republic, Kansas and Concordia, Kansas	Red Cloud, Nebraska Superior, Nebraska
Superior-Courtland Scandia	(Same as Courtland Unit) Concordia, Kansas	Superior, Nebraska Concordia, Kansas

The procedure followed in determining the irrigation and diversion requirements was as follows: the consumptive use and the effective precipitation were determined for each unit; the consumptive use of irrigation water was then determined by subtracting the effective precipitation from the consumptive use requirement. Diversion requirements were then determined by multiplying the consumptive use requirements of irrigation water by factors which allowed for the distribution and farm losses.

Consumptive use--The Lowry-Johnson method was used in determining consumptive use requirements for the project areas.^{1/} This method makes use of a relationship between effective heat units and annual consumptive use of water. The correlation was established by Lowry and Johnson in a study of a considerable number of irrigated areas receiving a full water supply, where the difference between total inflows and outflows could be observed.

Temperature records used were those for the stations maintained by the Weather Bureau nearest the respective project area, or in some cases, the average of appropriate stations.

By accumulating the daily maximum degrees in excess of 32 degrees Fahrenheit during the effective growing season, a value representing the total day degrees of effective heat for each year was obtained, which, by use of the Lowry-Johnson curve, could be translated to annual consumptive use of water in feet depth.

The effective heat in day degrees and total consumptive use for the Franklin-Red Cloud Unit, for Republic, Kansas and for the Scandia Unit are shown in tables 46, 47, and 48. An average of the consumptive use determined in the above tables was used for the Superior and Superior-Courtland Unit. The consumptive use thus determined is listed in the distribution of consumptive use, table 50.

The effective growing season for each unit was defined by a plotted line showing the date on which the mean minimum temperature rose above 32 degrees in the spring and the date on which it dropped below 32 degrees in the fall.

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

The annual consumptive use was distributed throughout the year by use of the following percentages:

Monthly distribution of annual consumptive use					
Month	Percent	Month	Percent	Month	Percent
Jan.	1	May	10	Sept.	12
Feb.	2	June	14	Oct.	6
Mar.	5	July	19	Nov.	3
Apr.	8	Aug.	18	Dec.	2

This distribution is based upon published data obtained 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 figures because of a difference in the anticipated crop pattern. Tables 49 through 51 show the annual consumptive use distributed on a monthly basis for the units in the Bostwick Division.

Effective precipitation--Since not all precipitation falling on a project area is effective in meeting consumptive use requirements, recorded precipitation must be adjusted to compensate for runoff. Effective precipitation is the rainfall that percolates into the soil and is held in the crop root zone for future use.

The effective precipitation for the Bostwick Division was determined by applying percentages of effectiveness to increments of monthly precipitation to determine the effective precipitation for each unit in the division. An average of the incremental percentages suggested in the Water Requirement section of the Bureau Manual were used. These average values are as follows:

<u>Precipitation Increment</u>		<u>Effective Precipitation</u>	
Inches per month	Percent	Inches 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	

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Precipitation recorded by the Weather Bureau at Red Cloud and Superior, Nebraska, and at Republic and Concordia, Kansas, are listed in tables 52, 53, 54, and 55, respectively. The effective precipitation for all units in the division is listed in tables 56 through 58.

Consumptive use requirements of irrigation water--The consumptive use requirement of irrigation water was determined by subtracting the monthly effective precipitation for each unit from the monthly consumptive use requirement for that unit. Since the soil acts as a reservoir, effective precipitation unused during any month was considered available for use the following month, providing the maximum holding capacity of the soil was not exceeded. This holding capacity was considered to be 0.5 foot.

Any consumptive use requirements for the November through March period not satisfied by effective precipitation were treated as requirements for irrigation during the following April and May, one-half the deficiency being applied to each month. Tables 59 through 61 list the consumptive use requirements of irrigation water in acre-feet per acre for the Bostwick Division Units.

Diversion requirements--In order to satisfy crop irrigation requirements it is necessary to divert water sufficient to meet farm distribution losses and transportation losses and have enough water left to satisfy the consumptive use of irrigation water requirements. Estimates of these losses were made by operations specialists of Region 7, Bureau of Reclamation.

The crop irrigation requirement multiplied by 100 divided by 100 minus the percent of farm loss gives the farm delivery requirement. The diversion requirement in feet per acre is obtained by multiplying the farm delivery requirement by 100 divided by 100 minus the percent of transportation loss.

Transportation losses and farm losses, used to determine the diversion requirements are listed in the following table:

Table 62. Transportation and farm losses for units in the Bostwick Division

Unit and canal	Transportation loss, percent	Farm loss percent
Franklin Unit		
Franklin, Naponee and		
Franklin, Pump Canal	35	35
Red Cloud Pump	25	35

Table 62. Transportation and farm losses for units in the Bostwick Division (Contd)

Unit and canal	Transportation loss, percent	Farm loss percent	
Superior-Courtland Unit			
Superior Canal	35	31	69
Courtland Unit			
Courtland Canal	33	23	77
Scandia Unit			
Scandia Canal	30	30	70

The diversion requirement in acre-feet per acre for each canal in the division has been determined and is shown in tables 63 through 67. The diversion requirement is shown to be considerably less in the eastern end of the division than in the western end. The average annual diversion requirement varies from 2.39 acre-feet per acre under the Franklin Canal to 1.76 acre-feet per acre in the Scandia Unit. Annual diversion requirements are shown to be as great as 4.22 acre-feet per acre, see 1934, Franklin Canal, table 63, and as little as 0.24 acre-feet per acre, see 1944, Scandia Unit, table 67.

The diversion requirements for 18,250 acres in the Franklin-Red Cloud Unit are listed in table 72. This table is the sum of tables 68 through 71, the diversion requirement for 14,410 acres under the Franklin Canal, for 2,070 acres under the Franklin Pump Canal, for 1,490 acres under the Naponee Canal and 280 acres under the Red Cloud Pump. Table 73 lists the diversion requirements for the 6,790 acres under the Superior Canal. It was necessary to break the diversion requirements for the Courtland Canal down into separate components for the operation study. Accordingly, table 74 lists the diversion requirements for the 2,960 acres under the Courtland Canal in Nebraska, table 75 lists the requirements for the 12,500 acres under the Courtland Canal in Kansas, and 76 lists the diversion requirement for the 36,500 acres below Lovewell. The diversion requirements for the 13,000 acres in the Scandia Unit are listed in table 77.

Return flow--Return flow results from that portion of the transportation and farm distribution losses which return to the stream. Water is lost in canal and farm laterals due to evaporation, transpiration by stream-bank vegetation, and percolation into the ground from the banks of the canal. The water that percolates into the ground will

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eventually reach the ground water where it will generally cause the ground water table to rise until the water can enter the stream. The foregoing discussion of ground water shows the slope of the water table is toward the stream due to this gradient. The ground water will eventually re-enter the stream and become live flow or it will be used by vegetation. The raising of the ground water table due to irrigation will often cause an increase in the consumptive use of native vegetation in the area due to seepage areas being formed or due to the ground water becoming more readily available to native vegetation.

Since most of the project area lies close to the river and because the ground water table slopes toward the river, it is anticipated that most of the return flow will enter the river and become live flow. Any possible increase in the consumptive use of water by native vegetation is not expected to be great. For these reasons it has been estimated that 75 percent of the difference between annual diversions and annual consumptive use of irrigation water by crops will eventually return to the stream.

Due to variations in geological formations and ground water movement the return flow pattern in any area can be expected to have its own individual characteristics. It can be expected to enter the stream during every month of the year at varying rates. The monthly distribution of return flow is expected to be similar to that for the North Platte Project in Nebraska, with a slight variation during the summer months due to an expected peak demand in July and August.

The percent of the total annual return flow for each month as used in this study is shown below:

Month	Percent of total	Month	Percent of total	Month	Percent of total
Jan.	7	May	7	Sept.	12
Feb.	6	June	8	Oct.	11
Mar.	6	July	9	Nov.	9
Apr.	6	Aug.	11	Dec.	8

The return flow for each unit in the division is shown in tables 76 through 83. The return flow is based upon the diversion requirement, therefore, the return flow after years of short water supply will be slightly less than determined. Return flows were not corrected for periods of shortages. The return flow determined is considered to be within the accuracy of the study.

The return flow from the Franklin-Red Cloud Unit, table 78, was considered available at the Superior-Courtland Diversion in the operation study. The return flows from the land under the Superior Canal, table 79; the return flows from the land under the Courtland Canal in Nebraska, table 80; and the return flows from an estimated 23,000 acres above Scandia are considered to be available at the Scandia Diversion Dam. The remainder of the return flows from the land under the Courtland Canal, 26,000 acres, and the return flows from the Scandia Unit, table 83, will pass downstream unused.

Municipal, domestic and industrial requirements--At the present time practically all of the water used in the division for municipal, domestic and industrial purposes is obtained from wells. There are no large cities in the division requiring large quantities of water. Industries existing in the area do not materially affect the water supply. Future growth of the cities in the area and the growth or change of industry are not expected to affect the water supply to any great extent, therefore, no allowance has been made in this study for the use of water for these purposes.

Investigations have been made regarding the possibility of supplying water from Lovewell Reservoir to three towns in north central Kansas, namely Mankato, Jewell and Formoso. The 1930, 1940 and 1950 population of these towns is listed in the following tabulation:

City	1950	1940	1930
Formoso	271	293	381
Jewell	593	669	707
Mankato	1,462	1,426	1,404

Mankato, about eight miles south of the upper end of Lovewell Reservoir, would obtain water from the reservoir by use of pumps and a pipe line about eight miles long. Since the town is now served by wells located in the vicinity of the upper portion of the reservoir, it is likely that the ground water conditions in the area of the wells will be improved enough to satisfy the municipal requirements of Mankato. However, in the event that the ground water supply proves inadequate it is possible that a water supply could be obtained from the reservoir. Assuming a use of 120 gallons per day per capita this would amount to about 180,000 gallons per day or about 202 acre-feet per year.

Jewell, which is about nine miles south of Mankato, could obtain water through the Mankato system by extending a pipe line nine miles from the Mankato water tower to the existing Jewell water tower. The

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use of water based upon the 1930 population would be about 84,000 gallons per day or about 94 acre-feet per year. Since part of the project area is in the vicinity of Jewell, it is expected that the water table will rise as a result of irrigation on the project and will thus increase the output of the municipal wells.

Formoso, about eight miles southeast of Lovewell Reservoir, could obtain water from Lovewell Reservoir by use of a gravity pipe line about nine miles long or by taking water out of the irrigation canal, or by a pipe line from Mankato. The use of water based upon a population of 400 would amount to 48,000 gallons per day or 54 acre-feet per year.

In the event that the three towns do obtain water from Lovewell Reservoir the initial use of water as determined above would amount to about 350 acre-feet per year excluding transportation losses. It is estimated that when transportation losses and increases in population are considered the total future use will not exceed 1,000 acre-feet per year. Use of this quantity of water would have little effect upon the water supply studies presented in this report.

Past investigations concerning the water supply for towns below Harlan County Dam also considered the possibility of supplying supplemental municipal water supply from Harlan County Reservoir to Superior, Nebraska. This town with a 1950 population of 3,227 is on the Republican River near where the river first crosses the state line. Studies of anticipated flow of the Republican River at this point after project development have indicated that the base flow of the river will be improved. It is also expected that the increase in ground water supply, because of irrigation in the area, will increase the output of wells now serving the town of Superior.

The quality of the municipal water supplies in the Bostwick Division is considered satisfactory in regard to all factors except hardness. Water from city wells in this area have a hardness ranging from 250 to as much as 400 parts per million. Water with less than 60 parts per million hardness is considered soft, 61 to 120 parts per million is usually rated as moderately hard. Water with 120 to 180 parts per million is classified as hard and above 180 parts per million as very hard. Considerable savings in soap consumption can be effected by softening the water when the hardness is above 120 parts per million. So far as is known Superior, Nebraska, is the only town in this area that softens its water. A study of the quality of water for municipal use in the Republican Valley in Nebraska has been made by the Geological Survey Circular 19, August 1948.^{1/}

^{1/} Progress Report on the ground water hydrology of the Republican and Frenchman River Valleys by Herbert A. Waite and Others, with a section on the chemical quality of the ground water by Herbert A. Swenson.

It has been pointed out that return flows from irrigation are expected to improve the ground water supply. It is not expected that return flow will materially affect the quality of the ground water.

Power---A right for the use of 400 second-feet of Republican River water near Superior, Nebraska, was held by the Consumers Public Power District for the development of power. Full irrigation development as presented herein was dependent upon the subordination of this right to irrigation rights as provided for under Nebraska water laws.

The Bureau of Reclamation purchased the Superior hydro and obtained title on November 13, 1951. The Bureau of Reclamation permitted the Consumers District to operate the hydro under a lease agreement until supplemental power could be furnished from the power lines of the Nebraska Public Power System. The lease agreement expired February 1, 1952, and the power plant ceased operation on this date. The present Bureau plan of development for the Bostwick Division does not provide for the construction of any power plants. All of the regulated water in both Harlan County and Lovewell Reservoirs is required for the irrigation of the land in the division, hence, no water is available for the generation of base load power. A considerable amount of electric energy could be generated at Harlan County Reservoir with water released for irrigation purposes and with spills in high water years if the power could be absorbed in a scheme of system operation with other power plants of the Missouri Basin development. A power penstock is being provided at the Harlan County Dam for the possible addition of a small power plant in the future but up to the present time the construction of a power plant has not been considered feasible because of the high costs. No power installations are to be made at the Lovewell Reservoir.

Pollution abatement---The Public Health Service has made recommendations for specified minimum flows at certain points along the Republican River to maintain live flow and avoid harmful pollution of the stream. The two most important points are near Superior, Nebraska, where a minimum summer flow of 40 second-feet is desirable and at Scandia, Kansas, where a minimum summer flow of 30 second-feet is recommended. These minimum flows were satisfied in the operation study by natural flow or by reservoir releases. It was assumed that by maintaining the recommended flow at Superior, Nebraska, and Scandia, Kansas, that the recommended flow at other points would be satisfied.

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The minimum flows recommended by the Public Health Service at critical points in the district and at Clay Center and Junction City, Kansas, below the district are listed in the following table: 1/

Table 84. Recommended minimum flows of the Republican River below Harlan County Reservoir

(Unit - second-feet)							
Month	Franklin	Red Cloud	Superior	Scandia	Concordia	Clay Center	Junction
	Nebraska	Nebraska	Nebraska	Kansas	Kansas	Kansas	City, Kans.
Jan.	1.6	4	8	6	9.4	6.6	8
Feb.	1.6	4	8	6	9.4	6.6	8
Mar.	2	5	10	7.5	9.3	8.3	10
Apr.	3.2	8	16	12	18.8	13.2	16
May	4.8	12	24	18	28.2	19.8	24
June	8	20	40	30	47	33	40
July	8	20	40	30	47	33	40
Aug.	8	20	40	30	47	33	40
Sept.	8	20	40	30	47	33	40
Oct.	3.6	9	18	13.5	21.2	14.8	18
Nov.	2.4	6	12	9	14.1	9.9	12
Dec.	1.6	4	8	6	9.4	6.6	8

In the operation study the desired minimum flows as recommended at Superior, Nebraska, and Scandia, Kansas, by Public Health Service were taken into consideration and in all months these requirements were satisfied. The desired minimum flows at Franklin and Red Cloud, Nebraska, are small in comparison with the required minimum flows at Superior and Scandia, therefore no releases were needed for these towns. Below Scandia there is sufficient gain in the flow plus the return flows from Scandia Unit and Lower Courtland area to meet the required minimum flows at Concordia, Clay Center, and Junction City, Kansas.

Fish and wildlife--It is expected that the maintenance of a live stream in the Republican River below Harlan County Reservoir as recommended by Public Health Service will also adequately provide for fish and wildlife requirements, therefore no additional releases are to be made for the purpose. Large benefits will accrue to fish and wildlife due to the storage of water in Harlan County and Lovewell Reservoirs. These reservoirs will have an initial surface area for water fowl, with the irrigation storage pool filled, of 13,600 acres and 2,975 acres, respectively. During the first ten years of operation

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

the surface area in Harlan County Reservoir will not drop below 9,100 acres. The operation study for the conditions after 50 years indicates that the storage in Harlan County Reservoir may be reduced to the sill of the irrigation outlet (elevation 1920.0) during extreme dry cycles. The minimum surface area at this elevation would be 5,200 acres.

Navigation--There are no navigation requirements on the Republican River. This irrigation development in the Republican River Basin will not adversely affect the navigability of the streams below the mouth of the Republican River. Flood flows will be largely eliminated, which will limit releases to channel capacities and the low flows will be improved by return flows from the irrigated areas.

Estimation of Reservoir Losses

Seepage

Geologists of the Bureau of Reclamation estimate that the seepage from Harlan County and Lovewell Reservoirs will be very low. The foundation at both dams will be in clay or silt and shale, and the cut-off complete. At Harlan County Dam, the seepage as estimated will range from 1 to 2½ second-feet and at Lovewell Dam seepage will be ¼ to 2 second-feet. An average figure of 100 acre-feet per month for each reservoir was used in this study. This seepage was not used to satisfy any of the irrigation demands, but was allowed to pass downstream.

Surface Losses

The gross reservoir evaporation rate at Harlan County Reservoir was computed by use of evaporation records at Hays, Kansas, and data published by the Minnesota Resources Commission.^{1/} The Hays, Kansas, evaporation records were corrected to free surface evaporation, see table 85. A Bureau of Plan Industry evaporation pan was used up to June 1937 for measuring the evaporation. These records were corrected by multiplying by a coefficient of 0.94. After June 1937 the evaporation was measured from a U. S. Weather Bureau pan and these records were corrected by using a coefficient of 0.70.

^{1/} Minnesota Resources Commission Report June 1942, "Evaporation From Lakes and Reservoirs" study directed by Adolph F. Meyer.

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The gross evaporation rate at Lovewell Reservoir was computed by using evaporation records at Lincoln, Nebraska, and data published by the Minnesota Resources Commission.^{1/} These records are from the U. S. Weather Bureau evaporation pan measurements and were corrected to free surface evaporation by use of a coefficient of 0.70, see table 86.

Since these evaporation stations are located some distance from the reservoirs, a correction factor had to be applied to obtain the gross evaporation rate at the reservoirs. These correction factors were determined by using a series of charts published by the Minnesota Resources Commission which shows the average monthly evaporation rates for each section of the United States.^{1/}

By interpolation between the lines of equal evaporation, a ratio was obtained between average evaporation at the points where records were kept and the average evaporation at the reservoir areas. These ratios were applied to the free water surface evaporation determined for each month and the gross evaporation rates at the reservoirs were obtained. The ratios thus determined are as follows:

Month	Harlan Co. Res. ^{a/}	Lovewell Res. ^{b/}
April	0.91	1.12
May	0.95	1.08
June	0.94	1.09
July	0.94	1.08
August	0.92	1.06
September	0.92	1.16
October	0.92	1.09

a/ Factor applied to Hays evaporation rates.

b/ Factor applied to Lincoln evaporation rates.

Records of evaporation were not collected at Lincoln or Hays during the November through March period, therefore evaporation rates for these months were taken directly from published charts.^{1/} Prior to 1937, no records were kept during October at Hays.

^{1/} Minnesota Resources Commission Report June 1942, "Evaporation From Lakes and Reservoirs" study directed by Adolph F. Meyer.

The rates for the October through March period, taken from the Minnesota Resources Commission charts are listed in the following tabulation:^{1/}

Month	Evaporation in inches	
	Harlan Co. Res.	Lovewell Res.
October	4.70	4.65
November	2.65	2.55
December	1.20	1.15
January	1.00	0.95
February	1.20	1.15
March	2.20	2.10

Table 87 lists the gross evaporation rate determined for Harlan County Reservoir and table 88 lists the gross evaporation rate determined for Lovewell Reservoir.

Net reservoir evaporation rate--Net reservoir evaporation loss was considered to be the difference between future and past consumptive use from the reservoir area.

For this study the net evaporation rate was computed to be the gross evaporation rate minus the precipitation over the reservoir area. The precipitation at Orleans, Nebraska, table 89, was used for the precipitation upon Harlan County Reservoir and the precipitation at Burr Oak, Kansas, table 90, was used for the precipitation upon Lovewell Reservoir. The net evaporation rate in inches for Harlan County and Lovewell Reservoirs is shown in tables 91 and 92.

To facilitate computations in monthly reservoir operations, a series of curves, one for each inch of net evaporation, were drawn by plotting reservoir content in 1,000 acre-feet as ordinates and evaporation loss in 1,000 acre-feet as abscissas. The evaporation loss for any month was obtained by entering this curve with the monthly evaporation rate in inches and the average reservoir content for the month. The reservoir evaporation curves are shown in exhibits 23 and 24.

Operation Studies

General Operation plan

The irrigable lands of the five units that comprise the Bostwick Division were served by the operation of Harlan County Reservoir and

^{1/} Minnesota Resources Commission Report June 1942, "Evaporation From Lakes and Reservoirs" study directed by Adolph F. Meyer

in part by Lovewell Reservoir. 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 Bostwick Division for development. The study was based upon the water supply and climatic conditions existing during the period of January 1929 through September 1947. This period was selected for the study because it includes the 10-year period 1931 through 1940 which is considered to be the most critical period of water supply that has been experienced in this area. It is reasonably certain that if the water supply is adequate to satisfy conditions existing during this period without intolerable shortages, there will be an adequate water supply for all planned development. Water supply and climatic conditions over the period of 1941 through 1947 represent conditions that are more nearly normal.

The operation study included in this report is based upon reservoir storage capacity expected to exist in Harlan County Reservoir and Lovewell Reservoir after 50 years of operation. It is estimated at the end of 50 years that the active irrigation storage capacity in Harlan County Reservoir will be 175,000 acre-feet and in Lovewell Reservoir the active irrigation storage capacity will be 35,000 acre-feet. However, in Lovewell Reservoir only 24,000 acre-feet of the irrigation capacity were considered active in the operation study for reasons explained in the paragraph on operation criteria. The reduction in storage capacity from initial conditions is the result of the accumulation of sediment in the reservoir. Water available for development of all units in the Bostwick Division was computed to be the water remaining after allowances for future development that will occur above the division in the Republican Basin due to Bureau planned development and for anticipated future private development of irrigation and ponds.

Operation criteria

The following operation criteria were used in making the operation study:

- A. Method of meeting irrigation demands.
 1. Sectional gains made up of natural gain, return flow and wastes from upstream units were first diverted to meet irrigation demands.
 2. Irrigation demands not met by the sectional gains were met by releases from Harlan County and Lovewell Reservoirs. Spills occurred only after irrigation demands were met.

B. Requirements for other than irrigation demands.

1. Negative sectional gains that occurred historically on the Republican River between Harlan County Reservoir and Scandia Diversion Dam were met by reservoir releases before irrigation or Public Health Service demands on the reservoir could be supplied.
2. Releases were made from Harlan County Reservoir to supply a flow at Superior, Nebraska and Scandia, Kansas equal to or greater than the required minimum flow as determined by the Public Health Service at these two locations.
3. Evaporation losses from Harlan County and Lovewell Reservoirs were determined in accordance with the average monthly reservoir content and monthly evaporation rate.
4. Seepage was estimated to be 100 acre-feet per month from each reservoir.

C. Reservoir contents.

1. The reservoir irrigation storage capacity is full when Harlan County Reservoir reaches a content of 250,000 acre-feet; and when Lovewell Reservoir reaches a content of 36,000 acre-feet.
2. No releases could be made from the reservoirs when storage was drawn down to a content of 75,000 acre-feet for Harlan County Reservoir and 12,000 acre-feet for Lovewell Reservoir. The storage in Lovewell Reservoir was held to a minimum of 12,000 acre-feet to provide sufficient head in the reservoir to assure the delivery of the maximum diversion requirement of 634 second-feet to the Courtland Canal from Lovewell Reservoir.

D. Integration of operation with other units.

1. No releases from upstream reservoirs were made to help satisfy demands in the Bostwick Division.

2. No releases were made from Bostwick Division reservoirs to help satisfy demands outside the Division.

The operation study for the Bostwick Division consists of two tables. Table 93 presents the computations made to determine the total demand on Harlan County Reservoir by the lands above Lovewell Reservoir and below Scandia Diversion Dam. Table 94 presents the operation of Harlan County and Lovewell Reservoirs together in meeting the demands as computed in the previous table.

Determination of demand on reservoirs

Computations to determine the total demand to be met by the reservoirs in the Bostwick Division are shown in table 93. An explanation of columns that make up this table is as follows:

- Col. 1 lists the years and months of the period of study.
- Col. 2 is the Diversion requirement for the Franklin-Red Cloud Unit, a total of 18,250 acres. The demand by units is shown in table 72. This demand is met by direct releases from Harlan County Reservoir.
- Col. 3 is the depleted sectional gain, table 38, between Harlan County Reservoir and Superior-Courtland Diversion Dam. The historical pickup was depleted for anticipated future private irrigation and pond development in the reach.
- Col. 4 is the return flow occurring from the 18,250 acres in the Franklin-Red Cloud Unit which will be available at the Superior-Courtland Diversion Dam. See table 78.
- Col. 5 is the sum of Col. 3 and Col. 4 and is the total natural flow available for use at the Superior-Courtland Diversion Dam.
- Col. 6, Col. 7 and Col. 8 are the diversion requirements for the Superior Canal, 6,790 acres; Courtland Canal in Nebraska, 2,960 acres, and the Courtland Canal in Kansas above Lovewell, 12,500 acres. These are shown in tables 73, 74 and 75.

Col. 9 is the sum of Col. 6, Col. 7 and Col. 8 and is the total demand for Superior Canal and the Courtland lands above Lovewell Reservoir.

Col. 10 lists reservoir releases from Harlan County Dam which must be made to meet the demand shown in Col. 9, after the natural flow in the section, Col. 5, has been used.

Col. 11 Reservoir releases from Harlan County Dam which must be made to meet negative flows as shown in Col. 5.

Col. 12 is the natural flow diverted to Lovewell Reservoir through Courtland Canal. During all months except January and February, any of the natural flow not used for the demands shown in Col. 9, is diverted through the Courtland Canal to Lovewell Reservoir. No attempt was made to determine if the water thus diverted would be stored or spilled. The quantities for June 1935 and 1941 are in excess of 44,600 acre-feet, the amount which can be passed through the canal in one month. The Lovewell operation study shows this water is spilled from the reservoir unused. The indicated diversion would not be made in actual practice.

Col. 13 is the natural flow passing Superior-Courtland Diversion, during January and February.

Col. 14 is the natural gain between Superior-Courtland and the Nebraska-Kansas state line. See table 20.

Col. 15 and 16 are the return flow from the lands under the Superior Canal and the Nebraska portion of the Courtland Canal, see tables 79 and 80.

Col. 17 is the sum of Cols. 13, 14, 15 and 16 and is the total natural flow at the state line that has not been used above this point or diverted to Lovewell Reservoir. Negative values indicate a loss in flow for the reach.

- Col. 18 lists the minimum flows recommended at Superior, Nebraska, by the Public Health Service. These minimum flows vary according to the season of the year. See Table 84.
- Col. 19 releases made to meet negative values occurring in Col. 17.
- Col. 20 lists releases made to bring low flows up to the minimum recommended by Public Health Service.
- Col. 21 is the total flow passing Superior except spills. This column is for the purpose of comparing actual flows with recommended minimum flows, the flow at the state line being considered same as the flow at Superior. It is the sum of Cols. 17, 19, 20, 26, 27, 28 plus the seepage from Harlan County Reservoir of 100 acre-feet per month. The seepage from Harlan County Reservoir is not shown in previous columns.
- Col. 22 is the natural gain between the state line and Scandia, Table 21.
- Col. 23 is the return flow entering the river between the state line and Scandia Diversion dam. This will be from 23,000 acres under the Courtland Canal in the plan which includes Lovewell Reservoir, see Table 81.
- Col. 24 is the total natural flow available at Scandia Diversion and is the sum of Cols. 17, 19, 20, 22, and 23.
- Col. 25 is the irrigation demand for 13,000 acres in the Scandia Unit, Table 77.
- Col. 26 is the portion of Col. 25 not met by Col. 24, and therefore is a demand on Harlan County Reservoir.
- Col. 27 lists releases to be made for meeting negative flows occurring in Col. 24.
- Col. 28 lists releases required for meeting minimum Public Health requirements shown in Col. 30.
- Col. 29 is a check column for comparing flows passing Scandia with the recommended minimum flows, Col. 30. It includes Col. 24 minus Col. 25 plus Col. 26 plus Col. 27 plus Col. 28 plus seepage from the two reservoirs.

Water Supply

- Col. 30 is the minimum monthly flows recommended by Public Health Service. See Table 84.
- Col. 31 is the total demand on Harlan County Reservoir for irrigation after using all available river accretion and return flow. It is the total of Cols. 2, 10, and 26.
- Col. 32 is the total reservoir requirement for meeting river losses, the sum of Cols. 11, 19 and 27.
- Col. 33 is the total reservoir release for meeting public health requirements. It is the sum of Cols. 20 and 28.
- Col. 34 is the sum of Cols. 31, 32 and 33 and is the demand on Harlan County Reservoir by all lands in the Bostwick Division except those under the Courtland Canal below Lovewell Reservoir. It also includes all releases necessary for meeting river losses and minimum public health requirements.

Reservoir Operation

An explanation of each column presented in the operation of Harlan County and Lovewell Reservoirs together, table 94, is as follows:

- Col. 1 shows the years and months the operation study was made.
- Col. 2 is the depleted inflow computed as explained under the topic "Project Water Supply," and is the same flow presented in table 36.
- Col. 3 evaporation rate in inches (table 91) equals gross evaporation less precipitation.
- Col. 4 reservoir evaporation loss computed by using the average content for that month and the previous month (see Col. 9) and entering the "Reservoir Evaporation Chart," exhibit 23, with the known evaporation rate, Col. 3 and determining the loss therefrom.
- Col. 5 seepage from Harlan County Dam was estimated as 100 acre-feet a month and was used to help meet the minimum flow required by Public Health Service at Superior, Nebraska, and Scandia, Kansas.

Water Supply

- Col. 6 shows the demand on Harlan County Reservoir in meeting demands in the Bostwick Division above Lovewell and below Scandia Diversion Dam. These releases consist of requirements for irrigation, stream losses, and Public Health Service. They were determined in Col. 34, table 93.
- Col. 7 shows releases required from Harlan County Reservoir for meeting the demands of the Courtland Unit below Lovewell that can not be supplied by Lovewell Reservoir. It is the demand computed in Col. 23.
- Col. 8 is the change in reservoir content computed as Col. 2 less the sum of Cols. 4, 5, 6, 7, 10; plus 11.
- Col. 9 is the reservoir content at the end of each month computed by adding or subtracting figures in Col. 8 to the content of the previous month.
- Col. 10 lists the reservoir spills - Computations for Col. 9 in excess of 250,000 acre-feet, the limit of storage in Harlan County Reservoir.
- Col. 11 lists the irrigation shortage. It is that amount of Col. 6 and Col. 7 that cannot be met by reservoir inflow or reservoir releases and maintain a minimum storage content of 75,000 acre-feet.
- Col. 12 is the inflow to Lovewell Reservoir made up of the flow of White Rock Creek, table 13.
- Col. 13 is the inflow to Lovewell of the Republican River computed in Col. 12 of table 93.
- Col. 14 lists the portion of the spills from Harlan County Reservoir, Col. 10, which could be stored in Lovewell Reservoir in the amount not to exceed the storage capacity of 36,000 acre-feet in Lovewell Reservoir.
- Col. 15 lists the inflow in Lovewell Reservoir. It is the sum of Col. 12, 13 and 14.
- Col. 16 lists the reservoir evaporation rate for Lovewell Reservoir, table 92, computed as the gross evaporation less precipitation.

Water Supply

- Col. 17 lists the reservoir evaporation loss computed by entering the "Reservoir Evaporation Chart," exhibit 24, with the known evaporation rate, Col. 16, and the average reservoir content of that month and the previous month.
- Col. 18 is the seepage from Lovewell estimated as 100 acre-feet a month and utilized in helping to maintain the minimum flow requirements at Scandia, Kansas, as required by Public Health Service at that point.
- Col. 19 lists the irrigation demand for 36,500 acres in the Courtland Unit below Lovewell. See table 76.
- Col. 20 is the change in reservoir content computed as Col. 15 less the sum of Columns 17, 18, 19. Any change that would result in drawing the reservoir below a content of 12,000 acre-feet becomes a demand on Harlan County, Col. 23. Any change resulting in a content of more than 36,000 acre-feet becomes a spill and the excess is listed in Col. 22.
- Col. 21 is the reservoir content at the end of each month computed by adding or subtracting figures in Col. 20 to the content indicated in the previous month.
- Col. 22 is the reservoir spills. It is the water listed in Column 15 that cannot be stored in Lovewell Reservoir due to the limited irrigation storage capacity of 36,000 acre-feet.
- Col. 23 is the amount of Col. 19 not supplied by Lovewell Reservoir thus making a demand on Harlan County Reservoir.

The operations of Harlan County Reservoir and Lovewell Reservoir are presented graphically in exhibits 25 and 26 respectively.

Operation hydrographs of reservoirs

Exhibit 25 shows the various hydrographs for Harlan County Reservoir. The top hydrograph represents the available inflow at Harlan County Reservoir depleted for all Bureau and Future Private development. The portion of the inflow not storable is indicated to spill. The middle hydrograph shows the total demands and how each was supplied. The demands not supplied (shortages) are

indicated by a solid black mark. The bottom hydrograph represents the changes in the reservoir content.

Exhibit 26 shows the various hydrographs for Lovewell Reservoir. The top hydrograph made up of different parts representing the total inflow to Lovewell Reservoir, namely White Rock Creek flow, storable accretion from Republican River and spills from Harlan County Reservoir. Each part is as explained under the legend shown on the exhibit.

The middle hydrograph shows how the total demand for that area below Lovewell Reservoir was served. Shortages occurred in 1934 and 1940.

The lower hydrograph shows the changes in the reservoir content during the period of study and the spills occurring during the operation study.

Effect of Courtland Canal capacity upon operation criteria

The Courtland Canal is designed with a headgate capacity of 751 cubic-feet per second. This capacity is not large enough for serving all the lands under the Courtland Canal from Harlan County Dam. Demands were not placed upon Harlan County Reservoir in the water supply study presented in this report until all usable water in Lovewell Reservoir was released. Under actual operating conditions this criteria would have to be changed and enough water will have to be held in Lovewell Reservoir at the first of July in order to assure that maximum demands for July and August can be met.

There are 51,960 acres served by the Courtland Canal. A capacity of 912 cubic-feet per second would be required to deliver the maximum monthly requirement of 0.97 acre-feet per acre plus 10 percent for peaking requirements from Harlan County Dam. The canal was designed with a headgate capacity of 751 cubic feet per second to serve approximately 43,000 acres. The canal, therefore, lacks 161 cubic feet per second of being able to serve all the lands under it from Harlan County Dam. This capacity would deliver 8,800 acre-feet in one month. If 8,800 acre-feet is held in storage in Lovewell the first of August and 17,600 acre-feet the first of July it will be possible to operate and serve maximum demands to the 51,960 acres under the Courtland Canal. In some years this would mean that water would have to be released from Harlan County and stored in Lovewell during the last part of June.

Water Supply

A check of the operation studies indicates that the content of the reservoirs at the end of August would be the same as shown in the operation study in this report when the above criteria is used. It is concluded, therefore, that this criteria can be used in actual operations without increasing the shortages as determined.

Operation summary

Table 95 summarizes the operation of Harlan County Reservoir and Lovewell Reservoir by years. It is interesting to note that spills occur 16 years out of 19 years for Harlan County Reservoir and spills occur 15 years out of 19 years for Lovewell Reservoir. The average annual spill for 18 complete years was 213,900 acre-feet for Harlan County Reservoir and 39,300 acre-feet for Lovewell Reservoir. There would have been four years in which all the irrigation demand was not met, resulting in irrigation shortages for those years. The total diversion shortages for the years of 1934, 1935, 1937, and 1940 are 75,200 acre-feet, 1,300 acre-feet, 8,300 acre-feet and 74,400 acre-feet respectively. In terms of percent of consumptive use shortage, the shortage in 1934 would be 14.7 percent, the shortage in 1935 is very small and is considered negligible, the shortage in 1937 would be 1.8 percent and the shortage in 1940 would be 15.6 percent. The computations of these shortages for 90,000 acres are as follows:

	<u>1934</u>	<u>1935</u>	<u>1937</u>	<u>1940</u>
Total Diversion shortage (1000 A.F.)	75.2	1.3	8.3	74.4
Diversion shortage Ac-ft per Ac. irrigated	0.84	0.01	0.09	0.83
Shortage to crop Ac-ft per Ac.	0.41	-	0.04	0.40
Consumptive Use requirement Ac-ft per Ac.	2.76	-	2.56	2.57
Shortage in percent of consumptive use	14.7	-	1.8	15.6

The total diversion shortage was first converted to acre-feet per acre by dividing the total diversion shortage by 90,000 acres, the irrigated area in the division. The shortage to the crop was then computed by computing the amount of diversion shortage that would be lost in transportation and farm waste. The factor used is 2.06 and it represents the weighted mean loss factor for all the units that comprise the Bostwick Division. The shortage in percent of consumptive use is the ratio of the crop shortage to the weighted mean annual consumptive use for all units.

Water Supply

Water Budget	Average Annual Flows 1929-47 Period	
Historical Inflow - Harlan County Reservoir	511,300	A.-Ft.
Anticipated Upstream Depletions	154,900	" "
Depleted Inflow to Harlan County Reservoir	356,400	" "
Historical Accretions-Republican River-Harlan Co. to Sup. C. Dam	52,800	" "
Historical Accretions-Republican River-Sup. C. Div. Dam to Hardy	17,900	" "
Historical Accretions-Republican River-Hardy to Scandia Less White Rock Creek	65,100	" "
Historical Flow White Rock Creek into Lovewell Reservoir	17,700	" "
Total Available Water Supply	509,900	" "
Bostwick Project Depletions	138,200	" "
Depleted Flow Republican River below Scandia, Kansas	371,700	" "
Historical Flow at Scandia, Kansas	664,000	" "
Total Republican Drainage Depletions	292,300	" "

Comparison studies operating with and without Lovewell

Monthly operation studies without storage in Lovewell Reservoir indicate that 80,000 acres can be irrigated if Harlan County Reservoir is the only storage provided in the Division. In this study it was assumed that the reduction in area to be served would occur by reduction of the area served by the Courtland Canal in Kansas. An area of 39,000 acres could thus be served by the Courtland Canal in Kansas. This compares with 49,000 acres that could be irrigated under the plan of development presented in this report. Table 96 is a summary of the Harlan County Operation Study without Lovewell Reservoir. Shortages of 15.2 percent in 1940, 13 percent in 1934, and 1.7 percent in 1935 would have occurred. These shortages are approximately the same as the shortages in the plan of development presented in this report.

River Operation PlanOperating Criteria

The use of water in the Bostwick Division of the Republican River development is based on the concept that the Federal Government will control the stored water in the reservoirs, built or to be built by the Government, to the extent that such storage water can be administered to supplement natural flow so that all areas proposed for development in the division will share the available water supply. Local supplies will be used first before storage water is called upon. This will be accomplished through terminology in the repayment contract with the Nebraska Bostwick and Kansas Bostwick Irrigation Districts.

It is intended that this concept of using the Government reservoirs to supply storage water to supplement natural flow, so that all areas will share the water supply, shall apply in all of the Republican River Basin. The Harlan County Reservoir and the units of the Bostwick Division are but one part of a river system of reservoirs in the Republican Drainage Area. Water stored in upstream reservoirs can be used to share shortages in downstream reservoirs. This type of operation will permit the greatest use of the available water supply.

The operation study in this report is made without use of benefits from storage from upstream reservoirs. The operation was made with Harlan County Reservoir receiving only return flows and unused natural flow from upstream. Even on this basis the maximum shortage is only 15.6 percent which is well within the maximum tolerable shortage limit of 25 percent. With the reservoirs operated on the concept of sharing shortages, the shortage for Harlan County Reservoir would be reduced to less than 10 percent. The operation studies, contained in the Frenchman-Cambridge Division report Volume 1 of the Definite Plan report, were all made on the basis that each reservoir was operated to serve only one unit, the unit immediately below the reservoir. The benefits of system operation of the reservoirs will only be evident primarily during years of short water supply. In most years water supplies are adequate so that a sharing of shortages is not necessary. Therefore, in most years each reservoir will serve only the lands lying immediately below the reservoirs as indicated in the Definite Plan Reports. Table 32, entitled "Shortages occurring in Reservoirs in the Republican River Drainage area when units are operated independently," shows that during the 19 year period of the operation studies there were only 4 years when

shortages occurred and only 2 years when shortages in Harlan County Reservoir were of any consequence. Irrigators in the Bostwick Division would have been aided by sharing shortages in a system operation of the reservoirs in these two years. There were only six years when a system operation plan could have materially benefited the lands of the Frenchman-Cambridge Division. An inspection of table 32 will show that Trenton Reservoir could be used to alleviate shortages under the Bartley and Cambridge Canal systems. In most years, system operation will consist primarily of the regulation of river pickup, spills and operational wastes through reservoir control and in use of reservoir for flood control and flood routing.

Priority Administration

It is expected, under actual operating conditions, the priorities will be enforced in Nebraska with respect to the use of natural flow and for the storage of water in the reservoirs. However, such enforcement will not materially change the use of water as presented in the Republican Drainage Basin studies and will not prevent system operation of the reservoirs where it is necessary, if the Bureau of Reclamation retains the right to supplement natural flow with storage water.

The filings for the storage of water in Harry Strunk and Enders Reservoirs are prior in time to the filing for storage of water in Harlan County Reservoir. The Parks, Trenton, and Red Willow Reservoirs will have storage appropriations junior to Harlan County Reservoir filing but according to the operation studies 1940 is the only year when water stored out-of-priority in these three junior reservoirs would have been released to relieve shortages in Harlan County Reservoir under strict priority administration. If such releases of storage had been made, the shortage of water on the respective lands would not have been intolerable. Secondary filings have not yet been made for the use of storage from any of the reservoirs in the Republican drainage area, as required by Nebraska law, but the Nebraska irrigation officials have indicated that such filings can be made in a manner which will permit the use of storage water to share shortages in a scheme of system operation. It is also intended that agreements will be made between the various irrigation districts and the Bureau of Reclamation permitting system operation.

Under the plan of operation presented the greatest use of storage water will be realized if the storage is held as far upstream as possible at all times. Water from upstream reservoirs should not be transferred to down-stream reservoirs in anticipation of expected events except to alleviate floods.

Water Supply

An integrated operation of the reservoirs of the Republican drainage area on the basis of priority administration has not been presented in this report because it is impossible to simulate priority administration for the full period of study in view of the fact that daily figures are not available. Much of the water supply data is based upon monthly values determined by correlations. In addition the priorities of the canals in the Bostwick District in Nebraska diverting from the Republican River on the north side have not been finally determined.

Table 5 shows a priority of February 1, 1937 for the Republican River canals, Nos. 1, 2, and 3, under the appropriation name of "The Republican River Public Power and Irrigation District." These priorities cover the same lands as are under the Franklin and Superior canals. These applications were not made by the present Bostwick Irrigation District but were made by some of the backers of the present district. Table 5 also shows applications with the priority date of February 6, 1948, by the present Bostwick Irrigation District for these same canals.

It is not known at the present time what action the Nebraska Bureau of Irrigation will take in regard to the 1937 applications, but the Bureau of Reclamation is recommending the adoption of the 1948 priorities. The appropriations of water for the canals of the Upper Republican and the Frenchman-Cambridge Divisions are prior to the 1948 appropriations for the Bostwick Division canals mentioned above and for the balance of the Bostwick Division canals except for 4,620 acres in the Driftwood area and 5,210 acres in the Upper Meeker area of the Driftwood Unit, 3,580 acres in the McCook table land area of the Frenchman Unit, and 1,000 acres in the Red Willow Unit. These acres have been added to the Frenchman-Cambridge Division since the 1948 appropriations for the use of water were filed by the Bostwick Division. Hence, the water appropriations for these lands will be junior to all of the Bostwick Division lands and, consequently, will be largely dependent upon storage water. The enforcement of the Bostwick Division canal priorities against these junior Frenchman-Cambridge lands will not provide the Bostwick canals with any appreciable water because at times when the water supplies were short, demands of the senior appropriations of the Frenchman-Cambridge District and the senior appropriations of the Culbertson and Meeker canals would absorb all of the natural flow available.

The water appropriations for the Upper Republican and Frenchman-Cambridge Divisions are, however, junior to the 1937 applications for the Franklin and Superior canals and if these priorities were

Water Supply

adopted, these canals could demand water from all of the Frenchman-Cambridge Division canals with a priority of January 22, 1946, or later.

Studies have been made on a monthly basis to determine the quantity of water which would have been released from the Frenchman-Cambridge Division canals if the 1937 priority had been enforced during the 1929 to 1947 period of study. These studies are not presented herein. They show that intolerable shortages would not have resulted in the Frenchman-Cambridge Division even if the 1937 priority had been enforced. The maximum degree of shortage for canals served from Swanson Lake, Red Willow Reservoir, and Harry Strunk Lake was 10 percent of the consumptive use requirement applying this criteria.

Bostwick Division compact study -- The inflow for the theoretical operation study of Harlan County Reservoir contained in this report is based upon the use of water upstream under the Bureau of Reclamation's comprehensive plan of development. The upper limit of irrigation development in the Republican River Basin has necessarily been based upon a separate study known as the "Compact Study" because of the Republican River Compact.

Table 97 is a summary of the operation of Harlan County and Lovewell Reservoirs based upon the inflow to the Harlan County Reservoir depleted for full compact allowances for use of water in Kansas, Colorado, and Nebraska. This table shows a maximum degree of shortage of the consumptive use requirement equal to 36.9 percent in 1934 and 29.2 percent in 1940. These percentages are in excess of the adopted maximum of 25 percent which is considered the tolerable limit for shortages, but these shortages are without the benefits of system operation and of sharing shortages.

The use of upstream reservoirs to share these shortages will reduce these quantities to considerably less than 25 percent.

Complete use of the compact allocation in the area above Harlan County Reservoir is not considered feasible under present economic conditions. If it should prove economically feasible to make further use of the water supply and approach compact allocations, additional reservoir regulation may also be feasible.

Operating Agreement - Harlan County

The Harlan County Reservoir was constructed by the Corps of Engineers, U. S. Department of Army, but the reservoir is to be

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operated for multiple purposes, including flood control, irrigation, recreation, public health, and fish and wildlife preservation. The control and release of storage for irrigation purposes is subject to the demands of the Bureau of Reclamation.

The Bureau of Reclamation has placed a filing with the Nebraska Bureau of Irrigation, Water Power and Drainage for the storage of 350,000 acre-feet of water in Harlan County Reservoir for irrigation and silt control with a priority date of June 26, 1948.

The various public agencies interested in the irrigation, public health, recreation, and fish and wildlife features of the Harlan County Reservoir on March 29, 1950 drafted a "Statement of Operational Objectives for Harlan County Reservoir." This statement of objectives has been presented to the Governors of Nebraska and Kansas and has been approved by the interested agencies. This is Appendix "A" in the following "Field Working Agreement" for Harlan County reservoir between the Bureau of Reclamation and the Corps of Engineers. This agreement has been approved at the field levels.

FIELD WORKING AGREEMENT BETWEEN
DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, AND
DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION
REGARDING OPERATION OF
HARLAN COUNTY DAM AND RESERVOIR
REPUBLICAN RIVER, HARLAN COUNTY, NEBRASKA

THIS AGREEMENT, made and entered into this _____ day of _____, 1952, between the Corps of Engineers and Bureau of Reclamation, WITNESSETH, THAT:

WHEREAS, the Department of the Army, acting through the Corps of Engineers, represented by its appropriate District Engineer, hereinafter referred to as the District Engineer, has constructed the Harlan County Dam and Reservoir on the Republican River near Alma, Nebraska, and is responsible for the safety of the structure, for flood-control operations of the reservoir, and for certain other operations as defined herein, and

WHEREAS, the Department of the Interior, acting through the Bureau of Reclamation, represented by its appropriate District Manager, hereinafter referred to as the District Manager, is responsible

for irrigation operation of the comprehensive system of irrigation works in the Republican River Basin, and

WHEREAS, the irrigation storage in said dam and reservoir serves the comprehensive system of irrigation works, and,

WHEREAS, a statement of operational objectives for purposes of flood control, irrigation, public health, recreation and fish and wildlife preservation has been agreed upon by the various Federal and State agencies concerned (a copy of the statement of operational objectives is attached as Appendix A), and

WHEREAS, the District Engineer and the District Manager, together with other Federal and State agencies, are considered to have to a varying degree, a joint interest in operational objectives other than flood control and irrigation, and

WHEREAS, there is need for a working agreement in order that there will be a clear understanding between the District Engineer and the District Manager as to reservoir operations for irrigation and related conservation uses, including details of storage allocations and possible reallocations, hydrologic data collection and reporting arrangements.

NOW, THEREFORE, it is mutually understood and agreed by and between the parties hereto as follows:

1. Storage capacity allocations. -- The storage capacity allocations of Harlan County Dam and Reservoir, exclusive of surcharge storage capacity above elevation 1973.5 feet, m.s.l., which is provided in combination with spillway capacity to insure safety of the structure, are defined in the following subparagraphs:

a. Flood-control storage. -- Flood-control storage capacity shall include the storage capacity between elevation 1946.0 feet, m.s.l., and elevation 1973.5 feet, m.s.l. (initially amounting to 500,000 acre-feet).

b. Irrigation, conservation and sediment reserve storage. -- Irrigation, conservation and sediment reserve storage capacity shall include the storage capacity below elevation 1946.0 feet, m.s.l. This capacity initially amounts to 350,000 acre-feet, of which 150,000 acre-feet are specifically planned for irrigation and 200,000 acre-feet are provided as a reserve for the accumulation of sediment. Until such time as sediment fully occupies the allocated reserve capacity, it will be used for irrigation and various conservation purposes including public health, recreation, and fish and wildlife preservation.

2. Storage reallocations.—The District Engineer 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, respectively, is reduced by an amount exceeding 10 percent of the specific allocation for either purpose, the operating plan described herein with respect to storage allocations and/or the elevation limits of the storage allocations shall be reviewed with the view of compensating for such reduction in storage capacity by assignment of equitable shares of an appropriate part of the remaining sediment reserve capacity.

3. Plan of operation

a. The District Engineer will operate the storage capacity in the Harlan County Reservoir referenced in paragraph 1b above, through appropriate instruction to the dam tender to supply the water requirements for the Bostwick Irrigation Project as prescribed by the Bureau of Reclamation, and to fulfill the other operational objectives stated in Appendix A insofar as may be practicable in accordance with general storage and release schedules worked out with the District Manager and representatives of other interested agencies and agreed upon with the states in annual and more frequent conferences as may be necessary.

b. The District Manager will furnish the District Engineer with weekly estimates of daily irrigation release requirements, which shall be subject to interim adjustment by the District Manager as required. The weekly estimates and interim adjustments shall be furnished simultaneously to the District Engineer and to operating personnel at the dam, using communication methods under detailed arrangements as may be made from time to time. Oral messages shall be confirmed in writing under date of the day issued.

c. When the reservoir level is in the flood-control pool, the District Engineer will make such minimum releases as the District Manager may prescribe as necessary to meet irrigation requirements. Procedures will be the same as given paragraph 3b, insofar as applicable.

4. Operation and hydrologic data and reporting arrangements.—Proposed schedules of flood-control releases and flood-control storage changes, if available, and current operating data shall be provided to the District Manager by the District Engineer. The current reservoir operating data shall be tabulated daily and furnished periodically as required, and shall include such items as:

Water Supply

reservoir elevation, storage inflow, and outflow. All available reports from meteorologic and stream-flow stations pertinent to the operation of the reservoir obtained by either the District Engineer or the District Manager shall be exchanged as required. These data shall be furnished or exchanged by the most expeditious method of communication under detailed arrangements as may be made from time to time.

IN WITNESS WHEREOF, the parties hereto have caused this memorandum of agreement of be executed as of the day and date first above written.

CORPS OF ENGINEERS:

BUREAU OF RECLAMATION:

By L. J. LINCOLN
Colonel, Corps of Engineers
District Engineer
Kansas City District

By H. E. ROBINSON
District Manager
Bureau of Reclamation
Kansas River District

Attachment:

Appendix A - Statement of Objectives dated 29 March 1950

29 March 1950

APPENDIX A

STATEMENT OF OPERATIONAL OBJECTIVES
FOR
HARLAN COUNTY RESERVOIR, NEBRASKA

1. General.--Harlan County Dam is located on the Republican River approximately 8 miles east of Alma, Harlan County, Nebraska. Harlan County Reservoir will have an initial capacity of 850,000 acre-feet, with allocations of 500,000 acre-feet to flood control, 150,000 acre-feet to irrigation and 200,000 acre-feet for accumulation of sediment. (a) Until such time as sediment fully occupies the allocated sediment capacity, it also will be utilized for various conservation purposes.

2. General operational objectives.---The general operational objectives for Harlan County Reservoir, as visualized at this time, are for the multiple use purposes of flood control, irrigation, public health, recreation, and fish and wildlife preservation. A bulkheaded opening is being provided in the dam to permit a possible future power installation. In order to assure realization of the greatest public benefits, operation plans should be sufficiently comprehensive to permit the maximum integration of the other uses consistent with the primary purposes of flood control and irrigation. To the maximum extent possible and consistent with the Republican River Compact, Harlan County Reservoir should be considered as but one part of the system of reservoirs in the Republican River Basin, and should be operated to obtain maximum system benefit for all concerned uses from all reservoirs in the system operating as a unit of the Missouri River Basin Project. Reservoir operations will be complemented by the programs of land management and soil conservation, which will extend the efficient operation of the reservoir for all purposes by reduction of sediment accumulation.

OBJECTIVES OF INDIVIDUAL PURPOSES

3. Flood Control.---The operational objective will be to control the flow of Republican River to effect the maximum practicable reduction in flood damages below the dam on the Republican, Kansas and Missouri Rivers with incidental reduction in flood damages on the Mississippi River.

4. Irrigation.---The operational objective will be to regulate natural flow, including return flow from upstream development, in such a manner as to provide a satisfactory quantity of irrigation water to irrigation development on the Republican River between Harlan County Dam and a point near Concordia, Kansas. This area comprises the Bostwick Division of the Missouri Basin Project, and embraces a total potential irrigated area of 91,000 acres. With the exception of the Scandia Unit in Kansas, which is temporarily delayed, development of the Bostwick Division is contemplated as rapidly as construction and appropriation considerations will allow.

5. Public health.---The operational objective will be to maintain flows in the Republican River downstream from the dam that are required for sanitary quality of stream water as related to municipal water supply and stream sanitation. The minimum flows currently required for those purposes, assuming primary treatment of municipal and industrial waste and for present population and

Water Supply

industry, have been determined cooperatively by the Kansas State Board of Health, the Nebraska State Department of Health, and the U. S. Public Health Service for various points on the river as follows:

Desired minimum flow during given period in second-feet

	Dec. to Feb.	Mar.	Apr.	May	June to Sept.	Oct.	Nov.	
Franklin, Nebr.	: 2	: 2	: 3	: 5	: 8	: 4	: 2	:
Red Cloud, Nebr.	: 4	: 5	: 8	: 12	: 20	: 9	: 6	:
Superior, Nebr.	: 8	: 10	: 16	: 24	: 40	: 18	: 12	:
Scandia, Kans.	: 6	: 8	: 12	: 18	: 30	: 14	: 9	:
Concordia, Kans.	: 9	: 12	: 19	: 28	: 47	: 21	: 14	:
Clay Center, Kans.	: 7	: 8	: 13	: 20	: 33	: 15	: 10	:
Junction City, Kans.	: 8	: 10	: 16	: 24	: 40	: 18	: 12	:

Control of mosquitoes in the reservoir area as necessary to safeguard health and welfare is recognized as part of the over-all program of reservoir operation.

6. Recreation.—The operational objective will be to maintain a pool of maximum area and minimum fluctuation. A satisfactory plan for recreational development of the area can be evolved under operational plans which do not drain the reservoir below elevation 1925. A more extensive development of recreation along the shoreline would be possible with drawdowns limited to elevation 1935.

7. Fish and wildlife preservation.—The primary operational objective will be to maintain the reservoir at the highest practicable level above the minimum required elevation of 1930 feet to permit the development of refuge conditions and facilities at Harlan County Reservoir (of national importance in assisting in the rehabilitation of a large portion of the continental water-fowl population using the Central Flyway) and to enhance local hunting and fishing on the Reservoir.

8. A secondary operational objective will be to maintain stream flows below the reservoir to preserve fishing and hunting values, insofar as such maintenance would not conflict with the primary objective of refuge development and operation. To achieve

this secondary objective it will be desirable to maintain the following minimum flows at every point in the Republican River below the dam: An instantaneous minimum flow of 10 second-feet; a mean minimum weekly flow of 20 second-feet throughout the year; and a mean minimum monthly flow of 40 second-feet during the months of May to October, inclusive. Benefits from these flows would be of local nature as compared with the national benefits expected from refuge development.

RECONCILIATION OF OBJECTIVES

9. Discussion.—Operation studies of the period 1929-47, including the most critical streamflow period of record from April 1934 to June 1935, indicate the degree to which compromises between objectives may be required. These studies indicate that during the initial 10-year development period the full requirements of flood control, irrigation, public health, recreation, and fish and wildlife preservation can be met without shortages occurring for any one use. The desired flows for maintaining fishing and hunting values below the reservoir cannot be fully met without incurring shortages for other uses, but releases for public health and irrigation will approach these flows.

10. Between the 10th and 20th years of project development of sediment accumulation, additional shortages of a minor nature would occur only in case of a critical period such as occurred in 1934-35. If such conditions were to occur in the 20th year, and the shortages were accepted entirely by irrigation such shortages would be approximately 8 percent of the annual diversion demand. If accepted entirely by wildlife, it would cause a reduction in water surface area of approximately 5 percent. If shortages were accepted entirely by public health to the extent of its demands, nuisances due to stream pollution would result at numerous locations.

11. During the succeeding 30 years of operation, the shortages can become progressively more significant, primarily because of accumulation of sediment. Long range studies indicate that conditions such as occurred in 1934-35 will have a frequency of only about 3 times in 100 years. It is possible that increases in efficiency of system operation, obtained as a result of operating experience, may lessen the need for compromises between the various uses.

12. A satisfactory plan of recreational development can be evolved under these operational objectives.

13. Conclusions.— The decision as to which use shall accept shortages will rest with the states, as administrators of water. Since studies indicate that shortages will not occur for at least 10 years, it appears unwise to request that a decision be made at this time. Such a decision can be deferred until the situation arises, at which time specific needs of each use and the conditions affecting those uses will be more definitely known.

(a) The reservoir will also serve the collateral purposes of fish and wildlife preservation, recreation and stream pollution abatement.

Hydrologic Requirements for Operation

Forecasting Requirements

Routine seasonal forecasts of the water supply for each irrigation season are expected to be made about April 1 of each year and during each irrigation season as required. These forecasts will take into account the carryover storage from the previous year, the expected reservoir inflow, and the various water requirements expected for the season.

Special floodwarning services have been requested of the Weather Bureau. The Corps of Engineers and the Bureau of Reclamation are paying the Weather Bureau to operate a floodwarning network in the Kansas River Basin. (See exhibit 27.) The map indicates the channeling of flood reports to the various offices of the Bureau of Reclamation, the Corps of Engineers, and the Weather Bureau. In all cases the flood reports from upstream drainage areas are made available to Bureau of Reclamation or Corps of Engineers offices which are located downstream or which have other reasons for being interested in such reports. Arrangements have been made to have the reporting stations, both precipitation and stream gage, in the area near Harlan County Dam report flood data to the Corps of Engineers office at Harlan County Dam. The Corps relays this information to the Weather Bureau office in Kansas City, Missouri, and to the Reservoir Operations Center of the Bureau of Reclamation at McCook (Indianola), Nebraska. The Bostwick Division office at Superior, Nebraska is warned of any flood conditions that may affect that area.

Water Supply

The Weather Bureau has also been requested to give the Bureau of Reclamation all forecasts of flood runoff which may cause a river discharge of 5,000 second-feet, or greater, on the Republican River at Guide Rock, Nebraska. It is planned that a similar setup for forecasting will eventually be arranged regarding river stages at the Scandia Diversion Dam. It is also planned that any flood forecasts provided by the Corps of Engineers affecting areas of the Kansas River Basin in which the Bureau of Reclamation operates, including the Bostwick Division, will also be made available to the Bureau of Reclamation.

Hydrologic Installations

The hydrologic installations required for a floodwarning network are, for the most part, already installed and in operation. (See exhibit 27.) It is expected that three or four additional precipitation stations will be added in the drainage area above Lovewell Dam when construction starts on the dam.

Most of the stream-gaging stations required for operation of the system are installed and are shown on the map on exhibit 27. The stream-gaging stations at which records will be quite important are listed as follows:

<u>Station</u>	<u>Data Measured</u>	<u>Present Status</u>
Rep. R. at Orleans, Nebr.	Inflow into Harlan Co. Res.	Existing
Sappa Cr. nr. Stamford, Kan.	Inflow into Harlan Co. Res.	Existing
Prairie Dog Cr. nr. Woodruff, Kan.	Inflow into Harlan Co. Res.	Existing
Rep. R. below Harlan Co. Dam	Outflow from Harlan Co. Res.	Under Cons.
Rep. R. nr. Guide Rock, Nebr.	Flow passing Superior-Courtland Div. Dam	Existing
Rep. R. nr. Hardy, Nebr.	Flow passing Nebr.-Kansas State Line	Existing
Rep. R. at Scandia, Kansas	Flow passing Scandia Div. Dam	Existing
Rep. R. at Concordia, Kansas	Flow passing Scandia Unit	Existing
White Rock Cr. above Lovewell Res.	Inflow into Lovewell Res.	To be installed
White Rock Cr. nr. Lovewell, Kan.	Outflow from Lovewell Res.	Existing

Water Supply

The stream-gaging stations are installed and operated by the Geological Survey. At the present time, the Corps and the Bureau each pay half of the costs for installing and operating inflow gaging stations for reservoirs. The agency responsible for operation of the reservoir pays all of the costs for outflow gaging stations. The Bureau of Reclamation pays for operation of river-gaging stations at diversion dams. The transfer of funds from the Bureau to the Geological Survey is made at the Washington level. It is anticipated that in time the operation costs of these stream-gaging stations will be borne entirely by the states and by the Geological Survey.

Gaging stations with recorders should be operated on the canals at the points indicated below:

Canal	Location	Data Measured
Superior	Near point of diversion	Canal diversion
Superior	Nebr.-Kan. State Line	Wastes passing state line
Courtland	Near point of diversion	Canal diversion
Courtland	Nebr.-Kan. State Line	Flow passing state line
Courtland	Near Lovewell Reservoir	Flow into Lovewell Res.
Courtland	Below Lovewell Reservoir	Div. from Lovewell Res.
Franklin	Near Harlan Co. Dam	Canal diversion
Naponee	Near Harlan Co. Dam	Canal diversion
Franklin Pump	Near point of diversion	Canal diversion
Red Cloud Pumps (3)	Near points of diversion	Canal diversion
Republic Canal	Near point of diversion	Canal diversion
Scandia Canal	Near point of diversion	Canal diversion

The recurring costs of the existing floodwarning network operated in cooperation with the Weather Bureau in the area of the Bostwick Division amount to \$810 per year charged to the Corps of Engineers and \$460 per year charged to the Bureau of Reclamation. Three additional precipitation stations will cost \$150 for initial installation and will cost \$345 per year for operation and reporting services. An evaporation station at Lovewell Reservoir will cost \$515 initially and \$82 per year for operation. This need not be installed until the reservoir is in operation.

All precipitation stations in the floodwarning network report all rainfall of 0.50 inches or more. During the flood season and irrigation season routine daily reports are exchanged between

the Corps and the Bureau of Reclamation regarding the various stream-gaging stations on the Republican River between Benkelman and Guide Rock, Nebraska, on Frenchman Creek, Red Willow Creek, Beaver Creek, Sappa Creek, and on Prairie Dog Creek. Special flood reports from these stations are made at more frequent intervals if required. Stages at which flows exceed 300 second-feet are reported regarding Thompson Creek and Center Creek.

Radio Network

An AM system and an FM system will be used in the radio network of communication between the various operating offices and with field personnel. The AM system (5,287.5 and 3,207.5 kilocycles) will be installed at McCook (Indianola), Nebraska, Harlan County Dam (cost paid by Corps), and Superior, Nebraska. Terminal FM stations are being installed at Superior and at Superior-Courtland Diversion Dam. It is expected that terminal FM stations of the same frequency (40,700 kilocycles) will be installed at Lovewell Dam and at Scandia Diversion Dam when they are constructed. The ditchriders on the canals will be equipped with mobile FM sets in order for them to communicate with each other and with their division offices. This network and its relation with the overall network of the Kansas River District existing or planned for immediate installation is shown on the map, exhibit 28.

Operational Procedures

Exchange of hydrologic operational data.

Arrangements have been made with the Corps of Engineers to provide for a daily exchange of routine information regarding reservoir and stream-flow data. During flood conditions the exchange of data will be as often as necessary and may be on an hourly basis with the Corps and with the Weather Bureau. Routine information exchanged between the Corps and the Bureau of Reclamation by telephone or radio will be confirmed by periodic written reports.

Origin and channeling of operational orders.

The office of the Bostwick Division Irrigation Superintendent will assemble data pertaining to canal use requirements on a day to day basis for the division. This information will be relayed to

Water Supply

the Reservoir Operations personnel of the Kansas River District office. The existing reservoir and stream conditions in the drainage area above Harlan County Reservoir, as well as those in the Bostwick Division, will be considered in planning releases from Harlan County Reservoir to meet irrigation requirements. The Corps' office at Harlan County Dam and the Bureau of Reclamation's Kansas River District office will, in their routine daily exchange of information, determine the required releases to be made from Harlan County Reservoir for all purposes. The filling of Lovewell Reservoir from flow in the Republican River and the releases from Lovewell will be planned by the Division Irrigation Superintendent and personnel of the Reservoir Operations Section.

It will be possible for the Superior office to talk to Harlan County Dam by AM radio to discuss details of operating procedures.

Reservoir surveys and storage reallocations.

Reservoir operating agreements with the Corps of Engineers state that when the conditions in the reservoir change so that the actual storage between the elevations fixing storage allocations varies more than ten percent of the allocation, a reallocation of the storage space in the reservoir is in order. The initiation of surveys to determine such changes rests with the agency responsible for operation of the reservoir. The Corps will make such surveys as required for Harlan County Reservoir and the Bureau will make those for Lovewell Reservoir.

Operating Organization

Until such time as portions of the irrigation systems are taken over by the Irrigation Districts, as provided for under the terms of the repayment contracts, the entire Bostwick Division will be operated under the direction of the Irrigation Superintendent of the Kansas River District, except for the operation and maintenance of Harlan County Dam and Reservoir by the Corps of Engineers.

Existing Operation Organization.

At present there is a Division Irrigation Superintendent, with offices at Superior, who is responsible for operating and maintaining the diversion dams and canals in the Bostwick Division. Personnel in the Hydrology Section of the District Office have been delegated with the responsibility of working out details of agreements with cooperating agencies and coordinating the operation of

Water Supply

the various reservoirs for the benefit of the irrigation systems of the Kansas River District, including those in the Bostwick Division. Both the Division Irrigation Superintendent and the District Hydrologist, who is in charge of Reservoir Operations, are supervised by the District Irrigation Superintendent.

Future problems of operation organization.

Additional personnel will be required to operate the canals and diversion dams which remain to be constructed. A caretaker will also be required to operate Lovewell Reservoir.

Operation responsibility between agencies.

The operation responsibilities of the different Federal agencies are defined in the "Field Working Agreement" regarding Harlan County Dam and Reservoir. A similar agreement is planned for Lovewell Reservoir.

The operating agreement for Harlan County Dam and Reservoir states that the Corps of Engineers is responsible for the safety of the structure and for flood control operations of the reservoir. The agreement also states that the Bureau of Reclamation is responsible for irrigation operation of the comprehensive system of irrigation works in the Republican River Basin.

The Corps of Engineers, through their District Engineer, will operate the reservoir to supply the water requirements for the Bostwick Irrigation Project as prescribed by the Bureau of Reclamation, through their District Manager. Insofar as may be practicable, the reservoir will be operated to fulfill other benefits, such as those planned by the Public Health Service, Fish and Wildlife Service, National Park Service, and various state agencies. General storage and release schedules will be worked out by the Corps in cooperation with the Bureau of Reclamation, other interested agencies, and the states concerned in a meeting to be held annually, or more frequently if necessary.

The operating agreement for Lovewell Dam and Reservoir will make the Bureau of Reclamation responsible for the safety of the structure and for irrigation operations of the reservoir. The Bureau will operate the flood control storage in accordance with instructions supplied by the Corps of Engineers.

Recommended organizational plan.

A general outline of the organizational plan for a staff to operate the Bostwick Division is suggested as follows:

District Irrigation Superintendent

District Hydrologist	Division Irrigation Superintendent		
Operations Hydrologist	Watermasters	Carötaker	Clerk
Hydrographer	Gatetenders	(Lovewell	Radio Operator
Radio Operator & Clerk	(Div. Dams)	Res.)	& Clerk
	Ditchriders	Laborers	
	Laborers		

Comparison of Republican River "Compact Study" and "Basin Study"

The Republican River Compact was agreed upon by the states of Colorado, Nebraska, and Kansas in order to assure that there would be no interstate disagreements regarding the use of water by Bureau of Reclamation developments.

In view of this compact agreement the Bureau of Reclamation, as a preliminary step to the Bureau practical plan of development, prepared a study known as the "Compact Study" for determining the upper limits of irrigation development that could be made in each state using the water allocated to each state by the Compact.

This summary of the "Compact Study" is presented herein to compare the use of water in the "Compact Study" with the use of water in the Bureau of Reclamation's water supply studies for a comprehensive plan of development of the water resources of the Republican River Basin, of which the Bostwick Division report is a part.

This Bureau of Reclamation practical plan of development for the Republican drainage area will hereinafter for purposes of comparison, be referred to as the "Basin Study."

"Compact Study." Article I of the Republican River Compact reads in part:

"The major purposes of this Compact are to provide for the most efficient use of the waters of the Republican River Basin for multiple purposes; to provide for an equitable division of such waters; to remove all causes, present and future, which might lead to controversies, to promote interstate comity;

to recognize that the most efficient utilization of the waters within the Basin is for beneficial consumptive use; and to promote joint action by the States and the United States in the efficient use of water and the control of destructive floods."

The specific allocations in acre-feet made to each state derived from the computed average annual virgin water supply originating in the designated drainage basins, or parts thereof, of the Republican River Drainage Basin are shown in table 3.

The amount allocated to each state on the various tributaries and the main stem of the Republican River is the governing factor considered by the Bureau of Reclamation in making water supply studies for the "Compact Study." The allocations, as presented under the Republican River Compact, are listed in table 3. The "Compact Study" was made for a 19 year period, namely 1929 through 1947. This period includes the period, 1930 through 1940, which was the period used in establishing the basic information used in negotiating the Republican River Compact. The 1929-1947 period was also used in the "Basin Study."

The "Compact Study" shows the amount of development that can be made in the various drainage areas using all the water as allocated in the compact. In order to provide for the full consumptive use of the water allocated to each state it was necessary in some cases to assume depletions irrespective of the matter of the feasibility of such consumptive use. The same operating criteria with minor exceptions as noted in the following discussion of "Compact Study" vs. "Basin Study," were used in each of the two studies. The complete "Compact Study" is available for inspection in the Kansas River District Office at Indianola, Nebraska.

"Basin Study." The "Basin Study" was made using the available water supply to develop projects that were considered feasible under the Missouri River Basin plan of development, however, the maximum acreage to be irrigated in all drainage areas has been limited to the area that could be developed as determined in the "Compact Study." The unused water was passed downstream and was used to alleviate shortage. If in the future a change in economic conditions make possible additional development where complete compact depletions were not made, the full compact allocations may then be used without causing intolerable shortages.

Water Supply

"Compact Study" vs. "Basin Study." The basic information used in preparation of the water supply for the two studies is practically identical. A brief comparison of water use for both studies is as follows:

1. Depletions by anticipated stock pond development and for expected increase in private irrigation are estimated to be approximately the same in both studies.

2. An investigation was made of present water uses throughout the Republican River drainage area. The results obtained from this investigation showed that the present use was approximately the same as estimated by the Commissioners. The present uses of water were the same in both studies.

3. Project areas receiving a supplemental and a full water supply are the same with the exception of Red Willow and Cambridge Units. The project area of 12,590 acres served in the "Compact Study" has been reduced to 11,990 acres in the "Basin Study" for Red Willow Unit. An area of 20,150 acres used in the "Compact Study" for the Cambridge Unit has been reduced to 17,230 acres in the "Basin Study." This reduction in acreage for the units mentioned above is the result of recent land classification surveys.

4. Both studies were made in a downstream order to reflect the water use of all upstream developments.

5. In the "Compact Study" it was found that all the water allocated under the compact was not used after all depletions were made for practical development. In order to provide for a complete use of the compact allocation in Colorado and upper drainage area in Kansas, an additional depletion for unidentified development was made. In Nebraska, additional depletions were made on Beaver Creek, Sappa Creek, and on the main stem of the Republican River above Harlan County Reservoir.

6. In both studies water loss due to reservoir evaporation was accounted for and charged to the states, depending on the location of the reservoirs and the areas served.

The evaporation of Harlan County Reservoir charged to Nebraska and Kansas was distributed on a storage delivery basis. The storage water delivered to Nebraska and Kansas on an annual basis for both studies is shown in table 98. The percent of storage water delivered to Nebraska and Kansas for

Water Supply

each study is also shown on this table. Total evaporation was adjusted by the evaporation loss from the dead storage pool of 75,000 acre-feet. The difference between the total evaporation and that resulting from 75,000 acre-feet is the total evaporation loss charged to irrigation in Nebraska and Kansas. Evaporation loss was prorated to each state on a percentage basis as listed in the following tabulation. The percentages are determined as shown in table 98.

Period		Percent Nebraska	Percent Kansas	Total
Compact Study	1930-1940	38.0	62.0	100.0
" "	1929-1947	38.7	61.3	100.0
Basin Study	1930-1940	31.0	69.0	100.0
" "	1929-1947	32.0	68.0	100.0

In addition to being charged evaporation loss due to irrigation, Nebraska was also charged the loss due to keeping 75,000 acre-feet of dead storage in Harlan County Reservoir.

7. Exhibit 29 shows a comparison of the average annual use of water on the Republican River and its tributaries by states for the period 1930 through 1940 as determined in each of the two studies. It is shown in this comparison of the two studies for the 1930 through the 1940 period that the use of water in the "Basin Study" does not exceed the use as allocated under the Compact. In the "Compact Study" depletions were made for approximately full compact allocations for Colorado and Nebraska, and Kansas total use shown by the "Basin Study" amounted to 67 percent of her allocations. However, this does not represent the total water available for use by Kansas. Computations to determine the total flow of the Republican River crossing the Nebraska-Kansas state line for the "Compact Study" are shown on table 99 and for the "Basin Study," see table 100. An explanation of the computations made to compute flow passing the state line in the "Basin Study", table 100, follows. The same procedure was used to compute table 99, however, only a summary of the operation study for the compact conditions is included in this report.

Col. 1 indicates the year of study.

Water Supply

Col. 2 lists the reservoir demands on Harlan County reservoir for the 12,500 acres in Kansas above Lovewell as determined from data in table 93. The natural flow listed in Col. 5, table 93, was used first to meet the demands in Nebraska Col. 6 and 7, and if any was left, it was considered to meet the Courtland above Lovewell demands - Col. 8. The demand required for Courtland lands above Lovewell, Col. 8, not met by natural flow is the demand on the reservoir listed in this column.

Col. 3 is the reservoir demands on Harlan County for lands below Lovewell. It is determined in Col. 23 of table 94.

Col. 4 is the reservoir demand for the Scandia Unit as listed in Col. 26 of table 93.

Col. 5 is the natural flow crossing the state line and used by the Courtland lands in Kansas above Lovewell. It is the portion of Col. 8 of table 93 that is met by natural flow and was computed by subtracting Col. 2 of this table from Col. 8 of table 93.

Col. 6 is the natural flow crossing the state line that is used by Courtland lands below Lovewell. It is computed from table 94 and is equal to Col. 13 less any portion of Col. 13 indicated to spill by Col. 22.

Col. 7 is computed from table 93. It is the portion of Col. 17 that could be used to meet demands for Scandia Col. 25.

Col. 8 is the demand on the reservoir for river loss as listed in Col. 27 of table 93.

Col. 9 is from table 93, Col. 28.

Col. 10 is the spills from Harlan County diverted to Lovewell as determined in Col. 14 of table 94.

Col. 11 is the shortages to Kansas lands computed to be 62/90 of the shortage listed in Col. 11 of table 94.

Col. 12 is the sum of Columns 1 through 10, less Col. 11.

Col. 13 is computed from table 93 data. It is Col. 21, table 93 less Col. 7 above and less Cols. 26, 27, and 28 of table 93. The result is corrected for shortages to Scandia.

Water Supply

Col. 14 is the spills from Harlan County, table 94, Col. 10 less the portion diverted to Lovewell Col. 14.

Col. 15 is the sum of the above Col. 13 and Col. 14.

Col. 16 is the sum of the above Columns 12, 13 and 14.

8. The average annual use of water as shown by tributaries and states for the periods of study, namely, 1929 through 1947, are presented in exhibit 30. A comparison of both studies is shown on this exhibit. This comparison shows that the average annual use of water by states is less for the "Basin Study" than used in the "Compact Study."

9. Tables 101 through 115 show the tabulation of the average annual water use by states. The water use is determined for the various units along the tributaries and main stem of the Republican River. The computations are listed for both the "Compact Study" and the "Basin Study."

Summary and conclusions -- Storage reservoirs are required on most of the main water producing tributaries as well as on the main stem to utilize the maximum practical water resources of the Republican River Basin for irrigation development. Even then our studies indicated that all of the water supply allocated under the compact was not used. Our investigations and those of other agencies have not disclosed a practical plan for development which will use all water as allocated in the compact. An investigation was made of present use areas, and for scattered areas that were anticipated to be developed by private enterprise. Depletions by anticipated stock pond development were made. Reservoir evaporation loss was accounted for. Water supply operation studies were made to determine the adequacy of the available water supply for all the irrigable area found in each unit. Additional depletions for unidentified development were necessary in the "Compact Study" to allow full compact depletions. Even then the water supply was adequate to serve the project areas without intolerable shortages.

Table 1

Table 1. Canal Data and Arable Acreage in the Bostwick Division

Unit	Canal	Length in Miles	Headgate Capacity in c.f.s.	Acreage Basis Water Supply Study			Planned Development			Total Probable Development		
				Nebraska	Kansas	Total	Nebraska	Kansas	Total	Nebraska	Kansas	Total
Franklin - Red Cloud	Franklin	54.0	230	14,410	0	14,410	11,987	0	11,987	13,794	0	13,794
	Naponee	9.6	36	1,490	0	1,490	1,544	0	1,544	1,696	0	1,696
	Franklin Pump	4.9	42	2,070	0	2,070	2,070	0	2,070	2,070	0	2,070
	(Red Cloud Pump Area)	-	-	280	0	280	0	0	0	0	0	0
Superior - Courtland				18,250	0	18,250	15,601	0	15,601	17,560	0	17,560
	Superior Courtland	33.1	139	6,790	0	6,790	6,069	0	6,069	7,491	0	7,491
Courtland		16.1	751	2,960	0	2,960	2,573	0	2,573	2,949	0	2,949
				9,750	0	9,750	8,642	0	8,642	10,440	0	10,440
	Courtland above Lovewell	18.3a/	685	0	12,500	12,500	0	13,200	13,200	0	13,200	13,200
Scandia	Courtland below Lovewell	49.1b/	634	0	36,500	36,500	0	35,800	35,800	0	35,800	35,800
				0	49,000	49,000	0	49,000	49,000	0	49,000	49,000
	Scandia	18.1	230	0	13,000	13,000	0	13,000	13,000	0	13,000	13,000
Total		203.4	-	28,000	62,000	90,000	24,243	62,000	86,243	28,000	62,000	90,000

a/ Excludes North and Ridge Canals, 6.2 and 6.0 miles long respectively; and Pump Canal No. 1, 5.0 miles long.

b/ Excludes White Rock Creek Canal (7.6 miles long) and Miller Canal (8.4 miles long), and Pump Canals Nos. 2, 3, and 4 (6.1, 2.3, and 3.5 miles long, respectively).

Table 2 . Storage allocation in Harlan County and Lovettell Reservoirs - Content in acre-feet

HARLAN COUNTY RESERVOIR										
Use	Elev.	Initial Conditions			50 yr. Conditions			100 yr. Conditions		
		Sediment	Water	Total	Sediment	Water	Total	Sediment	Water	Total
Inactive Stor.	1920.0	0	97,200	97,200	22,200	75,000	75,000	97,200	0	0
Irrigation	1946.0 a/	0	252,000	350,000	77,000	175,000	250,000	102,000	150,000	150,000
Flood Control	1973.5	0	500,000	850,000	0	500,000	750,000	0	500,000	650,000
Total	-	0	849,200	850,000	100,000	750,000	750,000	100,000	550,000	650,000

a/ Top of Irrigation pool is at elevation 1946.0 under initial conditions; under 50 year and 100 year conditions the top of the irrigation pool is at elevation 1942.5 and 1937.0 respectively. The change in elevation of the top irrigation pool is necessary to maintain 500,000 acre-feet for flood control as required by the Corps of Army Engineers.

LOVETELL RESERVOIR										
Use	Elev.	Initial Conditions			50 yr. Conditions			100 yr. Conditions		
		Sediment	Water	Total	Sediment	Water	Total	Sediment	Water	Total
Dead Storage	1550.0	0	3,000	3,000	2,000	1,000	1,000	3,000	0	0
Inactive Stor.	1971.7	0	15,000	18,000	4,000	11,000	12,000	9,300	5,700	5,700
Irrigation	1932.6	0	25,200	44,000	1,200	24,000	36,000	2,900	22,300	28,000
Flood Control	1994.3	0	50,000	94,000	0	50,000	66,000	0	50,000	78,000
Total	-	0	94,000	94,000	6,000	66,000	66,000	16,000	78,000	78,000

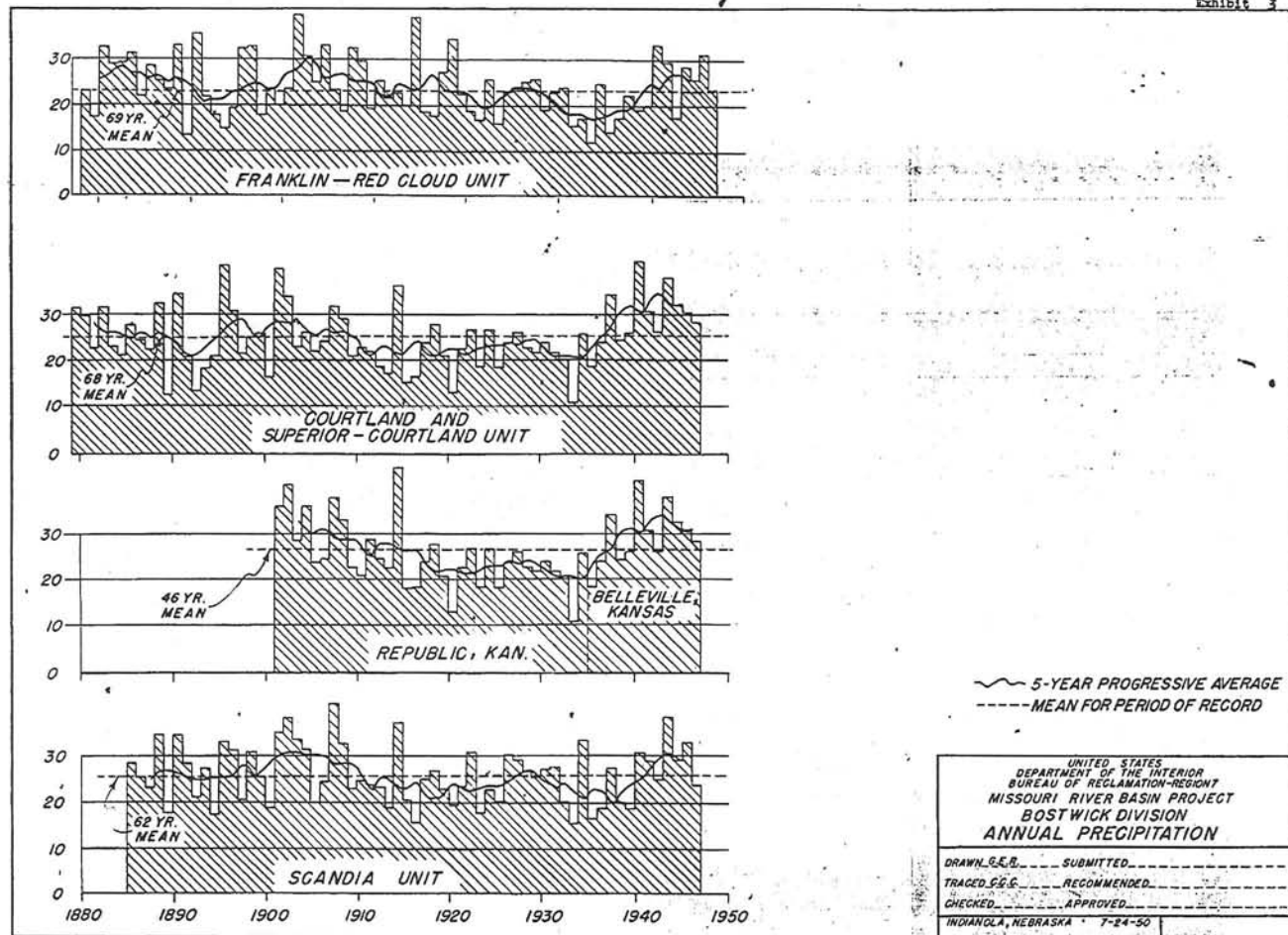


Table 3. Allocations under Republican River Compact of 1942.

Stream	Acre-feet		Amount allocated		
	Avg. annual flow assumed in Compact	Colo.	Nebr.	Kans.	Total
N. Fk. Republican R.	44,700	10,000	11,000		21,000
Arikaree R.	19,610	15,400	3,300	1,000	19,700
Buffalo Cr.	7,890		2,600		2,600
Rock Cr.	11,000		4,400		4,400
S. Fk. Republican R.	57,200	25,400	800	23,000	49,200
Frenchman Cr.	98,500 ^{a/}	All in Colo.	52,800		52,800
Red Willow Cr. (Colo.) ^{b/}		All in Colo.			
Rep. R. & Trib. at Colo.-Nebr. ^{c/}	87,700				
St. Line					
Blackwood Cr.	6,800				
Driftwood Cr.	7,300		1,200	500	1,700
Red Willow Cr. (Nebr.) ^{d/}	21,900		4,200		4,200
Medicine Cr.	50,800		4,600		4,600
Beaver Cr.	16,500	3,300	6,700	6,400	16,400
Sappa Cr.	21,400		8,800	8,800	17,600
Prairie Dog Cr.	27,600		2,100	12,600	14,700
Rep. R. at Nebr.-Kans. ^{e/}					
St. Line				138,000	138,000
Additional ^{f/}			132,000		132,000
Total	478,900	54,100	234,500	190,300	478,900

a/ Frenchman Creek (River) drainage basin in Nebraska.

b/ Red Willow Creek drainage basin in Colorado.

c/ N. Fork of Republican River in Nebraska and main stem of the Republican River between the junction of the North Fork and the Arikaree River and the lowest crossing of the river of the Nebraska-Kansas State Line and the small tributaries thereof.

d/ Red Willow Creek drainage basin in Nebraska.

e/ From the main stem of the Republican River upstream from the lowest crossing of the river at the Nebraska-Kansas State Line and from water supplies of upstream basins otherwise unallocated. Kansas shall have the right to divert all or any portion thereof at or near Guide Rock, Nebraska. In addition, the entire water supply originating in the Basin downstream from this point is allocated to Kansas.

f/ From the N. Fork of the Republican River in Nebraska, the main stem of the Republican River between the junction of the North Fork and Arikaree River and the lowest crossing of the river at the Nebraska-Kansas State Line, from the small tributaries thereof, and from water supplies of upstream basins otherwise unallocated herein.

NOTE: Should the future computed virgin water supply of any source vary more than 10 percent from the virgin water supply herein set forth, the allocations hereinafter made from such source shall be increased or decreased in the relative proportions that the future computed virgin water supply of such source bears to the computed virgin water supply used herein. Such action requires unanimous action of officials representing the three states.

Table 4. Claims and Applications for Water Rights in Harlan Co. Reservoir Area 1/

Source	Appropriator or Operator	Post Office	Carrier	Use	Provisional Grant	Location of Diversion Sec. T R County	Date Priority	Document or Applic. No.
Cook Creek	Haskell, John G. et al.	Alma	Cook Cr. Canal	Irrig.	0.57 cfs	33-2-18 Harlan	July 21, 1917	1491
Flag Creek	Kerr, Robert H.	Alma	Pump	Irrig.	0.32	27-2-19 Harlan	Apr. 19, 1943	3607
Flag Creek	Davis, John E.	Orleans	Pump	Irrig.	0.22	21-2-19 Harlan	Apr. 12, 1944	3712
Flag Creek	Landgreen, Mrs. Alma	Orleans	Pump	Irrig.	0.29	22-2-19 Harlan	July 5, 1944	3741
Mitrose Creek	Kerr, Robert H.	Alma	Pump	Irrig.	0.74	8-2-19 Harlan	June 14, 1943	3621
Prairie Dog Cr.	Fease, C. A.	Alma	Pump No. 1	Irrig.	0.69	24-1-18 Harlan	Aug. 2, 1937	2758
Prairie Dog Cr.	Fease, C. A.	Alma	Pump No. 2	Irrig.	0.44	25-1-18 Harlan	Aug. 2, 1937	2768
Prairie Dog Cr.	Seyler, Lew	Alma	Pump	Irrig.	0.50	33-1-18 Harlan	Sept 13, 1937	2786
Prairie Dog Cr.	Stolts, Carroll	Republican City	Pump	Irrig.	0.39	24-1-18 Harlan	Aug. 2, 1939	2946
Prairie Dog Cr.	Kauk, Fred	Alma	Pump	Irrig.	0.29	32-1-18 Harlan	Aug. 7, 1939	2943
Prairie Dog Cr.	McCleary, Winifred W.	Alma	Pump	Irrig.	0.44	31-1-18 Harlan	Nov. 6, 1939	3010
Prairie Dog Cr.	Lethem, John R.	Republican City	Pump	Irrig.	0.33	24-1-18 Harlan	Dec. 12, 1939	3046
Prairie Dog Cr.	Kauk, Wm.	Alma	Pump	Irrig.	0.19	28-1-18 Harlan	Jan. 19, 1940	3078
Prairie Dog Cr.	Stone, Earl D.	Republican City	Pumps	Irrig.	0.58	23-1-18 Harlan	Mar. 4, 1940	3103
Prairie Dog Cr.	Thompson, Mayma	Alma	Pumps	Irrig.	0.31	34-1-18 Harlan	Mar. 4, 1940	3104
Prairie Dog Cr.	(Beyer, Freda)	Alma	Pump	Irrig.	0.25	23-1-18 Harlan	Sept 5, 1940	3256
Prairie Dog Cr.	(Waldo, Cartha)	Republican City	Pump	Irrig.	0.93	35-1-19 Harlan	Oct. 11, 1940	3292
Prairie Dog Cr.	Miller, Glen	Woodruff, Kansas	Pump	Irrig.	0.40	33-1-18 Harlan	Nov. 20, 1940	3334
Prairie Dog Cr.	Stone, James S.	Alma	Pump	Irrig.	0.40	33-1-18 Harlan	Nov. 20, 1940	3334
Prairie Dog Cr.	King, Louise et al	Kearney	Pump	Irrig.	0.84	19-1-17 Harlan	Mar. 6, 1941	3411
Prairie Dog Trib	Kauk, Fred	Alma	Pump	Irrig.	0.22	29-1-18 Harlan	Dec. 12, 1939	3047
Republican River	Kirtland, E. S.	Orleans	Orleans Mill	Power		27-2-19 Harlan		1043
Republican River	Pisubach, George	Longmont, Colo.	Pump	Irrig.	1.58	33-2-19 Harlan	Aug. 27, 1925	1776
Republican River	Stevenson, L. E. et	Alma	Pump	Irrig.	6.34	5-1-13 Harlan	Sept 30, 1925	1781
Republican River	Hasker, K. G.	Alma	Pump	Irrig.	4.60	35-2-19 Harlan	Mar. 2, 1926	1798
Republican River	Fischbach, George	Orleans	Pump	Irrig.		33-2-19 Harlan	Feb. 15, 1933	2304
Republican River	Uplinger, Mabel E.	Kearney	Uplinger Canal	Irrig.	0.75	11-1-17 Harlan	Nov. 15, 1939	3019
Republican River	Sindt, John	Republican City	Pump	Irrig.		12-1-18 Harlan	Sept 16, 1948	4343
Repub. River Trib	Hasker, Robert	Orleans	Hasker Reservoir	Storage	105 A. F.	2-1-19 Harlan	Aug. 30, 1946	3950
Rope Creek	Bortfield, Fred E.	Orleans	Pump	Irrig.	0.32	25-2-19 Harlan	Dec. 19, 1940	3357
Republican River	Weidel, Albert E.	Orleans	Weidel Pump	Irrig.	1.94	19-2-19 Harlan	Nov. 30, 1948	4387
Republican River	Hergott, Francis	Orleans	Hergott Pump	Irrig.	0.81	18-2-19 Harlan	Jan. 13, 1949	4421
Prairie Dog Cr.	Miller, Glen	Woodruff, Kansas	Miller Pump	Irrig.	0.23	35-1-19 Harlan	Feb. 11, 1949	4434
Sappa Creek	Pape, Frank	Orleans	Pape Pump	Irrig.	1.41	29-2-19 Harlan	Feb. 17, 1949	4436

Total (Irrig.) 26.72

1/ Includes all claims and applications not cancelled. Also includes applications which have not been approved.

Table 5

Table 5. Claims and Applications for water rights on Republican River, main stem below Harlan County Dam 1/

Appropriator or Operator	Post Office	Carrier	Use	Provisional Grant c.f.s.	Location	Date Priority	Doc. or Applic. No
Consumers Public Power Dist.	Columbus	Ourthrie Canal	Power	400.00	34-1-7 Nuckolls	Sept. 1, 1877	1036
Worden, Dorsey	Superior	Pump	Irrig.	1.04	32-1-6 Nuckolls	Sept. 23, 1886	1862
Keifer, J. Warren Jr.	Bostwick	Keifer Canal #1	Irrig.	9.83	21-1-8 Nuckolls	Sept. 22, 1930	2167
Mendell, B. C.	Superior	Mendell Canal	Irrig.	2.61	35-1-7 Nuckolls	Sept. 7, 1932	2283
Arneson, F. L.	Red Cloud	Pumps	Irrig.	0.23	(2-1-12 Webster 5-1-12	Apr. 17, 1933	2318
Rep. Riv. P. P. and Irrig. Dist.	Bostwick	Rep. Riv. Canal #1	Irrig.		11-1-17 Harlan	Feb. 1, 1937	2691
Rep. Riv. P. P. and Irrig. Dist.	Bostwick	Rep. Riv. Canal #2	Irrig.		5-1-13 Franklin	Feb. 1, 1937	2691
Rep. Riv. P. P. and Irrig. Dist.	Bostwick	Rep. Riv. Canal #3	Irrig.		8-1-9 Webster	Feb. 1, 1937	2691
Rep. Riv. P. P. and Irrig. Dist.	Bostwick	Rep. City Res.	Storage		14-1-17 Harlan	Feb. 1, 1937	2692
Kiehl, W. C. Est.	Guide Rock	Pump	Irrig.	0.26	9-1-9 Webster	May 2, 1939	2919
Mendell, B. C.	Superior	Mendell Canal	Irrig.	0.07	35-1-7 Nuckolls	July 13, 1939	2934
Dunn and Chambers	Inavale	Pump	Irrig.	0.36	1-1-16 Franklin	Jan. 19, 1940	3099
Kahrs and Lieneman	Franklin	Pump	Irrig.	0.78	7-1-15 Franklin	Jan. 22, 1940	3081
Martin, Morris O., Et al	Hastings	Pump	Irrig.	0.18	8-1-11 Webster	Mar. 13, 1940	3116
Houchin, George	Red Cloud	Pump	Irrig.	0.07	15-1-9 Webster	Apr. 5, 1940	3131
Howell, Charles	Bloomington	Pump	Irrig.	0.75	10-1-16 Franklin	Apr. 15, 1940	3134
Meyer, Ernst	Superior	Pump	Irrig.	0.87	34-1-7 Nuckolls	Aug. 26, 1940	3240
Amack, George	Red Cloud	Pump	Irrig.	0.19	7-1-10 Webster	Aug. 28, 1940	3244
Back, W. J.	Riverton	Pump	Irrig.	0.47	3-1-14 Franklin	Jan. 22, 1941	3375
Auld, Jessica C.	Palo Alto	Pump	Irrig.	1.36	9-1-11 Webster	Aug. 31, 1940	3248
Back, Mrs. Theo	Riverton	Pump	Irrig.	0.90	3-1-14 Franklin	Feb. 6, 1941	3384
Butler, Floyd R.	Superior	Pump	Irrig.	0.59	34-1-7 Nuckolls	Sept. 3, 1940	3252
Butler, Floyd R.	Superior	Pump	Irrig.	0.03	34-1-7 Nuckolls	May 9, 1941	3443
Keifer, Oswin	Red Cloud	Keifer Canal #1	Irrig.	2.08	21-1-8 Nuckolls	Jan. 27, 1942	3547
Arneson, F. L.	Red Cloud	Valley Grove Canal	Irrig.	0.25	5-1-12 Webster	Mar. 11, 1942	3558
Myers, H. Leslie	Superior	Pump	Irrig.	0.31	34-1-7 Nuckolls	Apr. 11, 1947	4066
Ohmsted, Gerhard	Guide Rock	Pump	Irrig.	0.36	10-1-9 Webster	June 13, 1947	4080
Nebraska Cement Co.	Superior	Pump	Mfg.	11.50	27-1-7 Nuckolls	Sept. 10, 1947	4109
Jackson, Marvin W.	Napones	Pump	Irrig.	0.74	11-1-16 Franklin	Nov. 5, 1947	4140
Crosier, Walter	Guide Rock	Pump	Irrig.	0.15	1-1-9 Webster	Nov. 14, 1947	4143
U.S. of America	Guide Rock	Pump	Irrig.	0.15	1-1-9 Webster	Nov. 14, 1947	4143
Harris, Lyle A.	Denver	Harlan Co. Res.	Storage	350,000 A.F.	2-1-17 Harlan	Jan. 26, 1948	4190
Bostwick Irrig. Dist.	Red Cloud	Pump	Irrig.	1.02	10-1-10 Webster	Feb. 7, 1948	4205
Bostwick Irrig. Dist.	Red Cloud	Franklin Canal	Irrig.		11-1-17 Harlan	Feb. 26, 1948	4216
Bostwick Irrig. Dist.	Red Cloud	Napones Canal	Irrig.		11-1-17 Harlan	Feb. 26, 1948	4217
Bostwick Irrig. Dist.	Red Cloud	Red Cloud #1 Pump Canal	Irrig.		7-1-12 Webster	Feb. 26, 1948	4218
Bostwick Irrig. Dist.	Red Cloud	Red Cloud #2 Pump Canal	Irrig.		2-1-12 Webster	Feb. 26, 1948	4219
Bostwick Irrig. Dist.	Red Cloud	Red Cloud #3 Pump Canal	Irrig.		8-1-11 Webster	Feb. 26, 1948	4220
Bostwick Irrig. Dist.	Red Cloud	Superior Canal	Irrig.		7-1-9 Webster	Feb. 26, 1948	4221
Bostwick Irrig. Dist.	Red Cloud	Courtland Canal	Irrig.		7-1-9 Webster	Feb. 26, 1948	4222
Bostwick Irrig. Dist.	Red Cloud	Franklin Canal	Irrig.		5-1-4 Franklin	Feb. 28, 1948	4227
Thompson and Johnston	Guide Rock	Pump #1	Irrig.		18-1-8 Nuckolls	April 12, 1948	4243
Grant, Ray	Napones	Pump	Irrig.		16-1-16 Franklin	April 26, 1948	4250
Thompson and Johnston	Guide Rock	Pump	Irrig.	2.14	18-1-18 Nuckolls	April 14, 1949	4463
			Total Irrig	39.14			

1/ Includes all claims and applications not cancelled. Also includes applications which have not been approved.

GAGING STATIONS AND PERIODS OF RECORD AS USED IN WATER STUDIES FOR BOSTWICK DIVISION

GAGING STATION	NET DRAINAGE AREA	1925	1930	1935	1940	1945	1950
REPUBLICAN RIVER NEAR BLOOMINGTON, NEBR	(SQ MI) 14,405						
REPUBLICAN RIVER NEAR HARDY, NEBR	15,563						
98 REPUBLICAN RIVER AT SCANDIA, KANSAS	16,096						
REPUBLICAN RIVER AT CLAY CENTER, KAN	17,637						
SOLOMON RIVER AT BELOIT, KANSAS	5,430						
WHITE ROCK CREEK NEAR LOVEWELL, KAN	634						

TYPE OF GAGE

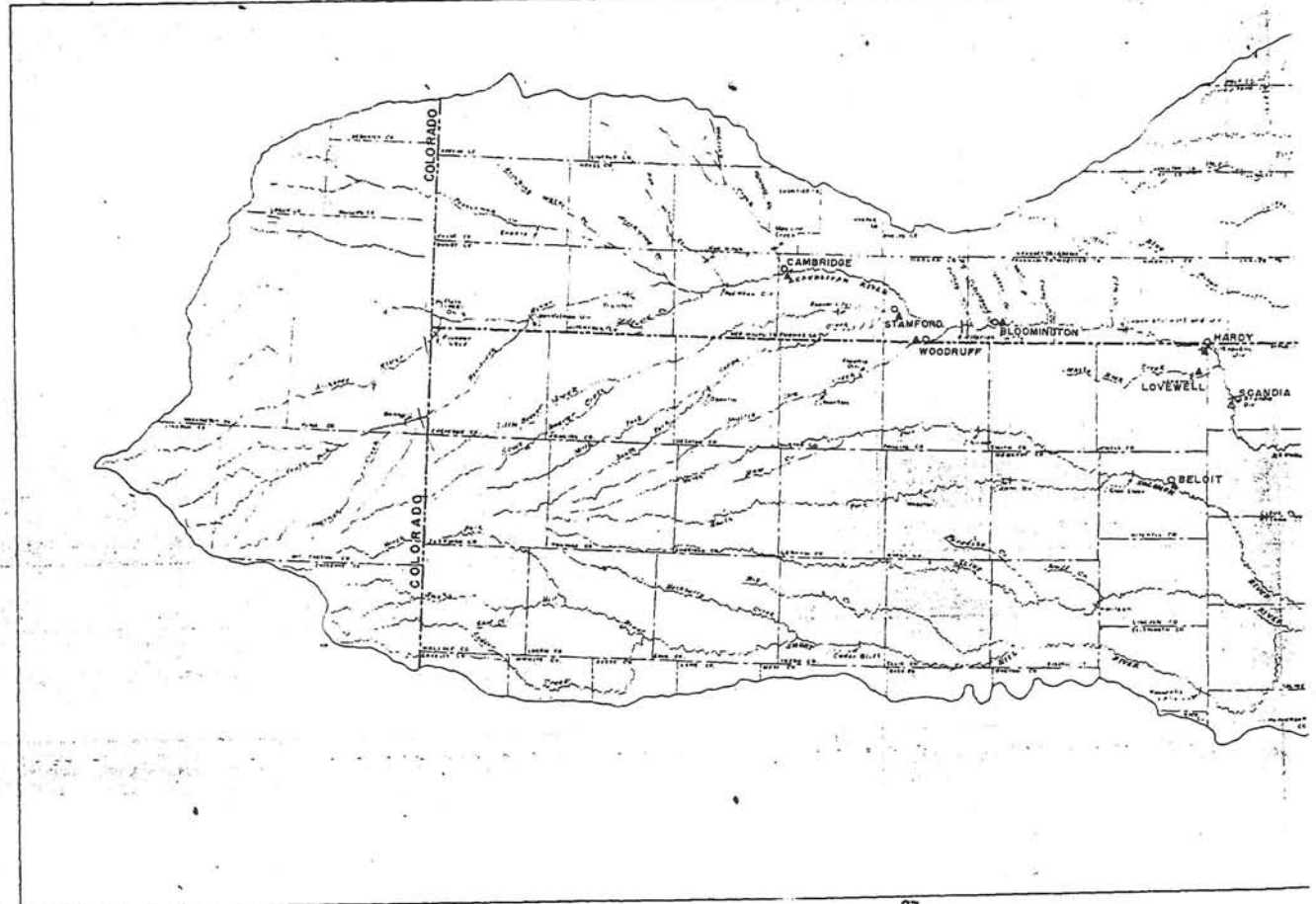
RECORDER

CHAIN

STAFF

WIRE WEIGHT

A



8

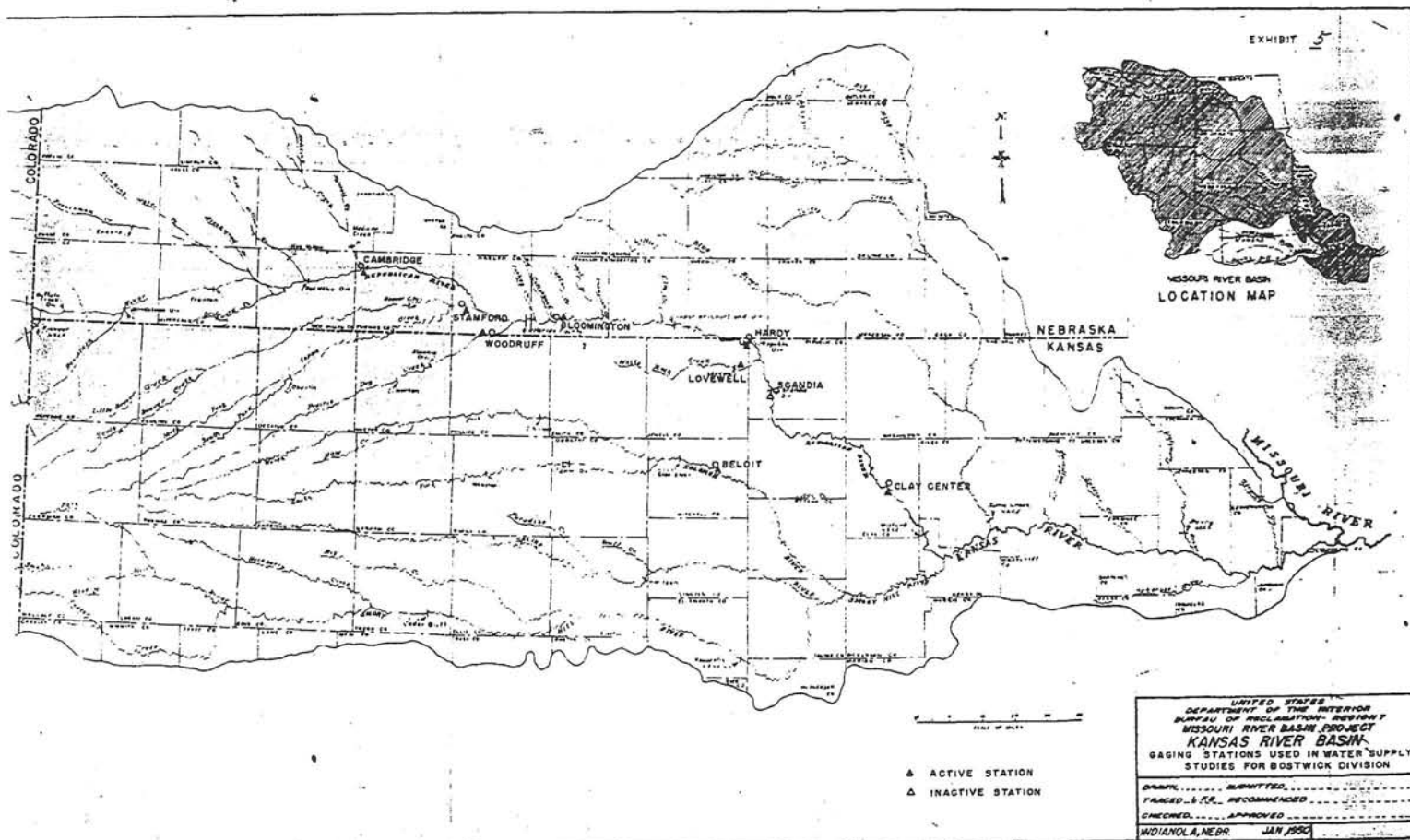


Table 6. Historical Records of Stream Flow at Stream-gaging Stations used in Water Supply Studies for Bostwick Division.

Station Number	Stream	Station	Contributing Drainage Area in Square Miles	Average Annual Historical Flow Acre-Feet		Period of Record	Type of Source of	
				Period of Study Including Estimates	Records		Gage 1/	Data 2/
1.	Republican River	Near Bloomington, Nebraska	14,405	521,800	821,800	Apr. 13, 1929 - Nov. 18, 1938 Nov. 19, 1938 - Present	C R	A, B, C A, D
2.	Republican River	Near Hardy, Nebraska	15,563	581,300	605,200	May 19, 1932 - Present	R	A, D
3.	Republican River	at Scandia, Kansas	16,096	664,000	608,600	Aug. 27, 1919 - July 2, 1925 Aug. 14, 1928 - Sept. 30, 1934 Oct. 1, 1935 - Sept. 30, 1944	S C W	C, E D, E D, E
4.	Republican River	At Clay Center, Kansas	17,684	804,000	918,100	Aug. 1, 1904 - Dec. 21, 1911 ^{a/} Feb. 17, 1912 - Oct. 31, 1917 ^{a/} Feb. 8, 1924 - June 2, 1935 June 3, 1935 - May 6, 1936 May 7, 1936 - Present	C C R C R	D, E D, E D, E D, E D, E
5.	Solomon River	At Beloit, Kansas	5,430	245,900	288,200	Apr. 22, 1895 - June 30, 1897 Jan. 3, 1905 - Apr. 8, 1918 ^{a/} Apr. 9, 1918 - July 31, 1919 ^{a/} Apr. 14, 1929 - Mar. 18, 1930 Mar. 19, 1930 - Present	S S C W R	D, E D, E D, E D, E D, E
6.	White Rock Creek	Near Lovewell, Kansas	764	17,700	77,650	May 21, 1946 - Sept. 12, 1947 Sept. 13, 1947 - Present	W R	A A

^{a/} Records of gage heights only.

1/ Type of Gage

2/ Source of Data

C - Chain
S - Staff
W - Wire Weight
R - Recorder

A - U. S. Geological Survey (Unpublished)
B - Nebraska Department of Roads and Irrigation, Biennial Report
C - Bureau of Agricultural Economics Report, June 1941
D - U. S. Geological Survey, Water Supply Papers
E - Division of Water Resources (Kansas)

Table 7 Historical flow of Republican River near Bloomington, Nebraska 1/

(Unit - 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 :	47.0 :	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 :	715.8
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
Av. :													
1929-47 :	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

1/ October 1928 through April 1929 estimated to be 87.7 percent of annual flow at Hardy, Nebraska based upon relationships of annual historical flow records. May 1927 through Sept. 1947 are historical records.

Table 7

Table 8 Historical flow of Republican River near Hardy and near Nebraska-Kansas State Line. 1/

(Unit - 1000 acre-feet)													
Year :	Oct. :	Nov. :	Dec. :	Jan. :	Feb. :	Mar. :	Apr. :	May :	June :	July :	Aug. :	Sept. :	Total
1929 :	26.1 :	25.1 :	26.7 :	21.1 :	15.6 :	67.9 :	52.8 :	45.7 :	113.0 :	42.7 :	14.9 :	9.0 :	460.6
1930 :	17.2 :	21.4 :	24.0 :	14.1 :	34.3 :	27.4 :	41.1 :	119.6 :	125.0 :	19.4 :	27.4 :	46.8 :	517.7
1931 :	87.0 :	50.2 :	34.7 :	34.9 :	37.2 :	39.3 :	49.5 :	75.2 :	45.3 :	12.6 :	29.6 :	6.7 :	502.2
1932 :	8.3 :	13.9 :	22.9 :	20.8 :	99.4 :	57.0 :	30.2 :	31.2 :	121.0 :	21.7 :	27.1 :	23.2 :	476.7
1933 :	4.7 :	8.7 :	18.4 :	26.1 :	22.5 :	37.4 :	66.0 :	83.0 :	115.6 :	14.5 :	55.3 :	107.0 :	459.2
1934 :	24.6 :	21.4 :	34.0 :	32.6 :	26.9 :	38.3 :	29.4 :	12.8 :	66.6 :	6.8 :	1.1 :	19.0 :	313.5
1935 :	5.8 :	14.2 :	15.2 :	19.2 :	30.4 :	32.2 :	30.8 :	111.1 :	618.2 :	63.2 :	74.6 :	104.1 :	1119.0
1936 :	23.6 :	27.0 :	31.5 :	18.9 :	15.0 :	45.0 :	33.4 :	124.2 :	72.7 :	7.3 :	2.1 :	9.9 :	410.6
1937 :	3.7 :	10.9 :	17.6 :	10.0 :	39.0 :	42.8 :	23.4 :	25.5 :	103.5 :	54.5 :	47.0 :	27.7 :	405.6
1938 :	8.5 :	9.0 :	13.0 :	25.5 :	25.3 :	35.7 :	32.2 :	89.7 :	100.2 :	56.8 :	51.0 :	49.9 :	496.8
1939 :	7.6 :	11.0 :	15.7 :	17.5 :	15.2 :	41.0 :	50.7 :	37.7 :	139.8 :	42.8 :	26.6 :	1.9 :	407.5
1940 :	1.2 :	44.1 :	8.2 :	6.3 :	11.8 :	46.4 :	26.1 :	30.5 :	77.3 :	38.1 :	33.0 :	14.2 :	297.2
1941 :	16.8 :	15.6 :	18.5 :	26.7 :	33.8 :	34.5 :	48.1 :	64.9 :	321.9 :	119.0 :	64.0 :	93.8 :	857.6
1942 :	46.5 :	34.1 :	30.4 :	27.6 :	43.9 :	72.8 :	112.1 :	79.3 :	213.6 :	53.4 :	72.5 :	116.8 :	903.0
1943 :	31.0 :	33.5 :	30.3 :	28.7 :	51.4 :	39.1 :	85.5 :	28.6 :	106.1 :	23.7 :	5.1 :	7.6 :	470.6
1944 :	2.6 :	9.0 :	12.0 :	21.8 :	29.1 :	48.0 :	104.2 :	118.9 :	135.1 :	192.8 :	97.6 :	23.7 :	794.8
1945 :	15.9 :	22.1 :	22.2 :	33.3 :	36.5 :	36.6 :	51.4 :	80.1 :	145.8 :	90.5 :	24.0 :	9.4 :	567.8
1946 :	22.0 :	17.6 :	13.6 :	24.7 :	38.3 :	38.2 :	24.6 :	39.1 :	354.7 :	95.7 :	24.5 :	87.5 :	480.5
1947 :	257.9 :	81.8 :	53.1 :	34.0 :	32.1 :	59.0 :	56.7 :	53.8 :	352.7 :	90.3 :	22.9 :	8.9 :	1103.2
Av. :													
1929-47 :	32.2 :	22.7 :	23.3 :	23.4 :	33.5 :	44.1 :	49.9 :	65.8 :	154.0 :	55.1 :	36.9 :	40.4 :	581.3

1/ October 1928 through May 1932 based on correlation with Republican River at Scandia, Kansas (92%).
June 1932 through September 1947 are records.



Table 9 Historical flow of the Republican River at Scandia, Kansas. 1/

(Unit - 1000 acre-feet)													
Year :	Oct. :	Nov. :	Dec. :	Jan. :	Feb. :	Mar. :	Apr. :	May :	June :	July :	Aug. :	Sept. :	Total
1929 :	28.4 :	27.3 :	29.0 :	22.9 :	17.0 :	73.8 :	57.4 :	49.7 :	123.0 :	46.4 :	16.2 :	9.8 :	500.9
1930 :	18.7 :	23.2 :	26.1 :	15.3 :	37.3 :	29.8 :	44.7 :	130.0 :	136.0 :	21.1 :	29.8 :	50.9 :	562.9
1931 :	94.5 :	54.6 :	37.7 :	37.9 :	40.4 :	42.7 :	53.8 :	81.7 :	49.3 :	13.7 :	32.2 :	7.3 :	545.8
1932 :	9.0 :	15.1 :	24.9 :	22.6 :	108.0 :	62.0 :	32.8 :	33.9 :	121.0 :	24.2 :	36.3 :	26.1 :	515.9
1933 :	10.4 :	12.0 :	16.9 :	26.1 :	24.8 :	38.0 :	75.5 :	87.9 :	18.5 :	20.1 :	54.7 :	106.0 :	490.9
1934 :	18.7 :	18.9 :	33.5 :	33.8 :	27.8 :	43.8 :	33.1 :	13.6 :	63.1 :	8.4 :	1.2 :	19.7 :	315.6
1935 :	6.5 :	15.2 :	15.4 :	19.2 :	32.0 :	34.1 :	29.8 :	146.8 :	666.5 :	66.1 :	73.1 :	109.6 :	1214.3
1936 :	28.7 :	26.3 :	34.7 :	19.4 :	14.7 :	49.8 :	36.5 :	134.3 :	68.2 :	9.3 :	1.5 :	10.2 :	433.6
1937 :	3.7 :	11.6 :	19.9 :	11.4 :	44.3 :	47.0 :	27.2 :	28.8 :	112.7 :	58.1 :	44.5 :	27.1 :	436.3
1938 :	8.8 :	11.2 :	14.4 :	25.1 :	22.7 :	36.4 :	33.4 :	93.0 :	106.4 :	59.1 :	58.5 :	59.9 :	528.9
1939 :	9.5 :	10.4 :	16.2 :	22.6 :	15.0 :	43.9 :	43.6 :	42.9 :	159.0 :	54.6 :	31.7 :	1.8 :	451.2
1940 :	1.2 :	3.8 :	8.0 :	6.3 :	10.0 :	44.7 :	24.7 :	32.9 :	80.8 :	37.8 :	35.2 :	13.3 :	298.7
1941 :	16.9 :	15.7 :	18.9 :	24.0 :	31.4 :	35.2 :	56.2 :	78.5 :	454.6 :	131.6 :	80.5 :	110.5 :	1054.0
1942 :	64.0 :	44.5 :	35.2 :	38.0 :	51.4 :	80.8 :	105.5 :	83.0 :	243.4 :	62.0 :	94.5 :	154.3 :	1056.6
1943 :	35.5 :	34.5 :	33.8 :	30.4 :	54.3 :	39.4 :	96.9 :	31.3 :	186.4 :	28.5 :	6.5 :	6.6 :	564.1
1944 :	2.6 :	8.2 :	12.8 :	20.8 :	30.0 :	49.6 :	107.6 :	138.9 :	156.6 :	195.1 :	137.2 :	33.8 :	893.2
1945 :	17.2 :	23.5 :	23.9 :	34.5 :	39.1 :	43.4 :	75.1 :	245.5 :	179.5 :	139.4 :	31.5 :	12.1 :	864.7
1946 :	23.2 :	18.9 :	14.0 :	25.7 :	38.2 :	40.6 :	26.7 :	38.1 :	66.0 :	129.1 :	29.9 :	115.1 :	565.5
1947 :	261.4 :	96.4 :	56.6 :	41.9 :	33.7 :	63.0 :	89.9 :	67.6 :	450.5 :	104.7 :	27.5 :	10.6 :	1303.8
Av.	34.7	24.8	24.8	25.2	35.4	47.2	55.3	82.0	181.1	63.6	43.2	46.6	664.5

1/ October 1928 through September 1944 are historical records. October 1944 through September 1947 estimated as 1935-1943 monthly percentage of pickup, Hardy to Clay Center occurring above Scandia, plus run-off at Hardy.

Table 10. Accretion of Republican River flow between Hardy, Nebraska and Scandia, Kansas 1/

(Unit 1000 acre-feet)													
Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	August	Sept.	Total
1929	2.3	2.2	2.3	1.8	1.4	5.9	4.6	4.0	10.0	3.7	1.3	0.8	40.3
1930	1.5	1.8	2.1	1.2	3.0	2.4	3.6	10.4	11.0	1.7	2.4	4.1	45.2
1931	7.5	4.4	3.0	3.0	3.2	3.4	4.3	6.5	4.0	1.1	2.6	0.6	43.6
1932	0.7	1.2	2.0	1.8	8.6	5.0	2.6	2.7	0	2.5	9.2	2.9	39.2
1933	5.7	3.3	-1.5	0	2.3	0.6	9.5	4.9	2.9	5.6	-0.6	-1.0	31.7
1934	-5.9	-2.5	-0.5	1.2	0.9	5.5	3.7	0.8	-3.5	1.6	0.1	0.7	2.1
1935	0.7	1.0	0.2	0	1.6	1.9	-1.0	35.7	48.3	2.9	-1.5	5.5	95.3
1936	5.1	-0.7	3.2	0.5	-0.3	4.8	3.1	10.1	-4.5	2.0	-0.6	0.3	23.0
1937	0	0.7	2.3	1.4	5.3	4.2	3.8	3.3	9.2	3.6	-2.5	-0.6	30.7
1938	0.3	2.2	1.4	-0.4	-2.6	0.7	1.2	3.3	6.2	2.3	7.5	10.0	32.1
1939	1.9	-0.6	0.5	5.1	-0.2	2.9	-7.1	5.2	19.2	11.8	5.1	-0.1	43.7
1940	0	-0.3	-0.2	0	-1.8	-1.7	-1.4	2.4	3.5	-0.3	2.2	-0.9	1.5
1941	0.1	0.1	0.4	-2.7	-2.4	0.7	8.1	13.6	132.7	12.6	16.5	16.7	196.4
1942	17.5	10.4	4.8	10.4	7.5	8.0	-6.6	3.7	29.8	8.6	22.0	37.5	153.6
1943	4.5	1.0	3.5	1.7	2.9	0.3	11.4	2.7	80.3	4.8	1.4	-1.0	113.5
1944	0	-0.8	0.8	-1.0	0.9	1.6	3.4	20.0	21.5	2.3	39.6	10.1	98.4
1945	1.3	1.4	1.7	1.2	2.6	6.8	23.7	165.4	33.7	48.9	7.5	2.7	296.9
1946	1.2	1.3	0.4	1.0	-0.1	2.4	2.1	-1.0	11.3	33.4	5.4	27.6	85.0
1947	3.5	14.6	3.5	7.9	1.6	4.0	33.2	13.8	97.8	14.4	4.6	1.7	200.6
Av.	2.5	2.1	1.6	1.8	1.8	3.1	3.4	14.2	57.0	8.6	6.4	6.2	82.7

1/ June 1932 through September 1944 accretions are based upon concurrent records of flow at Hardy and Scandia. Oct 1928 through May 1932 accretions are based upon historical records at Scandia and estimated flows at Hardy. Oct. 1944 through September 1947 accretions are based upon historical records at Hardy and estimated records at Scandia. Accretions between Hardy and Scandia coincide with accretions between Republic Diversion Dam and the Scandia Diversion Dam.

Table // Historical accretion of Republican River between Hardy, Nebraska and Clay Center, Kansas. 1/

(Unit - 1,000 acre-feet)													
Year :	Oct. :	Nov. :	Dec. :	Jan. :	Feb. :	Mar. :	Apr. :	May :	June :	July :	Aug. :	Sept. :	Total
1929 :	3.7 :	3.6 :	3.6 :	2.7 :	2.1 :	13.1 :	9.7 :	:	:	:	:	:	:
1930 :	:	:	:	:	:	:	:	:	:	:	:	:	:
1931 :	:	:	:	:	:	:	:	:	:	:	:	:	:
1932 :	:	:	:	:	:	:	:	:	:	:	:	:	:
1933 :	:	:	:	:	:	:	:	:	:	:	:	:	:
1934 :	:	:	:	:	2.4 :	0.3 :	1.4 :	14.3 :	-9.7 :	5.2 :	-1.0 :	-5.0 :	:
1935 :	-1.0 :	-2.7 :	-1.7 :	-2.8 :	-0.1 :	-0.8 :	-0.2 :	22.2 :	55.1 :	33.0 :	5.6 :	105.6 :	212.2
1936 :	29.6 :	19.6 :	17.1 :	6.8 :	3.8 :	16.1 :	1.2 :	19.6 :	6.1 :	6.1 :	1.5 :	0.6 :	128.1
1937 :	3.3 :	-0.7 :	0.9 :	2.4 :	11.9 :	20.0 :	6.6 :	1.7 :	24.3 :	24.5 :	5.3 :	0.9 :	101.1
1938 :	0.5 :	0.1 :	-0.2 :	-2.8 :	-0.9 :	2.9 :	0.8 :	60.9 :	106.1 :	16.1 :	21.1 :	3.0 :	207.6
1939 :	3.6 :	0.7 :	0 :	6.2 :	0.9 :	11.3 :	15.4 :	4.3 :	30.1 :	11.6 :	8.5 :	2.0 :	94.6
1940 :	1.1 :	-0.9 :	-0.5 :	-0.8 :	-0.2 :	1.7 :	3.0 :	3.7 :	2.1 :	-14.3 :	14.5 :	6.8 :	16.2
1941 :	1.7 :	-1.7 :	-0.3 :	-4.3 :	-0.4 :	1.7 :	4.1 :	5.9 :	152.7 :	24.0 :	39.4 :	38.2 :	261.0
1942 :	150.9 :	32.4 :	22.9 :	16.3 :	10.2 :	19.0 :	-10.6 :	21.1 :	88.8 :	30.8 :	23.4 :	73.4 :	478.6
1943 :	10.8 :	5.1 :	3.7 :	3.5 :	3.7 :	5.1 :	19.3 :	35.3 :	248.7 :	21.9 :	10.4 :	1.5 :	379.0
1944 :	3.5 :	-0.3 :	1.2 :	-2.0 :	0.6 :	5.1 :	34.6 :	79.3 :	42.3 :	22.7 :	113.6 :	47.5 :	348.1
1945 :	8.7 :	5.3 :	4.4 :	1.9 :	9.9 :	24.0 :	81.7 :	360.8 :	74.1 :	155.6 :	19.5 :	9.3 :	755.2
1946 :	7.9 :	4.8 :	1.1 :	1.5 :	-0.4 :	8.5 :	7.3 :	-2.1 :	24.9 :	106.7 :	13.9 :	95.2 :	269.3
1947 :	23.3 :	54.7 :	9.2 :	12.1 :	6.1 :	14.2 :	114.4 :	30.0 :	215.0 :	45.7 :	11.9 :	5.7 :	542.3
1935-47	18.7	4.0	4.4	5.1	4.2	4.7	21.3	47.4	82.5	37.3	22.2	30.6	291.8

1/ October 1928 through April 1929 determined from the estimated Scandia flows less the historical records at Hardy. February 1934 through September 1947 determined from historical records at Hardy and Clay Center.

Table 12 Historical flow of Republican River at Clay Center, Kansas. 1/

(Unit - 1000 acre-feet)													
Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1929	29.8	28.7	30.3	23.8	17.7	81.0	62.5	53.3	139.0	50.0	17.0	10.7	543.8
1930	19.4	24.3	27.2	16.0	39.8	31.0	48.0	147.5	154.5	22.0	31.0	55.0	615.7
1931	105.0	59.5	39.8	40.0	43.2	46.0	58.0	90.5	53.2	14.4	34.2	8.3	592.1
1932	10.0	15.9	25.9	23.4	121.0	67.5	34.8	35.9	137.5	25.2	38.6	27.2	562.9
1933	11.3	12.9	17.6	27.2	25.8	40.2	83.0	97.0	19.2	21.0	59.8	119.0	634.0
1934	19.4	19.6	35.5	35.8	29.3	38.6	30.8	27.1	56.9	12.0	0.1	14.0	319.1
1935	4.8	11.5	13.5	16.4	30.3	31.4	30.6	133.3	673.3	96.2	80.2	209.9	1531.4
1936	53.2	46.6	46.6	25.7	18.8	61.1	34.6	143.8	78.8	13.4	3.6	10.5	538.7
1937	7.0	10.2	18.5	12.4	50.9	62.8	30.0	27.2	127.8	79.0	52.3	28.6	506.7
1938	9.0	9.1	12.8	22.7	24.4	38.6	33.0	150.6	206.3	72.9	72.1	52.9	704.4
1939	11.2	11.7	15.7	23.7	16.1	52.3	68.1	42.0	169.9	54.4	35.1	3.9	502.1
1940	2.3	3.2	7.7	5.5	11.6	48.1	29.1	34.2	79.4	23.8	47.5	21.0	313.4
1941	18.5	13.9	16.2	22.4	33.4	36.2	52.2	70.8	474.6	143.0	103.4	132.0	1118.6
1942	197.4	66.5	53.3	43.9	54.1	91.8	101.5	100.4	302.4	84.2	95.9	190.2	1381.6
1943	41.8	38.6	34.0	32.2	65.1	44.2	104.8	63.9	354.8	45.6	15.5	9.1	849.6
1944	6.1	8.7	13.2	15.8	29.7	53.1	138.8	198.2	177.4	215.5	211.2	71.2	1142.9
1945	24.6	27.4	26.6	35.2	46.4	60.6	133.1	440.9	219.9	246.1	43.5	16.7	1323.0
1946	29.9	22.4	14.7	28.2	37.9	46.7	31.9	37.0	79.6	202.4	38.4	182.7	749.8
1947	291.2	136.5	62.3	46.1	38.2	73.2	171.1	83.8	567.7	136.0	34.8	14.6	1645.5
Av.													
1929-47	46.4	29.9	27.1	26.2	38.6	52.9	67.0	104.1	214.3	82.0	53.4	62.1	804.0

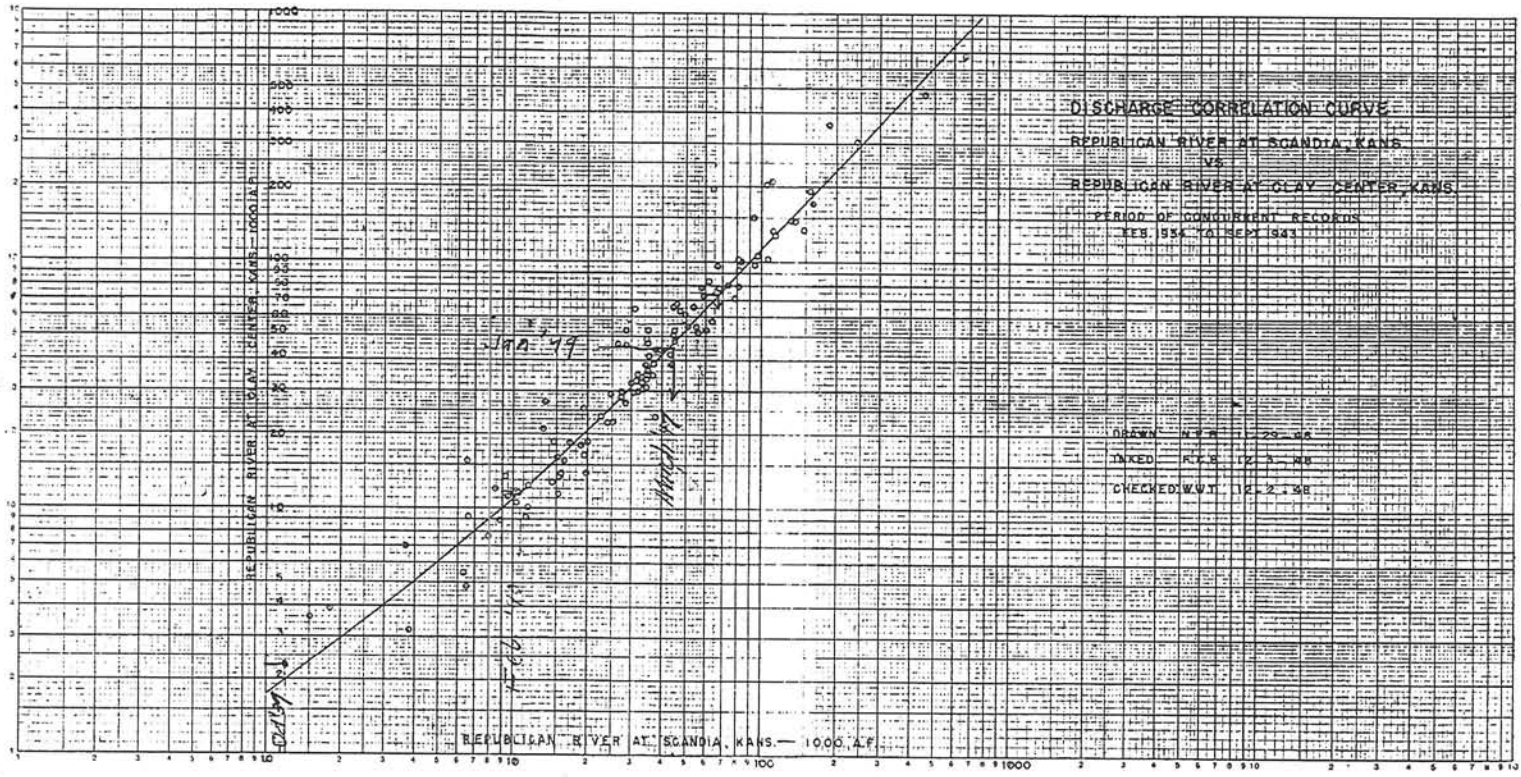
1/ October 1926 through January 1934 based on correlation with Scandia, Kansas. Remaining values are records.

Table 12

KS002034



REPUBLICAN RIVER AT CLAY CENTER, KANS. - 1000 A.F.



DRAWN BY R. J. 12-29-58
CHECKED BY R. J. 12-3-58
CHECKED BY W. J. 12-2-58

Table 13. Historical flow of White Rock Creek at Lovewell Dam Site near Lovewell, Kansas. 1/

(Unit - 1,000 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	0.7	0.4	1.2	6.2	1.7	0.6	0.4	11.7
1930	0.6	0.5	0.3	0.2	0.3	0.3	0.3	1.7	1.7	0.2	0.7	1.1	7.9
1931	1.4	1.0	0.5	0.4	0.4	0.4	0.8	2.4	0.5	3.0	1.9	0.1	12.8
1932	0.3	0.3	0.3	0.2	0.9	0.3	0.2	0.2	1.1	0.3	0.8	1.5	6.4
1933	0.3	0.1	0.1	0.1	0.1	0.1	1.3	0.6	0.1	0.5	0.2	0.5	4.0
1934	0	0.1	0.1	0.1	0.1	0	0	0.7	0	0.2	0	0	1.3
1935	0	0	0	0	0	0	0	1.2	3.8	2.0	0.2	8.5	15.7
1936	1.8	1.1	0.9	0.3	0.1	0.8	0	1.1	0.3	0.3	0	0	6.7
1937	0.1	0	0	0.1	0.6	1.1	0.3	0.1	1.4	1.4	0.2	0	5.3
1938	0	0	0	0	0	0.1	0	4.3	8.5	0.8	1.2	0.1	15.0
1939	0.1	0	0	0.3	0	0.5	0.8	0.2	1.8	0.6	0.4	0.1	4.8
1940	0	0	0	0	0	0.1	0.1	0.1	0.1	0	0.7	0.3	1.4
1941	0.1	0	0	0	0	0.1	0.2	0.2	13.4	1.4	2.5	2.4	20.3
1942	13.3	2.0	1.3	0.8	0.5	1.0	0	1.2	6.8	1.9	1.3	5.4	35.5
1943	0.5	0.2	0.1	0.1	0.7	0.2	1.0	2.2	24.3	1.2	0.5	0	31.0
1944	0.1	0	0	0	0	0.2	2.1	5.9	2.7	1.3	9.3	3.2	24.8
1945	0.4	0.2	0.2	0.1	0.5	1.4	6.2	38.3	5.5	13.7	1.1	0.4	68.0
1946	0.3	0.2	0	0	0	0.4	0.3	0	2.5	5.3	0	12.0	21.0
1947	2.4	4.5	0.4	0.3	0.5	1.0	8.6	1.7	21.2	1.5	0.4	0.1	42.6
1948	0.2	0.2	0.3	0.2	4.1	7.0	0.3	0.4	1.5	4.1	0.9	0	19.2
1949	0	0	0	0.9	1.3	5.1	0.4	11.2	21.6	0.9	0.3	2.2	43.9

Av. 1.0 0.5 0.2 0.2 0.5 1.0 1.1 3.6 6.0 2.0 1.1 1.8 19.0
 1/ Oct. 1928 through April 1929 and Febr. 1934 through May 1946 based on correlation with pickup on Republican River between Hardy and Clay Center. May 1929 through Jan. 1934 based on correlation with Solomon River at Beloit. June 1946 through Sept. 1949 are records.

Table 13

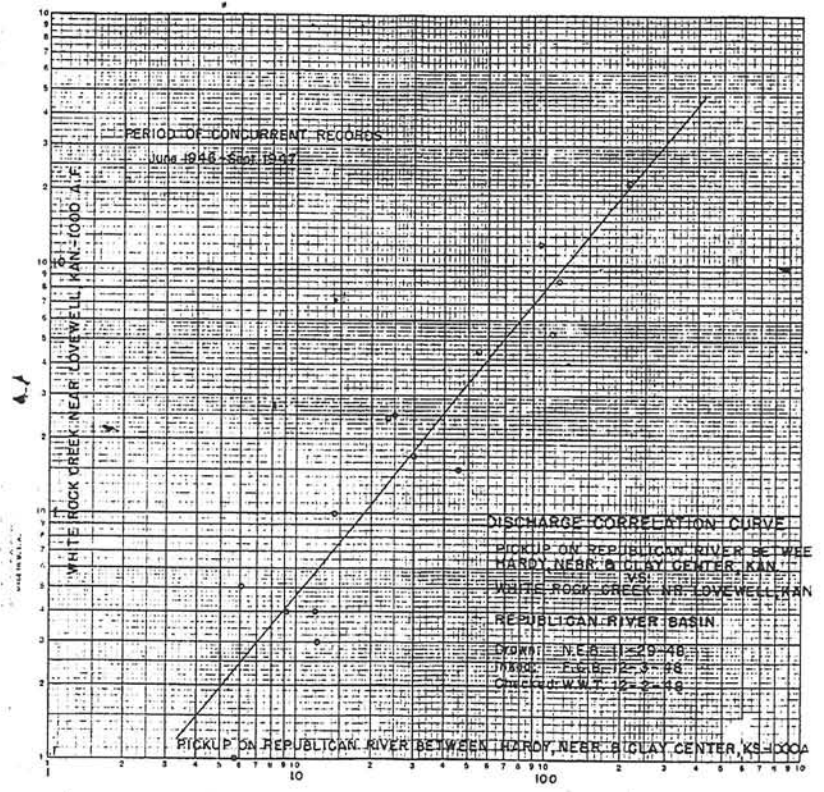


Table 14. Historical flow of the Solomon River at Beloit, Kansas 1/

(Unit - 1000 acre-feet)

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1929	15.5	12.6	10.0	6.4	6.8	16.3	51.0	19.2	83.3	26.0	10.9	7.4	265.4
1930	9.7	9.0	5.3	3.5	5.8	5.0	6.0	26.3	26.0	4.5	12.2	17.7	131.0
1931	21.4	15.7	9.2	6.7	6.5	6.5	14.0	35.5	9.6	43.0	28.6	2.4	199.1
1932	6.1	5.7	5.8	4.7	14.6	6.2	3.3	4.4	17.1	5.4	13.5	23.7	110.5
1933	5.2	1.7	1.4	1.4	2.2	2.6	20.4	9.7	1.8	8.4	4.7	9.2	68.7
1934	1.1	1.3	2.7	1.6	1.6	2.3	2.2	3.4	59.0	2.2	1.8	14.8	94.0
1935	0.4	0.8	0.7	0.6	0.9	0.8	0.9	93.1	296.1	24.1	33.5	68.3	520.2
1936	7.5	4.0	3.2	2.0	1.6	3.3	2.1	40.1	7.9	1.6	1.0	26.6	100.9
1937	3.7	1.0	1.5	0.7	9.8	4.7	1.7	2.8	77.8	19.7	15.4	10.0	148.8
1938	2.0	1.0	1.1	1.7	1.5	3.8	12.7	55.8	66.2	25.1	12.4	5.7	189.0
1939	1.4	0.6	0.6	0.9	0.6	3.8	4.9	6.7	43.5	17.5	49.0	0.8	130.3
1940	0.2	0.3	0.4	0.2	0.4	1.7	1.1	25.4	6.2	7.2	4.0	12.4	59.5
1941	1.3	2.4	1.1	1.1	1.8	2.4	16.7	8.1	265.9	40.8	26.1	125.5	493.2
1942	75.5	22.5	10.0	13.2	7.3	11.3	36.8	36.2	58.8	18.0	53.1	54.1	396.8
1943	7.2	5.5	5.4	4.1	17.8	5.4	56.2	8.2	132.1	21.0	5.4	4.9	273.2
1944	2.3	2.3	2.0	2.3	3.2	5.8	50.8	104.2	72.6	96.2	65.1	17.6	424.4
1945	5.8	5.4	5.4	5.6	5.5	5.7	20.7	52.6	48.4	108.0	6.7	3.2	273.0
1946	2.9	2.7	2.4	2.8	3.8	5.4	3.9	8.9	41.0	41.6	27.0	167.5	309.9
1947	96.3	43.2	10.6	7.0	5.5	12.0	42.3	33.0	192.4	31.3	7.0	3.2	483.8

Av. 14.0 7.2 4.2 3.5 5.1 5.5 17.3 30.1 77.5 20.5 14.9 32.3 245.9

1/ Oct. 1928 - April 1929 based on correlation with Solomon River at Niles. Records after April 1929.

Table 14

EXIST

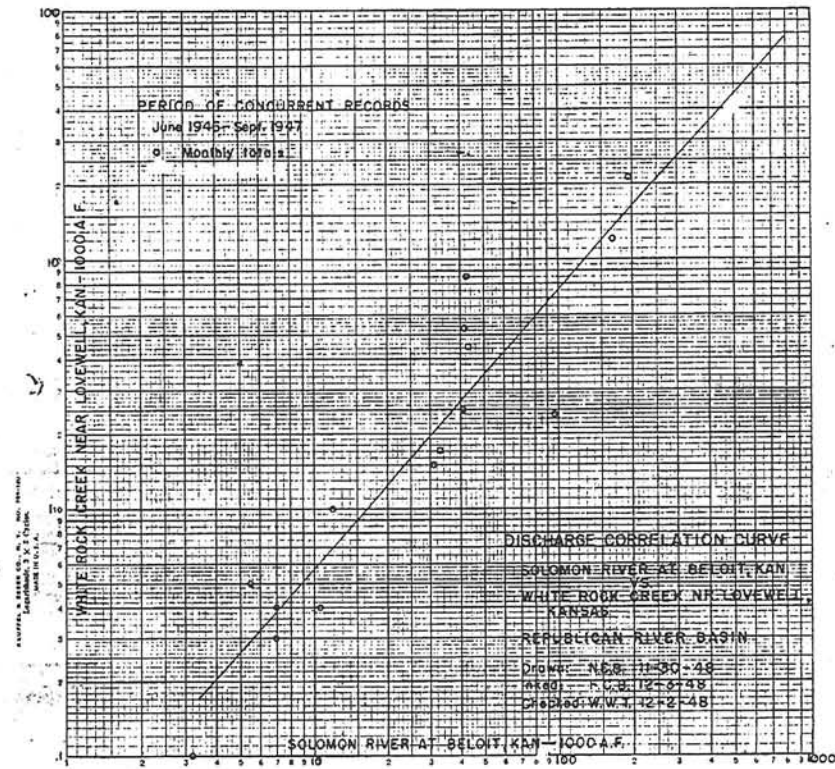


Table 15 Historical flow of Republican River at Harlan County Dam

1/

(Unit - 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	73.8	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
Av.	31.2	20.3	21.7	21.4	27.7	39.3	43.7	55.7	136.4	47.9	31.3	32.7	571.3

1/ Run-off at Harlan County Dam site estimated as 98% of the run-off at Floomington.

Table 15

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Table 15 Historical accretion of Republican River between Bloomington and Hardy. 1/

(Unit - 1000 acre-feet)													
Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1929	3.2	3.1	3.3	2.6	1.9	8.4	6.5	-11.0	4.0	-27.4	2.9	0.4	-2.1
1930	0.6	-2.5	-0.5	-7.3	8.5	-3.0	-7.6	34.8	-11.0	-7.2	-4.4	0.5	0.9
1931	-12.0	-3.7	-3.6	0.8	-3.6	-6.6	-5.8	33.4	4.1	3.1	4.6	2.1	12.8
1932	4.3	1.5	11.0	6.0	44.1	14.1	0.4	4.1	22.8	3.7	0.2	3.3	115.5
1933	-0.6	-0.1	-3.1	0	1.6	4.8	-0.6	10.4	2.1	6.1	5.7	13.6	39.9
1934	5.0	0.5	-1.4	1.2	1.4	3.9	3.1	3.9	-0.8	1.5	-1.6	-5.2	11.5
1935	0.6	2.4	0.1	-7.2	7.7	2.4	3.3	-10.2	62.3	13.8	8.7	32.8	116.7
1936	5.1	1.2	0.4	-1.0	0.7	-0.7	7.8	-16.3	21.0	3.7	0.4	2.0	30.3
1937	1.2	-1.2	-0.3	1.0	4.3	8.0	2.5	1.2	2.6	21.5	-1.1	2.0	41.7
1938	1.5	-3.1	-1.1	-0.3	1.5	4.2	-4.5	17.3	17.1	-1.8	12.9	9.2	52.9
1939	1.3	1.3	-1.3	-0.4	0.1	5.5	15.0	-2.0	30.9	9.4	3.9	1.0	64.7
1940	0.4	-0.2	-3.8	-1.8	-3.6	7.0	2.2	9.4	6.8	-3.9	8.9	-7.2	14.0
1941	-2.4	3.8	2.7	3.9	1.7	1.4	4.3	3.8	63.7	-30.6	-14.4	-3.9	34.1
1942	8.3	5.7	4.1	4.3	9.4	3.9	24.6	13.1	52.8	12.4	12.4	36.4	187.4
1943	4.3	3.8	-2.0	7.4	15.6	2.5	27.4	5.3	38.2	9.6	1.9	1.2	115.2
1944	1.3	0.5	0.2	3.3	-1.9	9.3	-10.9	29.8	14.9	3.6	33.6	12.4	95.2
1945	3.4	2.1	-2.2	4.3	4.8	6.7	13.6	44.7	-21.4	41.4	4.3	-5.4	96.3
1946	3.9	-0.3	2.3	2.9	7.9	2.8	4.0	-8.9	18.8	10.5	6.6	37.2	87.7
1947	-23.4	21.7	11.5	8.6	-1.0	2.4	14.5	8.0	-44.0	8.9	7.1	1.5	15.8
Av.													
1929-47	0.4	1.9	1.2	1.5	5.3	4.0	5.2	9.0	14.8	4.2	4.9	7.1	59.5

1/ Historical flow at Hardy less than historical flow at Bloomington.

Table 17. Historical accretion of Republican River between Bloomington and the Superior-Courtland Diversion Dam 1/

(Unit 1000 acre-feet)													
Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1929	2.2	2.2	2.3	1.8	1.3	5.9	4.5	-7.7	2.8	-19.1	2.0	0.3	-1.5
1930	0.4	-1.7	-0.3	-5.1	5.9	-2.1	-5.3	24.3	-7.7	-5.0	-3.1	0.3	0.6
1931	-8.4	-2.6	-2.5	0.6	-2.5	-4.6	-4.0	23.3	2.9	2.2	3.2	1.5	9.1
1932	3.0	1.0	7.7	4.2	30.8	9.8	0.3	2.9	15.9	2.6	0.1	2.3	80.6
1933	-0.4	-0.1	-2.2	0	1.1	3.4	-0.4	7.3	1.5	4.3	4.0	9.5	28.0
1934	3.5	0.3	-1.0	0.8	1.0	2.7	2.2	2.7	-0.6	1.0	-1.1	-3.6	7.9
1935	0.4	1.7	0.1	-5.0	5.4	1.7	2.3	-7.1	43.5	9.6	6.1	22.9	81.6
1936	3.6	0.8	4.5	-0.7	0.5	-0.5	5.4	-11.4	14.7	2.6	0.3	1.4	21.2
1937	0.8	-0.8	-0.2	0.7	3.0	5.6	1.7	0.8	1.8	15.0	-0.8	1.4	29.0
1938	1.0	-2.2	-0.8	-0.2	1.0	2.9	-3.1	12.1	11.9	-1.3	9.0	6.4	36.7
1939	0.9	0.9	-0.9	-0.3	0.1	3.8	10.5	-1.4	21.6	5.6	2.7	0.7	45.2
1940	0.3	-0.1	-2.7	-1.3	-2.5	4.9	1.5	6.6	4.6	-2.7	6.2	-5.0	9.8
1941	-1.7	2.7	1.9	2.7	1.2	1.0	3.0	2.7	44.5	-21.4	-10.1	-2.7	23.8
1942	5.8	4.0	2.9	3.0	6.6	2.7	17.2	9.1	36.9	8.7	8.7	25.4	131.0
1943	3.0	2.7	-1.4	5.2	10.9	1.7	19.1	3.7	26.7	6.7	1.3	0.8	80.4
1944	0.9	0.3	0.1	2.3	-1.3	6.5	-7.6	20.8	9.8	2.5	23.5	8.7	66.5
1945	2.4	1.5	-1.5	3.0	3.4	4.7	9.5	31.2	-14.9	28.9	3.0	-3.8	67.4
1946	2.7	-0.2	1.6	2.0	5.5	2.0	2.8	-6.2	13.1	7.3	4.6	26.0	61.2
1947	-16.3	15.1	8.0	6.0	-0.7	1.7	10.1	5.6	-30.7	6.2	5.0	1.0	11.0
Average	0.2	1.3	0.8	1.0	3.7	2.8	3.7	6.3	10.4	2.9	3.4	4.9	41.4

1/ Accretion between Bloomington and Diversion Dam equal 69.8 percent of Bloomington-Hardy accretion based upon drainage area relationship.

Table 17

Table 12 Historical flow of the Republican River at Superior-Courtland Diversion Dam. 1/

(Unit 1000 acre-feet)													
Year :	Oct. :	Nov. :	Dec. :	Jan. :	Feb. :	Mar. :	Apr. :	May :	June :	July :	Aug. :	Sept. :	Total
1929 :	25.1 :	24.2 :	25.7 :	20.3 :	15.0 :	65.4 :	50.8 :	49.0 :	111.8 :	51.0 :	14.0 :	8.9 :	461.2
1930 :	17.0 :	22.2 :	24.2 :	16.3 :	31.7 :	28.3 :	43.4 :	109.1 :	128.3 :	21.6 :	28.7 :	46.6 :	517.4
1931 :	90.6 :	51.3 :	35.8 :	34.7 :	38.3 :	41.3 :	51.3 :	65.1 :	44.1 :	11.7 :	28.2 :	6.1 :	498.5
1932 :	7.0 :	13.4 :	19.6 :	19.0 :	86.1 :	52.7 :	30.1 :	30.0 :	114.1 :	20.6 :	27.0 :	22.2 :	441.8
1933 :	4.9 :	8.7 :	19.3 :	26.1 :	22.0 :	36.0 :	66.2 :	79.9 :	15.0 :	12.7 :	53.6 :	102.9 :	447.3
1934 :	23.1 :	21.2 :	34.4 :	32.2 :	26.5 :	37.1 :	28.5 :	11.6 :	66.8 :	6.3 :	1.6 :	20.6 :	309.9
1935 :	5.6 :	13.5 :	15.2 :	21.4 :	28.1 :	31.5 :	29.8 :	114.2 :	599.4 :	59.0 :	72.0 :	94.2 :	1083.9
1936 :	22.1 :	26.6 :	29.6 :	19.2 :	14.8 :	45.2 :	31.0 :	129.1 :	66.4 :	6.2 :	2.0 :	9.3 :	401.5
1937 :	3.3 :	11.3 :	17.7 :	9.7 :	37.7 :	40.4 :	22.6 :	25.1 :	102.7 :	48.0 :	47.3 :	27.1 :	392.9
1938 :	8.0 :	9.9 :	13.3 :	25.6 :	24.8 :	34.4 :	33.6 :	84.5 :	95.0 :	57.3 :	47.1 :	47.1 :	480.6
1939 :	7.2 :	10.6 :	16.1 :	17.6 :	15.2 :	39.3 :	46.2 :	38.3 :	130.5 :	40.0 :	25.4 :	1.6 :	388.0
1940 :	1.1 :	4.2 :	9.3 :	6.8 :	12.9 :	44.3 :	25.4 :	27.7 :	75.3 :	39.3 :	30.3 :	16.4 :	293.0
1941 :	17.5 :	14.5 :	17.7 :	25.5 :	33.3 :	34.1 :	46.8 :	63.7 :	302.7 :	128.2 :	68.3 :	95.0 :	847.3
1942 :	44.0 :	32.4 :	29.2 :	26.3 :	41.1 :	71.6 :	104.7 :	75.3 :	197.7 :	49.7 :	68.8 :	105.8 :	846.6
1943 :	29.7 :	32.4 :	30.9 :	26.5 :	46.7 :	38.3 :	77.2 :	27.0 :	94.6 :	20.8 :	4.5 :	7.2 :	435.8
1944 :	2.2 :	8.8 :	11.9 :	20.8 :	29.7 :	45.2 :	107.5 :	109.9 :	130.9 :	191.7 :	87.5 :	20.0 :	766.1
1945 :	14.9 :	21.5 :	22.9 :	32.0 :	35.1 :	34.6 :	47.3 :	66.6 :	152.3 :	78.0 :	22.7 :	11.0 :	538.9
1946 :	20.8 :	17.7 :	12.9 :	23.8 :	35.9 :	37.4 :	23.4 :	41.8 :	49.0 :	92.5 :	22.5 :	76.3 :	454.0
1947 :	265.0 :	75.2 :	49.6 :	31.4 :	32.4 :	58.3 :	52.3 :	51.4 :	366.0 :	87.6 :	20.8 :	8.4 :	1098.4
Total :	609.1 :	419.6 :	435.3 :	435.2 :	607.3 :	815.4 :	918.1 :	1199.3 :	2842.6 :	1022.2 :	672.3 :	726.7 :	10703.1
Avg. :	32.1 :	22.1 :	22.9 :	22.9 :	32.0 :	42.9 :	48.3 :	63.1 :	149.6 :	53.8 :	35.4 :	38.2 :	563.3

1/ Historical flow at Bloomington plus the accretion between Bloomington and the Diversion Dam.

Table 16

Table/7. Historical accretion at the Republican River between Harlan County Dam and Superior-Courtland Diversion Dam

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1929	2.7	2.6	2.8	2.2	1.6	7.1	5.4	-6.6	5.0	-17.6	2.2	0.5	7.9
1930	0.7	-1.2	0.2	-4.7	6.4	-1.5	-4.3	26.0	-4.9	-4.5	-2.5	1.2	10.9
1931	-5.4	-1.5	-1.7	1.3	-1.7	-3.7	-2.9	24.1	3.7	2.4	3.7	1.6	19.9
1932	3.1	1.3	7.9	4.5	21.9	10.7	0.9	3.5	17.9	3.0	0.6	2.7	78.0
1933	-0.3	0.1	-1.8	0.5	1.5	4.1	0.9	8.8	1.8	4.5	5.0	11.4	36.5
1934	3.9	0.7	-0.3	1.4	1.5	3.4	2.7	2.9	0.8	1.1	-1.0	-3.1	14.0
1935	0.5	1.9	0.4	-4.5	5.9	2.3	2.9	-4.6	54.6	10.6	7.4	24.4	101.8
1936	4.0	1.3	5.0	-0.3	0.8	0.4	5.9	-8.5	15.8	2.7	0.3	1.6	29.0
1937	0.9	-0.6	-0.2	0.9	3.7	6.3	2.1	1.3	3.8	15.7	0.2	1.9	36.0
1938	1.1	-2.0	-0.5	0.3	1.5	3.6	-2.4	13.5	13.6	-0.1	9.8	7.2	45.6
1939	1.0	1.1	-0.5	0.1	0.4	4.5	11.2	-0.6	23.9	7.3	3.2	0.7	52.3
1940	0.3	0	-2.5	-1.1	-2.2	5.7	2.0	7.0	6.1	-1.9	6.7	-4.6	15.5
1941	-1.3	2.9	2.2	3.2	1.8	1.7	3.9	3.9	49.7	-18.4	-8.5	-0.7	40.4
1942	6.6	4.6	3.4	3.5	7.3	4.1	19.0	10.5	40.2	9.5	9.9	27.0	145.6
1943	3.5	3.3	0.2	5.6	11.6	2.4	20.3	4.2	28.1	7.0	1.4	0.9	88.5
1944	0.9	0.5	0.3	2.7	-0.7	7.3	-5.3	22.6	12.3	6.3	24.8	8.9	80.6
1945	2.7	1.8	0	3.6	4.0	5.3	10.3	31.9	-11.6	29.9	3.4	-3.5	77.8
1946	2.1	0.2	1.8	2.4	6.1	2.7	3.2	-5.2	13.8	9.1	5.0	27.0	68.2
1947	10.6	16.3	8.8	6.5	0	2.9	10.9	6.5	-22.8	7.8	5.3	1.1	53.9
Total	37.6	33.3	25.5	28.1	71.4	69.3	86.7	141.2	251.8	74.4	76.9	106.2	1002.4
Ave.	2.0	1.8	1.3	1.5	3.8	3.6	4.6	7.4	13.3	3.9	4.0	5.6	52.8

Table 20. Historical accretion of the Republican River between Superior-Courtland Diversion Dam and
Nebraska-Kansas State line

(Unit - 1000 acre-feet)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1928	:	:	:	:	:	:	:	:	:	1.0	0.9	1.0	2.9
1929	0.8	0.6	2.5	2.0	-3.3	1.2	-8.3	0.9	0.1	0.2	-0.8	-0.2	-4.3
1930	-2.2	2.6	-0.9	-2.3	10.5	-3.3	-2.2	-1.3	0.2	-3.6	-1.1	-1.1	-4.7
1931	0.2	-1.1	-2.0	-1.8	10.1	1.2	0.9	1.4	0.6	1.3	0.5	3.3	14.6
1932	1.8	13.3	4.3	0.1	1.2	6.9	1.1	0.1	1.0	-0.2	0	-0.9	28.7
1933	0	0.5	1.4	-0.2	3.1	0.6	1.8	1.7	4.1	1.5	0.2	-0.4	14.3
1934	0.4	0.4	1.2	0.9	1.2	-0.2	0.5	-0.5	-1.6	0.2	0.7	0	3.2
1935	-2.2	2.3	0.7	1.0	-3.1	18.8	4.2	2.6	9.9	1.5	0.4	1.9	38.0
1936	-0.3	0.2	-0.2	2.1	-4.9	6.3	1.1	0.1	0.5	0.4	-0.4	-0.1	5.2
1937	0.3	1.3	2.4	0.6	0.4	0.8	6.5	-0.3	0.6	0.5	-0.9	-0.3	12.1
1938	-0.1	0.5	1.3	-1.4	5.2	5.2	-0.5	3.9	2.8	0.4	0.4	-0.4	17.3
1939	-0.1	0	1.7	4.5	-0.6	9.3	2.8	1.2	0.3	0.1	-0.1	-1.1	18.0
1940	-0.5	-1.1	2.1	0.7	2.8	2.0	-1.2	2.7	-2.2	-0.7	1.1	0.6	6.5
1941	1.2	0.5	0.1	1.3	1.2	19.2	-9.2	-4.3	-1.2	2.5	1.7	1.2	14.5
1942	1.3	2.8	1.2	7.4	4.0	15.9	3.7	3.7	11.0	1.3	1.1	-0.6	52.8
1943	2.2	4.7	0.8	8.3	1.6	11.5	2.9	0.6	0.4	0.4	0.2	0.1	33.7
1944	1.0	-0.6	2.8	-3.3	9.0	4.2	1.1	10.1	3.7	1.0	0.6	-0.7	28.9
1945	1.3	1.4	2.0	4.1	13.5	-6.5	12.5	1.3	-1.6	1.2	-0.1	0.7	29.8
1946	0.9	2.4	0.8	1.2	-2.7	5.7	3.2	2.0	11.2	-7.1	6.6	3.5	27.7
1947	2.6	-0.3	0.7	4.1	2.4	-13.3	2.7	2.1	0.5	-			1.8
Av.	0.5	1.6	1.2	1.6	2.7	4.5	1.2	1.5	2.1	0.1	0.6	0.3	17.9

Table 21. Historical accretion of the Republican River flow between Nebraska-Kansas State line and Scandia Diversion Dam less White Rock Creek

(Unit - 1000 acre-feet)													
Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
1929	2.2	2.1	2.2	1.7	1.3	5.2	4.2	2.8	3.8	2.0	0.7	0.4	28.6
1930	0.9	1.3	1.8	1.0	2.7	2.1	3.3	8.7	9.3	1.5	1.7	3.0	37.3
1931	6.1	3.4	2.5	2.6	2.8	3.0	3.5	4.1	3.5	-1.9	0.7	0.5	30.8
1932	0.4	0.9	1.7	1.6	7.7	4.7	2.4	2.5	-1.1	2.2	8.4	1.4	32.8
1933	5.4	3.2	-1.6	-0.1	2.2	0.5	8.2	4.3	2.8	5.1	-0.8	-1.5	27.7
1934	-5.9	-2.6	-0.6	1.1	0.8	5.5	3.7	0.1	-3.5	1.4	0.1	0.7	0.8
1935	0.7	1.0	0.2	0	1.6	1.9	-1.0	34.5	44.5	0.9	-1.7	-3.0	79.6
1936	3.3	-1.8	2.3	0.2	-0.4	4.0	3.1	9.0	-1.8	1.7	-0.6	0.3	16.3
1937	-0.1	0.7	2.3	1.3	4.7	3.1	3.5	3.2	7.8	2.2	-2.7	-0.6	25.4
1938	0.3	2.2	1.4	-0.4	-2.6	0.5	1.2	-1.0	-2.3	1.5	6.3	9.9	17.1
1939	1.8	-0.6	0.5	4.8	-0.2	2.4	-7.9	5.0	17.4	11.2	4.7	-0.2	38.9
1940	0	-0.3	-0.2	0	-1.8	-1.8	-1.5	2.3	3.4	-0.3	1.5	-1.2	0.1
1941	0	0.1	0.4	-2.7	-2.4	0.5	7.9	13.4	119.3	11.2	14.0	14.3	176.1
1942	4.2	8.4	3.5	9.6	7.0	7.0	-5.5	2.5	23.0	6.7	20.7	32.1	118.1
1943	4.0	0.8	3.4	1.6	2.2	0.1	10.4	0.5	56.0	3.6	0.9	-1.0	82.5
1944	-0.1	-0.8	0.8	-1.0	0.9	1.4	1.3	14.1	18.8	1.0	30.3	6.9	73.6
1945	0.9	1.2	1.5	1.1	2.1	5.4	17.5	127.1	28.2	35.2	6.4	2.3	228.9
1946	0.9	1.1	0.4	1.0	-0.1	2.0	1.8	-1.0	8.8	28.1	5.4	15.6	64.0
1947	1.1	10.1	3.1	7.6	1.1	3.0	24.6	12.1	76.6	12.9	4.2	1.6	158.0
Av.	1.4	1.6	1.3	1.6	1.6	2.7	4.2	12.9	21.6	6.6	5.3	4.3	65.1

Table 21.

Table 22. Capacities of reservoirs planned for development in the Upper Republican and Frenchman-Cambridge Divisions.

Division	Reservoir	(storage in acre-feet)				
		Conservation or Dead at end of first 50 years	50 years of Sediment	Active irrigation at end of first 50 years	Flood Control	Total
Upper Republican	Wray	0	500	8,000	1,000	9,500
	Pioneer	10,000	9,000	0	73,000	92,000
	Bonny	1,000	9,000	33,000	132,000	175,000
	Rock Creek	0	500	10,000	0	10,500
Frenchman- Cambridge	Enders	5,000	10,000	29,000	30,000	74,000
	Trenton	0	64,000	58,800	133,800	256,600
	Red Willow	0	8,400	18,000	22,000	48,400
	Medicine Creek	800	15,000	24,200	53,000	93,000

Table 23. Irrigable acreages in units of Frenchman-Cambridge Division and acreages of private development.

Unit	Presently Irrigated	New Lands	Total	Private Development <u>a/</u>
Frenchman	11,425 <u>a/</u>	11,485	22,910	6,600
Meeker-Driftwood	2,924	13,516	16,440	0
Red Willow	823	11,167	11,990	500
Cambridge	<u>1,655</u>	<u>15,575</u>	<u>17,230</u>	<u>1,650</u>
Total	16,827	51,743	68,570	8,750

a/ Includes 890 acres private development not in project but water supplied in project water supply studies.

b/ Water requirements for private development were determined and the stream flow was depleted for the private development requirements.

TABLE 14. SUMMARY OF ANNUAL DEPLETIONS

1000 ACF

KS002049

Table 24

Total 24

DEPLETIONS IN FRENCHMAN-CAMBRIDGE DIVISION										CAMBRIDGE UNIT										DEPLETIONS FOR DIVISION			
1,000 ACRE-FEET																							
WILLOW UNIT																							
PLANNED DEPLETIONS										CAMBRIDGE UNIT										DEPLETIONS FOR DIVISION			

Table 25 . Computed flow of Republican River into Harlan County Reservoir after proposed upstream development, excluding flow of tributaries in Kanaska Division. 1/

(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 :	31.7 :	409.1
1931 :	28.1 :	36.5 :	39.8 :	42.8 :	30.6 :	30.9 :	1.4 :	1.0 :	1.1 :	1.4 :	1.1 :	1.2 :	215.9
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 :	2.5 :	0.7 :	0.9 :	0.2 :	4.2 :	180.2
1944 :	1.8 :	2.0 :	10.0 :	79.2 :	59.4 :	94.2 :	65.1 :	27.2 :	2.9 :	2.0 :	4.7 :	4.6 :	353.1
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 :	41.5 :	17.0 :	8.5 :	14.2 :	15.3 :	11.0 :	12.0 :	285.0

1/ Seepage, spills, wastes and releases for Public Health Service minimum flow requirement plus return flow from 17,230 acres plus gain of Republican River between Cambridge Diversion and Harlan County Dam.

Table 25

Table 26. 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	<u>400</u>
Total	1900
St. Francis Unit	
Above Bonny Dam	3100
Below Bonny Dam	<u>1700</u>
Total	4800
Benkelman Unit	
Total	0
Total	6700

Table 27. Potential Project Lands in the Upper Republican Division

(Unit - acres)

Unit	Colorado		Kansas		Nebraska		Total	Total	Total to be Irrigated
	New Lands	Presently Irrigated	New Lands	Presently Irrigated	New Lands	Presently Irrigated	New Lands	Presently 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 28. Average annual depletions for future development in the Upper Republican Division in 1000 acre-feet

	Private Depletions by				North Republican Unit				Depletions due to Bureau planned development				Reservoir Evaporation				Total				St. Francis			
	Irrigation Wray Dam Pioneer Above				Total				Pioneer Area				Wray Pioneer Total				Depletions Depletions Depletions				Private for irrig. for Diver			
	Lands to Pioneer Diversion Pioneer				Historic Required Pioneer Diversion Return				Pioneer Diversion Return				Wray Pioneer Total				Irrigation & ponds Private				recu			
	Above Diversion to Reservoir				diversions div. from supply				depletions require Flow Area Reservoir Reservoir Evap.				and ponds below develop.				above Bonny Bonny St. Fra. Div.							
	(840 ac.)	(450 ac.)	(210 ac.)	(400 ac.)	(2680 ac.)	(2680 ac.)	(2680 ac.)	(2400 ac.)	(2400 ac.)	(2400 ac.)	(2400 ac.)						(3100 ac.)	(1700 ac.)			(3720 ac.)			
1928	0.8	0.4	0.2	0.6	2.0	10.5	10.5	0	4.3	1.5	2.8	1.8	2.2	4.0	8.8	2.4	1.3	3.7	5.4					
1930	0.7	.4	.2	.7	2.0	10.2	10.2	0	4.1	1.5	2.6	1.8	2.1	3.9	8.5	2.6	1.5	4.3	6.3					
1931	1.3	.7	.3	.8	3.1	14.0	14.0	0	7.0	2.3	4.7	2.2	3.0	5.2	13.0	3.6	2.0	5.6	8.6					
1932	0.9	.5	.2	.6	2.2	10.1	10.1	0	4.9	1.9	3.0	2.0	2.9	4.9	10.1	3.4	1.8	5.2	7.5					
1933	.9	.5	.2	.8	2.4	12.2	12.2	0	5.1	1.8	3.3	1.8	2.5	4.3	10.0	4.2	2.3	6.5	9.7					
1934	1.5	.8	.4	.9	3.6	12.4	13.2	0.8	7.9	2.5	5.4	2.0	3.3	5.3	15.1	5.3	3.2	8.5	14.2					
1935	.7	.4	.2	.7	2.0	11.7	11.7	0	3.9	1.7	2.2	1.9	2.0	3.9	8.1	4.1	2.5	6.4	9.4					
1936	1.0	.6	.3	.8	2.7	11.5	12.0	0.5	5.5	1.9	3.6	2.0	2.9	4.9	11.7	4.3	2.5	6.8	11.1					
1937	1.2	.6	.3	.8	2.9	11.0	11.9	0.9	5.3	2.2	4.1	1.9	3.0	4.9	12.8	4.2	2.4	6.6	10.6					
1938	1.1	.6	.3	.9	2.9	10.0	10.6	0.6	5.8	2.1	3.7	1.7	2.5	4.2	11.4	4.0	2.2	6.2	9.3					
1939	1.2	.7	.3	.7	2.9	13.4	13.4	0	5.7	2.4	4.3	1.9	3.3	5.2	12.4	4.4	2.5	6.9	11.6					
1940	1.1	.6	.3	.7	2.7	11.5	11.7	0.2	5.8	2.1	3.7	1.9	3.0	4.9	11.5	4.1	2.4	6.5	11.5					
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	2.4	1.3	3.7	4.3					
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	2.8	1.4	4.2	5.4					
1943	1.3	.7	.3	.9	3.2	13.6	15.0	1.4	7.2	2.4	4.8	1.8	2.9	4.7	14.1	4.1	2.4	6.5	10.8					
1944	0.8	.4	.2	.6	2.0	15.0	15.0	0	4.2	1.7	2.5	1.5	2.0	3.5	8.0	3.5	2.0	5.5	7.9					
1945	0.9	.5	.2	.6	2.1	12.7	13.3	0.6	4.6	1.6	3.0	1.3	2.0	3.3	9.0	3.0	1.6	4.6	7.0					
1946	0.9	.5	.2	.7	2.3	13.5	14.5	1.0	4.8	1.7	3.1	1.5	1.6	3.1	9.5	4.5	2.6	7.0	10.5					
1947	0.8	.5	.2	.7	2.2	13.0	13.0	0	4.6	1.6	3.0	1.3	2.2	3.5	8.7	2.9	1.5	4.4	5.6					
Total	18.4	10.1	4.7	13.6	46.8	225.6	232.2	6.4	99.7	35.5	64.2	22.5	46.8	79.3	195.7	70.0	39.1	109.1	165.6					
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	3.7	2.1	5.7	8.8					
Average depletions for all private development																								
6,700 acres plus pond depletions																								
Average depletions for all reservoir evaporation																								
Average depletions for development of all units																								
6,500 acres new lands and 6,500 acres presently irrigated																								
Depletions for full water supply to 11,120 acres																								
Depletions for supplemental supply to 2,680 acres																								
Total																								
Total Depletions																								
35.7 100																								

Table 28-3

Station	Total	St. Francis Unit										Bankelman Unit									
		Bureau planned develop.					Bureau planned development					Bankelman Canal					Bankelman Canal				
		Private for irrig.					Private for irrig.					Private for irrig.					Private for irrig.				
		Flow	due to	Flow	due to	Flow	Flow	due to	Flow	due to	Flow	Flow	due to	Flow	due to	Flow	Flow	due to	Flow	due to	Flow
Evap.		and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.	and ponds below develop.
		(3100 ac)(1700 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)	(3720 ac)(3720 ac)
4.0	8.8	2.4	1.3	3.7	5.4	2.5	2.9	5.5	12.1		2.6	1.2	1.4	7.4	3.1	4.3	5.7	1.0	6.7	27.6	
3.9	8.5	2.2	1.5	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	24.4	
6.2	13.0	3.6	2.0	5.6	8.6	3.3	5.3	6.3	17.2		3.9	1.3	2.6	11.2	4.0	7.2	9.3	1.2	11.0	41.2	
4.9	10.1	3.4	1.8	5.2	7.5	3.2	4.3	6.5	16.0		3.9	1.6	2.3	11.0	4.5	6.5	8.8	1.3	10.1	36.2	
4.3	10.0	4.2	2.3	6.5	9.7	3.8	5.9	5.9	18.3		4.2	1.7	2.5	12.1	4.8	7.3	9.8	1.1	10.9	38.2	
5.3	15.1	5.3	3.2	8.5	14.2	5.5	8.7	8.1	25.3		5.3	2.1	3.2	15.2	6.0	9.2	12.4	1.2	15.8	64.0	
3.9	8.1	4.1	2.3	6.4	9.4	4.1	5.3	6.3	18.0		3.7	1.4	1.7	8.7	4.1	4.6	6.3	1.0	7.3	33.4	
4.9	11.7	4.3	2.5	6.8	11.1	4.4	6.7	7.0	20.5		4.0	1.6	2.4	11.4	4.6	6.9	9.3	1.0	10.3	42.5	
4.9	12.8	4.2	2.4	6.6	10.5	4.4	6.1	5.9	18.6		4.2	1.7	2.5	12.1	4.8	7.3	9.8	1.0	10.8	42.3	
4.2	11.4	4.0	2.2	6.2	9.3	3.9	5.4	5.5	17.1		3.9	1.6	2.3	11.1	4.6	6.5	8.8	1.2	10.0	38.5	
5.2	12.4	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	
4.9	11.5	4.1	2.4	6.5	11.5	4.7	6.8	4.5	17.8		4.6	1.8	2.7	12.8	5.1	7.7	10.4	0.7	11.1	40.4	
7	6.4	2.4	1.3	3.7	4.3	2.4	1.9	3.5	9.1		2.7	1.2	1.5	7.8	3.6	4.2	5.7	0.9	6.6	22.2	
4.9	7.5	2.8	1.4	4.2	5.4	2.1	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	
4.7	14.1	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	
3.5	8.0	3.5	2.0	5.5	7.9	3.5	4.4	4.0	13.9		2.8	1.2	1.6	7.9	3.6	4.3	5.9	0.5	6.4	28.3	
3.3	9.0	3.0	1.6	4.6	7.0	2.9	4.1	4.4	13.1		2.6	1.1	1.5	7.3	3.0	4.3	5.8	0.9	6.7	28.0	
3.1	9.5	4.5	2.5	7.0	10.5	4.1	6.4	5.5	18.9		3.3	1.2	2.1	9.5	3.8	5.7	7.8	0.9	8.7	37.1	
3.5	8.7	2.9	1.5	4.4	5.6	2.7	2.9	5.3	12.6		3.2	1.3	1.9	9.0	3.7	5.3	7.2	0.9	8.1	29.4	
79.3	186.7	70.0	39.1	109.1	166.6	68.4	98.2	105.4	312.7		68.1	26.9	39.2	188.4	77.0	111.4	150.6	18.4	189.0	678.4	
4.2	10.4	3.7	2.1	5.7	8.8	3.6	5.2	5.5	16.4		3.5	1.4	2.0	8.8	4.1	5.5	7.9	1.0	9.0	35.7	

Table 29. Capacities of reservoirs planned for development in the Kanaska Division

Reservoir	(storage in acre-feet)				
	Conservation or Dead storage at end of first 50 years	50-years of 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

Table 30. Irrigable acreages in units of Kanaska Division and
acreages of private development.

Unit	Presently Irrigated	New Lands	Total	Private Development ^{1/}
Beaver City	0	1,200	1,200	3,500
Oberlin	0	1,500	1,500	3,000
Almena	<u>0</u>	<u>5,000</u>	<u>5,000</u>	<u>900</u>
Total		7,700	7,700	7,400

^{1/} Water requirements for private development were determined and the stream flow was depleted for the private development requirements.

WUAL DEPLETIONS from FUTURE DEVELOPMENT of KANASKA DIVISION - 1000 Acre-feet

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(B)

Table 31. SUMMARY of ANNUAL DEPLETIONS from FUTURE DEVELOP.

	Beaver Creek										Sappa Creek									
	Private Depletions			Bureau Planned Depletions			Total				Private Depletions			Bureau Planned Depletions			Total			
	Irrigation Above Beaver C.	Irrigation Below Beaver C.	Ponds	Private Depletions	Amount Diverted	Return Flow	Depletion for Irrig.	Evap. from Res.	Depletion on Beaver Creek		Irrig. Above Oberlin	Irrig. Below Oberlin	Ponds	Private Depletions	Amount Diverted	Return Flow	Depletion for Irrig.	Evap. from Res.	Depletion on Beaver Creek	
1929	2.5	0	0.5	3.0	1.7	0.6	1.1	2.2	6.3		0.8	2.5	0.3	3.6	3.1	1.1	2.0	3.5		
1930	1.8	0	0.6	2.4	1.2	0.4	0.8	1.5	4.7		0.8	1.3	.5	2.4	1.7	0.6	1.1	2.1		
1931	3.8	.1	0.9	4.8	2.6	0.9	1.7	2.8	9.3		0.8	2.2	.5	3.5	2.9	1.0	1.9	3.8		
1932	4.0	.1	0.6	4.7	2.6	0.9	1.7	2.8	9.2		1.0	2.9	.3	4.2	3.7	1.3	2.4	3.7		
1933	4.3	.1	0.9	5.3	2.9	1.0	1.9	2.4	9.6		1.0	2.9	.4	4.3	3.6	1.3	2.3	1.9		
1934	5.6	.1	0.6	6.2	3.7	1.3	2.4	2.5	11.1		1.4	4.2	.2	5.8	2.0	1.2	0.8	0.3		
1935	3.5	.1	1.0	4.6	2.1	0.8	1.5	2.2	8.3		1.1	3.2	.5	4.8	3.2	1.1	2.1	1.6		
1936	5.2	.1	0.7	6.0	3.4	1.2	2.2	3.1	11.3		1.3	4.0	.2	5.5	4.3	1.7	3.2	1.6		
1937	3.1	0	0.9	4.0	2.1	0.7	1.4	1.7	7.1		1.0	2.9	.4	4.3	2.3	0.8	1.5	0.9		
1938	4.5	.1	0.9	5.5	3.0	1.1	1.9	2.6	9.9		1.1	3.3	.3	4.7	4.0	1.4	2.6	1.1		
1939	4.8	.1	0.7	5.6	3.1	1.1	2.0	2.6	10.2		1.4	4.2	.2	5.8	2.4	0.9	1.5	0.2		
1940	4.3	.1	0.5	4.9	2.9	1.0	1.9	1.4	8.2		1.2	3.7	.3	5.2	2.7	1.0	1.7	0.1		
1941	2.6	0	1.0	3.6	1.8	0.6	1.2	1.8	6.6		0.3	0.9	.5	1.7	1.1	0.4	0.7	1.2		
1942	1.7	0	1.0	2.7	1.8	0.4	0.8	1.7	5.2		0.7	2.0	.5	3.2	2.6	0.9	1.7	2.8		
1943	3.8	0.1	0.6	4.5	2.5	0.9	1.6	2.7	8.8		0.9	2.6	.2	3.7	3.2	1.1	2.1	3.5		
1944	2.2	0	1.0	3.2	1.5	0.5	1.0	1.4	5.6		0.7	2.0	.5	3.2	2.6	0.9	1.7	1.8		
1945	3.6	.1	0.9	4.6	2.4	0.9	1.6	2.3	8.4		0.6	2.2	.3	3.1	2.8	1.0	1.8	2.5		
1946	4.1	.1	0.6	4.7	2.7	1.0	1.7	1.7	8.1		0.7	2.1	.2	3.0	2.7	1.0	1.7	1.7		
1947	3.1	0	1.0	4.1	2.0	0.7	1.3	2.1	7.5		0.6	1.8	.5	2.9	2.1	0.7	1.4	2.5		
Total	68.5	1.2	14.7	34.4	45.6	16.0	23.6	41.4	155.4		17.1	51.0	6.8	74.9	53.6	19.4	34.2	36.8		
Average	3.6	0.1	0.8	4.4	2.4	0.8	1.3	2.2	8.2		0.9	2.7	0.4	4.0	2.8	1.0	1.6	1.9		

Table 3 2. 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		
	Wray		Pioneer-Haigler		Dodge		Bonny		Enders		Swanson Lake		Red Willow		Medicine Creek		Beaver City	
	A.F. %	A.F. %	A.F. %	A.F. %	A.F. %	A.F. %	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
1934	0	0	0	0	0	0	0	0	9.1	7.9	0	0	8.3	13.6	0	0	3.3	42.1
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	9.8
1936	0	0	0	0	0	0	0	0	14.8	13.3	0	0	5.8	10.1	0	0	0.1	1.4
1937	0	0	0	0	0	0	0	0	11.4	10.7	0	0	3.3	5.2	0	0	1.3	29.1
1938	0	0	0	0	0	0	0	0	0	0	0	0	.4	.7	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	2.9	38.9
1940	0	0	0	0	1.8	6.6	0	0	0	0	0	b/	4.2	7.2	c/	0	2.1	28.5
1943	0	0	0	0	0	0	0	0	7.4	6.9	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 10.4 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.

Table 33 . Flow at mouth of Prairie Dog Creek after development of the Almena Unit

(Unit - 1000 acre-feet)													
Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1929	0.5	0.4	2.0	0.8	1.2	2.9	13.3	1.4	0.9	2.6	0.5	0.6	27.2
1930	0.5	0.8	0.7	1.4	3.3	12.5	0.9	1.9	1.8	10.3	4.0	1.7	39.8
1931	1.7	1.3	1.3	1.8	1.2	0.9	0.7	4.0	1.0	0.8	0.7	0.7	16.1
1932	0.6	10.6	1.3	0.7	1.5	1.9	0.7	0.9	1.1	0.7	0.5	0.6	21.2
1933	0.6	0.5	0.7	2.2	2.2	0.8	0.7	0.8	2.2	0.9	0.9	0.9	13.3
1934	0.8	0.5	0.8	0.6	0.5	1.9	0.4	0.3	1.2	0.3	0.5	0.2	8.0
1935	0.4	0.4	0.5	0.5	6.2	4.0	1.0	2.1	0.1	0.8	0.5	0.5	19.7
1936	0.5	0.4	1.0	0.6	3.7	1.2	0.8	0.9	1.1	0.9	0.8	0.6	12.5
1937	0.4	1.1	0.8	0.5	0.5	9.5	1.1	3.5	2.0	0.7	0.6	0.6	21.1
1938	0.5	0.5	0.6	1.1	3.7	5.1	2.1	0.9	1.0	0.6	0.7	0.5	16.6
1939	0.6	0.5	0.5	0.5	2.5	5.0	1.3	0.9	0.7	0.5	0.1	0.4	13.9
1940	0.4	0.3	0.5	0.2	1.1	0.7	5.0	2.5	2.1	0.8	0.5	0.5	14.7
1941	0.1	0.6	0.4	1.1	1.8	32.2	16.9	5.5	22.4	1.1	1.1	1.1	86.6
1942	0.9	0.9	1.1	8.3	3.0	18.7	4.4	10.3	3.4	0.8	0.6	0.7	53.1
1943	0.7	0.6	0.6	1.8	0.7	1.4	0.9	0.9	1.4	0.7	0.7	0.6	14.0
1944	0.6	0.6	0.7	2.3	6.5	5.5	39.8	8.1	1.1	0.8	0.8	0.7	67.5
1945	0.7	0.7	0.7	0.8	0.8	6.3	7.4	1.0	0.7	0.7	0.6	0.5	20.9
1946	0.5	0.3	0.8	0.4	5.6	1.5	0.4	0.7	2.2	16.2	3.6	2.0	36.2
1947	1.6	1.8	4.8	1.4	1.5	69.3	3.1	1.6	0.8				85.9
Avg.	0.7	1.2	1.0	1.4	2.5	9.7	5.3	2.5	2.6	2.3	1.0	0.8	31.0

Table 34. Flow at mouth of Sappa Creek near Stamford less Beaver Creek after development of the Oberlin Unit 1/

(Unit - 1000 acre-feet)

Year:	Jan.:	Feb.:	Mar.:	Apr.:	May:	June:	July:	Aug.:	Sept.:	Oct.:	Nov.:	Dec.:	Total
1929:	0.3	0.2	3.3	0.2	5.1	3.0	0	0	0	0	0	0	12.1
1930:	0	2.1	0.5	0.4	0.5	13.0	0.7	2.4	1.5	9.7	2.0	2.7	35.7
1931:	1.4	1.3	2.7	4.7	1.9	1.2	0	8.5	1.3	0.4	0.9	0.9	24.2
1932:	0.9	1.1	0	0.8	1.2	0	0	0	1.1	0	0.3	0.8	6.2
1933:	0.8	0.3	1.5	3.1	3.8	0.3	0.1	0	2.3	0.4	1.1	1.5	16.1
1934:	1.3	0.6	1.6	0.1	0.2	3.3	0	0	0	0	0	0	7.5
1935:	0.5	0.4	0.7	0.3	12.6	6.1	0.7	2.9	1.0	0.7	1.8	0.7	33.6
1936:	0.5	0.3	2.6	0	6.0	1.3	0	0	0	0	0	0	10.7
1937:	0.1	2.0	1.4	0	0	13.4	0.7	1.5	1.8	0.1	0.3	0.3	24.9
1938:	0.1	0.3	0.5	1.0	3.5	7.1	1.8	0.2	0.3	0	0.3	0.3	16.1
1939:	0.3	0.1	0.1	0	2.7	7.1	0.6	0	0	0	0	0	11.2
1940:	0	0	0.1	0	0.2	0	6.7	2.5	2.9	0.3	0.3	0.4	13.5
1941:	0.4	0.5	0.1	1.8	2.7	27.2	12.0	1.8	17.4	1.4	0.9	0.8	70.0
1942:	0.5	0.9	1.7	6.5	2.5	15.5	1.1	8.4	2.2	0.7	0.8	0.8	44.6
1943:	0.9	0.8	0.8	1.0	0.1	1.8	0.1	0.2	1.2	0.1	0.1	0.1	10.8
1944:	0.8	0.6	0.7	3.0	1.9	1.7	36.3	8.1	0.7	0.7	0.9	0.8	51.5
1945:	0.8	0.7	0.9	1.0	0.5	2.5	9.2	0.7	0	0.1	0.4	0.4	17.2
1946:	0.4	0.5	1.1	0	1.6	0.9	5.9	0	2.0	20.4	5.6	2.4	40.8
1947:	1.7	1.5	3.5	1.2	1.5	31.2	4.5	0.7	0.3				46.5
Avg.	0.6	0.7	1.2	1.4	2.7	7.6	4.5	2.3	2.0	2.0	0.9	0.8	26.7

1/ Depleted for 750 acres above reservoir and 2250 acres below.

Table 35 . Flow at mouth of Beaver Creek near Stamford after development of Beaver City Unit 1/

(Unit - 1000 acre-feet)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1929	0.2	0.2	2.3	2.5	2.1	4.8	2.1	0.1	0.4	0.2	0.2	0.2	15.3
1930	0.2	0.4	0.1	0	2.5	4.2	0	0.1	0.8	4.2	2.2	1.0	15.7
1931	1.0	1.4	2.0	2.3	1.7	0.2	0.1	0	0	0.1	0.3	0.3	9.4
1932	0.3	0	0	0	0	1.5	0.4	0.2	0.3	0.3	0.3	0.5	3.8
1933	0.5	0.2	0.6	0.2	1.3	0.4	0.3	0.3	0.3	0.4	0.6	0.7	5.8
1934	0.7	0.5	0.7	0.2	0.3	0.3	0.3	0.3	0.4	0.3	0.5	0.3	4.8
1935	0.4	0.1	0.5	0.3	1.5	5.1	0.2	0.3	3.0	0.4	1.1	0.6	13.9
1936	0.3	0.2	1.5	0.1	1.6	0.1	0.4	0.2	0.1	0.3	0.3	0.1	9.6
1937	0.3	0.9	0.7	0.3	0.1	1.5	0.5	0.9	0.5	0.3	0.3	0.3	7.0
1938	0.2	0.2	0.2	0.3	0.7	3.9	1.7	0.1	0.3	0.3	0.3	0.3	8.6
1939	0.3	0.3	0.3	0.3	0.5	2.3	1.1	0.3	0.3	0.3	0.3	0.3	6.3
1940	0.3	0.3	0.3	0.2	0.3	0.1	1.0	0.5	0.7	0.1	0.3	0.3	5.0
1941	0.2	0.2	0.2	0.5	0.5	11.1	1.5	3.4	5.5	1.9	0.7	0.9	29.0
1942	1.1	1.0	1.4	3.1	3.4	15.0	1.8	5.3	3.0	0.1	0.3	0.3	38.5
1943	0.3	0.7	0.7	1.7	0.1	1.0	0.1	0.3	0.3	0.3	0.3	0.3	6.9
1944	0.3	0.2	1.2	0.7	0.8	5.3	24.0	5.9	0.8	0.1	0.1	0.3	42.6
1945	0.3	0.5	1.2	1.4	0.1	3.0	3.0	0.5	0.3	0.3	0.3	0.3	11.5
1946	0.3	0.2	0.3	0.2	0.5	0.9	0	0	1.0	21.6	3.0	2.8	30.8
1947	2.0	1.3	2.4	1.9	1.7	20.3	6.2	0.5	0.5	0.3			37.1
AVG.	0.5	0.5	0.8	0.8	1.3	4.5	2.5	1.0	1.0	1.7	0.6	0.6	15.8

1/ Depleted for 3450 acres above Res. 1200 A. in project and 50 A. below. Flow at mouth of Beaver Creek = Sum of pickup between the damsite and mouth of Beaver Creek, return flow from 1200 acres. Spills from reservoir, seepage from reservoir minus: depletion for 50 acres future private irrigation development below the reservoir.

Table 35

Table 36 . Depleted inflow, Harlan County Reservoir ^{1/}

(Unit - 1000 acre-feet)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1929	20.8	16.4	56.7	32.5	52.5	85.4	51.7	3.0	2.9	6.8	6.7	8.9	344.5
1930	7.4	17.7	24.7	39.7	83.2	121.8	14.6	5.7	18.2	81.7	48.9	36.7	500.3
1931	32.2	40.5	45.8	51.6	35.4	33.2	2.2	13.5	2.4	2.7	3.0	3.1	265.6
1932	2.9	13.6	19.3	17.6	16.8	81.4	2.6	3.1	11.7	2.5	2.8	5.0	179.3
1933	6.6	5.2	19.0	45.2	46.6	2.9	2.4	6.2	51.0	3.7	17.7	31.9	238.4
1934	31.8	27.1	32.1	3.1	2.5	34.7	2.6	2.6	13.7	2.7	9.1	2.6	164.6
1935	4.6	6.2	8.6	4.7	55.4	524.4	5.3	33.3	11.4	6.4	16.5	14.3	724.1
1936	14.5	14.3	41.8	2.8	127.2	16.1	2.9	3.3	5.9	3.3	5.6	8.0	245.7
1937	2.6	17.6	12.3	2.3	2.7	38.3	10.2	23.6	7.6	3.7	8.0	7.3	136.4
1938	15.3	11.5	17.7	13.5	57.4	32.6	20.4	13.6	13.5	3.0	6.4	10.9	215.6
1939	17.7	11.1	36.5	13.3	26.3	70.8	7.2	4.8	3.1	2.7	5.3	5.6	206.2
1940	2.1	2.6	6.1	3.7	13.8	32.3	16.2	7.5	7.3	4.9	3.3	5.4	106.5
1941	9.9	9.4	15.8	26.0	47.9	211.8	107.6	38.8	68.2	19.5	22.1	27.5	526.5
1942	23.6	34.9	67.1	67.0	58.3	156.5	19.1	36.2	47.7	3.5	22.2	26.4	583.0
1943	20.9	35.6	35.8	45.6	6.9	12.7	8.1	2.4	2.9	1.4	4.5	5.5	211.9
1944	3.5	3.4	11.6	55.4	71.7	109.7	171.2	49.6	5.2	2.3	8.4	6.4	527.9
1945	8.1	15.3	25.4	31.1	27.7	146.5	20.8	4.1	3.3	2.0	7.9	8.4	304.1
1946	16.4	21.7	32.8	2.5	26.6	17.6	38.6	12.7	40.2	226.3	49.8	39.7	527.1
1947	25.8	33.2	54.6	41.5	47.6	392.1	55.7	8.8	4.7				664.2
Avg.	13.9	18.0	29.7	29.0	42.5	113.3	29.5	14.4	19.3	21.2	13.8	14.1	359.2

^{1/} Computed flow of Republican River into Harlan County Reservoir after proposed upstream development plus flow at the mouth of Prairie Dog Creek after development of the Almota Unit plus flow of Beaver Creek near Stamford after development of the Beaver City Unit plus flow at mouth of Sappa Creek near Stamford less Beaver Creek after development of the Oberlin Unit.

Table 37. Depletions for 2,600 acres of private development of irrigation between Harlan County Dam and Superior-Courtland Diversion

1,000 Acre-Feet													
Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1929	0	0	0	0	0	.3	.9	1.2	.3	0	0	0	2.7
1930	0	0	0	0	0	0	.9	.8	.5	0	0	0	2.2
1931	0	0	0	0	0	.4	.9	.6	.4	0	0	0	2.3
1932	0	0	0	0	.2	.4	.9	.9	.5	0	0	0	2.9
1933	0	0	0	.1	.4	.9	.8	.5	.7	.4	0	0	3.8
1934	0	0	0	.4	.7	.4	1.3	1.0	.5	.4	0	0	4.7
1935	0	0	0	.6	0	.3	1.0	.4	0	0	0	0	2.3
1936	0	0	0	.4	.1	.8	1.2	.7	.3	.3	0	0	3.8
1937	0	0	0	.4	.2	.3	.4	1.2	.5	.1	0	0	3.1
1938	0	0	0	.4	0	.5	.5	.9	.3	.3	0	0	2.9
1939	0	0	0	.3	.1	.2	1.1	.6	.7	.3	0	0	3.3
1940	0	0	0	.3	.1	.3	1.0	.8	.5	.3	0	0	3.3
1941	0	0	0	0	0	0	.4	.6	0	0	0	0	1.0
1942	0	0	0	0	0	0	.5	.6	0	.2	0	0	1.3
1943	0	0	0	0	.5	0	.9	.5	.8	.3	0	0	3.0
1944	0	0	0	0	0	0	.4	.3	.6	.1	0	0	1.4
1945	0	0	0	0	0	0	.3	.9	.2	.3	0	0	1.7
1946	0	0	0	.4	.1	.2	.6	.8	0	0	0	0	2.1
1947	0	0	0	0	0	0	.4	.6	.7	.4	0	0	2.1
Total				3.3	2.4	5.0	14.4	13.9	7.5	3.4			49.9
Ave.				.1	.1	.3	.8	.7	.4	.2			2.6

Table 37

Table 35. Depleted inflow of the Republican River between Harlan County Dam and Superior-Courtland Diversion

1,000 Acre-Feet													
Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1929	2.2	1.6	7.1	5.4	-6.6	4.7	-18.5	1.0	0.2	0.7	-1.2	0.2	-3.2
1930	-4.7	6.4	-1.5	-4.3	26.0	-4.9	-5.4	-3.3	0.7	-6.4	-1.5	-1.7	-0.6
1931	1.3	-1.7	-3.7	-2.9	24.1	3.3	1.5	3.1	1.2	3.1	1.3	7.9	38.5
1932	4.5	31.9	10.7	0.9	3.3	17.5	2.1	-0.3	2.2	-0.3	0.1	-1.8	70.8
1933	0.5	1.5	4.1	0.8	8.4	0.9	3.7	4.5	10.7	3.5	0.7	-0.3	39.0
1934	1.4	1.5	3.4	2.3	2.2	40.4	-0.2	-2.0	-3.6	0.1	1.9	0.4	7.8
1935	-4.5	5.9	2.3	2.3	-4.6	54.3	9.6	7.0	24.4	4.0	1.3	5.0	107.0
1936	-0.3	0.8	0.4	5.5	-8.6	15.0	1.5	-0.4	1.3	0.6	-0.6	0.2	15.4
1937	0.9	3.7	6.3	1.7	1.1	3.5	15.3	-1.0	1.4	1.0	-2.0	-0.5	31.4
1938	0.3	1.5	3.6	-2.8	13.5	13.1	-0.6	8.9	6.9	0.7	1.4	-0.5	46.0
1939	0.1	0.4	4.5	10.9	-0.7	23.7	6.2	2.6	0	0	0	-2.5	45.2
1940	-1.1	-2.2	5.7	1.7	6.9	5.8	-2.9	5.9	-5.1	-1.6	2.9	2.2	18.2
1941	3.2	1.8	1.7	3.9	3.9	49.7	-18.8	-9.1	-0.7	6.6	4.6	3.4	50.2
1942	3.5	7.3	4.1	19.0	10.5	40.2	9.0	9.3	27.0	3.3	3.3	-0.8	135.7
1943	5.6	11.6	2.4	20.3	3.7	28.1	6.1	0.9	0.1	0.6	0.5	0.3	80.2
1944	2.7	-0.7	7.3	-5.3	22.6	12.3	5.9	24.5	8.3	2.6	1.9	-1.0	81.1
1945	3.6	4.0	5.3	10.3	31.9	-11.6	29.6	2.5	-3.7	2.8	0.2	1.8	76.7
1946	2.4	6.1	2.7	2.8	-5.3	13.6	8.5	4.2	27.0	-10.6	16.3	8.8	76.5
1947	6.5	-1.8	2.9	10.9	6.5	-22.8	7.4	4.7	0.4	-	-	-	14.7
Total	28.1	79.6	69.3	83.4	138.8	246.8	160.0	63.0	98.7	10.7	31.1	21.1	930.6
Ave.	1.5	4.2	3.6	4.4	7.3	13.0	3.2	3.3	5.2	.6	1.6	1.1	49.0

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1948

Table 39. Mineral constituents, in parts per million, of Republican River near Orleans, Nebraska.

Sample Number	Date Collected	Dis- charge cfs	Specific Conduc- tance (Kx10 ⁶)	Calcium (Ca)	Magnes- ium (Mg)	Sodium (Na)	Potas- sium (K)	Bicarb- onate (HCO ₃)	Sul- fate (SO ₄)	Chloride (Cl)	Nitrate (NO ₃)	Boron (B)	Percent Sodium
5913	6-16-48	2,790	396	43	11		31	202	44	4.0	0.8	0.15	30
6071	6-22-48	13,100	336	42	8.6		18	200	10	1.1	1.2	.08	22
7356	8-6-48	231	323	40	8.0		20	179	18	4.5	3.8	.07	24
7882	9-1-48	137	381	48	9.5		19	198	26	6.0	2.2	.15	21
9442	10-1-48		440	46	14		32	257	18	8.0	0.6	0.11	29

Table-D. Mineral constituents, in parts per million, of Republican River near Bloomington, Nebraska

Sample Number	Date Collected	Dis-charge cfs	Specific Conduc-tance (Kx10 ⁶)	Calcium (Ca)	Magnes-ium (Mg)	Sodium (Na)	Potas-sium (K)	Bicarb-onate (HCO ₃)	Sul-fate (SO ₄)	Chloride (Cl)	Nitrate (No ₃)	Boron (B)	Percent Sodium
3360	3-21-47	838	48.2	65	21	10		255	42	9.2	4.6	0.36	8
3357	5-6-47	636	48.7	58	17	37		261	63	9.8	.0	.45	27
3359	5-31-47	2,030	49.8	59	26	13		261	51	8.5	.0	.39	10
3361	9-1-47	172	56.1	64	26	23		301	50	12	.0	.08	16
6462	6-22-48	6,610	466	47	10	38		220	50	4.0	1.4	0.12	34
7352	7-22-48	915	358	42	8.3	26		191	24	6.0	5.1	.22	29
.7888	8-26-48	171	494	62	12	25		256	34	7.0	.8	.14	21
9413	9-29-48	64	525	62	16	33		291	36	9.0	2.2	.05	24
9414	11-1-48		502	44	15	54		272	48	8.0	4.0	0.06	41
11539	3-1-49		354	44	8.0	18		177	26	4.5	3.2	.06	22
11540	3-31-49		496	58	12	34		241	52	9.0	3.8	.02	28
M-377	5-10-49		319	39	6.6	17		170	16	1.0	2.0	--	22
M-379	5-31-49		491	51	12	40		245	46	7.0	4.1	--	33

Table 4/. Mineral constituents, in parts per million, of Republican River near Hardy, Nebraska

Sample Number	Date Collected	Dis- charge cfs	Specific Conduc- tance (Kx10 ⁶)	Calcium (Ca)	Magnes- ium (Mg)	Sodium (Na)	Potas- sium (K)	Bicarb- onate (HCO ₃)	Sul- fate (SO ₄)	Chloride (Cl)	Nitrate (NO ₃)	Boron (B)	Percent Sodium
	10-12-45	325	43.4	51	13	16	14	217	36	5.8	4.1	0.2	15

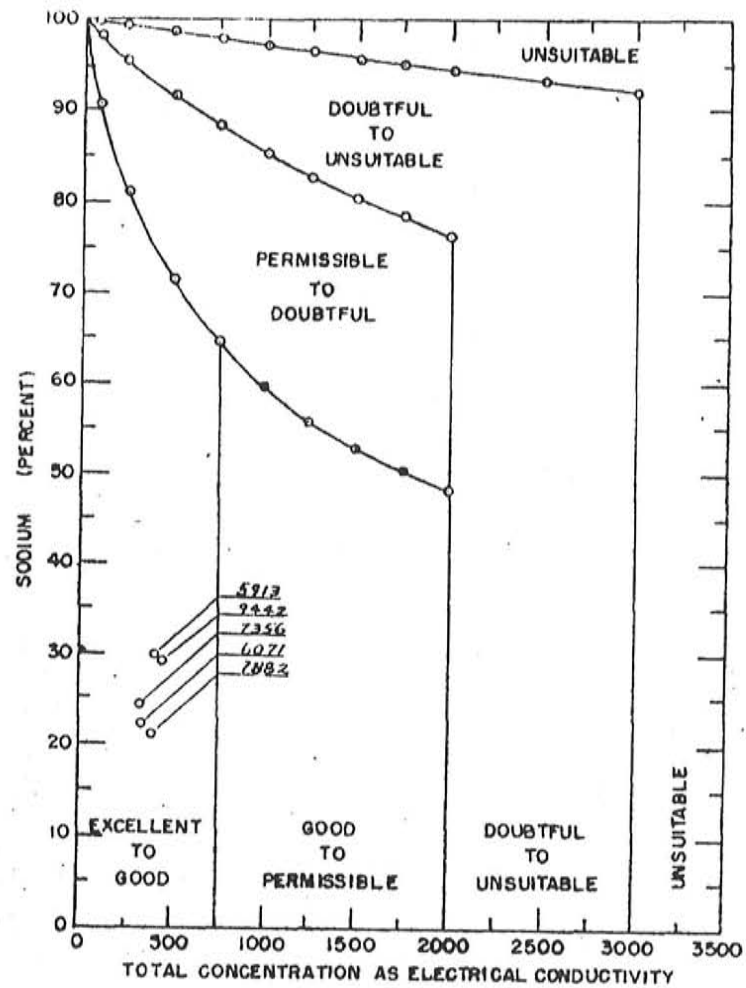
Table 42. Mineral constituents, in parts per million, of Nappa Creek water near Stamford, Nebraska

Sample Number	Date Collected	Discharge cfs	Specific Conductance (Kx10 ⁶)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Nitrate (NO ₃)	Boron (B)	Percent Sodium
6015	6-16-48	76	275	40	5.0	11	11	154	14	1.6	3.8	0.10	15
7380	6-25-48	984	218	29	3.0		14	130	8.6	.0	.5	.09	27
7381	8-6-48	50	452	60	10		32	258	35	5.4	5.3	.11	27
7883	9-1-48	36	281	39	7.3		9.3	156	13	2.0	2.6	.02	14
10548	10-1-48	1.3	580	83	17	16	16	328	54	8.2	2.1	0.10	10
11570	3-12-49		374	47	5.0		24	189	23	6.0	1.6	.08	27
M-350	4-13-49		623	69	13		57	330	50	15	5.5	—	36
M-351	5-6-49		354	52	5.0		22	236	1.0	1.1	.4	—	24
11797	5-7-49		267	36	7.9		6.4	153	4.0	3.5	.9	.04	10
11796	5-21-49		239	30	6.3		10	129	11	3.0	1.7	.06	18
M-413	5-22-49		337	46	6.1		20	186	17	8.0	.6	—	23
M-415	6-5-49		411	50	6.7		33	224	27	8.0	.3	—	32

Table 43. Mineral constituents, in parts per million, of Prairie Dog Creek near Norton, Kansas

Sample Number	Date Collected	Dis-charge cfs	Specific Conductance (Kx10 ⁶)	Calcium (Ca.)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Nitrate (NO ₃)	Boron (B)	Percent Sodium
548	3-27-47	20	56.3	76	16	18	8.4	304	34	9.8	8.0	0.17	13
549	4-29-47	22	52.0	64	16	18	14	281	33	11	1.5	.09	14
3328	5-27-47	15	57.7	80	18	24		331	35	10	2.3	.38	16
3329	8-23-47	10	59.8	91	16	16		344	29	7.0	4.7	.11	10
5894	5-30-48	472	224	31	5.0		8.3	136	1.0	1.0	0.8	0.07	16
6470	6-27-48	1,250	225	32	5.0	14		140	9.6	3.0	.5	.07	23
7912	8-5-48	73	421	65	10	11		256	3.2	9.0	.3	.00	11
7879	8-13-48	250	249	32	7.0		6.5	150	46	.5	1.2	.09	8
9410	9-8-48	16	339	39	6.7	23		186	12	3.0	5.8	.05	29
9408	10-7-48		512	69	16	30		320	26	8.0	1.2	0.09	21
11535	3-19-49		496	64	13	27		282	24	8.0	4.8	.06	22
M-356	5-6-49		390	66	10	10		266	8.4	.5	.3	--	10
M-360	5-18-49		330	52	8.5		7.1	207	8.8	.5	1.4	--	9
M-357	5-21-49		264	40	6.3		6.4	160	5.6	.5	1.7	--	10
M-362	6-7-49		257	36	5.4	17		164	5.2	3.0	2.9	--	24
M-361	6-9-49		177	24	6.1		3.5	104	3.8	.5	2.4	--	8
M-358	6-18-49		308	46	8.3		6.7	188	6.2	1.0	.6	--	9
M-359	7-9-49		289	49	8.1		5.8	189	9.2	2.0	.1	--	7
M-355	7-14-49		260	45	7.4		4.6	176	6.6	.5	.6	--	7
M-643	7-26-49		284	41	5.0		9.2	164	4.8	1.0	1.4	--	14

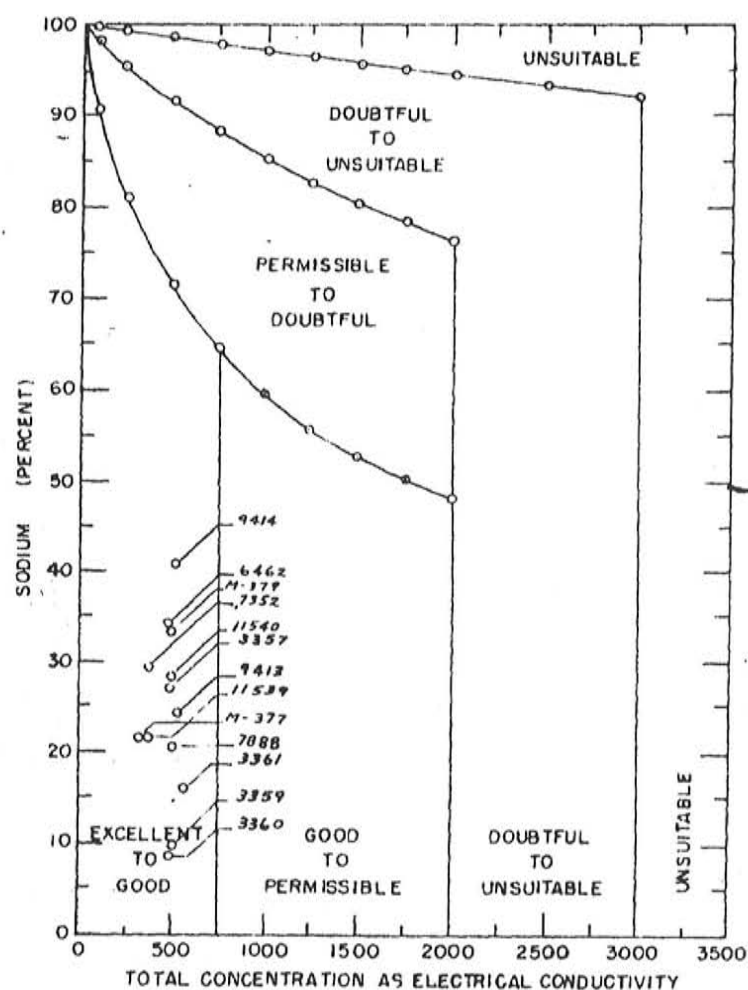
EXHIBIT 10 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS
OF WATER SAMPLES FROM
REPUBLICAN RIVER AT ORLEANS, NEBR.



USDA CIRCULAR NO. 784, MAY 1948

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

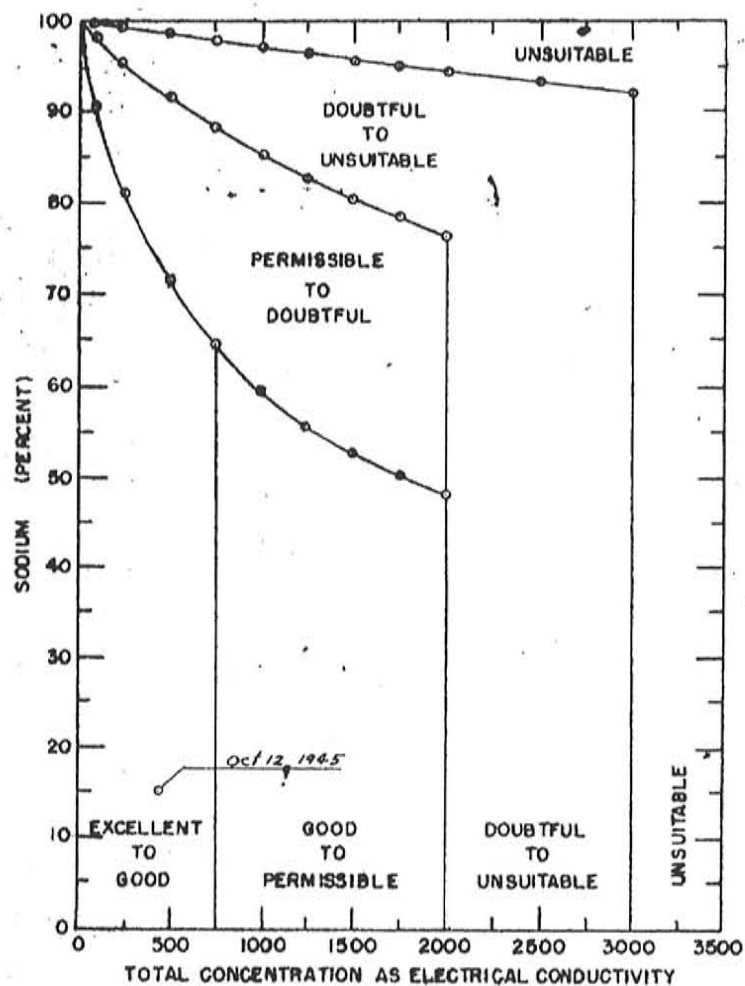
EXHIBIT // DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS
OF WATER SAMPLES FROM
REPUBLICAN RIVER AT BLOOMINGTON NEBR.



USDA CIRCULAR NO. 784, MAY 1948

"EXPLANATION AND INTERPRETATION OF ANALYSIS OF
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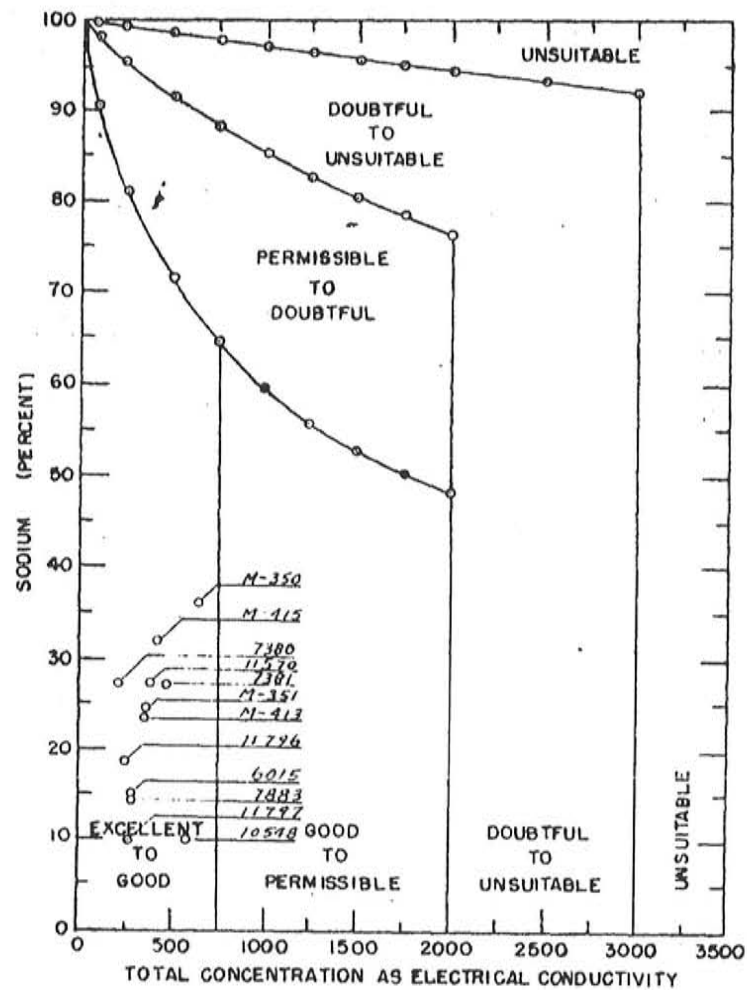
EXHIBIT 12 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS
OF WATER SAMPLES FROM
REPUBLICAN RIVER NEAR HARDY, NEBR.



USDA CIRCULAR NO. 784, MAY 1948

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

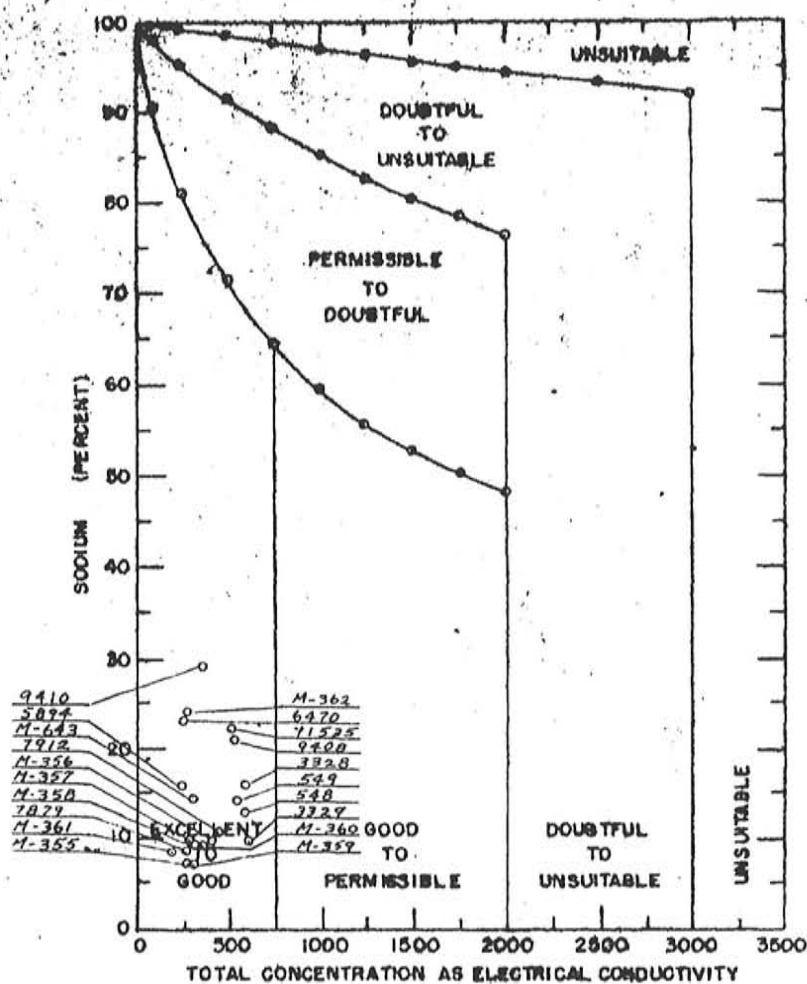
EXHIBIT 13 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS
OF WATER SAMPLES FROM:
SAPPA CREEK NEAR STAMFORD NEBR.



USDA CIRCULAR NO. 784, MAY 1948

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

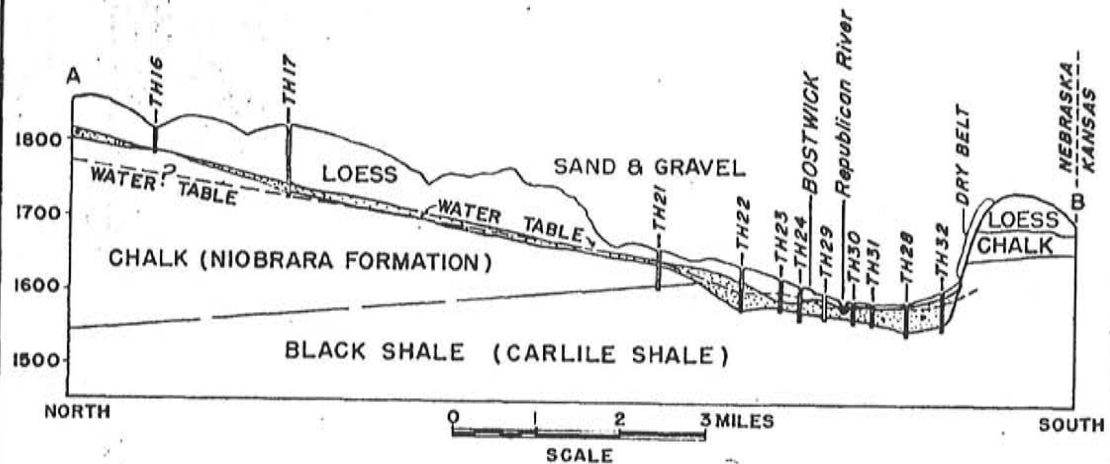
EXHIBIT 74 DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS
OF WATER SAMPLES FROM
PRAIRIE DOG CREEK NEAR NORTON KANSAS



USDA CIRCULAR NO. 764, MAY 1948

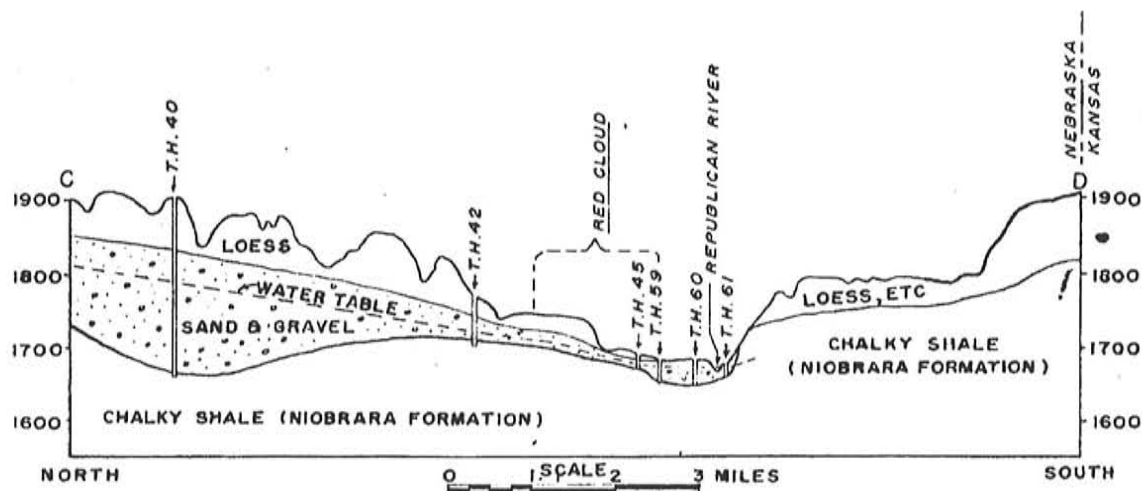
"EXPLANATION AND INTERPRETATION OF ANALYSIS OF
IRRIGATION WATERS" L.V. WILCOX

Exhibit 15. Geologic profile showing the Republican River Valley west of Bostwick, Nebraska



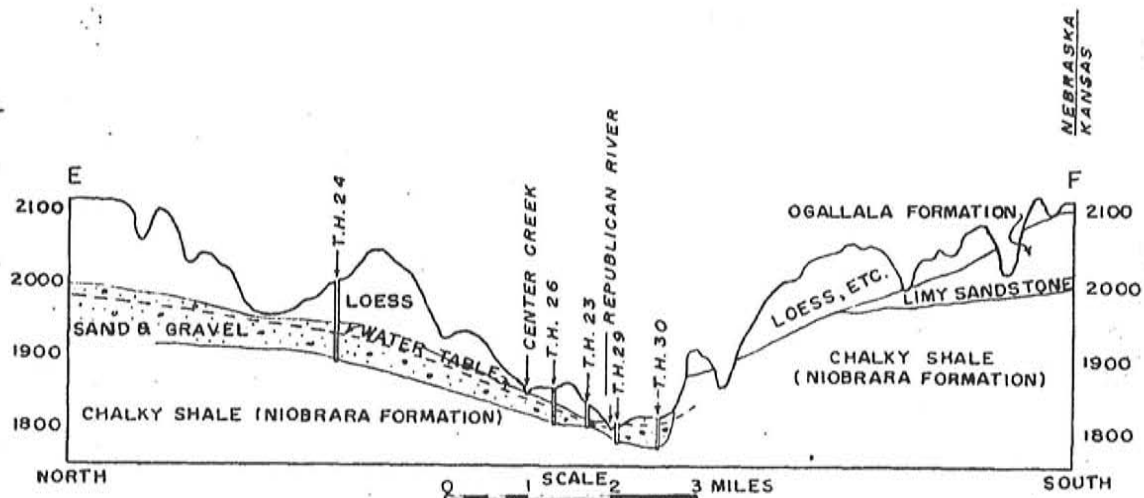
Geologic Profile Section A-B. Location along a north-south line three-fourths mile west of Bostwick extending from a point 12 miles north of the Nebraska-Kansas line (A) southward to the Nebraska-Kansas line (B). Note (1) the relatively thin sand and gravel which occurs above the chalk bedrock north of the Republican Valley (2) the deeper buried channel in the Valley Region filled with thicker water-bearing sands and gravels (3) the unusually high chalk and shale bedrock south of the Valley and (4) the position of the water table, sloping southward toward the Republican Valley, as shown by the dashed line. The locations of the test holes are shown on the profile section and numbered (T.H.16, etc.) according to the numbers shown on the Ground-Water Map. The black shale shown in the profile section is the Carlile shale and the chalk is a part of the Niobrara formation.

Exhibit 16 . Geologic profile, showing Republic River Valley at Red Cloud, Nebraska



Geologic Profile Section C-D. This section is located one-half mile east of Red Cloud and extends in a north-south direction from a point 12 miles north of the Nebraska-Kansas line (C) to the Nebraska-Kansas line (D). Note the deep, sand- and gravel-filled channel in the vicinity of test hole 40, the buried ridge near test hole 42, the buried channel and relatively good infiltration area in the southern part of the Republican Valley region and the high chalky shale bed-rock south of the Valley. The dashed line, representing the water table (top of the zone of saturated water-bearing material), slopes southward toward the Republican Valley in the region north of the Valley. The chalky shale is relatively impervious and is a part of the Niobrara formation of Cretaceous age. (Nebraska Water Resources Survey, Water Supply Paper 1, Part 1)

Exhibit 17. Geologic profile, showing the Republican River Valley west of Franklin, Nebraska



Geologic Profile Section E-F. This section is located 1 mile west of the center of the town of Franklin and extends in a north-south direction from a point 12 miles north of the Nebraska-Kansas state line (E) to the Nebraska-Kansas state line (F). Note the increase in thickness of the sand and gravel northward between test holes 26 and 24, the bedrock ridge in the vicinity of test hole 24, the relatively good infiltration area immediately south of the Republican River in the vicinity of test holes 29 and 30, the high chalky shale bedrock (Niobrara formation) south of the Valley, and the relatively thick loess cap both north and south of the Republican Valley. The dashed line representing the water table indicates that the water table slopes southward toward the Republican Valley. The chalky shale is relatively impervious and is a part of the Niobrara formation of Cretaceous age. Variable thicknesses of limy sandstone (Ogallala formation of Tertiary age) occur above the Niobrara formation and below the loess and associated materials in much of the upland south of the Republican River. (Nebraska Water Resources Survey Water Supply Paper 1, Part 1)

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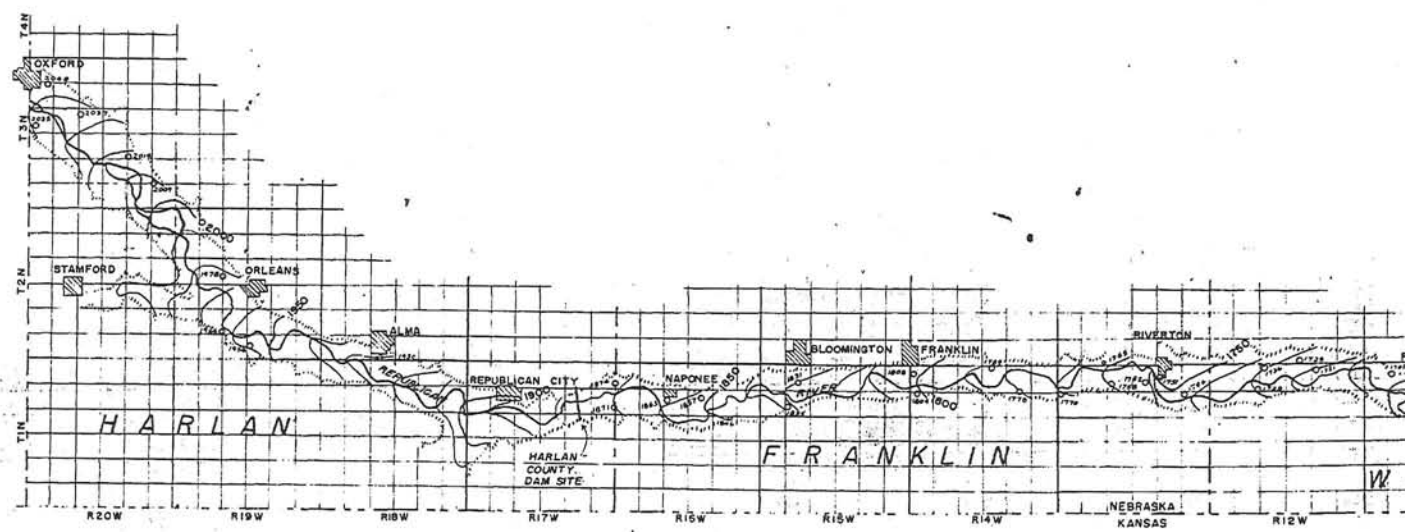
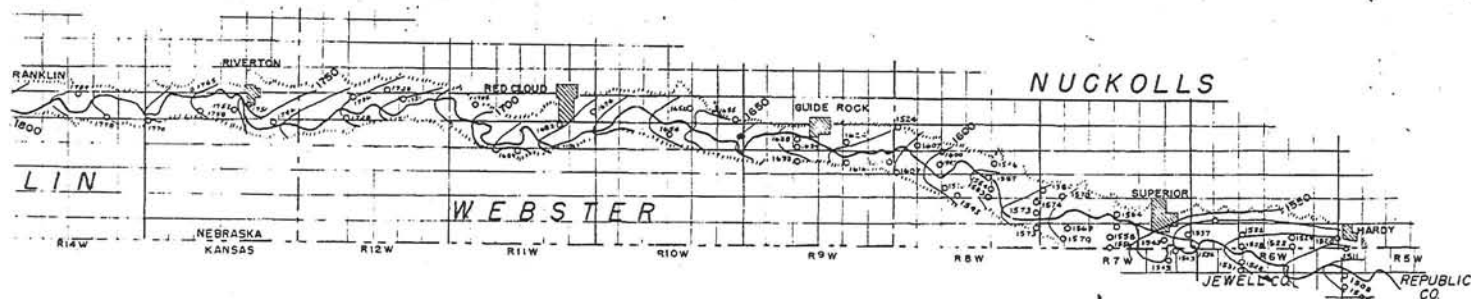


EXHIBIT (B)

MAP OF THE REPUBLICAN RIVER VALLEY, NEBRASKA
SHOWING
LOCATION OF OBSERVATION WELLS AND CONTOURS ON THE WATER TABLE
ALTITUDES ARE REFERRED TO MEAN 'SEA LEVEL' DATUM
CONTOUR INTERVALS 10 FEET



- Legend
- O 1635 OBSERVATION WELLS SHOWING ELEVATION OF WATER TABLE DURING FEBRUARY AND MARCH, 1947
 - ~ 1650 CONTOUR ON WATER TABLE
 - CITY OR TOWN
 - EDGE OF BLUFFS ALONG VALLEY FLOOR



FROM CIRCULAR 19, U.S. GEOLOGICAL SURVEY, 1948

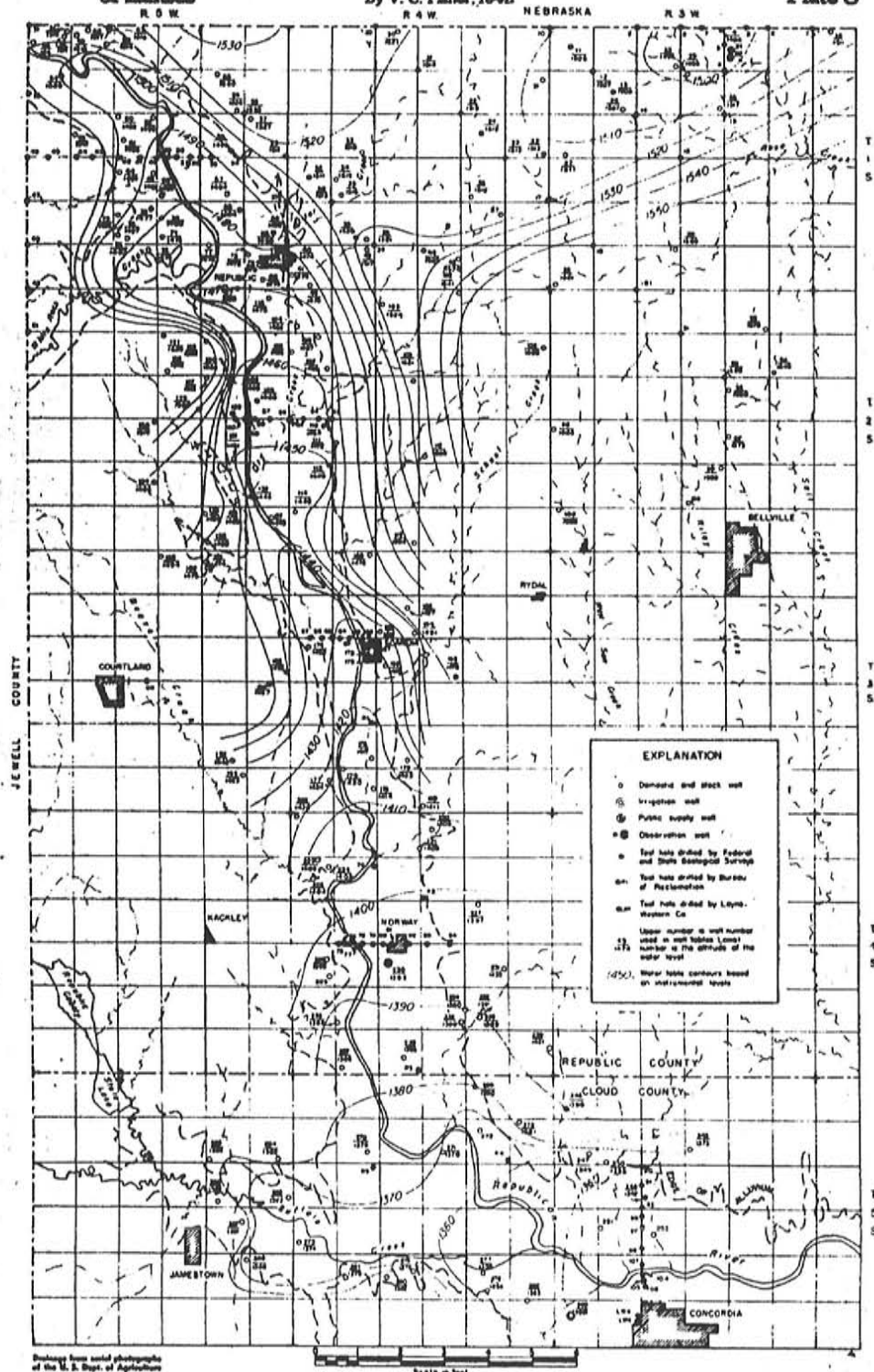
MAP OF WESTERN REPUBLIC COUNTY AND NORTHWESTERN CLOUD COUNTY, KANSAS

Showing Water-table Contours Along Present and Ancestral Republican River Valleys

State Geological Survey
of Kansas

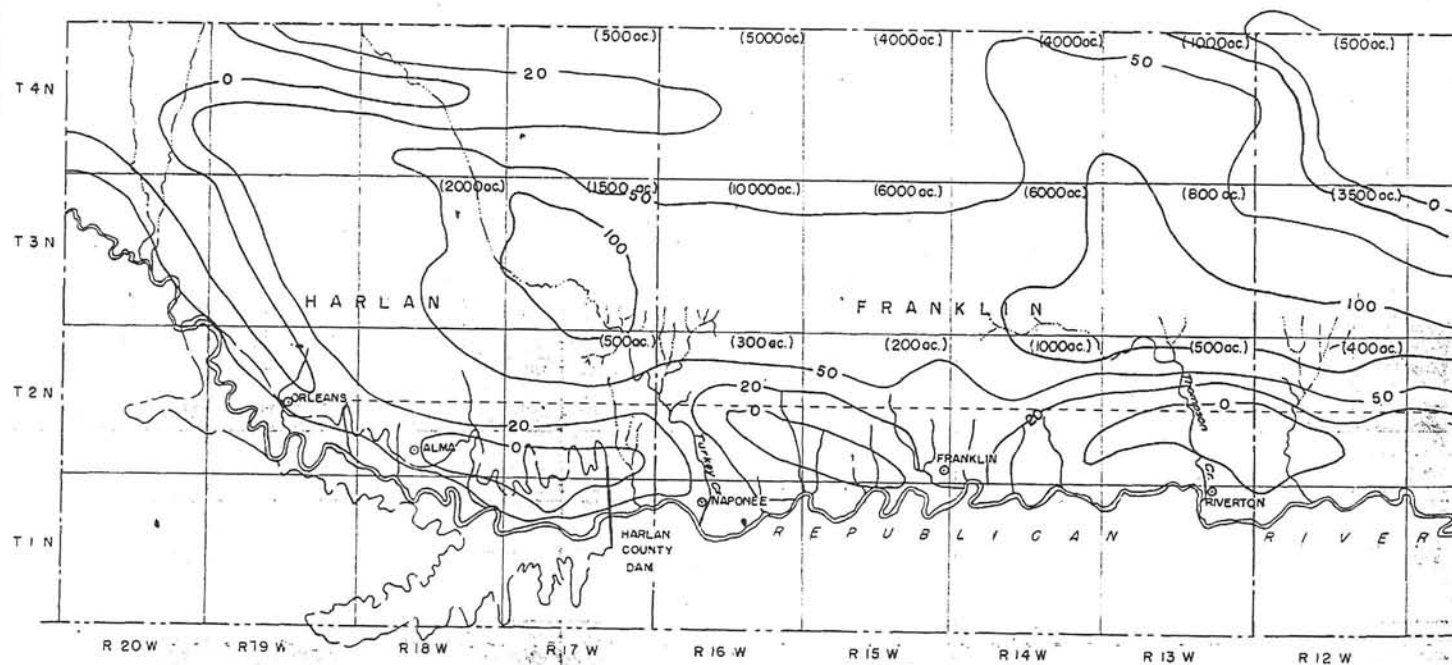
By V. C. Fisher, 1942

Bulletin 73
Plate 8



(A)

SATURATE THICKNESS OF PLEISTOGENE MATERIAL
HARLAN, FRANKLIN AND WEBSTER COUNTIES



Data from Advance Information Given by
Conservation and Survey Division, University
of Nebraska.

----- AVERAGE LINE FOR BEGINNING PERENNIAL STREAM
- - - - - INTERMITTANT STREAM
~~~~~ PERENNIAL STREAM

( ac ) ESTIMATED IRRIGABLE AREA IN TOWNSHIP  
CONTOUR LINES REPRESENT SATURATED  
THICKNESS OF PLEISTOGENE MATERIAL

SATURATE THICKNESS OF PLEISTOCENE MATERIAL  
HARLAN, FRANKLIN AND WEBSTER COUNTIES

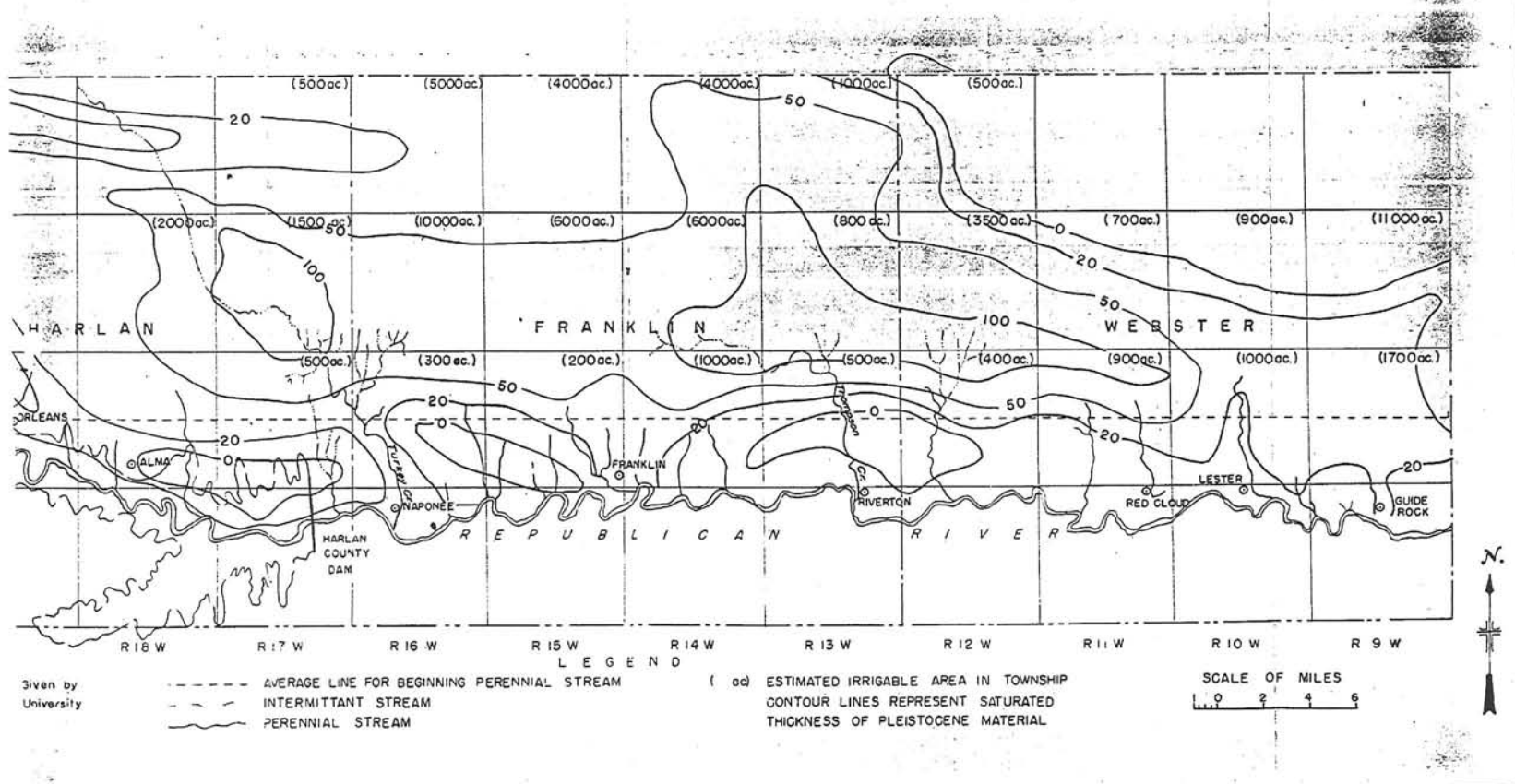


Table 44 Potential groundwater depletion in the Platte-Republican Divide area.

| Township | Acres  | D in feet | $\frac{M^2}{V}$ | $x_1$ feet | $\frac{x_1}{\sqrt{4h^2t}}$ when "t" is |        |        |        |        | $1 - \frac{G}{F}$ = probability integral of argument $\frac{x_1}{\sqrt{4h^2t}}$ * |        |        |        |        | $\frac{G}{F}$ or Ratio of river flow depletion to water pumped at well after indicated period in years |        |        |        |        | 10 |
|----------|--------|-----------|-----------------|------------|----------------------------------------|--------|--------|--------|--------|-----------------------------------------------------------------------------------|--------|--------|--------|--------|--------------------------------------------------------------------------------------------------------|--------|--------|--------|--------|----|
|          |        |           |                 |            | 10 yrs                                 | 20 yrs | 30 yrs | 40 yrs | 50 yrs | 10 yrs                                                                            | 20 yrs | 30 yrs | 40 yrs | 50 yrs | 10 yrs                                                                                                 | 20 yrs | 30 yrs | 40 yrs | 50 yrs |    |
|          |        |           |                 |            | (6)                                    | (7)    | (8)    | (9)    | (10)   | (11)                                                                              | (12)   | (13)   | (14)   | (15)   | (16)                                                                                                   | (17)   | (18)   | (19)   | (20)   |    |
| T2R17    | 500    | 50        | 0.3875          | 7,920      | .358                                   | .253   | .207   | .179   | .160   | .387                                                                              | .279   | .230   | .1998  | .179   | .613                                                                                                   | .720   | .770   | .800   | .821   |    |
| T2R16    | 300    | 50        | 0.3875          | 7,920      | .358                                   | .253   | .207   | .179   | .160   | .387                                                                              | .279   | .230   | .1998  | .179   | .613                                                                                                   | .720   | .770   | .800   | .821   |    |
| T2R15    | 200    | 50        | 0.3875          | 7,920      | .358                                   | .253   | .207   | .179   | .160   | .387                                                                              | .279   | .230   | .1998  | .179   | .613                                                                                                   | .720   | .770   | .800   | .821   |    |
| T2R14    | 1500   | 50        | 0.3875          | 7,920      | .358                                   | .253   | .207   | .179   | .160   | .387                                                                              | .279   | .230   | .1998  | .179   | .613                                                                                                   | .720   | .770   | .800   | .821   |    |
| T2R13    | 500    | 50        | 0.3875          | 7,920      | .358                                   | .253   | .207   | .179   | .160   | .387                                                                              | .279   | .230   | .1998  | .179   | .613                                                                                                   | .720   | .770   | .800   | .821   |    |
| T2R12    | 400    | 75        | 0.58125         | 7,920      | .292                                   | .207   | .169   | .146   | .131   | .320                                                                              | .230   | .1887  | .1636  | .147   | .600                                                                                                   | .770   | .811   | .836   | .853   |    |
| T2R11    | 900    | 75        | 0.58125         | 7,920      | .292                                   | .207   | .169   | .146   | .131   | .320                                                                              | .230   | .1887  | .1636  | .147   | .600                                                                                                   | .770   | .811   | .836   | .853   |    |
| T2R10    | 1000   | 30        | 0.2325          | 7,920      | .463                                   | .327   | .267   | .231   | .207   | .487                                                                              | .356   | .2937  | .256   | .230   | .513                                                                                                   | .644   | .706   | .744   | .770   |    |
| T2R9     | 1700   | 30        | 0.2325          | 7,920      | .463                                   | .327   | .267   | .231   | .207   | .487                                                                              | .356   | .2937  | .256   | .230   | .513                                                                                                   | .644   | .706   | .744   | .770   |    |
| T3R18    | 2000   | 50        | 0.3875          | 31,680     | 1.433                                  | 1.012  | .827   | .716   | .640   | .957                                                                              | .848   | .758   | .689   | .635   | .343                                                                                                   | .452   | .522   | .511   | .565   |    |
| T3R17    | 1500   | 80        | 0.62            | 31,680     | 1.13                                   | .800   | .653   | .566   | .506   | .890                                                                              | .742   | .644   | .577   | .526   | .310                                                                                                   | .425   | .493   | .423   | .474   |    |
| T3R16    | 10,000 | 50        | 0.3875          | 31,680     | 1.433                                  | 1.012  | .827   | .716   | .640   | .957                                                                              | .848   | .758   | .689   | .635   | .343                                                                                                   | .452   | .522   | .511   | .565   |    |
| T3R15    | 6000   | 50        | 0.3875          | 31,680     | 1.433                                  | 1.012  | .827   | .716   | .640   | .957                                                                              | .848   | .758   | .689   | .635   | .343                                                                                                   | .452   | .522   | .511   | .565   |    |
| T3R14    | 6000   | 60        | 0.465           | 31,680     | 1.308                                  | .923   | .754   | .652   | .584   | .936                                                                              | .808   | .714   | .644   | .591   | .364                                                                                                   | .492   | .566   | .409   | .459   |    |
| T3R13    | 800    | 80        | 0.62            | 31,680     | 1.131                                  | .800   | .653   | .566   | .506   | .890                                                                              | .742   | .644   | .577   | .526   | .310                                                                                                   | .425   | .493   | .423   | .470   |    |
| T3R12    | 3500   | 75        | 0.58125         | 31,680     | 1.168                                  | .827   | .675   | .584   | .523   | .901                                                                              | .753   | .660   | .591   | .540   | .309                                                                                                   | .422   | .490   | .409   | .460   |    |
| T3R11    | 700    | 50        | 0.3875          | 26,400     | 1.195                                  | .842   | .689   | .597   | .534   | .909                                                                              | .766   | .670   | .601   | .550   | .309                                                                                                   | .422   | .490   | .409   | .450   |    |
| T3R10    | 900    | 50        | 0.3875          | 21,120     | .956                                   | .675   | .552   | .4775  | .427   | .824                                                                              | .660   | .565   | .501   | .454   | .309                                                                                                   | .422   | .490   | .409   | .456   |    |
| T3R9     | 1100   | 50        | 0.3875          | 21,120     | .956                                   | .675   | .552   | .4775  | .427   | .824                                                                              | .660   | .565   | .501   | .454   | .309                                                                                                   | .422   | .490   | .409   | .456   |    |
| T4R17    | 500    | 50        | 0.3875          | 63,360     | 2.868                                  | 2.024  | 1.655  | 1.432  | 1.282  | .999                                                                              | .996   | .921   | .857   | .800   | 0                                                                                                      | .040   | .019   | .042   | .070   |    |
| T4R16    | 5000   | 50        | 0.3875          | 63,360     | 2.868                                  | 2.024  | 1.655  | 1.432  | 1.282  | .999                                                                              | .996   | .921   | .857   | .800   | 0                                                                                                      | .040   | .019   | .042   | .070   |    |
| T4R15    | 4000   | 50        | 0.3875          | 63,360     | 2.868                                  | 2.024  | 1.655  | 1.432  | 1.282  | .999                                                                              | .996   | .921   | .857   | .800   | 0                                                                                                      | .040   | .019   | .042   | .070   |    |
| T4R14    | 4000   | 50        | 0.3875          | 63,360     | 2.868                                  | 2.024  | 1.655  | 1.432  | 1.282  | .999                                                                              | .996   | .921   | .857   | .800   | 0                                                                                                      | .040   | .019   | .042   | .070   |    |
| T4R13    | 1000   | 50        | 0.3875          | 63,360     | 2.868                                  | 2.024  | 1.655  | 1.432  | 1.282  | .999                                                                              | .996   | .921   | .857   | .800   | 0                                                                                                      | .040   | .019   | .042   | .070   |    |
| T4R12    | 500    | 50        | 0.3875          | 63,360     | 2.868                                  | 2.024  | 1.655  | 1.432  | 1.282  | .999                                                                              | .996   | .921   | .857   | .800   | 0                                                                                                      | .040   | .019   | .042   | .070   |    |

\* See Peirce "A Short Table of Integrals" 1929 pg. 116

Thom (B)

Table 44 Potential groundwater depletion in the Platte-Republican Divide area.

| $\frac{Q}{4h^2t}$ |        |        | $1 - \frac{Q}{F} = \text{probability integral of argument} = \frac{X_1}{\sqrt{2h^2t}}$ |        |        |        |        | $\frac{Q}{F}$ or<br>Ratio of river flow depletion to water pumped at well after infiltration in years |        |        |        |        | Rate of land development-acres added in 10-yr period |             |             |             |            | Depletion in acre-feet per annum by land irrigated over indicated period in years |                |                |                |                | Total depletion per annum at 50 yrs |
|-------------------|--------|--------|----------------------------------------------------------------------------------------|--------|--------|--------|--------|-------------------------------------------------------------------------------------------------------|--------|--------|--------|--------|------------------------------------------------------|-------------|-------------|-------------|------------|-----------------------------------------------------------------------------------|----------------|----------------|----------------|----------------|-------------------------------------|
| 30 yrs            | 40 yrs | 50 yrs | 10 yrs                                                                                 | 20 yrs | 30 yrs | 40 yrs | 50 yrs | 10 yrs                                                                                                | 20 yrs | 30 yrs | 40 yrs | 50 yrs | 7%<br>(21)                                           | 13%<br>(22) | 12%<br>(23) | 10%<br>(24) | 3%<br>(25) | 50 yrs<br>(26)                                                                    | 40 yrs<br>(27) | 30 yrs<br>(28) | 20 yrs<br>(29) | 10 yrs<br>(30) | (31)                                |
| (8)               | (9)    | (10)   | (11)                                                                                   | (12)   | (13)   | (14)   | (15)   | (16)                                                                                                  | (17)   | (18)   | (19)   | (20)   |                                                      |             |             |             |            |                                                                                   |                |                |                |                |                                     |
| .207              | .179   | .160   | .387                                                                                   | .279   | .230   | .1998  | .179   | .613                                                                                                  | .720   | .770   | .800   | .821   | 35                                                   | 65          | 60          | 50          | 15         | 29                                                                                | 52             | 46             | 36             | 9              | 172                                 |
| .207              | .179   | .160   | .387                                                                                   | .279   | .230   | .1998  | .179   | .613                                                                                                  | .720   | .770   | .800   | .821   | 21                                                   | 39          | 36          | 30          | 9          | 17                                                                                | 31             | 28             | 23             | 6              | 104                                 |
| .207              | .179   | .160   | .387                                                                                   | .279   | .230   | .1998  | .179   | .613                                                                                                  | .720   | .770   | .800   | .821   | 14                                                   | 26          | 20          | 20          | 6          | 12                                                                                | 21             | 18             | 14             | 4              | 69                                  |
| .207              | .179   | .160   | .387                                                                                   | .279   | .230   | .1998  | .179   | .613                                                                                                  | .720   | .770   | .800   | .821   | 70                                                   | 130         | 120         | 100         | 30         | 57                                                                                | 104            | 92             | 72             | 18             | 343                                 |
| .213              | .179   | .160   | .387                                                                                   | .279   | .230   | .1998  | .179   | .613                                                                                                  | .720   | .770   | .800   | .821   | 35                                                   | 65          | 60          | 50          | 15         | 29                                                                                | 52             | 46             | 36             | 9              | 172                                 |
| .169              | .146   | .131   | .320                                                                                   | .230   | .1897  | .1636  | .147   | .680                                                                                                  | .770   | .811   | .836   | .853   | 26                                                   | 52          | 48          | 40          | 12         | 24                                                                                | 44             | 39             | 31             | 8              | 146                                 |
| .169              | .146   | .131   | .320                                                                                   | .230   | .1897  | .1636  | .147   | .680                                                                                                  | .770   | .811   | .836   | .853   | 63                                                   | 117         | 108         | 90          | 27         | 54                                                                                | 98             | 88             | 69             | 18             | 327                                 |
| .167              | .231   | .207   | .487                                                                                   | .356   | .2937  | .256   | .230   | .513                                                                                                  | .644   | .706   | .744   | .770   | 70                                                   | 130         | 120         | 100         | 30         | 54                                                                                | 97             | 85             | 64             | 15             | 315                                 |
| .167              | .231   | .207   | .487                                                                                   | .356   | .2937  | .256   | .230   | .513                                                                                                  | .644   | .706   | .744   | .770   | 119                                                  | 221         | 204         | 170         | 51         | 92                                                                                | 164            | 144            | 110            | 26             | 536                                 |
| .827              | .716   | .640   | .937                                                                                   | .845   | .756   | .689   | .635   | .043                                                                                                  | .152   | .242   | .311   | .365   | 140                                                  | 260         | 240         | 200         | 60         | 51                                                                                | 81             | 58             | 30             | 3              | 223                                 |
| .653              | .566   | .506   | .890                                                                                   | .742   | .644   | .577   | .526   | .110                                                                                                  | .250   | .356   | .423   | .474   | 105                                                  | 195         | 180         | 150         | 45         | 50                                                                                | 32             | 64             | 39             | 5              | 240                                 |
| .827              | .716   | .640   | .937                                                                                   | .845   | .758   | .689   | .635   | .043                                                                                                  | .152   | .242   | .311   | .365   | 700                                                  | 1300        | 1200        | 1000        | 300        | 255                                                                               | 404            | 291            | 153            | 13             | 1115                                |
| .927              | .716   | .640   | .937                                                                                   | .845   | .758   | .689   | .635   | .043                                                                                                  | .152   | .242   | .311   | .365   | 430                                                  | 780         | 720         | 600         | 180        | 153                                                                               | 243            | 174            | 91             | 8              | 669                                 |
| .754              | .652   | .584   | .933                                                                                   | .808   | .714   | .644   | .591   | .064                                                                                                  | .152   | .236   | .356   | .409   | 420                                                  | 780         | 720         | 600         | 180        | 172                                                                               | 273            | 206            | 115            | 12             | 733                                 |
| .653              | .566   | .506   | .890                                                                                   | .742   | .644   | .577   | .526   | .110                                                                                                  | .258   | .356   | .423   | .470   | 56                                                   | 104         | 96          | 80          | 24         | 26                                                                                | 44             | 34             | 21             | 3              | 128                                 |
| .675              | .584   | .523   | .901                                                                                   | .753   | .660   | .591   | .540   | .099                                                                                                  | .242   | .340   | .409   | .460   | 245                                                  | 455         | 420         | 350         | 105        | 113                                                                               | 156            | 143            | 85             | 10             | 537                                 |
| .689              | .587   | .514   | .903                                                                                   | .755   | .670   | .601   | .550   | .09                                                                                                   | .234   | .330   | .399   | .450   | 40                                                   | 81          | 84          | 70          | 21         | 22                                                                                | 36             | 23             | 16             | 2              | 104                                 |
| .552              | .4775  | .427   | .824                                                                                   | .686   | .595   | .501   | .454   | .176                                                                                                  | .340   | .435   | .499   | .546   | 63                                                   | 117         | 108         | 90          | 27         | 34                                                                                | 58             | 47             | 31             | 5              | 175                                 |
| .552              | .4775  | .427   | .824                                                                                   | .686   | .595   | .501   | .454   | .176                                                                                                  | .340   | .435   | .499   | .546   | 77                                                   | 143         | 132         | 110         | 33         | 42                                                                                | 71             | 52             | 37             | 6              | 203                                 |
| 1.655             | 1.432  | 1.252  | .999                                                                                   | .845   | .742   | .681   | .630   | 0                                                                                                     | .040   | .019   | .042   | .070   | 35                                                   | 65          | 60          | 50          | 15         | 2                                                                                 | 3              | 1              | 0              | 0              | 6                                   |
| 1.655             | 1.432  | 1.252  | .999                                                                                   | .845   | .742   | .681   | .630   | 0                                                                                                     | .040   | .019   | .042   | .070   | 350                                                  | 650         | 600         | 500         | 150        | 24                                                                                | 27             | 11             | 2              | 0              | 64                                  |
| 1.655             | 1.432  | 1.252  | .999                                                                                   | .845   | .742   | .681   | .630   | 0                                                                                                     | .040   | .019   | .042   | .070   | 240                                                  | 450         | 420         | 350         | 120        | 20                                                                                | 24             | 9              | 2              | 0              | 53                                  |
| 1.655             | 1.432  | 1.252  | .999                                                                                   | .845   | .742   | .681   | .630   | 0                                                                                                     | .040   | .019   | .042   | .070   | 20                                                   | 380         | 360         | 300         | 120        | 20                                                                                | 22             | 9              | 2              | 0              | 53                                  |
| 1.655             | 1.432  | 1.252  | .999                                                                                   | .845   | .742   | .681   | .630   | 0                                                                                                     | .040   | .019   | .042   | .070   | 70                                                   | 130         | 120         | 100         | 30         | 5                                                                                 | 5              | 2              | 0              | 0              | 12                                  |
| 1.655             | 1.432  | 1.252  | .999                                                                                   | .845   | .742   | .681   | .630   | 0                                                                                                     | .040   | .019   | .042   | .070   | 35                                                   | 65          | 60          | 50          | 15         | 2                                                                                 | 3              | 1              | 0              | 0              | 6                                   |

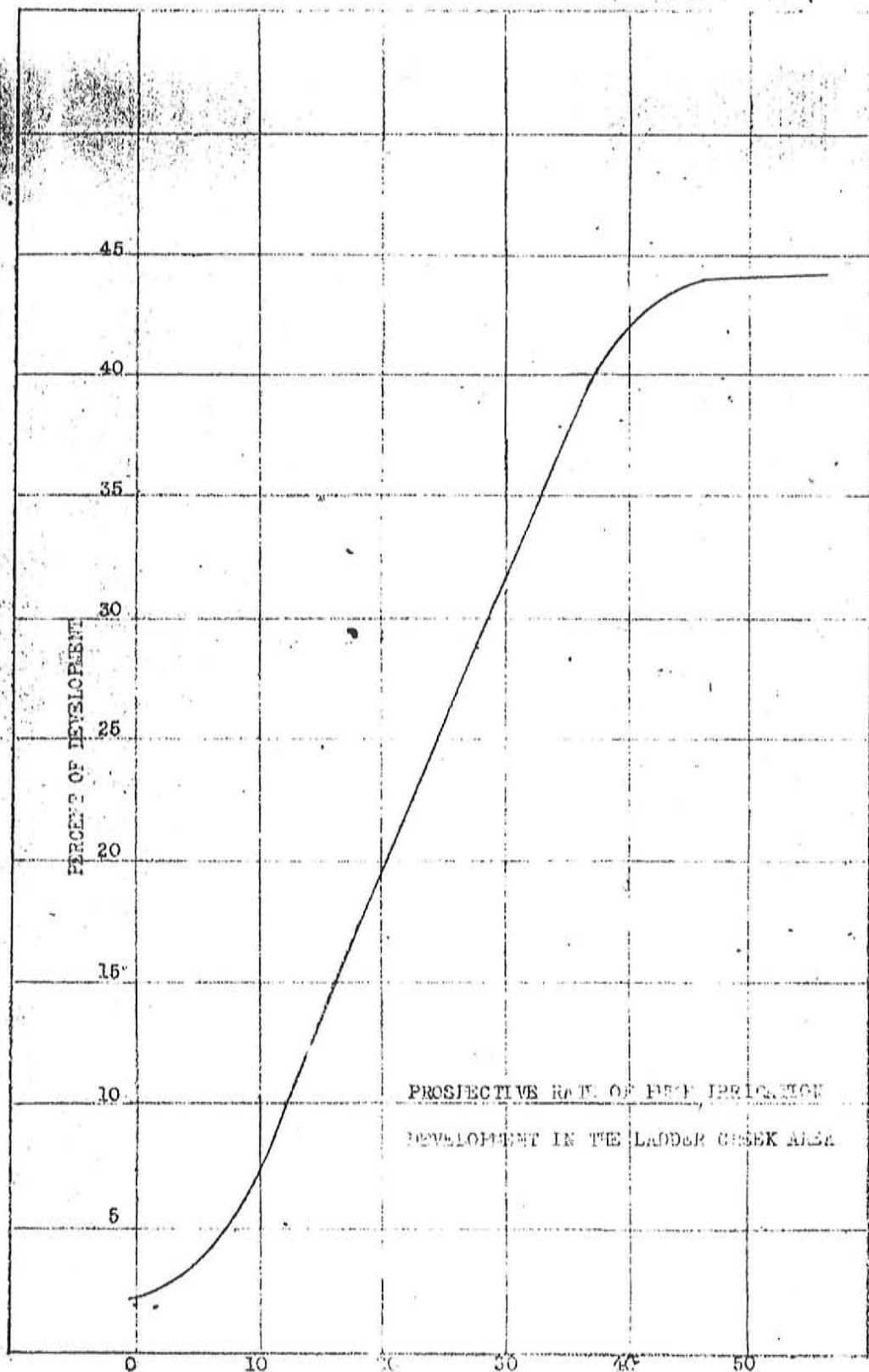


Table 45

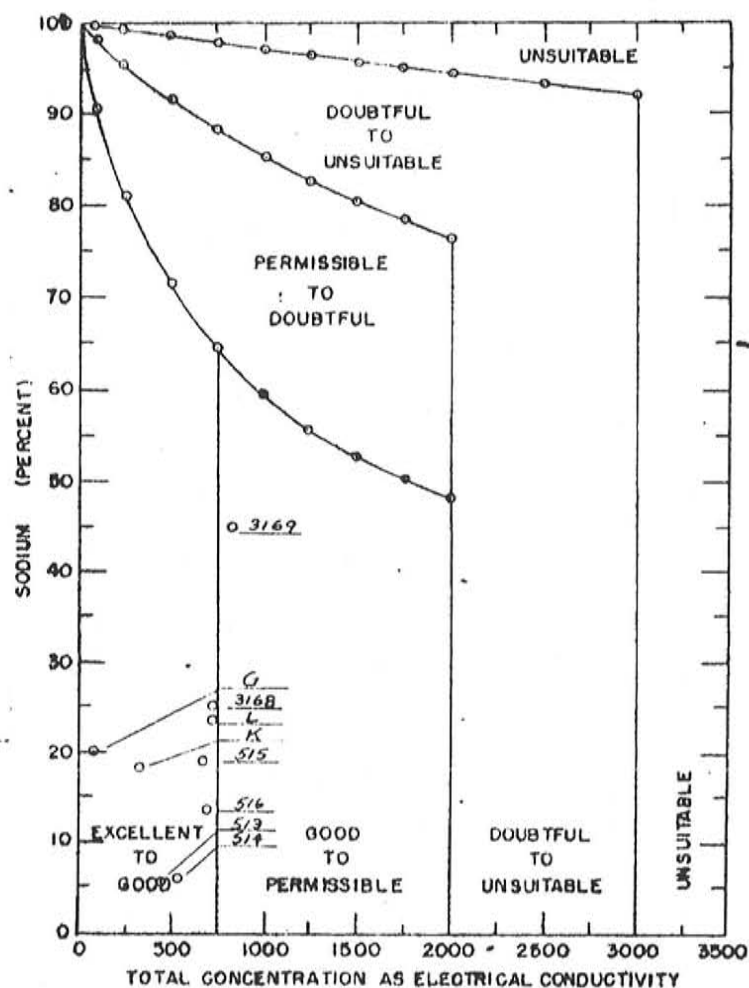
Table 45. Mineral constituents, in parts per million, and related physical measurements of wells in the Bostwick Division

| Analysis Number | Owner and Well Number (Location)   | Date of Collection | Well | Depth Feet |              | To Water Surface | Discharge, G.P.M. | Temperature (°C) | pH   | Specific Conductance Kx10 <sup>3</sup> at 25° C | Silica (SiO <sub>2</sub> ) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate (HCO <sub>3</sub> ) | Sulfate (SO <sub>4</sub> ) | Chloride (Cl) | Fluoride (F) | Nitrate (NO <sub>3</sub> ) | Boron (B) | Manganese (Mn) | Dissolved Solids | Hardness as Ca CO <sub>3</sub> |      |  |
|-----------------|------------------------------------|--------------------|------|------------|--------------|------------------|-------------------|------------------|------|-------------------------------------------------|----------------------------|-----------|--------------|----------------|-------------|---------------|---------------------------------|----------------------------|---------------|--------------|----------------------------|-----------|----------------|------------------|--------------------------------|------|--|
|                 |                                    |                    |      | Total      | Noncarbonate |                  |                   |                  |      |                                                 |                            |           |              |                |             |               |                                 |                            |               |              |                            |           |                |                  | Percent Carbonate              |      |  |
| (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) |  |
| 513             | City of Bloomington<br>2-15-32 abl | 5-15-47            | 52   | 52         | 26           | 100              | 55                | 8.0              | 44.4 | 27                                              | .05                        | 68        | 12           | 7.1            | 8.8         | 264           | 8.2                             | 12                         | 0.2           | 5.0          | .14                        | 0         | 315            | 219              | 3                              |      |  |
| 514             | City of Franklin<br>2-15-15 da2    | 5-15-47            | 59   | 16         | 30           | 200              | 56                | 8.1              | 53.5 | 22                                              | 0                          | 90        | 15           | 8.1            | 6.4         | 318           | 21                              | 17                         | 0.2           | 6.5          | .13                        | 0         | 374            | 286              | 25                             |      |  |
| 515             | Univ. of Nebraska<br>3-11-36 dd    | 11-12-36           | 30.4 | -          | 1.25         | -                | -                 | -                | -    | 30                                              | .16                        | 7.1       | 2.1          | 3.5            | 3.2         | 33            | 6.3                             | 1.1                        | 0.2           | 5.4          | -                          | -         | 88             | 26               | 0                              |      |  |
| 516             | City of Riverton<br>2-13-35 cd     | 5-15-47            | 28   | 18         | 24           | 150              | 55                | 8.2              | 66.6 | 24                                              | 0                          | 108       | 10           | 3.1            | 2.4         | 329           | 70                              | 28                         | 0.1           | 6.0          | 0                          | 481       | 311            | 41               | 16                             |      |  |
| 516             | City of Red Cloud<br>2-11-35 cc3   | 5-15-47            | 13   | 24         | 11           | 200              | 56                | 7.9              | 67.2 | 21                                              | .03                        | 105       | 17           | 23             | 8.0         | 314           | 67                              | 29                         | 0.1           | 30           | -                          | 0         | 526            | 332              | 75                             | 13   |  |
| 516             | Henry Comphalder<br>2-11-36 dd     | 11-12-36           | 35.4 | 25         | 1.0          | 300              | -                 | -                | -    | -                                               | -                          | 12        | 7.1          | 1.1            | 164         | 14            | 8.0                             | 0.2                        | 5.5           | -            | -                          | -         | 135            | 0                | 16                             |      |  |
| 3168            | U. S. Geol. Survey<br>1-1-47 cc    | 1-1-47             | 13   | 7.75       | 1.25         | -                | 60                | 7.5              | 71.5 | 35                                              | 0                          | 123       | 12           | 54             | 423         | 19            | 1.0                             | 0.6                        | 0.8           | .16          | -                          | 159       | 356            | 9                | 14                             |      |  |
| 3168            | City of Superior 1/<br>cl-7-2 ab   | 11-1-47            | -    | -          | 2.0          | -                | -                 | -                | -    | 39                                              | 1.1                        | 92        | 20           | 1.3            | 325         | 120           | 7.0                             | 0.2                        | 1.1           | -            | -                          | 510       | 312            | 48               | 23                             |      |  |
| 3169            | U. S. Geol. Survey<br>1-5-31 cc    | 5-13-47            | 11   | -          | -            | -                | 58                | 7.3              | 79.8 | 37                                              | 0                          | 100       | 13           | 118            | 406         | 74            | 23                              | 0.6                        | 0.1           | .14          | -                          | 516       | 303            | 0                | 15                             |      |  |

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**EXHIBIT - DIAGRAM FOR USE IN INTERPRETING THE ANALYSIS  
OF WATER SAMPLES FROM WELLS  
BELOW HARLAN COUNTY RESERVOIR**



USDA CIRCULAR NO. 784, MAY 1948

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

Table 46 . Effective heat and annual consumptive use for Franklin - Red Cloud Unit <sup>a/</sup> 40

| (Unit - day-degrees) |                   |                   |       |                     |       |       |       |       |       |      |                 |        |                                   |
|----------------------|-------------------|-------------------|-------|---------------------|-------|-------|-------|-------|-------|------|-----------------|--------|-----------------------------------|
| Year :               | Start of Season : | Mar.              | Apr.  | May                 | June  | July  | Aug.  | Sept. | Oct.  | Nov. | End of Season : | Total  | Consump. Use in Ft. <sup>b/</sup> |
| 1929 :               | Mar. 22 :         | 264               | 1,095 | 1,224               | 1,521 | 1,838 | 1,928 | 1,329 | 1,054 | 17   | Nov. 1 :        | 10,270 | 2.45                              |
| 1930 :               | Mar. 30 :         | 28                | 1,128 | 1,277               | 1,551 | 2,043 | 1,869 | 1,548 | 986   | 201  | Nov. 7 :        | 10,631 | 2.51                              |
| 1931 :               | Apr. 2 :          | -                 | 934   | 1,262               | 1,824 | 1,972 | 1,761 | 1,740 | 1,212 | 342  | Nov. 11 :       | 11,047 | 2.57                              |
| 1932 :               | Mar. 31 :         | -                 | 1,122 | 1,476               | 1,623 | 2,024 | 1,851 | 1,485 | 1,046 | -    | Oct. 29 :       | 10,627 | 2.51                              |
| 1933 :               | Mar. 24 :         | 263               | 1,035 | 1,293               | 1,955 | 1,941 | 1,696 | 1,695 | 1,209 | 92   | Nov. 3 :        | 11,189 | 2.60                              |
| 1934 :               | Mar. 28 :         | 61                | 1,158 | 1,724               | 1,902 | 2,244 | 2,027 | 1,377 | 1,358 | 417  | Nov. 13 :       | 12,268 | 2.76                              |
| 1935 :               | Mar. 11 :         | 742               | 951   | 1,054               | 1,473 | 2,046 | 1,900 | 1,440 | 955   | 14   | Nov. 2 :        | 10,575 | 2.51                              |
| 1936 :               | Apr. 2 :          | -                 | 1,042 | 1,457               | 1,815 | 2,158 | 2,105 | 1,536 | 941   | -    | Oct. 27 :       | 11,054 | 2.58                              |
| 1937 :               | Apr. 1 :          | -                 | 976   | 1,410               | 1,605 | 1,941 | 2,027 | 1,563 | 1,110 | 57   | Nov. 2 :        | 10,589 | 2.52                              |
| 1938 :               | Mar. 11 :         | 630               | 1,026 | 1,234               | 1,575 | 1,953 | 1,931 | 1,473 | 1,432 | 144  | Nov. 4 :        | 11,398 | 2.63                              |
| 1939 :               | Mar. 26 :         | 90                | 1,035 | 1,576               | 1,611 | 2,040 | 1,755 | 1,728 | 1,228 | -    | Oct. 31 :       | 11,065 | 2.58                              |
| 1940 :               | Mar. 26 :         | 196 <sup>c/</sup> | 1,014 | 1,376               | 1,704 | 1,987 | 1,720 | 1,569 | 1,383 | 162  | Nov. 5 :        | 11,111 | 2.58                              |
| 1941 :               | Mar. 25 :         | 165               | 996   | 1,460               | 1,488 | 1,844 | 1,776 | 1,452 | 1,042 | 166  | Nov. 8 :        | 10,389 | 2.47                              |
| 1942 :               | Mar. 24 :         | 109               | 1,125 | 1,302               | 1,495 | 1,894 | 1,699 | 1,299 | 1,162 | 70   | Nov. 3 :        | 10,145 | 2.43                              |
| 1943 :               | Apr. 1 :          | -                 | 1,146 | 1,302               | 1,563 | 1,891 | 1,975 | 1,479 | 925   | -    | Oct. 23 :       | 10,281 | 2.46                              |
| 1944 :               | Apr. 5 :          | -                 | 633   | 1,414               | 1,596 | 1,782 | 1,736 | 1,413 | 1,200 | 357  | Nov. 11 :       | 10,131 | 2.43                              |
| 1945 :               | Mar. 12 :         | 730               | 921   | 1,076 <sup>d/</sup> | 1,263 | 1,748 | 1,810 | 1,509 | 1,076 | -    | Oct. 31 :       | 10,133 | 2.43                              |
| 1946 :               | Mar. 4 :          | 894               | 1,317 | 1,209               | 1,743 | 1,894 | 1,773 | 1,353 | 1,091 | 153  | Nov. 10 :       | 11,427 | 2.63                              |
| 1947 :               | Apr. 1 :          | -                 | 818   | 1,215               | 1,455 | 1,767 | 2,043 | 1,650 | 1,504 | 201  | Nov. 10 :       | 10,653 | 2.52                              |
| Av.                  |                   |                   |       |                     |       |       |       |       |       |      |                 | 10,794 | 2.54                              |

<sup>a/</sup> Based upon temperature records of Weather Bureau at Red Cloud, Nebraska<sup>b/</sup> From Lowry-Johnson Curve.<sup>c/</sup> Average of Phillipsburg, Kansas and Hastings, Nebraska used for March 29.<sup>d/</sup> Average of Phillipsburg and Belleville, Kansas used.

Table 47. Effective heat and annual consumptive use for Republic Kan. a/

| (Unit - day-degrees) |                 |       |       |       |       |       |       |       |       |      |               |        |                       |
|----------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|------|---------------|--------|-----------------------|
| Year                 | Start of Season | Mar.  | Apr.  | May   | June  | July  | Aug.  | Sept. | Oct.  | Nov. | End of Season | Total  | Consump. Use in Ft.b/ |
| 1929                 | Mar. 21         | 320   | 963   | 1,116 | 1,551 | 1,885 | 1,950 | 1,374 | 1,063 | 61   | Nov. 3        | 10,283 | 2.46                  |
| 1930                 | Mar. 29         | 62    | 1,101 | 1,268 | 1,521 | 2,018 | 1,863 | 1,533 | 995   | 461  | Nov. 14       | 10,822 | 2.54                  |
| 1931                 | Mar. 30         | 15    | 978   | 1,259 | 1,797 | 1,916 | 1,727 | 1,761 | 1,265 | 441  | Nov. 14       | 11,159 | 2.59                  |
| 1932                 | Mar. 30         | 35    | 1,125 | 1,442 | 1,623 | 1,965 | 1,745 | 1,383 | 1,107 | 0    | Oct. 29       | 10,425 | 2.47                  |
| 1933                 | Mar. 20         | 293   | 1,023 | 1,311 | 1,941 | 1,888 | 1,677 | 1,614 | 1,172 | 125  | Nov. 7        | 11,044 | 2.57                  |
| 1934                 | Mar. 30         | 23    | 1,116 | 1,693 | 1,869 | 2,217 | 2,024 | 1,401 | 1,367 | 575  | Nov. 19       | 12,285 | 2.76                  |
| 1935c/               | Mar. 9          | 765   | 939   | 1,082 | 1,440 | 2,049 | 1,838 | 1,485 | 989   | 110  | Nov. 8        | 10,697 | 2.52                  |
| 1936                 | Mar. 27         | 94    | 1,023 | 1,497 | 1,824 | 2,164 | 2,117 | 1,497 | 989   | 79   | Nov. 7        | 11,284 | 2.62                  |
| 1937                 | Mar. 25         | 50    | 966   | 1,463 | 1,656 | 1,993 | 2,049 | 1,635 | 1,159 | 346  | Nov. 10       | 11,317 | 2.62                  |
| 1938                 | Mar. 7          | 777   | 1,035 | 1,243 | 1,608 | 1,953 | 1,956 | 1,632 | 1,534 | 231  | Nov. 9        | 11,969 | 2.71                  |
| 1939                 | Mar. 18         | 424   | 1,014 | 1,562 | 1,674 | 2,043 | 1,776 | 1,716 | 1,299 | 362  | Nov. 13       | 11,870 | 2.70                  |
| 1940                 | Mar. 21         | 273   | 933   | 1,395 | 1,666 | 1,978 | 1,720 | 1,518 | 1,420 | 289  | Nov. 10       | 11,194 | 2.60                  |
| 1941                 | Mar. 23         | 189   | 1,062 | 1,462 | 1,554 | 1,891 | 1,869 | 1,494 | 1,085 | 289  | Nov. 14       | 10,915 | 2.55                  |
| 1942                 | Mar. 20         | 263   | 1,140 | 1,324 | 1,527 | 1,891 | 1,730 | 1,326 | 1,194 | 241  | Nov. 10       | 10,636 | 2.51                  |
| 1943                 | Mar. 30         | 49    | 1,107 | 1,162 | 1,563 | 1,826 | 1,956 | 1,428 | 1,144 | 86   | Nov. 3        | 10,321 | 2.46                  |
| 1944                 | Apr. 2          | 0     | 659   | 1,355 | 1,575 | 1,711 | 1,792 | 1,440 | 1,212 | 489  | Nov. 17       | 10,233 | 2.45                  |
| 1945                 | Mar. 9          | 835   | 939   | 1,197 | 1,335 | 1,742 | 1,810 | 1,527 | 1,206 | 339  | Nov. 11       | 10,930 | 2.56                  |
| 1946                 | Feb. 28         | 1,020 | 1,251 | 1,221 | 1,746 | 1,900 | 1,746 | 1,377 | 1,088 | 154  | Nov. 10       | 11,505 | 2.64                  |
| 1947                 | Mar. 28         | 138   | 882   | 1,240 | 1,488 | 1,814 | 2,127 | 1,704 | 1,485 | 219  | Nov. 11       | 11,097 | 2.58                  |

Av.

11,052 2.57

a/ Based on Weather Bureau records at Republic, Kansas

b/ From Lowry and Johnson

c/ Station moved to Belleville, Kansas in 1935

Table 47

Table 4/8 Effective heat and annual consumptive use for the Scandia Unit. 1/

| (Unit - day-degrees) |                 |      |       |       |       |       |       |       |       |      |               |        |              |
|----------------------|-----------------|------|-------|-------|-------|-------|-------|-------|-------|------|---------------|--------|--------------|
| Year                 | Start of Season | Mar. | Apr.  | May   | June  | July  | Aug.  | Sept. | Oct.  | Nov. | End of Season | Total  | Percent Mean |
| 1929                 | Feb. 20         | 772  | 1,044 | 1,147 | 1,482 | 1,752 | 1,795 | 1,326 | 1,038 | 135  | Nov. 8        | 10,566 | 2.50         |
| 1930                 | Mar.            | 130  | 1,107 | 1,246 | 1,512 | 1,922 | 1,823 | 1,497 | 958   | 611  | Nov. 20       | 10,806 | 2.54         |
| 1931                 | Mar. 25         | 37   | 954   | 1,190 | 1,746 | 1,888 | 1,690 | 1,698 | 1,203 | 70   | Nov. 8        | 10,476 | 2.49         |
| 1932                 | Mar. 27         | 137  | 1,053 | 1,398 | 1,593 | 1,848 | 1,739 | 1,392 | 1,032 | 196  | Nov. 7        | 10,388 | 2.47         |
| 1933                 | Mar. 14         | 103  | 954   | 1,274 | 1,896 | 1,854 | 1,696 | 1,578 | 1,153 | 578  | Nov. 23       | 11,386 | 2.63         |
| 1934                 | Mar. 21         | 157  | 1,125 | 1,566 | 1,827 | 2,161 | 1,956 | 1,359 | 1,321 | 680  | Nov. 25       | 12,152 | 2.75         |
| 1935                 | Mar. 1          | 830  | 897   | 1,038 | 1,422 | 2,006 | 1,835 | 1,446 | 973   | 189  | Nov. 13       | 10,636 | 2.51         |
| 1936                 | Mar. 15         | 455  | 978   | 1,410 | 1,737 | 2,124 | 2,086 | 1,509 | 1,014 | 129  | Nov. 9        | 11,442 | 2.63         |
| 1937                 | Mar. 21         | 123  | 936   | 1,404 | 1,593 | 1,722 | 1,996 | 1,533 | 1,094 | 294  | Nov. 10       | 10,895 | 2.55         |
| 1938                 | Mar. 4          | 771  | 966   | 1,194 | 1,533 | 1,903 | 1,906 | 1,590 | 1,479 | 276  | Nov. 11       | 11,618 | 2.66         |
| 1939                 | Mar. 15         | 435  | 957   | 1,510 | 1,623 | 2,024 | 1,755 | 1,677 | 1,274 | 533  | Nov. 20       | 11,788 | 2.69         |
| 1940                 | Mar. 18         | 355  | 900   | 1,327 | 1,617 | 1,956 | 1,646 | 1,464 | 1,380 | 78   | Nov. 10       | 10,723 | 2.52         |
| 1941                 | Mar. 20         | 262  | 990   | 1,442 | 1,542 | 1,841 | 1,804 | 1,446 | 1,017 | 520  | Nov. 25       | 10,864 | 2.55         |
| 1942                 | Mar. 14         | 370  | 1,089 | 1,256 | 1,491 | 1,903 | 1,683 | 1,284 | 1,132 | 389  | Nov. 15       | 10,597 | 2.51         |
| 1943                 | Mar. 27         | 186  | 1,098 | 1,153 | 1,557 | 1,835 | 1,968 | 1,401 | 1,107 | 192  | Nov. 9        | 10,497 | 2.49         |
| 1944                 | Mar. 28         | 43   | 690   | 1,373 | 1,626 | 1,748 | 1,742 | 1,380 | 1,194 | 509  | Nov. 21       | 10,305 | 2.46         |
| 1945                 | Mar. 3          | 886  | 843   | 1,169 | 1,308 | 1,720 | 1,770 | 1,455 | 1,147 | 357  | Nov. 12       | 10,655 | 2.52         |
| 1946                 | Feb. 25         | 983  | 1,164 | 1,159 | 1,671 | 1,844 | 1,674 | 1,341 | 1,088 | 240  | Nov. 14       | 11,245 | 2.61         |
| 1947                 | Mar. 25         | 141  | 879   | 1,141 | 1,425 | 1,755 | 1,987 | 1,629 | 1,442 | 230  | Nov. 13       | 10,629 | 2.51         |
| Av.                  |                 |      |       |       |       |       |       |       |       |      |               | 10,750 | 2.56         |

1/ Based on Weather Bureau temperature records at Scandia, Kansas.

Table 49 Distribution of consumptive use for Franklin — Red Cloud Unit

| (Unit - feet per acre) |      |      |      |      |      |      |      |      |       |      |      |      |       |
|------------------------|------|------|------|------|------|------|------|------|-------|------|------|------|-------|
| Year                   | Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
| 1929                   | 0.02 | 0.05 | 0.12 | 0.20 | 0.25 | 0.34 | 0.47 | 0.44 | 0.29  | 0.15 | 0.07 | 0.05 | 2.45  |
| 1930                   | .02  | .05  | .13  | .20  | .25  | .35  | .48  | .45  | .30   | .15  | .08  | .05  | 2.51  |
| 1931                   | .03  | .05  | .13  | .20  | .26  | .36  | .49  | .46  | .31   | .15  | .08  | .05  | 2.57  |
| 1932                   | .02  | .05  | .13  | .20  | .25  | .35  | .48  | .45  | .30   | .15  | .08  | .05  | 2.51  |
| 1933                   | .03  | .05  | .13  | .21  | .26  | .36  | .49  | .47  | .31   | .16  | .08  | .05  | 2.60  |
| 1934                   | .03  | .06  | .14  | .22  | .27  | .38  | .52  | .50  | .33   | .17  | .08  | .06  | 2.76  |
| 1935                   | .02  | .05  | .13  | .20  | .25  | .35  | .48  | .45  | .30   | .15  | .08  | .05  | 2.51  |
| 1936                   | .03  | .05  | .13  | .21  | .26  | .36  | .49  | .46  | .31   | .15  | .08  | .05  | 2.58  |
| 1937                   | .03  | .05  | .13  | .20  | .25  | .35  | .48  | .45  | .30   | .15  | .08  | .05  | 2.52  |
| 1938                   | .03  | .05  | .13  | .21  | .26  | .37  | .50  | .47  | .32   | .16  | .08  | .05  | 2.63  |
| 1939                   | .03  | .05  | .13  | .21  | .26  | .36  | .49  | .46  | .31   | .15  | .08  | .05  | 2.58  |
| 1940                   | .03  | .05  | .13  | .21  | .26  | .36  | .49  | .46  | .31   | .15  | .08  | .05  | 2.58  |
| 1941                   | .02  | .05  | .12  | .20  | .25  | .35  | .47  | .44  | .30   | .15  | .07  | .05  | 2.47  |
| 1942                   | .02  | .05  | .12  | .20  | .24  | .34  | .46  | .44  | .29   | .15  | .07  | .05  | 2.43  |
| 1943                   | .02  | .05  | .12  | .20  | .25  | .34  | .47  | .44  | .30   | .15  | .07  | .05  | 2.46  |
| 1944                   | .02  | .05  | .12  | .20  | .24  | .34  | .46  | .44  | .29   | .15  | .07  | .05  | 2.43  |
| 1945                   | .02  | .05  | .12  | .20  | .24  | .34  | .46  | .44  | .29   | .15  | .07  | .05  | 2.43  |
| 1946                   | .03  | .05  | .13  | .21  | .26  | .37  | .50  | .47  | .32   | .16  | .08  | .05  | 2.63  |
| 1947                   | .03  | .05  | .13  | .20  | .25  | .35  | .48  | .45  | .30   | .15  | .08  | .05  | 2.52  |
| Av.                    | 0.02 | 0.05 | 0.13 | 0.20 | 0.25 | 0.35 | 0.48 | 0.46 | 0.30  | 0.15 | 0.08 | 0.05 | 2.54  |

Table 49

Table 50. Distribution of consumptive use for the Superior-Courtland and Courtland Unit

(Unit - feet per acre)

| Year | Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total   |
|------|------|------|------|------|------|------|------|------|-------|------|------|------|---------|
| 1929 | 0.02 | 0.05 | 0.12 | 0.20 | 0.25 | 0.35 | 0.47 | 0.44 | 0.30  | 0.15 | 0.07 | 0.05 | 2.47 a/ |
| 1930 | .03  | .05  | .13  | .20  | .25  | .35  | .48  | .46  | .30   | .15  | .08  | .05  | 2.53    |
| 1931 | .03  | .05  | .13  | .20  | .25  | .36  | .48  | .46  | .31   | .15  | .08  | .05  | 2.55    |
| 1932 | .02  | .05  | .12  | .20  | .25  | .35  | .47  | .45  | .30   | .15  | .07  | .05  | 2.48    |
| 1933 | .03  | .05  | .13  | .21  | .26  | .36  | .49  | .47  | .31   | .16  | .08  | .05  | 2.60    |
| 1934 | .03  | .06  | .14  | .22  | .27  | .38  | .52  | .50  | .33   | .17  | .08  | .06  | 2.76    |
| 1935 | .02  | .05  | .13  | .20  | .25  | .35  | .48  | .45  | .30   | .15  | .08  | .05  | 2.51    |
| 1936 | .03  | .05  | .13  | .21  | .26  | .36  | .50  | .47  | .31   | .16  | .08  | .05  | 2.61    |
| 1937 | .03  | .05  | .13  | .20  | .26  | .36  | .48  | .46  | .31   | .15  | .08  | .05  | 2.56    |
| 1938 | .03  | .05  | .13  | .21  | .27  | .38  | .51  | .48  | .32   | .16  | .08  | .05  | 2.67    |
| 1939 | .03  | .05  | .13  | .21  | .27  | .37  | .51  | .48  | .32   | .16  | .08  | .05  | 2.66    |
| 1940 | .03  | .05  | .13  | .20  | .26  | .36  | .49  | .46  | .31   | .15  | .08  | .05  | 2.57    |
| 1941 | .03  | .05  | .13  | .20  | .25  | .35  | .48  | .45  | .30   | .15  | .08  | .05  | 2.52    |
| 1942 | .02  | .05  | .12  | .20  | .25  | .35  | .47  | .45  | .30   | .15  | .07  | .05  | 2.48    |
| 1943 | .02  | .05  | .12  | .20  | .25  | .35  | .47  | .44  | .30   | .15  | .07  | .05  | 2.47    |
| 1944 | .02  | .05  | .12  | .20  | .25  | .34  | .47  | .44  | .29   | .15  | .07  | .05  | 2.45    |
| 1945 | .02  | .05  | .12  | .20  | .25  | .35  | .48  | .45  | .30   | .15  | .08  | .05  | 2.50    |
| 1946 | .03  | .05  | .13  | .21  | .26  | .37  | .50  | .47  | .32   | .16  | .08  | .05  | 2.63    |
| 1947 | .03  | .05  | .13  | .20  | .25  | .36  | .48  | .46  | .30   | .15  | .08  | .05  | 2.54    |
| Av.  | .03  | .05  | .13  | .20  | .26  | .36  | .48  | .46  | .31   | .15  | .08  | .05  | 2.56    |

a/ Mean of consumptive use determined for Red Cloud, Nebraska, and Republic City and Concordia in Kansas.

Table 50



Table 51 . Distribution of consumptive use for the Scandia Unit <sup>1/</sup>

| (Unit - feet per acre) |        |        |        |        |        |        |        |        |         |        |        |        |       |  |  |
|------------------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|--------|--------|--------|-------|--|--|
| Year :                 | Jan. : | Feb. : | Mar. : | Apr. : | May :  | June : | July : | Aug. : | Sept. : | Oct. : | Nov. : | Dec. : | Total |  |  |
| 1929 :                 | 0.02 : | 0.05 : | 0.12 : | 0.20 : | 0.25 : | 0.35 : | 0.47 : | 0.45 : | 0.30 :  | 0.15 : | 0.07 : | 0.05 : | 2.48  |  |  |
| 1930 :                 | .03 :  | .05 :  | .13 :  | .20 :  | .25 :  | .36 :  | .48 :  | .46 :  | .30 :   | .15 :  | .08 :  | .05 :  | 2.54  |  |  |
| 1931 :                 | .03 :  | .05 :  | .13 :  | .20 :  | .25 :  | .36 :  | .48 :  | .46 :  | .30 :   | .15 :  | .08 :  | .05 :  | 2.54  |  |  |
| 1932 :                 | .02 :  | .05 :  | .12 :  | .20 :  | .25 :  | .35 :  | .47 :  | .44 :  | .30 :   | .15 :  | .07 :  | .05 :  | 2.47  |  |  |
| 1933 :                 | .03 :  | .05 :  | .13 :  | .21 :  | .26 :  | .36 :  | .49 :  | .47 :  | .31 :   | .16 :  | .08 :  | .05 :  | 2.60  |  |  |
| 1934 :                 | .03 :  | .06 :  | .14 :  | .22 :  | .27 :  | .38 :  | .52 :  | .50 :  | .33 :   | .17 :  | .08 :  | .06 :  | 2.76  |  |  |
| 1935 :                 | .03 :  | .05 :  | .13 :  | .20 :  | .25 :  | .35 :  | .48 :  | .45 :  | .30 :   | .15 :  | .08 :  | .05 :  | 2.52  |  |  |
| 1936 :                 | .03 :  | .05 :  | .13 :  | .21 :  | .26 :  | .37 :  | .50 :  | .47 :  | .31 :   | .16 :  | .08 :  | .05 :  | 2.62  |  |  |
| 1937 :                 | .03 :  | .05 :  | .13 :  | .21 :  | .26 :  | .36 :  | .49 :  | .46 :  | .31 :   | .15 :  | .08 :  | .05 :  | 2.58  |  |  |
| 1938 :                 | .03 :  | .05 :  | .13 :  | .22 :  | .27 :  | .38 :  | .51 :  | .48 :  | .32 :   | .16 :  | .08 :  | .05 :  | 2.62  |  |  |
| 1939 :                 | .03 :  | .05 :  | .14 :  | .22 :  | .27 :  | .38 :  | .51 :  | .49 :  | .32 :   | .16 :  | .08 :  | .05 :  | 2.70  |  |  |
| 1940 :                 | .03 :  | .05 :  | .13 :  | .20 :  | .26 :  | .36 :  | .48 :  | .46 :  | .31 :   | .15 :  | .08 :  | .05 :  | 2.56  |  |  |
| 1941 :                 | .02 :  | .05 :  | .13 :  | .20 :  | .26 :  | .36 :  | .48 :  | .46 :  | .31 :   | .15 :  | .08 :  | .05 :  | 2.55  |  |  |
| 1942 :                 | .02 :  | .05 :  | .13 :  | .20 :  | .25 :  | .35 :  | .48 :  | .45 :  | .30 :   | .15 :  | .08 :  | .05 :  | 2.51  |  |  |
| 1943 :                 | .02 :  | .05 :  | .12 :  | .20 :  | .25 :  | .35 :  | .47 :  | .45 :  | .30 :   | .15 :  | .07 :  | .05 :  | 2.48  |  |  |
| 1944 :                 | .02 :  | .05 :  | .12 :  | .20 :  | .25 :  | .34 :  | .47 :  | .44 :  | .30 :   | .15 :  | .07 :  | .05 :  | 2.46  |  |  |
| 1945 :                 | .03 :  | .05 :  | .13 :  | .20 :  | .25 :  | .36 :  | .48 :  | .46 :  | .30 :   | .15 :  | .08 :  | .05 :  | 2.54  |  |  |
| 1946 :                 | .03 :  | .05 :  | .13 :  | .21 :  | .26 :  | .37 :  | .50 :  | .47 :  | .31 :   | .16 :  | .08 :  | .05 :  | 2.62  |  |  |
| 1947 :                 | .03 :  | .05 :  | .13 :  | .20 :  | .25 :  | .36 :  | .48 :  | .46 :  | .30 :   | .15 :  | .08 :  | .05 :  | 2.54  |  |  |
| Av.                    | .03    | .05    | .13    | .20    | .26    | .36    | .49    | .46    | .31     | .15    | .08    | .05    | 2.57  |  |  |

<sup>1/</sup> Mean of records at Concordia and Republic City in Kansas

Table 51

Table 52-- Precipitation at Red Cloud, Nebraska -- Inches

| Year  | Jan.  | Feb.  | Mar.  | Apr.  | May   | June  | July  | Aug.  | Sept. | Oct.  | Nov.  | Dec. | Total  |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|--------|
| 1929  | .05   | .81   | .02   | 3.46  | 3.27  | 2.86  | 1.41  | .13   | 2.12  | 3.23  | 1.07  | .06  | 18.49  |
| 1930  | 1.76  | .15   | .23   | 4.01  | 5.01  | 2.82  | .83   | 2.12  | .92   | 2.34  | 1.42  | .37  | 22.28  |
| 1931  | .13   | .52   | 2.43  | 2.38  | 4.20  | 1.94  | 1.54  | 2.73  | 2.30  | 2.03  | 2.57  | .32  | 23.84  |
| 1932  | 1.74  | .98   | .80   | .81   | 1.67  | 2.79  | 1.38  | 1.46  | 1.12  | 1.56  | .23   | .33  | 15.17  |
| 1933  | .14   | .14   | 1.21  | 3.63  | 2.19  | .26   | 2.32  | 3.39  | .55   | T     | .32   | 1.49 | 16.74  |
| 1934  | .31   | 1.66  | .28   | .97   | .38   | 2.94  | .37   | 1.33  | 1.59  | .53   | .74   | .14  | 11.94  |
| 1935  | .04   | .98   | .18   | .61   | 5.91  | 3.42  | 1.00  | 4.40  | 4.49  | 1.82  | 1.41  | .06  | 24.32  |
| 1936  | .34   | .48   | .20   | 1.64  | 3.73  | .97   | .75   | 2.33  | 2.37  | .31   | T     | .36  | 13.98  |
| 1937  | 1.45  | .59   | .94   | .95   | 2.31  | 5.34  | 4.56  | .28   | .97   | 1.31  | .05   | .07  | 16.82  |
| 1938  | .56   | 1.09  | 1.57  | 1.58  | 5.53  | 1.60  | 3.91  | 1.74  | 3.00  | .47   | .34   | .01  | 22.00  |
| 1939  | .49   | 1.32  | 1.23  | 1.65  | 2.45  | 5.94  | .67   | 3.24  | .07   | .42   | .10   | 1.02 | 18.60  |
| 1940  | .35   | 1.07  | 1.58  | 1.33  | 2.65  | 3.29  | 1.42  | 2.14  | 1.09  | 1.02  | 1.82  | 1.07 | 19.43  |
| 1941  | .69   | .34   | .65   | 3.36  | 2.73  | 8.18  | 4.00  | 2.56  | 5.30  | 2.29  | .92   | 1.56 | 33.07  |
| 1942  | .14   | .70   | 1.53  | 3.23  | 2.17  | 6.44  | 2.42  | 2.65  | 7.15  | .39   | .78   | 1.71 | 29.32  |
| 1943  | .11   | .63   | .36   | 2.66  | .22   | 6.35  | 1.55  | 3.02  | .22   | .36   | .14   | .27  | 16.99  |
| 1944  | 1.29  | .73   | 2.62  | 4.60  | 4.05  | 2.98  | 2.67  | 5.34  | .33   | 1.55  | 1.13  | .32  | 28.11  |
| 1945  | .55   | .97   | .94   | 5.42  | 3.97  | 2.66  | 4.36  | 1.25  | 2.47  | .47   | .03   | 2.01 | 25.50  |
| 1946  | .93   | .09   | 1.96  | .09   | 3.33  | 4.46  | 3.94  | 1.99  | 8.16  | 4.02  | 1.94  | .04  | 30.95  |
| 1947  | .91   | .31   | 1.24  | 3.33  | 3.26  | 4.61  | 2.26  | 2.47  | .55   | 0.42  | 1.61  | 1.35 | 22.92  |
| Total | 13.04 | 14.53 | 20.74 | 40.31 | 50.53 | 34.25 | 41.12 | 40.10 | 44.44 | 34.44 | 17.20 | .92  | 416.27 |
| Avg.  | 0.65  | 0.77  | 1.09  | 2.44  | 3.16  | 3.56  | 2.21  | 2.40  | 2.36  | 1.31  | .81   | 0.73 | 21.59  |

Table 53-- Precipitation at Superior, Nebraska -- Inches

| Year :               | Jan. :  | Feb. :  | Mar. :  | Apr. :  | May :   | June :  | July :  | Aug. :  | Sept. : | Oct. :  | Nov. :  | Dec. :  | Total  |
|----------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| 1929 <sup>a/</sup> : | .12 :   | .80 :   | .07 :   | 4.00 :  | 3.44 :  | 2.37 :  | 1.46 :  | 1.57 :  | 2.10 :  | 4.58 :  | 3.05 :  | 0 :     | 23.58  |
| 1930 :               | .49 :   | .30 :   | .38 :   | 3.36 :  | 7.22 :  | 2.51 :  | 1.23 :  | 1.44 :  | 1.55 :  | 1.94 :  | 1.76 :  | .13 :   | 22.21  |
| 1931 :               | .20 :   | 1.40 :  | 1.30 :  | 3.19 :  | 5.04 :  | .61 :   | 2.29 :  | 2.74 :  | 1.48 :  | 1.92 :  | 3.49 :  | .55 :   | 24.41  |
| 1932 :               | 2.13 :  | .47 :   | .25 :   | .47 :   | 1.96 :  | 2.73 :  | 3.30 :  | 2.01 :  | .96 :   | 2.52 :  | .30 :   | .26 :   | 17.36  |
| 1933 :               | .07 :   | .09 :   | 1.90 :  | 2.72 :  | 1.35 :  | .92 :   | 3.11 :  | 4.46 :  | 1.19 :  | 7 :     | .22 :   | 1.53 :  | 17.56  |
| 1934 :               | .25 :   | 1.15 :  | .32 :   | .37 :   | 1.06 :  | 2.33 :  | .29 :   | .64 :   | 2.81 :  | .45 :   | .73 :   | .24 :   | 10.64  |
| 1935 :               | .01 :   | .70 :   | .26 :   | .49 :   | 6.92 :  | 6.21 :  | .26 :   | 3.17 :  | 4.11 :  | 1.52 :  | 1.18 :  | .28 :   | 25.03  |
| 1936 :               | .41 :   | .35 :   | .23 :   | 3.42 :  | 2.06 :  | 2.45 :  | .08 :   | 2.46 :  | 3.27 :  | .42 :   | 0 :     | .47 :   | 15.67  |
| 1937 :               | 1.04 :  | .48 :   | 1.86 :  | 1.14 :  | 2.62 :  | 4.19 :  | 5.33 :  | 1.62 :  | .58 :   | 2.39 :  | .08 :   | .06 :   | 21.41  |
| 1938 :               | .30 :   | 1.42 :  | .90 :   | 2.46 :  | 7.02 :  | 3.97 :  | 5.32 :  | 2.26 :  | 2.38 :  | .13 :   | .30 :   | .06 :   | 27.13  |
| 1939 :               | .54 :   | 1.09 :  | 2.43 :  | 1.15 :  | 2.26 :  | 5.19 :  | 1.27 :  | 4.23 :  | .04 :   | .15 :   | .04 :   | .77 :   | 19.16  |
| 1940 :               | .69 :   | .25 :   | 1.48 :  | 2.46 :  | 3.55 :  | 2.03 :  | .84 :   | 1.99 :  | 1.10 :  | 1.42 :  | 2.64 :  | .99 :   | 20.04  |
| 1941 :               | .71 :   | .54 :   | .90 :   | 3.16 :  | 3.29 :  | 12.81 : | 2.33 :  | .87 :   | 4.84 :  | 2.88 :  | 1.65 :  | 2.36 :  | 35.49  |
| 1942 :               | .28 :   | .99 :   | 1.24 :  | 2.91 :  | 2.13 :  | 9.73 :  | 1.57 :  | 7.40 :  | 6.96 :  | .56 :   | .50 :   | 1.77 :  | 36.04  |
| 1943 :               | .13 :   | 1.05 :  | .57 :   | 3.21 :  | 2.17 :  | 7.02 :  | 2.05 :  | 1.55 :  | .43 :   | .14 :   | .22 :   | .26 :   | 19.00  |
| 1944 :               | 1.66 :  | 1.00 :  | 2.98 :  | 5.97 :  | 3.97 :  | 4.69 :  | 2.69 :  | 7.57 :  | 1.78 :  | .59 :   | 1.80 :  | .45 :   | 35.55  |
| 1945 :               | .43 :   | 1.11 :  | .75 :   | 5.34 :  | 5.35 :  | 2.37 :  | 5.20 :  | 3.61 :  | 2.22 :  | .16 :   | .03 :   | 1.91 :  | 28.39  |
| 1946 :               | .83 :   | .03 :   | 1.31 :  | .16 :   | 2.66 :  | 3.52 :  | 4.57 :  | 2.30 :  | 6.39 :  | 2.23 :  | 4.23 :  | .03 :   | 28.76  |
| 1947 :               | .44 :   | .22 :   | 1.19 :  | 3.10 :  | 2.89 :  | 6.21 :  | 1.16 :  | .70 :   | .54 :   | .39 :   | 1.33 :  | 1.72 :  | 19.99  |
| Total :              | 10.73 : | 14.14 : | 20.12 : | 47.10 : | 50.07 : | 44.41 : | 44.41 : | 42.07 : | 42.07 : | 34.09 : | 25.77 : | 15.77 : | 447.91 |
| Avg. :               | 0.57 :  | 0.74 :  | 1.10 :  | 2.58 :  | 3.47 :  | 4.35 :  | 2.34 :  | 2.78 :  | 2.39 :  | 1.29 :  | 1.24 :  | 0.72 :  | 23.54  |

<sup>a/</sup> Republic, Kansas records.

Table 54 Precipitation at Republic, Kansas <sup>2/</sup> -- Inches

[illegible]

a/ Moved to Belleville in 1935.



Table 56 . Effective precipitation for the Franklin - Red Cloud Unit <sup>1/</sup>

| (Unit - feet) |        |        |        |        |        |        |        |        |         |        |        |        |       |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|--------|--------|--------|-------|
| Year :        | Jan. : | Feb. : | Mar. : | Apr. : | May :  | June : | July : | Aug. : | Sept. : | Oct. : | Nov. : | Dec. : | Total |
| 1928 :        | 0.02 : | 0.14 : | 0.06 : | 0.02 : | 0.21 : | 0.30 : | 0.26 : | 0.27 : | 0.08 :  | 0.32 : | 0.19 : | 0 :    | 1.87  |
| 1929 :        | 0 :    | .07 :  | 0 :    | .25 :  | .24 :  | .21 :  | .11 :  | .01 :  | .16 :   | .24 :  | .08 :  | 0 :    | 1.37  |
| 1930 :        | .14 :  | .04 :  | .02 :  | .28 :  | .32 :  | .21 :  | .07 :  | .16 :  | .07 :   | .18 :  | .11 :  | .03 :  | 1.63  |
| 1931 :        | .01 :  | .04 :  | .19 :  | .18 :  | .29 :  | .14 :  | .13 :  | .21 :  | .18 :   | .16 :  | .20 :  | .07 :  | 1.80  |
| 1932 :        | .13 :  | .08 :  | .07 :  | .07 :  | .13 :  | .21 :  | .11 :  | .11 :  | .09 :   | .14 :  | .02 :  | .03 :  | 1.19  |
| 1933 :        | .01 :  | .01 :  | .14 :  | .26 :  | .17 :  | .02 :  | .18 :  | .27 :  | .04 :   | 0 :    | .03 :  | .12 :  | 1.25  |
| 1934 :        | .02 :  | .13 :  | .02 :  | .08 :  | .05 :  | .22 :  | .03 :  | .10 :  | .13 :   | .04 :  | .06 :  | .04 :  | 0.92  |
| 1935 :        | 0 :    | .08 :  | .01 :  | .05 :  | .33 :  | .25 :  | .08 :  | .30 :  | .30 :   | .14 :  | .11 :  | 0 :    | 1.65  |
| 1936 :        | .03 :  | .04 :  | .02 :  | .13 :  | .26 :  | .08 :  | .06 :  | .18 :  | .18 :   | .02 :  | 0 :    | .07 :  | 1.07  |
| 1937 :        | .11 :  | .05 :  | .07 :  | .08 :  | .18 :  | .24 :  | .30 :  | .02 :  | .08 :   | .10 :  | 0 :    | .01 :  | 1.24  |
| 1938 :        | .05 :  | .09 :  | .12 :  | .12 :  | .33 :  | .13 :  | .27 :  | .13 :  | .22 :   | .04 :  | .07 :  | 0 :    | 1.57  |
| 1939 :        | .04 :  | .10 :  | .10 :  | .13 :  | .19 :  | .33 :  | .05 :  | .24 :  | .01 :   | .03 :  | .01 :  | .08 :  | 1.31  |
| 1940 :        | .07 :  | .08 :  | .12 :  | .10 :  | .20 :  | .24 :  | .10 :  | .16 :  | .09 :   | .08 :  | .14 :  | .08 :  | 1.46  |
| 1941 :        | .05 :  | .07 :  | .05 :  | .24 :  | .20 :  | .34 :  | .28 :  | .19 :  | .32 :   | .18 :  | .07 :  | .12 :  | 2.11  |
| 1942 :        | .01 :  | .06 :  | .12 :  | .24 :  | .17 :  | .34 :  | .19 :  | .20 :  | .34 :   | .03 :  | .06 :  | .13 :  | 1.89  |
| 1943 :        | .01 :  | .07 :  | .05 :  | .20 :  | .07 :  | .34 :  | .12 :  | .22 :  | .02 :   | .03 :  | .01 :  | .02 :  | 1.16  |
| 1944 :        | .10 :  | .06 :  | .20 :  | .30 :  | .28 :  | .22 :  | .20 :  | .33 :  | .03 :   | .12 :  | .09 :  | .03 :  | 1.96  |
| 1945 :        | .04 :  | .08 :  | .07 :  | .33 :  | .28 :  | .20 :  | .31 :  | .10 :  | .19 :   | .04 :  | 0 :    | .15 :  | 1.79  |
| 1946 :        | .07 :  | .01 :  | .15 :  | .01 :  | .24 :  | .30 :  | .27 :  | .15 :  | .34 :   | .28 :  | .15 :  | 0 :    | 1.97  |
| 1947 :        | .07 :  | .02 :  | .10 :  | .27 :  | .24 :  | .30 :  | .18 :  | .19 :  | .04 :   | .03 :  | .13 :  | .11 :  | 1.68  |
| 1929-47       |        |        |        |        |        |        |        |        |         |        |        |        |       |
| Av. :         | 0.05 : | 0.06 : | 0.07 : | 0.17 : | 0.22 : | 0.23 : | 0.16 : | 0.17 : | 0.15 :  | 0.16 : | 0.07 : | 0.06 : | 1.53  |

<sup>1/</sup> Based upon Red Cloud, Nebraska precipitation records.

Table 56



Table 57 Effective precipitation for the Superior-Courtland and Courtland Units. 1/

| (Unit - feet) |      |      |      |      |     |      |      |      |       |      |      |      |       |
|---------------|------|------|------|------|-----|------|------|------|-------|------|------|------|-------|
| Year          | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
| 1929          | .01  | .07  | .01  | .28  | .25 | .18  | .12  | .12  | .16   | .30  | .22  | 0    | 1.72  |
| 1930          | .04  | .02  | .03  | .24  | .34 | .19  | .10  | .11  | .12   | .14  | .14  | .01  | 1.48  |
| 1931          | .02  | .11  | .10  | .17  | .32 | .07  | .18  | .20  | .12   | .15  | .25  | .04  | 1.73  |
| 1932          | .16  | .04  | .02  | .04  | .15 | .20  | .24  | .15  | .08   | .19  | .02  | .02  | 1.31  |
| 1933          | .01  | .02  | .15  | .20  | .11 | .07  | .23  | .30  | .09   | 0    | .02  | .12  | 1.32  |
| 1934          | .02  | .09  | .03  | .03  | .08 | .18  | .02  | .05  | .21   | .04  | .00  | .02  | .83   |
| 1935          | 0    | .06  | .02  | .04  | .34 | .34  | .02  | .23  | .28   | .12  | .09  | .02  | 1.56  |
| 1936          | .03  | .03  | .02  | .25  | .16 | .19  | .01  | .19  | .24   | .03  | 0    | .04  | 1.19  |
| 1937          | .08  | .04  | .14  | .09  | .20 | .29  | .33  | .13  | .05   | .18  | .01  | .01  | 1.55  |
| 1938          | .02  | .11  | .07  | .19  | .34 | .28  | .33  | .18  | .22   | .01  | .02  | 0    | 1.77  |
| 1939          | .04  | .09  | .19  | .09  | .18 | .32  | .10  | .29  | 0     | .01  | 0    | .06  | 1.37  |
| 1940          | .05  | .07  | .12  | .19  | .25 | .16  | .07  | .15  | .09   | .11  | .20  | .08  | 1.54  |
| 1941          | .06  | .04  | .07  | .23  | .18 | .34  | .18  | .08  | .31   | .21  | .13  | .18  | 2.01  |
| 1942          | .02  | .08  | .10  | .22  | .16 | .34  | .12  | .34  | .34   | .04  | .04  | .14  | 1.94  |
| 1943          | .01  | .08  | .05  | .23  | .17 | .34  | .16  | .13  | .03   | .01  | .02  | .02  | 1.25  |
| 1944          | .13  | .08  | .22  | .33  | .28 | .31  | .20  | .34  | .14   | .07  | .14  | .04  | 2.28  |
| 1945          | .03  | .09  | .06  | .13  | .33 | .21  | .32  | .26  | .18   | .01  | 0    | .14  | 1.96  |
| 1946          | .07  | 0    | .14  | .01  | .20 | .25  | .30  | .18  | .34   | .18  | .29  | 0    | 1.96  |
| 1947          | .04  | .02  | .09  | .23  | .21 | .34  | .09  | .06  | .05   | .03  | .10  | .13  | 1.39  |
| Av.           | .04  | .06  | .09  | .18  | .22 | .24  | .17  | .19  | .17   | .10  | .09  | .05  | 1.60  |

1/ Based upon Superior, Nebraska precipitation records.

Table 58. Effective precipitation for the Scandia Unit 1/

| (Unit - feet) |        |        |        |        |        |        |        |        |         |        |        |        |       |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|--------|--------|--------|-------|
| Year :        | Jan. : | Feb. : | Mar. : | Apr. : | May :  | June : | July : | Aug. : | Sept. : | Oct. : | Nov. : | Dec. : | Total |
| 1928 :        | 0.01 : | 0.16 : | 0.04 : | 0.10 : | 0.10 : | 0.31 : | 0.34 : | 0.33 : | 0.07 :  | 0.22 : | 0.19 : | 0 :    | 1.87  |
| 1929 :        | .06 :  | .07 :  | 0 :    | .32 :  | .19 :  | .28 :  | .15 :  | .10 :  | .22 :   | .27 :  | .11 :  | .01 :  | 1.78  |
| 1930 :        | .05 :  | .01 :  | .02 :  | .25 :  | .33 :  | .26 :  | .17 :  | .14 :  | .14 :   | .18 :  | .23 :  | .01 :  | 1.79  |
| 1931 :        | .01 :  | .11 :  | .11 :  | .24 :  | .27 :  | .05 :  | .22 :  | .32 :  | .15 :   | .19 :  | .20 :  | .07 :  | 1.94  |
| 1932 :        | .10 :  | .05 :  | .07 :  | .11 :  | .18 :  | .34 :  | .25 :  | .34 :  | .16 :   | .19 :  | 0 :    | .02 :  | 1.81  |
| 1933 :        | .02 :  | .01 :  | .15 :  | .19 :  | .12 :  | .10 :  | .27 :  | .24 :  | .25 :   | 0 :    | .07 :  | .06 :  | 1.48  |
| 1934 :        | .03 :  | .10 :  | .02 :  | .06 :  | .19 :  | .24 :  | .38 :  | .06 :  | .14 :   | .06 :  | .18 :  | .02 :  | 1.18  |
| 1935 :        | .01 :  | .05 :  | .04 :  | .06 :  | .34 :  | .34 :  | .10 :  | .33 :  | .34 :   | .16 :  | .10 :  | .01 :  | 1.88  |
| 1936 :        | .05 :  | .01 :  | .01 :  | .16 :  | .21 :  | .08 :  | .36 :  | .11 :  | .30 :   | .36 :  | 0 :    | .10 :  | 1.18  |
| 1937 :        | .14 :  | .03 :  | .18 :  | .04 :  | .14 :  | .18 :  | .28 :  | .15 :  | .13 :   | .12 :  | .02 :  | .01 :  | 1.42  |
| 1938 :        | .01 :  | .12 :  | .09 :  | .13 :  | .34 :  | .32 :  | .21 :  | .26 :  | .12 :   | .01 :  | .13 :  | 0 :    | 1.74  |
| 1939 :        | .03 :  | .09 :  | .15 :  | .19 :  | .26 :  | .24 :  | .03 :  | .29 :  | .05 :   | .05 :  | .04 :  | .04 :  | 1.46  |
| 1940 :        | .04 :  | .07 :  | .12 :  | .13 :  | .12 :  | .09 :  | .08 :  | .26 :  | .07 :   | .12 :  | .20 :  | .10 :  | 1.40  |
| 1941 :        | .09 :  | .07 :  | .08 :  | .10 :  | .14 :  | .34 :  | .14 :  | .21 :  | .30 :   | .33 :  | .07 :  | .15 :  | 2.02  |
| 1942 :        | .02 :  | .11 :  | .16 :  | .13 :  | .25 :  | .32 :  | .12 :  | .30 :  | .29 :   | .11 :  | .05 :  | .13 :  | 1.99  |
| 1943 :        | .01 :  | .05 :  | .06 :  | .18 :  | .33 :  | .34 :  | .15 :  | .06 :  | .18 :   | .11 :  | .03 :  | .05 :  | 1.55  |
| 1944 :        | .16 :  | .09 :  | .25 :  | .32 :  | .27 :  | .28 :  | .32 :  | .34 :  | .11 :   | .12 :  | .15 :  | .07 :  | 2.48  |
| 1945 :        | .05 :  | .09 :  | .09 :  | .31 :  | .34 :  | .30 :  | .28 :  | .12 :  | .18 :   | .02 :  | .02 :  | .08 :  | 1.88  |
| 1946 :        | .05 :  | .01 :  | .11 :  | .07 :  | .19 :  | .29 :  | .34 :  | .15 :  | .34 :   | .22 :  | .19 :  | 0 :    | 1.96  |
| 1947 :        | .04 :  | .01 :  | .16 :  | .27 :  | .22 :  | .34 :  | .04 :  | .02 :  | .01 :   | .10 :  | .08 :  | .19 :  | 1.48  |
| 1929-47       |        |        |        |        |        |        |        |        |         |        |        |        |       |
| Av.           | .65    | .06    | .10    | .17    | .23    | .25    | .17    | .20    | .18     | .13    | .10    | .05    | 1.69  |

1/ Based upon the Concordia, Kansas precipitation records.

Table 58

Table 57. Consumptive Use Requirements of Irrigation Water  
Franklin - Red Cloud Unit

| Acre-feet per acre irrigated |         |        |      |      |      |       |      |       |
|------------------------------|---------|--------|------|------|------|-------|------|-------|
| Year                         | Apr. a/ | May a/ | June | July | Aug. | Sept. | Oct. | Total |
| 1929                         | 0       | 0.02   | 0.13 | 0.36 | 0.43 | 0.13  | 0    | 1.07  |
| 1930                         | 0       | 0      | 0    | .35  | .29  | .23   | 0    | 0.87  |
| 1931                         | 0       | 0      | .11  | .36  | .25  | .13   | 0    | 0.88  |
| 1932                         | 0       | .02    | .14  | .37  | .34  | .21   | .01  | 1.09  |
| 1933                         | .02     | .15    | .34  | .31  | .20  | .27   | .16  | 1.45  |
| 1934                         | .16     | .24    | .16  | .49  | .40  | .20   | .13  | 1.78  |
| 1935                         | .23     | 0      | .09  | .40  | .15  | 0     | .01  | 0.88  |
| 1936                         | .15     | .07    | .28  | .43  | .28  | .13   | .13  | 1.47  |
| 1937                         | .14     | .09    | .11  | .18  | .43  | .22   | .05  | 1.22  |
| 1938                         | .13     |        | .20  | .23  | .34  | .10   | .12  | 1.12  |
| 1939                         | .10     | .08    | .03  | .44  | .22  | .30   | .12  | 1.29  |
| 1940                         | .09     | .06    | .12  | .19  | .30  | .22   | .07  | 1.25  |
| 1941                         | 0       | 0      | 0    | .14  | .25  | 0     | 0    | 0.39  |
| 1942                         | 0       | 0      | 0    | .18  | .24  | 0     | .07  | 0.49  |
| 1943                         | 0       | .17    | 0    | .35  | .22  | .28   | .12  | 1.14  |
| 1944                         | 0       | 0      | 0    | .16  | .11  | .26   | .03  | 0.56  |
| 1945                         | 0       | 0      | 0    | .12  | .34  | .10   | .11  | 0.67  |
| 1946                         | .15     | .02    | .07  | .23  | .32  | 0     | 0    | 0.79  |
| 1947                         | 0       | 0      | 0    | .15  | .26  | .26   | .12  | 0.79  |
| Average                      | .06     | .05    | .09  | .30  | .28  | .16   | .07  | 1.01  |

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

Table 60. Consumptive Use Requirements of Irrigation Water  
Superior-Courtland and Courtland Units.

| Acre-feet per acre irrigated |                    |                   |      |      |      |       |      |       |
|------------------------------|--------------------|-------------------|------|------|------|-------|------|-------|
| Year                         | Apr. <sup>a/</sup> | May <sup>a/</sup> | June | July | Aug. | Sept. | Oct. | Total |
| 1929                         | 0                  | 0                 | 0.09 | 0.35 | 0.32 | 0.14  | 0    | 0.90  |
| 1930                         | 0                  | 0                 | 0    | .28  | .35  | .18   | .01  | 0.82  |
| 1931                         | 0                  | 0                 | .21  | .30  | .26  | .19   | 0    | 0.96  |
| 1932                         | 0                  | .07               | .15  | .23  | .30  | .22   | 0    | 0.97  |
| 1933                         | .05                | .18               | .29  | .26  | .17  | .22   | .16  | 1.33  |
| 1934                         | .23                | .23               | .20  | .50  | .45  | .12   | .13  | 1.86  |
| 1935                         | .25                | 0                 | .01  | .46  | .22  | .02   | .03  | 0.99  |
| 1936                         | .04                | .17               | .17  | .49  | .28  | .07   | .13  | 1.35  |
| 1937                         | .13                | .08               | .07  | .15  | .33  | .26   | 0    | 1.02  |
| 1938                         | .07                | 0                 | .07  | .18  | .30  | .10   | .15  | 0.87  |
| 1939                         | .12                | .09               | .05  | .41  | .19  | .32   | .15  | 1.33  |
| 1940                         | .03                | .03               | .20  | .42  | .31  | .22   | .04  | 1.25  |
| 1941                         | 0                  | 0                 | 0    | .24  | .37  | 0     | 0    | 0.61  |
| 1942                         | 0                  | 0                 | 0    | .17  | .11  | 0     | .07  | 0.35  |
| 1943                         | 0                  | .04               | .01  | .31  | .31  | .27   | .14  | 1.08  |
| 1944                         | 0                  | 0                 | 0    | 0    | .08  | .15   | .08  | 0.31  |
| 1945                         | 0                  | 0                 | 0    | .04  | .19  | .12   | .14  | 0.49  |
| 1946                         | .19                | .06               | .12  | .20  | .29  | 0     | 0    | 0.86  |
| 1947                         | 0                  | 0                 | 0    | .28  | .40  | .25   | .12  | 1.05  |
| Average                      | .06                | .05               | .09  | .28  | .27  | .15   | .07  | 0.97  |

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

Table 6/ . Consumptive Use Requirements of Irrigation Water  
Scandia Unit

| Acre-feet per acre irrigated |                |               |      |      |      |       |      |       |
|------------------------------|----------------|---------------|------|------|------|-------|------|-------|
| Year                         | Apr. <u>a/</u> | May <u>a/</u> | June | July | Aug. | Sept. | Oct. | Total |
| 1929                         | 0              | 0             | 0.01 | 0.32 | 0.35 | 0.08  | 0    | 0.76  |
| 1930                         | 0              | 0             | 0    | .29  | .32  | .16   | 0    | .77   |
| 1931                         | 0              | 0             | .09  | .26  | .14  | .15   | 0    | .64   |
| 1932                         | 0              | 0             | 0    | .18  | .10  | .14   | 0    | .42   |
| 1933                         | .07            | .18           | .26  | .22  | .23  | .06   | .16  | 1.18  |
| 1934                         | .20            | .12           | .14  | .44  | .44  | .19   | .11  | 1.64  |
| 1935                         | .17            | 0             | 0    | .32  | .12  | 0     | 0    | 0.61  |
| 1936                         | .11            | .10           | .29  | .44  | .33  | .01   | .10  | 1.38  |
| 1937                         | .06            | .12           | .18  | .21  | .31  | .18   | .03  | 1.09  |
| 1938                         | .14            | 0             | .03  | .30  | .22  | .20   | .15  | 1.04  |
| 1939                         | 0              | 0             | .13  | .48  | .20  | .27   | .11  | 1.19  |
| 1940                         | .09            | .15           | .27  | .40  | .20  | .24   | .03  | 1.38  |
| 1941                         | 0              | .01           | .02  | .34  | .25  | .01   | 0    | 0.63  |
| 1942                         | 0              | 0             | 0    | .10  | .15  | .01   | .04  | 0.30  |
| 1943                         | .03            | 0             | 0    | .26  | .39  | .12   | .04  | 0.84  |
| 1944                         | 0              | 0             | 0    | 0    | 0    | .09   | .03  | 0.12  |
| 1945                         | 0              | 0             | 0    | 0    | .28  | .12   | .13  | 0.53  |
| 1946                         | .18            | .10           | .08  | .16  | .32  | 0     | 0    | 0.84  |
| 1947                         | 0              | 0             | 0    | .27  | .44  | .29   | .05  | 1.05  |
| Average                      | .06            | .04           | .08  | .26  | .25  | .12   | .05  | 0.86  |

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

Table 63. Diversion requirements for the Franklin Canal,  
Franklin pump and Naponee Canal.  
(Unit - acre-feet per acre)

| Year : | Apr. : | May :  | June : | July : | Aug. : | Sept. : | Oct. : | Total |
|--------|--------|--------|--------|--------|--------|---------|--------|-------|
| 1929 : | 0 :    | 0.05 : | 0.31 : | 0.85 : | 1.02 : | 0.31 :  | 0 :    | 2.54  |
| 1930 : | 0 :    | 0 :    | 0 :    | .83 :  | .69 :  | .54 :   | 0 :    | 2.06  |
| 1931 : | 0 :    | 0 :    | .33 :  | .85 :  | .59 :  | .31 :   | 0 :    | 2.08  |
| 1932 : | 0 :    | .05 :  | .33 :  | .88 :  | .90 :  | .50 :   | .02 :  | 2.58  |
| 1933 : | .05 :  | .36 :  | .81 :  | .73 :  | .47 :  | .64 :   | .38 :  | 3.44  |
| 1934 : | .38 :  | .57 :  | .38 :  | 1.16 : | .95 :  | .47 :   | .31 :  | 4.22  |
| 1935 : | .55 :  | 0 :    | .21 :  | .95 :  | .35 :  | 0 :     | .02 :  | 2.08  |
| 1936 : | .35 :  | .17 :  | .66 :  | 1.02 : | .66 :  | .31 :   | .31 :  | 3.48  |
| 1937 : | .33 :  | .21 :  | .26 :  | .43 :  | 1.02 : | .52 :   | .12 :  | 2.89  |
| 1938 : | .31 :  | 0 :    | .47 :  | .54 :  | .81 :  | .24 :   | .28 :  | 2.65  |
| 1939 : | .24 :  | .19 :  | .07 :  | 1.04 : | .52 :  | .71 :   | .29 :  | 3.06  |
| 1940 : | .21 :  | .14 :  | .29 :  | .92 :  | .71 :  | .52 :   | .17 :  | 2.96  |
| 1941 : | 0 :    | 0 :    | 0 :    | .33 :  | .59 :  | 0 :     | 0 :    | 0.92  |
| 1942 : | 0 :    | 0 :    | 0 :    | .43 :  | .57 :  | 0 :     | .16 :  | 1.16  |
| 1943 : | 0 :    | .40 :  | 0 :    | .83 :  | .52 :  | .66 :   | .29 :  | 2.70  |
| 1944 : | 0 :    | 0 :    | 0 :    | .38 :  | .26 :  | .62 :   | .07 :  | 1.33  |
| 1945 : | 0 :    | 0 :    | 0 :    | .28 :  | .81 :  | .24 :   | .26 :  | 1.59  |
| 1946 : | .35 :  | .05 :  | .17 :  | .54 :  | .76 :  | 0 :     | 0 :    | 1.87  |
| 1947 : | 0 :    | 0 :    | 0 :    | .35 :  | .62 :  | .62 :   | .28 :  | 1.87  |
| Av.    | 0.15   | 0.11   | 0.25   | 0.42   | 0.67   | 0.39    | 0.15   | 2.39  |



Table 64. Diversion requirements for the Red Cloud Pump

| (Unit - acre-feet per acre) |        |        |        |        |        |        |       |       |
|-----------------------------|--------|--------|--------|--------|--------|--------|-------|-------|
| Year :                      | Apr. : | May    | June   | July   | Aug.   | Sept.  | Oct.  | Total |
| 1929 :                      | 0 :    | 0.04 : | 0.26 : | 0.74 : | 0.88 : | 0.27 : | 0 :   | 2.19  |
| 1930 :                      | 0 :    | 0 :    | 0 :    | .72 :  | .59 :  | .47 :  | 0 :   | 1.78  |
| 1931 :                      | 0 :    | 0 :    | .29 :  | .74 :  | .51 :  | .26 :  | 0 :   | 1.80  |
| 1932 :                      | 0 :    | .04 :  | .29 :  | .76 :  | .70 :  | .43 :  | .02 : | 2.24  |
| 1933 :                      | .04 :  | .31 :  | .70 :  | .63 :  | .41 :  | .55 :  | .33 : | 2.97  |
| 1934 :                      | .33 :  | .49 :  | .33 :  | 1.00 : | .82 :  | .41 :  | .27 : | 3.65  |
| 1935 :                      | .47 :  | 0 :    | .18 :  | .82 :  | .31 :  | 0 :    | .02 : | 1.80  |
| 1936 :                      | .31 :  | .14 :  | .57 :  | .88 :  | .57 :  | .27 :  | .27 : | 3.01  |
| 1937 :                      | .29 :  | .18 :  | .23 :  | .37 :  | .88 :  | .45 :  | .10 : | 2.50  |
| 1938 :                      | .27 :  | 0 :    | .41 :  | .47 :  | .70 :  | .20 :  | .25 : | 2.30  |
| 1939 :                      | .20 :  | .16 :  | .06 :  | .90 :  | .45 :  | .62 :  | .25 : | 2.64  |
| 1940 :                      | .18 :  | .12 :  | .25 :  | .80 :  | .62 :  | .45 :  | .14 : | 2.56  |
| 1941 :                      | 0 :    | 0 :    | 0 :    | .29 :  | .51 :  | 0 :    | 0 :   | 0.80  |
| 1942 :                      | 0 :    | 0 :    | 0 :    | .37 :  | .49 :  | 0 :    | .14 : | 1.00  |
| 1943 :                      | 0 :    | .35 :  | 0 :    | .72 :  | .45 :  | .57 :  | .25 : | 2.34  |
| 1944 :                      | 0 :    | 0 :    | 0 :    | .33 :  | .23 :  | .53 :  | .06 : | 1.15  |
| 1945 :                      | 0 :    | 0 :    | 0 :    | .25 :  | .70 :  | .20 :  | .22 : | 1.37  |
| 1946 :                      | .31 :  | .04 :  | .14 :  | .47 :  | .66 :  | 0 :    | 0 :   | 1.62  |
| 1947 :                      | 0 :    | 0 :    | 0 :    | .31 :  | .53 :  | .53 :  | .25 : | 1.62  |
| Av.                         | 0.13   | 0.10   | 0.19   | 0.41   | 0.58   | 0.33   | 0.13  | 2.07  |

Table 65. Diversion Requirements for the Superior Canal, Superior-Courtland Unit

| (Unit - acre-feet per acre) |        |       |        |        |        |         |        |       |
|-----------------------------|--------|-------|--------|--------|--------|---------|--------|-------|
| Year :                      | Apr. : | May : | June : | July : | Aug. : | Sept. : | Oct. : | Total |
| 1929 :                      | 0 :    | 0 :   | 0.20 : | 0.78 : | 0.72 : | 0.31 :  | 0 :    | 2.01  |
| 1930 :                      | 0 :    | 0 :   | 0 :    | .63 :  | .78 :  | .40 :   | .02 :  | 1.83  |
| 1931 :                      | 0 :    | 0 :   | .47 :  | .67 :  | .58 :  | .42 :   | 0 :    | 2.14  |
| 1932 :                      | 0 :    | .16 : | .33 :  | .51 :  | .67 :  | .49 :   | 0 :    | 2.16  |
| 1933 :                      | .11 :  | .40 : | .65 :  | .58 :  | .38 :  | .49 :   | .36 :  | 2.97  |
| 1934 :                      | .51 :  | .51 : | .45 :  | 1.12 : | 1.00 : | .27 :   | .29 :  | 4.15  |
| 1935 :                      | .56 :  | 0 :   | .02 :  | 1.03 : | .49 :  | .04 :   | .07 :  | 2.21  |
| 1936 :                      | .09 :  | .38 : | .38 :  | 1.09 : | .62 :  | .16 :   | .29 :  | 3.01  |
| 1937 :                      | .29 :  | .18 : | .15 :  | .33 :  | .74 :  | .58 :   | 0 :    | 2.27  |
| 1938 :                      | .16 :  | 0 :   | .16 :  | .40 :  | .67 :  | .22 :   | .33 :  | 1.94  |
| 1939 :                      | .27 :  | .20 : | .11 :  | .91 :  | .43 :  | .71 :   | .34 :  | 2.97  |
| 1940 :                      | .07 :  | .07 : | .44 :  | .94 :  | .69 :  | .49 :   | .09 :  | 2.79  |
| 1941 :                      | 0 :    | 0 :   | 0 :    | .54 :  | .82 :  | 0 :     | 0 :    | 1.36  |
| 1942 :                      | 0 :    | 0 :   | 0 :    | .38 :  | .24 :  | 0 :     | .16 :  | 0.78  |
| 1943 :                      | 0 :    | .09 : | .02 :  | .69 :  | .69 :  | .60 :   | .32 :  | 2.41  |
| 1944 :                      | 0 :    | 0 :   | 0 :    | 0 :    | .18 :  | .33 :   | .18 :  | 0.69  |
| 1945 :                      | 0 :    | 0 :   | 0 :    | .09 :  | .42 :  | .27 :   | .31 :  | 1.09  |
| 1946 :                      | .42 :  | .13 : | .27 :  | .45 :  | .65 :  | 0 :     | 0 :    | 1.92  |
| 1947 :                      | 0 :    | 0 :   | 0 :    | .62 :  | .89 :  | .56 :   | .27 :  | 2.34  |
| Av.                         | 0.13   | 0.11  | 0.19   | 0.42   | 0.42   | 0.33    | 0.16   | 2.16  |

Table 66. Diversion requirement for the Courtland Canal, Superior-Courtland and Courtland Units.

| (Unit - acre-feet per acre) |        |       |        |        |        |         |        |       |
|-----------------------------|--------|-------|--------|--------|--------|---------|--------|-------|
| Year :                      | Apr. : | May : | June : | July : | Aug. : | Sept. : | Oct. : | Total |
| 1929 :                      | 0      | 0     | 0.17   | 0.68   | 0.62   | 0.27    | 0      | 1.74  |
| 1930 :                      | 0      | 0     | 0      | .54    | .68    | .35     | .02    | 1.59  |
| 1931 :                      | 0      | 0     | .41    | .58    | .50    | .37     | 0      | 1.86  |
| 1932 :                      | 0      | .13   | .29    | .45    | .58    | .43     | 0      | 1.88  |
| 1933 :                      | .10    | .35   | .56    | .50    | .33    | .43     | .31    | 2.58  |
| 1934 :                      | .44    | .45   | .39    | .97    | .87    | .23     | .26    | 3.61  |
| 1935 :                      | .48    | 0     | .02    | .89    | .43    | .04     | .06    | 1.92  |
| 1936 :                      | .08    | .33   | .33    | .95    | .54    | .13     | .26    | 2.62  |
| 1937 :                      | .26    | .15   | .14    | .29    | .64    | .50     | 0      | 1.98  |
| 1938 :                      | .14    | 0     | .14    | .35    | .58    | .19     | .29    | 1.69  |
| 1939 :                      | .23    | .17   | .10    | .80    | .37    | .62     | .29    | 2.58  |
| 1940 :                      | .06    | .06   | .39    | .81    | .60    | .42     | .08    | 2.42  |
| 1941 :                      | 0      | 0     | 0      | .46    | .72    | 0       | 0      | 1.18  |
| 1942 :                      | 0      | 0     | 0      | .33    | .21    | 0       | .14    | 0.68  |
| 1943 :                      | 0      | .08   | .02    | .60    | .60    | .53     | .27    | 2.10  |
| 1944 :                      | 0      | 0     | 0      | 0      | .16    | .29     | .15    | 0.60  |
| 1945 :                      | 0      | 0     | 0      | .08    | .37    | .23     | .27    | 0.95  |
| 1946 :                      | .37    | .12   | .23    | .39    | .56    | 0       | 0      | 1.67  |
| 1947 :                      | 0      | 0     | 0      | .54    | .78    | .49     | .23    | 2.04  |
| Av.                         | 0.11   | 0.10  | 0.17   | 0.54   | 0.53   | 0.29    | 0.14   | 1.88  |

Table 67. Diversion Requirements for the Scandia Unit

(Unit - acre-feet per acre)

| Year : | Apr. : | May : | June : | July : | Aug. : | Sept. : | Oct. : | Total |
|--------|--------|-------|--------|--------|--------|---------|--------|-------|
| 1929 : | 0 :    | 0 :   | 0.02 : | 0.65 : | 0.72 : | 0.16 :  | 0 :    | 1.55  |
| 1930 : | 0 :    | 0 :   | 0 :    | .59 :  | .65 :  | .33 :   | 0 :    | 1.57  |
| 1931 : | 0 :    | 0 :   | .18 :  | .53 :  | .28 :  | .30 :   | 0 :    | 1.29  |
| 1932 : | 0 :    | 0 :   | 0 :    | .37 :  | .20 :  | .29 :   | 0 :    | 0.86  |
| 1933 : | .14 :  | .37 : | .53 :  | .45 :  | .47 :  | .12 :   | 0.33 : | 2.41  |
| 1934 : | .41 :  | .24 : | .28 :  | .90 :  | .90 :  | .39 :   | .22 :  | 3.34  |
| 1935 : | .35 :  | 0 :   | 0 :    | .65 :  | .24 :  | 0 :     | 0 :    | 1.24  |
| 1936 : | .23 :  | .20 : | .59 :  | .90 :  | .67 :  | .02 :   | .20 :  | 2.81  |
| 1937 : | .12 :  | .24 : | .37 :  | .43 :  | .63 :  | .37 :   | .06 :  | 2.22  |
| 1938 : | .28 :  | 0 :   | .06 :  | .61 :  | .45 :  | .41 :   | .31 :  | 2.12  |
| 1939 : | 0 :    | 0 :   | .27 :  | .98 :  | .41 :  | .55 :   | .22 :  | 2.43  |
| 1940 : | .18 :  | .30 : | .55 :  | .82 :  | .41 :  | .49 :   | .06 :  | 2.81  |
| 1941 : | 0 :    | .02 : | .04 :  | .69 :  | .51 :  | .02 :   | 0 :    | 1.28  |
| 1942 : | 0 :    | 0 :   | 0 :    | .20 :  | .31 :  | .02 :   | .08 :  | 0.61  |
| 1943 : | .06 :  | 0 :   | 0 :    | .53 :  | .80 :  | .24 :   | .08 :  | 1.71  |
| 1944 : | 0 :    | 0 :   | 0 :    | 0 :    | 0 :    | .18 :   | .06 :  | 0.24  |
| 1945 : | 0 :    | 0 :   | 0 :    | 0 :    | .57 :  | .24 :   | .27 :  | 1.08  |
| 1946 : | .37 :  | .20 : | .16 :  | .33 :  | .65 :  | 0 :     | 0 :    | 1.71  |
| 1947 : | 0 :    | 0 :   | 0 :    | .55 :  | .90 :  | .59 :   | .10 :  | 2.14  |

|     |      |      |      |      |      |      |      |      |
|-----|------|------|------|------|------|------|------|------|
| Av. | 0.11 | 0.08 | 0.16 | 0.54 | 0.52 | 0.25 | 0.10 | 1.76 |
|-----|------|------|------|------|------|------|------|------|

Table 68. Diversion requirements for Franklin Canal - 14,410 acres

| 1,000 Acre-Feet |      |      |      |       |       |       |      |       |
|-----------------|------|------|------|-------|-------|-------|------|-------|
| Year            | Apr. | May  | June | July  | Aug.  | Sept. | Oct. | Total |
| 1929            | 0    | .7   | 4.5  | 12.2  | 14.7  | 4.4   | 0    | 36.5  |
| 1930            | 0    | 0    | 0    | 11.9  | 9.9   | 7.8   | 0    | 29.6  |
| 1931            | 0    | 0    | 4.7  | 12.2  | 8.5   | 4.5   | 0    | 29.9  |
| 1932            | 0    | .7   | 4.7  | 12.7  | 11.5  | 7.2   | .3   | 37.1  |
| 1933            | 0.7  | 5.2  | 11.7 | 10.5  | 6.8   | 9.2   | 5.4  | 49.5  |
| 1934            | 5.4  | 8.2  | 5.5  | 16.7  | 13.7  | 6.8   | 4.4  | 60.7  |
| 1935            | 7.9  | 0    | 3.0  | 13.7  | 5.0   | 0     | .3   | 29.9  |
| 1936            | 5.0  | 2.4  | 9.5  | 14.7  | 9.5   | 4.4   | 4.5  | 50.0  |
| 1937            | 4.7  | 3.0  | 3.7  | 6.2   | 14.7  | 7.5   | 1.7  | 41.5  |
| 1938            | 4.5  | 0    | 6.8  | 7.8   | 11.6  | 3.4   | 4.0  | 38.1  |
| 1939            | 3.4  | 2.7  | 1.0  | 15.0  | 7.5   | 10.2  | 4.2  | 44.0  |
| 1940            | 3.0  | 2.0  | 4.2  | 13.2  | 10.2  | 7.5   | 2.4  | 42.5  |
| 1941            | 0    | 0    | 0    | 4.7   | 8.5   | 0     | 0    | 13.2  |
| 1942            | 0    | 0    | 0    | 6.2   | 8.2   | 0     | 2.3  | 16.7  |
| 1943            | 0    | 5.7  | 0    | 11.9  | 7.5   | 9.5   | 4.2  | 38.8  |
| 1944            | 0    | 0    | 0    | 5.5   | 3.7   | 8.9   | 1.0  | 19.1  |
| 1945            | 0    | 0    | 0    | 4.0   | 11.7  | 3.5   | 3.7  | 22.9  |
| 1946            | 5.0  | .7   | 2.5  | 7.8   | 10.9  | 0     | 0    | 26.9  |
| 1947            | 0    | 0    | 0    | 5.1   | 8.9   | 8.9   | 4.0  | 26.9  |
| Total           | 39.6 | 31.3 | 61.8 | 192.0 | 183.0 | 103.7 | 42.4 | 653.8 |
| Ave.            | 2.1  | 1.6  | 3.3  | 10.1  | 9.6   | 5.5   | 2.2  | 34.4  |

Table 69. Diversion requirements for Franklin Southside Pump Canal -  
2,070 acres

| 1,000 Acre-Feet |      |     |      |      |      |       |      |       |
|-----------------|------|-----|------|------|------|-------|------|-------|
| Year            | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
| 1929            | 0    | .1  | .7   | 1.8  | 2.1  | .6    | 0    | 5.3   |
| 1930            | 0    | 0   | 0    | 1.7  | 1.4  | 1.1   | 0    | 4.2   |
| 1931            | 0    | 0   | .7   | 1.8  | 1.2  | .6    | 0    | 4.3   |
| 1932            | 0    | .1  | .7   | 1.8  | 1.7  | 1.0   | 0    | 5.3   |
| 1933            | .1   | .7  | 1.7  | 1.5  | 1.0  | 1.3   | .8   | 7.1   |
| 1934            | .8   | 1.2 | .8   | 2.4  | 2.0  | 1.0   | .6   | 8.8   |
| 1935            | 1.1  | 0   | .4   | 2.0  | .7   | 0     | .1   | 4.3   |
| 1936            | .7   | .4  | 1.4  | 2.1  | 1.4  | .6    | .6   | 7.2   |
| 1937            | .7   | .4  | .5   | .9   | 2.1  | 1.1   | .3   | 6.0   |
| 1938            | .6   | 0   | 1.0  | 1.1  | 1.7  | .5    | .6   | 5.5   |
| 1939            | .5   | .4  | .1   | 2.1  | 1.1  | 1.5   | .6   | 6.3   |
| 1940            | .4   | .3  | .6   | 1.9  | 1.5  | 1.1   | .3   | 6.1   |
| 1941            | 0    | 0   | 0    | .7   | 1.2  | 0     | 0    | 1.9   |
| 1942            | 0    | 0   | 0    | .9   | 1.2  | 0     | .3   | 2.4   |
| 1943            | 0    | .8  | 0    | 1.7  | 1.1  | 1.4   | .6   | 5.6   |
| 1944            | 0    | 0   | 0    | .8   | .5   | 1.3   | .2   | 2.8   |
| 1945            | 0    | 0   | 0    | .6   | 1.7  | .5    | .5   | 3.3   |
| 1946            | .7   | .1  | .4   | 1.1  | 1.6  | 0     | 0    | 3.9   |
| 1947            | 0    | 0   | 0    | .7   | 1.3  | 1.3   | .6   | 3.9   |
| Total           | 5.6  | 4.5 | 9.0  | 27.6 | 26.5 | 14.9  | 6.1  | 94.2  |
| Ave.            | .3   | .2  | .5   | 1.5  | 1.4  | .8    | .3   | 5.0   |

Table 70. Diversion requirements for Naponee Canal - 1,490 acres

| 1,000 Acre-Feet |      |     |      |      |      |       |      |       |
|-----------------|------|-----|------|------|------|-------|------|-------|
| Year            | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
| 1929            | 0    | .1  | .5   | 1.3  | 1.5  | .4    | 0    | 3.8   |
| 1930            | 0    | 0   | 0    | 1.2  | 1.0  | .8    | 0    | 3.0   |
| 1931            | 0    | 0   | .5   | 1.2  | .9   | .5    | 0    | 3.1   |
| 1932            | 0    | .1  | .5   | 1.3  | 1.2  | .7    | 0    | 3.8   |
| 1933            | .1   | .5  | 1.2  | 1.1  | .7   | .9    | .6   | 5.1   |
| 1934            | .6   | .8  | .6   | 1.7  | 1.4  | .7    | .5   | 6.3   |
| 1935            | .8   | 0   | .3   | 1.4  | .5   | 0     | .1   | 3.1   |
| 1936            | .5   | .3  | 1.0  | 1.5  | 1.0  | .4    | .5   | 5.2   |
| 1937            | .5   | .3  | .4   | .6   | 1.5  | .8    | .2   | 4.3   |
| 1938            | .5   | 0   | .7   | .8   | 1.2  | .4    | .4   | 4.0   |
| 1939            | .4   | .3  | .1   | 1.5  | .8   | 1.1   | .4   | 4.6   |
| 1940            | .3   | .2  | .4   | 1.4  | 1.1  | .8    | .2   | 4.4   |
| 1941            | 0    | 0   | 0    | .5   | .9   | 0     | 0    | 1.4   |
| 1942            | 0    | 0   | 0    | .6   | .9   | 0     | .2   | 1.7   |
| 1943            | 0    | .6  | 0    | 1.2  | .8   | 1.0   | .4   | 4.0   |
| 1944            | 0    | 0   | 0    | .6   | .4   | .9    | .1   | 2.0   |
| 1945            | 0    | 0   | 0    | .4   | 1.2  | .4    | .4   | 2.4   |
| 1946            | .5   | .1  | .3   | .8   | 1.1  | 0     | 0    | 2.8   |
| 1947            | 0    | 0   | 0    | .5   | .9   | 1.0   | .4   | 2.8   |
| Total           | 4.2  | 3.3 | 6.5  | 19.6 | 19.0 | 10.8  | 4.4  | 67.8  |
| Ave.            | .2   | .2  | .3   | 1.0  | 1.0  | .6    | .3   | 3.6   |



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Table 71. Diversion requirements for Red Cloud Pump - 280 acres

| 1,000 Acre-Feet |      |     |      |      |      |       |      |       |
|-----------------|------|-----|------|------|------|-------|------|-------|
| Year            | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
| 1929            | 0    | 0   | .1   | .2   | .2   | .1    | 0    | .6    |
| 1930            | 0    | 0   | 0    | .2   | .2   | .1    | 0    | .5    |
| 1931            | 0    | 0   | .1   | .2   | .1   | .1    | 0    | .5    |
| 1932            | 0    | 0   | .1   | .2   | .2   | .1    | 0    | .6    |
| 1933            | 0    | .1  | .2   | .2   | .1   | .1    | .1   | .8    |
| 1934            | .1   | .1  | .1   | .3   | .2   | .1    | .1   | 1.0   |
| 1935            | .1   | 0   | .1   | .2   | .1   | 0     | 0    | .5    |
| 1936            | .1   | 0   | .2   | .2   | .1   | .1    | .1   | .8    |
| 1937            | .1   | .1  | .1   | .1   | .2   | .1    | 0    | .7    |
| 1938            | .1   | 0   | .1   | .1   | .2   | .1    | .1   | .7    |
| 1939            | .1   | 0   | 0    | .3   | .1   | .2    | 0    | .7    |
| 1940            | .1   | 0   | .1   | .2   | .2   | .1    | 0    | .7    |
| 1941            | 0    | 0   | 0    | .1   | .1   | 0     | 0    | .2    |
| 1942            | 0    | 0   | 0    | .1   | .1   | 0     | .1   | .3    |
| 1943            | 0    | .1  | 0    | .2   | .1   | .2    | .1   | .7    |
| 1944            | 0    | 0   | 0    | .1   | .1   | .1    | 0    | .3    |
| 1945            | 0    | 0   | 0    | .1   | .2   | 0     | .1   | .4    |
| 1946            | .1   | 0   | .1   | .1   | .2   | 0     | 0    | .5    |
| 1947            | 0    | 0   | 0    | .1   | .1   | .2    | .1   | .5    |
| Total           | 0.8  | 0.4 | 1.3  | 3.2  | 2.8  | 1.7   | 0.8  | 11.0  |
| Ave.            |      | 0   | .1   | .2   | .2   | .1    |      | 0.6   |

Table 72. Diversion requirements for Franklin - Red Cloud Unit,  
18,250, acres

| 1,000 Acre-Feet |      |      |      |       |       |       |      |       |
|-----------------|------|------|------|-------|-------|-------|------|-------|
| Year            | Apr. | May  | June | July  | Aug.  | Sept. | Oct. | Total |
| 1929            | 0    | .9   | 5.8  | 15.5  | 18.5  | 5.5   | 0    | 46.2  |
| 1930            | 0    | 0    | 0    | 15.0  | 12.5  | 9.8   | 0    | 37.3  |
| 1931            | 0    | 0    | 6.0  | 15.4  | 10.7  | 5.7   | 0    | 37.8  |
| 1932            | 0    | .9   | 6.0  | 16.0  | 14.6  | 9.0   | .3   | 46.8  |
| 1933            | .9   | 6.5  | 14.8 | 13.3  | 8.6   | 11.5  | 6.9  | 62.5  |
| 1934            | 6.9  | 10.3 | 7.0  | 21.1  | 17.3  | 8.6   | 5.6  | 76.8  |
| 1935            | 9.9  | 0    | 3.8  | 17.3  | 6.3   | 0     | .5   | 37.8  |
| 1936            | 6.3  | 3.1  | 12.1 | 18.5  | 12.0  | 5.5   | 5.7  | 63.2  |
| 1937            | 6.0  | 3.8  | 4.7  | 7.8   | 18.5  | 9.5   | 2.2  | 52.5  |
| 1938            | 5.7  | 0    | 8.6  | 9.8   | 14.7  | 4.4   | 5.1  | 48.3  |
| 1939            | 4.4  | 3.4  | 1.4  | 18.9  | 9.5   | 13.0  | 5.2  | 55.6  |
| 1940            | 3.8  | 2.5  | 5.3  | 16.7  | 13.0  | 9.5   | 2.9  | 53.7  |
| 1941            | 0    | 0    | 0    | 6.0   | 10.7  | 0     | 0    | 16.7  |
| 1942            | 0    | 0    | 0    | 7.8   | 10.4  | 0     | 2.9  | 21.1  |
| 1943            | 0    | 7.2  | 0    | 15.0  | 9.5   | 12.1  | 5.3  | 49.1  |
| 1944            | 0    | 0    | 0    | 7.0   | 4.7   | 11.2  | 1.3  | 24.2  |
| 1945            | 0    | 0    | 0    | 5.1   | 14.8  | 4.4   | 4.7  | 29.0  |
| 1946            | 6.3  | .9   | 3.3  | 9.8   | 13.8  | 0     | 0    | 34.1  |
| 1947            | 0    | 0    | 0    | 6.4   | 11.2  | 11.4  | 5.1  | 34.1  |
| Total           | 50.2 | 39.5 | 78.6 | 242.4 | 231.3 | 131.1 | 53.7 | 826.8 |
| Ave.            | 2.6  | 2.1  | 4.1  | 12.8  | 12.2  | 6.9   | 2.8  | 43.5  |

Table 73. Diversion Requirements for Superior-Courtland Unit (Superior Canal)  
6,790 Acres

| 1,000 Acres Feet |      |      |      |      |      |       |      |       |
|------------------|------|------|------|------|------|-------|------|-------|
| Year             | Apr. | May  | June | July | Aug. | Sept. | Oct. | Total |
| 1929             | 0    | 0    | 1.4  | 5.3  | 4.9  | 2.1   | 0    | 13.7  |
| 1930             | 0    | 0    | 0    | 4.3  | 5.3  | 2.7   | .2   | 12.5  |
| 1931             | 0    | 0    | 3.2  | 4.6  | 3.9  | 2.9   | 0    | 14.6  |
| 1932             | 0    | 1.1  | 2.2  | 3.5  | 4.6  | 3.3   | 0    | 14.7  |
| 1933             | .8   | 2.7  | 4.4  | 3.9  | 2.6  | 3.3   | 2.5  | 20.2  |
| 1934             | 3.5  | 3.5  | 3.0  | 7.6  | 6.8  | 1.8   | 2.0  | 28.2  |
| 1935             | 3.8  | 0    | .1   | 7.0  | 3.4  | .3    | .5   | 15.1  |
| 1936             | .6   | 2.6  | 2.6  | 7.4  | 4.2  | 1.1   | 2.0  | 20.5  |
| 1937             | 2.0  | 1.2  | 1.0  | 2.3  | 5.0  | 4.0   | 0    | 15.5  |
| 1938             | 1.1  | 0    | 1.1  | 2.7  | 4.6  | 1.5   | 2.2  | 13.2  |
| 1939             | 1.8  | 1.4  | .8   | 6.2  | 2.9  | 4.8   | 2.3  | 20.2  |
| 1940             | .5   | .5   | 3.0  | 6.4  | 4.7  | 3.3   | .6   | 19.0  |
| 1941             | 0    | 0    | 0    | 3.7  | 5.6  | 0     | 0    | 9.3   |
| 1942             | 0    | 0    | 0    | 2.6  | 1.6  | 0     | 1.1  | 5.3   |
| 1943             | 0    | .6   | .1   | 4.7  | 4.7  | 4.1   | 2.2  | 16.4  |
| 1944             | 0    | 0    | 0    | 0    | 1.2  | 2.3   | 1.2  | 4.7   |
| 1945             | 0    | 0    | 0    | .6   | 2.9  | 1.8   | 2.1  | 7.4   |
| 1946             | 2.9  | .9   | 1.8  | 3.1  | 4.4  | 0     | 0    | 13.1  |
| 1947             | 0    | 0    | 0    | 4.2  | 6.1  | 3.8   | 1.8  | 15.9  |
| Total            | 17.0 | 14.5 | 24.7 | 80.1 | 79.4 | 43.1  | 20.7 | 279.5 |
| Ave.             | .9   | .8   | 1.3  | 4.2  | 4.2  | 2.3   | 1.0  | 14.7  |

Table 74. Diversion requirements for Courtland Canal in Nebraska -  
2,960 acres

| 1,000 Acre-Feet |      |     |      |      |      |       |      |       |
|-----------------|------|-----|------|------|------|-------|------|-------|
| Year            | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
| 1929            | 0    | 0   | .5   | 2.0  | 1.9  | .8    | 0    | 5.2   |
| 1930            | 0    | 0   | 0    | 1.6  | 2.0  | 1.0   | .1   | 4.7   |
| 1931            | 0    | 0   | 1.2  | 1.7  | 1.5  | 1.1   | 0    | 5.5   |
| 1932            | 0    | .4  | .9   | 1.3  | 1.7  | 1.3   | 0    | 5.6   |
| 1933            | .3   | 1.0 | 1.7  | 1.5  | 1.0  | 1.3   | .9   | 7.7   |
| 1934            | 1.3  | 1.3 | 1.2  | 2.9  | 2.6  | .7    | .7   | 10.7  |
| 1935            | 1.4  | 0   | .1   | 2.6  | 1.3  | .1    | .2   | 5.7   |
| 1936            | .2   | 1.0 | 1.0  | 2.8  | 1.6  | .4    | .8   | 7.8   |
| 1937            | .8   | .4  | .4   | .9   | 1.9  | 1.5   | 0    | 5.9   |
| 1938            | .4   | 0   | .4   | 1.0  | 1.7  | .6    | .9   | 5.0   |
| 1939            | .7   | .5  | .3   | 2.4  | 1.1  | 1.8   | .9   | 7.7   |
| 1940            | .2   | .2  | 1.2  | 2.4  | 1.8  | 1.2   | .2   | 7.2   |
| 1941            | 0    | 0   | 0    | 1.4  | 2.1  | 0     | 0    | 3.5   |
| 1942            | 0    | 0   | 0    | 1.0  | .6   | 0     | .4   | 2.0   |
| 1943            | 0    | .2  | .1   | 1.8  | 1.8  | 1.6   | .8   | 6.3   |
| 1944            | 0    | 0   | 0    | 0    | .5   | .9    | .4   | 1.8   |
| 1945            | 0    | 0   | 0    | .2   | 1.1  | .7    | .8   | 2.8   |
| 1946            | 1.1  | .4  | .7   | 1.2  | 1.6  | 0     | 0    | 5.0   |
| 1947            | 0    | 0   | 0    | 1.6  | 2.3  | 1.5   | .7   | 6.1   |
| Total           | 6.4  | 5.4 | 9.7  | 30.3 | 30.1 | 16.5  | 7.8  | 106.2 |
| Ave.            | .3   | .3  | .5   | 1.6  | 1.6  | .9    | .4   | 5.6   |

Table 75. Diversion requirements for Courtland Canal in Kansas above Lovewell - 12,500 acres

| 1,000 Acre-Feet |      |     |      |      |      |       |      |       |
|-----------------|------|-----|------|------|------|-------|------|-------|
| Year            | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
| 1929            | 0    | 0   | 2.1  | 8.5  | 7.8  | 3.4   | 0    | 21.8  |
| 1930            | 0    | 0   | 0    | 6.8  | 8.5  | 4.4   | .3   | 20.0  |
| 1931            | 0    | 0   | 5.1  | 7.3  | 6.3  | 4.6   | 0    | 23.3  |
| 1932            | 0    | 1.6 | 3.6  | 5.7  | 7.3  | 5.4   | 0    | 23.6  |
| 1933            | 1.3  | 4.4 | 7.0  | 6.3  | 4.1  | 5.4   | 3.9  | 32.4  |
| 1934            | 5.5  | 5.6 | 4.9  | 12.2 | 10.9 | 2.9   | 3.3  | 45.3  |
| 1935            | 6.0  | 0   | .2   | 11.2 | 5.4  | .5    | .8   | 24.1  |
| 1936            | 1.0  | 4.1 | 4.1  | 11.9 | 6.8  | 1.6   | 3.3  | 32.8  |
| 1937            | 3.3  | 1.9 | 1.7  | 3.6  | 8.0  | 6.3   | 0    | 24.8  |
| 1938            | 1.8  | 0   | 1.7  | 4.4  | 7.3  | 2.4   | 3.6  | 21.2  |
| 1939            | 2.9  | 2.1 | 1.3  | 10.0 | 4.7  | 7.8   | 3.6  | 32.4  |
| 1940            | .8   | .8  | 4.9  | 10.1 | 7.5  | 5.3   | 1.0  | 30.4  |
| 1941            | 0    | 0   | 0    | 5.8  | 9.0  | 0     | 0    | 14.8  |
| 1942            | 0    | 0   | 0    | 4.1  | 2.6  | 0     | 1.3  | 8.5   |
| 1943            | 0    | 1.0 | .3   | 7.5  | 7.5  | 6.7   | 3.4  | 26.4  |
| 1944            | 0    | 0   | 0    | 0    | 2.0  | 3.6   | 1.9  | 7.5   |
| 1945            | 0    | 0   | 0    | 1.0  | 4.6  | 2.9   | 3.4  | 11.9  |
| 1946            | 4.6  | 1.5 | 2.9  | 4.9  | 7.0  | 0     | 0    | 20.9  |
| 1947            | 0    | 0   | 0    | 6.8  | 9.8  | 6.1   | 2.9  | 25.6  |
| Ave.            | 1.4  | 1.2 | 2.1  | 6.8  | 6.7  | 3.6   | 1.8  | 23.6  |

Table 76. Diversion requirements for Courtland below Lovewell -  
36,500 acres

| 1,000 Acre-Feet |      |      |       |       |       |       |      |         |
|-----------------|------|------|-------|-------|-------|-------|------|---------|
| Year            | Apr. | May  | June  | July  | Aug.  | Sept. | Oct. | Total   |
| 1929            | 0    | 0    | 6.2   | 24.8  | 22.6  | 9.9   | 0    | 63.5    |
| 1930            | 0    | 0    | 0     | 19.7  | 24.8  | 12.8  | .7   | 58.0    |
| 1931            | 0    | 0    | 15.0  | 21.2  | 18.2  | 13.5  | 0    | 67.9    |
| 1932            | 0    | 4.7  | 10.6  | 16.4  | 21.2  | 15.7  | 0    | 68.6    |
| 1933            | 3.7  | 12.8 | 20.4  | 18.2  | 12.1  | 15.7  | 11.3 | 94.2    |
| 1934            | 16.1 | 16.4 | 14.2  | 35.4  | 31.8  | 8.4   | 9.5  | 131.8   |
| 1935            | 17.5 | 0    | .7    | 32.4  | 15.7  | 1.5   | 2.2  | 70.0    |
| 1936            | 2.9  | 12.1 | 12.0  | 34.6  | 19.7  | 4.8   | 9.5  | 95.6    |
| 1937            | 9.5  | 5.5  | 5.1   | 10.6  | 23.4  | 18.2  | 0    | 72.3    |
| 1938            | 5.1  | 0    | 5.1   | 12.8  | 21.2  | 6.9   | 10.6 | 61.7    |
| 1939            | 8.4  | 6.2  | 3.7   | 29.2  | 13.5  | 22.6  | 10.6 | 94.2    |
| 1940            | 2.2  | 2.2  | 14.2  | 29.6  | 21.9  | 15.3  | 2.9  | 88.3    |
| 1941            | 0    | 0    | 0     | 16.8  | 26.3  | 0     | 0    | 43.1    |
| 1942            | 0    | 0    | 0     | 12.1  | 7.6   | 0     | 5.1  | 24.8    |
| 1943            | 0    | 2.9  | .7    | 21.9  | 21.9  | 19.4  | 9.8  | 76.6    |
| 1944            | 0    | 0    | 0     | 0     | 5.8   | 10.6  | 5.5  | 21.9    |
| 1945            | 0    | 0    | 0     | 2.9   | 13.5  | 8.4   | 9.9  | 34.7    |
| 1946            | 13.5 | 4.4  | 8.4   | 14.2  | 20.4  | 0     | 0    | 60.9    |
| 1947            | 0    | 0    | 0     | 19.7  | 28.4  | 17.9  | 8.4  | 74.4    |
| Total           | 78.9 | 67.2 | 116.3 | 372.5 | 370.0 | 201.6 | 96.0 | 1,302.5 |
| Ave.            | 4.2  | 3.5  | 6.1   | 19.6  | 19.5  | 10.6  | 5.1  | 68.6    |

Table 77. Diversion requirements for Scandia Unit - 13,000 acres

| Year | 1,000 Acre-Feet |     |      |      |      |       |      | Total |
|------|-----------------|-----|------|------|------|-------|------|-------|
|      | Apr.            | May | June | July | Aug. | Sept. | Oct. |       |
| 1929 | 0               | 0   | .3   | 8.4  | 9.3  | 2.1   | 0    | 20.1  |
| 1930 | 0               | 0   | 0    | 7.7  | 8.4  | 4.3   | 0    | 20.4  |
| 1931 | 0               | 0   | 2.3  | 6.9  | 3.7  | 3.9   | 0    | 16.8  |
| 1932 | 0               | 0   | 0    | 4.8  | 2.6  | 3.8   | 0    | 11.2  |
| 1933 | 1.8             | 4.8 | 6.9  | 5.8  | 6.1  | 1.6   | 4.3  | 31.3  |
| 1934 | 5.3             | 3.1 | 3.6  | 11.7 | 11.7 | 5.1   | 2.9  | 43.4  |
| 1935 | 4.5             | 0   | 0    | 8.5  | 3.1  | 0     | 0    | 16.1  |
| 1936 | 3.0             | 2.6 | 7.7  | 11.7 | 8.7  | .2    | 2.6  | 36.5  |
| 1937 | 1.6             | 3.1 | 4.8  | 5.6  | 8.2  | 4.8   | .8   | 28.9  |
| 1938 | 3.6             | 0   | .8   | 7.9  | 5.9  | 5.3   | 4.0  | 27.5  |
| 1939 | 0               | 0   | 3.5  | 12.8 | 5.3  | 7.1   | 2.9  | 31.6  |
| 1940 | 2.3             | 3.9 | 7.1  | 10.7 | 5.3  | 6.4   | .8   | 36.5  |
| 1941 | 0               | .3  | .5   | 9.0  | 6.6  | .3    | 0    | 16.7  |
| 1942 | 0               | 0   | 0    | 2.6  | 4.0  | .3    | 1.0  | 7.9   |
| 1943 | .8              | 0   | 0    | 6.9  | 10.4 | 3.1   | 1.0  | 22.2  |
| 1944 | 0               | 0   | 0    | 0    | 0    | 2.3   | .8   | 3.1   |
| 1945 | 0               | 0   | 0    | 0    | 7.4  | 3.1   | 3.5  | 14.0  |
| 1946 | 4.8             | 2.6 | 2.1  | 4.3  | 8.4  | 0     | 0    | 22.2  |
| 1947 | 0               | 0   | 0    | 7.1  | 11.7 | 7.7   | 1.3  | 27.8  |
| Ave. | 1.4             | 1.1 | 2.1  | 7.0  | 6.7  | 3.2   | 1.4  | 22.9  |



Table 78. Return flow from Franklin - Red Cloud Unit - 18,215 acres

| 1,000 Acre-Feet |      |      |      |      |      |      |      |      |       |      |      |      |       |
|-----------------|------|------|------|------|------|------|------|------|-------|------|------|------|-------|
| Year            | Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
| 1929            | 1.3  | 1.1  | 1.1  | 1.2  | 1.4  | 1.6  | 1.8  | 2.2  | 2.4   | 2.2  | 1.8  | 1.6  | 19.7  |
| 1930            | 1.4  | 1.2  | 1.2  | 1.0  | 1.1  | 1.3  | 1.5  | 1.8  | 1.9   | 1.8  | 1.5  | 1.3  | 17.0  |
| 1931            | 1.1  | .9   | 1.0  | 1.0  | 1.1  | 1.3  | 1.5  | 1.8  | 2.0   | 1.8  | 1.5  | 1.3  | 16.3  |
| 1932            | 1.1  | 1.0  | 1.0  | 1.2  | 1.4  | 1.6  | 1.8  | 2.3  | 2.5   | 2.3  | 1.8  | 1.6  | 19.6  |
| 1933            | 1.4  | 1.2  | 1.2  | 1.6  | 1.9  | 2.2  | 2.4  | 3.0  | 3.3   | 3.0  | 2.4  | 2.2  | 25.8  |
| 1934            | 1.9  | 1.6  | 1.6  | 2.0  | 2.3  | 2.7  | 3.0  | 3.6  | 4.0   | 3.7  | 3.0  | 2.7  | 32.1  |
| 1935            | 2.3  | 2.0  | 2.0  | 1.0  | 1.1  | 1.3  | 1.5  | 1.8  | 2.0   | 1.8  | 1.5  | 1.3  | 19.6  |
| 1936            | 1.1  | 1.0  | 1.0  | 1.6  | 1.9  | 2.2  | 2.5  | 3.0  | 3.3   | 3.0  | 2.5  | 2.2  | 25.3  |
| 1937            | 1.9  | 1.7  | 1.6  | 1.4  | 1.6  | 1.8  | 2.0  | 2.5  | 2.7   | 2.5  | 2.0  | 1.8  | 23.5  |
| 1938            | 1.6  | 1.4  | 1.4  | 1.2  | 1.5  | 1.7  | 1.9  | 2.3  | 2.5   | 2.3  | 1.9  | 1.7  | 21.4  |
| 1939            | 1.5  | 1.2  | 1.2  | 1.4  | 1.7  | 1.9  | 2.2  | 2.7  | 2.9   | 2.7  | 2.2  | 1.9  | 23.5  |
| 1940            | 1.7  | 1.4  | 1.4  | 1.4  | 1.6  | 1.9  | 2.1  | 2.6  | 2.8   | 2.5  | 2.1  | 1.9  | 23.4  |
| 1941            | 1.6  | 1.4  | 1.4  | .4   | .5   | .6   | .7   | .8   | .8    | .8   | .7   | .6   | 10.3  |
| 1942            | .5   | .4   | .4   | .6   | .6   | .7   | .8   | 1.0  | 1.1   | 1.0  | .8   | .7   | 8.6   |
| 1943            | .6   | .6   | .6   | 1.3  | 1.5  | 1.7  | 1.9  | 2.3  | 2.6   | 2.3  | 1.9  | 1.7  | 19.0  |
| 1944            | 1.5  | 1.3  | 1.3  | .6   | .7   | .8   | 1.0  | 1.2  | 1.3   | 1.2  | 1.0  | .8   | 12.7  |
| 1945            | .7   | .6   | .6   | .8   | .9   | 1.0  | 1.1  | 1.4  | 1.5   | 1.4  | 1.1  | 1.0  | 12.1  |
| 1946            | .9   | .7   | .8   | .9   | 1.0  | 1.2  | 1.3  | 1.6  | 1.8   | 1.7  | 1.3  | 1.2  | 14.4  |
| 1947            | 1.0  | .9   | .9   | .9   | 1.0  | 1.2  | 1.3  | 1.6  | 1.8   | 1.7  | 1.3  | 1.2  | 14.8  |
| Total           | 25.1 | 21.6 | 21.7 | 21.5 | 24.8 | 28.7 | 32.3 | 39.5 | 43.2  | 39.7 | 32.3 | 28.7 | 359.1 |
| Ave.            | 1.3  | 1.1  | 1.1  | 1.1  | 1.3  | 1.5  | 1.7  | 2.1  | 2.3   | 2.1  | 1.7  | 1.5  | 18.8  |

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Table 79. Return flow from Superior Canal - 6,790 acres

1,000 Acre-Feet

| Year  | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|-------|------|------|------|------|-----|------|------|------|-------|------|------|------|-------|
| 1929  | .4   | .4   | .4   | .3   | .4  | .5   | .5   | .6   | .7    | .6   | .5   | .5   | 5.8   |
| 1930  | .4   | .4   | .3   | .3   | .4  | .4   | .5   | .6   | .6    | .6   | .5   | .4   | 5.4   |
| 1931  | .3   | .3   | .3   | .4   | .4  | .5   | .5   | .7   | .7    | .7   | .5   | .5   | 5.8   |
| 1932  | .4   | .4   | .3   | .4   | .4  | .5   | .5   | .7   | .7    | .7   | .5   | .5   | 6.0   |
| 1933  | .4   | .4   | .4   | .5   | .6  | .7   | .7   | .9   | 1.0   | .9   | .7   | .7   | 7.9   |
| 1934  | .6   | .5   | .5   | .7   | .8  | .9   | 1.0  | 1.3  | 1.4   | 1.3  | 1.1  | .9   | 11.0  |
| 1935  | .8   | .7   | .7   | .4   | .4  | .5   | .6   | .7   | .7    | .7   | .6   | .5   | 7.3   |
| 1936  | .4   | .4   | .3   | .5   | .6  | .7   | .8   | .9   | 1.0   | .9   | .8   | .7   | 8.0   |
| 1937  | .6   | .5   | .5   | .4   | .4  | .5   | .6   | .7   | .8    | .7   | .6   | .5   | 6.8   |
| 1938  | .4   | .4   | .4   | .4   | .4  | .4   | .5   | .6   | .7    | .6   | .5   | .4   | 5.7   |
| 1939  | .4   | .4   | .3   | .5   | .6  | .7   | .7   | .9   | 1.0   | .9   | .7   | .7   | 7.8   |
| 1940  | .6   | .5   | .5   | .5   | .5  | .6   | .7   | .9   | .9    | .9   | .7   | .6   | 7.9   |
| 1941  | .5   | .5   | .5   | .2   | .3  | .3   | .3   | .4   | .5    | .4   | .4   | .3   | 4.6   |
| 1942  | .3   | .2   | .2   | .1   | .2  | .2   | .2   | .2   | .3    | .2   | .2   | .2   | 2.5   |
| 1943  | .2   | .1   | .1   | .4   | .5  | .5   | .6   | .8   | .8    | .8   | .6   | .5   | 5.9   |
| 1944  | .5   | .4   | .4   | .1   | .1  | .2   | .2   | .2   | .2    | .2   | .2   | .2   | 2.9   |
| 1945  | .1   | .1   | .1   | .2   | .2  | .2   | .3   | .4   | .4    | .3   | .3   | .2   | 2.8   |
| 1946  | .2   | .2   | .2   | .3   | .4  | .4   | .5   | .6   | .7    | .6   | .5   | .4   | 5.0   |
| 1947  | .4   | .3   | .3   | .4   | .5  | .5   | .6   | .7   | .8    | .7   | .6   | .5   | 6.3   |
| Total | 7.9  | 7.0  | 6.7  | 7.0  | 8.1 | 9.2  | 10.3 | 12.8 | 13.9  | 12.7 | 10.5 | 9.2  | 115.4 |
| Ave.  | .4   | .4   | .4   | .4   | .4  | .5   | .5   | .7   | .7    | .7   | .5   | .5   | 6.1   |

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Table 79

Table 80. Return flow from Courtland Canal in Nebraska - 2,960 acres

| 1,000 Acre-Feet |      |      |      |      |     |      |      |      |       |      |      |      |       |
|-----------------|------|------|------|------|-----|------|------|------|-------|------|------|------|-------|
| Year            | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
| 1929            | .3   | .1   | .1   | .1   | .1  | .2   | .2   | .2   | .2    | .2   | .2   | .2   | 1.9   |
| 1930            | .1   | .1   | .1   | .1   | .1  | .1   | .2   | .2   | .2    | .2   | .2   | .1   | 1.7   |
| 1931            | .1   | .1   | .1   | .1   | .1  | .2   | .2   | .2   | .3    | .2   | .2   | .2   | 2.0   |
| 1932            | .1   | .1   | .1   | .1   | .1  | .2   | .2   | .2   | .3    | .2   | .2   | .2   | 2.0   |
| 1933            | .1   | .1   | .1   | .2   | .2  | .2   | .2   | .3   | .3    | .3   | .3   | .2   | 2.5   |
| 1934            | .2   | .2   | .2   | .2   | .3  | .3   | .4   | .4   | .5    | .4   | .4   | .3   | 3.8   |
| 1935            | .3   | .2   | .2   | .1   | .2  | .2   | .2   | .2   | .3    | .2   | .2   | .2   | 2.5   |
| 1936            | .1   | .1   | .1   | .2   | .2  | .2   | .3   | .3   | .3    | .3   | .2   | .2   | 2.5   |
| 1937            | .2   | .2   | .2   | .1   | .2  | .2   | .2   | .2   | .3    | .2   | .2   | .2   | 2.4   |
| 1938            | .1   | .1   | .1   | .1   | .1  | .2   | .2   | .2   | .2    | .2   | .2   | .1   | 1.8   |
| 1939            | .1   | .1   | .1   | .2   | .2  | .2   | .3   | .3   | .3    | .3   | .2   | .2   | 2.5   |
| 1940            | .2   | .2   | .2   | .2   | .2  | .2   | .2   | .3   | .3    | .3   | .2   | .2   | 2.7   |
| 1941            | .2   | .2   | .1   | .1   | .1  | .1   | .1   | .1   | .2    | .1   | .1   | .1   | 1.5   |
| 1942            | .1   | .1   | .1   | .1   | .1  | .1   | .1   | .1   | .1    | .1   | .1   | .1   | 1.2   |
| 1943            | .1   | .1   | 0    | .1   | .2  | .2   | .2   | .2   | .3    | .3   | .2   | .2   | 2.1   |
| 1944            | .2   | .1   | .1   | 0    | 0   | .1   | .1   | .1   | .1    | .1   | .1   | .1   | 1.1   |
| 1945            | 0    | 0    | 0    | 0    | .1  | .1   | .1   | .1   | .1    | .1   | .1   | .1   | .8    |
| 1946            | .1   | .1   | 0    | .1   | .1  | .1   | .2   | .2   | .2    | .2   | .2   | .2   | 1.7   |
| 1947            | .1   | .1   | .1   | .1   | .1  | .2   | .2   | .2   | .3    | .3   | .2   | .2   | 2.1   |
| Total           | 2.5  | 2.3  | 2.0  | 2.2  | 2.7 | 3.3  | 3.8  | 4.0  | 4.8   | 4.2  | 3.7  | 3.3  | 38.8  |

Table 8/. Return flow from Courtland Canal above Scandia Diversion - 23,000 acres

| 1,000 Acre-Feet |      |      |      |      |      |      |      |      |       |      |      |      |       |
|-----------------|------|------|------|------|------|------|------|------|-------|------|------|------|-------|
| Year.           | Jan. | Feb. | Mar. | Apr. | May  | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
| 1929            | 1.1  | 0.9  | 1.0  | 0.9  | 1.0  | 1.2  | 1.3  | 1.6  | 1.7   | 1.6  | 1.3  | 1.2  | 14.8  |
| 1930            | 1.0  | 0.9  | 0.9  | 0.8  | 0.9  | 1.1  | 1.2  | 1.5  | 1.6   | 1.5  | 1.2  | 1.1  | 13.7  |
| 1931            | 0.9  | 0.7  | 0.8  | 0.9  | 1.1  | 1.3  | 1.4  | 1.7  | 1.9   | 1.7  | 1.4  | 1.3  | 15.1  |
| 1932            | 1.1  | 0.9  | 0.9  | 0.9  | 1.1  | 1.3  | 1.4  | 1.7  | 2.0   | 1.7  | 1.4  | 1.3  | 15.7  |
| 1933            | 1.1  | 0.9  | 0.9  | 1.3  | 1.5  | 1.7  | 2.0  | 2.4  | 2.6   | 2.4  | 1.9  | 1.7  | 20.4  |
| 1934            | 1.5  | 1.3  | 1.3  | 1.8  | 2.1  | 2.4  | 2.7  | 3.3  | 3.6   | 3.3  | 2.7  | 2.4  | 28.4  |
| 1935            | 2.1  | 1.9  | 1.9  | 1.0  | 1.1  | 1.3  | 1.4  | 1.8  | 1.9   | 1.8  | 1.4  | 1.3  | 18.9  |
| 1936            | 1.1  | 0.9  | 1.0  | 1.3  | 1.5  | 1.8  | 2.0  | 2.4  | 2.6   | 2.4  | 2.0  | 1.8  | 20.8  |
| 1937            | 1.5  | 1.3  | 1.3  | 1.0  | 1.2  | 1.3  | 1.5  | 1.8  | 2.0   | 1.8  | 1.5  | 1.3  | 17.5  |
| 1938            | 1.2  | 0.9  | 1.0  | 0.9  | 1.0  | 1.1  | 1.3  | 1.5  | 1.7   | 1.5  | 1.3  | 1.1  | 14.5  |
| 1939            | 1.0  | 0.8  | 0.9  | 1.3  | 1.5  | 1.7  | 2.0  | 2.4  | 2.6   | 2.4  | 1.9  | 1.7  | 20.2  |
| 1940            | 1.5  | 1.3  | 1.3  | 1.3  | 1.4  | 1.6  | 1.8  | 2.2  | 2.4   | 2.2  | 2.8  | 1.6  | 20.4  |
| 1941            | 1.4  | 1.3  | 1.3  | 0.6  | 0.7  | 0.8  | 0.9  | 1.1  | 1.2   | 1.1  | 0.9  | 0.8  | 12.1  |
| 1942            | 0.7  | 0.5  | 0.6  | 0.3  | 0.4  | 0.5  | 0.5  | 0.6  | 0.7   | 0.6  | 0.6  | 0.5  | 6.5   |
| 1943            | 0.4  | 0.3  | 0.3  | 1.0  | 1.2  | 1.4  | 1.6  | 1.9  | 2.1   | 1.9  | 1.6  | 1.4  | 15.1  |
| 1944            | 1.2  | 1.1  | 1.1  | 0.3  | 0.3  | 0.4  | 0.5  | 0.5  | 0.6   | 0.5  | 0.5  | 0.4  | 7.4   |
| 1945            | 0.4  | 0.3  | 0.3  | 0.5  | 0.6  | 0.6  | 0.7  | 0.9  | 0.9   | 0.9  | 0.7  | 0.6  | 7.4   |
| 1946            | 0.6  | 0.4  | 0.5  | 0.8  | 1.0  | 1.1  | 1.3  | 1.5  | 1.7   | 1.5  | 1.3  | 1.1  | 12.8  |
| 1947            | 1.0  | 0.8  | 0.8  | 1.0  | 1.2  | 1.4  | 1.5  | 1.9  | 2.0   | 1.9  | 1.5  | 1.4  | 16.4  |
| 1948            | 1.2  | 1.0  | 1.0  |      |      |      |      |      |       |      |      |      |       |
| Total           | 20.9 | 17.5 | 18.1 | 17.9 | 20.8 | 24.0 | 27.0 | 32.7 | 35.8  | 32.7 | 26.9 | 24.0 | 298.1 |

Table 82. Return flow from Courtland Canal entering river below Scandia Diversion <sup>1/</sup>

| Year    | (100 acre-feet) |      |      |      |     |      |      |      |       |      |      |      | Total |
|---------|-----------------|------|------|------|-----|------|------|------|-------|------|------|------|-------|
|         | Jan.            | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |       |
| 1929    | 1.2             | 1.1  | 1.1  | 1.0  | 1.2 | 1.3  | 1.5  | 1.8  | 2.0   | 1.9  | 1.5  | 1.3  | 16.9  |
| 1930    | 1.2             | 1.0  | 1.0  | 0.9  | 1.1 | 1.2  | 1.4  | 1.7  | 1.8   | 1.7  | 1.4  | 1.2  | 15.6  |
| 1931    | 1.0             | 0.9  | 0.9  | 1.1  | 1.2 | 1.4  | 1.6  | 2.0  | 2.1   | 2.0  | 1.6  | 1.4  | 17.2  |
| 1932    | 1.2             | 1.1  | 1.1  | 1.1  | 1.3 | 1.4  | 1.6  | 2.0  | 2.1   | 2.0  | 1.6  | 1.4  | 17.9  |
| 1933    | 1.3             | 1.1  | 1.1  | 1.5  | 1.7 | 2.0  | 2.2  | 2.7  | 3.0   | 2.7  | 2.2  | 2.0  | 23.5  |
| 1934    | 1.7             | 1.5  | 1.5  | 2.1  | 2.4 | 2.8  | 3.1  | 3.8  | 4.1   | 3.8  | 3.1  | 2.7  | 32.6  |
| 1935    | 2.4             | 2.1  | 2.1  | 1.1  | 1.3 | 1.5  | 1.6  | 2.0  | 2.2   | 2.0  | 1.6  | 1.5  | 21.4  |
| 1936    | 1.3             | 1.1  | 1.1  | 1.5  | 1.8 | 2.0  | 2.3  | 2.8  | 3.0   | 2.8  | 2.2  | 2.0  | 23.9  |
| 1937    | 1.7             | 1.5  | 1.5  | 1.1  | 1.3 | 1.5  | 1.7  | 2.1  | 2.3   | 2.1  | 1.7  | 1.5  | 20.0  |
| 1938    | 1.3             | 1.2  | 1.2  | 1.0  | 1.1 | 1.3  | 1.5  | 1.8  | 1.9   | 1.8  | 1.4  | 1.3  | 16.8  |
| 1939    | 1.1             | 1.0  | 1.0  | 1.5  | 1.7 | 2.0  | 2.2  | 2.7  | 3.0   | 2.7  | 2.2  | 2.0  | 23.1  |
| 1940    | 1.7             | 1.5  | 1.5  | 1.4  | 1.6 | 1.9  | 2.1  | 2.5  | 2.8   | 2.6  | 2.1  | 1.8  | 23.5  |
| 1941    | 1.6             | 1.4  | 1.4  | 0.7  | 0.8 | 0.9  | 1.0  | 1.2  | 1.4   | 1.2  | 1.0  | 0.9  | 13.5  |
| 1942    | .8              | .7   | .7   | .4   | .4  | .5   | .6   | .7   | .8    | .7   | .6   | .5   | 7.4   |
| 1943    | .5              | .4   | .4   | 1.2  | 1.4 | 1.6  | 1.8  | 2.2  | 2.5   | 2.3  | 1.8  | 1.6  | 17.7  |
| 1944    | 1.4             | 1.2  | 1.2  | .3   | .4  | .5   | .5   | .6   | .7    | .6   | .6   | .5   | 8.5   |
| 1945    | .4              | .4   | .3   | .5   | .7  | .7   | .8   | 1.0  | 1.1   | 1.0  | .8   | .8   | 8.5   |
| 1946    | 0.6             | 0.6  | 0.5  | 0.9  | 1.1 | 1.3  | 1.4  | 1.8  | 1.9   | 1.8  | 1.4  | 1.3  | 14.6  |
| 1947    | 1.1             | 1.0  | 1.0  | 1.2  | 1.4 | 1.6  | 1.7  | 2.1  | 2.3   | 2.1  | 1.7  | 1.6  | 18.8  |
| Average | 1.2             | 1.1  | 1.1  | 1.1  | 1.3 | 1.4  | 1.6  | 2.0  | 2.2   | 2.0  | 1.6  | 1.4  | 18.0  |

<sup>1/</sup> Return flow from an estimated 25,000 acres.

Table 82

Table 83 Return flow from 13,000 acres under the Scandia Canal

| (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  | 0.4  | 0.5 | 0.6  | 0.7  | 0.8  | 0.9   | 0.8  | 0.7  | 0.6  | 7.6   |
| 1930                    | 0.5  | 0.5  | 0.5  | 0.5  | 0.5 | 0.6  | 0.7  | 0.8  | 0.9   | 0.8  | 0.7  | 0.6  | 7.6   |
| 1931                    | 0.5  | 0.5  | 0.5  | 0.4  | 0.4 | 0.5  | 0.6  | 0.7  | 0.7   | 0.7  | 0.6  | 0.5  | 6.6   |
| 1932                    | 0.4  | 0.4  | 0.4  | 0.3  | 0.3 | 0.3  | 0.4  | 0.5  | 0.5   | 0.5  | 0.4  | 0.3  | 4.7   |
| 1933                    | 0.3  | 0.2  | 0.2  | 0.7  | 0.8 | 0.9  | 1.1  | 1.3  | 1.4   | 1.3  | 1.1  | 0.9  | 10.2  |
| 1934                    | 0.8  | 0.7  | 0.7  | 1.0  | 1.1 | 1.3  | 1.5  | 1.8  | 1.9   | 1.8  | 1.4  | 1.3  | 15.3  |
| 1935                    | 1.1  | 1.0  | 1.0  | 0.4  | 0.4 | 0.5  | 0.5  | 0.7  | 0.7   | 0.6  | 0.5  | 0.5  | 7.9   |
| 1936                    | 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  |
| 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                    | 0.7  | 0.6  | 0.6  | 0.6  | 0.7 | 0.8  | 0.9  | 1.1  | 1.3   | 1.2  | 1.0  | 0.8  | 10.3  |
| 1939                    | 0.7  | 0.6  | 0.6  | 0.7  | 0.8 | 0.9  | 1.1  | 1.3  | 1.4   | 1.3  | 1.1  | 1.0  | 11.5  |
| 1940                    | 0.8  | 0.7  | 0.7  | 0.8  | 1.0 | 1.1  | 1.2  | 1.5  | 1.6   | 1.5  | 1.2  | 1.1  | 13.2  |
| 1941                    | 1.0  | 0.8  | 0.8  | 0.4  | 0.4 | 0.5  | 0.6  | 0.7  | 0.7   | 0.7  | 0.6  | 0.5  | 7.7   |
| 1942                    | 0.4  | 0.4  | 0.4  | 0.2  | 0.2 | 0.2  | 0.3  | 0.3  | 0.3   | 0.3  | 0.3  | 0.2  | 3.5   |
| 1943                    | 0.2  | 0.2  | 0.2  | 0.5  | 0.6 | 0.7  | 0.7  | 0.9  | 1.0   | 0.9  | 0.7  | 0.7  | 7.3   |
| 1944                    | 0.6  | 0.5  | 0.5  | 0.1  | 0.1 | 0.1  | 0.1  | 0.1  | 0.1   | 0.1  | 0.1  | 0.1  | 2.5   |
| 1945                    | 0.1  | 0.1  | 0.1  | 0.3  | 0.4 | 0.4  | 0.5  | 0.6  | 0.6   | 0.6  | 0.5  | 0.4  | 4.6   |
| 1946                    | 0.3  | 0.3  | 0.3  | 0.5  | 0.6 | 0.7  | 0.7  | 0.9  | 1.0   | 0.9  | 0.7  | 0.7  | 7.6   |
| 1947                    | 0.6  | 0.5  | 0.5  | 0.6  | 0.7 | 0.8  | 0.9  | 1.2  | 1.3   | 1.2  | 0.9  | 0.9  | 10.1  |
| Av.                     | 0.6  | 0.5  | 0.5  | 0.5  | 0.6 | 0.7  | 0.8  | 0.9  | 1.0   | 0.9  | 0.8  | 0.7  | 8.5   |

Table 85. Free water surface evaporation rates, from Hays, Kansas  
evaporation pan records

(Unit - Inches)

| Year    | Apr. | May   | June    | July  | Aug.  | Sept. | Oct. | Total |
|---------|------|-------|---------|-------|-------|-------|------|-------|
| 1929 a/ | 5.25 | 5.00  | 7.49    | 8.78  | 7.97  | 6.62  | -    | 41.11 |
| 1930    | 5.40 | 6.30  | 8.17    | 10.33 | 9.21  | 6.00  | -    | 45.41 |
| 1931    | 4.43 | 6.18  | 8.95    | 9.65  | 8.99  | 10.94 | -    | 49.14 |
| 1932    | 5.46 | 6.69  | 6.29    | 10.38 | 8.94  | 5.78  | -    | 43.54 |
| 1933    | 6.44 | 6.57  | 12.10   | 11.70 | 8.36  | 7.90  | -    | 53.07 |
| 1934    | 6.59 | 10.10 | 11.89   | 15.34 | 12.27 | 6.19  | -    | 62.38 |
| 1935    | 6.85 | 5.17  | 6.49    | 12.36 | 10.64 | 7.08  | -    | 48.59 |
| 1936    | 6.87 | 6.39  | 9.50    | 13.76 | 11.36 | 7.55  | -    | 55.43 |
| 1937    | 6.42 | 7.91  | 9.79 b/ | 11.19 | 12.18 | 8.06  | 5.04 | 60.59 |
| 1938    | 6.13 | 5.16  | 7.70    | 12.05 | 13.22 | 7.96  | 7.96 | 60.18 |
| 1939    | 6.27 | 10.01 | 11.52   | 14.40 | 10.07 | 11.72 | 6.93 | 70.92 |
| 1940    | 5.91 | 7.87  | 9.71    | 11.82 | 7.22  | 6.46  | 5.21 | 54.20 |
| 1941    | 4.41 | 6.31  | 7.05    | 9.21  | 8.57  | 7.71  | 3.11 | 46.37 |
| 1942    | 4.68 | 7.15  | 6.31    | 10.73 | 8.49  | 5.37  | 4.06 | 46.79 |
| 1943    | 7.12 | 6.23  | 10.75   | 11.04 | 11.31 | 6.79  | 4.60 | 57.84 |
| 1944    | 3.33 | 6.09  | 9.00    | 8.44  | 7.60  | 5.88  | 3.66 | 44.00 |
| 1945    | 4.77 | 6.00  | 5.04    | 9.14  | 8.77  | 7.46  | 4.21 | 45.39 |
| 1946    | 6.94 | 5.97  | 11.21   | 11.34 | 8.68  | 6.91  | 3.69 | 54.74 |
| 1947    | 3.33 | 5.52  | 6.47    | 9.69  | 12.19 | 11.06 | 7.11 | 55.37 |
| 1948    | 8.76 | 7.81  | 7.63    | 8.24  | 7.57  | 8.41  | 6.01 | 54.43 |
| Avg.    | 5.77 | 6.72  | 8.65    | 10.98 | 9.68  | 7.59  | 5.13 | 54.52 |

a/ April, 1929 - June 1937 are Bureau of Plant Industry sunken pan readings multiplied by 0.94.

b/ July, 1937 to present are U. S. Weather Bureau pan readings multiplied by 0.70.



Table 26 . Free water surface evaporation rates from Lincoln, Nebraska  
evaporation pan records. <sup>1/</sup>

| (Unit - Inches) |        |        |        |         |        |         |        |       |
|-----------------|--------|--------|--------|---------|--------|---------|--------|-------|
| Year :          | Apr. : | May :  | June : | July :  | Aug. : | Sept. : | Oct. : | Total |
| 1929 :          | 2.52 : | 4.14 : | 5.45 : | 6.29 :  | 5.66 : | 4.61 :  | 2.50 : | 31.17 |
| 1930 :          | 4.20 : | 5.19 : | 7.34 : | 10.03 : | 6.36 : | 5.98 :  | 4.53 : | 43.63 |
| 1931 :          | 4.38 : | 5.18 : | 7.27 : | 7.88 :  | 6.89 : | 7.44 :  | 4.28 : | 43.32 |
| 1932 :          | 4.44 : | 6.31 : | 5.84 : | 8.81 :  | 6.74 : | 5.54 :  | 4.05 : | 41.73 |
| 1933 :          | 4.32 : | 5.28 : | 9.75 : | 6.75 :  | 5.05 : | 5.54 :  | 3.79 : | 40.48 |
| 1934 :          | 6.31 : | 9.93 : | 9.93 : | 12.36 : | 7.76 : | 4.41 :  | 3.99 : | 54.69 |
| 1935 :          | 3.74 : | 2.69 : | 4.86 : | 8.35 :  | 6.87 : | 4.54 :  | 2.25 : | 33.30 |
| 1936 :          | 5.73 : | 5.35 : | 7.52 : | 11.85 : | 9.06 : | 5.36 :  | 3.56 : | 48.43 |
| 1937 :          | 4.01 : | 4.74 : | 6.47 : | 8.32 :  | 8.81 : | 5.94 :  | 3.63 : | 41.92 |
| 1938 :          | 4.27 : | 3.49 : | 5.31 : | 7.55 :  | 7.05 : | 4.07 :  | 4.50 : | 36.24 |
| 1939 :          | 4.44 : | 6.61 : | 6.11 : | 7.50 :  | 6.17 : | 6.90 :  | 3.79 : | 41.52 |
| 1940 :          | 3.11 : | 4.35 : | 5.89 : | 7.99 :  | 4.30 : | 4.07 :  | 3.21 : | 32.92 |
| 1941 :          | 4.00 : | 4.99 : | 4.96 : | 7.65 :  | 7.16 : | 4.63 :  | 2.25 : | 35.64 |
| 1942 :          | 4.24 : | 3.92 : | 4.75 : | 6.57 :  | 5.59 : | 3.01 :  | 2.53 : | 30.61 |
| 1943 :          | 4.77 : | 4.35 : | 5.54 : | 6.26 :  | 5.67 : | 3.85 :  | 2.97 : | 33.41 |
| 1944 :          | 2.24 : | 4.41 : | 5.36 : | 6.29 :  | 5.64 : | 3.76 :  | 2.10 : | 29.80 |
| 1945 :          | 2.80 : | 3.18 : | 3.97 : | 5.08 :  | 5.25 : | 4.63 :  | 2.30 : | 27.21 |
| 1946 :          | 4.31 : | 3.75 : | 7.29 : | 6.79 :  | 4.40 : | 3.18 :  | 1.85 : | 31.57 |
| 1947 :          | 2.22 : | 3.88 : | 4.34 : | 5.98 :  | 7.22 : | 6.45 :  | 3.78 : | 33.67 |
| Avg. :          | 4.00 : | 4.82 : | 6.20 : | 7.80 :  | 6.40 : | 4.94 :  | 3.25 : | 37.41 |

<sup>1/</sup> Weather Bureau pan records multiplied by 0.70.

Table 27 . Gross evaporation rate at Harlan County Reservoir <sup>1/</sup>

(Unit - Inches)

| Year | Jan. | Feb. | Mar. | Apr. | May  | June  | July  | Aug.  | Sept. | Oct. | Nov. | Dec. | Total |
|------|------|------|------|------|------|-------|-------|-------|-------|------|------|------|-------|
| 1929 | 1.00 | 1.20 | 2.20 | 4.78 | 4.75 | 7.04  | 8.25  | 7.34  | 6.09  | 4.70 | 2.65 | 1.20 | 51.20 |
| 1930 | 1.00 | 1.20 | 2.20 | 4.92 | 5.98 | 7.68  | 9.71  | 8.48  | 5.52  | 4.70 | 2.65 | 1.20 | 55.24 |
| 1931 | 1.00 | 1.20 | 2.20 | 4.03 | 5.87 | 8.42  | 9.07  | 8.27  | 10.06 | 4.70 | 2.65 | 1.20 | 58.67 |
| 1932 | 1.00 | 1.20 | 2.20 | 4.97 | 6.36 | 5.92  | 9.76  | 8.22  | 5.32  | 4.70 | 2.65 | 1.20 | 53.50 |
| 1933 | 1.00 | 1.20 | 2.20 | 5.86 | 6.24 | 11.38 | 11.00 | 7.69  | 7.27  | 4.70 | 2.65 | 1.20 | 62.39 |
| 1934 | 1.00 | 1.20 | 2.20 | 6.00 | 9.60 | 11.18 | 11.12 | 11.29 | 5.70  | 4.70 | 2.65 | 1.20 | 71.14 |
| 1935 | 1.00 | 1.20 | 2.20 | 6.24 | 4.91 | 6.10  | 11.62 | 9.79  | 6.52  | 4.70 | 2.65 | 1.20 | 58.13 |
| 1936 | 1.00 | 1.20 | 2.20 | 6.25 | 6.07 | 6.93  | 12.94 | 10.45 | 6.94  | 4.70 | 2.65 | 1.20 | 64.53 |
| 1937 | 1.00 | 1.20 | 2.20 | 5.84 | 7.52 | 9.20  | 10.52 | 11.20 | 7.42  | 4.64 | 2.65 | 1.20 | 64.59 |
| 1938 | 1.00 | 1.20 | 2.20 | 5.58 | 4.90 | 7.24  | 11.33 | 12.17 | 7.32  | 7.32 | 2.65 | 1.20 | 64.11 |
| 1939 | 1.00 | 1.20 | 2.20 | 5.70 | 9.51 | 10.83 | 13.54 | 9.26  | 10.79 | 6.38 | 2.65 | 1.20 | 74.26 |
| 1940 | 1.00 | 1.20 | 2.20 | 5.38 | 7.48 | 9.13  | 11.12 | 6.64  | 5.94  | 4.79 | 2.65 | 1.20 | 58.73 |
| 1941 | 1.00 | 1.20 | 2.20 | 4.01 | 6.00 | 6.63  | 8.66  | 7.88  | 7.10  | 2.86 | 2.65 | 1.20 | 51.39 |
| 1942 | 1.00 | 1.20 | 2.20 | 4.26 | 6.79 | 5.93  | 10.09 | 7.81  | 4.94  | 3.73 | 2.65 | 1.20 | 51.80 |
| 1943 | 1.00 | 1.20 | 2.20 | 6.48 | 5.92 | 10.11 | 10.38 | 10.41 | 6.25  | 4.23 | 2.65 | 1.20 | 62.03 |
| 1944 | 1.00 | 1.20 | 2.20 | 3.03 | 5.78 | 8.46  | 7.94  | 6.99  | 5.41  | 3.37 | 2.65 | 1.20 | 49.23 |
| 1945 | 1.00 | 1.20 | 2.20 | 4.34 | 5.70 | 4.74  | 8.59  | 8.07  | 6.86  | 3.87 | 2.65 | 1.20 | 50.42 |
| 1946 | 1.00 | 1.20 | 2.20 | 6.32 | 5.67 | 10.54 | 10.66 | 7.98  | 6.36  | 3.40 | 2.65 | 1.20 | 59.18 |
| 1947 | 1.00 | 1.20 | 2.20 | 3.03 | 5.24 | 6.08  | 9.11  | 11.21 | 10.18 | 6.54 | 2.65 | 1.20 | 59.64 |
| Avg. | 1.00 | 1.20 | 2.20 | 5.11 | 6.33 | 8.19  | 10.46 | 9.01  | 6.94  | 4.67 | 2.65 | 1.20 | 58.96 |

<sup>1/</sup> (Apr. - Sept.) 1929 through 1936 and (Apr. - Oct.) 1937 through 1947 based on correction factors for Hays, Kansas. Other months estimated from Meyer's maps. (Apr. - 0.91, May - 0.95, June - 0.94, July - 0.94, Aug. - 0.92, Sept. - 0.92, and Oct. - 0.92)

Table 88 . Gross evaporation rate at Lovewell Reservoir 1/

(Unit - inches)

| Year | Jan. | Feb. | Mar. | Apr. | May   | June  | July  | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|------|------|------|------|------|-------|-------|-------|------|-------|------|------|------|-------|
| 1929 | 0.95 | 1.15 | 2.10 | 2.82 | 4.47  | 5.94  | 6.79  | 6.00 | 5.35  | 2.72 | 2.55 | 1.15 | 41.99 |
| 1930 | 0.95 | 1.15 | 2.10 | 4.70 | 5.60  | 8.00  | 10.83 | 6.74 | 6.94  | 4.94 | 2.55 | 1.15 | 55.65 |
| 1931 | 0.95 | 1.15 | 2.10 | 4.90 | 5.59  | 7.92  | 8.51  | 7.30 | 8.63  | 4.66 | 2.55 | 1.15 | 55.41 |
| 1932 | 0.95 | 1.15 | 2.10 | 4.97 | 6.82  | 6.36  | 9.51  | 7.14 | 6.12  | 4.41 | 2.55 | 1.15 | 53.53 |
| 1933 | 0.95 | 1.15 | 2.10 | 4.84 | 5.70  | 10.63 | 7.28  | 5.35 | 6.42  | 4.13 | 2.55 | 1.15 | 52.25 |
| 1934 | 0.95 | 1.15 | 2.10 | 7.07 | 10.72 | 10.82 | 13.35 | 8.22 | 5.12  | 4.35 | 2.55 | 1.15 | 67.55 |
| 1935 | 0.95 | 1.15 | 2.10 | 1.19 | 2.90  | 5.30  | 9.02  | 7.28 | 5.26  | 2.15 | 2.55 | 1.15 | 44.30 |
| 1936 | 0.95 | 1.15 | 2.10 | 6.42 | 5.78  | 8.20  | 12.75 | 9.60 | 6.22  | 3.88 | 2.55 | 1.15 | 60.75 |
| 1937 | 0.95 | 1.15 | 2.10 | 4.49 | 5.12  | 7.05  | 8.98  | 9.34 | 6.89  | 3.96 | 2.55 | 1.15 | 53.73 |
| 1938 | 0.95 | 1.15 | 2.10 | 4.78 | 3.77  | 5.79  | 8.15  | 7.17 | 4.72  | 4.90 | 2.55 | 1.15 | 47.48 |
| 1939 | 0.95 | 1.15 | 2.10 | 4.97 | 7.14  | 6.66  | 8.10  | 6.54 | 8.00  | 4.13 | 2.55 | 1.15 | 53.44 |
| 1940 | 0.95 | 1.15 | 2.10 | 3.48 | 4.70  | 6.12  | 8.62  | 4.56 | 4.72  | 3.50 | 2.55 | 1.15 | 43.90 |
| 1941 | 0.95 | 1.15 | 2.10 | 4.48 | 5.39  | 5.40  | 8.26  | 7.58 | 5.37  | 2.45 | 2.55 | 1.15 | 46.83 |
| 1942 | 0.95 | 1.15 | 2.10 | 4.75 | 4.23  | 5.18  | 7.10  | 5.92 | 3.49  | 2.76 | 2.55 | 1.15 | 41.33 |
| 1943 | 0.95 | 1.15 | 2.10 | 5.34 | 4.70  | 6.04  | 6.76  | 6.01 | 4.46  | 3.24 | 2.55 | 1.15 | 44.45 |
| 1944 | 0.95 | 1.15 | 2.10 | 2.51 | 4.76  | 5.84  | 6.79  | 5.98 | 4.36  | 2.29 | 2.55 | 1.15 | 40.13 |
| 1945 | 0.95 | 1.15 | 2.10 | 3.14 | 3.43  | 4.32  | 5.48  | 5.56 | 5.37  | 2.51 | 2.55 | 1.15 | 37.71 |
| 1946 | 0.95 | 1.15 | 2.10 | 4.83 | 4.05  | 7.94  | 7.33  | 4.66 | 3.69  | 2.02 | 2.55 | 1.15 | 42.42 |
| 1947 | 0.95 | 1.15 | 2.10 | 2.49 | 4.19  | 4.73  | 6.46  | 7.65 | 7.48  | 4.12 | 2.55 | 1.15 | 45.02 |
| Avg. | 0.95 | 1.15 | 2.10 | 4.48 | 5.21  | 6.77  | 8.43  | 6.78 | 5.73  | 3.55 | 2.55 | 1.15 | 48.85 |

1/ Nov. - Mar. estimated from Meyer's maps. Apr. - Sept. based on correction factors for records at Lincoln, Nebr. (Apr. 1.12, May - 1.08, June - 1.09, July - 1.08, Aug. - 1.06, Sept. - 1.09, and Oct. - 1.09)

Table 88

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Table 89-- Precipitation at Orleans, Nebraska -- Inches

| Year              | Jan. | Feb. | Mar. | Apr.  | May   | June  | July  | Aug.  | Sept. | Oct.  | Nov.  | Dec. | Total  |
|-------------------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|------|--------|
| 1929              | 0    | .60  | T    | 3.48  | 1.74  | 1.36  | 3.13  | .80   | 2.05  | 4.71  | 1.65  | 0    | 19.52  |
| 1930              | .60  | .25  | 0    | 5.66  | 4.23  | 4.40  | 2.05  | 5.05  | .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  | .35  | 24.43  |
| 1932              | 1.90 | 1.90 | .60  | 1.81  | 2.70  | 4.10  | 1.55  | 1.43  | 3.41  | .77   | 0     | .40  | 20.57  |
| 1933              | 0    | .40  | 1.50 | 5.65  | 2.98  | .53   | 1.33  | 4.71  | 2.81  | 0     | .90   | 1.45 | 22.56  |
| 1934              | .10  | 1.35 | .65  | 1.10  | 1.07  | 5.13  | 1.31  | 1.43  | 1.38  | .37   | 1.80  | .60  | 18.49  |
| 1935              | .25  | .50  | .50  | 1.13  | 7.29  | 4.52  | .77   | 3.85  | 2.68  | .75   | 1.50  | 0    | 23.74  |
| 1936              | .10  | .45  | .25  | .74   | 6.43  | 1.00  | .92   | .66   | 3.97  | 0     | .05   | .60  | 15.57  |
| 1937              | 1.20 | .79  | 1.92 | .41   | 2.84  | 3.27  | 2.46  | 2.96  | 1.80  | 1.53  | .10   | .05  | 19.04  |
| 1938              | .25  | .55  | 1.27 | 2.91  | 4.78  | 1.61  | 1.59  | 3.59  | 2.44  | 0     | 0     | .10  | 19.09  |
| 1939              | .70  | .95  | 1.12 | 1.99  | 2.93  | 5.39  | .98   | 2.45  | .38   | 0     | 0     | .50  | 17.39  |
| 1940              | 1.00 | .50  | 1.32 | .89   | 4.12  | 1.30  | 4.59  | .89   | 1.71  | 1.63  | 1.10  | .70  | 19.75  |
| 1941              | 1.20 | .70  | .70  | 4.87  | 2.41  | 10.18 | 6.46  | 5.99  | 2.52  | .90   | 1.07  | 1.00 | 38.00  |
| 1942              | .35  | .55  | 1.68 | 3.19  | 1.87  | 6.20  | .43   | 4.39  | 6.27  | .31   | .65   | .90  | 26.99  |
| 1943              | .10  | .60  | .70  | 5.10  | .62   | 5.81  | 2.24  | 1.77  | .71   | .12   | .28   | .10  | 18.15  |
| 1944 <sup>a</sup> | 1.37 | .92  | 1.50 | 7.22  | 1.71  | 2.39  | 6.12  | 2.28  | .48   | 1.09  | 1.36  | .26  | 26.70  |
| 1945 <sup>a</sup> | .64  | .36  | .30  | 4.85  | 2.93  | 4.31  | 1.40  | 1.38  | 1.28  | .34   | 0     | .81  | 16.50  |
| 1946 <sup>a</sup> | .35  | .10  | 1.57 | T     | 5.15  | 2.14  | 3.27  | 5.41  | 4.74  | 5.58  | 1.62  | T    | 29.93  |
| 1947 <sup>a</sup> | .19  | .24  | .42  | 1.98  | 2.70  | 8.30  | 2.30  | 1.25  | .60   | 1.71  | 1.42  | .79  | 21.90  |
|                   |      |      |      |       |       |       |       |       |       |       |       |      |        |
|                   | 1.50 | 1.20 | 1.10 | 56.20 | 60.36 | 73.50 | 45.69 | 59.75 | 41.65 | 27.55 | 17.07 | 9.01 | 430.36 |
|                   | .55  | .70  | .70  | 2.16  | 3.18  | 3.37  | 2.90  | 2.70  | 2.17  | 1.45  | 1.00  | .92  | 20.64  |

a/ Alma Records

Table 89

KS002131

Table 90--- Precipitation at Burr Oak, Kansas -- Inches

| Year | Jan. | Feb. | Mar. | Apr. | May  | June  | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|------|------|------|------|------|------|-------|------|------|-------|------|------|------|-------|
| 1929 | 0.16 | 0.89 | 0.04 | 3.26 | 3.83 | 4.19  | 1.57 | 0.79 | 1.49  | 4.12 | 1.26 | 0.02 | 21.53 |
| 1930 | 0.71 | 0.37 | 0.36 | 2.92 | 5.62 | 2.06  | 1.86 | 1.47 | 1.75  | 2.02 | 1.72 | 0.22 | 21.08 |
| 1931 | 0.24 | 0.52 | 2.08 | 2.87 | 5.13 | 1.22  | 1.78 | 2.27 | 1.21  | 2.11 | 3.32 | 0.94 | 23.69 |
| 1932 | 2.64 | 0.89 | 0.78 | 0.97 | 1.53 | 3.73  | 1.69 | 1.90 | 2.07  | 2.60 | 0.18 | 0.30 | 19.25 |
| 1933 | 0.12 | 0.08 | 2.94 | 2.91 | 1.87 | 1.73  | 3.04 | 5.00 | 1.33  | 0.09 | 0.27 | 1.64 | 20.12 |
| 1934 | 0.22 | 1.67 | 0.39 | 1.08 | 0.82 | 2.95  | 0.27 | 1.29 | 2.62  | 0.37 | 0.36 | 0.36 | 12.92 |
| 1935 | 0.02 | 1.06 | 0.57 | 0.51 | 8.15 | 6.26  | 0.06 | 4.01 | 4.12  | 1.94 | 1.14 | 0.15 | 26.02 |
| 1936 | 0.37 | 0.27 | 0.05 | 1.44 | 2.14 | 1.77  | 0.04 | 1.34 | 3.52  | 0.62 | 0.03 | 0.79 | 12.38 |
| 1937 | 1.49 | 0.51 | 1.70 | 0.95 | 2.33 | 5.24  | 3.47 | 1.61 | 0.48  | 2.38 | 0.03 | 0.17 | 20.37 |
| 1938 | 0.25 | 1.22 | 0.35 | 2.11 | 5.49 | 2.24  | 7.42 | 1.88 | 4.25  | 0.39 | 1.14 | 0.02 | 27.20 |
| 1939 | 0.68 | 0.75 | 1.46 | 1.11 | 3.27 | 11.25 | 0.45 | 3.41 | 0.17  | 0.56 | 0.06 | 0.72 | 23.89 |
| 1940 | 0.85 | 0.95 | 1.35 | 3.25 | 2.84 | 2.59  | 1.99 | 2.20 | 1.19  | 1.77 | 2.43 | 1.10 | 23.01 |
| 1941 | 0.89 | 0.46 | 0.83 | 3.81 | 1.98 | 10.68 | 2.53 | 1.19 | 6.75  | 2.93 | 1.36 | 2.19 | 35.60 |
| 1942 | 0.15 | 0.68 | 1.18 | 2.78 | 1.83 | 6.35  | 2.74 | 4.43 | 5.53  | 0.67 | 0.25 | 1.51 | 28.10 |
| 1943 | 0.06 | 0.69 | 0.26 | 3.26 | 2.37 | 7.52  | 1.93 | 1.95 | 0.64  | 0.84 | 0.24 | 0.21 | 20.07 |
| 1944 | 1.71 | 0.55 | 2.66 | 5.49 | 3.18 | 4.20  | 3.95 | 5.82 | 1.41  | 1.14 | 1.98 | 0.32 | 32.41 |
| 1945 | 0.45 | 0.88 | 0.45 | 4.59 | 5.43 | 3.45  | 3.44 | 1.34 | 2.01  | 0.32 | 0.04 | 1.48 | 23.88 |
| 1946 | 0.68 | 0.04 | 1.79 | 0.11 | 3.42 | 2.26  | 3.21 | 1.68 | 6.56  | 2.09 | 3.05 | 0.01 | 24.90 |
| 1947 | 0.41 | 0.20 | 1.62 | 3.96 | 2.64 | 7.53  | 1.35 | 0.60 | 0.86  | 0.41 | 1.32 | 1.70 | 22.60 |
| 1948 | 0.63 | 0.68 | 1.10 | 2.49 | 3.36 | 4.60  | 2.24 | 2.32 | 2.54  | 1.43 | 1.09 | 0.73 | 23.21 |

Table 91. Net evaporation rate at Harlan County Reservoir 1/

(Unit - inches)

| Year | Jan.  | Feb.  | Mar. | Apr.  | May   | June  | July  | Aug. | Sept. | Oct.  | Nov.  | Dec.  | Total |
|------|-------|-------|------|-------|-------|-------|-------|------|-------|-------|-------|-------|-------|
| 1929 | 1.00  | 0.60  | 2.20 | 1.30  | 3.01  | 5.68  | 5.12  | 6.54 | 4.04  | -0.01 | 1.00  | 1.20  | 31.68 |
| 1930 | 0.20  | 0.95  | 2.20 | -0.74 | 1.75  | 3.28  | 7.66  | 3.43 | 4.73  | -1.14 | -0.32 | 1.20  | 23.20 |
| 1931 | 1.00  | -0.90 | 0.30 | 0.81  | 3.91  | 7.10  | 6.28  | 3.81 | 8.23  | 2.80  | 0.05  | 0.85  | 34.24 |
| 1932 | -0.90 | -0.70 | 1.60 | 3.16  | 3.66  | 1.82  | 8.21  | 6.79 | 1.91  | 3.93  | 2.65  | 0.80  | 32.93 |
| 1933 | 1.00  | 0.80  | 0.70 | 0.21  | 3.26  | 10.55 | 9.67  | 2.98 | 4.46  | 4.70  | 1.75  | -0.25 | 39.83 |
| 1934 | 0.90  | -0.15 | 1.55 | 4.90  | 8.53  | 6.05  | 13.11 | 9.86 | 4.32  | 4.33  | 0.85  | 0.40  | 54.65 |
| 1935 | 0.75  | 0.70  | 1.70 | 5.11  | -2.38 | 1.58  | 10.85 | 5.94 | 3.84  | 3.95  | 1.15  | 1.20  | 34.39 |
| 1936 | 0.90  | 0.75  | 1.95 | 5.51  | -0.36 | 7.93  | 12.02 | 9.59 | 2.97  | 4.70  | 2.60  | 0.40  | 48.96 |
| 1937 | -0.20 | 0.50  | 0.28 | 5.43  | 4.68  | 5.93  | 8.06  | 8.24 | 5.82  | 3.11  | 2.55  | 1.15  | 45.55 |
| 1938 | 0.75  | 0.65  | 0.93 | 2.67  | 0.12  | 5.63  | 9.74  | 8.58 | 4.88  | 7.32  | 2.65  | 1.10  | 45.02 |
| 1939 | 0.30  | 0.25  | 1.08 | 3.71  | 6.58  | 5.44  | 12.56 | 6.81 | 10.41 | 6.38  | 2.65  | 0.70  | 56.87 |
| 1940 | 0     | 0.70  | 0.88 | 4.49  | 3.36  | 7.83  | 6.53  | 5.75 | 4.23  | 3.16  | 1.55  | 0.50  | 38.98 |
| 1941 | -0.20 | 0.50  | 1.50 | -0.86 | 3.59  | -3.55 | 2.20  | 1.89 | 4.58  | 1.96  | 1.58  | 0.20  | 13.39 |
| 1942 | 0.65  | 0.65  | 0.32 | 1.07  | 4.92  | -0.27 | 9.66  | 3.42 | -1.33 | 3.42  | 2.00  | 0.30  | 24.81 |
| 1943 | 0.90  | 0.60  | 1.50 | 1.38  | 5.30  | 4.30  | 8.14  | 8.64 | 5.54  | 4.11  | 2.37  | 1.10  | 43.88 |
| 1944 | -0.37 | 0.28  | 0.70 | -4.19 | 4.07  | 6.07  | 1.82  | 4.71 | 4.93  | 2.28  | 1.29  | 0.94  | 22.53 |
| 1945 | 0.36  | 0.84  | 1.90 | -0.51 | 2.87  | 0.43  | 7.19  | 6.69 | 5.58  | 3.53  | 2.65  | 0.39  | 31.92 |
| 1946 | 0.65  | 1.10  | 0.63 | 6.32  | 0.52  | 8.40  | 7.39  | 2.57 | 1.62  | -2.18 | 1.03  | 1.20  | 29.25 |
| 1947 | 0.81  | 0.96  | 1.78 | 1.05  | 2.54  | -2.22 | 6.81  | 9.96 | 9.58  | 4.83  | 1.23  | 0.41  | 37.74 |
| Avg. | 0.45  | 0.48  | 1.25 | 2.15  | 3.15  | 4.32  | 8.05  | 6.12 | 4.75  | 3.22  | 1.64  | 0.73  | 36.31 |

1/ Gross evaporation less precipitation at Orleans, Nebr. Negative values indicate the amount that precipitation exceeds gross evaporation.



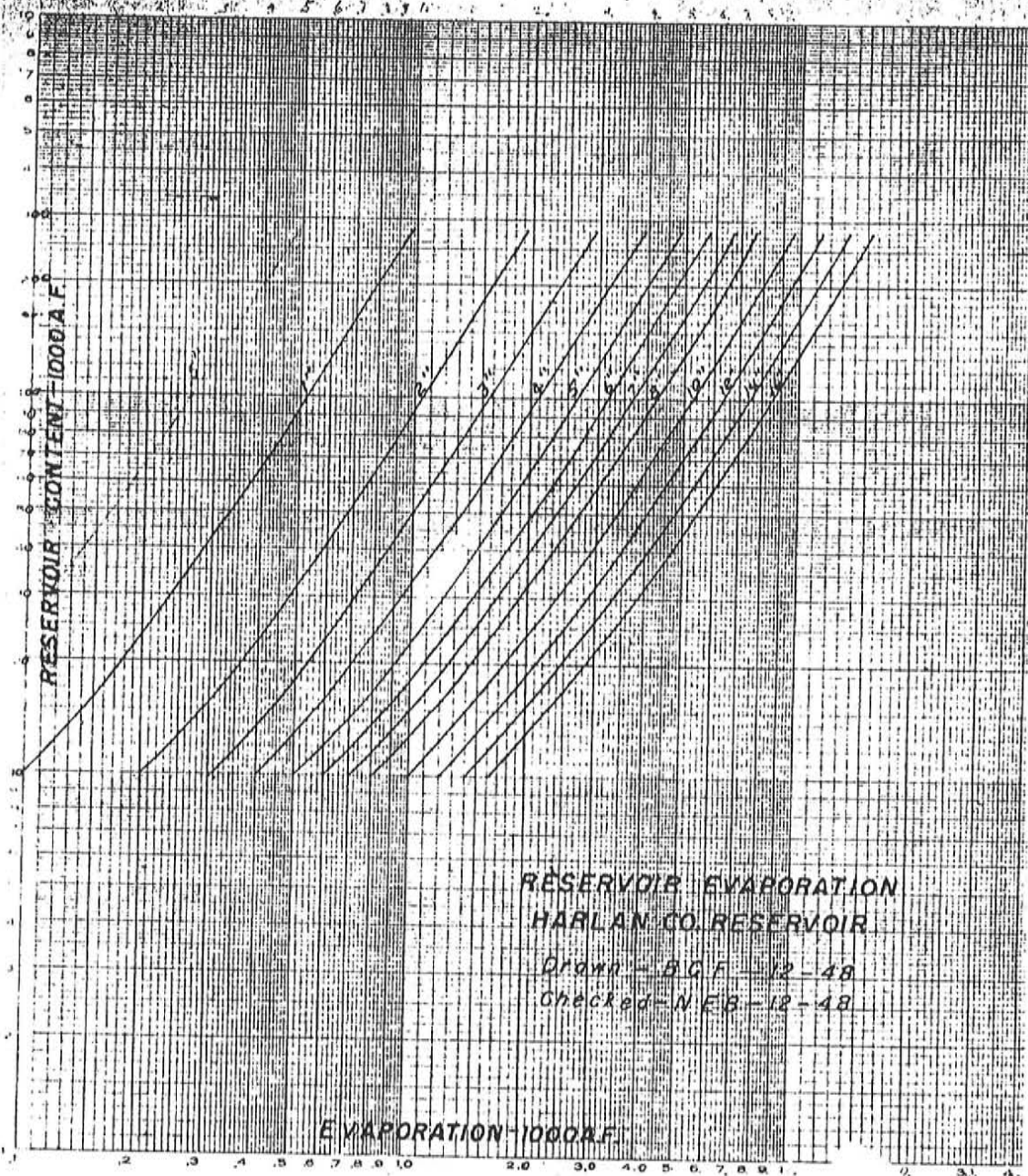
Table 93. Net Evaporation at Lovewell Reservoir <sup>a/</sup>

| Year :    | Jan. :  | Feb. : | Mar. : | Apr. :  | May :   | June :  | July :  | Aug. : | Sept. : | Oct. :  | Nov. : | Dec. :  | Total |
|-----------|---------|--------|--------|---------|---------|---------|---------|--------|---------|---------|--------|---------|-------|
| 1929 :    | 0.79 :  | 0.35 : | 2.06 : | 0.44 :  | 0.64 :  | 1.75 :  | 5.22 :  | 5.21 : | 3.86 :  | -1.40 : | 1.29 : | 1.13 :  | 20.46 |
| 1930 :    | .24 :   | .78 :  | 1.74 : | 1.78 :  | -.02 :  | 5.94 :  | 8.97 :  | 5.27 : | 5.19 :  | 2.92 :  | .83 :  | .93 :   | 34.57 |
| 1931 :    | .71 :   | .63 :  | .02 :  | 2.03 :  | .46 :   | 6.70 :  | 6.73 :  | 5.03 : | 7.42 :  | 2.55 :  | -.77 : | .21 :   | 31.72 |
| 1932 :    | -1.69 : | .26 :  | 1.32 : | 4.00 :  | 5.29 :  | 2.63 :  | 7.82 :  | 5.24 : | 4.35 :  | 1.81 :  | 2.40 : | .85 :   | 34.28 |
| 1933 :    | .83 :   | 1.07 : | .06 :  | 1.93 :  | 3.83 :  | 8.90 :  | 4.24 :  | .35 :  | 5.09 :  | 4.04 :  | 2.28 : | -.49 :  | 32.13 |
| 1934 :    | .73 :   | -.52 : | 1.71 : | 5.99 :  | 9.90 :  | 7.87 :  | 13.08 : | 6.93 : | 2.50 :  | 3.98 :  | 1.69 : | .77 :   | 54.63 |
| 1935 :    | .93 :   | .09 :  | 1.53 : | 3.68 :  | -5.26 : | -.98 :  | 8.97 :  | 3.27 : | 1.14 :  | .51 :   | 1.41 : | .99 :   | 16.28 |
| 1936 :    | .58 :   | .88 :  | 2.05 : | 4.98 :  | 3.64 :  | 6.43 :  | 12.71 : | 8.26 : | 2.70 :  | 3.26 :  | 2.52 : | .36 :   | 48.37 |
| 1937 :    | -.54 :  | .64 :  | .40 :  | 3.54 :  | 2.79 :  | 1.81 :  | 5.51 :  | 7.73 : | 6.40 :  | 1.58 :  | 2.58 : | .98 :   | 33.36 |
| 1938 :    | .70 :   | -.07 : | 1.22 : | 2.67 :  | -1.63 : | 3.55 :  | .73 :   | 5.59 : | .47 :   | 4.51 :  | 1.41 : | 1.13 :  | 20.28 |
| 1939 :    | .27 :   | .40 :  | .64 :  | 3.86 :  | 3.87 :  | -4.59 : | 7.65 :  | 3.13 : | 7.83 :  | 3.57 :  | 2.49 : | .43 :   | 29.55 |
| 1940 :    | .10 :   | .20 :  | .25 :  | .23 :   | 1.86 :  | 3.83 :  | 6.63 :  | 2.36 : | 3.53 :  | 1.73 :  | .12 :  | .05 :   | 20.89 |
| 1941 :    | .06 :   | .69 :  | 1.27 : | .67 :   | 3.41 :  | -5.28 : | 5.73 :  | 6.39 : | -1.38 : | -.48 :  | 1.19 : | -1.04 : | 11.23 |
| 1942 :    | .80 :   | .47 :  | .92 :  | 1.97 :  | 2.40 :  | -1.17 : | 4.36 :  | 1.49 : | -2.04 : | 2.09 :  | 2.30 : | -.36 :  | 13.23 |
| 1943 :    | .89 :   | .26 :  | 1.84 : | 2.08 :  | 2.33 :  | -1.48 : | 4.93 :  | 4.16 : | 3.52 :  | 2.60 :  | 2.31 : | .94 :   | 24.38 |
| 1944 :    | -.76 :  | .50 :  | -.56 : | -2.98 : | 1.58 :  | 1.64 :  | 2.94 :  | .16 :  | 2.95 :  | 1.15 :  | .57 :  | .83 :   | 8.02  |
| 1945 :    | .50 :   | .27 :  | 1.65 : | -1.45 : | -2.00 : | .87 :   | 2.04 :  | 4.22 : | 3.36 :  | 2.19 :  | 2.51 : | -.33 :  | 13.83 |
| 1946 :    | .27 :   | 1.11 : | .31 :  | 4.72 :  | .63 :   | 5.68 :  | 4.12 :  | 2.98 : | -2.87 : | -.07 :  | -.50 : | 1.14 :  | 17.52 |
| 1947 :    | .54 :   | .95 :  | .48 :  | -1.37 : | 1.55 :  | -2.90 : | 5.11 :  | 7.05 : | 6.62 :  | 3.71 :  | 1.23 : | -.55 :  | 22.42 |
| Av. :     |         |        |        |         |         |         |         |        |         |         |        |         |       |
| 1929-47 : | .31 :   | .47 :  | 1.00 : | 1.99 :  | 1.86 :  | 2.17 :  | 6.18 :  | 4.47 : | 3.19 :  | 2.12 :  | 1.46 : | .42 :   | 25.64 |

<sup>a/</sup>Gross evaporation less precipitation at Burr Oak, Kansas.

Negative values indicate the amount that precipitation exceeds gross evaporation.





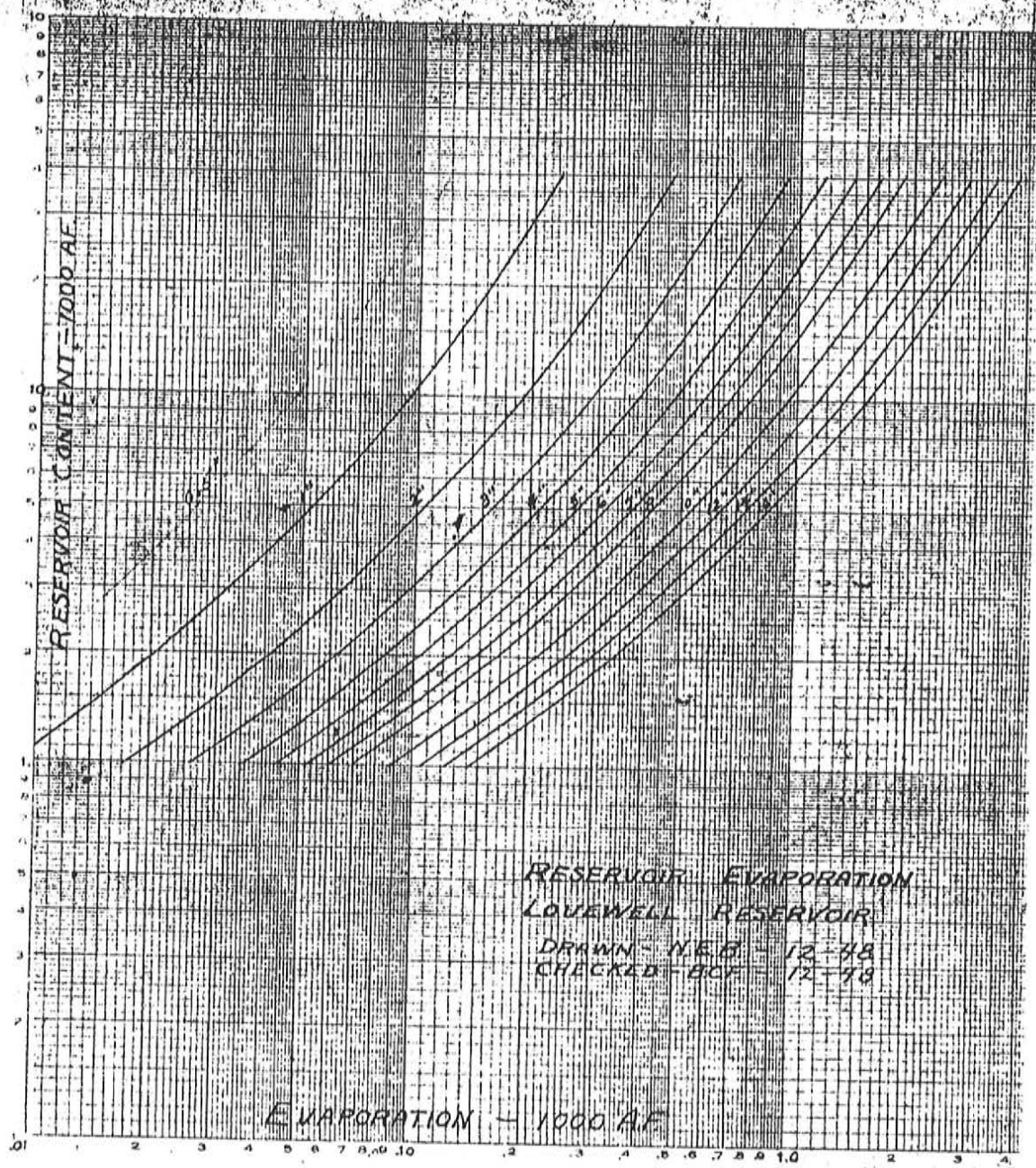


Table 2. Computations to determine the total demand on Harlan Co. Reservoir - Bostwick Division - 1000 A.F.  
Harlan County and Lowell Reservoirs serving 90,000 acres

[illegible]



Table 93

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Table 93

Table 1 - COMPUTATIONS TO DETERMINE THE TOTAL DEMAND ON HARLAN CO. RESERVOIR - BOSTWICK DIVISION - 1000 A.F.  
HARLAN COUNTY AND LOWELL RESERVOIRS SERVING 90,000 ACRES

| YEAR | 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 | 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 | 360 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 | 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 | 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 | 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 | 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 | 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 | 480 | 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 | 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 | 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 | 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 | 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 | 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 | 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 | 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 | 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 | 661 | 662 | 663 | 664 | 665 | 666 | 667 | 668 | 669 | 670 | 671 | 672 | 673 | 674 | 675 | 676 | 677 | 678 | 679 | 680 | 681 | 682 | 683 | 684 | 685 | 686 | 687 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 698 | 699 | 700 | 701 | 702 | 703 | 704 | 705 | 706 | 707 | 708 | 709 | 710 | 711 | 712 | 713 | 714 | 715 | 716 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 | 737 | 738 | 739 | 740 | 741 | 742 | 743 | 744 | 745 | 746 | 747 | 748 | 749 | 750 | 751 | 752 | 753 | 754 | 755 | 756 | 757 | 758 | 759 | 760 | 761 | 762 | 763 | 764 | 765 | 766 | 767 | 768 | 769 | 770 | 771 | 772 | 773 | 774 | 775 | 776 | 777 | 778 | 779 | 780 | 781 | 782 | 783 | 784 | 785 | 786 | 787 | 788 | 789 | 790 | 791 | 792 | 793 | 794 | 795 | 796 | 797 | 798 | 799 | 800 | 801 | 802 | 803 | 804 | 805 | 806 | 807 | 808 | 809 | 810 | 811 | 812 | 813 | 814 | 815 | 816 | 817 | 818 | 819 | 820 | 821 | 822 | 823 | 824 | 825 | 826 | 827 | 828 | 829 | 830 | 831 | 832 | 833 | 834 | 835 | 836 | 837 | 838 | 839 | 840 | 841 | 842 | 843 | 844 | 845 | 846 | 847 | 848 | 849 | 850 | 851 | 852 | 853 | 854 | 855 | 856 | 857 | 858 | 859 | 860 | 861 | 862 | 863 | 864 | 865 | 866 | 867 | 868 | 869 | 870 | 871 | 872 | 873 | 874 | 875 | 876 | 877 | 878 | 879 | 880 | 881 | 882 | 883 | 884 | 885 | 886 | 887 | 888 | 889 | 890 | 891 | 892 | 893 | 894 | 895 | 896 | 897 | 898 | 899 | 900 | 901 | 902 | 903 | 904 | 905 | 906 | 907 | 908 | 909 | 910 | 911 | 912 | 913 | 914 | 915 | 916 | 917 | 918 | 919 | 920 | 921 | 922 | 923 | 924 | 925 | 926 | 927 | 928 | 929 | 930 | 931 | 932 | 933 | 934 | 935 | 936 | 937 | 938 | 939 | 940 | 941 | 942 | 943 | 944 | 945 | 946 | 947 | 948 | 949 | 950 | 951 | 952 | 953 | 954 | 955 | 956 | 957 | 958 | 959 | 960 | 961 | 962 | 963 | 964 | 965 | 966 | 967 | 968 | 969 | 970 | 971 | 972 | 973 | 974 | 975 | 976 | 977 | 978 | 979 | 980 | 981 | 982 | 983 | 984 | 985 | 986 | 987 | 988 | 989 | 990 | 991 | 992 | 993 | 994 | 995 | 996 | 997 | 998 | 999 | 1000 | 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 | 1011 | 1012 | 1013 | 1014 | 1015 | 1016 | 1017 | 1018 | 1019 | 1020 | 1021 | 1022 | 1023 | 1024 | 1025 | 1026 | 1027 | 1028 | 1029 | 1030 | 1031 | 1032 | 1033 | 1034 | 1035 | 1036 | 1037 | 1038 | 1039 | 1040 | 1041 | 1042 | 1043 | 1044 | 1045 | 1046 | 1047 | 1048 | 1049 | 1050 | 1051 | 1052 | 1053 | 1054 | 1055 | 1056 | 1057 | 1058 | 1059 | 1060 | 1061 | 1062 | 1063 | 1064 | 1065 | 1066 | 1067 | 1068 | 1069 | 1070 | 1071 | 1072 | 1073 | 1074 | 1075 | 1076 | 1077 | 1078 | 1079 | 1080 | 1081 | 1082 | 1083 | 1084 | 1085 | 1086 | 1087 | 1088 | 1089 | 1090 | 1091 | 1092 | 1093 | 1094 | 1095 | 1096 | 1097 | 1098 | 1099 | 1100 | 1101 | 1102 | 1103 | 1104 | 1105 | 1106 | 1107 | 1108 | 1109 | 1110 | 1111 | 1112 | 1113 | 1114 | 1115 | 1116 | 1117 | 1118 | 1119 | 1120 | 1121 | 1122 | 1123 | 1124 | 1125 | 1126 | 1127 | 1128 | 1129 | 1130 | 1131 | 1132 | 1133 | 1134 | 1135 | 1136 | 1137 | 1138 | 1139 | 1140 | 1141 | 1142 | 1143 | 1144 | 1145 | 1146 | 1147 | 1148 | 1149 | 1150 | 1151 | 1152 | 1153 | 1154 | 1155 | 1156 | 1157 | 1158 | 1159 | 1160 | 1161 | 1162 | 1163 | 1164 | 1165 | 1166 | 1167 | 1168 | 1169 | 1170 | 1171 | 1172 | 1173 | 1174 | 1175 | 1176 | 1177 | 1178 | 1179 | 1180 | 1181 | 1182 | 1183 | 1184 | 1185 | 1186 | 1187 | 1188 | 1189 | 1190 | 1191 | 1192 | 1193 | 1194 | 1195 | 1196 | 1197 | 1198 | 1199 | 1200 | 1201 | 1202 | 1203 | 1204 | 1205 | 1206 | 1207 | 1208 | 1209 | 1210 | 1211 | 1212 | 1213 | 1214 | 1215 | 1216 | 1217 | 1218 | 1219 | 1220 | 1221 | 1222 | 1223 | 1224 | 1225 | 1226 | 1227 | 1228 | 1229 | 1230 | 1231 | 1232 | 1233 | 1234 | 1235 | 1236 | 1237 | 1238 | 1239 | 1240 | 1241 | 1242 | 1243 | 1244 | 1245 | 1246 | 1247 | 1248 | 1249 | 1250 | 1251 | 1252 | 1253 | 1254 | 1255 | 1256 | 1257 | 1258 | 1259 | 1260 | 1261 | 1262 | 1263 | 1264 | 1265 | 1266 | 1267 | 1268 | 1269 | 1270 | 1271 | 1272 | 1273 | 1274 | 1275 | 1276 | 1277 | 1278 | 1279 | 1280 | 1281 | 1282 | 1283 | 1284 | 1285 | 1286 | 1287 | 1288 | 1289 | 1290 | 1291 | 1292 | 1293 | 1294 | 1295 | 1296 | 1297 | 1298 | 1299 | 1300 | 1301 | 1302 | 1303 | 1304 | 1305 | 1306 | 1307 | 1308 | 1309 | 1310 | 1311 | 1312 | 1313 | 1314 | 1315 | 1316 | 1317 | 1318 | 1319 | 1320 | 1321 | 1322 | 1323 | 1324 | 1325 | 1326 | 1327 | 1328 | 1329 | 1330 | 1331 | 1332 | 1333 | 1334 | 1335 | 1336 | 1337 | 1338 | 1339 | 1340 | 1341 | 1342 | 1343 | 1344 | 1345 | 1346 | 1347 | 1348 | 1349 | 1350 | 1351 | 1352 | 1353 | 1354 | 1355 | 1356 | 1357 | 1358 | 1359 | 1360 | 1361 | 1362 | 1363 | 1364 | 1365 | 1366 | 1367 | 1368 | 1369 | 1370 | 1371 | 1372 | 1373 | 1374 | 1375 | 1376 | 1377 | 1378 | 1379 | 1380 | 1381 | 1382 | 1383 | 1384 | 1385 | 1386 | 1387 | 1388 | 1389 | 1390 | 1391 | 1392 | 1393 | 1394 | 1395 | 1396 | 1397 | 1398 | 1399 | 1400 | 1401 | 1402 | 1403 | 1404 | 1405 | 1406 | 1407 | 1408 | 1409 | 1410 | 1411 | 1412 | 1413 | 1414 | 1415 | 1416 | 1417 | 1418 | 1419 | 1420 | 1421 | 1422 | 1423 | 1424 | 1425 | 1426 | 1427 | 1428 | 1429 | 1430 | 1431 | 1432 | 1433 | 1434 | 1435 | 1436 | 1437 | 1438 | 1439 | 1440 | 1441 | 1442 | 1443 | 1444 | 1445 | 1446 | 1447 | 1448 | 1449 | 1450 | 1451 | 1452 | 1453 | 1454 | 1455 | 1456 | 1457 | 1458 | 1459 | 1460 | 1461 | 1462 | 1463 | 1464 | 1465 | 1466 | 1467 | 1468 | 1469 | 1470 | 1471 | 1472 | 1473 | 1474 | 1475 | 1476 | 1477 | 1478 | 1479 | 1480 | 14 |
|------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|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TABLE 2: COMPUTATIONS TO DETERMINE THE TOTAL DEMAND ON HARLAN CO. RESERVOIR - BOSTWICK DIVISION - 1,000 A.F.  
HARLAN COUNTY AND LOWELL RESERVOIRS SERVING 90,000 ACRES

| YEAR |   |   | MARLAN ALBERT AND LOVELL MESSINGERS DE |   |   |   |   |   |    |    |    |    | DECEMBER OF 1960 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |
|------|---|---|----------------------------------------|---|---|---|---|---|----|----|----|----|------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 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 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |

Table 94 RESERVOIR OPERATIONS-BOSTWICK DIVISION HARLAN COUNTY, AND LOVEWELL RESERVOIR 1000 A.F.

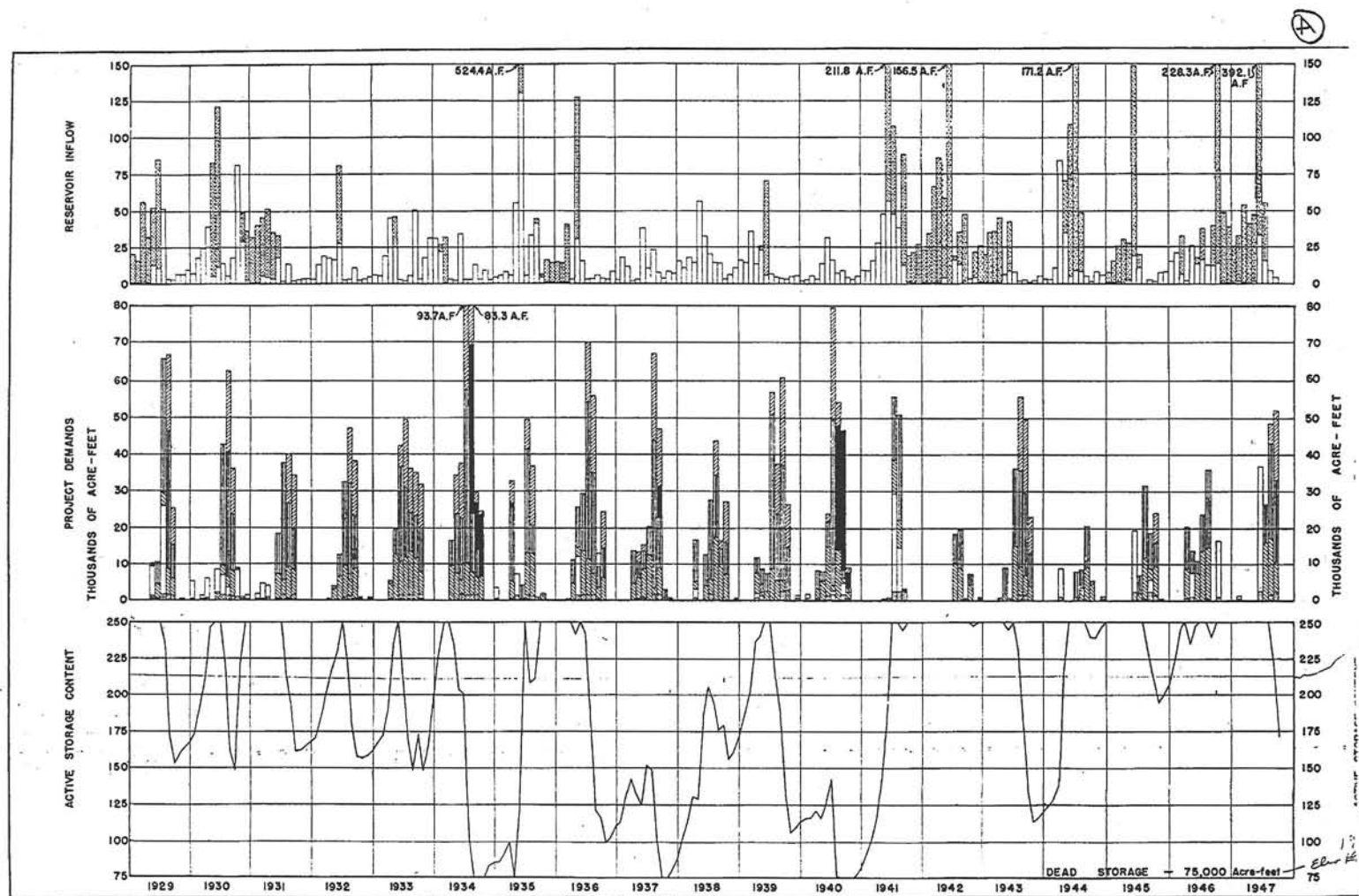
[illegible]

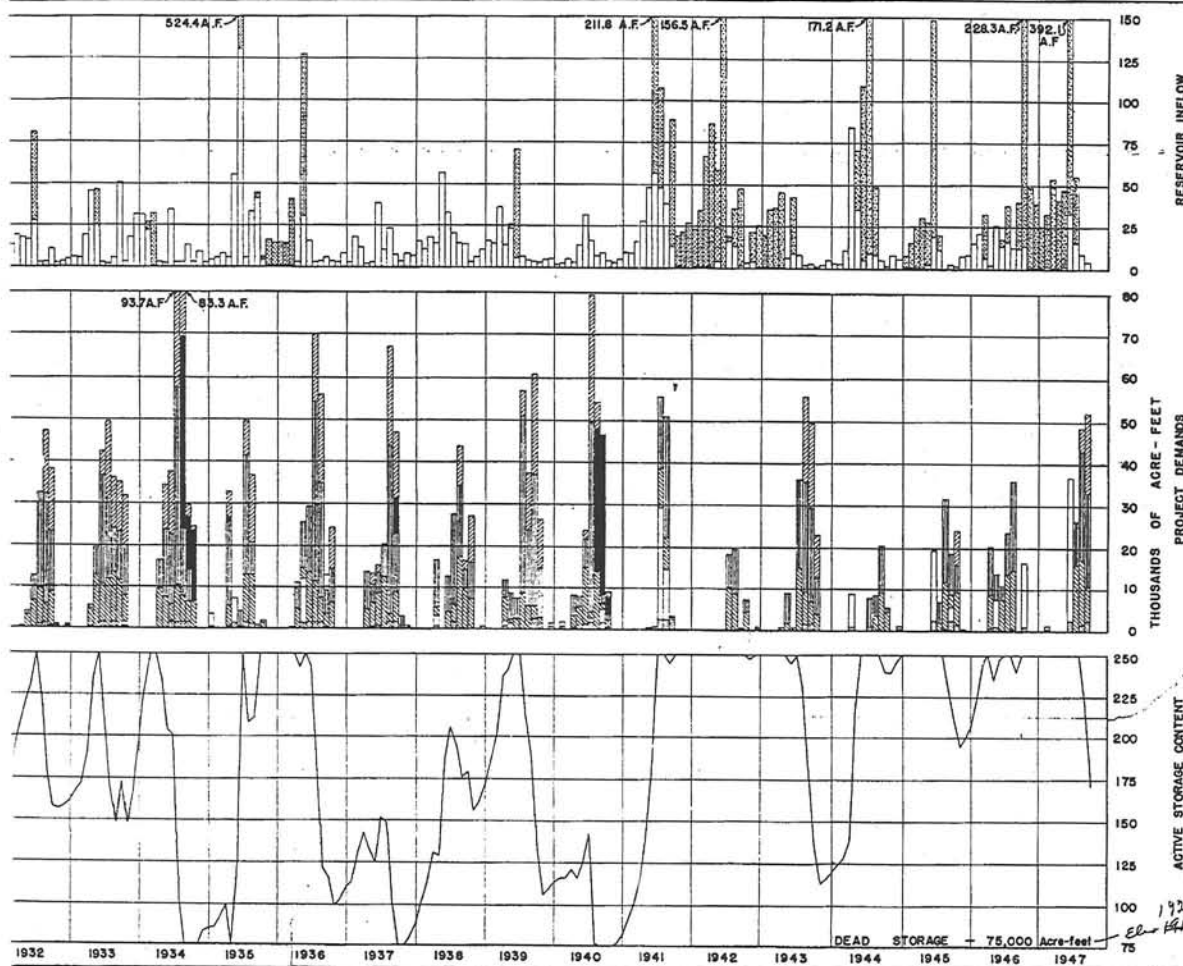


[illegible]

Table 94

| Table 94 RESERVOIR OPERATIONS-BOSTWICK DIVISION HARLAN COUNTY AND LOVEWELL RESERVOIR 1000 A.E |       |           |           |         |           |         |           |         |           |         |           |                   |       |           |           |         |           |         |           |         |           |      |       |           |
|-----------------------------------------------------------------------------------------------|-------|-----------|-----------|---------|-----------|---------|-----------|---------|-----------|---------|-----------|-------------------|-------|-----------|-----------|---------|-----------|---------|-----------|---------|-----------|------|-------|-----------|
| Harlan County Reservoir                                                                       |       |           |           |         |           |         |           |         |           |         |           | Loweell Reservoir |       |           |           |         |           |         |           |         |           |      |       |           |
| Year                                                                                          | Month | Discharge | Reservoir | Storage | Reservoir | Storage | Reservoir | Storage | Reservoir | Storage | Reservoir | Year              | Month | Discharge | Reservoir | Storage | Reservoir | Storage | Reservoir | Storage | Reservoir | Year | Month | Discharge |
| 1951                                                                                          | 1     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         | 1951              | 1     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 1951 | 1     | 2.0       |
|                                                                                               | 2     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 2     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 2     | 2.0       |
|                                                                                               | 3     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 3     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 3     | 2.0       |
|                                                                                               | 4     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 4     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 4     | 2.0       |
|                                                                                               | 5     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 5     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 5     | 2.0       |
|                                                                                               | 6     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 6     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 6     | 2.0       |
|                                                                                               | 7     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 7     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 7     | 2.0       |
|                                                                                               | 8     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 8     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 8     | 2.0       |
|                                                                                               | 9     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 9     | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 9     | 2.0       |
|                                                                                               | 10    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 10    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 10    | 2.0       |
|                                                                                               | 11    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 11    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 11    | 2.0       |
|                                                                                               | 12    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 12    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 12    | 2.0       |
|                                                                                               | 13    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 13    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 13    | 2.0       |
|                                                                                               | 14    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 14    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 14    | 2.0       |
|                                                                                               | 15    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 15    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 15    | 2.0       |
|                                                                                               | 16    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 16    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 16    | 2.0       |
|                                                                                               | 17    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 17    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 17    | 2.0       |
|                                                                                               | 18    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 18    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 18    | 2.0       |
|                                                                                               | 19    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 19    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 19    | 2.0       |
|                                                                                               | 20    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 20    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 20    | 2.0       |
|                                                                                               | 21    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 21    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 21    | 2.0       |
|                                                                                               | 22    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 22    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 22    | 2.0       |
|                                                                                               | 23    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 23    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 23    | 2.0       |
|                                                                                               | 24    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 24    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 24    | 2.0       |
|                                                                                               | 25    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 25    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 25    | 2.0       |
|                                                                                               | 26    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 26    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 26    | 2.0       |
|                                                                                               | 27    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 27    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 27    | 2.0       |
|                                                                                               | 28    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 28    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 28    | 2.0       |
|                                                                                               | 29    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 29    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 29    | 2.0       |
|                                                                                               | 30    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 30    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 30    | 2.0       |
|                                                                                               | 31    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 31    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 31    | 2.0       |
|                                                                                               | 32    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 32    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 32    | 2.0       |
|                                                                                               | 33    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 33    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 33    | 2.0       |
|                                                                                               | 34    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 34    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 34    | 2.0       |
|                                                                                               | 35    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 35    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 35    | 2.0       |
|                                                                                               | 36    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 36    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 36    | 2.0       |
|                                                                                               | 37    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 37    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 37    | 2.0       |
|                                                                                               | 38    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 38    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 38    | 2.0       |
|                                                                                               | 39    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 39    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 39    | 2.0       |
|                                                                                               | 40    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 40    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 40    | 2.0       |
|                                                                                               | 41    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 41    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 41    | 2.0       |
|                                                                                               | 42    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 42    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 42    | 2.0       |
|                                                                                               | 43    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 43    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 43    | 2.0       |
|                                                                                               | 44    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 44    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 44    | 2.0       |
|                                                                                               | 45    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 45    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 45    | 2.0       |
|                                                                                               | 46    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 46    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 46    | 2.0       |
|                                                                                               | 47    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 47    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 47    | 2.0       |
|                                                                                               | 48    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 48    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 48    | 2.0       |
|                                                                                               | 49    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 49    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 49    | 2.0       |
|                                                                                               | 50    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 50    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 50    | 2.0       |
|                                                                                               | 51    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 51    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 51    | 2.0       |
|                                                                                               | 52    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 52    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 52    | 2.0       |
|                                                                                               | 53    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 53    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 53    | 2.0       |
|                                                                                               | 54    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 54    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 54    | 2.0       |
|                                                                                               | 55    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 55    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 55    | 2.0       |
|                                                                                               | 56    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 56    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 56    | 2.0       |
|                                                                                               | 57    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 57    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 57    | 2.0       |
|                                                                                               | 58    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 58    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 58    | 2.0       |
|                                                                                               | 59    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 59    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 59    | 2.0       |
|                                                                                               | 60    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 60    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 60    | 2.0       |
|                                                                                               | 61    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 61    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 61    | 2.0       |
|                                                                                               | 62    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 62    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 62    | 2.0       |
|                                                                                               | 63    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 63    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 63    | 2.0       |
|                                                                                               | 64    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 64    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 64    | 2.0       |
|                                                                                               | 65    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 65    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 65    | 2.0       |
|                                                                                               | 66    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 66    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 66    | 2.0       |
|                                                                                               | 67    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 67    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 67    | 2.0       |
|                                                                                               | 68    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 68    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 68    | 2.0       |
|                                                                                               | 69    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 69    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 69    | 2.0       |
|                                                                                               | 70    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         | 0       | 0         |                   | 70    | 2.0       | 0.50      | 0.1     | 0         | 0       | 0         | 0       | 0         |      | 70    | 2.0.      |





UNITED STATES DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION

MISSOURI RIVER BASIN PROJECT  
EASTWICK DIVISION

## RESERVOIR OPERATION

### HARLAN COUNTY RESERVOIR

#### ACRES IRRIGATED

|              |        |
|--------------|--------|
| New          | 53,500 |
| Supplemental | 36,500 |

#### AFTER 50 YEARS OF OPERATION

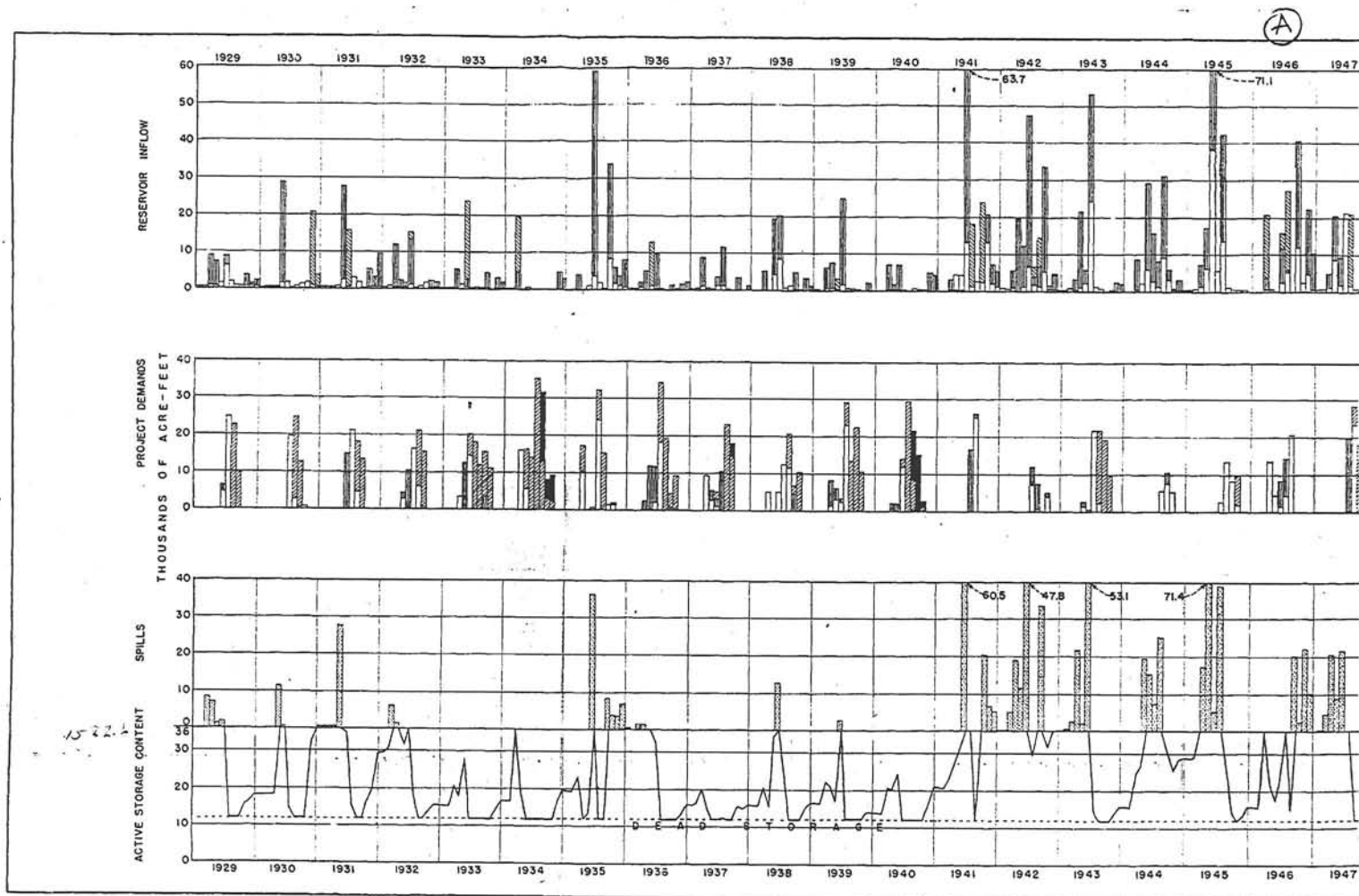
|                 |                   |
|-----------------|-------------------|
| Maximum Storage | 250,000 Acre-feet |
| Dead Storage    | 75,000 Acre-feet  |

#### LOSSES

|                                 |        |
|---------------------------------|--------|
| Transportation                  | 25-35% |
| Farm Waste and Deep Percolation | 23-35% |

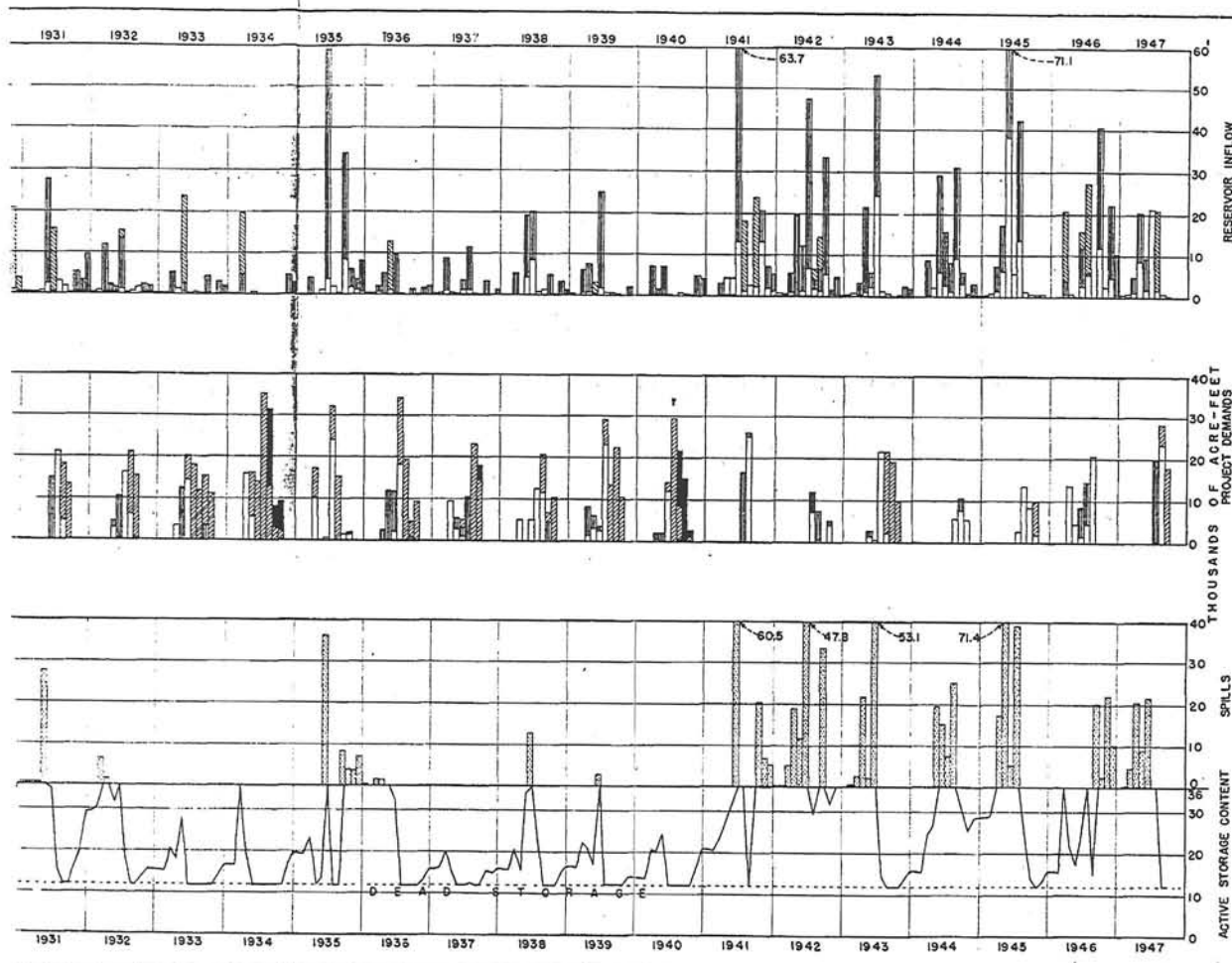
#### EXPLANATION

|                                                      |  |
|------------------------------------------------------|--|
| INFLOW                                               |  |
| PROJECT DEMANDS                                      |  |
| Supplied by Harlan Co. Res.                          |  |
| Supplied by Rep. Rk. accretion below Harlan Co. Res. |  |
| Supplemental water to lands below Lovewell Res.      |  |
| OTHER RELEASES                                       |  |
| To counteract stream losses                          |  |
| To meet Public Health Service recommendations        |  |
| SHORTAGE                                             |  |
| RESERVOIR CONTENT                                    |  |
| SPILLS                                               |  |



ⓑ

Exhibit 26



UNITED STATES DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION

MISSOURI RIVER BASIN PROJECT  
BOSTWICK DIVISION

## RESERVOIR OPERATION

LOVEWELL RESERVOIR

ACRES IRRIGATED 36,500  
AFTER 50 YEARS OF OPERATION  
Maximum Storage 36,000 Acre-feet  
Inactive & Dead Storage 12,000 Acre-feet  
LOSSES  
Transportation 33 %  
Farm Waste and Deep Percolation 23 %

### EXPLANATION

#### INFLOW

- Spills-Harlan Co. Res.
- Storable accretion of Rep. River below Harlan Co. Res.
- White Rock Creek flows

#### PROJECT DEMANDS

- Supplied by -
- Harlan Co. Res.
- Accretion of Rep. Riv. below Harlan Co. Res. or spills from Harlan Co. Res.
- White Rock Cr. or Lovewell Res.

#### SHORTAGE

#### RESERVOIR CONTENT

#### SPILLS

DEC. 1952

GPO 82-230214-1

Table 95

RESERVOIR OPERATION SUMMARY  
HARLAN COUNTY AND LOVELL RESERVOIRS  
UNIT 1,000 A.F.  
90,000 Acres

Table 95 :

| HARLAN COUNTY RESERVOIR |        |                   |                |              |                     |        |          | LOVELL RESERVOIR           |                |                    |              |                   |                |                     |        |                  |  |
|-------------------------|--------|-------------------|----------------|--------------|---------------------|--------|----------|----------------------------|----------------|--------------------|--------------|-------------------|----------------|---------------------|--------|------------------|--|
| Year                    | Inflow | Evap. and Seepage | Demand on Res. |              | Content end of Year | Spills | Shortage | Inflow to Lovell Reservoir |                |                    |              | Evap. and Seepage | Demand on Res. | Content end of Year | Spills | Demand on Harlan |  |
|                         |        |                   | Above Lovell   | Below Lovell |                     |        |          | White Rock Creek           | Rep. Riv. Flow | Spills from Harlan | Total Inflow |                   |                |                     |        |                  |  |
| 1929                    | 344.5  | 27.9              | 126.7          | 32.8         | 250.0               | 235.3  | 0        | 12.8                       | 22.4           | 0                  | 35.2         | 4.1               | 63.5           | 36.0                | 18.2   | 32.8             |  |
| 1930                    | 500.3  | 20.0              | 126.3          | 34.4         | 250.0               | 241.4  | 0        | 9.4                        | 27.1           | 22.7               | 59.2         | 6.4               | 58.0           | 36.0                | 11.4   | 34.4             |  |
| 1931                    | 265.6  | 29.4              | 86.4           | 27.6         | 167.3               | 204.9  | 0        | 10.8                       | 42.1           | 15.3               | 68.2         | 6.4               | 67.9           | 29.3                | 28.2   | 27.6             |  |
| 1932                    | 179.3  | 27.4              | 74.4           | 29.6         | 161.4               | 53.8   | 0        | 6.0                        | 31.7           | 1.8                | 39.5         | 6.9               | 68.6           | 15.5                | 7.4    | 29.6             |  |
| 1933                    | 238.4  | 31.6              | 90.9           | 59.7         | 196.7               | 20.9   | 0        | 3.7                        | 16.5           | 20.9               | 41.1         | 5.3               | 94.2           | 16.8                | 0      | 59.7             |  |
| 1934                    | 164.6  | 38.1              | 163.9          | 113.1        | 85.9                | 35.5   | 75.2     | 1.1                        | 13.0           | 14.6               | 28.7         | 7.2               | 131.8          | 19.6                | 0      | 113.1            |  |
| 1935                    | 724.1  | 28.2              | 75.1           | 30.8         | 250.0               | 427.2  | 1.3      | 19.5                       | 98.4           | 0                  | 117.9        | 3.9               | 70.0           | 36.0                | 58.4   | 30.8             |  |
| 1936                    | 245.7  | 37.8              | 134.0          | 50.3         | 110.7               | 162.9  | 0        | 3.0                        | 22.0           | 11.9               | 36.9         | 9.1               | 95.6           | 15.8                | 2.7    | 50.3             |  |
| 1937                    | 136.4  | 28.2              | 92.6           | 46.8         | 87.8                | 0      | 8.3      | 5.2                        | 25.4           | 0                  | 30.6         | 5.0               | 72.3           | 15.9                | 0      | 46.8             |  |
| 1938                    | 215.6  | 34.3              | 75.9           | 22.3         | 170.9               | 0      | 0        | 15.1                       | 41.0           | 0                  | 56.1         | 4.0               | 61.7           | 16.1                | 12.5   | 22.3             |  |
| 1939                    | 206.2  | 45.5              | 96.7           | 54.0         | 113.4               | 67.5   | 0        | 4.7                        | 38.0           | 2.9                | 45.6         | 4.7               | 94.2           | 13.8                | 3.0    | 54.0             |  |
| 1940                    | 106.5  | 21.8              | 117.3          | 72.6         | 82.6                | 0      | 74.4     | 1.5                        | 24.8           | 0                  | 26.3         | 3.5               | 88.3           | 20.9                | 0      | 72.6             |  |
| 1941                    | 626.5  | 12.4              | 90.7           | 1.0          | 250.0               | 355.0  | 0        | 36.8                       | 78.9           | 38.1               | 153.8        | 3.0               | 43.1           | 36.0                | 93.6   | 1.0              |  |
| 1942                    | 583.0  | 23.5              | 21.9           | 0            | 250.0               | 537.6  | 0        | 19.7                       | 116.9          | 10.8               | 147.4        | 4.1               | 24.8           | 36.0                | 118.5  | 0                |  |
| 1943                    | 211.9  | 36.2              | 88.8           | 49.7         | 120.8               | 166.4  | 0        | 30.3                       | 61.7           | 0                  | 92.0         | 5.0               | 76.6           | 15.8                | 80.3   | 49.7             |  |
| 1944                    | 527.9  | 21.5              | 34.9           | 0            | 250.0               | 342.3  | 0        | 25.5                       | 79.9           | 2                  | 105.6        | 2.7               | 21.9           | 28.8                | 68.0   | 0                |  |
| 1945                    | 304.1  | 28.7              | 68.1           | 7.9          | 207.4               | 242.0  | 0        | 67.7                       | 82.8           | 0                  | 150.5        | 3.5               | 34.7           | 15.8                | 133.2  | 7.9              |  |
| 1946                    | 527.1  | 27.3              | 76.3           | 0            | 250.0               | 380.9  | 0        | 27.8                       | 69.9           | 42.2               | 139.9        | 4.1               | 60.9           | 36.0                | 54.7   | 0                |  |
| 1947                    | 664.2  | 27.3              | 99.9           | 23.9         | 171.8               | 591.3  | 0        | 35.3                       | 23.1           | 19.4               | 77.8         | 3.7               | 66.0           | 12.0                | 56.0   | 23.9             |  |
| Total                   | 6771.9 | 547.1             | 1740.8         | 656.5        | -78.2               | 4064.9 | 159.2    | 335.9                      | 915.6          | 200.8              | 1452.3       | 92.6              | 1294.1         | -24.0               | 746.1  | 656.5            |  |
| Ave.                    | 356.4  | 28.8              | 91.6           | 34.6         | -4.1                | 213.9  | 8.4      | 17.7                       | 48.2           | 10.5               | 76.4         | 4.9               | 68.1           | -1.3                | 39.3   | 34.6             |  |

Definite Plan Inflow used in this study irrigating 90,000 acres of which 36,500 are under Lovell

| Franklin & Red Cloud | 18,250 | Courtland, Kansas |        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------------|--------|-------------------|--------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| Superior             | 6,790  | above Lovell      | 12,500 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Courtland, Nebraska  | 2,960  | Below Lovell      | 36,500 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                      |        | Scandia           | 13,000 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total, Nebraska      | 28,000 | Total, Kansas     | 62,000 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

| Shortages | 1934 | 1935 | 1937 | 1940 |  |
|-----------|------|------|------|------|--|
|           | 75.2 | 1.3  | 8.3  | 74.4 |  |
|           | 14.7 |      | 1.8  | 15.6 |  |



Table 96. Summary of Harlan County Operation Study serving 80,000 acres without Lovewell. 1/

| Year | Inflow <u>1/</u> | Evap. and Seepage | Demand on Reserv. | Content end of Year | Spills | Shortages |         |
|------|------------------|-------------------|-------------------|---------------------|--------|-----------|---------|
|      |                  |                   |                   |                     |        | Ac.ft.    | Percent |
| 1929 | 344.5            | 27.4              | 168.3             | 165.8               | 233.0  |           |         |
| 1930 | 500.3            | 20.0              | 169.1             | 250.0               | 227.0  |           |         |
| 1931 | 265.6            | 29.1              | 132.6             | 159.9               | 194.0  |           |         |
| 1932 | 179.3            | 26.9              | 114.5             | 152.8               | 45.0   |           |         |
| 1933 | 238.4            | 32.0              | 154.0             | 202.7               | 2.5    |           |         |
| 1934 | 164.6            | 37.5              | 261.7             | 85.9                | 41.3   | 59.1      | 13.0    |
| 1935 | 724.1            | 26.8              | 121.5             | 250.0               | 419.0  | 7.3       | 1.7     |
| 1936 | 245.7            | 38.0              | 190.5             | 113.0               | 154.2  |           |         |
| 1937 | 136.4            | 27.5              | 134.6             | 87.9                | 0      | 0.6       | -       |
| 1938 | 215.6            | 33.2              | 111.7             | 158.6               | 0      |           |         |
| 1939 | 206.2            | 43.5              | 155.7             | 112.2               | 53.4   |           |         |
| 1940 | 106.5            | 21.6              | 179.5             | 82.6                | 0      | 64.9      | 15.2    |
| 1941 | 626.5            | 12.5              | 121.8             | 250.0               | 324.8  |           |         |
| 1942 | 583.0            | 23.5              | 31.3              | 250.0               | 528.2  |           |         |
| 1943 | 211.9            | 35.8              | 142.1             | 117.6               | 166.4  |           |         |
| 1944 | 527.9            | 21.6              | 42.6              | 241.6               | 339.7  |           |         |
| 1945 | 304.1            | 28.3              | 89.8              | 194.0               | 233.6  |           |         |
| 1946 | 527.1            | 27.0              | 114.3             | 250.0               | 329.8  |           |         |
| 1947 | 664.2            | 28.7              | 149.0             | 159.0               | 577.3  |           |         |
| Avg. | 356.4            | 28.5              | 136.0             |                     | 203.6  | 6.9       | 1.6     |

1/ Basin study inflow.

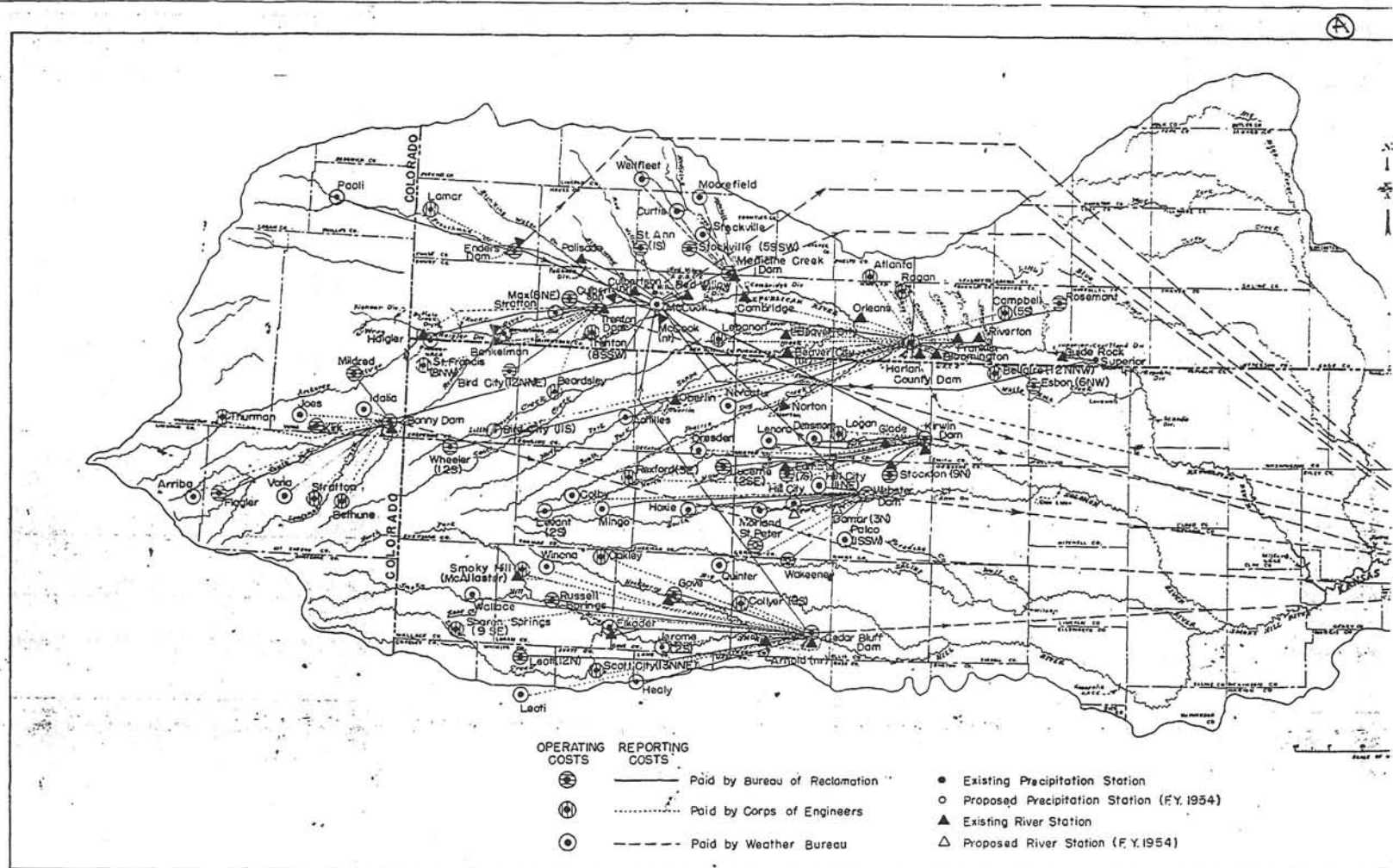
Table 97

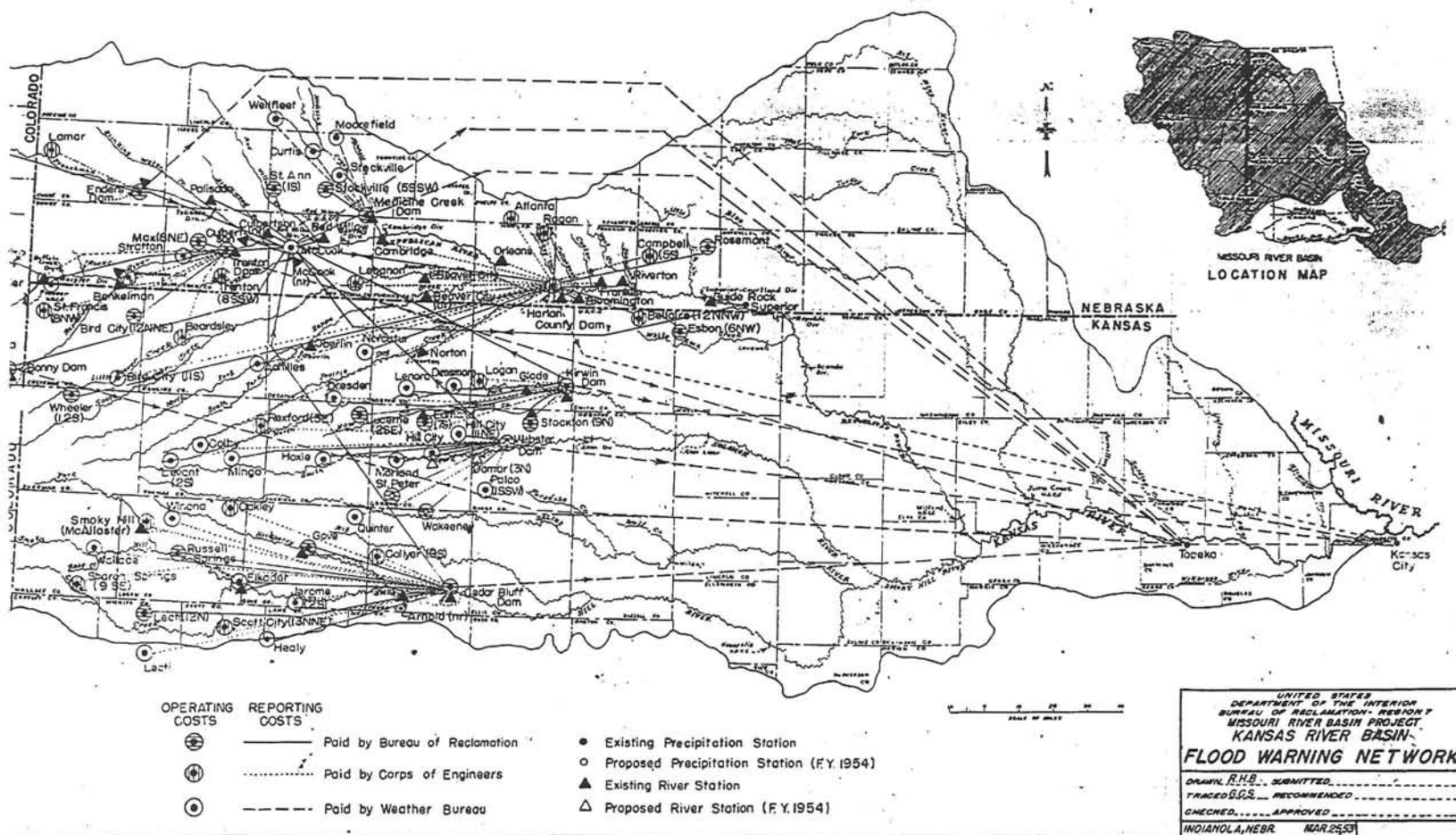
Table 97

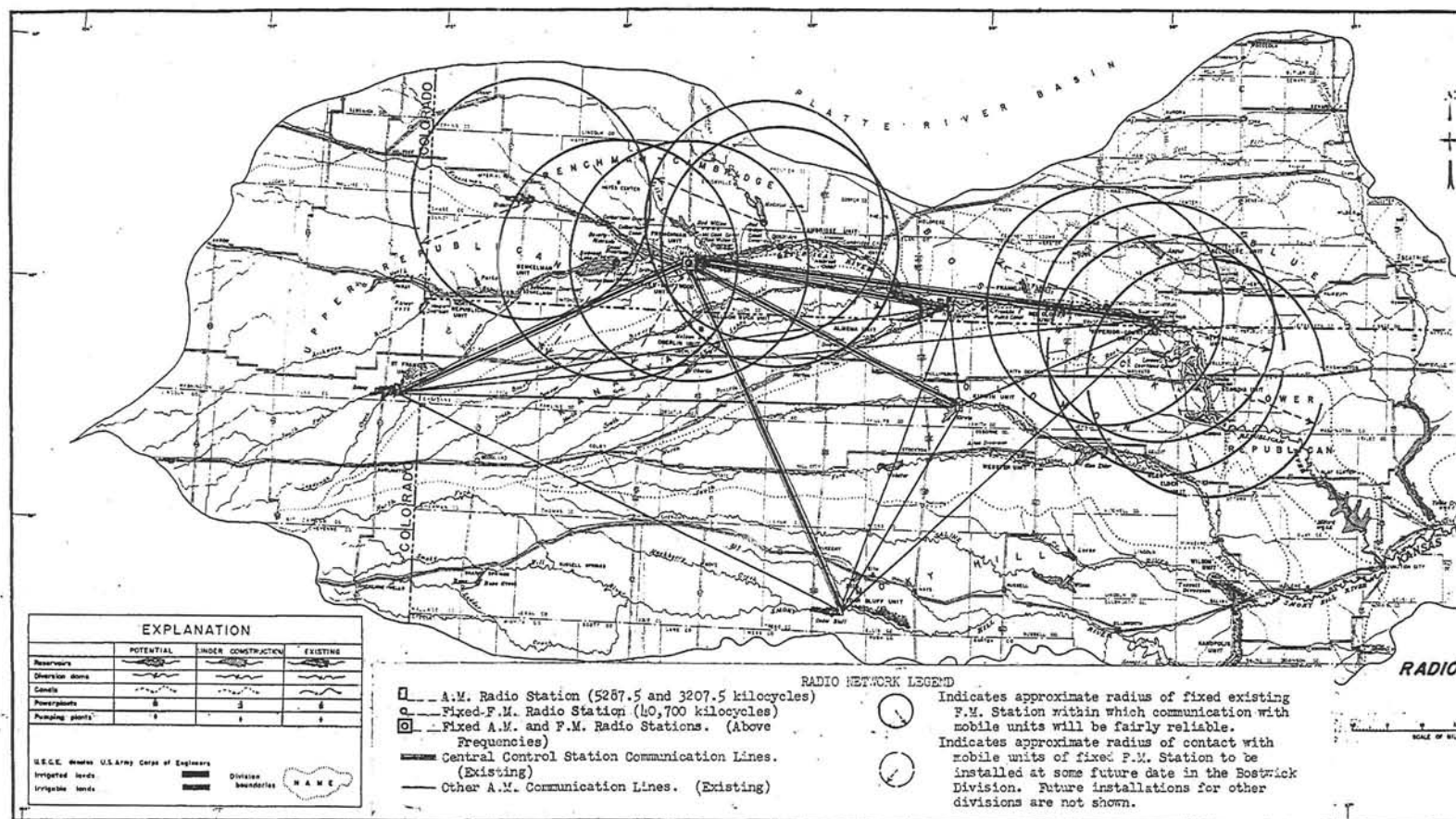
RESERVOIR OPERATION SUMMARY  
HARLAN COUNTY AND LOVELL RESERVOIRS  
UNIT 1,000 A. F.  
90,000 ACRES

| HARLAN COUNTY RESERVOIR |        |                   |              |              |                            |        |           |                        |                  | LOVELL RESERVOIR           |                    |              |                   |                |                     |        |                  |  |  |
|-------------------------|--------|-------------------|--------------|--------------|----------------------------|--------|-----------|------------------------|------------------|----------------------------|--------------------|--------------|-------------------|----------------|---------------------|--------|------------------|--|--|
| Demand on Reservoir     |        |                   |              |              | Inflow to Lovell Reservoir |        |           |                        |                  | Inflow to Lovell Reservoir |                    |              |                   |                | Demand on Res.      |        |                  |  |  |
| Year                    | Inflow | Evap. and Seepage | Above Lovell | Below Lovell | Content End of Year        | Spills | Short-age | Short-age in % of C.U. | White Rock Creek | Rep. River Flow            | Spills from Harlan | Total Inflow | Evap. and Seepage | Demand on Res. | Content End of Year | Spills | Demand on Harlan |  |  |
| 1929                    | 329.4  | 28.8              | 126.7        | 32.8         | 250.0                      | 225.9  | 0         |                        | 12.8             | 22.4                       | 0                  | 35.2         | 4.2               | 63.5           | 18.1                | 18.2   | 32.8             |  |  |
| 1930                    | 420.2  | 19.8              | 126.3        | 34.4         | 250.0                      | 154.9  | 0         |                        | 9.4              | 27.1                       | 0                  | 36.5         | 6.3               | 58.0           | 13.4                | 11.3   | 34.4             |  |  |
| 1931                    | 242.7  | 29.0              | 86.4         | 32.1         | 148.9                      | 196.3  | 0         |                        | 10.8             | 42.1                       | 32.1               | 85.0         | 5.9               | 67.9           | 29.3                | 27.4   | 32.1             |  |  |
| 1932                    | 143.8  | 26.8              | 74.4         | 29.7         | 148.7                      | 13.1   | 0         |                        | 6.0              | 31.7                       | 1.8                | 39.5         | 7.1               | 68.6           | 15.5                | 7.3    | 29.7             |  |  |
| 1933                    | 120.0  | 26.8              | 90.9         | 80.3         | 91.1                       | 0      | 20.4      | 4.2                    | 3.7              | 16.5                       | 0                  | 20.2         | 4.9               | 94.2           | 16.9                | 0      | 80.3             |  |  |
| 1934                    | 125.2  | 29.8              | 163.9        | 127.5        | 76.5                       | 0      | 181.4     | 36.9                   | 1.1              | 13.0                       | 0                  | 14.1         | 7.2               | 131.8          | 19.5                | 0      | 127.5            |  |  |
| 1935                    | 627.1  | 34.5              | 75.1         | 30.9         | 250.0                      | 323.8  | 10.7      | 2.3                    | 19.5             | 98.4                       | 0                  | 117.9        | 3.9               | 70.0           | 36.0                | 58.4   | 30.9             |  |  |
| 1936                    | 174.1  | 37.1              | 134.0        | 50.4         | 76.4                       | 126.2  | 0         |                        | 3.0              | 22.0                       | 11.9               | 36.9         | 9.1               | 95.6           | 15.8                | 2.8    | 50.4             |  |  |
| 1937                    | 97.3   | 23.1              | 92.6         | 46.8         | 77.4                       | 0      | 66.2      | 8.9                    | 5.2              | 25.4                       | 0                  | 30.6         | 5.0               | 72.3           | 15.9                | 0      | 46.8             |  |  |
| 1938                    | 134.2  | 26.5              | 75.9         | 22.0         | 87.2                       | 0      |           |                        | 15.1             | 44.0                       | 0                  | 56.1         | 4.2               | 61.4           | 16.1                | 12.3   | 22.0             |  |  |
| 1939                    | 131.9  | 33.4              | 96.7         | 54.0         | 71.3                       | 0      | 36.3      | 9.2                    | 4.7              | 38.0                       | 0                  | 42.7         | 4.9               | 94.2           | 13.6                | .1     | 54.0             |  |  |
| 1940                    | 64.5   | 18.5              | 117.3        | 72.7         | 73.1                       | 0      | 145.8     | 29.2                   | 1.5              | 24.8                       | 0                  | 26.3         | 3.4               | 88.3           | 20.9                | 0      | 72.7             |  |  |
| 1941                    | 514.9  | 11.8              | 90.7         | 1.0          | 250.0                      | 234.5  | 0         |                        | 36.8             | 78.9                       | 38.1               | 153.8        | 3.3               | 43.1           | 36.0                | 93.3   | 1.0              |  |  |
| 1942                    | 533.0  | 21.6              | 21.9         | 0            | 250.0                      | 189.5  | 0         |                        | 19.7             | 116.9                      | 10.6               | 147.2        | 3.9               | 24.8           | 36.0                | 118.5  | 0                |  |  |
| 1943                    | 187.9  | 35.9              | 88.8         | 49.7         | 104.5                      | 159.0  | 0         |                        | 30.3             | 61.7                       | 0                  | 92.0         | 4.9               | 76.6           | 15.9                | 80.3   | 49.7             |  |  |
| 1944                    | 469.2  | 21.3              | 34.9         | 0            | 240.5                      | 277.0  | 0         |                        | 25.5             | 79.9                       | 0                  | 105.4        | 2.8               | 21.9           | 28.5                | 68.1   | 0                |  |  |
| 1945                    | 270.9  | 28.3              | 68.1         | 7.9          | 203.2                      | 203.9  | 0         |                        | 67.7             | 82.8                       | 0                  | 150.5        | 3.4               | 34.7           | 15.8                | 133.0  | 7.9              |  |  |
| 1946                    | 425.7  | 25.7              | 76.3         | 38.2         | 250.0                      | 238.7  | 0         |                        | 27.8             | 69.9                       | 0                  | 97.7         | 3.1               | 60.9           | 36.0                | 51.7   | 38.2             |  |  |
| 1947                    | 633.0  | 27.3              | 99.9         | 23.7         | 165.2                      | 566.9  | 0         |                        | 35.3             | 23.1                       | 19.4               | 77.8         | 3.5               | 66.0           | 12.0                | 56.0   | 23.7             |  |  |
| Total                   | 5645.0 | 506.0             | 1740.8       | 734.1        | -84.8                      | 3209.7 | 460.8     |                        | 335.9            | 915.6                      | 113.9              | 1365.4       | 91.0              | 1293.8         | -24.0               | 735.7  | 734.1            |  |  |
| Ave.                    | 297.0  | 26.6              | 91.6         | 38.6         | -4.5                       | 168.9  | 24.2      |                        | 17.7             | 48.2                       | 6.0                | 71.9         | 4.8               | 68.1           | -1.3                | 38.9   | 38.6             |  |  |

"Compact study" inflow used in this study, irrigating 90,000 acres of which 36,500 are under Lovell.







3

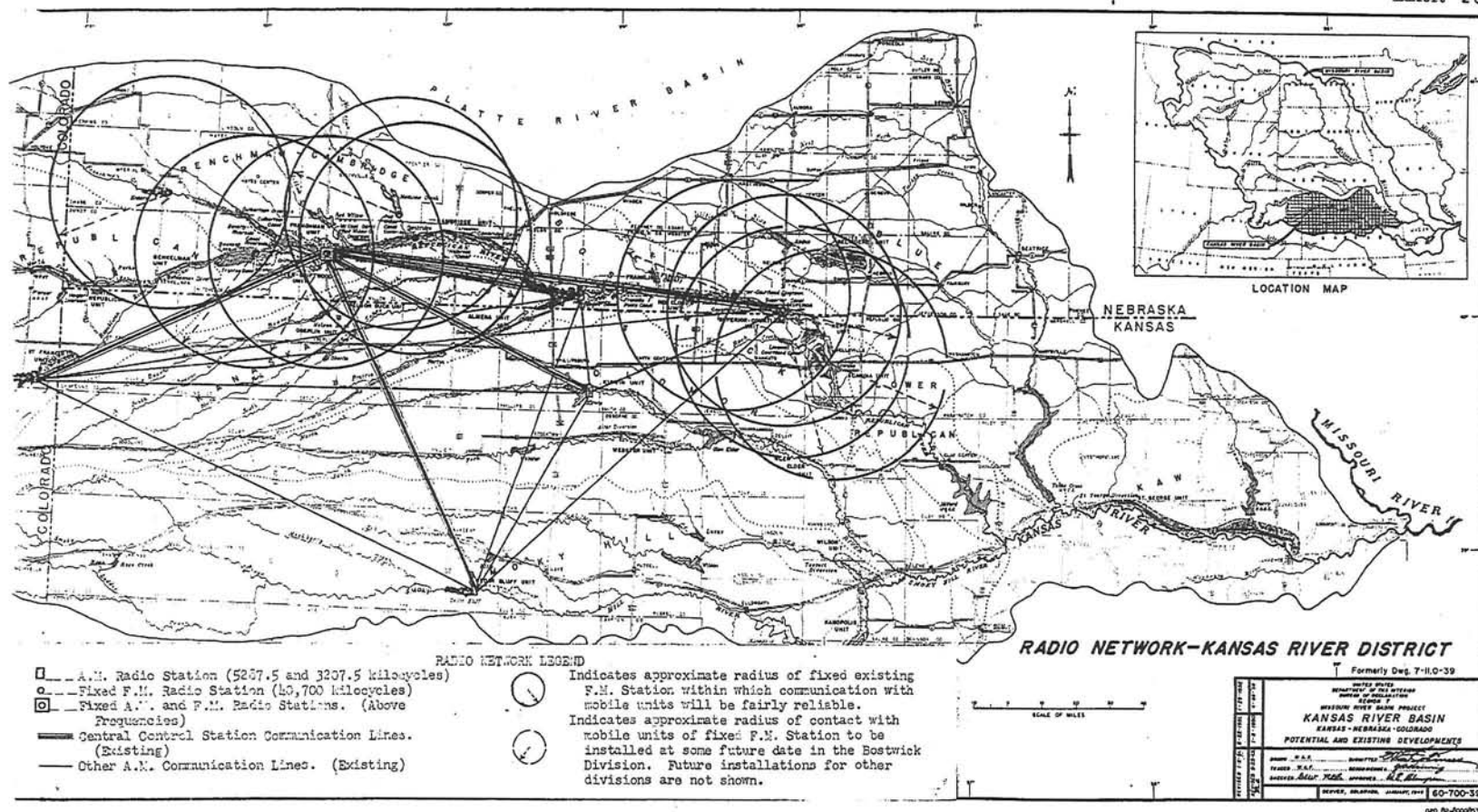




Table 98 . Storage delivery from Harlan County Reservoir

| Year    | <u>Basin Study</u> |       |        |         |         | <u>Compact Study</u> |       |        |         |         |
|---------|--------------------|-------|--------|---------|---------|----------------------|-------|--------|---------|---------|
|         | Nebr.              | Kans. | Total  | % Nebr. | % Kans. | Nebr.                | Kans. | Total  | % Nebr. | % Kans. |
| 1929    | 24.9               | 59.9  | 84.8   | 29.4    | 70.6    | 28.7                 | 54.2  | 82.9   | 34.6    | 65.4    |
| 1930    | 31.0               | 58.3  | 89.3   | 34.7    | 65.3    | 41.3                 | 61.5  | 102.8  | 40.2    | 59.8    |
| 1931    | 23.8               | 50.0  | 73.8   | 32.2    | 67.8    | 29.8                 | 52.7  | 82.5   | 36.1    | 63.9    |
| 1932    | 32.4               | 45.5  | 77.9   | 41.6    | 58.4    | 35.3                 | 46.3  | 81.6   | 43.3    | 56.7    |
| 1933    | 35.9               | 68.2  | 104.1  | 34.5    | 65.5    | 55.9                 | 81.5  | 137.4  | 40.7    | 59.3    |
| 1934    | 50.1               | 95.1  | 145.2  | 34.5    | 65.5    | 26.0                 | 39.7  | 65.7   | 39.6    | 60.4    |
| 1935    | 21.2               | 34.7  | 55.9   | 37.9    | 62.1    | 24.3                 | 28.2  | 52.5   | 46.3    | 53.7    |
| 1936    | 42.8               | 84.0  | 126.8  | 33.8    | 66.2    | 63.2                 | 88.9  | 152.1  | 41.6    | 58.4    |
| 1937    | 12.2               | 73.0  | 85.2   | 14.3    | 85.7    | 9.5                  | 20.8  | 30.3   | 31.4    | 68.6    |
| 1938    | 3.4                | 29.0  | 32.4   | 10.5    | 89.5    | 10.6                 | 37.9  | 48.5   | 21.9    | 78.1    |
| 1939    | 35.4               | 81.2  | 116.6  | 30.4    | 69.6    | 19.5                 | 56.6  | 76.1   | 25.6    | 74.4    |
| 1940    | 12.2               | 50.8  | 63.0   | 19.4    | 80.6    | 5.7                  | 9.9   | 15.6   | 36.5    | 63.5    |
| 1941    | 0                  | 4.0   | 4.0    | 0       | 100.0   | 0.5                  | 10.0  | 10.5   | 4.8     | 95.2    |
| 1942    | 0                  | 0     | 0      | 0       | 0       | 0                    | 0     | 0      | 0       | 0       |
| 1943    | 36.7               | 79.8  | 116.5  | 31.5    | 68.5    | 47.5                 | 81.6  | 129.1  | 36.8    | 63.2    |
| 1944    | 6.0                | 0     | 6.0    | 100.0   | 0       | 10.4                 | 0     | 10.4   | 100.0   | 0       |
| 1945    | 24.9               | 17.5  | 42.4   | 58.7    | 41.3    | 27.0                 | 18.5  | 45.5   | 59.3    | 40.7    |
| 1946    | 6.2                | 11.9  | 18.1   | 34.2    | 65.8    | 11.2                 | 12.3  | 23.5   | 47.7    | 52.3    |
| 1947    | 18.0               | 44.2  | 62.2   | 29.0    | 71.0    | 24.7                 | 44.2  | 68.9   | 35.8    | 64.2    |
| 1929-47 | 417.1              | 887.1 | 1304.2 | 32.0    | 68.0    | 471.1                | 744.8 | 1215.9 | 38.7    | 61.3    |
| 1930-40 | 300.4              | 669.8 | 970.2  | 31.0    | 69.0    | 321.1                | 524.0 | 845.1  | 38.0    | 62.0    |
| 1941-47 | 91.8               | 157.4 | 249.2  | 36.8    | 63.2    | 121.3                | 166.6 | 287.9  | 42.1    | 57.9    |



# USES OF WATER IN COLORADO

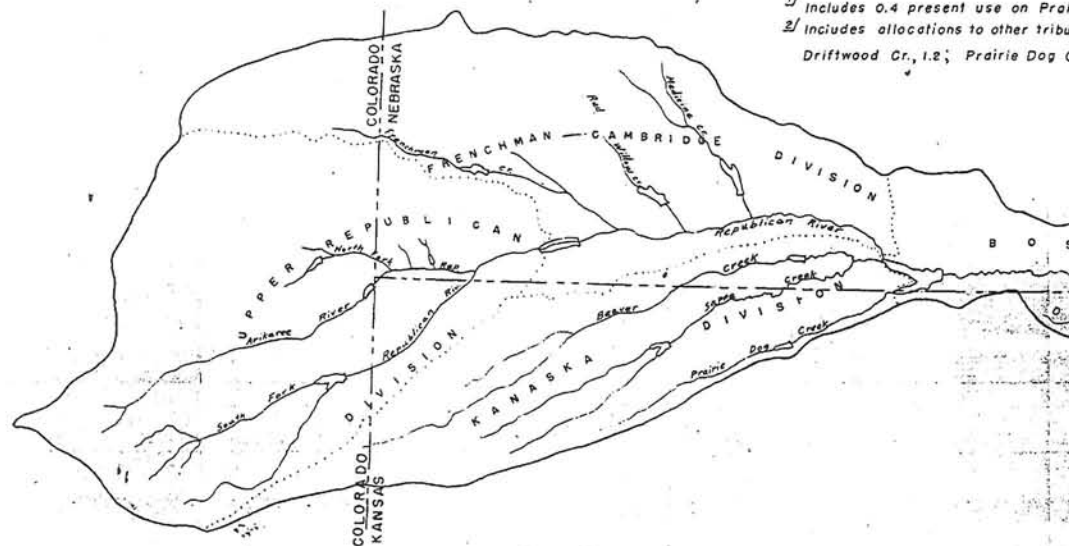
| USE                          | FRENCHMAN CR. |       | N. FORK REP. RIV. |       | ARIKAREE RIVER |       | S. FORK REP. RIV. |       | BEAVER CREEK |       | TOTALS  |       |
|------------------------------|---------------|-------|-------------------|-------|----------------|-------|-------------------|-------|--------------|-------|---------|-------|
|                              | COMPACT       | BASIN | COMPACT           | BASIN | COMPACT        | BASIN | COMPACT           | BASIN | COMPACT      | BASIN | COMPACT | BASIN |
| FUTURE PRACTICAL DEVELOPMENT | 2.3           | 2.3   | 1.9               | 1.9   | 0.7            | 3.5   | 10.4              | 10.1  | 0.2          | 0.2   | 15.5    | 18.0  |
| PRESENT USE                  | 0.0           | 0.0   | 5.5               | 2.2   | 2.2            | 0.0   | 4.8               | 0.0   | 0.0          | 0.0   | 17.9    | 17.9  |
| ADDITIONAL DEPLECTIONS       | 1.0           | 0.0   | 2.5               | 0.0   | 12.5           | 0.0   | 0.0               | 0.0   | 3.1          | 0.0   | 25.0    | 0.0   |
| TOTAL                        | 3.3           | 2.3   | 10.0              | 7.4   | 15.4           | 3.5   | 25.4              | 20.3  | 3.3          | 0.2   | 57.4    | 35.9  |
| COMPACT ALLOCATION           | 3.3           | 3.3   | 10.0              | 10.0  | 15.4           | 25.4  | 25.4              | 3.3   | 3.3          | 3.3   | 57.4    | 57.4  |

Includes entire water supply of Frenchman Creek in Colorado, estimated to be 3,300 acre-feet.

# USES OF WATER IN NEBRASKA

| USE                          | N. FORK REP. |       | BUFFALO & ROCK CREEKS |       | FRENCHMAN CR. |       | RED WILLOW CR. |       | MEDICINE CR. |       | BEAVER CREEK |       |
|------------------------------|--------------|-------|-----------------------|-------|---------------|-------|----------------|-------|--------------|-------|--------------|-------|
|                              | COMPACT      | BASIN | COMPACT               | BASIN | COMPACT       | BASIN | COMPACT        | BASIN | COMPACT      | BASIN | COMPACT      | BASIN |
| FUTURE PRACTICAL DEVELOPMENT | 5.2          | 5.6   | 6.0                   | 6.1   | 31.1          | 29.0  | 2.9            | 10.6  | 23.4         | 17.4  | 3.8          | 4.8   |
| PRESENT USE                  | 5.0          | 5.0   | 1.2                   | 1.2   | 15.0          | 15.0  | 0.8            | 0.8   | 0.5          | 0.5   | 0.2          | 0.2   |
| ADDITIONAL DEPLECTIONS       | 0.0          | 0.0   | 0.0                   | 0.0   | 0.0           | 0.0   | 0.0            | 0.0   | 0.0          | 0.0   | 2.7          | 0.0   |
| TOTAL                        | 10.2         | 10.6  | 7.2                   | 7.3   | 46.1          | 44.0  | 10.7           | 11.4  | 23.9         | 17.9  | 6.7          | 5.0   |
| COMPACT ALLOCATION           | 11.0         | 11.0  | 7.0                   | 7.0   | 52.8          | 52.8  | 4.2            | 4.2   | 4.6          | 4.6   | 6.7          | 6.7   |

1/ Includes 0.4 present use on Platte  
2/ Includes allocations to other tributaries: Driftwood Cr., 1.2; Prairie Dog Cr.



# USES OF WATER IN KANSAS

| USE                          | ARIKAREE R. |       | S. FORK REPUBLICAN |       | BEAVER CR. |       | SAPPA CR. |       | PRAIRIE DOG |       |
|------------------------------|-------------|-------|--------------------|-------|------------|-------|-----------|-------|-------------|-------|
|                              | COMPACT     | BASIN | COMPACT            | BASIN | COMPACT    | BASIN | COMPACT   | BASIN | COMPACT     | BASIN |
| FUTURE PRACTICAL DEVELOPMENT | 0.0         | 0.0   | 6.7                | 7.9   | 4.1        | 4.1   | 6.3       | 6.5   | 11.6        | 11.6  |
| PRESENT USE                  | 0.0         | 0.0   | 4.9                | 4.9   | 0.0        | 0.0   | 0.2       | 0.2   | 0.4         | 0.4   |
| ADDITIONAL DEPLECTIONS       | 1.0         | 0.0   | 11.3               | 0.0   | 2.8        | 0.0   | 2.2       | 0.0   | 0.6         | 0.6   |
| TOTAL                        | 1.0         | 0.0   | 22.9               | 12.8  | 6.9        | 4.1   | 8.7       | 6.7   | 12.6        | 12.6  |
| COMPACT ALLOCATION           | 1.0         | 1.0   | 23.0               | 23.0  | 6.4        | 6.4   | 9.8       | 9.8   | 12.6        | 12.6  |

Includes allocation

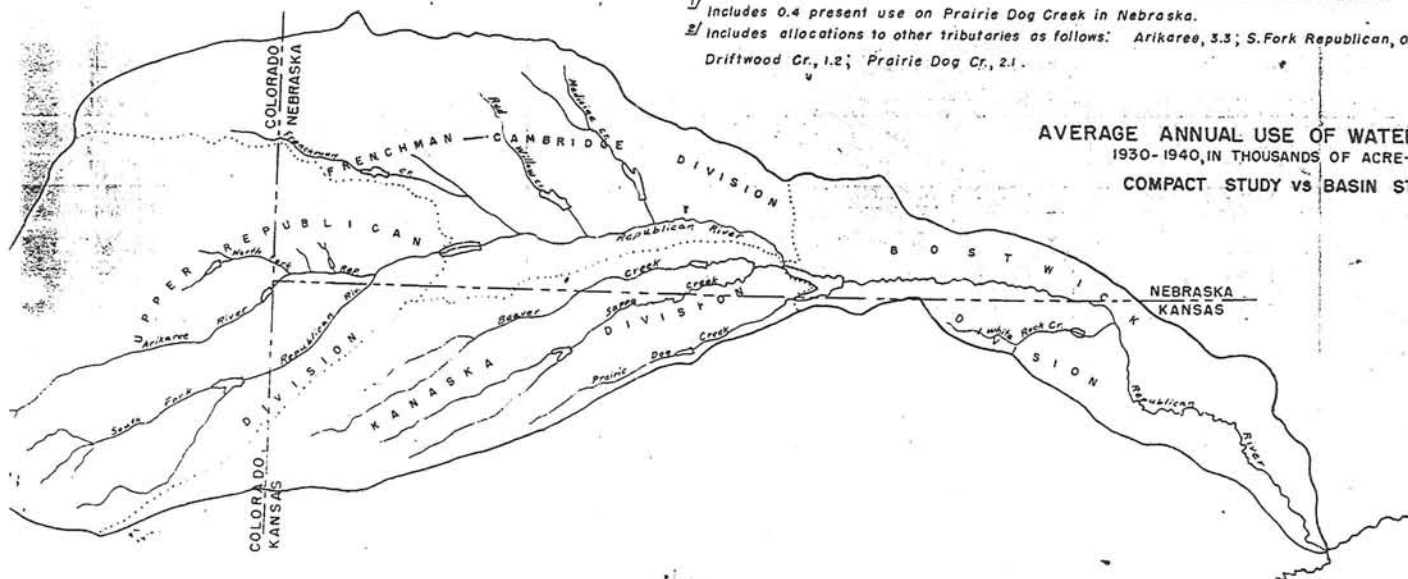
## USES OF WATER IN NEBRASKA

| USE                          | N. FORK REP. |       | BUFFALO & ROCK CREEKS |       | FRENCHMAN CR. |       | RED WILLOW CR. |       | MEDICINE CR. |       | BEAVER CREEK |       | SAPPA CREEK |       | MAIN STEM REP. |       | TOTALS  |       |
|------------------------------|--------------|-------|-----------------------|-------|---------------|-------|----------------|-------|--------------|-------|--------------|-------|-------------|-------|----------------|-------|---------|-------|
|                              | COMPACT      | BASIN | COMPACT               | BASIN | COMPACT       | BASIN | COMPACT        | BASIN | COMPACT      | BASIN | COMPACT      | BASIN | COMPACT     | BASIN | COMPACT        | BASIN | COMPACT | BASIN |
| FUTURE PRACTICAL DEVELOPMENT | 5.2          | 5.6   | 6.0                   | 6.1   | 31.1          | 29.0  | 9.9            | 10.6  | 23.4         | 17.4  | 3.8          | 4.8   | 1.6         | 1.6   | 110.9          | 118.9 | 191.9   | 194.0 |
| PRESENT USE                  | 5.0          | 5.0   | 1.2                   | 1.2   | 15.0          | 15.0  | 0.8            | 0.8   | 0.5          | 0.5   | 0.2          | 0.2   | 0.2         | 0.2   | 2.5            | 2.5   | 25.6    | 25.6  |
| ADDITIONAL DEPLETIONS        | 0.0          | 0.0   | 0.0                   | 0.0   | 0.0           | 0.0   | 0.0            | 0.0   | 0.0          | 0.0   | 0.0          | 0.0   | 0.0         | 0.0   | 0.0            | 0.0   | 0.0     | 0.0   |
| TOTAL                        | 10.2         | 10.6  | 7.2                   | 7.3   | 46.1          | 44.0  | 10.7           | 11.4  | 23.9         | 17.9  | 6.7          | 5.0   | 6.7         | 1.8   | 121.9          | 121.4 | 217.5   | 219.6 |
| COMPACT ALLOCATION           | 11.0         | 11.0  | 7.0                   | 7.0   | 52.8          | 52.8  | 4.2            | 4.2   | 4.6          | 4.6   | 6.7          | 6.7   | 8.8         | 8.8   | 132.0          | 132.0 | 234.5   | 234.5 |

1/ Includes 0.4 present use on Prairie Dog Creek in Nebraska.

2/ Includes allocations to other tributaries as follows: Arikaree, 3.3; S. Fork Republican, 0.6; Driftwood Cr., 1.2; Prairie Dog Cr., 2.1.

AVERAGE ANNUAL USE OF WATER BY STATES  
1930-1940, IN THOUSANDS OF ACRE-FEET  
COMPACT STUDY VS BASIN STUDY



## USES OF WATER IN KANSAS

| USE                          | ARIKAREE R. |       | S. FORK REPUBLICAN |       | BEAVER CR. |       | SAPPA CR. |       | PRAIRIE DOG CR. |       | REPUBLICAN R. |       | TOTALS  |       |
|------------------------------|-------------|-------|--------------------|-------|------------|-------|-----------|-------|-----------------|-------|---------------|-------|---------|-------|
|                              | COMPACT     | BASIN | COMPACT            | BASIN | COMPACT    | BASIN | COMPACT   | BASIN | COMPACT         | BASIN | COMPACT       | BASIN | COMPACT | BASIN |
| FUTURE PRACTICAL DEVELOPMENT | 0.0         | 0.0   | 6.7                | 7.9   | 4.1        | 4.1   | 6.3       | 6.6   | 11.6            | 10.7  | 77.9          | 93.0  | 105.6   | 122.2 |
| PRESENT USE                  | 0.0         | 0.0   | 4.9                | 4.9   | 0.0        | 0.0   | 0.2       | 0.2   | 0.4             | 0.4   | 0.0           | 0.0   | 5.5     | 5.5   |
| ADDITIONAL DEPLETIONS        | 1.0         | 0.0   | 11.3               | 0.0   | 2.8        | 0.0   | 2.2       | 0.0   | 0.6             | 0.0   | 0.0           | 0.0   | 17.9    | 0.0   |
| TOTAL                        | 1.0         | 0.0   | 22.9               | 12.8  | 6.9        | 4.1   | 8.7       | 6.7   | 12.6            | 11.1  | 77.9          | 93.0  | 129.0   | 127.7 |
| COMPACT ALLOCATION           | 1.0         | 1.0   | 23.0               | 23.0  | 6.4        | 6.4   | 8.8       | 8.8   | 12.6            | 12.6  | 136.0         | 136.0 | 190.3   | 190.3 |

1/ Includes allocation of 0.5 for Driftwood Cr. in Kansas.

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
MISSOURI RIVER BASIN PROJECT  
REPUBLICAN RIVER BASIN  
USE OF WATER  
COMPACT STUDY VS BASIN STUDY

DRAWN: \_\_\_\_\_ SUBMITTED: \_\_\_\_\_  
TRACED: \_\_\_\_\_ RECOMMENDED: \_\_\_\_\_  
CHECKED: \_\_\_\_\_ APPROVED: \_\_\_\_\_  
INDIANOLA, NEBR. 9-12-50

Table 99. Flow of Republican River passing Nebraska-Kansas State Line based on Operation of Harlan County and Lovewell Reservoirs -

| Year    | Irrigation releases<br>from Harlan Co. Res. |                           |         | Unusable natural flow<br>passing Nebr.-Kans. State Line |                           |         | Other releases |              | Spills<br>Diverted<br>to<br>Lovewell | Shortage<br>to<br>Kansas<br>Lands | Releases<br>and Usable<br>Nat. flow<br>crossing<br>State Line |
|---------|---------------------------------------------|---------------------------|---------|---------------------------------------------------------|---------------------------|---------|----------------|--------------|--------------------------------------|-----------------------------------|---------------------------------------------------------------|
|         | Courtland<br>Kansas above                   | Courtland<br>Kansas below | Scandia | Courtland<br>Kansas above                               | Courtland<br>Kansas below | Scandia | River Loss     | PMS Releases |                                      |                                   |                                                               |
|         | Lovewell                                    | Lovewell                  | Unit    | Lovewell                                                | Lovewell                  | Unit    | Kansas         | Scandia      |                                      |                                   |                                                               |
| (1)     | (2)                                         | (3)                       | (4)     | (5)                                                     | (6)                       | (7)     | (8)            | (9)          | (10)                                 | (11)                              | (12)                                                          |
| 1929    | 19.7                                        | 32.8                      | 10.4    | 2.1                                                     | 5.8                       | 3.0     | 0              | 3.2          | 0                                    |                                   | 77.0                                                          |
| 1930    | 20.0                                        | 34.4                      | 10.2    | 0                                                       | 16.1                      | 1.0     | 0              | 3.2          | 0                                    |                                   | 84.9                                                          |
| 1931    | 23.1                                        | 32.1                      | 5.9     | 0.2                                                     | 16.9                      | 7.4     | 0              | 3.8          | 32.1                                 |                                   | 121.5                                                         |
| 1932    | 18.3                                        | 29.7                      | 0       | 5.3                                                     | 24.4                      | 4.8     | 0              | 0.6          | 1.8                                  |                                   | 84.9                                                          |
| 1933    | 17.3                                        | 80.3                      | 6.8     | 15.1                                                    | 16.5                      | 15.8    | 0.8            | 3.8          | 0                                    | 14.1                              | 142.3                                                         |
| 1934    | 44.2                                        | 127.5                     | 16.9    | 1.1                                                     | 13.0                      | 10.4    | 0.1            | 6.4          | 0                                    | 125.0                             | 94.6                                                          |
| 1935    | 17.0                                        | 30.9                      | 4.2     | 7.1                                                     | 41.3                      | 9.6     | 0              | 3.2          | 0                                    | 7.4                               | 105.9                                                         |
| 1936    | 25.3                                        | 50.4                      | 14.9    | 7.5                                                     | 20.4                      | 15.5    | 0              | 4.8          | 11.9                                 |                                   | 150.7                                                         |
| 1937    | 18.1                                        | 46.8                      | 9.9     | 6.7                                                     | 25.4                      | 12.5    | 0.3            | 3.2          | 0                                    | 45.6                              | 77.3                                                          |
| 1938    | 12.2                                        | 22.0                      | 6.4     | 9.0                                                     | 29.4                      | 10.6    | 0              | 2.2          | 0                                    |                                   | 91.8                                                          |
| 1939    | 26.9                                        | 54.0                      | 2.4     | 5.5                                                     | 37.9                      | 12.6    | 1.4            | 2.1          | 0                                    | 24.9                              | 117.9                                                         |
| 1940    | 23.2                                        | 72.7                      | 15.5    | 7.2                                                     | 24.8                      | 12.1    | 0.1            | 5.0          | 0                                    | 100.4                             | 60.2                                                          |
| 1941    | 14.8                                        | 1.0                       | 0       | 0                                                       | 11.9                      | 0.8     | 0              | 0            | 38.1                                 |                                   | 66.6                                                          |
| 1942    | 0                                           | 0                         | 0       | 8.5                                                     | 13.2                      | 7.9     | 0              | 0            | 10.6                                 |                                   | 40.2                                                          |
| 1943    | 23.6                                        | 49.7                      | 6.5     | 2.8                                                     | 12.5                      | 8.6     | 0              | 3.2          | 0                                    |                                   | 106.9                                                         |
| 1944    | 0                                           | 0                         | 0       | 7.5                                                     | 61.8                      | 3.1     | 0              | 0            | 0                                    |                                   | 72.4                                                          |
| 1945    | 9.6                                         | 7.9                       | 0       | 2.3                                                     | 0                         | 3.4     | 0              | 1.4          | 0                                    |                                   | 24.6                                                          |
| 1946    | 13.1                                        | 38.2                      | 2.9     | 7.8                                                     | 25.1                      | 10.4    | 0              | 1.7          | 0                                    |                                   | 99.2                                                          |
| 1947    | 19.8                                        | 23.7                      | 4.4     | 2.9                                                     | 0                         | 8.1     | 0              | 3.2          | 19.4                                 |                                   | 81.5                                                          |
| 1929-47 |                                             |                           |         |                                                         |                           |         |                |              |                                      |                                   |                                                               |
| Total   | 346.2                                       | 734.1                     | 117.3   | 98.6                                                    | 396.4                     | 157.6   | 2.7            | 51.0         | 113.9                                | 317.4                             | 1700.4                                                        |
| Avg.    | 18.2                                        | 38.6                      | 6.2     | 5.2                                                     | 20.9                      | 8.3     | 0.1            | 2.7          | 6.0                                  | 16.7                              | 89.5                                                          |
| 1930-40 |                                             |                           |         |                                                         |                           |         |                |              |                                      |                                   |                                                               |
| Total   | 245.6                                       | 580.8                     | 93.1    | 64.7                                                    | 266.1                     | 112.3   | 2.7            | 38.3         | 45.8                                 | 317.4                             | 1132.0                                                        |
| Avg.    | 22.3                                        | 52.8                      | 8.5     | 5.9                                                     | 24.2                      | 10.2    | 0.2            | 3.5          | 4.2                                  | 28.9                              | 102.9                                                         |

Table 99

Table 99. Flow of Republican River passing Nebraska-Kansas State line based on Operation of Harlan County and Lovewell Reservoirs - "Compact Study" November 1952

| Operation releases<br>in Harlan Co. Res. |                 | Unusable natural flow<br>passing Nebr.-Kans. State line |                                       |                 |                      | Other releases          |  | Spills<br>Diverted<br>to | Shortage<br>to | Releases<br>and Usable<br>Nat. flow<br>crossing<br>State line | Unusable<br>Waste<br>passing<br>State<br>line | Unusable<br>Spills<br>from<br>Harlan<br>County | Total<br>Unused<br>water<br>passing<br>State line | Total<br>flow<br>passing<br>State<br>line |
|------------------------------------------|-----------------|---------------------------------------------------------|---------------------------------------|-----------------|----------------------|-------------------------|--|--------------------------|----------------|---------------------------------------------------------------|-----------------------------------------------|------------------------------------------------|---------------------------------------------------|-------------------------------------------|
| Courtland<br>Kansas below<br>Lovewell    | Scandia<br>Unit | Courtland<br>Kansas above<br>Lovewell                   | Courtland<br>Kansas below<br>Lovewell | Scandia<br>Unit | River Loss<br>Kansas | PHS Releases<br>Scandia |  | Lovewell                 | Lans           |                                                               |                                               |                                                |                                                   |                                           |
| (3)                                      | (4)             | (5)                                                     | (6)                                   | (7)             | (8)                  | (9)                     |  | (10)                     | (11)           | (12)                                                          | (13)                                          | (14)                                           | (15)                                              | (16)                                      |
| 32.8                                     | 10.4            | 2.1                                                     | 5.8                                   | 3.0             | 0                    | 3.2                     |  | 0                        |                | 77.0                                                          | 21.9                                          | 225.9                                          | 247.8                                             | 324.8                                     |
| 34.4                                     | 10.2            | 0                                                       | 16.1                                  | 1.0             | 0                    | 3.2                     |  | 0                        |                | 84.9                                                          | 30.3                                          | 154.9                                          | 185.2                                             | 270.1                                     |
| 32.1                                     | 5.9             | 0.2                                                     | 16.9                                  | 7.4             | 0                    | 3.8                     |  | 32.1                     |                | 121.5                                                         | 24.4                                          | 164.9                                          | 189.3                                             | 310.8                                     |
| 29.7                                     | 0               | 5.3                                                     | 24.4                                  | 4.8             | 0                    | 0.6                     |  | 1.8                      |                | 84.9                                                          | 74.9                                          | 11.3                                           | 86.2                                              | 171.1                                     |
| 80.3                                     | 6.8             | 15.1                                                    | 16.5                                  | 15.8            | 0.8                  | 3.8                     |  | 0                        | 14.1           | 142.3                                                         | 15.1                                          | 0                                              | 15.1                                              | 157.4                                     |
| 127.5                                    | 16.9            | 1.1                                                     | 13.0                                  | 10.4            | 0.1                  | 6.4                     |  | 0                        | 125.0          | 94.6                                                          | 26.1                                          | 0                                              | 26.1                                              | 120.7                                     |
| 30.9                                     | 4.2             | 7.1                                                     | 41.3                                  | 9.6             | 0                    | 3.2                     |  | 0                        | 7.4            | 105.9                                                         | 52.6                                          | 323.8                                          | 376.4                                             | 482.3                                     |
| 50.4                                     | 14.9            | 7.5                                                     | 20.4                                  | 15.5            | 0                    | 4.8                     |  | 11.9                     |                | 150.7                                                         | 10.1                                          | 114.3                                          | 124.4                                             | 275.1                                     |
| 46.8                                     | 9.9             | 6.7                                                     | 25.4                                  | 12.5            | 0.8                  | 3.2                     |  | 0                        | 45.6           | 77.3                                                          | 21.2                                          | 0                                              | 21.2                                              | 98.5                                      |
| 22.0                                     | 6.4             | 9.0                                                     | 29.4                                  | 10.6            | 0                    | 2.2                     |  | 0                        |                | 91.8                                                          | 21.4                                          | 0                                              | 21.4                                              | 113.2                                     |
| 54.0                                     | 2.4             | 5.5                                                     | 37.9                                  | 12.6            | 1.4                  | 2.1                     |  | 0                        | 24.9           | 117.9                                                         | 23.3                                          | 0                                              | 23.3                                              | 141.2                                     |
| 72.7                                     | 15.5            | 7.2                                                     | 24.8                                  | 12.1            | 0.1                  | 5.0                     |  | 0                        | 100.4          | 60.2                                                          | 20.1                                          | 0                                              | 20.1                                              | 80.3                                      |
| 1.0                                      | 0               | 0                                                       | 11.9                                  | 0.8             | 0                    | 0                       |  | 38.1                     |                | 66.6                                                          | 49.0                                          | 196.4                                          | 245.4                                             | 312.0                                     |
| 0                                        | 0               | 8.5                                                     | 13.2                                  | 7.9             | 0                    | 0                       |  | 10.6                     |                | 40.2                                                          | 62.2                                          | 478.9                                          | 541.1                                             | 581.3                                     |
| 49.7                                     | 6.5             | 2.8                                                     | 12.5                                  | 8.6             | 0                    | 3.2                     |  | 0                        |                | 106.9                                                         | 52.7                                          | 159.0                                          | 211.7                                             | 318.6                                     |
| 0                                        | 0               | 7.5                                                     | 61.8                                  | 3.1             | 0                    | 0                       |  | 0                        |                | 72.4                                                          | 41.6                                          | 277.0                                          | 318.6                                             | 391.0                                     |
| 7.9                                      | 0               | 2.3                                                     | 0                                     | 3.4             | 0                    | 1.4                     |  | 0                        |                | 24.6                                                          | 52.8                                          | 203.9                                          | 256.7                                             | 281.3                                     |
| 38.2                                     | 2.9             | 7.8                                                     | 25.1                                  | 10.4            | 0                    | 1.7                     |  | 0                        |                | 99.2                                                          | 44.2                                          | 238.7                                          | 283.5                                             | 382.7                                     |
| 23.7                                     | 4.4             | 2.9                                                     | 0                                     | 8.1             | 0                    | 3.2                     |  | 19.4                     |                | 81.5                                                          | 23.9                                          | 547.5                                          | 571.4                                             | 652.9                                     |
| 734.1                                    | 117.3           | 98.6                                                    | 396.4                                 | 157.6           | 2.7                  | 51.0                    |  | 113.9                    | 317.4          | 1700.4                                                        | 668.4                                         | 3096.5                                         | 3764.9                                            | 5465.3                                    |
| 38.6                                     | 6.2             | 5.2                                                     | 20.9                                  | 8.3             | 0.1                  | 2.7                     |  | 6.0                      | 16.7           | 89.5                                                          | 35.2                                          | 163.0                                          | 198.2                                             | 287.7                                     |
| 580.8                                    | 93.1            | 64.7                                                    | 266.1                                 | 112.3           | 2.7                  | 38.3                    |  | 45.8                     | 317.4          | 1132.0                                                        | 319.5                                         | 769.2                                          | 1088.7                                            | 2220.7                                    |
| 52.8                                     | 8.5             | 5.9                                                     | 24.2                                  | 10.2            | 0.2                  | 3.5                     |  | 4.2                      | 28.9           | 102.9                                                         | 29.1                                          | 69.9                                           | 99.0                                              | 201.9                                     |

Table 100. Flow of Republican River passing Nebraska-Kansas State Line based on Operation of Harlan County and Lovewell Reservoirs - 1

| Year    | Irrigation releases from Harlan Co. Res. |                                 |              | Usable natural flow passing Nebr.-Kans. State Line |                                 |              | Other releases    |                      | Spills Diverted to Lovewell | Shortage to Kansas Lands | Releases and Unable Net. flow crossing State Line |
|---------|------------------------------------------|---------------------------------|--------------|----------------------------------------------------|---------------------------------|--------------|-------------------|----------------------|-----------------------------|--------------------------|---------------------------------------------------|
|         | Courtland Kansas above Lovewell          | Courtland Kansas below Lovewell | Scandia Unit | Courtland Kansas above Lovewell                    | Courtland Kansas below Lovewell | Scandia Unit | River Loss Kansas | PHS Releases Scandia |                             |                          |                                                   |
| (1)     | (2)                                      | (3)                             | (4)          | (5)                                                | (6)                             | (7)          | (8)               | (9)                  | (10)                        | (11)                     | (12)                                              |
| 1929    | 19.7                                     | 32.8                            | 10.4         | 2.1                                                | 5.8                             | 3.0          | 0                 | 3.2                  | 0                           |                          | 77.0                                              |
| 1930    | 20.0                                     | 34.4                            | 10.2         | 0                                                  | 16.0                            | 1.0          | 0                 | 3.2                  | 22.7                        |                          | 118.6                                             |
| 1931    | 23.1                                     | 27.6                            | 5.9          | 0.2                                                | 16.9                            | 7.4          | 0                 | 3.8                  | 15.3                        |                          | 100.2                                             |
| 1932    | 18.3                                     | 29.6                            | 0            | 5.3                                                | 24.3                            | 4.8          | 0                 | 0.6                  | 1.8                         |                          | 84.7                                              |
| 1933    | 17.3                                     | 29.7                            | 6.8          | 15.1                                               | 16.5                            | 15.8         | 0.8               | 3.8                  | 20.9                        |                          | 156.7                                             |
| 1934    | 44.2                                     | 113.1                           | 16.9         | 1.1                                                | 13.0                            | 10.4         | 0.1               | 6.4                  | 14.6                        | 51.8                     | 168.0                                             |
| 1935    | 17.0                                     | 30.8                            | 4.2          | 7.1                                                | 41.3                            | 9.6          | 0                 | 3.2                  | 0                           | 0.9                      | 112.3                                             |
| 1936    | 25.3                                     | 50.3                            | 14.9         | 7.5                                                | 19.4                            | 15.5         | 0                 | 4.8                  | 11.9                        |                          | 149.6                                             |
| 1937    | 18.1                                     | 46.8                            | 9.9          | 6.7                                                | 25.4                            | 12.5         | 0.3               | 3.2                  | 0                           | 5.7                      | 117.2                                             |
| 1938    | 12.2                                     | 22.3                            | 6.4          | 9.0                                                | 29.4                            | 10.6         | 0                 | 2.2                  | 0                           |                          | 92.1                                              |
| 1939    | 26.9                                     | 54.0                            | 2.4          | 5.5                                                | 35.0                            | 12.6         | 1.4               | 2.1                  | 2.9                         |                          | 142.8                                             |
| 1940    | 23.2                                     | 72.6                            | 15.5         | 7.2                                                | 24.8                            | 12.1         | 0.1               | 5.0                  | 0                           | 51.3                     | 109.2                                             |
| 1941    | 14.8                                     | 1.0                             | 0            | 0                                                  | 11.9                            | 0.8          | 0                 | 0                    | 38.1                        |                          | 66.6                                              |
| 1942    | 0                                        | 0                               | 0            | 8.5                                                | 4.5                             | 7.9          | 0                 | 0                    | 10.8                        |                          | 31.7                                              |
| 1943    | 23.6                                     | 49.7                            | 6.5          | 2.8                                                | 11.1                            | 8.6          | 0                 | 3.2                  | 0                           |                          | 105.5                                             |
| 1944    | 0                                        | 0                               | 0            | 7.5                                                | 18.2                            | 3.1          | 0                 | 0                    | 0.2                         |                          | 29.0                                              |
| 1945    | 9.6                                      | 7.9                             | 0            | 2.3                                                | 10.0                            | 3.4          | 0                 | 1.4                  | 0                           |                          | 34.6                                              |
| 1946    | 13.1                                     | 0                               | 2.9          | 7.8                                                | 22.1                            | 10.4         | 0                 | 1.7                  | 42.2                        |                          | 100.2                                             |
| 1947    | 19.8                                     | 23.9                            | 4.4          | 2.9                                                | 0                               | 8.1          | 0                 | 3.2                  | 19.4                        |                          | 81.7                                              |
| 1929-47 |                                          |                                 |              |                                                    |                                 |              |                   |                      |                             |                          |                                                   |
| Total   | 346.2                                    | 656.5                           | 117.3        | 98.6                                               | 345.6                           | 157.6        | 2.7               | 51.0                 | 200.8                       | 109.7                    | 1877.7                                            |
| Avg.    | 18.2                                     | 34.5                            | 6.2          | 5.2                                                | 18.2                            | 8.3          | 0.1               | 2.7                  | 10.6                        | 5.8                      | 98.8                                              |
| 1930-40 |                                          |                                 |              |                                                    |                                 |              |                   |                      |                             |                          |                                                   |
| Total   | 245.6                                    | 541.2                           | 93.1         | 64.7                                               | 262.0                           | 112.3        | 2.7               | 38.3                 | 90.1                        | 109.7                    | 1351.4                                            |
| Avg.    | 22.3                                     | 49.2                            | 8.5          | 5.9                                                | 23.8                            | 10.2         | 0.2               | 3.5                  | 8.2                         | 10.0                     | 122.8                                             |

Table 100

Table 100. Flow of Republican River passing Nebraska-Kansas State Line based on Operation of Harlan County and Lovewell Reservoirs - "Basin Study," November 1952

| Operation releases |       | Usable natural flow passing Nebr.-Kans. State Line |                                 |              |                   | Other releases       |       | Spills Diverted to Lovewell | Shortage to Kansas Lands | Releases and Usable Nat. flow crossing State Line | Unusable Waste passing State Line | Unusable Spills from Harlan County | Total Unusable Water passing State Line | Total flow passing State Line |
|--------------------|-------|----------------------------------------------------|---------------------------------|--------------|-------------------|----------------------|-------|-----------------------------|--------------------------|---------------------------------------------------|-----------------------------------|------------------------------------|-----------------------------------------|-------------------------------|
| Harlan Co. Res.    |       | Courtland Kansas above Lovewell                    | Courtland Kansas below Lovewell | Scandia Unit | River Loss Kansas | PHS Releases Scandia |       |                             |                          |                                                   |                                   |                                    |                                         |                               |
| (3)                | (4)   | (5)                                                | (6)                             | (7)          | (8)               | (9)                  | (10)  | (11)                        | (12)                     | (13)                                              | (14)                              | (15)                               | (16)                                    |                               |
| 32.8               | 10.4  | 2.1                                                | 5.8                             | 3.0          | 0                 | 3.2                  | 0     |                             | 77.0                     | 21.9                                              | 235.3                             | 257.2                              | 334.2                                   |                               |
| 34.4               | 10.2  | 0                                                  | 16.0                            | 1.0          | 0                 | 3.2                  | 22.7  |                             | 118.6                    | 30.3                                              | 218.7                             | 249.0                              | 356.5                                   |                               |
| 27.6               | 5.9   | 0.2                                                | 16.9                            | 7.4          | 0                 | 3.8                  | 15.3  |                             | 100.2                    | 24.4                                              | 189.6                             | 214.0                              | 314.2                                   |                               |
| 29.6               | 0     | 5.3                                                | 24.3                            | 4.8          | 0                 | 0.6                  | 1.8   |                             | 84.7                     | 74.9                                              | 52.0                              | 126.9                              | 211.6                                   |                               |
| 59.7               | 6.8   | 15.1                                               | 16.5                            | 15.8         | 0.8               | 3.8                  | 20.9  |                             | 156.7                    | 15.1                                              | 0                                 | 15.1                               | 171.8                                   |                               |
| 113.1              | 16.9  | 1.1                                                | 13.0                            | 10.4         | 0.1               | 6.4                  | 14.6  | 51.8                        | 168.0                    | 26.1                                              | 20.9                              | 47.0                               | 215.0                                   |                               |
| 30.8               | 4.2   | 7.1                                                | 41.3                            | 9.6          | 0                 | 3.2                  | 0     | 0.9                         | 112.3                    | 52.6                                              | 427.2                             | 479.8                              | 592.1                                   |                               |
| 50.3               | 14.9  | 7.5                                                | 19.4                            | 15.5         | 0                 | 4.8                  | 11.9  |                             | 149.6                    | 10.1                                              | 151.0                             | 161.1                              | 310.7                                   |                               |
| 48.8               | 9.9   | 6.7                                                | 25.4                            | 12.5         | 0.3               | 3.2                  | 0     | 5.7                         | 117.2                    | 21.2                                              | 0                                 | 21.2                               | 138.4                                   |                               |
| 22.3               | 6.4   | 9.0                                                | 29.4                            | 10.6         | 0                 | 2.2                  | 0     |                             | 92.1                     | 21.4                                              | 0                                 | 21.4                               | 113.5                                   |                               |
| 54.0               | 2.4   | 5.5                                                | 35.0                            | 12.6         | 1.4               | 2.1                  | 2.9   |                             | 142.8                    | 23.3                                              | 64.6                              | 87.9                               | 230.7                                   |                               |
| 72.6               | 15.5  | 7.2                                                | 24.8                            | 12.1         | 0.1               | 5.0                  | 0     | 51.3                        | 109.2                    | 20.1                                              | 0                                 | 20.1                               | 129.3                                   |                               |
| 1.0                | 0     | 0                                                  | 11.9                            | 0.8          | 0                 | 0                    | 38.1  |                             | 66.6                     | 49.0                                              | 316.9                             | 365.9                              | 432.5                                   |                               |
| 0                  | 0     | 8.5                                                | 4.5                             | 7.9          | 0                 | 0                    | 10.8  |                             | 31.7                     | 62.2                                              | 526.8                             | 589.0                              | 620.7                                   |                               |
| 49.7               | 6.5   | 2.8                                                | 11.1                            | 8.6          | 0                 | 3.2                  | 0     |                             | 105.5                    | 52.7                                              | 166.4                             | 219.1                              | 324.6                                   |                               |
| 0                  | 0     | 7.5                                                | 18.2                            | 3.1          | 0                 | 0                    | 0.2   |                             | 29.0                     | 41.6                                              | 342.1                             | 383.7                              | 412.7                                   |                               |
| 7.9                | 0     | 2.3                                                | 10.0                            | 3.4          | 0                 | 1.4                  | 0     |                             | 34.6                     | 52.8                                              | 242.0                             | 294.8                              | 329.4                                   |                               |
| 0                  | 2.9   | 7.8                                                | 22.1                            | 10.4         | 0                 | 1.7                  | 42.2  |                             | 100.2                    | 44.8                                              | 338.7                             | 383.5                              | 483.7                                   |                               |
| 23.9               | 4.4   | 2.9                                                | 0                               | 8.1          | 0                 | 3.2                  | 19.4  |                             | 81.7                     | 23.9                                              | 571.9                             | 595.8                              | 677.5                                   |                               |
| 656.5              | 117.3 | 98.6                                               | 345.6                           | 157.6        | 2.7               | 51.0                 | 200.8 | 109.7                       | 1877.7                   | 668.4                                             | 3864.1                            | 4532.5                             | 6399.1                                  |                               |
| 34.5               | 6.2   | 5.2                                                | 18.2                            | 8.3          | 0.1               | 2.7                  | 10.6  | 5.8                         | 98.8                     | 35.2                                              | 203.4                             | 238.6                              | 336.8                                   |                               |
| 541.2              | 93.1  | 64.7                                               | 262.0                           | 112.3        | 2.7               | 38.3                 | 90.1  | 109.7                       | 1351.4                   | 319.5                                             | 1124.0                            | 1443.5                             | 2783.8                                  |                               |
| 49.2               | 8.5   | 5.9                                                | 23.8                            | 10.2         | 0.2               | 3.5                  | 8.2   | 10.0                        | 122.8                    | 29.0                                              | 102.2                             | 131.2                              | 253.1                                   |                               |

# USES OF WATER IN COLORADO

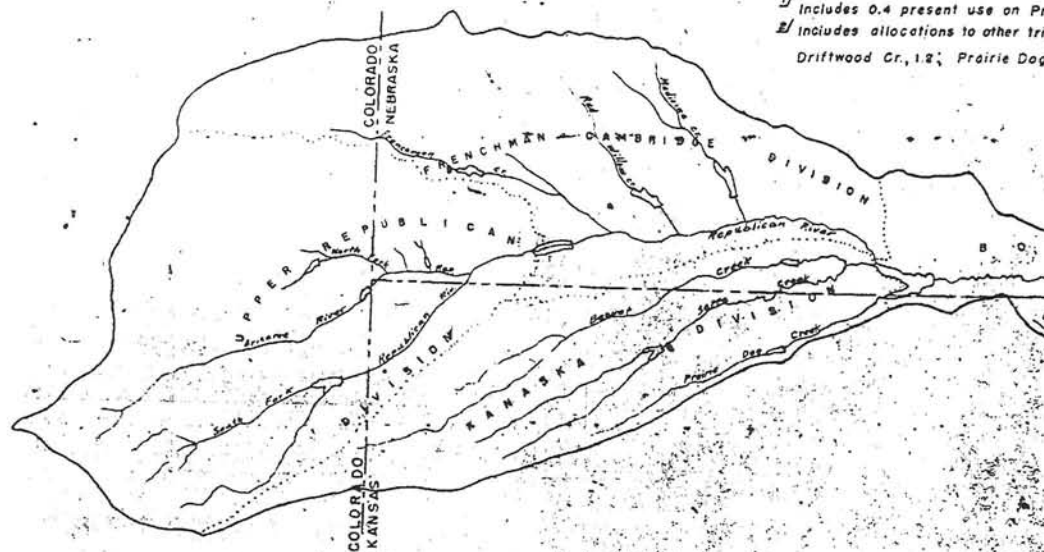
| USE                          | FRENCHMAN CR.<br>COMPACT BASIN | N. FORK REP. RIV.<br>COMPACT BASIN | ARIKAREE RIVER<br>COMPACT BASIN | S. FORK REP. RIV.<br>COMPACT BASIN | BEAVER CREEK<br>COMPACT BASIN | TOTALS<br>COMPACT BASIN |
|------------------------------|--------------------------------|------------------------------------|---------------------------------|------------------------------------|-------------------------------|-------------------------|
| FUTURE PRACTICAL DEVELOPMENT | 2.0                            | 1.0                                | 0.7                             | 9.2                                | 0.2                           | 13.1                    |
| PRESENT USE                  | 0.0                            | 0.0                                | 2.2                             | 10.2                               | 0.0                           | 12.4                    |
| ADDITIONAL DEPLETIONS        | 0.0                            | 0.0                                | 1.4                             | 4.2                                | 0.0                           | 5.6                     |
| TOTAL                        | 2.0                            | 1.0                                | 2.1                             | 13.6                               | 0.2                           | 19.4                    |
| COMPACT ALLOCATION           | 2.0                            | 1.0                                | 1.4                             | 13.6                               | 0.2                           | 19.4                    |

Includes entire water supply of Frenchman Creek in Colorado, estimated to be 3,500 acre-feet.

# USES OF WATER IN NEBRASKA

| USE                          | N. FORK REP.<br>COMPACT BASIN | BUFFALO &<br>BIG CREEKS<br>COMPACT BASIN | FRENCHMAN CR.<br>COMPACT BASIN | RED WILLOW CR.<br>COMPACT BASIN | MEDICINE CR.<br>COMPACT BASIN | BEAVER CREEK<br>COMPACT BASIN |
|------------------------------|-------------------------------|------------------------------------------|--------------------------------|---------------------------------|-------------------------------|-------------------------------|
| FUTURE PRACTICAL DEVELOPMENT | 4.8                           | 5.1                                      | 5.4                            | 5.6                             | 30.8                          | 28.7                          |
| PRESENT USE                  | 5.0                           | 5.0                                      | 1.2                            | 1.2                             | 15.0                          | 15.0                          |
| ADDITIONAL DEPLETIONS        | 0.0                           | 0.0                                      | 0.0                            | 0.0                             | 0.0                           | 0.0                           |
| TOTAL                        | 9.8                           | 10.1                                     | 6.6                            | 6.8                             | 45.8                          | 43.7                          |
| COMPACT ALLOCATION           | 11.0                          | 11.0                                     | 7.0                            | 7.0                             | 52.8                          | 52.8                          |

Includes 0.4 present use on Pro  
Includes allocations to other trib.  
Driftwood Cr., 1.2; Prairie Dog



# USES OF WATER IN KANSAS

| USE                          | ARIKAREE R.<br>COMPACT BASIN | S. FORK REPUBLICAN<br>COMPACT BASIN | BEAVER CR.<br>COMPACT BASIN | SAPPA CR.<br>COMPACT BASIN | PRAIRIE DOG<br>COMPACT BASIN |
|------------------------------|------------------------------|-------------------------------------|-----------------------------|----------------------------|------------------------------|
| FUTURE PRACTICAL DEVELOPMENT | 0.0                          | 0.0                                 | 6.1                         | 7.1                        | 3.7                          |
| PRESENT USE                  | 0.0                          | 0.0                                 | 4.9                         | 4.9                        | 0.0                          |
| ADDITIONAL DEPLETIONS        | 0.9                          | 0.0                                 | 10.1                        | 0.0                        | 2.6                          |
| TOTAL                        | 0.9                          | 0.0                                 | 21.1                        | 12.0                       | 6.3                          |
| COMPACT ALLOCATION           | 1.0                          | 1.0                                 | 23.0                        | 24.0                       | 6.4                          |

Includes allocations

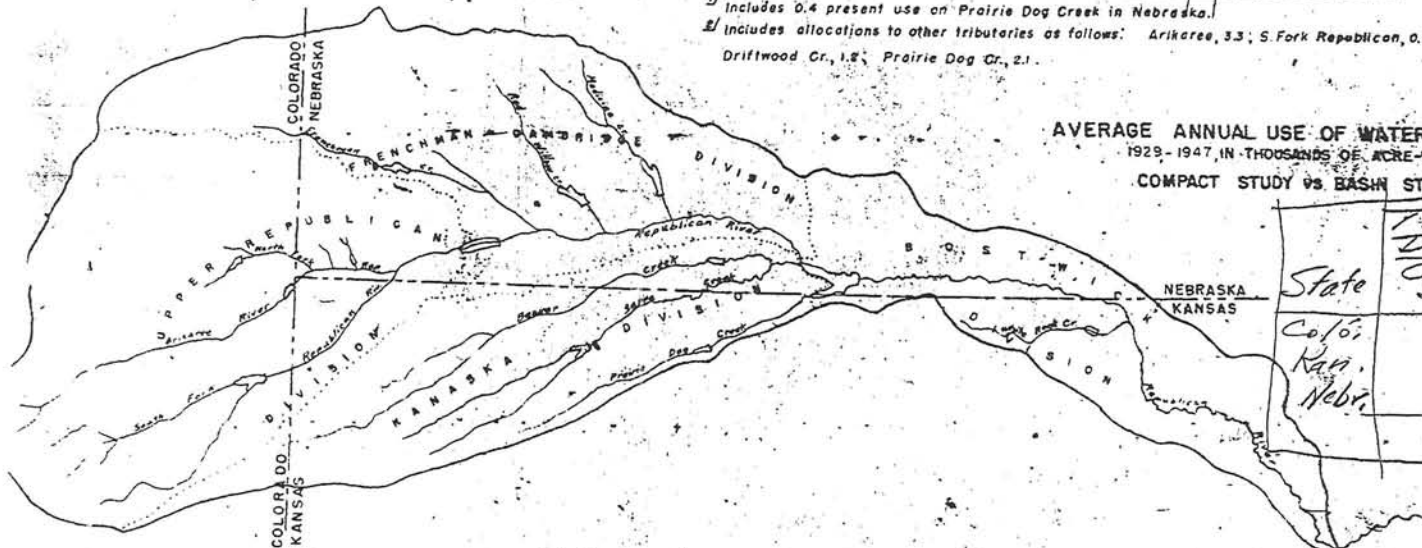


# USES OF WATER IN NEBRASKA

| USE                          | N. FORK REP.  | BUFFALO R.    | FRENCHMAN CR. | RED WILLOW CR. | MEDICINE CR.  | BEAVER CREEK  | SAPPA CREEK   | MAIN STEM REP. | TOTALS        |
|------------------------------|---------------|---------------|---------------|----------------|---------------|---------------|---------------|----------------|---------------|
|                              | COMPACT BASIN | COMPACT BASIN | COMPACT BASIN | COMPACT BASIN  | COMPACT BASIN | COMPACT BASIN | COMPACT BASIN | COMPACT BASIN  | COMPACT BASIN |
| FUTURE PRACTICAL DEVELOPMENT | 4.8           | 5.1           | 5.4           | 5.5            | 30.8          | 28.7          | 8.9           | 10.4           | 20.9          |
| PRESENT USE                  | 5.0           | 5.0           | 1.2           | 1.2            | 15.0          | 15.0          | 0.8           | 0.8            | 0.5           |
| ADDITIONAL DEPLECTIONS       | 0.0           | 0.0           | 0.0           | 0.0            | 0.0           | 0.0           | 0.0           | 0.0            | 0.0           |
| TOTAL                        | 9.8           | 10.1          | 6.6           | 6.7            | 45.8          | 43.7          | 9.7           | 11.2           | 21.4          |
| COMPACT ALLOCATION           | 11.0          | 11.0          | 7.0           | 7.0            | 52.8          | 52.8          | 4.2           | 4.2            | 4.6           |

Includes 0.4 present use on Prairie Dog Creek in Nebraska.

Includes allocations to other tributaries as follows: Arikaree, 3.3; S. Fork Republican, 0.8; Driftwood Cr., 1.8; Prairie Dog Cr., 2.1.



## AVERAGE ANNUAL USE OF WATER BY STATES 1929-1947, IN THOUSANDS OF ACRE-Feet

COMPACT STUDY VS. BASIN STUDY

| State | Compact Study | Basin Study |
|-------|---------------|-------------|
| Colo. | 14.6          | 16.4        |
| Kan.  | 6.1           | 7.1         |
| Nebr. | 19.4          | 19.9        |
| TOTAL | 40.1          | 43.4        |

# USES OF WATER IN KANSAS

| USE                          | ARIKAREE R.   | S. FORK REPUBLICAN | BEAVER CR.    | SAPPA CR.     | PRAIRIE DOG CR. | REPUBLICAN R. | TOTALS        |
|------------------------------|---------------|--------------------|---------------|---------------|-----------------|---------------|---------------|
|                              | COMPACT BASIN | COMPACT BASIN      | COMPACT BASIN | COMPACT BASIN | COMPACT BASIN   | COMPACT BASIN | COMPACT BASIN |
| FUTURE PRACTICAL DEVELOPMENT | 0.0           | 0.0                | 6.1           | 7.1           | 3.7             | 3.7           | 16.6          |
| PRESENT USE                  | 0.0           | 0.0                | 4.9           | 4.9           | 0.0             | 0.0           | 9.8           |
| ADDITIONAL DEPLECTIONS       | 0.0           | 0.0                | 10.1          | 0.0           | 2.5             | 0.0           | 12.6          |
| TOTAL                        | 0.0           | 0.0                | 21.1          | 12.0          | 6.2             | 3.7           | 43.0          |
| COMPACT ALLOCATION           | 1.0           | 1.0                | 23.0          | 23.0          | 9.4             | 16.4          | 73.8          |

Includes allocation of 0.5 for Driftwood Cr. in Kansas

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF RECLAMATION  
MISSOURI RIVER BASIN PROJECT  
REPUBLICAN RIVER BASIN  
USE OF WATER  
COMPACT STUDY VS. BASIN STUDY

DRAWN: SUBMITTED:  
TRACED: RECOMMENDED:  
CHECKED: APPROVED:  
REDAUNDIA, KERR. 5-11-50

Table 1. Average annual use of North Fork Republican River water by Colorado and Nebraska for the Compact Study and the Basin Study - 1000 acre-feet

| Use by North Republican Unit                            | Compact Study |         |          |         | Basin Study |         |          |         |
|---------------------------------------------------------|---------------|---------|----------|---------|-------------|---------|----------|---------|
|                                                         | Colorado      |         | Nebraska |         | Colorado    |         | Nebraska |         |
|                                                         | 1930-40       | 1929-47 | 1930-40  | 1929-47 | 1930-40     | 1929-47 | 1930-40  | 1929-47 |
| Supplemental water for 2,680 acres <sup>1/</sup>        | 0.1           | 0.1     | 0.1      | 0.2     | 0.1         | 0.1     | 0.1      | 0.2     |
| Water for 2,400 acres <sup>2/</sup>                     | 0             | 0       | 2.8      | 2.5     | 0           | 0       | 2.8      | 2.5     |
| Water used by non-irrigable lands                       | 0             | 0       | 0.7      | 0.7     | 0           | 0       | 0.7      | 0.7     |
| Evaporation from Wray Reservoir                         | 0.2           | 0.2     | 1.3      | 1.2     | 0.2         | 0.2     | 1.7      | 1.5     |
| Total future additional use<br>by North Republican Unit | 0.3           | 0.3     | 4.9      | 4.6     | 0.3         | 0.3     | 5.3      | 4.9     |
| Future private development (irrig.) <sup>3/</sup>       | 1.6           | 1.5     | 0.3      | 0.2     | 1.6         | 1.5     | 0.3      | 0.2     |
| Total future use assumed to be<br>practical             | 1.9           | 1.8     | 5.2      | 4.8     | 1.9         | 1.8     | 5.6      | 5.1     |
| Increased depletions to meet compact <sup>4/</sup>      | 2.6           | 2.3     | 0        | 0       | 0           | 0       | 0        | 0       |
| Present use estimate by Commissioners                   | 5.5           | 5.5     | 5.0      | 5.0     | 5.5         | 5.5     | 5.0      | 5.0     |
| Total use on stream                                     | 10.3          | 9.6     | 10.2     | 9.8     | 7.4         | 7.3     | 10.6     | 10.1    |
| Compact allocation on stream                            | 10.0          | -       | 11.0     | -       | 10.0        | -       | 11.0     | -       |

<sup>1/</sup> Of the 2,680 acre presently irrigated 650 acres are in Colorado and 2,030 acres are in Nebraska.

<sup>2/</sup> 2,400 acres all in Nebraska.

<sup>3/</sup> Private depletion for 1,500 acres of which 1,290 acres are in Colorado and the remaining 210 in Nebraska. No private development for ponds is expected.

<sup>4/</sup> An additional depletion for 2,200 acres to meet Colorado's allocation.

Table 1a

Table 102. Average annual use of Arikaree River water by Colorado and Kansas for the Compact Study and the Basin Study - 1000 acre-feet.

| Use on Arikaree River                                 | Compact Study |         |         |         | Basin Study |         |         |         |
|-------------------------------------------------------|---------------|---------|---------|---------|-------------|---------|---------|---------|
|                                                       | Colorado      |         | Kansas  |         | Colorado    |         | Kansas  |         |
|                                                       | 1930-40       | 1929-47 | 1930-40 | 1929-47 | 1930-40     | 1929-47 | 1930-40 | 1929-47 |
| Future private development (Irrigation) <sup>1/</sup> | 0.5           | 0.5     | 0       | 0       | 0.5         | 0.5     | 0       | 0       |
| Future private development (Ponds)                    | 0.2           | 0.2     | 0       | 0       | 0.2         | 0.2     | 0       | 0       |
| Evaporation from Pioneer Reservoir                    | 0             | 0       | 0       | 0       | 2.8         | 2.5     | 0       | 0       |
| Total future use assumed to be practical              | 0.7           | 0.7     | 0       | 0       | 3.5         | 3.2     | 0       | 0       |
| Increased depletions to meet compact <sup>2/</sup>    | 12.5          | 11.4    | 1.0     | 0.9     | 0           | 0       | 0       | 0       |
| Present use estimated by Commissioners                | 2.2           | 2.2     | 0       | 0       | 2.2         | 2.2     | 0       | 0       |
| Total use on stream                                   | 15.4          | 14.3    | 1.0     | 0.9     | 5.7         | 5.4     | 0       | 0       |
| Compact allocation on stream                          | 15.4          | -       | 1.0     | -       | 15.4        | -       | 1.0     | -       |

Note: Nebraska's allocation of 3300 acre-feet of water will be used elsewhere in Nebraska.

<sup>1/</sup> Private irrigation development for 400 acres.

<sup>2/</sup> An additional depletion was made for 9250 acres in Colorado and 740 acres in Kansas.

Table 103 . Average annual use of South Fork Republican River water by Colorado and Kansas for the Compact Study and the Basin Study - 1000 acre-feet.

| Use by St. Francis Unit                               | Compact Study |             |            |            | Basin Study |             |            |            |
|-------------------------------------------------------|---------------|-------------|------------|------------|-------------|-------------|------------|------------|
|                                                       | Colorado      |             | Kansas     |            | Colorado    |             | Kansas     |            |
|                                                       | 1930-40       | 1929-47     | 1930-40    | 1929-47    | 1930-40     | 1929-47     | 1930-40    | 1929-47    |
| Water used for 3720 acres <sup>1/</sup>               | 2.3           | 2.1         | 2.1        | 1.9        | 2.3         | 2.1         | 2.2        | 1.9        |
| Water used by non-irrigable lands                     | 0.7           | 0.6         | 1.2        | 1.1        | 0.7         | 0.6         | 0.7        | 0.6        |
| Evaporation from Bonny Reservoir                      | <u>3.4</u>    | <u>3.5</u>  | <u>1.3</u> | <u>1.2</u> | <u>3.1</u>  | <u>2.8</u>  | <u>2.9</u> | <u>2.7</u> |
| Total future additional use by St. Francis Unit       | 6.4           | 6.2         | 4.6        | 4.2        | 6.1         | 5.5         | 5.8        | 5.2        |
| Future private development (Irrigation) <sup>2/</sup> | 3.4           | 3.0         | 1.9        | 1.7        | 3.4         | 3.0         | 1.9        | 1.7        |
| Future private development (Ponds)                    | <u>0.6</u>    | <u>0.7</u>  | <u>0.2</u> | <u>0.2</u> | <u>0.6</u>  | <u>0.7</u>  | <u>0.2</u> | <u>0.2</u> |
| Total future use assumed to be practical              | 10.4          | 9.9         | 6.7        | 6.1        | 10.1        | 9.2         | 7.9        | 7.1        |
| Increased depletions to meet compact <sup>3/</sup>    | 4.8           | 4.3         | 11.3       | 10.1       | 0           | 0           | 0          | 0          |
| Present use estimated by Commissioners                | <u>10.2</u>   | <u>10.2</u> | <u>4.9</u> | <u>4.9</u> | <u>10.2</u> | <u>10.2</u> | <u>4.9</u> | <u>4.9</u> |
| Total use on stream                                   | 25.4          | 24.4        | 22.9       | 21.1       | 20.3        | 19.4        | 12.8       | 12.0       |
| Compact allocation on stream                          | 25.4          | -           | 23.0       | -          | 25.4        | -           | 23.0       | -          |

Note: Nebraska's allocation of 800 acre-feet of South Fork water will be used elsewhere in Nebraska.

<sup>1/</sup> 1920 acres are in Colorado and 1800 acres in Kansas.

<sup>2/</sup> Future private development allows for ultimate development of 3100 acres in Colorado and 1600 acres in Kansas.

<sup>3/</sup> Increased depletion for 2330 acres to meet Colorado allocation, and for 9400 acres to meet Kansas allocation.

Table 104. Average annual use of water from Buffalo Creek, Rock Creek and Main Stem Republican River by Nebraska for the Compact Study and the Basin Study - 1000 acre-feet.

| Use by Benkelman Unit                                        | Compact Study |            | Basin Study |            |
|--------------------------------------------------------------|---------------|------------|-------------|------------|
|                                                              | 1930-40       | 1929-47    | 1930-40     | 1929-47    |
| Buffalo and Rock Creek water used for 5000 acres             | 4.0           | 3.5        | 4.0         | 3.5        |
| Buffalo and Rock Creek water used for non-irrigable lands    | 1.2           | 1.1        | 1.2         | 1.1        |
| Evaporation from Rock Creek Reservoir                        | <u>0.8</u>    | <u>0.8</u> | <u>0.9</u>  | <u>1.0</u> |
| Total future additional use of Buffalo and Rock Creek water  | 6.0           | 5.4        | 6.1         | 5.6        |
| Present use estimated by Commissioners                       | <u>1.2</u>    | <u>1.2</u> | <u>1.2</u>  | <u>1.2</u> |
| Total use on Buffalo and Rock Creek                          | 7.2           | 6.6        | 7.3         | 6.8        |
| Compact allocation on Buffalo and Rock Creek                 | 7.0           | -          | 7.0         | -          |
| Part of Main Stem Republican River water used by 5000 acres  | 2.3           | 2.3        | 2.3         | 2.3        |
| Main Stem Republican River water used by non-irrigable lands | <u>0.7</u>    | <u>0.7</u> | <u>0.7</u>  | <u>0.7</u> |
| Total main stem water used                                   | 3.0           | 3.0        | 3.0         | 3.0        |
| Total used by Benkelman Unit                                 | 10.2          | 9.6        | 10.3        | 9.8        |

Note: No future private development for irrigation and ponds is anticipated.

Table 105. Average annual use of Main Stem Republican River water by Nebraska for the Compact Study and the Basin Study - 1000 acre-feet.

| Use by Meeker-Driftwood Unit                         | Compact Study |            | Basin Study |            |
|------------------------------------------------------|---------------|------------|-------------|------------|
|                                                      | 1930-40       | 1929-47    | 1930-40     | 1929-47    |
| Water for 16,440 acres                               | 18.9          | 16.9       | 18.9        | 16.9       |
| Water used by non-irrigable lands                    | 4.2           | 3.8        | 4.2         | 3.8        |
| Evaporation from Trenton Reservoir                   | <u>7.4</u>    | <u>7.4</u> | <u>9.2</u>  | <u>8.3</u> |
| Total future additional use by Meeker-Driftwood Unit | 30.5          | 28.1       | 32.3        | 29.0       |
| Present use estimated by Commissioners               | <u>2.5</u>    | <u>2.5</u> | <u>2.5</u>  | <u>2.5</u> |
| Total use on stream                                  | 33.0          | 30.6       | 34.8        | 31.5       |

Table 106. Average annual use of Frenchman Creek water by Nebraska for the Compact Study and the Basin Study - 1000 acre-feet

| Use by Frenchman Unit                                                       | Compact Study |         | Basin Study |         |
|-----------------------------------------------------------------------------|---------------|---------|-------------|---------|
|                                                                             | 1930-40       | 1929-47 | 1930-40     | 1929-47 |
| Supplemental water for 11,140 acres of presently irrigated lands            | 2.4           | 2.4     | 2.4         | 2.4     |
| Water used by non-irrigable lands near above lands                          | 0.6           | 0.6     | 0.6         | 0.6     |
| Water used for 11,770 acres of new lands                                    | 13.2          | 12.1    | 13.0        | 12.0    |
| Water used by non-irrigable lands near above lands                          | 3.0           | 2.7     | 2.9         | 2.8     |
| Evaporation from Enders Reservoir                                           | 3.6           | 3.6     | 3.6         | 3.3     |
| Total future additional use by Frenchman Unit                               | 22.8          | 21.4    | 22.5        | 21.1    |
| Future private irrigation of 3,000 acres above Enders Reservoir in Nebraska | 5.6           | 5.2     | 5.6         | 5.2     |
| Future private pond development above Enders Reservoir in Nebraska          | 0.2           | 0.2     | 0.2         | 0.2     |
| Future private irrigation of 1,750 acres below Enders Reservoir             | 2.2           | 1.9     | 2.2         | 1.9     |
| Future private pond development below Enders Reservoir                      | 0.3           | 0.3     | 0.3         | 0.3     |
| Total future use assumed to be practical                                    | 31.1          | 29.0    | 30.8        | 28.7    |
| Present use estimated by Commissioners                                      | 15.0          | 15.0    | 15.0        | 15.0    |
| Total use on stream                                                         | 46.1          | 44.0    | 45.8        | 43.7    |
| Compact allocation on stream                                                | 52.8          | -       | 52.8        | -       |

Note: Colorado's allocation on Frenchman Creek is the total flow originating above Colorado-Nebraska state line or an average annual flow of 3,300 acre-feet for the Compact Study. In the Basin Study an allowance was made for future private irrigation of 1,850 acres.



Table 107. Average annual use of Red Willow Creek water and Main Stem Republican River water by Nebraska for the Compact Study and the Basin Study - 1000 acre-feet

| Use by Red Willow Unit                                       | Compact Study |            | Basin Study |            |
|--------------------------------------------------------------|---------------|------------|-------------|------------|
|                                                              | 1930-40       | 1929-47    | 1930-40     | 1929-47    |
| Red Willow water used for 12,590 acres <sup>1/</sup>         | 6.4           | 5.6        | 7.2         | 6.1        |
| Use of Red Willow water for non-irrigable lands              | 1.4           | 1.3        | 1.6         | 1.4        |
| Evaporation from Red Willow Reservoir                        | <u>1.4</u>    | <u>1.4</u> | <u>1.1</u>  | <u>1.3</u> |
| Total future additional use of Red Willow water              | 9.2           | 8.3        | 9.9         | 9.8        |
| Future private development (Irrigation of 500 ac.)           | 0.6           | 0.5        | 0.6         | 0.5        |
| Future private development (Ponds)                           | <u>0.1</u>    | <u>0.1</u> | <u>0.1</u>  | <u>0.1</u> |
| Total future use of Red Willow water assumed to be practical | 9.9           | 8.9        | 10.6        | 10.4       |
| Present use estimated by Commissioners                       | <u>0.8</u>    | <u>0.8</u> | <u>0.8</u>  | <u>0.8</u> |
| Total use of Red Willow water                                | 10.7          | 9.7        | 11.4        | 11.2       |
| Compact allocation of Red Willow water                       | 4.2           | -          | 4.2         | -          |
| Main stem Republican water used for 12,590 acres             | 7.4           | 6.2        | 5.3         | 5.1        |
| Main stem water used by non-irrigable lands                  | <u>1.7</u>    | <u>1.3</u> | <u>1.2</u>  | <u>1.1</u> |
| Total main stem water used                                   | 9.1           | 7.5        | 6.5         | 6.2        |
| Total water used for Red Willow Unit                         | 19.8          | 17.2       | 17.9        | 17.4       |

<sup>1/</sup> In the Compact Study 12,590 acres were irrigated. In the Basin Study 11,990 acres were irrigated.

Table 107

Table 109. Average annual use of Beaver Creek water by Colorado, Kansas and Nebraska for the Compact Study and the Basin Study - 1000 acre-feet.

| Use by Beaver City Unit                         | Colorado      |            |             |            | Kansas        |            |             |            | Nebraska      |            |             |            |
|-------------------------------------------------|---------------|------------|-------------|------------|---------------|------------|-------------|------------|---------------|------------|-------------|------------|
|                                                 | Compact Study |            | Basin Study |            | Compact Study |            | Basin Study |            | Compact Study |            | Basin Study |            |
|                                                 | 1930-1940     | 1929-1947  | 1930-1940   | 1929-1947  | 1930-1940     | 1929-1947  | 1930-1940   | 1929-1947  | 1930-1940     | 1929-1947  | 1930-1940   | 1929-1947  |
| Water for 1200 acres                            | 0             | 0          | 0           | 0          | 0             | 0          | 0           | 0          | 1.3           | 1.2        | 1.4         | 1.3        |
| Water used by non-irrigable lands               | 0             | 0          | 0           | 0          | 0             | 0          | 0           | 0          | 0.3           | 0.2        | 0.3         | 0.3        |
| Evaporation from Beaver City Reservoir          | <u>0</u>      | <u>0</u>   | <u>0</u>    | <u>0</u>   | <u>0</u>      | <u>0</u>   | <u>0</u>    | <u>0</u>   | <u>1.4</u>    | <u>0.6</u> | <u>2.3</u>  | <u>2.2</u> |
| Total future additional use by Beaver City Unit | 0             | 0          | 0           | 0          | 0             | 0          | 0           | 0          | 3.0           | 3.0        | 4.0         | 3.8        |
| Future private development (Irrigation) 1/      | 0.1           | 0.1        | 0.1         | 0.1        | 3.6           | 3.1        | 3.6         | 3.1        | 0.7           | 0.6        | 0.7         | 0.6        |
| Future private development (Ponds)              | <u>0.1</u>    | <u>0.1</u> | <u>0.1</u>  | <u>0.1</u> | <u>0.5</u>    | <u>0.6</u> | <u>0.5</u>  | <u>0.6</u> | <u>0.1</u>    | <u>0.2</u> | <u>0.1</u>  | <u>0.2</u> |
| Total future use assumed to be practical        | 0.2           | 0.2        | 0.2         | 0.2        | 4.1           | 3.7        | 4.1         | 3.7        | 3.8           | 3.8        | 4.8         | 4.6        |
| Increased depletions to meet compact 2/         | 3.1           | 2.8        | 0           | 0          | 2.8           | 2.6        | 0           | 0          | 2.7           | 2.4        | 0           | 0          |
| Present use estimated by Commissioners          | <u>0</u>      | <u>0</u>   | <u>0</u>    | <u>0</u>   | <u>0</u>      | <u>0</u>   | <u>0</u>    | <u>0</u>   | <u>0.2</u>    | <u>0.2</u> | <u>0.2</u>  | <u>0.2</u> |
| Total use by states on stream                   | 3.3           | 3.0        | 0.2         | 0.2        | 6.9           | 6.3        | 4.1         | 3.7        | 6.7           | 6.4        | 5.0         | 4.8        |
| Compact allocation by states on stream          | 3.3           | -          | 3.3         | -          | 6.4           | -          | 6.4         | -          | 6.7           | -          | 6.7         | -          |

1/ Future private development for 100 acres in Colorado, 2950 acres in Kansas and 550 acres in Nebraska

2/ Additional depletions to meet Compact are as follows: 2670 acres in Colorado  
2430 acres in Kansas  
2280 acres in Nebraska

Table 109

Table 110 Average annual use of Sappa Creek water by Kansas and Nebraska for the Compact Study and the Basin Study  
1000 acre-feet

| Use by Oberlin Unit                                   | Compact Study |         |          |         | Basin Study |         |          |         |
|-------------------------------------------------------|---------------|---------|----------|---------|-------------|---------|----------|---------|
|                                                       | Kansas        |         | Nebraska |         | Kansas      |         | Nebraska |         |
|                                                       | 1930-40       | 1929-47 | 1930-40  | 1929-47 | 1930-40     | 1929-47 | 1930-40  | 1929-47 |
| Water for 1500 acres                                  | 1.4           | 1.6     | 0        | 0       | 1.6         | 1.5     | 0        | 0       |
| Water used by non-irrigable lands                     | 0.4           | 0.4     | 0        | 0       | 0.4         | 0.4     | 0        | 0       |
| Evaporation from Oberlin Reservoir                    | 1.6           | 1.8     | 0        | 0       | 1.6         | 1.9     | 0        | 0       |
| Total future additional use by Oberlin Unit           | 3.4           | 3.8     | 0        | 0       | 3.6         | 3.8     | 0        | 0       |
| Future private development (Irrigation) <sup>1/</sup> | 2.6           | 2.2     | 1.6      | 1.3     | 2.6         | 2.2     | 1.6      | 1.3     |
| Future private development (Ponds)                    | 0.3           | 0.4     | 0        | 0       | 0.3         | 0.4     | 0        | 0       |
| Total future use assumed to be practical              | 6.3           | 6.4     | 1.6      | 1.3     | 6.5         | 6.4     | 1.6      | 1.3     |
| Increase depletions to meet compact <sup>2/</sup>     | 2.2           | 1.9     | 6.9      | 6.0     | 0           | 0       | 0        | 0       |
| Present use estimated by Commissioners                | 0.2           | 0.2     | 0.2      | 0.2     | 0.2         | 0.2     | 0.2      | 0.2     |
| Total use by states on stream                         | 8.7           | 8.5     | 8.7      | 7.5     | 6.7         | 6.6     | 1.8      | 1.5     |
| Compact allocation by states on stream                | 8.8           | -       | 8.8      | -       | 8.8         | -       | 8.8      | -       |

<sup>1/</sup> An allowance for 1850 acres in Kansas and 1150 acres in Nebraska was made for future private irrigation development.

<sup>2/</sup> To meet the compact allocations on Sappa Creek it was necessary to deplete for an additional 1600 acres in Kansas and 4950 acres in Nebraska.

Table III . Average annual use of Prairie Dog Creek water by Kansas and Nebraska for the Compact Study and the Basin Study - 1000 acre-feet.

| Use by Almena Unit                                    | Compact Study |         |          |         | Basin Study |         |          |         |
|-------------------------------------------------------|---------------|---------|----------|---------|-------------|---------|----------|---------|
|                                                       | Kansas        |         | Nebraska |         | Kansas      |         | Nebraska |         |
|                                                       | 1930-40       | 1929-47 | 1930-40  | 1929-47 | 1930-40     | 1929-47 | 1930-40  | 1929-47 |
| Water for 5000 acres                                  | 6.0           | 5.4     | 0        | 0       | 5.5         | 5.1     | 0        | 0       |
| Water used by non-irrigable lands                     | 1.6           | 1.4     | 0        | 0       | 1.5         | 1.3     | 0        | 0       |
| Evaporation from Norton Reservoir                     | 2.5           | 2.6     | 0        | 0       | 2.2         | 2.4     | 0        | 0       |
| Total future additional use by Almena Unit            | 10.1          | 9.4     | 0        | 0       | 9.2         | 8.8     | 0        | 0       |
| Future private development (Irrigation) <sup>1/</sup> | 1.3           | 1.0     | 0        | 0       | 1.3         | 1.0     | 0        | 0       |
| Future private development (Ponds)                    | 0.2           | 0.2     | 0        | 0       | 0.2         | 0.2     | 0        | 0       |
| Total future use assumed to be practical              | 11.6          | 10.6    | 0        | 0       | 10.7        | 10.0    | 0        | 0       |
| Increased depletions to meet compact <sup>2/</sup>    | 0.6           | 0.5     | 0        | 0       | 0           | 0       | 0        | 0       |
| Present use estimated by Commissioners                | 0.4           | 0.4     | 0.4      | 0.4     | 0.4         | 0.4     | 0.4      | 0.4     |
| Total use by states on stream                         | 12.6          | 11.5    | 0.4      | 0.4     | 11.1        | 10.4    | 0.4      | 0.4     |
| Compact allocation by states on stream                | 12.6          | -       | 2.1      | -       | 12.6        | -       | 2.1      | -       |

<sup>1/</sup> Future private irrigation of 1000 acres.

<sup>2/</sup> To meet compact allocations an additional depletion for 500 acres in Kansas was made.

Table 112. Average annual use of water by Bostwick Division in Nebraska for the Compact Study -- 1000 acre-feet.

| Use by Bostwick<br>Division in Nebraska                            | Franklin-Red Cloud Unit<br>18,250 acres |         | Superior Canal<br>6,790 acres |         | Courtland Canal<br>2,960 acres |         | Total       |             |
|--------------------------------------------------------------------|-----------------------------------------|---------|-------------------------------|---------|--------------------------------|---------|-------------|-------------|
|                                                                    | 1930-40                                 | 1929-47 | 1930-40                       | 1929-47 | 1930-40                        | 1929-47 | 1930-40     | 1929-47     |
| Water for irrigated lands<br>(28,000 acres)                        | 18.4                                    | 16.3    | 6.5                           | 5.8     | 2.7                            | 2.5     | 27.6        | 24.6        |
| Water used by non-<br>irrigable lands                              | 6.3                                     | 5.6     | 2.0                           | 1.8     | 0.7                            | .6      | 9.0         | 8.0         |
| Evaporation from Harlan<br>County Reservoir                        |                                         |         |                               |         |                                |         | <u>21.1</u> | <u>19.4</u> |
| Total future additional use<br>in Nebraska by Bostwick<br>Division |                                         |         |                               |         |                                |         | 57.7        | 52.0        |
| Future private development<br>(Irrigation 2600 acres) <u>1/</u>    |                                         |         |                               |         |                                |         | 3.1         | 2.6         |
| Total future use assumed to<br>be practical                        |                                         |         |                               |         |                                |         | 60.8        | 54.6        |
| Increased depletions to<br>meet compact (8000 ac.) <u>2/</u>       |                                         |         |                               |         |                                |         | 8.5         | 7.5         |
| Present use estimated by<br>Commissioners                          |                                         |         |                               |         |                                |         | <u>0</u>    | <u>0</u>    |
| Total use on stream in<br>Nebraska                                 |                                         |         |                               |         |                                |         | 69.3        | 62.1        |

1/ An allowance was made for future private development of 2600 acres on tributaries between Harlan County Reservoir and Superior-Courtland Diversion Dam.

2/ An additional depletion for 8000 acres was made on the main stem of the Republican River between Cambridge Diversion Dam and Harlan County Reservoir.

Table 113. Average annual use of water by Bostwick Division in Nebraska for the Basin Study - 1000 acre-feet.

| Use by Bostwick<br>Division in Nebraska                             | Franklin-Red Cloud Unit |         | Superior Canal |         | Courtland Canal |         | Total       |             |
|---------------------------------------------------------------------|-------------------------|---------|----------------|---------|-----------------|---------|-------------|-------------|
|                                                                     | 18,250 acres            |         | 6,790 acres    |         | 2,960 acres     |         |             |             |
|                                                                     | 1930-40                 | 1929-47 | 1930-40        | 1929-47 | 1930-40         | 1929-47 | 1930-40     | 1929-47     |
| Water for irrigated lands<br>(28,000 acres)                         | 20.8                    | 17.7    | 7.4            | 6.3     | 3.2             | 2.7     | 31.4        | 26.7        |
| Water used by non-irrigable<br>lands                                | 7.1                     | 6.1     | 2.3            | 1.9     | .8              | .7      | 10.2        | 8.7         |
| Evaporation from Harlan<br>County Reservoir                         |                         |         |                |         |                 |         | <u>21.5</u> | <u>19.4</u> |
| Total future additional use<br>in Nebraska by Bostwick Div.         |                         |         |                |         |                 |         | 63.1        | 54.8        |
| Future private development<br>(Irrigation 2600 acres) <sup>1/</sup> |                         |         |                |         |                 |         | <u>3.1</u>  | <u>2.6</u>  |
| Total future use assumed to<br>be practical                         |                         |         |                |         |                 |         | 66.2        | 57.4        |
| Increased depletions to meet<br>compact <sup>2/</sup>               |                         |         |                |         |                 |         | 0           | 0           |
| Present use estimated by<br>Commissioners                           |                         |         |                |         |                 |         | <u>0</u>    | <u>0</u>    |
| Total use in Nebraska                                               |                         |         |                |         |                 |         | 66.2        | 57.4        |

<sup>1/</sup> An allowance was made for future private development of 2600 acres on tributaries between Harlan County Reservoir and Superior-Courtland Diversion Dam.

<sup>2/</sup> An additional depletion for 8000 acres was made on the main stem of the Republican River between Cambridge Diversion Dam and Harlan County Reservoir.

Table 114. Average annual use of water by Bostwick Division in Kansas for the Compact Study - 1000 acre-feet.

| Use by Bostwick<br>Division in Kansas                         | Courtland Canal<br>49,000 acres |         | Scandia Unit<br>13,000 acres |         | Total   |         |
|---------------------------------------------------------------|---------------------------------|---------|------------------------------|---------|---------|---------|
|                                                               | 1930-40                         | 1929-47 | 1930-40                      | 1929-47 | 1930-40 | 1929-47 |
| Water for irrigated lands<br>(62,000 acres)                   | 44.5                            | 40.6    | 10.4                         | 9.5     | 54.9    | 50.1    |
| Water used by non-irrigable<br>lands                          | 10.5                            | 9.6     | 2.7                          | 2.2     | 13.2    | 11.8    |
| Evaporation from Harlan County<br>Reservoir charged to Kansas |                                 |         |                              |         | 5.4     | 6.9     |
| Evaporation from Lovewell<br>Reservoir                        |                                 |         |                              |         | 4.4     | 3.6     |
| Future private development                                    |                                 |         |                              |         | 0       | 0       |
| Total future use assumed to be<br>practical                   |                                 |         |                              |         | 77.9    | 72.4    |
| Increased depletions to meet<br>compact <sup>1/</sup>         |                                 |         |                              |         | 0       | 0       |
| Present use estimated by<br>Commissioners                     |                                 |         |                              |         | 0       | 0       |
| Total use in Kansas                                           |                                 |         |                              |         | 77.9    | 72.4    |

<sup>1/</sup> No additional depletion was made for use of main stem water to meet Kansas allocation of 138,000 acre-feet.



Table 115. Average annual use of water by Bostwick Division in Kansas for the Basin Study - 1000 acre-feet.

| Use by Bostwick<br>Division in Kansas                         | Courtland Canal<br>49,000 acres |         | Scandia Unit<br>13,000 acres |         | Total   |         |
|---------------------------------------------------------------|---------------------------------|---------|------------------------------|---------|---------|---------|
|                                                               | 1930-40                         | 1929-47 | 1930-40                      | 1929-47 | 1930-40 | 1929-47 |
| Water for irrigated lands<br>(62,000 acres)                   | 52.3                            | 45.1    | 12.4                         | 10.6    | 64.7    | 55.7    |
| Water used by non-irrigable<br>lands                          | 12.3                            | 10.6    | 3.1                          | 2.6     | 15.4    | 13.2    |
| Evaporation from Harlan County<br>Reservoir charged to Kansas |                                 |         |                              |         | 8.4     | 8.2     |
| Evaporation from Lovewell<br>Reservoir                        |                                 |         |                              |         | 4.5     | 3.7     |
| Future private development                                    |                                 |         |                              |         | 0       | 0       |
| Total future use assumed to be<br>practical                   |                                 |         |                              |         | 93.0    | 80.8    |
| Increased depletions to meet<br>compact <sup>1/</sup>         |                                 |         |                              |         | 0       | 0       |
| Present use estimated by<br>Commissioners                     |                                 |         |                              |         | 0       | 0       |
| Total use in Kansas                                           |                                 |         |                              |         | 93.0    | 80.8    |

<sup>1/</sup> No additional depletion was made for use of main stem water to meet Kansas allocation of 138,000 acre-feet.