REPUBLICAN RIVER COMPACT ADMINISTRATION

GROUND WATER MODEL

June 30, 2003

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EXECUTIVE SUMMARY

In accordance with the December 15, 2002 Final Settlement Stipulation in Kansas v. Nebraska and Colorado, No. 126 Original, the Republican River Ground Water Modeling Committee developed a comprehensive ground water model to represent the ground water flow system in the Republican River Basin. The primary purpose of the Republican River Compact Administration Ground Water Model (RRCA Model) is to determine the amount, location, and timing of streamflow depletions to the Republican River caused by well pumping and to determine streamflow accretions from recharge of water imported from the Platte River Basin into the Republican River Basin.

Representatives from the State of Colorado, State of Kansas, and State of Nebraska developed the RRCA Model, with participation from the United States Bureau of Reclamation and United States Geological Survey. The data and information used in construction and calibration of the RRCA Model were provided and shared by all three States and the United States in a collegial manner. In a similar vein, the RRCA Model was constructed and calibrated in a collaborative exercise by technical experts from all three States.

The RRCA Model is fully operational and calibrated to represent the physical and hydrogeological characteristics of the Republican River Basin to a reasonable degree. The RRCA Model matches the trend and magnitude of ground water level changes and stream baseflow targets distributed throughout the Republican River Basin, without significant bias in any region or hydrologic characteristic. The RRCA Model is calibrated to a sufficient degree that depletions from ground water pumping and accretions from imported water from the Platte River System to the Republican River may be quantified and assigned to prescribed streamflow reaches in accord with the RRCA Accounting Procedures.

INTRODUCTION

The Republican River rises in the high plains of northeastern Colorado and western Kansas and Nebraska. The river flows in a generally eastern direction and encompasses approximately 24,900 square miles within its watershed that is illustrated below. The States of Colorado, Kansas, and Nebraska, with the consent of the United States of America, entered into the Republican River Compact in 1942 in order to equitably divide the waters of the Republican River Basin. Ground water accretions and depletions are subject to administration within the Compact for the portion of the basin that contributes flow above the streamflow gaging station on the Republican River near Hardy, Nebraska which is in the eastern part of the Republican River Basin near the Kansas-Nebraska state line.

The Final Settlement Stipulation (FSS) in Kansas v. Nebraska and Colorado, No. 126 Original, which resolved that interstate dispute, provided for development of a comprehensive ground water model to represent the ground water flow system in the Republican River Basin. This document describes the content, construction, and calibration of the Republican River Compact Administration Ground Water Model (RRCA Model). Representatives from the State of Colorado, State of Kansas, and State of Nebraska developed the RRCA Model, with participation from the United States Bureau of Reclamation and United States Geological Survey (USGS).

Purpose and Scope

The primary purpose of the RRCA Model is to determine the amount, location, and timing of streamflow depletions to the Republican River caused by well pumping and to determine streamflow accretions from recharge of water imported from the Platte River Basin into the Republican River Basin above the streamflow gaging station near Hardy, Nebraska. The RRCA Model construction and calibration represent the physical and hydrogeological characteristics of the Republican River Basin to a reasonable degree for the period 1918 to 2000. The RRCA Model simulates historical and current physical conditions; it is not an optimization or operational model and does not assess the impact of land use and conservation practices, reservoir operations, or other water supply or water administration practices.

The RRCA Model will be used to determine ground water depletions and imported water supply accretions in formulas prescribed in the RRCA Accounting Procedures. Future input data to the RRCA Model will be developed in accordance with the requirements of the Accounting Procedures.

Document Context

This document is intended to provide a detailed description of all major facets in the RRCA Model structure, data and information, calibration, and results that were reached in its construction by the State of Colorado, State of Kansas, and State of Nebraska in consultation with the United States. Updated with annual streamflow, climatological, irrigated acreage, ground water pumping, and other information, the RRCA Model will be used to quantify said streamflow depletions caused by well pumping and imported water supply accretions for application within the formulas prescribed in the RRCA Accounting Procedures. The data and information used in construction and calibration of the RRCA Model were provided and shared by all three States and the United States in a collegial manner. In a similar vein, the RRCA Model was constructed and calibrated in a collaborative exercise by technical experts from all three States. This document reflects the RRCA Model architecture, the data sets used, and calibration agreed upon by the States as required by the FSS.

The RRCA Model, consisting of the computer code, input files, and pre-processing and post-processing programs, is provided in Appendix A on a DVD ROM. Members of the RRCA Engineering Committee are working on a RRCA Ground Water Model Users Manual that will provide details related to the use of the model in conjunction with the RRCA Accounting Procedures. The Users Manual will discuss data content and formatting, the use of pre-processing programs, details on completing the various runs of the model, and application of the RRCA Model's outputs in the annual RRCA accounting.

Model Findings and Summary

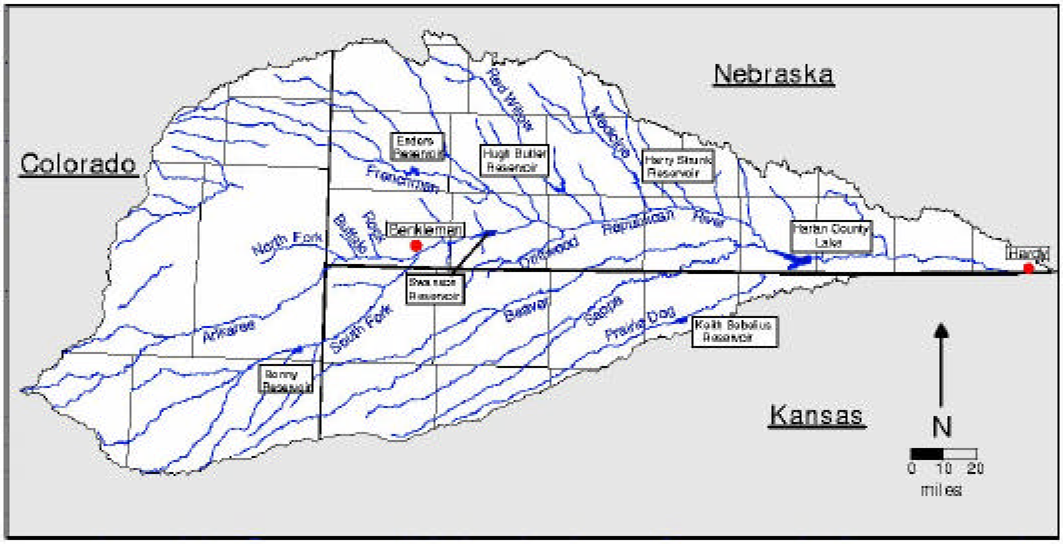
The RRCA Model is fully operational and calibrated to represent the physical and hydrogeological characteristics of the Republican River Basin to a reasonable degree. The RRCA Model reasonably matches the trend and magnitude of ground water levels and stream baseflow targets distributed throughout the Republican River Basin, without significant bias in any region or hydrologic characteristic. The RRCA Model is calibrated to a sufficient degree that depletions from ground water pumping and accretions from imported water from the Platte River System to the Republican River may be quantified and assigned to prescribed streamflow reaches in accord with the RRCA Accounting Procedures.

CONCEPTUAL MODEL OF GROUND WATER FLOW SYSTEM

Background and Physical Setting

The tributaries at the headwaters of the Republican River rise on the high plains of northeastern Colorado and western Kansas and Nebraska. The mainstem of the Republican River is formed by the junction of the North Fork of the Republican River and the Arikaree River near Haigler, Nebraska. The river flows in a generally eastern direction for approximately 445 miles before it joins the Smoky Hill River to form the Kansas River at Junction City, Kansas. The Republican River Basin encompasses approximately 24,900 square miles within its watershed that is illustrated below.

In order to include all ground water resources that affect stream flows within the Republican River Basin, the RRCA Model domain was extended beyond the Republican River watershed. The model domain boundaries extend from the Platte River in the north to the Ogallala aquifer outcrops on the southern, eastern, and western boundaries. The model domain coincides with that described in USGS Open File Report 02-175 except in the eastern portion of the Basin where it was extended eastward to the eastern edge of Kearney County, Nebraska and into Adams County, Nebraska to reflect increased water table elevations caused by imported water supplies from the Platte River. The model domain encompasses approximately 30,000 square miles. A map of the model domain, including model cell designations and boundary conditions, is provided in Appendix B.



Hydrogeology Framework

The predominant source of ground water supply within the Republican River Basin is the shallow alluvium and deeper bedrock formations that collectively form the High Plains aquifer. The High Plains aquifer underlies portions of eight western States, including Colorado, Kansas, and Nebraska, and the topography is characterized by flat to gently rolling terrain that is bisected by mostly eastward-flowing rivers and streams, such as the Republican River. The predominant geologic unit of the High Plains aquifer is the Miocene-aged Ogallala Formation of the Tertiary period. The Ogallala Formation principally consists of unconsolidated to semi-consolidated sands, gravels, clays, and silts. The High Plains aquifer is also composed of the shallower river alluvium and eolian deposits of the later Quaternary period. Water-table or unconfined conditions are predominant throughout the aquifer. However, in some areas the hydraulic interconnection between the stream systems and geologic units may have been broken and in other localized areas cemented "mortar" (caliche) beds are common and create artesian or confined aquifer conditions.

The depositional history of the High Plains Aquifer is complex because it contains both fluvial (stream-deposited) and eolian (wind-deposited) sediments. Braided streams systems that flowed eastward across the alluvial fans adjacent to the Rocky Mountains served as the primary source of deposition of coarse-grained and fine-grained sediments to the Ogallala Formation during the Tertiary time period. However, in the Quaternary period, as the climate in the area turned drier and colder due to mountain uplift, the major form of sediment deposition changed to eolian. The winds transported the fine materials caused by braided stream erosion in dust storms that carried very fine to medium sands to the east before settling into dune deposits, the largest and most prominent being located in west-central Nebraska. The Quaternary age alluvial, valley-fill, dune sand, and loess deposits are also considered to be part of the High Plains aquifer where they are hydraulically connected to the underlying Ogallala Formation.

The saturated thickness of the High Plains aquifer ranges from zero in the western edge of the aquifer in Colorado where the aquifer outcrops, to approximately 1,000 feet in west-central Nebraska. Ground water flow in the High Plains aquifer is generally from west to east in response to the predominant slope of the water table.

Water Budget

The water budget for the Republican River Basin changed dramatically over the simulation period of 1918-2000. As anticipated, during the pre-development period the natural precipitation recharge, evapotranspiration and stream gains were the only significant stresses on the system. Beginning in the 1940's, accretions from surface water canals in the Platte River Basin began to migrate into the Republican River Basin ground water system and introduce a significant new recharge into the system. Well pumping increased from approximately 1950 to 1980, then essentially leveled off but continued its impact as a major stress on the system. Coincident with well pumping increases, return flows from groundwater irrigation became a significant source of recharge. For illustrative and comparative purposes, the selected water budget components are tabulated below and a graphical representation is provided in Appendix C.

RRCA Model Global Water Budget

Annual Average Amount in acre-feet

Years	Inflows					
	Precipitation Recharge	Ground Water Recharge	Surface Water Recharge	Canal Leakage	Stream Losses	Decrease in Storage
1921-1930	1,440,697	0	0	0	222,780	424,581
1931-1940	601,512	1,264	421	15,996	229,750	632,529
1941-1950	1,916,460	15,262	47,777	632,988	208,071	467,162
1951-1960	1,283,039	69,083	99,152	652,719	207,269	812,763
1961-1970	1,479,667	237,718	102,332	598,784	230,134	1,217,401
1971-1980	1,452,260	595,112	111,638	665,139	236,637	2,511,248
1981-1990	1,740,645	572,102	101,767	623,134	233,679	2,309,917
1991-2000	1,998,741	498,803	86,742	607,402	234,982	2,221,763

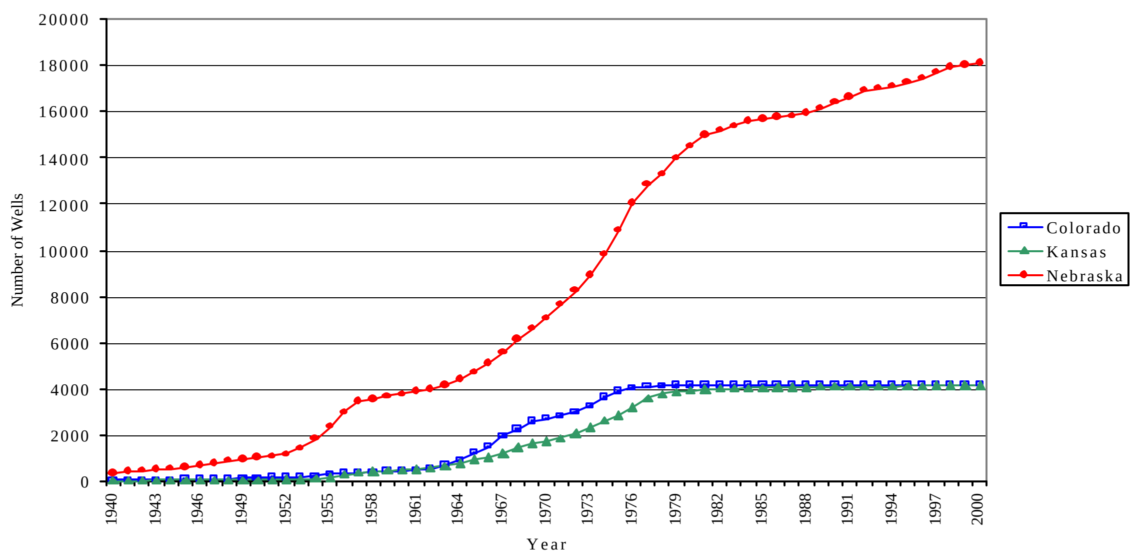
RRCA Model Global Water Budget Annual Average Amount in acre-feet						
Years	Outflows					
	Phreatophyte ET	Springs	Well Pumping	Constant Head Boundaries	Stream Gains	Increase in Storage
1921-1930	477,250	65,435	6,227	167,033	448,280	923,836
1931-1940	460,743	65,368	10,059	165,869	439,771	339,611
1941-1950	466,106	76,599	52,441	434,574	511,874	1,746,297
1951-1960	502,402	86,981	227,993	581,770	489,936	1,234,618
1961-1970	542,580	86,624	898,512	553,367	509,096	1,276,170
1971-1980	493,572	85,542	2,553,584	557,971	466,483	1,414,830
1981-1990	487,373	83,919	2,595,959	575,350	426,078	1,412,304
1991-2000	470,615	87,937	2,537,878	554,059	411,616	1,586,317

Ground Water Pumping

Irrigation Pumping

Ground water pumping for irrigation of croplands in the Republican River Basin was limited prior to World War II but progressed rapidly in the 1960's and 1970's. The cumulative number of irrigation wells within the Republican River model domain over time is illustrated in the graph below. The States agreed to accept the method each one developed to estimate gross irrigation pumping within their respective boundaries for the period 1940-2000. The methods used by each state for estimating historical ground water pumping and tabulations of the annual pumping estimates are provided in Appendix D**.**

Cumulative Number of Active Wells in the Republican River Model Domain



Pumping for Municipal and Industrial Uses

The pumping for municipal and industrial purposes for Colorado and Nebraska was obtained from the USGS and subsequently verified and refined by each state. Kansas developed its estimates from its wateruse database. Municipal and industrial pumping estimates include those quantities equal to or greater than 50 acre-feet/year.

Recharge

Recharge into the ground water aquifers is from two primary sources of water: recharge from precipitation and recharge from human-induced activities such as irrigation of cropland and seepage from ditches/canals. Recharge from irrigation is further segmented into two principal components based upon the source of water – surface water or ground water. The following narrative describes how these components were estimated for the period 1940 – 2000.

Recharge from Precipitation

Precipitation recharge is a significant variable in the overall water budget because it affects the entire model domain of over 19 million acres. Average precipitation between 1918 and 2000 varies from approximately 16 inches per year in the western part of the study area to approximately 27 inches per year in the eastern part of the Basin. Recharge from precipitation generally increases from west to east across the domain. Recharge from precipitation is also influenced by soil type. More recharge is generated on coarse textured soils than fine textured soils for the same amount of precipitation. Therefore, STATSGO soil maps were initially used to locate sandy soils in the domain. These areas are commonly referred to as the *sand hills* of Colorado and western Nebraska. In a similar manner, medium and fine textured soils were identified. For simplicity, the three soil classifications used in the RRCA Model are described as coarse, medium, and fine. The final distribution of soils across the model domain is illustrated in Appendix E.

Recognizing the amount of precipitation that recharges the ground water aquifer increases in proportion with the amount of precipitation, a set of two curves was developed for each soil classification. One curve is for irrigated lands and the other for non-irrigated lands. The Y-axis for each curve represents the number of inches of recharge from precipitation and the X-axis depicts the total amount of precipitation each year. In addition to the curves developed for the three predominant soil classifications, a two-curve precipitation recharge set was similarly developed for tributary alluviums and another for the main stem of the Republican River alluvium to represent their unique recharge and soil characteristics. The curves were developed from historical climate information and analysis of output from theoretical soil-water balance computer models and refined as part of the calibration process. The extent of the increase in precipitation recharge for irrigation conditions relative to non-irrigated conditions was the subject of extensive discussion and the resulting recharge curves represent a compromise agreement that shall not be considered a precedent toward application of precipitation recharge to surface water accounting. The Precipitation Recharge Curves are provided in Appendix F and the amount of recharge from precipitation is tabulated in Appendix G.

Recharge from Ground Water Irrigation

Recharge from ground water irrigation for all three states are calculated as the product of estimated pumping multiplied by an appropriate efficiency factor. The following methods are applied to calculate recharge from ground water irrigation in each State for 1940-2000 and the amount of ground water recharge is tabulated in Appendix H.

Colorado – Recharge from ground water pumping in Colorado is calculated for each year and for each county. Ground water recharge from sprinkler irrigation is calculated by multiplying the gross pumping for sprinkler irrigation by the percentage that returns as deep percolation. In a similar manner, the amount of ground water recharge from flood irrigation is calculated by multiplying the gross pumping for flood irrigation by the percentage that returns to the aquifer as deep percolation. The total amount of recharge from ground water per county and year is the sum of the returns to deep percolation from sprinkler and flood irrigation.

Kansas – Recharge from ground water irrigation was calculated by subtracting the net pumping from the gross pumping, and deducting spray loss for sprinkler irrigation or surface water runoff on lands that are flood irrigated. The average percentage of pumping lost to spray loss was 6% until 1986 and declined to 3% in more recent years. The net surface water runoff from flood irrigation is 5%. Once the county monthly pumping and return flow values were calculated, they were distributed to the sections within the county using the annual well count and irrigated acreage. A section's percentage of the county's total irrigated acreage was calculated and multiplied by the county pumping and return flows to obtain values for the section.

Nebraska - Based on professional judgment, Nebraska assumed recharge rates that are generally inverse to assumed farm efficiency. Nebraska applies a ground water irrigation efficiency of 70% from 1940 to 1960 and a linear increase from 70% in 1960 to 80% in 2000. These percentages were checked for reasonableness using information available on the number of wells and number of center-pivot irrigation systems for each year.

Recharge from Canals and Laterals

A number of canal systems supply surface water for irrigation within the domain that influences flow in the Republican River and its tributaries. Seepage from these canals and their corresponding laterals is specified in the model as a recharge term. The calculation of canal and lateral seepage recharge specified in the model is dependent on the type of canal system as summarized in the table below. Recharge estimates from canals and laterals are tabulated in Appendix I

Canal System Type	Method for Calculating Canal and Lateral Seepage Recharge
Small Non-Federal Ditches and Canals	Recharge from canal seepage and from surface water irrigation is combined into one term. The total amount of recharge for both the canal seepage and surface water irrigation is calculated to be 40 percent of tabulated diversions.
Federal Canals (Maintained by the US Bureau of Reclamation)	Recharge from canal seepage calculation based on methodology specified in Section IV.A.2.c in the RRCA Accounting Procedures.
Platte River Canals	Where available canal seepage was determined from measured farm headgate deliveries and diversions at the headgate with estimated evaporation from the canal surface subtracted out. Where these data were not available canal loss rates were estimated using the rates from like canal systems with available data.

Recharge from Surface Water Irrigation

Surface water irrigation recharge was specified based on a percentage of the water delivered to farm headgates by canal systems and small pumping plants that extracted water directly from surface water bodies. The methods used to calculate surface water irrigation recharge is provided in the table below. Recharge estimates from surface water are tabulated in Appendix J.

Canal System Type	Method for Calculating Surface Water Irrigation Recharge
Small Non-Federal Ditches and Canals	Recharge from canal seepage and from surface water irrigation is combined into one term. The total amount of recharge for both the canal seepage and surface water irrigation is calculated to be 40 percent of tabulated diversions.
Federal Canals (Maintained by the US Bureau of Reclamation)	Recharge from surface water irrigation calculation based on methodology specified in Section IV.A.2.c in the RRCA Accounting Procedures.
Platte River Canals	Recharge from surface water irrigation was specified to be 40 percent of farm headgate deliveries for 1940 to 1960 linearly decreasing to 30 percent in 2000.
Small Surface Water Pumping Plants	Recharge was specified to be 25 percent of the water diverted.

Irrigated Acreage

The States agreed to methods for estimating irrigated acreage for the period 1940-2000, which are documented in Appendix K. The summary of the total estimated irrigated acreage at the beginning of each decade is provided below and the estimates by county and year for each State are tabulated in Appendix K.

Total Estimated Irrigated Acreage in Republican River Basin			
Year	Colorado	Kansas	Nebraska
1940	5,409	2,952	22,427
1950	15,900	6,080	188,031
1960	62,736	50,882	451,385
1970	428,009	196,831	638,969
1980	664,161	357,710	1,428,685
1990	667,351	402,132	1,498,400
2000	667,891	434,767	1,654,452

Crop Irrigation Requirements

Colorado - The potential irrigation requirement for each crop for each county and year was estimated using the Hargreaves equation calibrated to the Penman-Monteith equation and are tabulated in Appendix L. The crop mix was obtained from County Assessor data. Effective rainfall was estimated using the procedure outlined in Irrigation Water Requirements, Technical Release No. 21, United States Department of Agriculture, April 1967 (Revised September 1970). The gain in soil moisture from winter and spring precipitation was an average of 2.0 inches (source: Republican River Basin Water Management Study, Steven J. Vandas, United States Bureau of Reclamation, March 1983). The net crop irrigation requirement was calculated as the potential consumptive use minus effective precipitation minus the gain in soil moisture from winter and spring precipitation.

Kansas - Using the Hargreaves equation calibrated to the Penman-Monteith calculations and effective rainfall from TR-21, the composite crop-weighted unit CIR was obtained for each year. At climate stations for which the requisite data to calculate the CIR for 1940-1949 was not available, data from a nearby station were substituted. The unit CIR for 1940-2000 was multiplied by the irrigated acreage described above to obtain volume of irrigation demand for each county. To account for winter soil moisture, a preliminary soil moisture factor was applied to each county in April and, if necessary, May, and was used to offset the CIR at the beginning of the irrigation season. The remaining CIR was then used as an initial estimate of net pumping.

Nebraska – Crop irrigation requirements are not estimated in the Nebraska procedure.

Streams and Reservoirs

The RRCA Model considers only the impact of ground water pumping and surface water imports to the baseflow for the major streams in the Republican River Basin. It is not a surface water model and total streamflows are not incorporated in its design or calculations. The stream network was adopted from the USGS Republican River Study and a schematic diagram is shown in Appendix M. The seven major federal reservoirs were simulated in the RRCA Model using historical elevations or reservoir stages.

Phreatophytes

The potential evapotranspiration rate for the various classifications of phreatophyte vegetation (forest, woody, and marsh) was collapsed into a single ET rate that was calculated by the Hargreaves method using appropriate equivalent crop coefficients. Results were obtained for the Akron, McCook, and Red Cloud climate stations on a monthly time step. For selected sub-basins, the change or encroachment of phreatophytes over time was adjusted in accordance with the curvilinear time-relationship developed from aerial photographic data provided by Michaela Johnson in a published Master's Thesis (Johnson, 2001) with refinements based on observed streamflows during calibration. The methods used by each State to calculate and assign phreatophyte distribution are provided in Appendix N. The phreatophyte potential evapotranspiration rates used in the RRCA Model are tabulated in Appendix N in addition to the sub-basin phreatophyte potential evapotranspiration factors that reflect the expansion of phreatophytes over time.

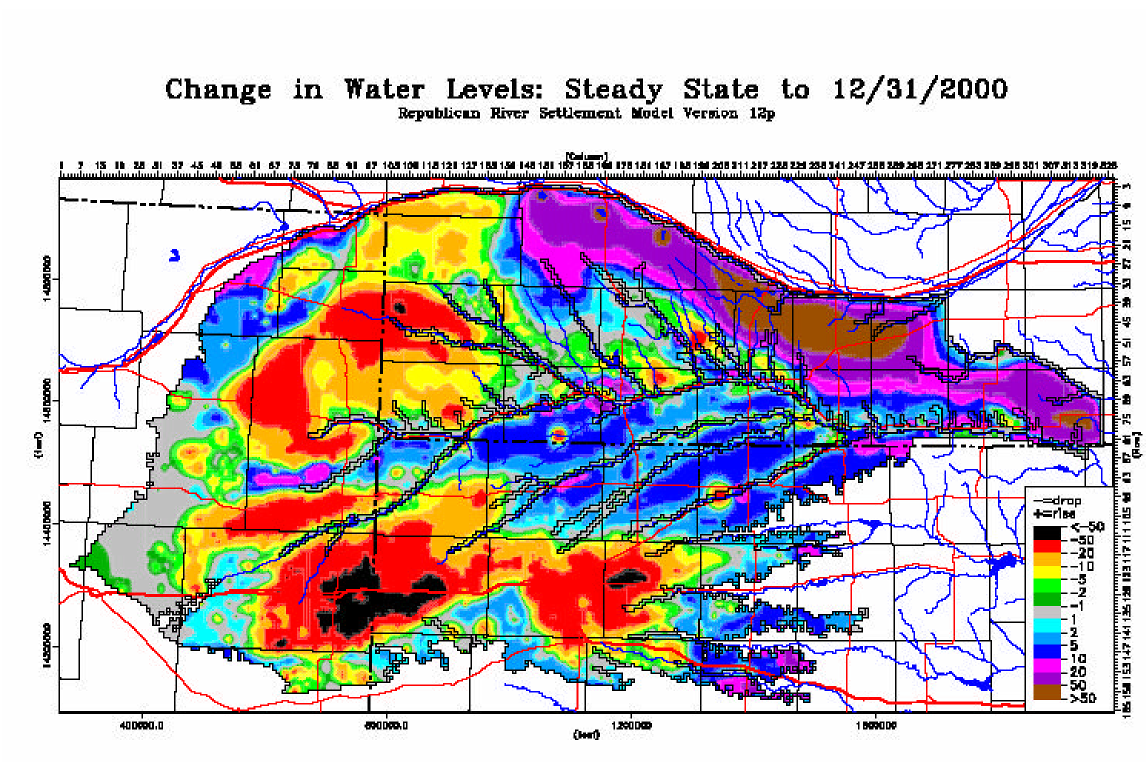
Discussion of Flow Pattern

The general direction of water flow in the Republican River Basin is west to east with tributaries intersecting from both the southern and northern boundaries to the mainstem in the center of this gourd-shaped watershed. In the extreme north-central portion of the basin in Nebraska, there is a small amount of ground water flow from the Republican River Basin north toward the Platte River Basin. Further east, ground water migrates south from the Platte River Basin into the Republican River Basin in the northeastern portion area of the watershed referred to as the "mound area" that is approximately centered on the 99th Meridian. Headwaters of the Republican River are born on the high plains of eastern Colorado and combine with tributaries from southwestern Nebraska and northwestern Kansas to form the mainstem of the Republican River at the confluence of the North Fork of the Republican River and Arikaree River near Haigler, Nebraska. The Republican River flows eastward and generally parallel to the Nebraska-Kansas stateline before turning in a southeastern direction to cross the border near Hardy, Nebraska. The Republican River meets the Smoky Hill River at Junction City, Kansas to form the Kansas River, a major tributary to the Missouri River.

Streamflows are captured and retained in seven federal reservoirs that are within the Republican River Basin upstream of the Nebraska-Kansas stateline near Hardy, Nebraska. The reservoirs and associated tributary streams are as follows, progressing from the headwaters downstream:

Bonny Reservoir	South Fork of the Republican River, Colorado
Swanson Lake	Mainstem of the Republican River, Nebraska
Enders Reservoir	Frenchman Creek, Nebraska
Hugh Butler Lake	Red Willow Creek, Nebraska
Harry Strunk Lake	Medicine Creek, Nebraska
Keith Sebelius Lake	Prairie Dog Creek, Kansas
Harlan County Lake	Mainstem of the Republican River, Nebraska

The RRCA Model predicted change in water levels vary dramatically across the Republican River Basin from the pre-development period through 2000. The maximum rise in water level is approximately 179 feet in the mound area in Nebraska and the greatest decline is approximately 86 feet near Burlington, Colorado. For illustrative purposes, the predicted change in water levels in the RRCA Model domain is shown below.



MATHEMATICAL REPRESENTATION OF GROUND WATER FLOW MODEL

Model Program

The RRCA Model applies a modified version of the United States Geological Survey modular ground water model MODFLOW 2000 (Harbaugh and others, 2000) version 1.10 to numerically calculate stream depletions from ground water pumping and accretions from imported water supplies. MODFLOW is a simulation program that uses a finite-difference method to solve the ground water flow equation.

In addition to its robust numerical solver capabilities, MODFLOW also offers two significant attributes. First, it is relatively easily understood, which promotes confidence in its application by those intending to use the computer model to simulate physical and hydrological conditions. Second, it is easily enhanced to accommodate the continuing need for additional capabilities to address a variety of physical and hydrogeological conditions.

The MODFLOW program promotes simulation accuracy and computational flexibility by segmenting various hydrologic attributes such as recharge, leakage from the aquifer to the rivers, or evapotranspiration from ground water as separate or distinct packages. For application within the RRCA Model, the following enhancement modules or packages were used:

- Basic (BAS6)
- Layer Property Flow (LPF1)
- Recharge (RCH6)
- Well (WEL6)
- Stream (STR6)
- Evapotranspiration (EVT6)
- Drains (DRN6)
- Preconditioned Conjugate Gradient (PCG2)
- Hydrograph (HYMOD1)

Model Architecture

The following items are the major components in the RRCA Model architecture:

? The model is a single layer bounded on the bottom by the impermeable Pierre Shale.
? The initial Stream Network was taken from USGS Open File Report 02-175.
? The interim aquifer base was taken from USGS Open File Report 02-175, and was adjusted to reflect elevation variances near streams and data available from Nebraska.
? Land surface elevations were obtained from the National Elevation Dataset (NED) one arc second Digital Elevation Model (DEM). The land surface elevations along stream channels were modified in order to provide strictly decreasing elevations along stream channels.
? The ground water flow system was simulated as if there were a constant transmissivity in order to preserve numerical stability.

Simulation Period

The RRCA Model represents the long-term steady-state conditions prior to 1918 and transient conditions from 1918 to 2000. Transient conditions are discretized into monthly stress periods. The RRCA Model will be updated annually by the RRCA to reflect data from 2001 to the current accounting year.

Discretization

The RRCA Model is spatially discretized into one-square mile grid cells and temporally discretized into one-month stress periods, with two time-steps per stress period.

Boundary Conditions

Constant head boundary conditions for the model were assigned along the Platte River, the eastern boundary of Kearney, Clay, Nuckolls, and Adams Counties, Nebraska; and in Cheyenne County, Colorado where the Ogallala aquifer continues south of the Republican River Basin. All other boundaries are no-flow boundaries or drains. See Appendix B, RRCA Model Domain for boundary and drain locations.

Initial Conditions

The steady state recharge, or initial condition, was established on the premise of no ground water irrigation prior to 1940. The historical recharge for the period of 1918-1940, assuming no irrigation, was used in conjunction with the developed recharge curve(s) to obtain the recharge for each year. The recharge obtained for each year in the 1918-1940 period was averaged and assigned as the initial recharge condition in 1918, also known as the steady state condition. A global multiplier called the steady state multiplier was used to adjust the steady state recharge. During model calibration, the value of the steady state multiplier was established at 0.75, in part to replicate the long-term upward trend in the hydrographs observed in the western part of the domain.

Aquifer Parameters

The RRCA Model considers two aquifer parameters:

- The specific yield values were obtained from previous USGS investigations and reports and are portrayed in the Distribution of Specific Yields in Appendix O.
- Hydraulic conductivities were quantified through the calibration process and are portrayed in the Distribution of Hydraulic Conductivities in Appendix P.

Stresses

Calculation of the model stresses is fairly complex due to the variance in the three States' data and methods used to calculate well pumping for ground water irrigation, surface water irrigation and the associated recharge. To provide resolution and a common platform, a set of programs was developed to transform the data from raw well and irrigation files to a common cell-by-cell format. This common format consists of a set of files named **yyyy.mm.xxx**, where the letters designate the year, month, and type of information respectively. The type of information is "pmp" for pumping, "rcs" for surface water recharge, "rcg" for ground water recharge and "rcc" for canal recharge. In addition, the file named **yyyy.xxx** is used to represent annual quantities and type of information respectively. For the annual quantities, "mi" is used to represent municipal and industrial pumping, "asw" is the surface water irrigated area, "agw" is the ground water irrigated area, and "aco" is the commingled irrigated area. Volumes are always specified in acre-feet, and areas are always specified in acres.

Colorado - The Colorado ground water input data consist of two databases. The well database specifies the location, county, appropriated acreage, and priority date for each well. The pumping database specifies the county totals for well pumping and the county-by-county ground water irrigated efficiency. The **mkgw** program is then used to calculate cell-by-cell pumping, ground water irrigation recharge, and irrigated areas. The program distributes pumping from the county to the model cells by assigning pumping proportional to the appropriated acreage of the active wells for that year. Pumping is distributed from the annual value to monthly values using a fixed proportioning. Irrigation recharge from ground water is assigned to the same cells where the pumping occurs. The ground water recharge is equal to the pumped amount multiplied by the return flow fraction, defined as one minus the irrigation efficiency. The appropriated acreage is used to calculate cell-by-cell ground water irrigated acreage.

The Colorado surface water input data are also contained within two databases. The ditch database consists of the acreage per cell for each ditch system. The diversion database consists of monthly diversions for each ditch. Surface water irrigation returns are calculated as the fixed percentage of the diverted amount as specified in the settlement agreement. The surface water return flow amount is distributed over the ditch acreage proportional to the acreage in each cell. The **mksw** program is used to perform this calculation. The surface water irrigated acreage is the sum of the ditch acreages for each cell. There are no commingled surface and ground water irrigation applications modeled in Colorado.

Kansas - The Kansas ground water input data consists of two databases. The well database specifies the location, county and irrigated acreage by year for each well. The pumping database specifies the total pumping for each county by year, the irrigation efficiency by county by year, and the annual to monthly distribution factors by county by year. The **mkgw** program is used to calculate monthly cell-by-cell pumping by distributing annual county totals to months using the monthly factors, and then to cells in proportion to the irrigated acreage for each year. For years that records indicate the well is not pumping, an irrigated acreage of zero switches off pumping in that well. The ground water recharge from ground water pumping is assigned in the same cell as where the pumping occurs. The ground water recharge amount is computed as a percentage of the pumped amount, equal to one minus the irrigation efficiency multiplied by pumping, adjusted down for runoff and spray loss.

The Kansas surface water return flow calculation is performed exactly like the surface water return flow calculation in Colorado except for those lands in Kansas served by the Almena Canal that are surface and ground water irrigated commingled land.

Nebraska - The Nebraska raw data consists of seven databases. They include the lands served exclusively by ground water irrigation database, the commingled lands ground water irrigated database, the lands served exclusively by surface water irrigation database, the commingled surface water database, the river pumpers database, the private canals database, and canal leakage database. Each of the first four databases specifies the annual volume of applied water and area over which it is applied on a cell-by-cell basis. The river pumpers database and private canals database supply only the annual volume by cell and the canal leakage database supplies the monthly volume by cell. The program **mknedat** is used to create the required monthly ground water pumping files by distributing the annual cell-by-cell pumping to a monthly timestep using a fixed set of factors. The ground water recharge is calculated as a factor of the pumped amount. This factor is a constant over the State of Nebraska, and is 30% until 1960 and then reduces linearly to 20% in 2000. The pumping and ground water irrigation recharge are calculated in the same manner for commingled and exclusively ground water irrigated lands. The total of both commingled and exclusively ground water pumping is written to a single pumping file. The exclusively ground water pumping acreage is stored to the ground water irrigation acreage files. The commingled ground water acreage is not used in this application since it is the identical acreage that is designated as surface water commingled acreage.

Surface water farm deliveries are specified on a land-by-land basis. For each land, the cell and appropriate canal system is specified. The return flows from each land are calculated as the delivered amount multiplied by a system specific fraction. This fraction is specified in the FSS, and for most systems it is a constant with time, but for some systems the return flow fraction varies with time. The annual volume is accumulated for each cell and distributed to a monthly timestep using the same set of factors used to distribute the pumping. The irrigated acreage served exclusively by surface water is saved to the surface water irrigated area file and the commingled surface water area is saved to the commingled area file for the year.

River pumpers and private canals are specified as annual totals by cell. The return flow from these irrigation methods are calculated as a fixed fraction of the applied amounts and added to the cell-by-cell surface water return flows. The irrigated acreage is not considered.

The canal leakage database specifies canal losses on a cell-by-cell basis for every month and is simply copied to change the file format.

Stress Calculation

The Republican River Pre-Processor (rrpp) program is used to construct MODFLOW recharge and well pumping input files from these cell-by-cell files. The input files for each state are kept in a separate directory. The rrpp program reads the cell-by-cell monthly and annual files for all three states, calculates recharge from precipitation and outputs the resulting recharge and well pumping data sets as input to the MODFLOW program. A steady state step is used to establish the model initial condition at the beginning of the 1918 to 2000 transient simulation. There is no well pumping, irrigation recharge or canal leakage in this initial steady state. Therefore, the recharge consists only of precipitation recharge. The rrpp program calculates the precipitation recharge for each year from 1918 to 1940 and then averages the recharge. Each cell is assumed to be only non-irrigated during this period.

The rrpp program is used to generate MODFLOW input files for both the historical or base run and the impact runs - "No State pumping" for each of the states and "No Nebraska import". The program reads a set of instructions from a parameter file. The NOPUMP instruction is used to switch off irrigation well pumping and return flows for a particular state as well as the M&I pumping. The MOUND instruction is used to switch off all surface water returns and canal leakage within the area in Nebraska designated as the mound area. A map of the mound area in Nebraska is provided in Appendix A.

Pumping is calculated on a month-by-month basis by accumulating the cell-by-cell pumping specified in the individual state files. If pumping is switched off for a state, pumping for that state is simply omitted. The total pumping for each month is then written to the MODFLOW well file.

Recharge from irrigation is calculated on a month-by-month basis by accumulating the cell-by-cell return flows from precipitation, surface water and ground water irrigation recharge, and canal leakage. Surface water return flows are accumulated on a cell-by-cell basis for each state, except when the MOUND instruction is used, in which case the surface water return flows inside the designated mound area are omitted. In a similar manner, canal leakage is accumulated on a cell-by-cell basis for each state, except again the mound area is omitted when so instructed. Ground water recharge is also accumulated on a cell-by-cell basis for each state, except when the NOPUMP instruction is used, in which case the ground water recharge for that state are omitted.

In order to calculate precipitation recharge, the irrigated area within each cell is accumulated as the sum of the ground water, surface water and commingled area in the cell. When the MOUND instruction is used, the exclusive surface water acreage is not added within the mound area. Similarly when the NOPUMP instruction is used, exclusive ground water acreage within the cell is not counted. Commingled acreage is always counted. If the total irrigated acreage within a cell equals or exceeds the number of acres in a cell, the entire cell is treated as irrigated. Otherwise the remaining acreage within a cell is treated as non-irrigated.

The annual precipitation for each cell is calculated by kriging the annual precipitation at a number of stations in the basin to the cell. For both the non-irrigated and irrigated fraction of the cell, the amount of recharge that corresponds to this precipitation amount is then calculated from precipitation recharge curves that correspond to non-irrigated and irrigated lands for the type of soil associated with this cell. The soil type and curves are specified in the parameter file read by the rrpp program. The resulting total recharge for the cell is then calculated as the product of the fraction of non-irrigated and irrigated lands multiplied by the respective recharge amounts. The total recharge from precipitation is then adjusted using a spatial multiplier to adjust the recharge amount for spatial variations in terrain. The resulting annual recharge amounts are then distributed to months using a fixed set of monthly factors.

The resultant total recharge is the sum of the precipitation recharge, surface and ground water irrigation recharge, and canal leakage, appropriately adjusted to honor the NOPUMP or MOUND instructions. These values are written to the MODFLOW recharge file.

Phreatophyte Evapotranspiration

The MODFLOW evapotranspiration input file is generated by the **mket** program. This program calculates the monthly maximum evapotranspiration rate required by MODFLOW from four input files. The monthly phreatophyte evapotranspiration rate at the Akron, McCook and Red Willow climate stations are read from the first database. This rate is then multiplied by the phreatophyte area. The phreatophyte area is calculated from the present day cell-by-cell areas multiplied by a set of sub-basin factors. The sub-basin factors vary by year and hydrologic sub-basin. Within each sub-basin, the area is adjusted by the sub-basin factor for that year. Basin factors were generated for the period 1938-1993. After 1993 the basin factors were assumed to remain at the 1993 levels. From 1935 to 1938, the basin factors were assumed to remain at the 1938 level. Although the basin factors were initially taken from the USGS, they were ultimately determined as calibration factors. However, no information prior to the catastrophic 1935 flood in the Republican River Basin is available. Since the flood regime of the basin changed with the construction of federal reservoirs in the 1950's and beyond, the present day phreatophyte growth is not representative of pre-development growth. Therefore the year 1950 was selected as a surrogate to represent pre-development phreatophyte evapotranspiration.

The evapotranspiration surface is set equal to the NED ground surface, and the extinction depth is set to a constant ten feet. The NED ground surface is adjusted in the stream package setup to provide for streams always flowing down gradient. In those cells, the evapotranspiration surface is set at five feet above the stream channel elevation. This offset is intended to represent the elevation of the stream banks relative to the incised stream channel and is a constant across the basin.

Streams and Reservoirs

The stream network previously generated by the USGS was adopted for this study. The streambed conductance, thickness and area were adopted verbatim. The **mkstr** program was used to adjust the streambed elevation to represent the more accurate NED data that became available after the original USGS work and to introduce reservoirs to the stream network.

The streambed elevation for a cell was calculated as the average of the minimum NED elevation for a cell and the upstream cells within the stream network. For headwater cells, the elevation was set equal to the average NED elevation in the cell. The stream network was then traversed in a series of operations designed to ensure that the stream network runs down gradient.

Where the NED reflects present day reservoir stages, a linear interpolation from the cell above and below the reservoir was used to represent pre-reservoir stream elevations.

In order to model reservoirs as part of the stream network, each reservoir was associated with one or more stream segments and a set of model cells. At the particular month that a reservoir came into operation, that stream segment was replaced by a set of reservoir cells with a conductance equal to one square mile in area, a hydraulic conductivity of one foot per day, and a thickness of ten feet. The reservoir segment of the stream network is isolated from the rest of the stream network by altering the tributaries array and an inflow into that segment is set to one million cubic feet per second. The stream elevation for each month is set equal to the middle of month stage for the reservoir. This arbitrarily large inflow ensures reservoir losses are not constrained within the reservoir segment. Since outflow from the reservoir segment is not transferred to downstream segments, the assignment of this inflow does not affect downstream computations. Note: the stream network must be specified for every stress period during which reservoirs are active because the reservoir stage changes from month to month. The specific yield was set to zero for those cells containing reservoirs because the reservoir storage change calculations are explicitly incorporated within the RRCA Accounting Procedures.

The HYDMOD package was used to extract stream flows and reservoir leakage at selected locations. A limitation of this package is the number of reaches within a stream segment cannot change in order for the HYDMOD package to extract the flow at the correct location. Therefore, the mkstr program pads the reservoir segments of the stream network with "dummy reaches" to ensure that each segment contains the same number of reaches before and after the reservoir goes in. The dummy reaches can be identified as having a conductance of zero, which precludes any surface-ground water interaction but ensures proper routing of flow and proper operation of the HYDMOD package.

CALIBRATION OF GROUND WATER FLOW MODEL

Purpose of Calibration

The purpose of calibrating the RRCA Model is to achieve an acceptable level of correspondence between model inputs, results and historical physical observations of the ground water flow system in the Republican River Basin. The process of calibrating the RRCA Model also included the mathematical representation of the hydrogeologic framework, boundary conditions and hydraulic properties to reflect the physical characteristics of the Republican River Basin.

Calibration Targets

Water Levels

Ground water levels have been measured throughout the Basin since the early 1900's, but the number of sites increased dramatically post-World War II. The source of ground water level information used in the RRCA Model is the Ground Water Site Inventory (GWSI) maintained by the United States Geological Survey (USGS) in cooperation with all three States. The tenure of static ground water level data ranges from a single-year measurement at a discrete location to a continuum of annual measurements that began in the early 1950's and continues to date at the same well. Ground water levels are typically measured once each year, usually in the non-irrigation season when effects from irrigation pumping are minimized. The RRCA Model is calibrated to a ground water level dataset that contains a total of 350,233 water level records at 10,835 different sites. The GWSI dataset was converted from latitude/longitude to an X-Y coordinate system. The entire dataset, including one-measurement water levels, was used in model calibration except for wells that were determined by the representative State to be clearly erroneous. The dataset and well hydrographs depicting observations and predictions are provided in electronic format in Appendix A.

Baseflow

Hydrograph separation is a technique that partitions the amount of surface water and ground water that is measured as total streamflow at a river gaging station. Determining the component of total streamflow that is contributed by ground water (also called baseflow) requires professional expertise and judgment. The hydrograph separation analysis used in this application is referred to as the Pilot Point method. This procedure was adopted for application in this ground water model since it combines the benefits of graphical baseflow analysis with the computational efficiency afforded by electronic spreadsheets. Daily streamflow information for one, or multiple years, is easily tabulated in a Microsoft Excel© electronic spreadsheet. Daily hydrographs are subsequently plotted using the graphics package. The analyst performing the baseflow separation uses the tools available in the electronic graphics package to select pilot or turning points that signify the baseflow component in the total amount of streamflow measured at a river gaging station. A significant contribution of the graphics and computational package afforded by Microsoft Excel© is the flexibility to easily change the assignment of each pilot or turning point upon comparative review with other nearby streamflow hydrographs or in collaboration with another analyst. The analyst may change one or multiple pilot points using the click-and-drag tool to another turning point and instantly recalculate the amount of baseflow for a defined period of time – from a month up to decades.

For the RRCA Model, sixty-five (65) independent baseflow analyses were performed and adopted as calibration targets. Annual and monthly baseflow estimates for each analysis is provided in electronic medium in Appendix A.

Comparison of model calculations to targets

The RRCA Model calculations match the representative baseflow and water-level targets to a reasonable and acceptable degree. For the baseflow evaluation, the RRCA Model results were evaluated in juxtaposition on a graphical format with the accepted baseflow quantifications for 65 different stream reaches. Based upon professional judgment, the model results reasonably match the trend and magnitude of the actual baseflow condition at the various locations.

Hydrographs showing the physical observations and model predictions were generated for all ground water wells with measurements. Professional judgment was again used to evaluate the accuracy of the measurements and the comparison to model predictions, with greater weight being given to wells with a consistent measurement set and longer periods of record. In consideration of the magnitude and complexity of the model domain, the RRCA Model generally matched the observed water-level targets. The comparative evaluation of model calculations to physical targets based upon professional judgment, as opposed to a statistical assignment, is an acceptable method for a mathematical model with the magnitude and complexity inherent within the Republican River Basin.

Calibrated Parameters

Calibration parameters are physical, climatic, and/or aquifer properties that can be adjusted to so that the mathematical representation of a ground water model better represents actual conditions. Selection of final values for calibration parameters requires consideration of the match between model outputs and calibration targets, and whether such values are reasonable considering geologic, climatic, and other conditions in the Republican River Basin. Calibration parameters may vary in a spatial context to reflect different physical and/or geographic conditions. The two principal calibration parameters used in application to the RRCA Model are hydraulic conductivity and precipitation recharge.

<u>Hydraulic Conductivity:</u> hydraulic conductivity may be defined as the measure of the ease in which water can be transmitted through a porous material, i.e. flow through an aquifer. The hydraulic conductivity values applied in the model are based upon professional expertise and vary across the model domain. Hydraulic conductivity parameters were refined and statistically distributed throughout the model domain during the calibration process. Hydraulic conductivity values were specified at a set of user-supplied points, approximately one per county. These point values were distributed to every cell in the domain using logarithmic kriging. The point values were varied during calibration using a combination of professional judgment and automated calibration using a parameter estimation program.

<u>Precipitation Recharge:</u> The amount of precipitation that percolates into the ground water aquifer is dependent upon different soil characteristics and the amount of precipitation. Three general soil classifications were identified and distributed throughout the Republican River Basin: coarse, medium, and fine. As part of the model calibration, the STATSGO Soil Type 832 that was originally classified as “fine” was reclassified as “medium” to better differentiate precipitation recharge in the mound area in Nebraska from the rest of the model domain. In addition, the alluvial valleys were treated as distinct soil groups, with one group for the tributary alluviums and one for the alluvium along the mainstem. Recognizing the amount of precipitation that recharges the ground water aquifer increases in proportion with precipitation, a set of two curves was developed for each of the three soil classifications. One curve is for irrigated lands and the other for non-

irrigated lands. The Y-axis for each curve is inches of recharge from precipitation and the X-axis depicts the total amount of precipitation each year.

Lesser calibration parameters that are used to further refine the ground water model include:

Spatial Multipliers – the Spatial Multiplier has a value of 1.0 throughout the model domain except in the mound area in Nebraska where the value is 1.5. A map of spatial multipliers with associated values is provided in Appendix Q.

Steady-State Multiplier – for the period of 1918 to 1940, the long-term average recharge is not fully indicative of all conditions in the model domain, primarily in the western area. A steady-state multiplier of 0.75 was applied to the average of the 1918-1940 recharge period throughout the Republican River Basin.

Phreatophyte potential evapotranspiration rate – the rate is indexed to the McCook and Red Cloud, Nebraska and Akron, Colorado climate stations. The annual potential evapotranspiration rates were linearly interpolated from west to east across the model domain. To improve the ability of the model to match baseflows, all phreatophyte evapotranspiration rates were adjusted by a factor of 2.0. For specific sub-basins, a second factor ranging between 0.03 and 1.12 was applied. The location of the phreatophyte areas and distribution of potential evapotranspiration are provided in Appendix R.

Saturated Thickness – Applied within the RRCA Model to improve the model performance, the saturated thickness in any given model cell was adjusted to a minimum of 10 feet. The saturated thickness is based upon average values for the period 1940-2000 and was kriged across the model domain between known data points. The distribution of saturated thickness is provided in Appendix S.

Transmissivity – The adjustments to hydraulic conductivity and saturated thickness described above were made during the calibration procedures and resulted in a distribution of transmissivity that is provided in Appendix T.

Model Output

The RRCA Model is fully operational and calibrated to represent the physical and hydrogeological characteristics of the Republican River Basin to a reasonable degree. The RRCA Model reasonably matches the trend and magnitude of ground water levels and stream baseflow targets distributed throughout the Republican River Basin, without significant bias in any region or hydrologic characteristic. The RRCA Model is calibrated to a sufficient degree that depletions from ground water pumping and accretions from imported water from the Platte River System to the Republican River are quantified and assigned to prescribed streamflow reaches that are in accord with the RRCA Accounting Procedures.

The RRCA Model calculates the amount of ground water depletions from well pumping as the difference in streamflows using two simulation runs of the model. The "base" run is the simulation with all ground water pumping, ground water pumping recharge, and surface water recharge within the model study boundary for the period 1918 to the current accounting year "on". The "no State pumping" run is the simulation run with the same model inputs as the base run with the exception that all ground water pumping and pumping recharge for that particular State is turned "off." The amount of recharge from precipitation is recalculated by converting all ground water-only irrigated land to non-irrigated lands. The amount of depletions charged to each respective State is the difference between the "base run" and the "no State pumping run". In a similar manner, the "no NE import" run is the simulation with the same model inputs as the base run with the exception that surface water recharge from irrigation and canal leakage that is associated with Nebraska's Imported Water Supply is turned "off." The amount of recharge from precipitation is recalculated by converting all surface water-only irrigated land to non irrigated lands and the Imported Water Supply Credit is the difference in stream flows between these two model simulation runs. For commingled lands, defined as receiving irrigation water from a combination of surface and ground water supplies, there is no switch or conversion from irrigated to non-irrigated lands because it is assumed any deficit from one supply source will be replaced by the other. Therefore, while the surface or ground water return flows may be removed in a no pumping or import simulation run, the derivation of recharge from precipitation remains unchanged for commingled lands.

An output of the model is baseflows at selected stream cells. Changes in the baseflows predicted by the model between the "base" run and the "no-State-pumping" model run are considered to be the depletions to streamflows, or ground water computed beneficial consumptive use due to State ground water pumping at that location. The values for each Sub-basin include all depletions and accretions upstream of the confluence with the Main Stem. For sub-basins with reservoirs and the Main Stem, the model's output totals the depletions and accretions above and below each federal reservoir and in the reservoir reaches. The values for the Main Stem include all depletions and accretions in stream reaches not otherwise accounted for in a Sub-basin. The values for the Main Stem are computed separately for the reach above Guide Rock, and the reach below Guide Rock. For subsequent years, the RRCA Model will be extended to include new hydrologic, pumping, climate, and other annualized datasets. The data will be compiled and exchanged in accordance with the RRCA Accounting Procedures.

For illustrative purposes, impact tables that quantify the depletion of ground water well pumping and imported water supply accretions by stream reach are provided in Appendix U for the period 1981-2000.

CONCLUSIONS

The RRCA Model fulfills the requirements of the FSS to develop a ground water model for use by the RRCA to aid in the administration of the Republican River Compact. The RRCA Model quantifies the amount, location, and timing of streamflow depletions caused by ground water well pumping and the accretions to streamflow from imported water across the model domain on an annual basis. The RRCA Model provides the required output information in an acceptable format to describe the amounts and timing of said ground water pumping depletions and imported water accretions that are necessary for application within the prescribed annual RRCA Accounting Procedures. The RRCA Model calibration represents the physical and hydrogeological characteristics of the Republican River Basin to a reasonable degree. The use of specific methods or computational procedures within the RRCA Model does not necessarily mean that any party represents or accepts them to be the best or only method for purposes other than that, which is applied in the RRCA Model. The RRCA Model will be used as is, with only annual updates to the appropriate data files and necessary modifications to pre-processor programs required to accommodate modified future data formats, but without recalibration, until such time as the RRCA approves any changes. The RRCA may consider revisions to the model as set forth in the FSS.

APPENDICES

Appendix A – RRCA Model DVD
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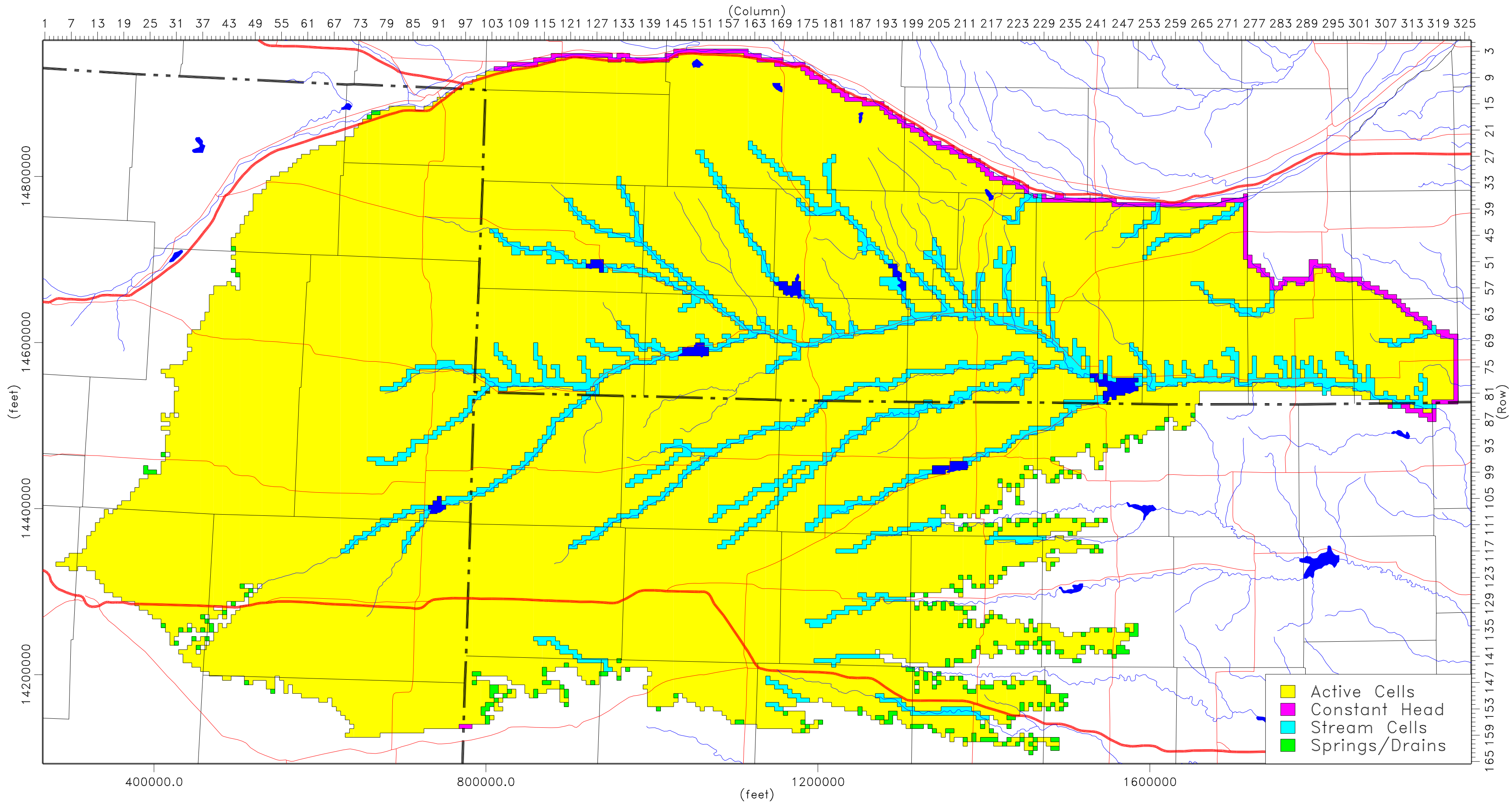
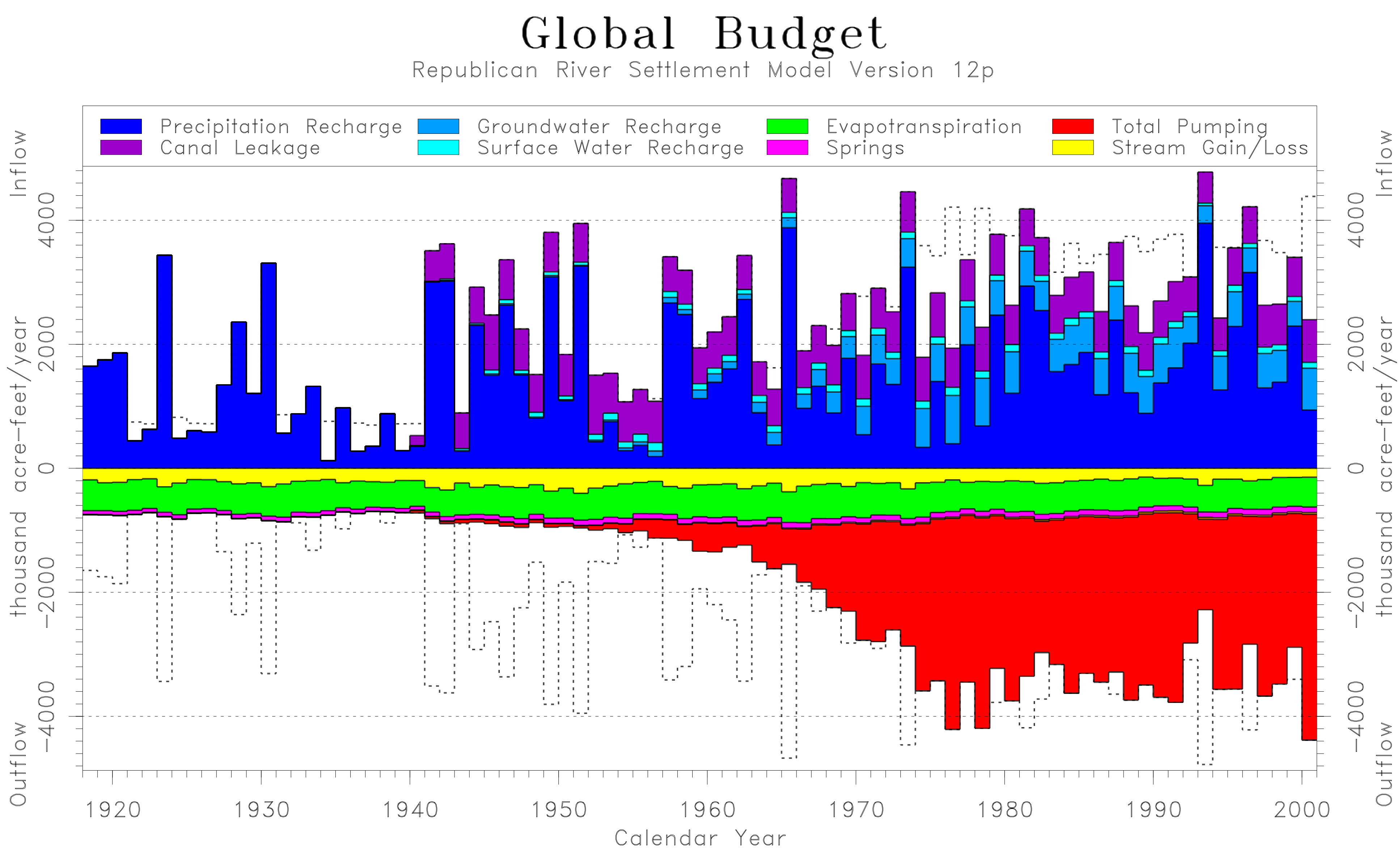
Appendix R – Location of Phreatophyte Sub-Basin and Phreatophyte Area
Appendix S - Saturated Thickness
Appendix T – Transmissivity
Appendix U – RRCA Model Impacts

RRCA Ground Water Model Domain




Global Budget
Republican River Settlement Model Version 12p
Precipitation Recharge
Canal Leakage
Groundwater Recharge
Surface Water Recharge
Evapotranspiration
Springs
Total Pumping
Stream Gain/Loss
Inflow
thousand acre-feet/year
Outflow
4000
2000
0
−2000
−4000
1920
1930
1940
1950
1960
1970
1980
1990
2000
Calendar Year

Appendix D – Pumping Estimates for each State

Pumping for Irrigation in Colorado - The State of Colorado employed an eight-step procedure to estimate ground water pumping:

1. Total acres irrigated by surface and ground water is estimated for each county based upon data from the respective County Assessor's Office for the area contained in the RRCA Model boundaries. This data was supplemented with irrigated acreage reported by the National Agricultural Statistics Service (NASS).
2. The acreage irrigated by surface water is identified from the County Assessor's Records
3. The acreage irrigated by ground water is calculated as the difference between the total acreage and the acreage irrigated by surface water.
4. The maximum farm efficiency for center-pivot sprinkler irrigation and flood irrigation is estimated for each year.
5. The percent of acreage irrigated by center-pivot sprinkler is estimated for each county for each year.
6. The crop water requirement is estimated for each county using the Hargreaves empirical formula calibrated to the Penman-Monteith method for reference crop evapotranspiration. The crop mix for each county is determined from NASS county-level crop statistics. The effective precipitation is estimated using the procedure outlined in Irrigation Water Requirements, Technical Release No. 21, United States Department of Agriculture, April 1967 (Revised September 1970). The crop irrigation requirement is calculated as the total or potential crop water requirement minus the effective precipitation.
7. The calculated crop irrigation requirement was reduced by two (2) inches per year to account for the gain in antecedent soil moisture from winter and spring precipitation.
8. Pumping for each county is estimated as the product of Irrigated Ground water Acreage multiplied by the Net Crop Irrigation Requirement multiplied by Fraction of Crop Irrigation Requirement satisfied. The Fraction of Crop Irrigation Requirement satisfied was estimated from available pumping records. The pumping for each county is then divided by the maximum farm efficiency. The maximum farm efficiency is a weighted average based on the amount of sprinkler and flood irrigation. County pumping estimates are distributed to ground water model cells using the well capacity for irrigation wells.

Pumping for Irrigation in Kansas - The State of Kansas developed estimates of pumping within the model domain using a combination of water use report data and estimates based on irrigated acreage and crop demand for years prior to the availability of reliable water use reports. The amount and location of pumping was taken from the water use report data for the period of 1989-2000. The estimated crop demand was compared to the water use reports for this period and a relationship developed, by county, to estimate pumping prior to 1989. Pumping estimates for 1940-1988 were made on a countywide basis.

The following procedure was used by the State of Kansas to estimate irrigation pumping for the period of 1989-2000: Kansas state officials have received water use reports from water right holders since 1957. In 1989, the Kansas Division of Water Resources (KDWR) was given additional enforcement authority and resources to require, obtain, and review water user reports of all water right holders. As a result, for the period 1989-2000, Kansas relied on the water use reports as its basis for estimating irrigation pumping. The water use report includes the total metered quantity or hours of operation, pumping rate, irrigated acreage, and crop type. Water users with meters are expected to report metered quantity; while those without meters report hours of pumping and diversion rate. Each water use report received by KDWR is reviewed for accuracy and completeness. All wells in the alluvium of the Republican River and its tributaries have been metered since 1998.

The State of Kansas completed a comparison of pumping reported for metered ground water wells against non-metered users. For the period 1989-2000, the KDWR and the Kansas Water Office published a series of annual reports entitled Kansas Irrigation Water Use Tables. The series summarizes Kansas' water use data in a number of ways, including the contrast of metered and un-metered reported use. The data is tabulated by region, including each of the five Groundwater Management Districts (GMDs) and areas outside the GMDs within western, central and eastern Kansas. The statistics contrasting metered and un-metered water use were tabulated for the Northwestern Kansas GMD No. 4. In addition, statistics for Western Kansas GMD No. 1 and Southwest Kansas GMD No. 3 were tabulated for comparative purposes.

For GMD No. 4, for the period 1989-2000, reports of un-metered pumping averaged 21.6 % greater than metered pumping on an acre-foot/acre basis. For 1994-2000, the period when the percent metered within the GMD was greater than 10%, the average reported pumping for un-metered points of diversions is 17 % greater than for metered**.** In 1992 and 1993, the un-metered reports were 38% and 39% higher than metered reports, respectively. For GMD No.1 and GMD No. 3, similar differences between metered and un-metered reporting are evident in the early years of the record. However, with increasing metering in each of these GMD's, metered and un-metered reporting merge toward near-identity by the end of the 1989-2000 period. The conclusion of this analysis is that non-metered reported use for 1989-2000 was higher than metered reported use. Based on the results of this analysis, the pumping from the non-metered reports was adjusted downward by 10%.

Net ground water pumping was determined by multiplying the total pumping by an estimated irrigation efficiency (which includes evaporative spray loss and runoff loss). Recognizing that the type of irrigation method has changed over time, Kansas assumed that all irrigation was flood irrigation until 1959, with an efficiency of 65%. Center pivots (85% efficiency) and other sprinklers (75% efficiency) were in use starting in 1960, and Low-Energy Precision Application systems (LEPA, 90% efficiency) use began in 1990. For 1960 to 1993, the proportion of center pivot and other sprinklers was interpolated from zero in 1959 to the value reported in the Kansas Water Rights Information System in 1993. The same procedure was applied to LEPA for the period

1990-1993. Flood irrigation was assumed to comprise the remainder for each year to bring the sum percentage of ground water irrigation methods to 100%.

The following procedure was used to estimate irrigation pumping for the period 1940 - 1988:

1. Determine the potential evapotranspiration (PET) for the irrigated area and crops determined for the study area:
    a. Compute reference ET with the Penman-Monteith method for years when detailed climate data are available
    b. Develop calibration coefficients for the Hargreaves method to use prior to availability of detailed weather data.
    c. Compute crop PET for study period.
    d. Compute effective precipitation during the growing season, using the procedure outlined in Irrigation Water Requirements, Technical Release No. 21, United States Department of Agriculture, April 1967, (Revised September, 1970). Over-winter soil moisture accumulation was separately computed, using values proposed by the State of Nebraska, and deducted from the CIR to obtain the seasonal irrigation requirement.
    e. Determine crop distribution from county level crop statistics.
    f. Compute crop irrigation requirement (CIR) on a unit basis (inches per acre).
2. Compile a history of well development, including location, date and source. The main data source is the Kansas water use database.
3. Compile irrigated area estimates, based on county crop statistics, previous studies and water use reports.
4. Compute the volume of crop demand for irrigation (CIR) on a county-wide basis, and use this as an initial estimate of the net irrigation pumping.
5. Compare the estimated net irrigation pumping to the water use reports for 1989 - 2000.
6. Use the comparison of estimated to reported pumping to develop a factor to multiply by the crop demand to estimate the actual net pumping for 1940-1988.

Water use reports collected prior to 1989 were reviewed to evaluate the levels of pumping indicated by these records. Although these records do not provide comprehensive pumping figures for the study area, there is a sufficiently large population of data to assess relative levels of pumping. The data showed that pumping rates (in gallons per minute - gpm) have steadily declined since 1970 to current levels. The data also indicate higher pumping amounts per well in the 1970's. The steady decline in pumping rates and amounts was corroborated by discussions with Kansas water officials. Probable reasons for the declines include reductions in well pumping capacities and changes in irrigation practices. Based on this evaluation, it was concluded that the 1989-2000 level of pumping used to establish the relationship between CIR and pumping was constrained by available pumping capacity and current irrigation practice to a greater degree than pre-1989 pumping. The reported pumping rate (gpm) was used as an indicator of this trend over time. The average pumping rate for a county in a given year (1970 - 1988), was compared to the 1989-2000 average to obtain an annual ratio. The 3-

year running average was used to smooth these values to provide annual adjustment factors to apply to the pumping computed from the fraction of crop demand indicated by the 1989 - 2000 data. The 1970 factor was used for 1940-1969.

Pumping for Irrigation in Nebraska - The State of Nebraska computes the volume of pumping based on electrical energy use, pumping power requirements, and estimated well discharge based on a correlation to the flow rate recorded at the time of well registration. The method uses a uniform time of operation for wells supplied by a Public Power District. The total volume of water pumped is distributed on a county-level basis for the number of wells and acres irrigated by each respective county within the Republican River Basin. Ground water is distributed at a uniform irrigation depth within each county for sole-source ground water irrigated lands and a different uniform depth for commingled lands that receive surface water and ground water as supply sources.

The total volume of ground water pumped per county (Vp) is the sum of volume pumped for sole-source ground water irrigation (Vg) and the volume pumped for commingled lands (Vc). The volume of ground water pumped for sole-source lands (Vg) is the product of the number of acres of irrigated lands served exclusively by ground water (Ag) and the depth of ground water applied to sole-source lands (Dg) in units of acre-inches/acre divided by conversion factor of 12 inches/foot. In a similar manner, the volume of ground water pumped for commingled lands (Vc) is the number of commingled acres (Ac) multiplied by the depth of ground water applied to commingled lands (Dc) divided by 12. Since commingled lands received both ground water and surface water, the average depth of ground water applied to commingled land is a fraction (f_g) of that applied to lands served exclusively by ground water (i.e., $Dc = f_g \times Dg$). The ratio of the depth of ground water applied to commingled land to the depth applied to sole-source ground water irrigated lands was 0.5 for most counties.

Appendix D Pumping Estimates Colorado

Year	Cheyenne	KitCarson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma
1918	0	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0
1921	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0
1924	0	0	0	0	0	0	0	0
1925	0	0	0	0	0	0	0	0
1926	0	0	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	0
1930	0	0	0	0	0	0	0	0
1931	0	0	0	0	0	0	0	0
1932	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0
1936	0	0	0	0	0	0	0	0
1937	0	0	0	0	0	0	0	0
1938	0	0	0	0	0	0	0	0
1939	0	0	0	0	0	0	0	0
1940	126	0	0	194	782	0	244	0
1941	94	0	6	112	446	0	614	130
1942	102	0	7	135	897	0	594	165
1943	142	0	8	223	1511	0	679	256
1944	152	0	7	201	1359	0	953	229
1945	322	0	5	103	657	0	1068	147
1946	478	0	7	176	1170	0	1449	336
1947	429	433	7	170	1172	0	2560	884
1948	301	1600	408	215	1523	0	3350	958
1949	322	2982	452	151	1540	196	2428	2747
1950	623	4209	502	178	2041	236	3243.4	2954.6
1951	657	3530	413	119	1499	393	3193	3578
1952	812	6085	671	246	4011	786	4924.4	8122.6
1953	1011	6487.6	611	195	3447	601	5028.9	8961.5
1954	1051	13328.4	784	202	4059	634	6391.1	12029.5
1955	1333	26766.5	658	192	4150	626	4970.8	14303
1956	1666	43798.2	780	229	5465	1033	6699.4	21906.1
1957	995	28941.3	458	448	5428	1314	5726.6	20337.5
1958	710	31050.3	462	348	4549	900	6319.3	19786.2
1959	971	54319.2	818	453	5822	1306	7105.2	26628.5
1960	1128	49657.4	645	463	6379	1315	7370.6	23129.1
1961	915	51574.4	607	385	5887	1063	6151.9	20922
1962	1238	53378.2	590	350	5553	1018	6978.4	17525
1963	1739	90614.1	760	669	8531	1516	8111	30809.4
1964	2327	128033.6	918	756	17763	1840	9919	52281.1
1965	2347.4	79503.3	465	445	15726	1084	9788.2	45574.3
1966	3015.3	160724.9	883	506	22790.5	1156	14022.6	71347.7
1967	3091.8	161996	714	450	34561	1633	18214.3	140716.6
1968	4265.3	200982.2	879	1618	55547.7	4144	24471.8	171711
1969	3551.8	217455.3	987	1650	60858.9	6036	25907	214575.8
1970	4721.9	238606.5	1153	1958	78191.2	6927.9	27766.8	242006.7
1971	6636	252694	1218	1496	65397.9	6273	32982.9	263157.1
1972	7018.4	216619.6	1090	1712	67124.1	6635.1	29560.8	242300.8
1973	8706.4	250188.5	1179	2719	77225.9	11055.3	33788.4	224427.7
1974	14386.9	319352.9	1741	7209	121147	31226.2	51141.8	381441.8
1975	14892.1	280397.1	2149	7653	112570.3	33631.3	47420.5	381339.2
1976	16465.2	328229.9	2447	9008	136485.9	41176.8	57132.7	415334
1977	17711.3	277924.3	2086	7944	116934.6	36198.1	67097.1	392632.3
1978	17735.9	269977.4	2335	10002	148311.6	46002.7	56078.7	481776.2
1979	16236.2	221499.2	1645	7197	110527.5	34158.4	46228.8	395826.8
1980	16113.4	243355.6	2098	8771	126998.6	41046	56423.9	360083.4
1981	15230.8	268250.9	2121	7307	109630.5	34386.5	52432.2	384906.5
1982	14079	198123.2	1577	5482	83114.9	26168.3	42561.7	290366.7
1983	14768.2	167691.3	1662	6365	94099.9	28966.3	42004.8	298094.3
1984	14796.6	224138.1	2133	7762	107713.3	34070.3	41045.8	385797
1985	14102.7	184164.5	1573	7597	105838.4	30977.7	41537.7	298091.8
1986	13412.8	216180.1	1981	7336	99597.1	30288.8	47159.4	304889.6
1987	13885.9	200054.7	1817	7063	100054.9	31026.2	42131.3	359662.9
1988	13276.5	230650.9	2078	7714	107816.6	33893.4	51889.1	399880.5
1989	11386.1	222116.5	2087	6328	86083.6	27902.1	47808.9	307374.9
1990	12378.4	220857	1955	7480	103701.3	33411.6	41257.7	322515.6
1991	13092.7	201308.3	1925	6880	102771.6	32135.4	54418.9	258002.8
1992	14074.6	210283.4	2104	6517	90525.1	28969.1	48548.7	294598.5
1993	16368	208258.2	1955	5198	70179.1	23074.1	47035.3	281548.8
1994	15444.6	224581	2099	9029	129309.7	39602	69147.1	337776.8
1995	14302.2	192651.7	1773	6759	97521.5	30412	42925.2	293804.1
1996	14046.3	210626.2	1913	3588	50343.2	16812.2	41129.6	255751.5
1997	13807	210598.9	1988	7107	104258.9	33008.6	49645.1	301518.6
1998	14515.4	197073.9	1782	6806	89641	29937.8	57600.3	347092.4
1999	14441.8	186178.8	1779	5789	79476.2	25239.4	37115.6	293224.3
2000	18094.4	267000.4	2548	10000	128365.4	41726.6	62570.8	371558.8

Appendix D Pumping Estimates Kansas

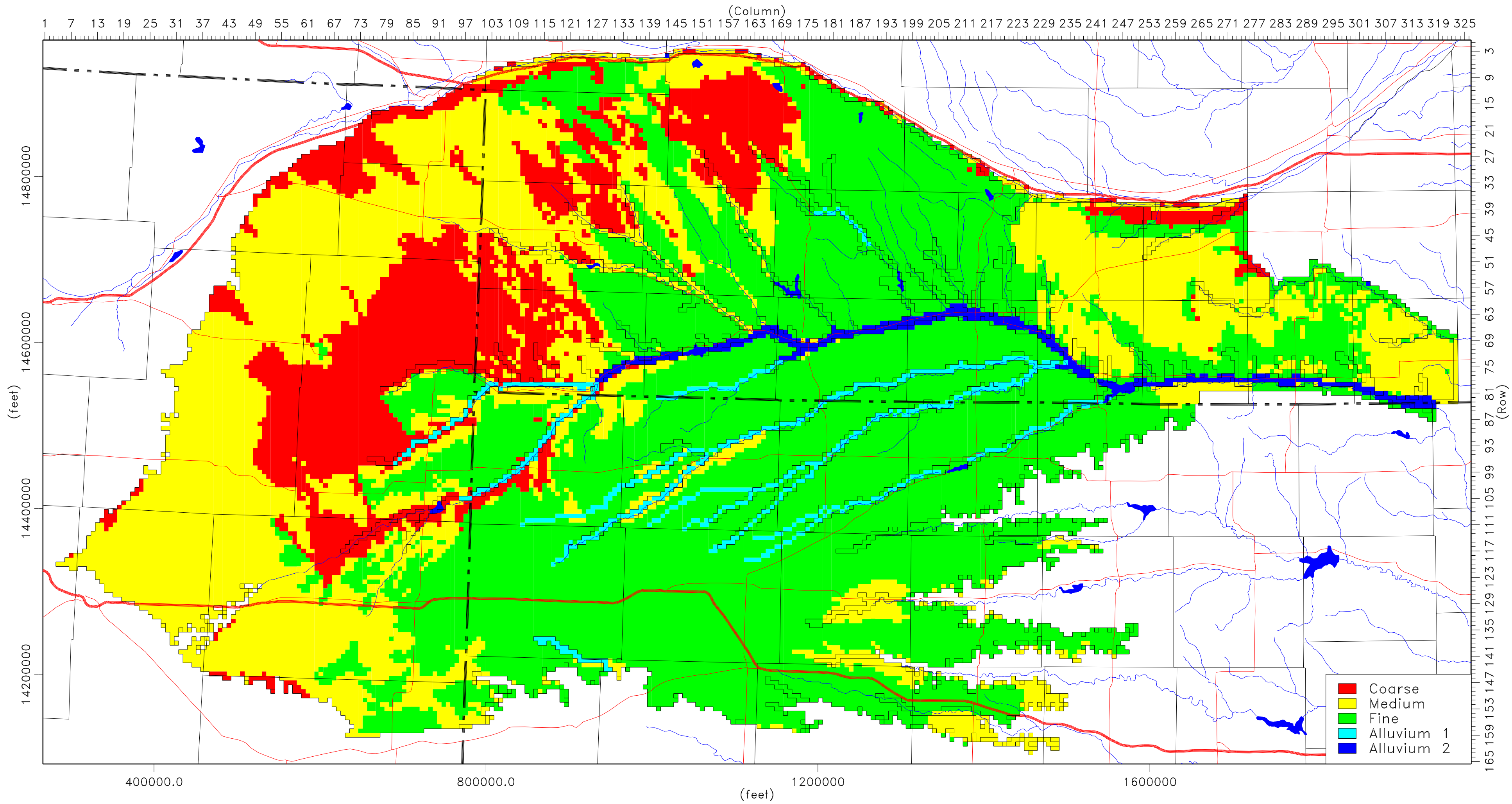
Year	Cheyenne	Decatur	Gove	Graham	Jewell	Logan	Norton	Phillips	Rawlins	Sheridan	Sherman	Thomas	Trego	Wallace
1918	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1921	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1926	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1931	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1932	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1936	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1937	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1939	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1940	1136.1	752.3	0	0	0	0	135	171	176	504.7	278	252	0	0
1941	1234	383.8	0	0	0	0	91	129	117	310	278	243	0	0
1942	2175	621	0	0	0	0	89	134	144	410.2	304	272	0	0
1943	3230	703.9	0	0	0	0	125	163	159	480	321	286	0	0
1944	3122.7	391.8	0	0	0	0	69	119	117	287	242	224	0	0
1945	3340.7	582.5	0	0	0	0	120	152	119	418	214	252	0	0
1946	4249	624.6	0	0	0	0	130	168	161	459.3	251	289	0	0
1947	3764	642.9	0	0	0	0	97	137	142	446.3	443	240	0	0
1948	3261	555.1	0	0	0	0	101	152	125	366	452	532.9	0	0
1949	3124	493.8	0	0	0	0	80	114	119	358	786	499	0	0
1950	3705	610.4	0	0	0	0	147	283	583	564.5	1260	505.9	0	0
1951	2328.8	363.4	0	0	0	0	69	192	309	321.3	796.9	585	0	0
1952	4661	852.1	0	0	0	0	270	398	711.9	791.5	4142	1336.9	0	0
1953	4094.4	761.9	0	0	0	178	173	748	1192	1122.5	4657.5	1287	0	0
1954	7361.5	1122.8	0	393	0	226	1064	1816.2	1443.6	1476.5	6171	1351.9	211	189
1955	8731.4	1948.5	312	563	0	246	1369.1	3879.6	2256.6	3845.3	10569.9	3112	187	197
1956	12202	3059.3	916	833	699.1	268	1747.8	5311	3405.6	9037.3	18601.1	9708	631.9	457
1957	12224.2	3026.1	589	466	323	267	1321.2	3870.4	2926.5	8461.9	17242.6	6804.5	342	324
1958	13742.2	2992.2	713.9	526.1	315	352	1383.2	4255.6	2984.5	9676.8	20513.2	7963.2	563	330
1959	16918.2	4238.7	1111.1	794.1	415	452	2080.6	6048	4109.9	14357.6	22260.8	11898.4	713	340.7
1960	22414.3	4985.3	1079	854.9	313	403	2047.1	4963.5	4688.4	14532.2	26401.2	11135.9	760	394.7
1961	17560.6	5327.6	654	700.1	427	567.9	2206.8	5442	3703.6	11145.2	20570.8	10736.6	162	278
1962	13444.1	3333.5	1075	880.1	447	417	1725.1	3567	2491.7	11420.7	25456.3	8842.2	669	289.4
1963	28337.1	6384.7	1748	1155	452	926.7	2122.8	5987	4896.2	16223.9	40631.3	13277.5	1068	360.7
1964	37992.4	5867.9	2583.7	1434.9	409	2620.3	3085.8	7457.7	5618.2	29080.9	62527.7	23795.9	1410.9	596.9
1965	30187.5	4035.2	1446	1290	409	1672.5	2152.5	3773	4633.8	15290.3	58785.1	16037.4	581	570.5
1966	41655.6	6121.4	4517.5	2405	556	2487.2	2695.2	6123.6	6678.8	28420.9	73431.3	28942.8	1150.9	1099
1967	45827.7	6996.9	6179	2009	453	3874	1912.5	3302.6	8068.1	33208.9	79619.7	38896.8	925	1002
1968	51311.2	6178.4	6408	2680.3	295	6507.2	1338.6	2693.8	8865	37803.1	101926.6	35433.7	975	1654.5
1969	54604	9721	8964.1	2449	343	8580.9	2184.8	3437.4	9176.6	50262.1	108264.6	43199.2	1307	1528.2
1970	61117.1	10679.8	10690.9	2830	474	10665.8	2924.2	5351.4	10681	66069	135239	50233.6	1550	2148
1971	64611.3	10385.8	15231.5	3836	520	12603.6	5966.8	7667.1	13160	81263.8	143600	62210.8	2159.2	2263.2
1972	53213.4	8416.4	15840.7	4206.1	417	10456	7647.7	7739.5	9209.8	73735.1	105014.7	61402.9	1384.9	2303.8
1973	66006.1	16810.9	17696.9	5590.1	372	12528.2	12961.9	7354.9	19074.1	93374.1	133113.3	65046.2	1657.2	3089.1
1974	68595.3	14724.6	26064.8	6548.1	639	11340.5	12239.1	14219.6	15493.2	120448.4	160254.2	91339.7	3018.7	5019.8
1975	66737	12110.7	17665.9	4612.1	321	10747.6	5654.6	4810.8	15976.5	84786.7	161579.5	71924.2	2016	4952.3
1976	84360.6	18953.7	33164.1	10328.1	411.8	16059.6	11926	12139	18785	161922.2	224080.4	175689	2474.8	7280
1977	65040.8	10806.4	16502.8	8667	961.9	9914.2	9072.4	7439.4	11992.1	106922.3	169534.7	96796.2	1921.2	5778.1
1978	76345.9	16035.1	21401.6	12968.6	1430.9	14112.2	11053	6858.9	18015.5	133007.9	202349.7	152435.2	1804	5742.2
1979	52008.2	7578.8	13274.8	8026.4	1767.5	8503.1	7352.2	4837.5	14154.2	91340.8	131651.8	96237.1	1703.2	4144.9
1980	45784.9	15863.9	16126.5	8064.7	1560.9	11179.3	16126.5	11752	11989.1	134149.9	126614.5	130619.4	1542.8	3714.8
1981	54106.7	15731.9	17914.6	8127.4	942.2	11992.6	6278.4	5362.3	11265	106812.9	180218.5	135468.9	2040.2	6007.3
1982	45155.4	13946.1	19479.6	9032.5	728.1	8809.7	8827.3	6030.5	14213.2	95967.9	108590.1	85137.8	2204	3036.5
1983	50151.2	16676.3	19348.8	8343.8	857.2	12893.1	7863.2	5896.7	15270.4	93884.3	135666	95271.7	2338	2929.5
1984	43793.3	17328.7	20831.2	10249.2	1295.2	10675.9	15743.4	7615.4	15011.6	128928.3	127522.9	115572.6	2285.2	3342.9
1985	42304.2	16089.4	19087.4	13451.1	942.8	8879.1	12803.6	7716.6	12821.1	109074.6	113327.5	112783.5	2110.2	3364.8
1986	53941.5	14350.2	21726.9	11420	1136.7	10158.2	11345.7	7667.3	15442.3	107093.1	138024	155222.6	1516.8	3719.7
1987	51404.8	9333.6	17028.7	7433.7	1035.9	5593.2	9257.4	7049.2	15688.4	85246.5	108467.3	109724.2	1599.8	3131.6
1988	53192.7	7994.1	17314.6	7455.6	1267.7	9362	10285	5412.4	18006.1	103421.9	112039	114440.7	2151	2925.1
1989	56642.5	14964.7	17511.2	8306.3	945.4	9473.6	11909.5	8192.5	18259.9	111863.6	134230.8	134713.6	2279	3710.1
1990	56449.1	13238.7	15437.5	9224.5	1069.4	9904.7	10699.9	7439.8	19325.9	95161.1	139954.5	129307.2	2332	3416.2
1991	50870.4	13063.8	16778.7	10264.1	1339.7	9213.1	10995.3	6349.1	17189.2	97371.5	121332.6	118946.3	1942.2	3018.1
1992	35857	4308.7	6750.9	4573.3	289.1	5997.7	4409.7	3779.1	8309.5	48089.5	81805.4	56967.1	656	2651.8
1993	39774.8	3800.4	5323	2143.6	116.1	4976.3	3926.5	2733.2	9770.5	34981.6	80321.3	64788.4	433	2627.2
1994	49688.9	7671.4	13003.8	6694.5	1029.5	6595.6	7045.7	5089.8	14183.9	76119	103625.9	97124.7	1632.8	3456.7
1995	36851.5	11570.6	12662.7	7714.7	1238.2	6338.3	8433.3	5535.9	14957.3	79004	89074.2	89993.2	1209	2704.5
1996	44605.2	8173.1	9849.6	6843.6	1196.3	6075.7	5094.6	3023.9	12297.3	67184	106803.4	89922.1	1077	3124
1997	54443.6	11631	10245.1	7819.9	1085.9	7181.2	7973.7	5347.8	17515.2	67269.3	120769.6	100178.1	1458.9	2545.2
1998	46618.5	11786.9	10706.2	8100	909.9	6082	7462.8	4462.9	15409.3	66273.1	111048	90677.7	1496	2740.5
1999	45990.5	8148.2	9352.3	6622	1077	5866.3	6296.4	4831.8	12061.1	57860.7	96174.9	75958.9	1514	2711.9
2000	60728.6	16301.7	13709.4	10268	1403.5	7578.1	7867.9	3999.6	21993.1	91260.2	131865.1	123856.7	2094.4	4023.6

Appendix D Pumping Estimates Nebraska

Year	Adams	Buffalo	Chase	Clay	Dawson	Deuel	Dundy	Franklin	Frontier	Furnas	Gosper	Harlan	Hayes	Hitchcock	Kearney	Keith	Lincoln	Nuckolls	Perkins	Phelps	RedWillow	Webster
1918	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1921	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1926	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1931	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1937	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1939	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1940	133.6	521	1154.3	0	5435	1345.3	608.6	745.9	279	835.1	1505.8	401.1	437.1	2286.7	5100.9	3230.4	5686.3	108.1	313.8	5835.5	1030.9	416.8
1941	82.3	318.3	1135.8	66	4649.3	1076	491.5	449	195.8	618.4	1322.9	448.1	289.6	1711.5	3895.5	2700.5	5440.4	113.9	253.4	4397.1	965.4	219.5
1942	67.7	262.9	939.3	54.3	4862.6	852.1	433.9	484.5	214.8	420.1	1307.1	442.3	353.2	2346.6	3521.3	3890.7	6169	82	268.5	4051.8	1067.9	158
1943	89.5	347.4	1766.8	71.8	6693.4	1367.2	870.6	575.2	249.7	747.9	1871.8	545.1	399.6	2945.2	4876.6	4234.3	7864.8	118.5	448.9	5759.1	1511	228.5
1944	88.6	440.8	1903.3	71.1	4535.3	1090.8	806.8	675.4	138.1	512	1845.8	675.1	295.4	1787	5759.1	3870.3	4478.2	109.8	356.6	5863.2	1081.6	211.7
1945	88.6	621.1	2393.5	71.1	8772.9	2378.9	1436.1	780.3	196.8	922.9	1929.5	815.3	406.2	2509.6	6811.7	6371	6866.4	91.6	445.4	5938.4	2018.3	176.6
1946	75	561.6	1675.7	60.1	8962.8	1849	1122	774.3	269.5	1139.1	1633.3	1087.9	534.1	2576.7	7859.7	9660.5	7035.6	100.3	290.1	5413.3	1986.1	225.3
1947	454.8	3.1	2391.1	0.3	89	2737.4	1560.9	1157.9	326.3	1388	48.1	2222.1	580.5	6195.8	166.3	9769.3	10447.6	583.6	401.1	161.7	2815	606.9
1948	461.3	2.1	2652.4	0.4	67.3	2774.1	1691	1017.2	418.3	1408	38.7	2009.5	398.2	5032.6	117.3	10977.6	656.4	479.1	811.3	136.1	2482.6	534.6
1949	857.4	5.2	3006.1	1.2	93.8	2597.7	1898.4	1349.3	605.1	1616.2	54	2021	908.2	7308.8	255.3	11816.8	1573.2	1067	881.1	143	2421.1	604
1950	834	7.9	2412.5	2.2	63.2	1005.6	94.2	209.2	571.7	113.6	27.6	308.4	283.9	1082.8	255.2	10213.5	2179.2	70.3	367.7	47.2	493.6	155.6
1951	355.7	3.5	2417.2	1	79.1	825.2	132.8	167.4	90.8	50.9	12.2	150.2	133.3	363	117.4	8303.3	2353.4	30.1	340.7	23.9	314.2	128.9
1952	1248.1	14.3	4718	3.9	232.2	2168.8	465.7	519.8	106.5	167.9	48.2	324.7	569.1	1294.6	544.3	14839.6	6509.5	132.1	1703.5	60.3	1030	451.1
1953	1929.1	65.1	5110.5	19	252.6	1925.9	701	858.8	134.3	236.9	66.8	678.5	823.7	1927.6	2558.3	12364.1	10612.7	192	2288	753.8	1730.5	961.3
1954	2631.6	107.6	7562.7	39.4	764.8	2469.4	2049	1272.6	935.2	831.8	482.3	1337.5	1433	3923.9	3649.8	16721.3	23624.8	194.9	3718.9	1240.4	3475.8	830.4
1955	2270.9	124	21345.8	690.8	2842.6	2683.1	7237.3	469.1	1919.1	2674.9	2206.9	5482.4	1558.8	7869.6	1058	7542.2	3995.5	3779.6	1472	3186.1	1516.1	10740.9
1956	3751.4	125.4	24873.8	483.4	3721.3	2687.2	9126.5	5990.8	3114.9	4123.3	3115.1	7853.5	2134.2	9612.4	11375.9	9097.1	6206.2	3422.9	2219.9	24118	2318.3	10172.7
1957	3692.4	534.2	14375.9	709.9	9179.3	1700.3	8435.6	7983.9	3120.6	7666.5	4663.5	9489.6	1924.8	7491.2	24079.9	10692.2	10121.8	4789.3	2505.3	24046.7	3820.6	6273.5
1958	2392	393	12281.2	403.4	5438.5	2181.5	6961.1	5323.5	3365.2	5400.8	3094.3	6164.7	1838.2	7476.2	17045.6	11885	6684.9	1838.4	1988.6	15788.4	3817.8	2778.4
1959	7765.6	1128.4	23394.3	1357	12842.2	4495	14651.9	10677.4	7608.9	13738	6418.5	14874.4	3635.2	15480.7	34616.9	24841.8	16618.8	5738.9	4277.9	32320.5	9501.1	9185
1960	7446.4	1231.2	24854.5	1340.8	14232.2	4889.8	15360	10436.4	6978.7	9942.2	6642.1	10932.2	3997.7	14734.9	33428.4	28167.1	18602	5321.2	5202.3	27714	7997.7	8758.8
1961	9586.6	985.4	9675.5	1765.2	11637.9	2394.9	13146.5	10656.4	4452.7	8982.9	5490.6	10278.6	3632.6	10435.6	34510.5	14753.2	13576.6	7118.1	2607.2	29332.3	5470.5	11643.2
1962	4896.2	477.9	8376.6	864.5	5547.5	1729.6	7333.4	7189.2	2438.9	4395.9	2592.8	5193.7	2552	6097.7	23295.8	10753	7294.8	3871.3	1884.7	19797.4	3032.5	5719
1963	9725.4	1666.9	16423.1	1657.8	19534.8	3226.1	17088.9	14841.1	6896.1	12018.3	8970.8	14329.5	7245	15378.6	48970.2	20737.4	22179.2	7507.8	3803.6	43140.3	7768.7	11496.9
1964	13830.6	1377.4	22099.3	2398	16148.5	3398.8	17350	13269.6	9506.6	13339.4	7704.8	14816.6	8241.8	19322.6	44063.3	21790.8	19850.8	11693	3847.6	39527.1	10227	17688.5
1965	10524.7	920.2	15835.9	1901.2	10608.5	2595.3	14652.8	13390.6	9593.1	8814.3	5477.7	10041.8	7005.5	17467.2	44335.5	17107.2	13926.3	8371.2	3435.7	39515.7	9167	12812.3
1966	16459.8	1437.6	22410.8	2620.9	17105.4	2879.1	14539.9	20111.8	11922.9	9391.6	8512.1	11138.5	6916.3	18576.3	67935.1	18940.9	20420.5	13395.3	4445.2	59505.1	10980.4	18687.8
1967	19525.5	1217.6	30071.5	2977.3	14701.9	5691.9	18191	18984.9	17081.4	14339.3	8939.7	18048.6	7711.8	23763.5	62883.6	35881.9	21353.5	15123.2	11042.9	59656	15016.6	21477
1968	19058	1293.3	61817.8	3326.6	16805.1	9788.9	32427	17655.6	27270	24501.1	12304.1	33719.4	13174.8	32819.5	58114.7	64019.3	28876.4	14537.2	24855.6	63182.1	22421.4	22600.4
1969	14026.1	1332.4	76208.5	2556	17893.5	7263.7	46082.3	17489	25797.4	19826.5	12636.6	27695.4	19405.3	31974.6	56708.8	50185.1	27578	9370.1	23764.3	59614.5	20355	16326
1970	24981.7	1911.1	101395.4	4612.9	25869.2	10107.5	57775.4	32893.9	41696.5	31179	19955.9	45007.9	25168.7	40888.7	103909.7	71242.8	39524.8	15719.1	35618.4	111465	32894.3	28644.1
1971	28085.4	2013	94420.1	5327.5	28023.2	5965.4	56820.6	35302	42925.6	31731.4	23607.1	47347.7	27821.7	37886.3	110517	43456.1	39474.9	17693.6	25131	111141.5	34101.8	32932.7
1972	19689.9	1847.2	88817.8	3417	26925.1	5493.7	40253.6	31104.7	52176.6	31810.3	27284.7	49689.4	22685.1	35177.6	95833.8	41477	41579.6	10442.2	25579.8	100630.7	39515.2	19771.4
1973	23372.7	1768.7	100777.7	4059.2	24803.6	6196.2	38084.3	36481.3	50410.9	30645.6	27658.2	52495.8	23158.9	32082.3	113387	46238.7	46631.3	11717	35060.4	122206	37223.7	23772.9
1974	32296.7	2686.5	148495	5677.6	39529.7	7537.7	57173.3	44852.9	72865.9	38907.8	41905.8	69161.4	28983.6	40090.4	136044.8	60424	74452.5	16445.1	59705.5	154514.6	53248.9	34993.9
1975	29254.6	2363.7	163245.3	4857.1	35665.5	6977.6	76762.3	46982.8	78076.9	39404.9	43052.9	69230.9	32618.2	42526.5	130812.1	61387.7	78570.9	14212	66055.5	152113.8	56316.8	32437.7
1976	39680.4	2922.7	216623.9	5966.5	42964	7199.1	103930.6	64303.3	87489.5	54419	58085.1	95081.5	41580.6	49183.5	170192.6	69179.9	100536.4	19355	80335.7	202895.9	62384.9	46005.1
1977	21350.5	2217	185047.7	2646.6	32181.9	5255.9	99806.9	47064.3	65872.7	44137.5	44148.4	72805.6	36444	39950.3	119485.6	53196.3	80222.6	8716.1	65743.8	144613.3	51700.5	23204.6
1978	30175.6	2517.3	260376.4	3724	38499	8794.5	124661.4	64024.2	90210.7	49138.2	51772.8	81398.1	46075.3	52262.8	159689.4	90100.7	117434	13549.3	113696.7	186500.2	70428.8	33345.5
1979	22579.4	1888.2	191437.7	3018.8	29147.7	6231.2	97877.3	43523.5	47040.4	30274.6	35429.8	48846.7	36910.9	38896.3	103388.7	67852.9	89391.8	11369.6	90723.8	119496.4	38940.3	26853
1980	31523.4	3071.1	204183.2	3876.4	48483.2	6475.4	97931.3	67045	78289.1	50040.2	58291.5	78846.9	37194	47549.8	158156.6	69312.1	122035.8	14413.9	95772.3	178612.5	61580.1	35581.6
1981	21253.5	1829.7	178689.9	2434	27240.9	5094.5	78526.7	50316.7	45980.5	27112.4	32696.9	43617.2	29803.7	34422.5	115050.8	57004.2	86252.1	8991.9	79605.4	125888.3	36593.3	22741.6
1982	19061.9	2163.9	139080.2	2361	33543.6	4280.5	67910.2	42281.7	54555.1	32569	39830.8	52516.9	26310.4	32537.3	95110.2	48567.1	88605.7	8496.4	68576.8	114068.3	42123.2	21269.7
1983	26254.4	1871.3	165185.4	3373.9	29200.4	5409.7	90043.9	52284.1	54483.2	31393.5	36336.7	50226.6	32353.2	38135.9	120485.1	61933.9	96212.7	12076.2	87299	134004.9	44342.1	30577.6
1984	29070.4	2528.7	217827.9	3500.6	38176.2	6428.8	111366	62816.7	67033.6	43785.6	48940	69524	39648.3	44632	143301.5	74416.8	119998.8	12554.5	106448.9	163134.3	53189	32260.1
1985	24568.3	2042.1	221161.6	3059.5	31704.9	6650.9	113411.3	49028.9	66257	32950.4	39228.1	52555.4	41533.3	46930.9	111726	77577.1	116502.1	11081.7	110816.9	126591.3	53373.9	28390.3
1986	23982.3	2519.9	183425.6	2674.8	39436.9	6234.9	107156.3	54916.3	69471.6	40691.2	48228	65977.3	39426.2	45342.9	125578.6	74466.9	121371	9287	105964.5	144253.4	54897	24864.9
1987	26035.2	2199.7	169902.2	2797.5	34041.8	5966.9	98462.3	59678.5	60301.3	28851.2	38478.6	47045	36390.2	40756.2	140292.5	67870.2	107885.6	9715.7	97104.7	153516.1	47472	25841.2
1988	42445.1	2914.3	200346.9	4979.1	44555.7	6485.2	107211.7	86038.7	63567.7	40104.7	51066	64458	39290.9	42355	202941.1	74192.5	123829.7	17431.5	105682.7	222033.6	49831.1	46185.5
1989	30074	2746.5	202602.4	3430.8	38495.8	6138.8	102387.4	67565.2	75794.2	47738.6	50434.2	76408.1	37555.3	43568.3	157228.2	71631	116950.6	11776.8	101306.5	178688.3	59546.9	31168.5
1990	27865.9	3365	236069.8	2898.8	49631.4	8103.1	135778.4	70870.6	77609.1	46205.8	57093	75421.3	49332.7	51687.3	165692.7	95203.4	147689.2	9993.2	134020.5	184897.2	61670.7	26707.1
1991	42162.9	3816.6	214761.8	4913	54757.4	8257.1	112315.9	96672.4	83911.2	54262.5	64094	87616.2	41611.7	46476.4	220279.2	97528.9	155272.6	17913.8	136737.5	251218.6	67407.2	44305.6
1992	18483.9	2253.7	174805.6	1879.2	34106	5129.4	74285.3	50135.3	42841.2	30206.1	37736.9	50012.2	26487.5	27657.4	112799.5	60478.6	93645.5	7119.2	86660.6	132588.7	35612.4	17911.2
1993	6523.3	657.1	143610.9	629.2	9901.7	3578.8	52838.8	18356	4515.1	6716.7	9962.9	11468.6	17704.1	13955	41408.7	42251.1	43590.2	2409.4	61003.9	45663.1	6279.7	6063.6
1994	24599.4	2327	244291.3	2756.6	33742.3	7873.4	117644.2	57664.8	71595.6	35192.6	40387.5	59188.5	42147.2	46002.8	130165.6	94731.5	126078.5	10821.7	133907	147586.5	62801.1	26495.7
1995	38543.4	3386.9	202246.4	4256.4	48633.5	7446.2	111603.9	90486.3	75981.7	44464.6	55209.7	75439.6	40162.9	44351.4	203718.4	91087.9	139789.7	16953.3	126302.3	223282.2	65334.9	41636.6
1996	23268.8	2199.7	165144.2	2567.7	32406	4671.2	83802	53914.2	42213.5	17875.3	31189.3	30694.7	29383	30477.1	121360.5	57976.4	90480.5	10782.9	80203.7	126377.5	37404.5	25559.1
1997	33686.8	3599.6	235756.6	3438.4	51988.7	6814.1	135981.3	86758.4	69947.6	44158.9	58175.4	76659.1	51008.2	48619.9	188432.5	85598.9	141660.5	14780.4	118603.9	202909	62511.7	35282.7
1998	24682.8	2874.2	236303.1	2445.6	42481	7129	146150.3	64780.9	70843.9	39490.7	49791.5	68175.3	56837.2	52047.9	140094.1	88420.2	135572.3	10639.1	121880.7	151042.6	65390.8	26216.3
1999	26203	2410.4	181923.5	2911.3	32969.6	5682.8	100441.7	58095.4	14303.3	24960.4	35643.1	44032.3	38700.2	26866.8	125274.7	72592.9	95953.6	13203.7	98645.1	129077.4	16236.7	31537
2000	41878.5	4597.4	298110.9	4304.6	64086.1	10651	181823.6	106837.9	83964	42474.3	67011.6	75268.8	75587.6	63833.8	226836	138003.2	202150.6	19437.2	184537.6	227509.8	77184.7	46619.7

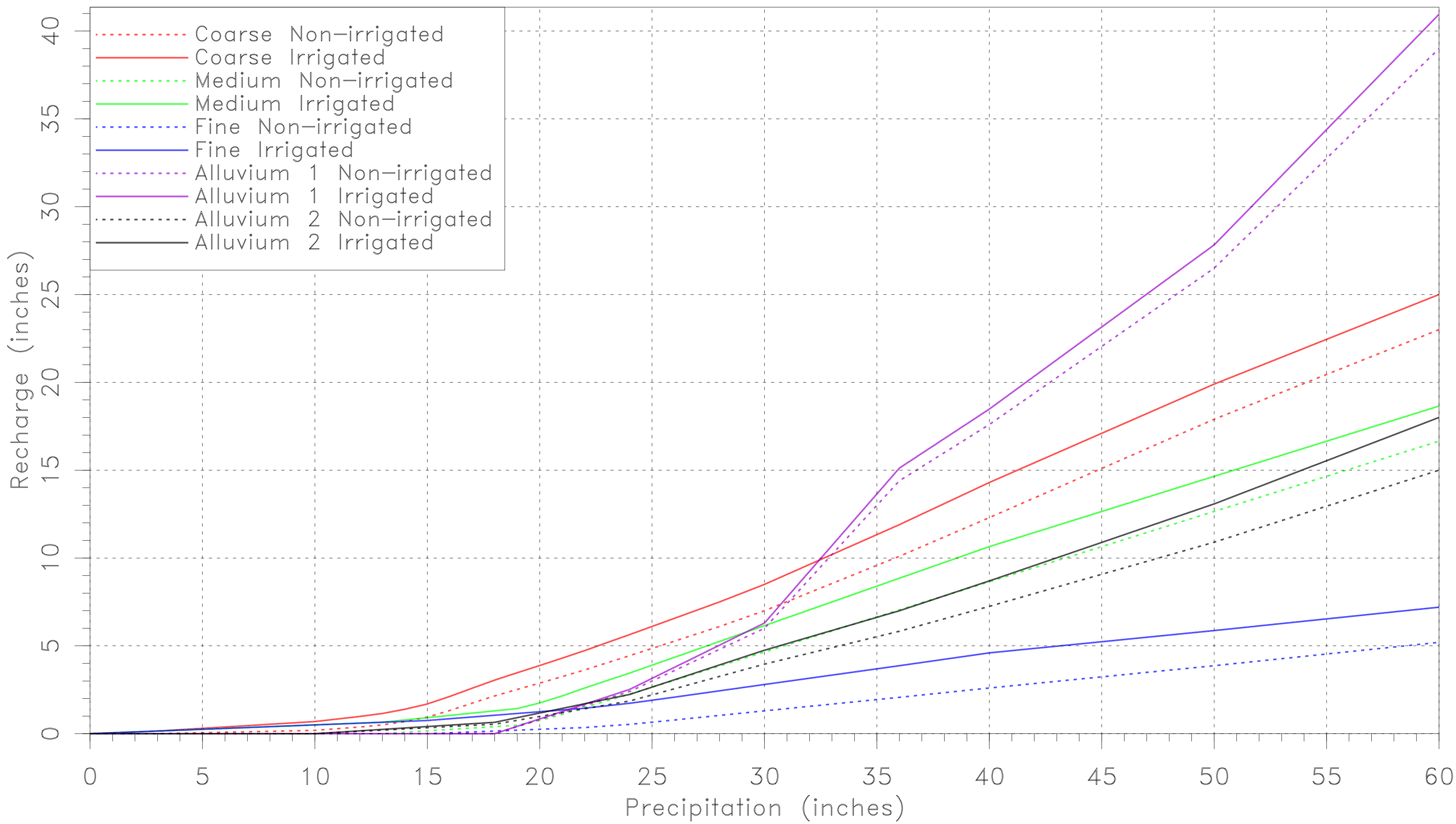
Distribution of Soil Classifications

Republican River Settlement Model Version 12p



Precipitation Recharge Curves

Republican River Settlement Model Version 12p



Appendix G Recharge from Precipitation (acre-feet per year)

Year	Colorado							
	Cheyenne	KitCarson	Lincoln	Logan	Phillips	Sedgwick	Washingto	Yuma
1918	22655.0	75803.9	28546.8	25385.8	35658.2	34597.5	87688.5	187601.7
1919	4979.8	22715.0	3386.4	1942.8	2806.1	8649.7	15190.6	21993.6
1920	18374.7	103662.5	29291.0	44130.9	86452.1	37108.4	141475.6	354719.5
1921	10027.6	39228.5	7104.1	2148.8	2876.0	3310.9	13022.7	38421.9
1922	7065.7	40064.3	10341.8	11542.1	16423.1	13268.2	46792.1	107421.6
1923	38300.1	189987.4	66738.9	33368.5	24669.9	68364.6	163601.5	172571.2
1924	458.5	7722.3	115.2	3938.0	9331.2	16580.5	5362.3	38572.0
1925	453.0	6297.1	92.0	3142.2	5448.3	15009.1	3642.0	25088.2
1926	1852.8	27262.0	10588.2	15657.1	12712.2	14980.8	65762.5	92093.5
1927	4199.4	31060.9	10599.2	19299.6	28395.7	22470.6	68644.5	151706.9
1928	15917.5	107212.9	11398.2	18827.6	55509.5	34467.6	53285.5	265210.5
1929	5518.8	60780.5	19748.8	27869.0	36782.5	19716.8	145347.6	238555.2
1930	30365.3	182012.0	23622.5	26751.9	49843.9	61301.1	85620.5	243877.2
1931	271.7	3350.9	80.0	808.3	1405.2	1228.9	2901.3	13640.0
1932	426.0	9730.4	212.0	18551.2	50422.3	21959.1	31402.5	204760.5
1933	8172.2	57382.0	14493.9	24133.9	31893.7	27833.3	77270.8	186730.0
1934	275.5	2094.1	168.3	2098.0	3220.6	2243.2	6143.2	24611.8
1935	375.8	12856.9	558.6	8065.0	8198.4	6363.2	41986.3	73389.0
1936	255.2	4467.7	41.0	1995.2	21856.1	4054.6	2961.1	94936.3
1937	295.1	4122.4	81.5	1305.0	3388.0	2537.4	3325.9	26569.2
1938	3389.8	39003.1	182.8	8705.2	31735.1	16628.8	13950.9	157937.0
1939	1198.0	8669.0	96.9	2377.9	6584.3	7595.6	3961.3	36597.1
1940	1822.7	9801.8	795.6	3288.6	7179.2	6603.6	13049.0	45201.7
1941	16721.4	105970.5	7591.7	37251.9	107065.9	54358.5	67795.7	393461.9
1942	12793.7	86910.5	14694.3	30124.8	102022.9	36307.1	104442.0	390054.4
1943	4140.0	20663.1	694.7	1461.3	3037.3	2071.4	7150.4	31956.1
1944	9730.7	57038.8	1164.2	8256.7	26528.1	19077.0	19170.9	143411.9
1945	14737.4	110853.3	19749.6	34129.7	49081.4	40214.0	103937.5	255268.3
1946	903.9	22251.8	111.4	9431.0	26182.4	23771.9	11950.1	121232.9
1947	12473.4	82962.3	7165.6	11803.5	61090.9	9620.0	46915.5	297171.7
1948	5446.2	22716.0	125.9	1453.9	6569.6	6596.9	4778.4	89546.2
1949	10715.2	116291.1	26571.2	57335.7	94800.6	39186.3	220800.8	443738.6
1950	866.7	10278.9	328.4	7237.6	11086.6	9108.4	21766.4	81354.6
1951	5832.9	56059.8	1916.3	32587.4	94333.5	74799.3	50352.4	241584.8
1952	1746.8	11825.8	1538.3	8458.0	8125.8	17453.5	17170.3	49730.9
1953	504.2	3164.5	256.3	14470.8	23940.8	24067.4	12064.6	49407.3
1954	230.8	1678.7	108.0	3664.5	18554.1	4755.7	3174.5	28915.7
1955	463.8	5204.4	312.1	13810.2	21810.2	19832.5	15692.6	44548.1
1956	231.6	2942.8	137.1	4411.4	7729.8	13534.0	3746.5	19623.3
1957	32504.2	162262.5	18475.4	15786.4	28148.5	26080.2	69547.0	223626.6
1958	44803.0	214889.2	26925.3	33816.5	91675.0	60333.1	83593.7	349895.9
1959	4305.4	10307.5	282.0	10335.0	36306.5	14101.4	11891.2	82035.9
1960	9275.6	54375.9	1067.4	3629.8	13996.7	9369.1	12383.1	106895.3
1961	11928.8	58433.5	10730.1	17719.0	31115.4	24160.2	53501.2	193743.1
1962	5100.1	49999.6	550.6	13561.4	61671.6	21725.5	38045.7	337693.0
1963	555.5	10891.6	249.5	5592.4	14004.1	10123.0	13712.8	68803.5
1964	370.1	5492.7	178.7	2920.6	4989.7	3980.7	6144.0	28356.8
1965	19657.9	143588.5	8058.5	23237.4	55094.5	59469.0	48099.8	256421.1
1966	6314.3	37764.6	5955.5	25250.3	65714.3	37259.8	38569.8	230376.5
1967	2229.0	27384.7	1953.5	17019.6	46953.6	19327.6	36658.6	141245.9
1968	404.5	11067.8	167.0	2472.8	5166.2	3675.7	7534.3	51977.0
1969	7906.3	20215.9	643.9	5472.5	20120.3	16305.3	8232.4	82275.1
1970	3313.0	13425.3	343.7	3862.3	12354.6	6255.7	8809.2	62794.6
1971	2991.4	23130.5	250.0	13412.5	58703.1	33112.9	11760.3	122649.2
1972	2509.0	19660.0	249.0	7331.3	31801.7	15168.0	10018.1	100607.0
1973	6038.9	58379.9	8446.0	38125.3	87020.9	38608.6	112304.7	354507.7
1974	569.1	10893.1	222.3	1888.3	8140.9	2565.8	7642.0	55220.1
1975	1340.3	20018.0	461.3	18327.1	28132.9	31853.4	31733.8	111419.2
1976	828.3	8732.6	263.7	1955.1	7189.3	2983.5	6429.0	35648.4
1977	1217.5	15707.6	246.1	20138.8	61859.5	40494.6	14584.4	153201.0
1978	2826.0	19871.6	641.9	2157.2	6055.1	3351.9	14069.2	47588.6
1979	9079.5	75300.5	12320.9	24076.3	40195.2	27725.8	78005.2	182606.3
1980	8227.1	70945.6	8224.9	14041.7	46077.5	13986.0	53384.8	267715.1
1981	10036.9	72246.6	8574.1	36010.5	97770.9	48362.2	77271.9	307862.3
1982	8199.2	66978.8	4879.3	27342.9	102058.5	35999.5	66886.5	361073.2
1983	6002.9	54518.6	7963.3	18823.8	31518.2	18277.1	55250.4	156155.6
1984	1291.2	18665.0	1695.1	13096.7	23023.5	9621.8	43286.9	93967.9
1985	9029.9	69301.1	11638.8	17845.9	28090.8	15410.0	65170.7	176645.5
1986	1614.5	15777.9	378.8	6095.6	16797.4	10319.7	12806.1	77502.8
1987	9532.7	66801.3	11684.0	30802.0	51122.3	51397.2	73005.0	165609.7
1988	5172.6	34885.6	8230.3	24822.5	43844.5	33523.5	50652.9	143692.2
1989	10577.0	34359.0	6173.3	6374.3	22340.5	9223.6	19963.4	91371.0
1990	4862.1	43936.4	9687.1	15031.5	25218.9	20520.6	68008.0	196032.5
1991	7646.9	63876.4	3962.3	15757.2	46359.7	26099.7	44466.4	291485.5
1992	11489.0	72329.8	6402.9	22703.2	37696.4	46653.1	51415.5	207924.4
1993	3104.5	31444.4	273.9	8560.1	45769.2	22536.9	19962.7	172425.9
1994	7626.1	48796.8	2421.5	3089.1	13480.4	6661.4	23322.4	143324.1
1995	30482.1	201935.5	63788.1	28008.1	45359.2	20945.8	204851.9	327633.9
1996	8336.4	63482.2	9837.5	62530.3	147649.5	82639.6	88245.3	293240.8
1997	5048.8	28642.7	618.0	4570.4	13277.7	18280.2	15224.3	88038.4
1998	16036.1	103493.5	6424.5	10506.9	31944.9	21457.4	27250.8	126009.4
1999	27690.2	200054.1	43688.2	35715.8	72346.0	38339.3	144165.5	305669.0
2000	1519.2	26130.0	423.6	2617.6	7505.5	5297.4	13689.7	74082.4

Appendix G Recharge from Precipitation (acre-feet per year)

Year	Kansas													
	Cheyenne	Decatur	Gove	Graham	Jewell	Logan	Norton	Phillips	Rawlins	Sheridan	Sherman	Thomas	Trego	Wallace
1918	33974.7	24513.5	11031.1	22246.2	1773.9	5527.1	30599.1	15184.2	25265.6	27556.7	14864.7	16567.7	22826.4	6134.5
1919	18675.1	26016.0	12692.4	45342.0	2540.5	3555.9	66272.6	36742.6	11244.4	29671.5	9326.4	11251.2	41226.9	2524.5
1920	65519.7	15916.6	13061.5	10155.5	1526.0	13077.9	13013.1	8790.2	52231.2	34591.9	33063.6	48869.1	8901.4	9695.4
1921	17737.3	9942.0	8401.6	7954.6	254.1	5134.6	5630.9	4189.2	9822.2	14821.3	13089.2	14414.6	13094.0	4459.5
1922	21947.3	13455.7	4962.0	6372.0	466.3	3306.7	7909.3	4280.0	13076.0	14050.1	9430.8	12134.4	4747.0	2562.1
1923	142692.3	122640.9	44149.4	57633.1	1673.5	21648.3	70029.0	22938.6	144981.2	121793.2	68669.7	75465.1	60083.0	18856.1
1924	16166.4	7234.7	1760.9	1258.1	274.5	800.3	3559.8	3051.7	11194.5	8260.7	3519.1	5525.5	1236.6	274.2
1925	7895.6	3705.3	1759.7	5356.6	1161.3	52.6	3518.5	5941.1	6752.4	4326.5	272.2	242.1	5441.1	175.2
1926	12573.9	82.3	478.6	161.3	692.1	0.2	193.9	3652.7	1350.1	4522.9	498.2	0.0	431.8	80.4
1927	21769.0	15237.7	8508.5	11953.0	1062.0	3425.2	14617.8	8612.7	20179.6	14267.0	6137.9	10951.7	25060.6	1615.3
1928	93873.8	35965.5	29877.9	49564.7	1270.6	9907.1	49521.6	30066.1	69762.1	67027.2	32574.8	27073.3	59741.2	9196.7
1929	46776.9	12119.2	8076.4	13481.1	725.9	4166.7	23038.3	7062.7	21197.0	28362.8	13931.1	15484.0	7423.7	2457.9
1930	86470.7	87930.1	25382.1	34793.3	929.0	13409.0	52960.6	20067.7	95075.1	66837.4	48928.3	47983.9	41955.1	14930.1
1931	7943.4	5981.6	5629.8	13956.1	931.6	1122.7	10738.6	13491.6	3572.9	9416.5	913.1	3256.0	22386.8	71.6
1932	26534.3	791.0	8553.8	11510.4	334.5	1649.3	2682.8	5586.8	5541.1	15493.8	1773.8	3111.4	27726.4	63.8
1933	60308.1	18457.7	7499.2	8009.7	318.3	3444.1	9485.6	3454.6	41741.7	31240.4	14909.9	14270.7	4637.9	2929.1
1934	1409.3	0.0	0.0	60.1	35.2	0.0	0.0	186.6	0.0	0.0	0.0	0.0	290.8	0.0
1935	21745.2	3326.4	6762.9	10841.2	1477.1	302.6	6167.9	6285.2	7612.9	14646.1	1764.3	772.7	19958.2	22.4
1936	7734.1	0.0	304.9	155.3	156.7	0.0	0.0	6.8	421.5	1527.2	0.0	0.0	1137.1	0.0
1937	9732.1	4670.4	212.7	100.3	609.6	41.6	1674.5	1520.6	5727.7	3874.4	312.0	924.1	399.1	26.6
1938	19135.0	4256.4	6636.7	7330.6	1382.9	3098.4	4023.6	4022.7	10183.7	10182.2	9836.1	9267.6	16636.5	2449.3
1939	8193.2	0.0	2272.1	1137.6	528.0	912.9	67.3	178.7	1104.4	3447.3	2026.1	1435.8	3486.5	694.0
1940	4468.9	7.4	3710.1	4576.1	554.5	1267.0	1262.3	2333.4	535.5	3207.1	251.1	1263.4	12811.1	477.8
1941	121148.7	96681.6	34420.3	46259.9	2905.5	20862.5	51785.5	27493.1	128792.6	91849.7	59835.8	81658.6	49463.7	14547.6
1942	83467.5	33808.1	16742.5	26513.1	2781.1	7304.9	44137.0	22144.5	43350.0	53479.5	23737.2	23133.5	25330.6	6221.0
1943	2175.1	1124.3	16.1	309.1	472.8	65.7	1882.9	3522.2	338.4	87.2	374.4	6.4	570.1	816.7
1944	63108.3	73746.2	24356.8	39121.3	2963.2	14662.1	55666.8	24899.1	101707.4	52277.1	36280.4	58729.4	51592.8	9604.3
1945	28666.9	9436.5	7506.0	7368.5	1774.3	4925.3	4885.2	5875.1	15135.0	15961.5	17756.9	14977.8	10499.8	5753.0
1946	79490.9	70190.8	27222.5	35485.8	1610.1	12075.3	37742.5	25223.5	103901.3	65101.2	29650.7	56883.6	51498.0	4193.4
1947	38687.8	14434.9	5265.0	11626.1	568.5	2684.2	20223.0	10850.7	20344.4	16630.5	13606.0	7978.2	7503.1	4256.8
1948	38304.8	16134.2	14996.9	14880.7	705.4	6310.1	7415.6	2094.9	24725.3	30534.4	15736.5	18113.2	30236.1	4170.4
1949	126411.1	43210.3	27096.8	35386.0	2305.9	14730.2	47736.6	24772.7	74682.6	88114.5	47250.3	58221.9	25130.7	8497.1
1950	4727.7	1877.9	1521.1	8224.7	1646.5	138.2	12683.1	12779.2	3131.8	2251.3	92.0	844.9	10743.8	209.4
1951	65214.5	43783.0	31687.3	63058.1	3729.2	9657.9	61690.8	47663.9	56662.7	59243.7	23257.8	28276.5	85205.3	5458.1
1952	2109.5	613.0	197.9	845.4	632.8	19.2	4303.1	5200.4	503.9	187.2	68.3	30.8	2067.6	161.8
1953	3241.8	20778.2	2561.3	13208.8	1451.9	1265.0	34936.0	8745.1	10455.2	5033.4	570.1	7431.6	12723.7	69.0
1954	852.5	19.9	78.6	1785.2	702.5	5.9	2083.8	3101.3	8.8	43.1	59.5	33.1	3090.3	0.0
1955	1419.0	33.7	542.2	2790.5	381.4	6.2	1096.1	2091.5	33.5	361.5	152.3	66.3	6409.3	0.0
1956	1555.4	28.7	21.5	27.2	291.9	4.7	14.1	24.1	20.3	200.3	228.2	149.7	35.3	5.7
1957	46373.7	27568.5	31636.7	42274.3	1357.4	19059.9	41016.4	32751.5	53751.8	42180.8	45677.5	54615.8	69983.0	17448.5
1958	81157.8	21522.3	26218.6	25348.1	2231.0	14156.3	20971.6	10725.9	38352.1	57884.6	47635.3	32847.4	40400.1	18195.0
1959	7672.5	10517.7	4615.9	10861.6	1692.4	1817.2	14491.1	8108.0	10715.2	6626.2	1900.6	4952.2	19300.0	1271.6
1960	18627.2	16475.9	9647.7	19138.4	1705.2	5442.1	29062.9	18627.8	25275.2	13481.9	15915.4	17635.4	29664.0	5357.0
1961	16329.9	14699.7	21194.4	36248.1	2012.1	5318.0	26510.0	22560.3	10071.2	21694.4	10205.4	10828.2	72104.3	4348.7
1962	63892.5	35757.3	7603.5	14276.2	1697.5	6064.0	30838.4	20776.6	78572.6	23007.5	19832.0	31529.5	11199.1	4006.2
1963	16592.1	13347.0	2944.8	8518.1	1332.6	1280.9	17153.0	13564.6	13006.0	10737.8	4088.4	7698.7	5361.6	253.0
1964	2988.5	2616.2	196.1	404.3	639.1	60.9	2255.6	2212.6	2080.6	1106.0	1063.6	488.6	2167.3	12.8
1965	84941.2	116243.8	30840.1	59265.4	1681.1	14332.3	99126.6	49704.5	115357.9	74745.8	51138.6	58206.6	64485.9	13384.7
1966	17649.6	6408.9	1279.3	3507.9	314.5	284.3	11444.2	3440.4	6850.0	7413.4	3270.2	1441.4	1581.0	999.3
1967	7250.2	11183.5	2067.0	11010.1	1456.0	161.5	24952.9	12426.4	6664.1	4939.7	2223.1	867.6	14438.9	223.6
1968	7746.0	16762.8	2636.9	9176.2	1522.5	1195.4	16509.4	17447.9	14812.6	8158.5	3911.4	9501.4	7389.0	121.2
1969	22873.9	17781.7	9171.7	20547.1	1805.0	3441.7	33361.2	32305.8	23898.5	17433.1	8115.4	9851.5	27691.2	2383.4
1970	4551.7	3954.3	5015.3	8055.6	827.4	2001.0	6121.9	4982.4	6807.3	4533.6	3573.5	5361.2	22489.3	751.5
1971	23434.0	24575.2	4673.8	10885.3	1090.1	2185.0	26961.1	11576.7	38909.2	11987.6	8430.8	10251.7	14054.2	1428.6
1972	25014.1	15392.8	10578.0	16919.1	1898.5	3643.0	20671.5	9478.6	22971.0	20349.4	10055.0	12583.8	28078.2	1633.8
1973	69407.8	59998.2	24314.7	35951.2	4810.4	10673.0	46524.9	32386.1	88129.3	50165.7	25402.3	42296.8	56442.9	4434.2
1974	8527.0	4868.2	1235.1	1196.6	219.6	488.0	2978.5	213.3	8127.4	6402.4	3962.8	6800.3	757.3	96.0
1975	20491.1	36299.8	12745.9	19142.2	1192.6	6300.4	29083.3	9970.9	31793.1	24949.5	15400.7	29748.9	31432.0	1747.1
1976	2403.5	2390.7	1435.4	2716.4	240.9	406.4	3529.9	5713.6	756.6	3296.4	3961.2	3957.8	5773.6	112.7
1977	14581.7	30604.9	4546.0	8528.4	2317.5	3457.5	21268.0	8644.2	34239.6	13550.3	11061.9	23090.2	8009.7	923.3
1978	4422.1	1484.8	2040.1	3399.1	1315.1	778.5	3197.4	4493.0	1376.1	4996.7	5986.0	5554.4	4919.6	535.6
1979	62605.9	66369.4	19321.1	27214.9	1600.0	10659.2	40077.4	21400.5	71699.5	61724.6	37354.5	51852.9	26647.2	6229.6
1980	44434.0	13561.1	8765.0	7528.6	911.7	3166.9	8143.9	4015.3	12538.7	29939.8	19481.6	12709.7	7359.3	2801.7
1981	94743.2	43740.0	16570.3	18083.3	1678.8	10275.4	39186.8	16358.0	76924.1	63657.3	39341.3	48912.0	11789.5	6459.4
1982	51957.1	39765.2	11821.7	12376.4	1434.4	9028.5	19810.4	11283.8	66329.3	30839.7	29829.1	46201.9	15167.2	5187.1
1983	15530.2	36059.5	2310.1	8727.0	2024.9	645.1	23256.9	16103.1	20303.6	13438.2	10626.5	8213.0	4391.7	1192.3
1984	23923.4	42683.4	12171.5	19545.2	1601.8	4008.0	24140.8	9257.0	47776.0	25509.8	12768.4	24571.5	36955.2	761.1
1985	16509.2	37131.8	5139.1	9930.8	1758.6	4066.4	27273.3	8911.1	30715.4	15903.9	19000.8	25581.8	8195.2	3376.6
1986	9438.8	14071.4	6268.2	13763.2	2589.2	1707.0	15298.3	9041.5	8658.1	12992.3	6669.2	12692.3	21078.0	464.2
1987	22628.2	32631.9	9197.0	19063.3	2900.2	3873.9	32327.7	22471.2	30286.8	21035.6	16855.6	21032.8	25916.4	3304.3
1988	22424.0	15362.0	3363.1	3182.5	310.5	1805.0	6996.5	3420.2	24706.4	14075.0	9993.0	13247.5	2305.0	1162.1
1989	7708.8	3432.4	3795.9	3875.4	556.7	2911.6	3354.4	2986.9	8479.5	7345.0	9606.5	13533.2	5518.1	2562.4
1990	37571.1	15723.3	13578.6	15960.6	1016.2	4571.5	11888.1	13711.8	13846.3	35018.7	16190.1	19552.3	26503.6	1917.7
1991	61818.3	33758.5	8898.4	10053.0	773.5	4299.2	14018.4	6866.9	41433.9	38609.0	23201.4	23913.8	5533.8	3198.9
1992	29915.9	32899.5	15021.7	30198.4	2908.4	10036.1	45145.6	17023.1	45868.3	28953.0	29834.2	43071.9	38762.1	7146.6
1993	55459.2	87059.9	31895.7	53257.2	3804.4	16744.4	77237.7	55678.6	106778.9	55947.2	36257.1	75754.6	81040.2	5900.1
1994	11461.5	30149.0	4050.1	5666.8	603.6	5260.7	23070.2	249.8	29567.4	12036.4	18489.8	30014.3	4170.1	3693.0
1995	40166.2	16380.6	25063.5	20970.5	965.9	11012.2	21822.3	321.5	20455.7	41985.4	35044.2	31472.3	43635.0	10913.4
1996	29925.8	46199.1	17414.9	23839.9	2590.4	9417.8	53605.5	2968.5	55456.9	27873.6	25889.3	41910.8	50581.0	4985.9
1997	11136.6	11368.0	13871.5	16931.1	2437.3	5195.2	17653.1	230.8	11009.0	16434.7	13756.1	19528.4	45454.1	2577.8
1998	22937.9	9426.8	19338.7	15475.7	1427.9	9815.4	11161.2	166.9	12403.9	26430.4	33025.9	29356.9	44624.8	9454.6
1999	20952.8	25930.9	9878.8	10644.1	725.3	5352.3	16704.6	212.8	21910.0	17264.3	26577.6	20285.9	26873.5	8089.5
2000	7735.8	5945.9	5946.7	7264.7	298.4	1778.2	10433.5	201.0	4136.7	9841.6	8634.8	9404.1	18190.0	578.4

Appendix G Recharge from Precipitation (acre-feet per year)

Year	Nebraska																					
	Adams	Buffalo	Chase	Clay	Dawson	Deuel	Dundy	Franklin	Frontier	Furnas	Gosper	Harlan	Hayes	Hitchcock	Kearney	Keith	Lincoln	Nuckolls	Perkins	Phelps	RedWillow	Webster
1918	10153.2	63.7	83359.8	1671.1	4737.0	1296.9	78328.5	49363.2	20596.7	23438.2	9480.7	30779.5	38064.1	16344.9	53766.7	25113.7	174668.2	80276.6	87893.4	26882.1	14272.1	44238.9
1919	24384.0	352.5	108214.5	3325.6	4472.5	885.4	33495.2	122131.7	14260.7	34607.2	15418.4	81695.5	25563.2	5920.6	182162.7	31340.8	186311.2	127515.4	113891.3	105295.8	10702.2	89186.6
1920	7279.6	90.5	92304.8	1045.8	5591.4	779.4	123739.7	26657.6	20887.3	26257.4	17733.7	14252.9	21626.1	20585.0	61837.6	9151.2	90269.0	59299.3	52602.3	19559.7	12498.2	24998.2
1921	1204.6	31.7	12371.3	161.2	2984.7	138.7	15574.7	8017.5	10125.4	13600.0	13387.5	12083.3	2711.9	1272.4	20460.8	1618.2	27817.5	7434.6	8122.7	23565.0	6900.3	5264.4
1922	2033.7	32.7	32041.7	250.6	1089.5	443.7	38688.1	11225.5	616.1	5753.1	1269.7	10221.0	5412.5	3193.9	26363.2	5863.2	44160.9	11305.5	30136.8	16706.6	2665.3	5874.8
1923	15294.1	279.3	129637.8	1952.2	11915.6	2797.1	132420.6	84138.9	65882.2	74255.6	41504.5	74869.3	86470.2	68614.2	136816.9	38429.9	235796.8	78769.3	164984.0	119217.1	69756.7	47003.5
1924	2002.4	59.9	47939.2	226.8	1786.2	710.4	42276.8	11527.1	5408.2	15075.0	7184.7	18237.6	9513.3	9230.4	34467.9	5414.2	33516.1	8469.8	35791.9	36887.4	5530.0	4597.3
1925	7572.0	88.2	32557.0	1267.6	3878.8	728.4	29119.9	34424.5	15646.5	6218.3	11600.1	20013.1	17205.2	11743.6	51375.8	7216.0	75324.3	56898.6	32512.4	46268.1	10628.8	25563.4
1926	3470.7	29.9	29969.1	584.7	2268.8	525.7	26817.0	16158.9	9270.3	6466.5	6379.4	11376.1	9588.0	5417.9	23307.5	6325.2	59169.4	27554.1	27685.0	19907.4	5736.4	18357.5
1927	9266.9	68.1	79254.2	1057.6	4117.2	764.3	75279.1	60793.7	20852.9	30122.5	14113.2	46077.8	37852.6	19961.0	62094.6	12979.0	125776.2	46956.1	64802.8	67154.4	20703.5	32503.4
1928	9182.3	73.1	146230.5	844.1	3768.7	999.4	183208.9	80266.1	29176.1	37737.7	9581.8	58866.9	81433.3	61124.5	75950.8	15958.6	163197.5	46507.5	85951.5	40559.8	30148.1	39106.6
1929	929.2	8.5	86900.5	227.8	2573.7	471.2	96830.5	5505.6	12798.8	21461.6	4755.8	10730.7	14513.5	11510.0	6983.0	6176.1	73066.0	19712.1	39683.4	7608.4	13434.1	5523.1
1930	12053.0	436.3	187670.3	1458.4	20526.6	2138.0	148805.4	72166.4	100509.3	88195.5	50845.4	95805.0	104085.7	58916.4	165934.3	28797.8	288144.6	49570.0	155730.7	191446.4	99904.5	28747.5
1931	6659.1	79.1	16630.2	1068.9	2388.4	62.9	10851.3	46216.0	8590.2	7846.0	9557.8	38551.9	8068.4	2358.2	48938.8	2255.2	53109.9	48314.6	15847.8	66007.3	8258.4	26830.3
1932	1635.1	48.3	52078.8	219.1	2591.5	587.2	78196.8	11831.0	6969.6	5335.7	10453.2	14711.4	8765.9	5011.1	28010.1	10944.8	74299.0	9712.5	47603.7	38587.6	2954.0	3813.1
1933	3360.4	136.2	69187.0	396.9	4527.5	940.5	110735.6	16839.7	20601.5	17976.2	20779.9	20799.1	24492.3	29082.7	58695.1	14824.5	112729.1	11886.2	48366.8	60890.6	16216.3	7292.0
1934	141.6	0.0	15068.6	0.0	125.4	63.0	13094.7	2722.7	782.8	952.0	0.0	1916.8	7728.0	2060.1	4410.1	622.3	17789.5	114.0	6764.8	2100.1	1912.5	318.7
1935	9279.6	96.8	47077.0	1872.7	7232.3	335.5	49043.7	31420.4	24996.0	15905.7	11301.6	21671.0	30239.0	14582.4	49896.1	14607.2	176110.6	77770.1	51763.2	35458.3	11746.2	32119.5
1936	86.8	0.0	31310.5	7.5	218.2	81.4	51758.5	572.4	16.4	964.6	0.0	649.8	4899.4	1516.4	2834.1	1047.3	21068.1	2146.7	13641.2	1098.4	793.4	425.5
1937	1905.9	26.7	20441.5	320.0	2543.5	130.1	22784.2	8759.4	6878.3	11961.4	3512.9	9919.6	10307.5	3582.3	19842.9	5011.9	75868.8	19448.8	33788.6	16120.5	4936.9	6239.6
1938	4847.4	33.9	49177.2	900.6	1355.5	525.2	61950.8	24049.6	9412.9	11060.7	5864.4	18542.1	14870.1	12597.5	30165.4	10807.6	84529.1	55645.6	39400.7	29128.9	8509.6	21016.1
1939	2287.7	34.7	15941.8	392.7	382.1	346.0	21107.9	8601.2	61.4	3124.3	2524.1	6954.4	2217.0	1133.3	25806.1	4928.0	27270.4	18069.9	21179.9	19448.5	1108.9	7794.9
1940	1728.1	7.2	30796.0	278.7	737.7	345.1	19857.8	8334.5	2332.3	3649.8	247.5	5216.4	7777.9	1283.9	10058.8	5738.0	50977.7	15947.7	39501.5	4604.7	2739.6	8713.3
1941	21920.7	199.0	90203.6	3390.6	9249.6	1300.1	159636.4	102701.2	50405.3	48766.6	30578.6	59167.4	36135.6	44575.0	124640.9	14772.4	135089.0	142071.9	68848.4	67613.7	61551.3	83378.1
1942	19863.2	320.5	206100.1	2725.9	12473.1	991.2	177098.8	108844.4	43322.4	64512.3	49088.4	96960.7	56087.8	25671.1	151436.4	22370.4	185850.8	122669.3	164797.9	183546.7	34903.2	69199.4
1943	2092.7	13.8	7574.5	215.3	2233.9	132.9	9222.5	19531.6	6376.6	9771.6	16202.5	12408.3	754.6	421.4	16730.3	2614.8	22735.3	10833.2	8916.3	21579.6	2301.6	6695.3
1944	23350.9	405.7	74328.0	3332.6	4933.3	825.6	104709.9	107042.7	20064.0	57495.5	18235.9	81754.3	31447.6	41672.4	198509.5	16104.2	133629.9	138307.1	67630.5	132312.1	44893.6	70555.6
1945	12166.7	133.1	49814.2	1857.3	3732.3	1444.0	59542.8	50524.2	10767.2	6888.4	4737.5	23835.8	15827.7	8347.7	81499.6	19430.7	118888.3	81356.8	64325.5	43626.0	9501.3	39697.1
1946	23104.5	554.3	107600.8	2785.9	11607.0	1120.6	127993.4	129821.1	50646.6	66640.8	43981.5	124312.4	72705.0	51692.7	239964.8	14652.0	166364.8	90107.5	84677.7	237974.2	54373.5	75799.2
1947	6512.2	164.4	73700.5	925.0	8113.7	253.7	110374.5	33860.6	22487.7	21996.7	12142.8	36772.9	31932.6	22431.2	70095.2	6087.2	129648.7	30092.6	53766.8	69626.6	19267.1	21304.4
1948	4390.0	59.7	36192.7	748.6	4322.9	515.1	59140.8	14209.7	13022.4	3814.3	6494.0	8805.7	17872.2	12668.2	36380.2	5411.5	73782.5	31847.4	40252.9	32461.0	13091.0	14574.7
1949	17913.8	265.2	138173.4	2963.1	8877.8	1084.7	172531.4	80404.9	31751.0	48455.0	22238.5	72555.6	67431.5	30031.1	123655.4	15414.4	166578.3	119347.8	100674.2	111103.9	30889.2	64147.9
1950	13239.5	399.8	28292.4	2066.0	5464.0	615.0	32884.5	56825.8	14983.2	18691.0	13647.7	57743.4	11960.3	6671.2	155892.1	14665.8	126631.7	81119.2	35958.2	131155.5	12883.9	44304.9
1951	29090.9	440.1	169611.4	4274.2	12917.5	2653.9	147489.9	143029.0	47173.5	45653.9	25445.7	99652.9	96191.8	44711.1	214307.4	42958.2	283037.9	174148.4	190901.6	134299.5	35128.2	111975.4
1952	3636.6	34.4	21778.9	729.3	846.4	917.5	18283.2	15477.1	2792.8	14509.6	2246.3	22063.5	6353.1	2951.4	27929.9	6918.2	30216.0	31048.5	24639.2	28412.9	6816.9	18846.3
1953	6521.8	74.3	35680.5	1318.1	1878.4	980.4	25766.4	22569.6	8501.8	29058.6	6678.9	35376.8	9814.9	7138.3	46836.9	8232.3	44274.5	66901.8	33108.5	51959.7	16743.6	23401.1
1954	3686.8	57.2	14850.7	544.7	1966.9	218.1	10545.4	16799.6	328.5	1810.9	2692.6	10087.1	890.9	751.9	38796.0	1553.5	15473.1	26988.9	7432.9	26728.4	560.2	16354.1
1955	4539.2	33.6	20977.8	495.6	1298.0	792.8	12739.9	18859.7	351.8	1547.9	2586.4	9453.8	3050.6	1168.4	32455.5	5804.5	22751.6	14376.7	23038.1	25291.8	1363.5	17510.8
1956	1451.0	12.0	25273.5	189.4	1439.1	746.6	13260.5	3037.8	426.1	665.2	511.3	832.3	2087.5	707.1	13231.3	4602.2	20353.3	8693.1	18229.0	5484.3	594.7	4679.2
1957	21055.8	423.1	82840.8	2599.1	12708.4	1360.8	88717.6	119182.1	38419.0	58433.7	37114.7	112567.1	40719.8	25178.3	188001.8	22518.7	188059.1	80827.0	85895.2	196587.1	36406.9	77846.6
1958	18860.9	172.2	112510.6	2981.5	5028.9	2090.0	121502.1	53194.4	16991.0	23560.8	6557.4	33502.6	35828.3	17899.3	107521.1	30297.6	166695.6	114194.7	126710.1	43533.1	16855.6	50574.6
1959	17335.8	330.6	51618.6	2696.2	7337.1	515.0	46917.4	42281.1	18330.8	15297.9	11399.4	33812.4	22315.8	16731.6	144870.5	6146.3	99873.7	93375.5	43636.3	91392.7	18495.8	39630.7
1960	19386.2	400.4	47671.7	3018.4	5780.7	545.4	66695.9	55460.1	12652.9	34164.6	16397.4	64812.0	19003.7	17067.4	172232.5	4731.4	67561.4	99811.7	27298.3	123704.0	12669.1	51077.1
1961	18309.1	237.7	45111.2	2847.9	4932.0	1019.8	60972.4	74460.7	12445.4	32661.1	9716.1	73119.5	14535.5	8928.7	127030.5	10155.6	80600.7	106302.8	41487.6	100403.0	12903.6	49391.2
1962	22326.3	335.9	178874.8	2922.8	15955.2	1011.1	210173.0	98723.5	55685.8	45603.9	34177.5	82813.3	86351.1	59541.2	165756.3	25158.6	263907.9	96467.9	130902.2	145508.1	36073.9	58454.5
1963	12618.0	32.9	45285.8	2017.7	5896.6	694.8	45864.0	46995.6	12246.0	23403.3	16048.5	36494.9	10727.3	7316.2	40582.3	10701.2	87298.6	77057.1	56619.9	48993.1	10730.5	38847.0
1964	5474.5	51.1	12171.6	1005.7	4644.7	362.0	14907.8	10477.0	8770.8	9748.3	4338.0	10772.8	5669.4	4781.2	35564.9	4322.0	70570.7	35484.2	12211.1	23543.1	5822.4	10982.0
1965	34382.4	654.6	149610.3	4329.5	20207.2	2514.9	153967.9	155251.9	72160.3	131979.3	69307.7	163429.6	69481.2	58144.9	286562.9	36598.8	256439.9	119524.5	136036.9	279853.4	73167.8	107756.4
1966	2866.5	29.0	57881.3	351.3	4116.1	1168.8	80516.9	8530.1	11366.6	20413.5	8542.5	14801.1	18219.5	12768.4	25638.8	9297.5	71859.3	11550.9	39616.7	28216.5	8186.8	5521.6
1967	13078.7	322.0	76449.1	1817.3	7043.1	664.0	70778.4	40152.1	21156.7	41094.7	25954.4	58114.9	20537.9	17410.2	137003.0	7104.7	88522.4	68358.4	35723.0	126194.3	18575.1	28866.0
1968	18888.6	251.2	8718.5	2811.9	4134.6	364.1	17682.3	69918.1	7068.3	17673.6	11549.8	59714.9	5566.5	9805.2	128974.6	2727.7	33424.4	92839.2	11547.0	107767.6	10094.2	49259.7
1969	24397.4	305.9	53411.0	3271.4	10760.4	904.0	74095.2	122978.2	39260.4	60156.3	51671.3	118299.8	35045.5	29212.7	163434.4	9147.3	102513.3	106940.9	45125.3	194304.3	24526.2	75772.9
1970	10553.0	45.4	16948.8	1616.1	1725.3	402.1	30853.6	29490.9	1377.5	5714.6	2512.7	20352.7	3103.5	6081.2	51375.0	2907.4	23755.2	52808.3	9063.4	34696.4	1062.0	28872.5
1971	14359.9	178.5	133922.8	2179.8	8953.2	1409.6	115962.1	48415.7	27730.6	48313.4	21207.9	61803.3	38305.4	38856.7	88887.8	21632.9	157707.2	69540.4	119279.0	113243.6	27310.7	43661.2
1972	21418.4	235.5	67611.2	3068.2	4240.3	737.0	80257.0	72287.2	12150.9	22072.1	9383.9	54170.6	20469.4	19878.1	137840.1	9288.2	82500.4	104711.1	45272.5	101602.1	12682.8	61697.9
1973	35911.9	426.1	137261.9	5972.6	9768.3	1222.2	174322.0	126993.0	42544.0	66551.7	23869.6	118050.5	71944.5	58877.2	213998.5	13015.8	149785.5	234427.5	86898.5	190027.5	57434.8	121529.1
1974	1966.6	6.2	23514.0	225.0	1968.2	229.8	32904.6	5293.2	4713.0	2125.0	2413.6	5910.1	10576.4	8296.5	14498.7	2327.9	34297.8	6689.6	11907.7	17903.2	6571.4	3309.2
1975	14096.7	180.4	53984.9	2315.6	8303.3	1483.9	47651.2	35902.7	33162.1	46698.2	30652.9	45516.0	27424.7	15700.4	93746.0	14142.5	104745.7	75085.7	50082.7	95116.2	32929.7	34772.7
1976	4900.0	21.9	13301.2	523.6	5673.6	252.8	10463.9	21857.5	13395.0	11663.8	9290.0	17667.7	6900.1	3671.1	32423.4	2965.7	53981.7	10875.3	13699.3	30126.1	7106.0	11363.3
1977	31805.7	337.3	81416.4	4619.7	14311.5	1560.9	73902.1	90771.2	52479.0	40091.6	28610.1	52941.5	60488.9	32930.8	184212.1	23435.6	217802.6	142262.0	87093.2	121617.1	44435.7	93780.3
1978	15237.8	84.3	29903.2	2281.8	7342.3	294.0	21907.5	42503.7	15257.8	7753.0	12851.5	24563.4	12512.5	3562.7	71876.7	2656.3	56001.0	77578.1	13636.5	60093.3	5093.0	43112.9
1979	30914.0	396.5	58502.1	3672.2	11824.1	1111.1	69087.8	131779.2	42941.7	50922.2	49734.6	97596.4	40732.2	28251.3	222738.9	14327.5	120872.5	102923.4	68300.1	203630.9	45978.1	89801.4
1980	8760.4	76.8	61771.5	1232.8	3655.6	421.7	89118.9	22118.2	11579.3	21401.0	11761.4	26707.6	9556.8	8816.4	68760.1	3776.1	23882.7	47313.7	30144.5	57590.9	15265.8	16294.6
1981	28709.0	418.0	148975.7	3632.0	16664.6	1492.6	164771.0	100308.2	57200.4	66615.0	34343.2	84383.3	68721.4	50030.7	220384.0	19799.4	205526.9	103925.5	100421.8	166341.4	50665.5	75948.5
1982	25771.1	307.2	170657.7	3268.5	9368.8	1095.6	163528.2	87321.5	33708.6	37366.7	31347.6	57390.8	74675.4	45443.9	182289.5	15156.5	138691.7	92239.8	115438.9	123699.2	25939.5	64618.6
1983	26542.2	293.3	45741.6	3962.5	5957.7	755.9	51279.4	93912.5	14380.0	39735.8	18485.6	76517.8	11642.4	11917.3	164350.5	10089.7	78247.7	127493.4	35209.4	129282.6	16499.5	69456.9
1984	17962.8	271.9	57089.9	2911.3	14216.3	506.4	64450.7	51403.9	42609.1	47780.8	32192.2	61521.5	45878.7	35125.5	134394.6	11798.3	165175.1	97487.8	56729.8	146156.5	38498.9	35891.0
1985	28420.9	386.6	43685.3	4121.8	13272.2	662.5	51582.6	81119.9	37915.6	57505.1	46937.9	70553.6	21704.6	17233.9	191927.8	10157.8	108647.8	121505.7	35304.5	182039.8	40167.8	76818.7
1986	21697.5	322.1	54194.0	4031.2	7361.5	637.6	45175.1	35106.4	20100.3	18392.0	16145.4	36093.8	18021.0	8558.4	148392.2	9303.1	87412.4	145696.2	43833.9	101636.4	18272.2	50218.4
1987	31105.8	390.1	94929.7	4291.5	14084.7	2039.7	70699.1	132431.1	35426.3	44646.9	40846.9	108554.5	41121.8	22103.2	213429.3	25676.9	169051.9	150730.2	110439.2	216214.7	25674.5	81947.0
1988	6366.4	83.2	65144.4	661.7	9675.1	1314.9	74784.5	23523.3	27558.7	18630.3	13144.5	26626.8	43768.1	28571.9	61282.4	16392.0	153476.4	14082.2	61328.8	64795.4	17521.2	10986.5
1989	11627.0	173.9	44160.7	1516.4	6370.2	491.3	40972.4	25632.4	15416.0	6122.1	14924.2	19865.2	18654.9	13305.6	95467.2	7673.4	78734.4	37850.1	40358.5	83545.3	8132.8	26627.3
1990	15959.6	31.8	89961.8	2290.3	5957.1	1038.1	80739.7	55452.5	15919.0	19382.9	16998.8	35936.0	15451.5	6573.2	55531.9	11252.7	65257.8	70597.1	61792.1	50549.2	13269.9	54618.2
1991	9009.0	35.3	102786.6	1290.6	7819.1	1124.9	131498.4	28743.6	24966.2	20247.5	12763.0	27728.9	33716.4	24460.1	49976.3	14754.1	120531.9	43541.2	81310.3	51271.6	25188.8	19410.1
1992	22288.0	212.4	60076.3	3781.7	8284.5	1952.4	73962.4	66207.6	25488.4	29745.3	24340.1	64179.0	44057.6	30291.5	123358.0	18154.9	123399.8	145576.0	65501.0	140707.6	25875.0	56683.5
1993	42664.5	772.1	186041.6	5909.5	23898.8	1241.4	150840.3	193178.2	82559.9	131512.2	76632.9	209538.3	87555.6	55149.8	363431.7	32556.4	288751.0	199266.7	146755.4	377060.8	69329.6	120537.0
1994	14597.1	284.7	66576.0	1798.5	9691.5	534.7	58755.7	22778.8	27119.0	24122.4	20992.0	17848.3	26001.1	16419.1	140127.6	9615.8	109566.1	41428.5	61922.7	106258.3	23478.4	23423.7
1995	18963.7	201.6	90767.7	2505.5	8619.8	933.0	74656.0	33891.6	30038.0	32035.3	24720.6	24749.1	32879.3	14765.3	116577.7	18523.6	135609.1	68344.8	112266.0	110548.6	26316.5	49897.3
1996	25304.3	454.9	165654.7	3305.8	14192.5	2329.6	126428.1	96940.1	46264.9	101725.0	53383.9	111208.6	68051.2	45082.0	217634.9	29856.9	197208.0	123171.8	131997.2	300788.9	45194.1	74592.2
1997	18643.3	213.8	59849.7	2735.3	7125.7	1334.6	40456.9	35193.0	17955.4	19526.3	17183.8	17258.8	16838.6	10545.0	122442.6	22668.5	121188.1	109464.5	103031.3	99513.7	20770.1	51542.6
1998	11028.0	232.3	48868.9	1607.1	5852.8	1117.5	33825.7	20454.2	10364.1	16699.6	16399.2	23393.9	14983.4	3976.6	108196.9	26271.7	136191.1	63213.0	78694.1	123223.0	6944.3	30189.5
1999	12438.3	281.4	112815.6	1376.8	12254.2	1485.5	85359.5	26980.6	40022.2	34309.0	38156.1	28808.1	47210.0	18466.6	129618.2	31291.9	200842.0	37524.3	125500.1	149938.9	34020.4	28912.6
2000	17343.1	203.7	41424.7	1464.9	6904.7	507.2	32617.5	51549.3	21090.5	22136.4	14228.8	20255.6	14915.7	7160.3	144438.1	9926.2	96410.4	22092.7	38310.4	81687.5	20334.2	39230.6

Appendix H Recharge from Ground Water Irrigation Colorado

Year	Cheyenne	KitCarson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma
1918	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1919	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1920	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1921	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1922	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1923	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1924	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1925	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1926	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1927	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1928	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1929	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1930	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1931	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1932	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1933	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1934	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1935	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1936	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1938	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1939	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1940	37.8	0.0	0.0	58.2	234.6	0.0	73.2	0.0
1941	28.2	0.0	1.8	33.6	133.8	0.0	184.2	39.0
1942	30.6	0.0	2.1	40.5	269.1	0.0	178.2	49.5
1943	42.6	0.0	2.4	66.9	453.3	0.0	203.7	76.8
1944	45.6	0.0	2.1	60.3	407.7	0.0	285.9	68.7
1945	96.6	0.0	1.5	30.9	197.1	0.0	320.4	44.1
1946	143.4	0.0	2.1	52.8	351.0	0.0	434.7	100.8
1947	128.7	129.9	2.1	51.0	351.6	0.0	768.0	265.2
1948	90.3	480.0	122.4	64.5	456.9	0.0	1005.0	287.4
1949	96.6	894.6	135.6	45.3	462.0	58.8	728.4	824.1
1950	186.9	1262.7	150.6	53.4	612.3	70.8	973.0	886.4
1951	197.1	1059.0	123.9	35.7	449.7	117.9	957.9	1073.4
1952	243.6	1825.5	201.3	73.8	1203.3	235.8	1477.3	2436.8
1953	303.3	1946.3	183.3	58.5	1034.1	180.3	1508.7	2688.4
1954	315.3	3998.5	235.2	60.6	1217.7	190.2	1917.3	3608.8
1955	399.9	8029.9	197.4	57.6	1245.0	187.8	1491.2	4290.9
1956	499.8	13139.5	234.0	68.7	1639.5	309.9	2009.8	6571.8
1957	298.5	8682.4	137.4	134.4	1628.4	394.2	1718.0	6101.3
1958	213.0	9315.1	138.6	104.4	1364.7	270.0	1895.8	5935.8
1959	291.3	16295.8	245.4	135.9	1746.6	391.8	2131.6	7988.5
1960	338.4	14897.2	193.5	138.9	1913.7	394.5	2211.2	6938.7
1961	265.4	15007.5	177.2	111.3	1719.0	307.2	1789.9	6046.9
1962	346.6	15051.6	167.6	97.3	1577.1	283.0	1960.6	4872.6
1963	469.5	24735.1	209.8	179.3	2354.6	406.3	2205.2	8227.3
1964	605.0	33669.5	246.0	194.3	4760.5	472.9	2607.0	13389.4
1965	584.5	20188.8	120.9	109.5	4088.8	266.7	2475.4	11171.2
1966	720.7	39370.7	222.5	118.9	5745.5	271.7	3420.1	16704.9
1967	708.0	38221.5	174.9	101.2	8470.5	367.4	4278.2	31395.8
1968	934.1	45610.4	208.3	346.3	13176.5	886.8	5503.8	36426.6
1969	742.3	47391.8	226.0	335.0	13949.9	1225.3	5588.7	43168.4
1970	939.7	49846.9	254.8	375.9	17303.7	1330.2	5738.9	46051.5
1971	1320.6	52789.3	269.2	287.2	14471.6	1204.4	6818.1	50064.2
1972	1396.7	45253.1	240.9	328.7	14853.4	1273.9	6111.1	46096.9
1973	1734.3	52268.7	260.6	522.0	17083.6	2122.6	6987.5	42714.0
1974	2865.1	66709.1	384.8	1384.1	26786.5	6021.1	10576.0	72568.9
1975	2965.3	58568.7	474.9	1469.4	24863.4	6479.7	9806.4	72557.3
1976	3278.7	68565.0	540.8	1729.5	30105.6	7932.0	11816.7	79041.5
1977	3528.6	58052.3	461.0	1525.2	25790.2	6972.0	13880.0	74717.5
1978	3533.4	56386.8	516.0	1920.4	32711.8	8860.3	11597.2	91656.0
1979	3234.2	46261.0	363.5	1381.8	24372.1	6579.2	9560.3	75299.5
1980	3210.1	50831.0	463.7	1684.0	28005.0	7904.7	11671.6	68518.9
1981	3034.9	56033.4	468.7	1402.9	24168.7	6622.6	10844.7	73225.3
1982	2804.6	41382.9	348.5	1052.5	18321.8	5039.5	8803.7	55242.7
1983	2941.3	35021.8	367.3	1222.1	20747.6	5578.7	8688.2	56715.7
1984	2947.8	46814.3	471.4	1490.3	23742.6	6562.1	8487.7	73389.0
1985	2809.1	38465.2	347.6	1458.6	23338.1	5967.9	8591.6	56721.3
1986	2672.3	45156.3	437.8	1408.5	21955.2	5833.6	9755.1	58015.2
1987	2766.2	41782.8	401.6	1356.1	22047.9	5975.3	8713.0	68421.0
1988	2525.9	46098.2	444.7	1403.9	22998.1	6190.3	10264.5	72089.0
1989	2166.6	44398.0	446.6	1151.7	18362.6	5095.7	9458.8	55427.3
1990	2232.0	42374.7	402.7	1294.0	21296.5	5802.0	7830.4	54952.9
1991	2360.2	38624.9	396.6	1190.2	21109.4	5581.1	10332.8	43979.2
1992	2537.1	40345.2	433.4	1127.4	18583.8	5030.7	9216.4	50181.5
1993	2982.0	39957.4	402.7	899.3	14400.3	4006.5	8929.2	47943.2
1994	2814.2	43087.8	445.0	1562.0	26175.2	6876.1	13129.0	57536.6
1995	2605.8	36961.4	375.9	1169.3	19546.1	5279.0	8148.0	50025.6
1996	2559.5	40415.2	401.7	620.7	9791.4	2915.7	7807.8	43537.1
1997	2515.9	40409.6	417.5	1229.5	20087.1	5723.8	9425.8	52213.6
1998	2644.4	37612.9	374.2	1177.4	16744.1	5187.5	10935.3	59408.7
1999	2630.8	35534.6	373.6	1001.5	14612.7	4372.2	6971.1	50170.5
2000	3292.0	47795.5	542.7	1730.0	23479.7	7227.4	11755.9	64308.8

Appendix H Recharge from Ground Water Irrigation Kansas

Year	Cheyenne	Decatur	Gove	Graham	Jewell	Logan	Norton	Phillips	Rawlins	Sheridan	Sherman	Thomas	Trego	Wallace
1918	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
1919	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
1920	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
1921	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
1922	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
1923	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
1924	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
1925	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
1926	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
1927	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
1928	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
1929	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
1930	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
1931	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
1932	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
1933	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
1934	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
1935	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
1936	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
1937	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
1938	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
1939	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
1940	340.8	225.7	0.0	0.0	0.0	0.0	40.5	51.3	52.8	151.4	83.4	75.6	0.0	0.0
1941	370.2	115.1	0.0	0.0	0.0	0.0	27.3	38.7	35.1	93.0	83.4	72.9	0.0	0.0
1942	652.5	186.3	0.0	0.0	0.0	0.0	26.7	40.2	43.2	123.1	91.2	81.6	0.0	0.0
1943	969.0	211.2	0.0	0.0	0.0	0.0	37.5	48.9	47.7	144.0	96.3	85.8	0.0	0.0
1944	936.8	117.5	0.0	0.0	0.0	0.0	20.7	35.7	35.1	86.1	72.6	67.2	0.0	0.0
1945	1002.2	174.8	0.0	0.0	0.0	0.0	36.0	45.6	35.7	125.4	64.2	75.6	0.0	0.0
1946	1274.7	187.4	0.0	0.0	0.0	0.0	39.0	50.4	48.3	137.8	75.3	86.7	0.0	0.0
1947	1129.2	192.9	0.0	0.0	0.0	0.0	29.1	41.1	42.6	133.9	132.9	72.0	0.0	0.0
1948	978.3	166.5	0.0	0.0	0.0	0.0	30.3	45.6	37.5	109.8	135.6	159.9	0.0	0.0
1949	937.2	148.1	0.0	0.0	0.0	0.0	24.0	34.2	35.7	107.4	235.8	149.7	0.0	0.0
1950	1111.5	183.1	0.0	0.0	0.0	0.0	44.1	84.9	174.9	169.4	378.0	151.8	0.0	0.0
1951	698.6	109.0	0.0	0.0	0.0	0.0	20.7	57.6	92.7	96.4	239.1	175.5	0.0	0.0
1952	1398.3	255.6	0.0	0.0	0.0	0.0	81.0	119.4	213.6	237.5	1242.6	401.1	0.0	0.0
1953	1228.3	228.6	0.0	0.0	0.0	53.4	51.9	224.4	357.6	336.8	1397.2	386.1	0.0	0.0
1954	2208.4	336.9	0.0	117.9	0.0	67.8	319.2	544.9	433.1	443.0	1851.3	405.6	63.3	56.7
1955	2619.4	584.6	93.6	168.9	0.0	73.8	410.7	1163.9	677.0	1153.6	3171.0	933.6	56.1	59.1
1956	3660.6	917.8	274.8	249.9	209.7	80.4	524.3	1593.3	1021.7	2711.2	5580.3	2912.4	189.6	137.1
1957	3667.3	907.8	176.7	139.8	96.9	80.1	396.3	1161.1	877.9	2538.6	5172.8	2041.3	102.6	97.2
1958	4122.7	897.7	214.2	157.8	94.5	105.6	414.9	1276.7	895.4	2903.0	6154.0	2389.0	168.9	99.0
1959	5075.5	1271.6	333.3	238.2	124.5	135.6	624.2	1814.4	1233.0	4307.3	6678.3	3569.5	213.9	102.2
1960	6502.1	1495.6	312.9	247.9	93.9	120.9	614.1	1489.1	1359.6	4218.1	7658.3	3229.4	220.4	118.4
1961	5092.4	1545.8	189.7	196.0	123.8	164.7	640.0	1578.2	1074.0	3228.3	5965.5	3006.2	47.0	80.6
1962	3764.1	967.0	301.0	237.6	129.6	120.9	500.3	1034.4	697.7	3199.7	7129.2	2475.8	187.3	83.9
1963	7650.4	1789.1	489.4	288.8	126.6	259.5	614.7	1736.2	1322.0	4384.2	10972.3	3586.8	288.4	101.0
1964	10254.6	1644.5	697.6	344.4	114.5	733.7	864.0	2088.2	1516.9	7849.4	16884.5	6192.2	380.9	167.1
1965	7846.8	1092.5	390.4	296.7	114.5	468.3	601.8	1056.4	1204.8	3975.1	15286.3	4012.9	151.1	159.7
1966	10414.3	1655.6	1174.5	529.1	150.1	671.5	753.3	1714.6	1736.5	7384.1	18360.4	6951.2	287.7	296.7
1967	11452.1	1826.0	1544.7	421.9	122.3	1046.0	532.5	891.7	2017.0	8300.9	19905.5	9339.9	231.3	270.5
1968	12309.5	1614.7	1602.0	536.1	76.7	1691.9	360.3	727.3	2127.6	9076.3	24462.7	8155.2	234.0	430.2
1969	12556.0	2534.5	2151.4	440.8	89.2	2231.0	588.3	928.1	2202.4	12065.6	24902.7	9511.6	300.6	397.3
1970	14049.0	2682.4	2565.8	481.1	123.3	2773.1	786.4	1391.4	2456.6	15198.0	29760.7	10562.7	356.5	537.7
1971	14208.2	2606.0	3503.3	613.8	130.0	3150.9	1550.6	1993.4	2895.2	17883.2	31590.1	12457.2	475.0	544.2
1972	11173.0	2034.0	3641.1	646.6	104.2	2614.0	1989.2	2012.3	2026.2	16221.3	22058.7	12292.7	290.8	557.1
1973	13856.0	4046.4	3891.0	799.1	89.3	3006.8	3367.6	1838.7	4005.6	19616.4	26641.0	12375.1	331.4	724.5
1974	13719.2	3406.8	5470.9	870.1	153.4	2721.7	3061.1	3554.9	3253.6	24092.0	32061.2	16467.7	603.7	1167.9
1975	12682.4	2795.7	3708.1	567.1	77.0	2579.4	1414.9	1202.7	3197.5	16954.6	30715.1	12254.6	383.0	1145.0
1976	16030.8	4365.2	6961.5	1263.1	98.9	3854.3	2981.3	3034.8	3758.0	32369.6	42593.0	29906.2	470.2	1700.3
1977	12359.1	2490.0	3463.8	1054.6	230.9	2379.4	2268.5	1859.8	2398.5	21372.3	32225.7	16478.5	365.0	1343.1
1978	14508.4	3693.8	4492.2	1573.4	343.4	3386.9	2762.0	1714.7	3605.9	26570.1	38458.8	25948.5	342.8	1332.8
1979	9883.6	1744.5	2786.2	974.8	424.4	2040.7	1837.2	1209.4	2831.8	18247.1	25022.9	16384.5	323.6	956.4
1980	8700.8	3650.4	3384.5	984.4	374.9	2683.0	4028.8	2938.0	2401.2	26811.0	24064.2	22232.0	293.1	853.9
1981	10281.8	3617.4	3760.4	988.4	226.3	2878.2	1566.3	1340.6	2258.3	21342.5	34255.0	23057.8	387.6	1403.3
1982	8581.4	3207.2	4089.2	1095.8	174.9	2114.3	2203.4	1507.6	2847.3	19185.2	20638.5	14495.6	418.8	696.4
1983	9530.8	3835.1	4061.8	1012.6	206.1	3094.4	1961.4	1474.2	3059.8	18769.1	25781.8	16225.9	444.2	667.8
1984	8322.7	3983.9	4372.6	1245.8	311.2	2562.2	3930.1	1903.9	3008.3	25772.9	24236.0	19674.1	434.2	767.6
1985	8039.5	3698.1	4006.7	1627.4	226.6	2131.0	3195.5	1929.2	2569.8	21801.4	21538.4	19195.8	400.9	774.9
1986	10250.9	3297.8	4561.0	1383.4	273.1	2438.0	2830.2	1916.8	3093.0	21390.8	26231.0	26414.1	288.2	860.0
1987	10276.7	2143.7	3574.7	902.3	249.0	1342.4	2309.7	1762.3	3141.3	17039.2	21696.7	19765.5	320.0	720.9
1988	10629.1	1834.0	3634.5	907.0	304.9	2246.9	2565.1	1353.1	3604.3	20672.2	22409.1	20620.1	430.2	667.0
1989	11323.7	3581.6	3850.8	1093.2	227.3	2273.7	2969.5	2048.1	3839.2	23470.4	26848.5	24273.0	455.8	858.8
1990	11273.6	3038.8	3240.5	1209.1	257.0	2179.0	2665.7	1860.0	3870.2	19010.9	26597.0	22006.0	466.4	751.5
1991	9659.4	2870.7	3354.3	1444.2	334.6	1842.6	2842.2	1650.8	3270.9	18481.8	23052.3	19052.4	407.9	636.2
1992	6802.0	904.8	1282.0	643.1	72.2	1079.6	1137.6	982.6	1498.0	8645.1	14729.8	8556.0	137.8	535.0
1993	6760.4	758.7	957.1	301.1	29.0	696.7	940.2	683.3	1566.0	5579.1	13655.2	7788.2	90.9	473.5
1994	7954.2	1606.0	2595.1	938.4	248.3	923.4	1548.4	1218.0	2274.2	11407.0	16583.7	11672.5	310.2	621.2
1995	5534.6	2313.5	2401.2	1005.2	299.0	887.4	1851.5	1377.8	2250.9	11845.9	13366.3	10812.8	217.6	465.5
1996	6691.4	1631.0	1768.9	890.7	288.1	789.8	1069.2	722.0	1728.7	9398.2	14963.2	9904.1	193.9	511.4
1997	7088.6	2094.0	1635.3	861.2	253.1	861.7	1671.0	1277.7	2284.2	8077.6	14507.5	10032.8	233.4	379.8
1998	5613.1	1896.8	1602.0	730.9	203.4	669.0	1489.6	1064.0	2006.7	7293.5	12231.0	8176.9	224.4	387.9
1999	5534.6	1302.1	1399.5	597.7	240.4	645.3	1256.8	1153.6	1570.1	6365.0	10594.6	6849.4	227.1	384.4
2000	7308.7	2617.3	2051.1	926.8	314.6	833.6	1568.2	952.7	2864.0	10043.8	14524.0	11168.6	314.2	562.6

Appendix H Recharge from Ground Water Irrigation Nebraska

Year	Adams	Buffalo	Chase	Clay	Dawson	Deuel	Dundy	Franklin	Frontier	Furnas	Gosper	Harlan	Hayes	Hitchcock	Kearney	Keith	Lincoln	Nuckolls	Perkins	Phelps	RedWillow	Webster
1918	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	0.0	0.0	0.0	0.0
1919	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	0.0	0.0	0.0	0.0
1920	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	0.0	0.0	0.0	0.0
1921	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	0.0	0.0	0.0	0.0
1922	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	0.0	0.0	0.0	0.0
1923	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	0.0	0.0	0.0	0.0
1924	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	0.0	0.0	0.0	0.0
1925	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	0.0	0.0	0.0	0.0
1926	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	0.0	0.0	0.0	0.0
1927	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	0.0	0.0	0.0	0.0
1928	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	0.0	0.0	0.0	0.0
1929	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	0.0	0.0	0.0	0.0
1930	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	0.0	0.0	0.0	0.0
1931	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	0.0	0.0	0.0	0.0
1932	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	0.0	0.0	0.0	0.0
1933	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	0.0	0.0	0.0	0.0
1934	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	0.0	0.0	0.0	0.0
1935	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	0.0	0.0	0.0	0.0
1936	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	0.0	0.0	0.0	0.0
1937	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	0.0	0.0	0.0	0.0
1938	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	0.0	0.0	0.0	0.0
1939	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	0.0	0.0	0.0	0.0
1940	40.1	156.3	346.3	0.0	1630.5	403.6	182.6	223.8	83.7	250.5	451.7	120.3	131.1	686.0	1530.3	969.1	1705.9	32.4	94.1	1750.7	309.3	125.0
1941	24.7	95.5	340.7	19.8	1394.8	322.8	147.5	134.7	58.7	185.5	396.9	134.4	86.9	513.5	1168.7	810.2	1632.1	34.2	76.0	1319.1	289.6	65.9
1942	20.3	78.9	281.8	16.3	1458.8	255.6	130.2	145.3	64.4	126.0	392.1	132.7	106.0	704.0	1060.6	1167.2	1850.7	24.6	80.5	1223.2	320.4	47.4
1943	26.8	104.2	530.0	21.5	2008.0	410.2	261.2	172.6	74.9	224.4	561.5	163.5	119.9	883.6	1468.5	1270.3	2359.4	35.6	134.7	1741.6	453.3	68.5
1944	26.6	132.2	571.0	21.3	1360.6	327.2	242.1	202.6	41.4	153.6	553.8	202.5	88.6	536.1	1733.3	1161.1	1343.5	33.0	107.0	1772.7	324.5	63.5
1945	26.6	186.3	718.0	21.3	2852.5	801.0	430.8	234.1	59.0	276.9	578.9	244.6	121.9	752.9	2049.0	2216.3	2072.0	27.5	133.6	1795.2	605.5	53.0
1946	22.5	168.5	502.7	18.0	2909.3	613.0	336.6	232.3	80.8	341.7	490.0	326.4	160.2	773.0	2364.1	3322.5	2123.6	30.1	87.0	1635.6	595.8	67.6
1947	136.4	0.9	717.3	0.1	30.0	900.4	468.3	347.4	97.9	416.4	14.4	666.6	174.2	1858.7	49.9	3342.0	3151.6	175.1	120.3	48.6	844.5	182.1
1948	138.4	0.6	795.7	0.1	21.9	912.5	507.3	305.2	125.5	422.4	11.6	602.8	119.4	1509.8	35.2	3731.7	197.8	143.7	243.4	40.9	744.8	160.4
1949	257.2	1.6	901.8	0.4	30.5	854.3	569.5	404.8	181.5	484.9	16.2	606.3	272.5	2192.6	76.8	4011.6	474.1	320.1	264.3	43.0	726.3	181.2
1950	250.2	2.4	723.7	0.6	20.6	330.3	28.3	62.8	171.5	34.1	8.3	92.5	85.2	324.8	77.0	3452.1	655.6	21.1	110.3	14.2	148.1	46.7
1951	106.7	1.1	725.2	0.3	25.8	271.1	39.9	50.2	27.2	15.2	3.7	44.5	40.0	108.9	35.4	2799.7	708.1	9.0	102.2	7.2	94.3	38.7
1952	374.4	4.3	1415.4	1.2	75.8	708.0	139.7	155.9	32.0	49.8	14.4	96.0	170.7	383.7	164.1	4984.0	1959.0	38.9	511.1	18.2	293.5	135.3
1953	578.7	19.5	1533.2	5.7	82.8	627.5	210.3	257.1	40.3	70.3	20.1	201.2	247.1	572.6	771.9	4115.2	3193.2	56.7	686.4	232.2	519.0	288.4
1954	789.5	32.3	2268.8	11.8	248.9	801.4	614.7	380.7	280.6	238.9	145.4	396.7	429.9	1164.3	1104.1	5518.5	7104.6	57.6	1115.7	380.9	1039.2	249.1
1955	681.3	37.2	6403.7	207.2	909.6	867.8	2171.2	140.5	575.7	776.3	664.2	1632.3	467.6	2337.4	319.7	2474.6	1201.3	1124.6	441.6	978.6	453.7	3144.9
1956	1125.4	37.6	7462.1	145.0	1195.3	867.6	2752.0	1794.9	934.5	1205.9	947.7	2342.0	640.2	2852.9	3443.3	2987.0	1866.5	1021.1	666.0	7436.3	694.1	3014.1
1957	1107.7	160.3	4312.8	213.0	2982.1	547.2	2548.1	2392.6	936.2	2248.5	1419.9	2832.0	577.5	2228.0	7292.6	3586.3	3044.3	1430.2	751.6	7534.1	1144.2	1867.8
1958	717.6	117.9	3684.4	121.0	1801.9	701.8	2109.3	1593.5	1009.5	1574.9	952.0	1829.9	551.5	2219.4	5164.0	4264.4	2031.7	545.7	596.6	5260.3	1068.2	825.4
1959	2329.7	338.5	7018.3	407.1	4203.1	1442.9	4442.1	3197.2	2282.7	4012.8	1959.4	4418.7	1090.6	4586.3	10479.7	8731.4	5045.0	1707.6	1283.4	10350.6	2705.0	2724.3
1960	2233.9	369.4	7456.4	402.2	4540.1	1569.2	4632.4	3126.1	2093.6	2922.6	2015.5	3252.6	1199.3	4378.7	10113.7	9426.5	5639.4	1587.0	1560.7	8737.4	2319.9	2605.1
1961	2852.0	293.1	2878.5	525.1	3766.7	763.8	3939.3	3165.6	1324.7	2619.8	1662.7	3033.0	1080.7	3075.7	10396.6	4897.3	4089.0	2101.3	775.6	9255.9	1576.0	3430.1
1962	1444.4	141.0	2471.1	255.0	1889.9	544.2	2181.4	2118.0	719.5	1266.7	782.3	1518.3	752.8	1784.7	6960.0	3554.4	2178.4	1134.5	556.0	6234.1	871.0	1662.7
1963	2844.7	487.6	4803.8	484.9	6328.9	1007.2	5025.9	4337.5	2017.1	3454.1	2665.2	4166.4	2119.2	4349.4	14488.1	6795.8	6573.4	2184.8	1112.6	13337.6	2055.4	3333.4
1964	4010.9	399.4	6408.8	695.4	5256.3	1052.6	5056.4	3846.0	2756.9	3763.3	2278.0	4268.1	2390.1	5517.4	12965.4	7252.4	5841.9	3367.8	1115.8	12231.8	2709.5	5056.2
1965	3025.9	264.6	4543.9	546.6	3455.5	798.2	4229.2	3849.3	2758.0	2467.3	1625.2	2869.1	2014.1	4953.3	12932.5	5733.3	4067.7	2393.0	987.8	12184.2	2483.8	3639.9
1966	4691.0	409.7	6368.5	747.0	5448.5	878.8	4161.0	5733.3	3398.0	2612.4	2484.3	3159.5	1971.2	5068.3	19616.5	6167.1	5912.1	3800.5	1266.9	17835.4	2955.1	5283.8
1967	5516.0	344.0	8467.3	841.1	4655.0	1721.6	5159.3	5365.8	4825.5	3988.0	2578.0	5079.7	2178.6	6642.5	17983.0	11465.5	6108.6	4255.6	3119.6	17825.4	4089.2	6031.3
1968	5336.2	362.1	17276.4	931.5	5338.4	3007.7	9105.7	4948.5	7635.6	6775.9	3508.1	9413.2	3688.9	9090.2	16477.0	19973.4	8201.6	4015.5	6959.6	18716.2	6045.7	6294.9
1969	3892.2	369.7	21097.2	709.3	5628.7	2171.3	12824.0	4860.5	7158.8	5422.6	3560.6	7664.0	5385.0	8778.3	15949.0	16067.3	7764.0	2562.6	6594.6	17274.3	5464.9	4508.1
1970	6870.0	525.6	27823.1	1268.6	8105.9	3061.6	15924.0	9061.2	11466.5	8479.4	5578.1	12349.3	6921.4	11148.9	28919.7	21879.9	11022.4	4274.7	9795.1	32298.3	8830.3	7847.4
1971	7653.3	548.5	25650.2	1451.8	8601.1	1754.3	15510.7	9639.4	11697.2	8574.0	6539.2	12876.8	7581.4	10247.6	30505.3	13187.7	10889.5	4767.6	6848.2	31542.2	9125.6	8945.1
1972	5316.3	498.7	23915.0	922.6	8143.5	1601.9	10886.8	8423.7	14087.7	8519.6	7481.5	13392.7	6125.0	9426.2	26225.5	12339.1	11380.2	2784.6	6906.5	28416.7	10463.6	5319.0
1973	6252.2	473.1	26904.4	1085.8	7318.8	1789.2	10204.0	9788.2	13484.9	8140.4	7515.1	14018.0	6195.0	8536.8	30698.3	13559.1	12629.0	3100.7	9378.7	34113.2	9754.5	6336.6
1974	8558.6	711.9	39271.3	1504.6	11420.1	2158.1	15175.6	11927.4	19309.5	10244.9	11269.4	18294.9	7680.7	10587.0	36476.8	17433.8	19929.2	4316.6	15822.0	42662.2	13855.2	9243.3
1975	7679.3	620.5	42780.0	1275.0	10225.0	1982.8	20177.8	12370.9	20495.2	10294.0	11455.7	18152.0	8562.3	11142.5	34748.4	17311.0	20837.7	3700.4	17339.6	41537.1	14592.4	8495.7
1976	10316.9	759.9	56251.7	1551.3	12187.1	2030.6	27071.9	16767.3	22747.3	14100.9	15323.6	24695.1	10810.5	12639.9	44749.4	19403.0	26380.3	4996.3	20887.3	54793.4	16034.0	11940.8
1977	5497.7	570.9	47586.3	681.5	9067.8	1471.2	25737.7	12158.2	16962.2	11330.5	11491.4	18734.1	9384.0	10198.9	31084.3	14675.3	20818.2	2227.9	16929.0	38404.5	13188.7	5967.5
1978	7694.8	641.9	66321.6	949.6	10737.2	2440.0	31857.2	16386.7	23003.7	12495.1	13371.9	20748.6	11749.0	13237.7	41158.9	24600.1	30168.0	3435.6	28992.7	49417.7	17824.9	8493.9
1979	5701.3	476.8	48279.8	762.2	7980.8	1711.0	24765.0	11036.5	11877.7	7628.2	9062.8	12332.1	9319.9	9788.9	26368.1	18203.3	22733.8	2856.8	22907.8	31252.9	9778.9	6773.8
1980	7880.9	767.8	50996.5	969.1	13104.8	1766.5	24542.7	16831.7	19572.3	12494.2	14741.0	19713.8	9298.4	11883.6	39928.1	18391.6	30706.5	3590.1	23943.1	46190.7	15344.2	8888.3
1981	5260.2	452.9	44173.9	602.4	7294.3	1379.0	19479.8	12516.1	11380.2	6706.9	8211.4	10800.0	7376.4	8543.1	28767.4	14989.2	21474.6	2218.0	19702.3	32246.4	9046.1	5624.5
1982	4670.2	530.2	34037.3	578.4	8934.6	1149.5	16679.6	10405.9	13366.0	7983.2	9901.6	12876.0	6446.0	8017.9	23554.0	12630.6	21859.6	2074.6	16801.3	28886.1	10329.5	5206.2
1983	6366.7	453.8	40020.9	818.2	8139.0	1441.6	21909.6	12779.0	13212.2	7626.6	9055.4	12196.4	7845.7	9372.6	29760.5	16106.8	23553.9	2918.1	21170.0	34564.8	10837.6	7407.9
1984	6976.9	606.9	52233.6	840.1	9927.4	1698.8	26783.6	15160.2	16088.1	10533.2	11922.4	16706.4	9515.7	10835.6	34774.7	18856.8	28987.9	3009.5	25547.7	40541.2	12861.3	7738.1
1985	5835.0	485.0	52492.9	726.6	8113.3	1743.3	26998.2	11709.8	15736.0	7851.8	9457.4	12503.8	9864.2	11292.9	26836.8	19440.8	27849.8	2630.3	26319.0	31101.4	12771.6	6739.5
1986	5635.8	592.2	43073.0	628.6	10165.2	1616.5	25245.0	12986.2	16325.8	9603.7	11545.7	15533.7	9265.3	10880.1	29861.0	18548.3	28739.7	2182.2	24901.7	35267.8	13079.3	5840.9
1987	6053.2	511.4	39466.6	650.4	8802.8	1539.4	22957.5	13978.3	14020.0	6747.1	9126.6	10966.6	8460.9	9733.2	33051.3	16981.1	25312.4	2260.4	22576.9	37212.3	11198.8	6005.9
1988	9762.4	670.3	46033.1	1145.2	11311.1	1659.4	24732.1	19931.5	14620.6	9289.2	11962.1	14861.1	9037.2	10033.2	47275.1	18423.2	28736.8	4016.1	24307.0	53168.9	11651.4	10621.1
1989	6841.8	624.8	46058.0	780.5	9624.3	1557.7	23356.5	15477.6	17243.2	10923.8	11653.5	17429.7	8544.2	10259.0	36165.4	17541.9	26816.4	2686.3	23047.2	42069.0	13785.5	7094.7
1990	6269.8	757.1	53074.4	652.2	12312.6	2038.6	30638.1	16063.1	17462.0	10469.5	13045.7	17018.8	11100.3	12041.6	37700.5	22939.7	33503.7	2257.5	30154.6	43057.6	14132.7	6012.8
1991	9381.2	849.2	47753.1	1093.1	13438.0	2059.8	25058.9	21679.8	18670.2	12172.8	14494.5	19557.1	9259.0	10726.2	49570.8	23282.8	34823.9	4012.9	30424.1	57830.5	15327.3	9878.0
1992	4066.4	495.8	38422.9	413.4	8368.2	1268.9	16392.0	11135.3	9425.1	6710.1	8444.9	11042.4	5827.5	6373.7	25096.7	14384.8	20770.2	1578.6	19065.3	30274.4	8014.2	3955.4
1993	1418.8	142.9	31204.2	136.8	2406.7	877.8	11522.9	4037.5	982.0	1479.9	2207.6	2509.2	3850.9	3221.6	9121.5	9988.7	9566.7	529.4	13268.3	10339.9	1405.7	1324.5
1994	5288.9	500.3	52487.3	592.7	8078.2	1914.4	25373.5	12537.1	15393.1	7654.6	8831.9	12773.5	9062.2	10494.9	28316.1	22079.9	27333.9	2352.0	28790.0	32848.0	13903.1	5721.4
1995	8190.5	719.7	42948.3	904.5	11558.6	1791.6	23791.6	19464.9	16146.1	9585.8	11942.8	16101.7	8535.2	10146.4	43813.6	21033.9	29953.8	3650.5	26839.2	49235.5	14407.5	8891.5
1996	4886.4	461.9	34656.5	539.2	7626.3	1115.9	17655.4	11467.2	8864.8	3809.7	6669.7	6475.2	6170.9	6841.3	25788.9	13171.9	19146.6	2294.8	16842.8	27523.9	8166.4	5394.5
1997	6990.0	746.9	48895.3	713.5	12110.9	1613.3	28316.2	18212.4	14514.1	9303.5	12288.7	15970.4	10585.0	10778.6	39577.0	19200.7	29632.0	3117.1	24610.3	43665.0	13487.7	7363.4
1998	5060.0	589.2	48414.6	501.4	9735.4	1672.6	30073.6	13447.3	14523.0	8246.7	10360.2	14036.6	11652.5	11483.1	29080.5	19597.3	27867.5	2215.0	24985.5	32176.6	14012.3	5400.9
1999	5306.1	488.1	36818.0	589.5	7440.9	1324.0	20424.0	11915.5	2896.4	5163.9	7336.8	8965.7	7837.4	5891.8	25689.5	15940.4	19486.9	2713.8	19975.6	27139.5	3455.4	6418.6
2000	8375.7	919.5	59598.8	860.9	14248.9	2560.8	36507.8	21649.7	16792.8	8645.5	13612.3	15126.8	15118.7	13790.2	45937.5	30035.9	40542.3	3958.3	36907.5	47210.3	16220.5	9374.3

Appendix I Recharge from Canals and Laterals Colorado

Year	Cheyenne	KitCarson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma
1918	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1919	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1920	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1921	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1922	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1923	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1924	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1925	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1926	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1927	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1928	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1929	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1930	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1931	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1932	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1933	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1934	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1935	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1936	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1938	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1939	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1940	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1941	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1942	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1943	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1944	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1945	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1946	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1947	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1948	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1949	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1950	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1951	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1952	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1953	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1954	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1955	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1956	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1957	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1958	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1959	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1961	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1973	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1975	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1976	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1983	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix I Recharge from Canals and Laterals Kansas

Year	Cheyenne	Decatur	Gove	Graham	Jewell	Logan	Norton	Phillips	Rawlins	Sheridan	Sherman	Thomas	Trego	Wallace
1918	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
1919	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
1920	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
1921	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
1922	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
1923	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
1924	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
1925	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
1926	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
1927	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
1928	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
1929	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
1930	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
1931	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
1932	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
1933	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
1934	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
1935	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
1936	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
1937	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
1938	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
1939	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
1940	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
1941	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
1942	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
1943	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
1944	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
1945	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
1946	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
1947	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
1948	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
1949	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
1950	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
1951	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
1952	0.0	0.0	0.0	0.0	183.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1953	0.0	0.0	0.0	0.0	268.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1954	0.0	0.0	0.0	0.0	1047.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1955	0.0	0.0	0.0	0.0	2500.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1956	0.0	0.0	0.0	0.0	3332.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1957	0.0	0.0	0.0	0.0	2083.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1958	0.0	0.0	0.0	0.0	2393.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1959	0.0	0.0	0.0	0.0	2524.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1960	0.0	0.0	0.0	0.0	2274.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1961	0.0	0.0	0.0	0.0	2416.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	0.0	0.0	0.0	0.0	2555.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.0	0.0	0.0	0.0	3386.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	0.0	0.0	0.0	0.0	1999.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.0	0.0	0.0	0.0	2842.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.0	0.0	0.0	0.0	3273.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.0	0.0	0.0	0.0	2739.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1968	0.0	0.0	0.0	0.0	2851.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.0	0.0	0.0	0.0	3218.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.0	0.0	0.0	0.0	2690.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.0	0.0	0.0	0.0	2618.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1972	0.0	0.0	0.0	0.0	2197.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1973	0.0	0.0	0.0	0.0	2524.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1974	0.0	0.0	0.0	0.0	2395.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1975	0.0	0.0	0.0	0.0	2668.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1976	0.0	0.0	0.0	0.0	3254.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	0.0	0.0	0.0	0.0	2145.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1978	0.0	0.0	0.0	0.0	3091.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1979	0.0	0.0	0.0	0.0	2553.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.0	0.0	0.0	0.0	2799.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	0.0	2528.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	0.0	0.0	0.0	0.0	3919.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1983	0.0	0.0	0.0	0.0	2711.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.0	0.0	0.0	0.0	3342.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.0	0.0	0.0	0.0	3204.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.0	0.0	0.0	0.0	3671.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.0	0.0	0.0	0.0	2933.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	3915.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	2810.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	2959.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	2653.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	1781.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	2976.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	4710.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	0.0	4479.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	0.0	0.0	0.0	0.0	2796.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	0.0	0.0	0.0	0.0	3488.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.0	3382.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	3970.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	3520.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Year	Adams	Buffalo	Chase	Clay	Dawson	Deuel	Dundy	Franklin	Frontier	Furnas	Gosper	Harlan	Hayes	Hitchcock	Kearney	Keith	Lincoln	Nuckolls	Perkins	Phelps	RedWillow	Webster
1918	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	0.0	0.0	0.0	0.0
1919	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	0.0	0.0	0.0	0.0
1920	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	0.0	0.0	0.0	0.0
1921	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	0.0	0.0	0.0	0.0
1922	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	0.0	0.0	0.0	0.0
1923	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	0.0	0.0	0.0	0.0
1924	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	0.0	0.0	0.0	0.0
1925	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	0.0	0.0	0.0	0.0
1926	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	0.0	0.0	0.0	0.0
1927	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	0.0	0.0	0.0	0.0
1928	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	0.0	0.0	0.0	0.0
1929	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	0.0	0.0	0.0	0.0
1930	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	0.0	0.0	0.0	0.0
1931	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	0.0	0.0	0.0	0.0
1932	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	0.0	0.0	0.0	0.0
1933	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	0.0	0.0	0.0	0.0
1934	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	0.0	0.0	0.0	0.0
1935	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	0.0	0.0	0.0	0.0
1936	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	0.0	0.0	0.0	0.0
1937	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	0.0	0.0	0.0	0.0
1938	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	0.0	0.0	0.0	0.0
1939	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	0.0	0.0	0.0	0.0
1940	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	1049.7	158913.6	0.0	0.0	0.0	0.0	0.0
1941	0.0	0.0	0.0	0.0	95167.9	0.0	0.0	0.0	0.0	0.0	121694.2	0.0	0.0	0.0	0.0	1083.8	259759.9	0.0	0.0	16203.8	0.0	0.0
1942	0.0	0.0	0.0	0.0	94599.1	0.0	0.0	0.0	0.0	0.0	112564.3	0.0	0.0	0.0	31656.8	1006.0	255654.7	0.0	0.0	69429.0	0.0	0.0
1943	0.0	0.0	0.0	0.0	80078.6	0.0	0.0	0.0	0.0	0.0	124597.3	0.0	0.0	0.0	31796.9	1446.9	267053.7	0.0	0.0	71701.1	0.0	0.0
1944	0.0	0.0	0.0	0.0	80350.9	0.0	0.0	0.0	0.0	0.0	116319.3	0.0	0.0	0.0	28761.2	1757.0	284812.6	0.0	0.0	67186.5	0.0	0.0
1945	0.0	0.0	0.0	0.0	80790.8	0.0	0.0	0.0	0.0	0.0	119514.6	0.0	0.0	0.0	24719.4	4767.9	596620.9	0.0	0.0	62236.4	0.0	0.0
1946	0.0	0.0	0.0	0.0	84357.0	0.0	0.0	0.0	0.0	0.0	144462.7	0.0	0.0	0.0	32545.5	2268.4	304883.7	0.0	0.0	75841.9	0.0	0.0
1947	0.0	0.0	0.0	0.0	81334.0	0.0	0.0	0.0	0.0	0.0	137374.7	0.0	0.0	0.0	31906.0	2442.9	338954.1	0.0	0.0	74025.8	0.0	0.0
1948	0.0	0.0	0.0	0.0	84436.5	0.0	0.0	0.0	0.0	0.0	118404.9	0.0	0.0	0.0	40313.8	1783.5	280415.4	0.0	0.0	86812.2	0.0	0.0
1949	0.0	0.0	0.0	0.0	75908.5	0.0	0.0	0.0	0.0	0.0	156340.9	0.0	0.0	0.0	31169.7	2016.7	297489.8	0.0	0.0	72829.2	0.0	0.0
1950	0.0	0.0	0.0	0.0	75503.6	0.0	0.0	0.0	0.0	0.0	119208.6	0.0	0.0	0.0	37339.9	2437.4	350786.7	0.0	0.0	82954.9	0.0	0.0
1951	0.0	0.0	0.0	0.0	73802.1	0.0	0.0	0.0	0.0	7298.0	146817.4	0.0	0.0	0.0	36441.6	1996.6	280399.2	0.0	0.0	78945.2	0.0	0.0
1952	0.0	0.0	0.0	0.0	45475.7	0.0	0.0	0.0	0.0	5448.0	114634.3	0.0	0.0	1271.2	36766.8	4979.2	654856.2	4390.1	0.0	83979.0	1747.9	1137.4
1953	0.0	0.0	0.0	0.0	56109.2	0.0	0.0	1879.0	0.0	13397.8	120911.3	0.0	0.0	706.1	39238.3	1895.6	305614.0	6410.8	0.0	94397.9	971.0	1660.9
1954	0.0	0.0	0.0	0.0	58019.6	0.0	0.0	3689.2	0.0	11714.2	104437.9	266.8	0.0	1155.8	41613.3	1993.0	315926.9	4679.2	0.0	93741.8	2074.1	3557.0
1955	0.0	0.0	0.0	0.0	43446.0	0.0	0.0	5148.3	0.0	12719.2	116377.3	639.0	0.0	1149.9	46278.6	2623.0	375465.6	6476.0	0.0	98610.0	3543.8	4759.7
1956	0.0	0.0	0.0	0.0	44117.7	0.0	0.0	6474.0	0.0	14455.0	100796.8	617.0	0.0	1015.6	49896.9	2126.4	320125.3	7363.6	0.0	106058.0	2565.6	6556.4
1957	0.0	0.0	0.0	0.0	55005.9	0.0	0.0	3265.0	0.0	15670.7	120854.3	310.7	0.0	1702.7	41267.2	1443.1	211698.4	5043.8	0.0	94217.6	4354.6	3872.3
1958	0.0	0.0	0.0	0.0	70620.7	0.0	0.0	5053.7	0.0	7194.1	110352.0	441.2	657.1	19499.9	40560.5	1161.0	170977.2	6534.1	0.0	99445.8	5618.9	5631.8
1959	0.0	0.0	0.0	0.0	60138.4	0.0	0.0	6910.8	0.0	7292.6	101310.9	677.0	521.4	18626.7	48223.7	1396.0	192109.2	7855.6	0.0	113308.7	9159.3	6771.2
1960	0.0	0.0	0.0	0.0	62137.2	0.0	0.0	6786.5	0.0	7592.9	106691.8	648.2	504.3	16805.6	40492.0	1556.1	215737.6	6983.6	0.0	96991.7	7515.3	6226.9
1961	0.0	0.0	0.0	0.0	85239.6	0.0	0.0	8418.7	0.0	8875.5	123268.4	866.1	653.9	21126.1	48221.4	1222.6	186028.3	7467.2	0.0	111541.8	9830.4	7352.5
1962	0.0	0.0	0.0	0.0	81991.3	0.0	0.0	7546.6	0.0	8758.3	110161.1	850.8	533.8	18393.8	38163.1	1011.0	160103.9	7343.9	0.0	93660.3	10870.2	7018.4
1963	0.0	0.0	0.0	0.0	59205.5	0.0	0.0	8113.0	0.0	9904.5	81550.3	804.2	761.5	25797.0	50199.8	1005.0	154014.5	9225.3	0.0	111364.2	15420.1	8039.8
1964	0.0	0.0	0.0	0.0	59116.6	0.0	0.0	8460.7	0.0	10491.5	93259.0	876.5	498.9	19494.5	42342.4	1239.3	215271.9	6923.5	0.0	102618.6	17071.2	7041.4
1965	0.0	0.0	0.0	0.0	66361.2	0.0	0.0	7564.4	0.0	8900.8	90716.7	771.9	443.9	18195.3	34946.8	1151.6	192861.4	7299.2	0.0	88770.2	16145.9	7009.8
1966	0.0	0.0	0.0	0.0	73556.4	0.0	0.0	9429.1	0.0	11343.5	107002.9	904.2	184.3	13158.2	43394.7	1022.8	185766.0	8443.2	0.0	104705.2	20049.2	8632.0
1967	0.0	0.0	0.0	0.0	66268.0	0.0	0.0	7613.8	0.0	9992.6	85947.0	765.2	523.7	20365.5	38483.1	1371.1	248838.4	6457.0	0.0	90941.3	17733.0	6709.8
1968	0.0	0.0	0.0	0.0	65359.4	0.0	0.0	6780.6	0.0	10735.8	105395.6	679.8	415.2	18259.1	44030.2	1181.0	242074.6	6614.1	0.0	104445.5	19605.9	6499.8
1969	0.0	0.0	0.0	0.0	66303.4	0.0	0.0	7139.0	0.0	9047.4	116134.5	677.6	453.9	18518.2	37612.3	1091.1	212312.4	7391.5	0.0	91439.5	18094.2	7186.4
1970	0.0	0.0	0.0	0.0	78060.1	0.0	0.0	9833.2	0.0	11805.5	114296.4	965.1	426.5	19219.4	42613.5	1644.4	280719.4	7126.2	0.0	101586.4	21095.6	7933.0
1971	0.0	0.0	0.0	0.0	79214.9	0.0	0.0	11308.2	0.0	11689.6	121020.2	1062.7	491.5	21071.0	43957.5	1278.1	207454.1	7522.4	0.0	103069.9	21071.8	8684.4
1972	0.0	0.0	0.0	0.0	73473.4	0.0	0.0	9613.5	0.0	12147.3	100429.7	951.5	469.3	20795.6	41855.3	1233.8	246999.7	6880.5	0.0	102540.4	21869.8	7848.9
1973	0.0	0.0	0.0	0.0	73825.4	0.0	0.0	10158.5	0.0	10012.7	108138.1	967.6	483.4	19189.7	39655.4	1143.0	250188.1	7519.3	0.0	96607.0	17911.2	8403.4
1974	0.0	0.0	0.0	0.0	68368.9	0.0	0.0	8893.8	0.0	11308.5	91210.0	898.2	339.3	15958.3	40540.9	1833.0	335601.8	6222.2	0.0	95684.1	18188.7	7256.1
1975	0.0	0.0	0.0	0.0	64181.1	0.0	0.0	10073.7	0.0	9236.6	87394.7	920.6	408.9	17184.3	37175.6	1790.2	357213.6	7186.3	0.0	90359.8	17563.3	7946.8
1976	0.0	0.0	0.0	0.0	82974.5	0.0	0.0	9813.5	0.0	12665.2	103237.1	1013.1	204.4	11888.7	41123.7	910.9	235113.3	8487.7	0.0	91971.2	17380.7	8458.2
1977	0.0	0.0	0.0	0.0	82686.8	0.0	0.0	7598.4	0.0	11149.1	129432.9	783.4	217.2	12030.9	35643.0	1189.3	266908.7	5588.5	0.0	80677.1	16710.7	6102.4
1978	0.0	0.0	0.0	0.0	77548.9	0.0	0.0	9512.3	0.0	11109.9	129768.0	986.5	242.9	12413.5	37593.9	1862.3	303579.5	8323.5	0.0	83347.9	15595.9	8373.1
1979	0.0	0.0	0.0	0.0	77189.4	0.0	0.0	6106.0	0.0	10145.5	134774.5	641.6	191.6	10949.4	32660.6	1277.9	277465.7	6588.2	0.0	74903.6	15360.5	5868.7
1980	0.0	0.0	0.0	0.0	86525.2	0.0	0.0	8397.5	0.0	10128.2	146746.8	871.0	181.0	11306.0	39740.3	942.9	206446.2	7652.2	0.0	87263.5	15710.8	7338.8
1981	0.0	0.0	0.0	0.0	73800.1	0.0	0.0	5889.7	0.0	9788.0	135510.4	597.8	195.0	12854.7	33395.7	916.4	206515.5	6283.3	0.0	78686.5	18091.3	5858.5
1982	0.0	0.0	0.0	0.0	68226.5	0.0	0.0	7916.7	0.0	9759.2	132887.7	797.0	158.6	11204.5	28477.3	939.2	238455.1	8466.1	0.0	69124.2	17702.5	8026.9
1983	0.0	0.0	0.0	0.0	70535.6	0.0	0.0	8907.5	0.0	9621.3	133665.5	902.6	161.5	11088.1	22844.5	1247.9	256570.6	8060.8	0.0	57241.3	16519.5	7826.8
1984	0.0	0.0	0.0	0.0	103070.4	0.0	0.0	10572.3	0.0	7266.0	160963.2	1039.0	186.7	11773.2	23110.4	1174.5	247462.4	9301.7	0.0	54867.0	16516.0	9135.7
1985	0.0	0.0	0.0	0.0	74325.8	0.0	0.0	10396.5	0.0	10236.9	124521.0	1079.8	199.3	11581.6	25156.4	1467.7	286600.4	9143.7	0.0	57559.4	16055.1	9126.7
1986	0.0	0.0	0.0	0.0	89116.5	0.0	0.0	11278.7	0.0	9480.8	143058.8	1142.1	229.7	12080.7	27882.5	1176.1	252873.7	10130.2	0.0	63275.6	14826.6	9683.4
1987	0.0	0.0	0.0	0.0	83410.7	0.0	0.0	9542.0	0.0	10003.0	149735.0	903.3	170.9	10102.4	22250.4	1024.2	238041.7	8145.8	0.0	51983.2	14708.7	8275.0
1988	0.0	0.0	0.0	0.0	65897.6	0.0	0.0	10644.1	0.0	10554.3	123891.9	985.6	205.3	10970.5	29500.8	1258.3	294842.3	10807.4	0.0	66927.9	14385.8	9752.4
1989	0.0	0.0	0.0	0.0	60727.3	0.0	0.0	9305.1	0.0	9163.0	116751.0	906.6	152.5	9430.2	25711.2	1150.4	276508.2	8607.5	0.0	61560.8	13405.4	8294.7
1990	0.0	0.0	0.0	0.0	66990.7	0.0	0.0	7758.8	0.0	8486.9	123045.6	788.7	190.3	10104.8	31451.9	1144.6	234172.3	7981.5	0.0	68654.4	12414.0	7261.1
1991	0.0	0.0	0.0	0.0	67303.2	0.0	0.0	7813.1	0.0	7124.7	137709.4	737.1	199.7	9948.1	32700.5	1144.1	277317.2	7534.6	0.0	71407.2	11401.6	6988.9
1992	0.0	0.0	0.0	0.0	62999.0	0.0	0.0	5680.4	0.0	8156.6	111046.3	525.4	202.7	9662.1	31163.0	1297.5	236893.4	5409.1	0.0	67095.7	11384.6	5140.0
1993	0.0	0.0	0.0	0.0	65142.6	0.0	0.0	3835.4	0.0	8536.2	98520.5	350.7	172.6	10660.2	16242.9	1216.7	223599.3	8653.1	0.0	40159.9	14180.0	5415.1
1994	0.0	0.0	0.0	0.0	64729.8	0.0	0.0	12997.6	0.0	12213.2	101131.5	1237.0	202.9	12241.7	22878.1	976.5	194872.8	10516.5	0.0	57461.1	16276.1	11368.1
1995	0.0	0.0	0.0	0.0	74519.4	0.0	0.0	13509.2	0.0	10728.6	116375.3	1274.2	170.7	13380.2	29163.9	1108.1	223631.2	11640.2	0.0	70360.7	18326.4	11773.6
1996	0.0	0.0	0.0	0.0	80920.6	0.0	0.0	11532.4	0.0	8208.8	110649.8	1070.9	184.8	10564.3	19595.2	1329.0	266622.0	8695.3	0.0	43805.8	12642.2	9803.5
1997	0.0	0.0	0.0	0.0	87534.6	0.0	0.0	12346.9	0.0	8887.0	123273.2	1238.9	161.9	10378.9	32997.2	1296.6	280158.7	8993.5	0.0	74984.1	14192.3	10303.7
1998	0.0	0.0	0.0	0.0	85791.2	0.0	0.0	12021.0	0.0	10043.3	118917.0	1137.9	170.7	10205.1	28342.9	1184.9	281738.5	8921.5	0.0	67221.6	13888.7	10357.0
1999	0.0	0.0	0.0	0.0	87233.7	0.0	0.0	12189.0	0.0	10506.6	120618.4	1204.8	96.0	7273.7	26678.8	1048.7	263685.2	10061.6	0.0	59996.7	12545.7	10859.4
2000	0.0	0.0	0.0	0.0	76408.3	0.0	0.0	14548.8	0.0	10860.5	128538.0	1445.8	154.4	8214.8	25923.7	1613.4	318572.6	10412.9	0.0	62290.6	11625.3	11874.0

Appendix J Recharge from Surface Water Irrigation Colorado

Year	Cheyenne	KitCarson	Lincoln	Logan	Phillips	Sedgwick	Washington	Yuma
1918	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1919	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1920	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1921	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1922	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1923	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1924	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1925	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1926	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1927	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1928	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1929	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1930	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1931	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1932	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1933	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1934	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1935	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1936	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1938	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1939	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1940	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2767.0
1941	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2654.0
1942	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2502.0
1943	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3165.2
1944	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3225.8
1945	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3246.4
1946	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3497.4
1947	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3064.8
1948	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1920.8
1949	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1783.6
1950	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2336.2
1951	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2353.6
1952	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2609.0
1953	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3266.4
1954	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4367.6
1955	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4119.4
1956	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4165.4
1957	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2874.0
1958	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3021.8
1959	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3775.6
1960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
1961	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3161.0
1962	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2550.8
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3336.2
1964	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3320.8
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2300.0
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2010.6
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2548.6
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3418.4
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3246.2
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2007.2
1971	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2123.2
1972	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2011.4
1973	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1278.2
1974	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2943.8
1975	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2832.6
1976	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3144.8
1977	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2466.6
1978	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2611.6
1979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2506.0
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1895.8
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1479.4
1982	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2429.8
1983	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2340.0
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2255.6
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1283.0
1986	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2562.6
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2185.4
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2576.4
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2099.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2138.4
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1937.8
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2882.2
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2393.4
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1318.0
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1793.0
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1105.0
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1909.8
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2079.4
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2446.6
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2020.0

Appendix J Recharge from Surface Water Irrigation Kansas

Year	Cheyenne	Decatur	Gove	Graham	Jewell	Logan	Norton	Phillips	Rawlins	Sheridan	Sherman	Thomas	Trego	Wallace
1918	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
1919	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
1920	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
1921	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
1922	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
1923	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
1924	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
1925	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
1926	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
1927	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
1928	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
1929	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
1930	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
1931	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
1932	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
1933	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
1934	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
1935	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
1936	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
1937	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
1938	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
1939	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
1940	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
1941	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
1942	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
1943	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
1944	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
1945	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
1946	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
1947	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
1948	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1949	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1950	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1951	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1952	0.0	0.0	0.0	0.0	45.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1953	0.0	0.0	0.0	0.0	104.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1954	0.0	0.0	0.0	0.0	98.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1955	0.0	0.0	0.0	0.0	278.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1956	0.0	0.0	0.0	0.0	241.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1957	0.0	0.0	0.0	0.0	208.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1958	1.1	0.0	0.0	0.0	100.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1959	1.5	0.0	0.0	0.0	255.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1960	1.5	0.0	0.0	0.0	178.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1961	1.3	0.0	0.0	0.0	182.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1962	0.8	0.0	0.0	0.0	138.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1963	0.9	0.0	0.0	0.0	187.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1964	1.1	0.0	0.0	0.0	225.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1965	0.9	0.0	0.0	0.0	171.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1966	0.6	0.0	0.0	0.0	204.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1967	0.9	0.0	0.0	0.0	210.8	0.0	1088.6	1574.7	0.0	0.0	0.0	0.0	0.0	0.0
1968	0.8	0.0	0.0	0.0	244.4	0.0	1736.2	2511.5	0.0	0.0	0.0	0.0	0.0	0.0
1969	0.9	0.0	0.0	0.0	136.5	0.0	1333.7	1929.2	0.0	0.0	0.0	0.0	0.0	0.0
1970	0.8	0.0	0.0	0.0	272.8	0.0	1400.2	2025.5	0.0	0.0	0.0	0.0	0.0	0.0
1971	0.8	0.0	0.0	0.0	250.0	0.0	1035.3	1497.6	0.0	0.0	0.0	0.0	0.0	0.0
1972	0.9	0.0	0.0	0.0	172.9	0.0	543.9	786.7	0.0	0.0	0.0	0.0	0.0	0.0
1973	0.6	0.0	0.0	0.0	159.1	0.0	1195.3	1729.1	0.0	0.0	0.0	0.0	0.0	0.0
1974	0.8	0.0	0.0	0.0	250.8	0.0	677.7	980.3	0.0	0.0	0.0	0.0	0.0	0.0
1975	0.9	0.0	0.0	0.0	215.6	0.0	1097.2	1587.1	0.0	0.0	0.0	0.0	0.0	0.0
1976	0.9	0.0	0.0	0.0	313.9	0.0	916.2	1325.4	0.0	0.0	0.0	0.0	0.0	0.0
1977	0.9	0.0	0.0	0.0	171.5	0.0	684.2	989.6	0.0	0.0	0.0	0.0	0.0	0.0
1978	0.6	0.0	0.0	0.0	174.0	0.0	777.1	1124.2	0.0	0.0	0.0	0.0	0.0	0.0
1979	0.9	0.0	0.0	0.0	104.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.9	0.0	0.0	0.0	203.6	0.0	260.9	377.3	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.8	0.0	0.0	0.0	80.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	0.6	0.0	0.0	0.0	136.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1983	0.4	0.0	0.0	0.0	176.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1984	0.6	0.0	0.0	0.0	175.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1985	0.6	0.0	0.0	0.0	123.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1986	0.6	0.0	0.0	0.0	149.6	0.0	412.1	596.1	0.0	0.0	0.0	0.0	0.0	0.0
1987	0.6	0.0	0.0	0.0	157.1	0.0	474.8	686.8	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.6	0.0	0.0	0.0	213.1	0.0	398.0	575.8	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.8	0.0	0.0	0.0	167.0	0.0	252.1	364.7	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.6	0.0	0.0	0.0	159.6	0.0	299.3	433.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.6	0.0	0.0	0.0	134.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.6	0.0	0.0	0.0	58.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.6	0.0	0.0	0.0	13.0	0.0	308.7	446.5	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.6	0.0	0.0	0.0	130.7	0.0	543.2	785.7	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.4	0.0	0.0	0.0	137.7	0.0	1069.9	1547.7	0.0	0.0	0.0	0.0	0.0	0.0
1996	0.6	0.0	0.0	0.0	117.2	0.0	988.8	1430.2	0.0	0.0	0.0	0.0	0.0	0.0
1997	0.6	0.0	0.0	0.0	95.8	0.0	1439.6	2082.4	0.0	0.0	0.0	0.0	0.0	0.0
1998	0.8	0.0	0.0	0.0	130.4	0.0	620.3	897.2	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.8	0.0	0.0	0.0	135.5	0.0	567.6	821.1	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.6	0.0	0.0	0.0	169.6	0.0	354.9	513.4	0.0	0.0	0.0	0.0	0.0	0.0

Appendix J Recharge from Surface Water Irrigation Nebraska

Year	Adams	Buffalo	Chase	Clay	Dawson	Deuel	Dundy	Franklin	Frontier	Furnas	Gosper	Harlan	Hayes	Hitchcock	Kearney	Keith	Lincoln	Nuckolls	Perkins	Phelps	RedWillow	Webster
1918	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	0.0	0.0	0.0	0.0
1919	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	0.0	0.0	0.0	0.0
1920	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	0.0	0.0	0.0	0.0
1921	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	0.0	0.0	0.0	0.0
1922	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	0.0	0.0	0.0	0.0
1923	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	0.0	0.0	0.0	0.0
1924	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	0.0	0.0	0.0	0.0
1925	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	0.0	0.0	0.0	0.0
1926	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	0.0	0.0	0.0	0.0
1927	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	0.0	0.0	0.0	0.0
1928	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	0.0	0.0	0.0	0.0
1929	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	0.0	0.0	0.0	0.0
1930	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	0.0	0.0	0.0	0.0
1931	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	0.0	0.0	0.0	0.0
1932	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	0.0	0.0	0.0	0.0
1933	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	0.0	0.0	0.0	0.0
1934	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	0.0	0.0	0.0	0.0
1935	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	0.0	0.0	0.0	0.0
1936	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	0.0	0.0	0.0	0.0
1937	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	0.0	0.0	0.0	0.0
1938	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	0.0	0.0	0.0	0.0
1939	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	0.0	0.0	0.0	0.0
1940	0.0	0.0	145.5	0.0	0.0	0.0	106.0	536.8	145.4	281.2	0.0	435.2	288.4	396.6	0.0	0.0	0.0	450.6	0.0	80.5	224.4	202.8
1941	0.0	0.0	145.5	0.0	0.0	0.0	106.0	536.8	141.5	452.4	0.0	451.8	296.6	396.6	0.0	0.0	0.0	450.6	0.0	80.5	220.0	202.8
1942	0.0	0.0	145.5	0.0	0.0	0.0	106.0	536.8	141.5	527.2	1961.2	443.5	296.6	396.6	6181.2	0.0	0.0	450.6	0.0	12259.7	209.9	241.3
1943	0.0	0.0	145.5	0.0	0.0	0.0	3735.6	536.8	151.3	543.9	2102.0	584.7	293.8	396.6	6680.8	0.0	0.0	450.6	0.0	13181.7	237.3	241.3
1944	0.0	0.0	145.5	0.0	0.0	0.0	3836.4	536.8	150.4	546.0	1783.6	595.4	293.8	396.6	5520.8	0.0	0.0	450.6	0.0	11066.5	236.2	241.3
1945	0.0	0.0	145.5	0.0	20025.2	842.4	4317.2	536.8	150.3	561.7	2096.0	579.8	293.8	396.6	6606.4	5836.4	1740.8	450.6	0.0	13093.3	236.2	241.3
1946	0.0	0.0	145.5	0.0	20025.2	842.4	4317.2	536.8	150.3	565.0	2096.0	576.4	293.8	396.6	6606.4	5836.4	1740.8	450.6	0.0	13093.3	236.2	241.3
1947	0.0	0.0	145.5	0.0	14897.2	1225.2	4409.5	536.8	150.3	565.0	1783.6	618.1	293.8	396.6	5466.8	8488.8	1418.0	450.6	0.0	11018.5	236.2	258.8
1948	0.0	0.0	145.5	0.0	14022.8	1458.0	3517.9	555.1	150.3	594.4	3083.6	813.5	293.8	396.6	10144.8	10102.0	1378.0	457.3	0.0	19619.7	236.2	495.8
1949	0.0	0.0	161.9	0.0	14400.4	1202.4	3491.1	587.1	150.3	601.8	2038.0	896.0	293.8	396.6	7589.6	8328.8	1264.0	606.4	0.0	13805.7	236.2	497.9
1950	0.0	0.0	161.9	0.0	10193.2	1034.8	4042.9	593.1	147.9	602.5	2192.8	836.6	293.8	530.7	6227.2	7171.6	867.2	550.4	0.0	13064.6	234.7	688.0
1951	0.0	0.0	161.9	0.0	8677.6	1382.0	2924.1	614.8	147.9	760.5	1879.2	869.4	293.8	576.5	3982.4	9570.8	755.6	504.7	0.0	9968.6	234.6	630.9
1952	0.0	0.0	161.9	0.0	18989.2	1910.4	4086.4	554.6	132.7	984.8	3248.4	864.0	503.7	1162.8	12294.8	13234.8	1635.7	811.7	0.0	22113.2	1461.2	659.3
1953	0.0	0.0	161.9	0.0	21957.2	1047.6	4429.1	1047.8	121.5	1602.0	3680.0	845.3	645.1	3763.2	15334.4	7255.6	1922.0	1204.4	0.0	29856.7	531.4	761.5
1954	0.0	0.0	268.5	0.0	16372.4	770.4	4593.2	1374.1	123.6	2650.1	5021.3	990.1	687.1	3381.1	12302.8	5337.2	1448.8	1117.2	0.0	26029.7	511.1	884.4
1955	0.0	0.0	298.0	0.0	19852.8	971.2	4751.2	2432.5	107.6	5785.3	6441.1	1410.2	655.2	2786.9	16255.2	6727.2	1716.2	2872.1	0.0	30514.8	829.7	1515.5
1956	0.0	0.0	298.0	0.0	19438.8	690.8	5076.9	3402.0	110.1	5573.4	7664.1	1327.5	657.3	3572.7	20483.6	4789.2	1703.0	2841.8	0.0	36700.7	882.1	2364.9
1957	0.0	0.0	298.0	0.0	14015.2	1463.6	4406.8	2658.4	111.5	2328.5	5507.7	740.4	660.7	3174.5	8554.8	10138.4	1242.0	2973.4	0.0	18748.9	628.1	2138.4
1958	0.0	0.0	298.0	0.0	11468.4	850.8	4288.0	1387.9	111.5	4020.9	4171.7	1413.9	660.7	1517.4	8131.6	5893.6	1558.8	1339.0	0.0	20036.1	2241.4	1401.4
1959	0.0	0.0	253.7	0.0	14155.6	864.8	5774.5	3809.5	114.5	6032.1	5419.4	2405.4	595.5	1387.5	10804.4	5988.8	2443.9	4171.2	0.0	24617.6	3183.5	3279.7
1960	0.0	0.0	237.6	0.0	11191.2	1000.4	5373.9	2999.9	115.2	5554.7	4726.0	2002.7	536.8	1830.5	10090.0	6930.8	2337.6	2922.5	0.0	21580.8	4644.9	2665.1
1961	0.0	0.0	241.6	0.0	13166.8	2143.6	4661.2	2938.4	103.2	5055.4	4628.0	1951.5	542.5	1840.7	9600.4	14851.2	2366.9	3160.6	0.0	22328.9	4565.9	2642.5
1962	0.0	0.0	411.1	0.0	9493.2	1550.8	3276.1	1656.6	41.2	3265.1	3866.3	1237.9	769.8	1698.1	5486.6	10741.6	1614.3	2436.5	0.0	16183.1	3462.8	1931.8
1963	0.0	0.0	1505.9	0.0	13108.8	886.4	3721.9	3649.9	202.3	6056.5	5387.8	2298.7	823.9	4560.7	13107.1	6144.8	2472.1	3707.9	0.0	26949.4	9325.0	3006.6
1964	0.0	0.0	1394.8	0.0	15393.6	530.4	4285.5	3918.1	188.3	6023.7	6017.7	2496.2	488.6	2871.0	10866.2	3674.0	2530.3	4218.7	0.0	26070.6	8160.8	3202.2
1965	0.0	0.0	1562.0	0.0	12896.8	1431.6	3430.1	2097.9	184.4	4189.8	3848.4	1581.1	602.8	2423.9	7599.3	9920.4	2126.4	3583.4	0.0	17728.0	7110.3	2042.4
1966	0.0	0.0	1524.0	0.0	15864.0	852.4	2537.6	3075.9	131.4	3833.3	5492.8	1754.6	595.9	6836.2	10873.6	5903.6	2592.4	3804.4	0.0	24720.4	7817.9	2713.1
1967	0.0	0.0	1331.5	0.0	15800.0	1246.8	3848.8	2984.0	134.3	4138.1	3858.9	1798.4	451.8	3142.6	10137.0	8640.4	2715.8	4086.0	0.0	20715.4	7576.2	2705.2
1968	0.0	0.0	1913.6	0.0	15261.2	1116.0	3102.4	3237.8	284.9	5597.2	4962.6	2112.3	805.5	3545.3	10953.9	7734.0	2603.5	3915.0	0.0	24254.2	9427.1	3100.2
1969	0.0	0.0	1187.0	0.0	15936.4	903.6	3237.3	2434.1	187.6	5137.4	3880.7	2024.9	515.8	3179.6	8271.8	6258.0	2690.9	2306.0	0.0	17477.8	9180.6	2144.1
1970	0.0	0.0	1136.5	0.0	18086.4	1864.4	3120.2	4375.3	260.2	6544.1	4890.1	2644.5	480.0	3392.1	9919.1	12918.0	2986.0	4982.4	0.0	21383.0	9465.3	3911.4
1971	0.0	0.0	1284.7	0.0	20515.6	517.6	2793.2	4095.1	314.9	6219.6	5111.0	2621.4	361.4	3455.6	11824.3	3585.6	3238.5	4337.8	0.0	23339.4	9493.8	3623.0
1972	0.0	0.0	1334.2	0.0	20514.0	677.2	3496.2	3250.8	327.6	5910.2	5308.4	2364.6	250.4	2862.8	8856.3	4693.6	3256.9	2941.6	0.0	20122.1	8563.1	2742.7
1973	0.0	0.0	1155.8	0.0	21174.0	752.8	2725.0	3593.0	371.8	5912.8	4591.3	2367.0	228.1	3127.9	10720.0	5213.2	3290.8	3025.5	0.0	21099.6	9399.4	3075.7
1974	0.0	0.0	1125.3	0.0	21233.6	825.2	3234.5	4630.4	368.8	7222.5	5493.1	3123.4	133.3	3411.2	10998.2	5716.0	3439.1	5105.3	0.0	22937.8	9610.1	4365.1
1975	0.0	0.0	1227.2	0.0	19226.4	1060.8	3560.6	3916.0	354.6	6378.4	4665.1	3034.6	146.0	3362.4	10199.3	7347.2	3038.4	4502.3	0.0	20387.7	9857.2	3867.6
1976	0.0	0.0	1165.9	0.0	19227.2	623.2	3950.1	5349.4	416.6	8163.7	5930.1	3694.7	225.5	6254.3	12611.1	4317.6	3315.1	6630.6	0.0	25391.4	10326.0	5190.7
1977	0.0	0.0	1191.8	0.0	17521.2	590.0	3652.9	3389.7	260.0	5277.7	4889.2	2474.1	302.7	4874.6	9908.3	4088.8	2797.1	3286.8	0.0	20194.8	6790.0	2814.5
1978	0.0	0.0	852.9	0.0	20553.6	567.2	2505.4	3008.1	303.2	5753.5	6326.9	2202.6	307.3	4726.9	12221.1	3929.6	3336.4	3595.2	0.0	28919.4	8228.4	2803.3
1979	0.0	0.0	661.9	0.0	17974.0	1645.6	3093.8	2031.1	147.7	2664.4	4877.4	1194.8	127.7	3562.9	6080.8	11400.8	2498.7	2471.7	0.0	19907.6	4465.1	1830.8
1980	0.0	0.0	583.1	0.0	23243.6	605.6	3120.0	4366.1	338.2	4863.1	6648.3	2290.7	153.6	3881.5	11174.1	4194.0	3617.2	4224.7	0.0	29186.0	6243.8	3732.5
1981	0.0	0.0	1059.5	0.0	18244.4	1116.0	2979.0	1589.4	199.6	2494.2	5328.2	1184.8	307.3	3781.1	7354.1	7734.0	2225.3	1904.8	0.0	23560.2	4753.0	1536.9
1982	0.0	0.0	920.0	0.0	20142.8	924.0	2395.7	2622.2	258.9	3929.5	4825.4	1851.6	233.5	3620.6	7841.6	6402.4	2670.3	2863.1	0.0	22173.7	5502.1	2378.7
1983	0.0	0.0	141.6	0.0	17546.0	1752.4	1510.7	3408.4	436.4	4186.9	4753.7	1789.4	123.1	3950.2	7748.9	12141.2	2200.8	3673.5	0.0	21242.1	6293.4	2970.8
1984	0.0	0.0	233.8	0.0	18036.0	1910.4	1885.5	3720.2	208.1	5032.6	6010.1	2064.5	150.8	4099.5	11255.3	13234.8	2735.2	3808.2	0.0	28180.4	6606.8	3287.9
1985	0.0	0.0	629.0	0.0	20022.0	1818.8	2098.5	3221.7	234.2	3289.4	4608.5	1558.5	150.1	3639.0	6875.0	12602.4	2695.2	2578.7	0.0	19223.0	6080.2	2673.8
1986	0.0	0.0	847.0	0.0	22502.8	996.0	2109.3	4162.0	274.1	4419.8	5603.1	2089.5	149.8	3930.0	7338.4	6905.6	3232.8	3070.1	0.0	22734.8	6345.4	3325.4
1987	0.0	0.0	1063.1	0.0	19750.4	849.6	2205.4	2891.3	233.5	3690.9	4649.3	1742.4	156.3	3911.1	6799.1	5886.0	2731.5	3127.2	0.0	19540.0	6060.2	2572.0
1988	0.0	0.0	801.1	0.0	19371.6	1030.8	2223.1	4066.4	186.5	4625.0	5320.9	2093.9	125.5	3764.4	9112.0	7139.6	3086.0	4579.4	0.0	24871.5	5621.9	3222.0
1989	0.0	0.0	792.2	0.0	20722.4	804.4	2517.9	2964.0	216.9	4989.7	5056.0	2131.7	143.4	4027.0	7602.2	5575.6	3077.8	3595.6	0.0	22512.7	6048.7	2403.9
1990	0.0	0.0	502.6	0.0	20650.0	1107.6	2253.7	2397.6	296.1	4740.6	5686.2	1964.3	190.7	3794.7	10094.5	7673.6	3335.5	3558.7	0.0	26605.5	6712.6	2067.9
1991	0.0	0.0	46.2	0.0	19155.6	1046.8	2075.8	2467.0	231.5	4493.7	5374.8	1956.5	143.1	3288.4	11072.8	7252.0	3202.1	2793.6	0.0	27246.9	5162.9	1902.0
1992	0.0	0.0	62.8	0.0	17784.8	1452.0	2465.6	1720.2	232.9	3610.2	4132.1	1578.9	146.9	2483.1	6502.3	10059.2	2539.2	727.3	0.0	18106.3	3599.3	1068.6
1993	0.0	0.0	23.5	0.0	10668.8	685.6	1984.3	326.9	62.2	1164.5	1130.7	469.2	65.6	2831.7	1166.1	4751.2	1302.3	306.6	0.0	4768.7	3646.6	285.4
1994	0.0	0.0	56.8	0.0	17644.8	632.8	2221.7	3179.9	370.6	4334.6	5242.3	2020.5	201.3	3645.4	6594.9	4381.2	2921.2	2932.5	0.0	20603.0	6264.0	2703.1
1995	0.0	0.0	40.1	0.0	21688.0	881.6	1634.2	3225.8	313.0	4870.6	5087.1	2011.1	137.8	3524.2	9742.8	6108.4	3155.6	3564.5	0.0	24434.3	6326.6	2957.6
1996	0.0	0.0	46.0	0.0	17258.0	985.2	2239.5	1891.3	241.7	1905.5	3687.5	967.2	139.4	3310.8	3648.6	6826.8	2271.1	3131.6	0.0	12888.8	4552.3	2048.9
1997	0.0	0.0	46.0	0.0	19066.8	1402.4	2083.1	3045.4	241.7	4797.0	5208.7	2029.7	139.9	3882.1	8659.3	9719.6	2835.9	2615.3	0.0	22435.1	6309.0	2594.2
1998	0.0	0.0	46.0	0.0	19524.0	1116.4	2639.9	2651.9	241.7	4069.5	4373.3	1787.0	139.4	3339.8	6068.6	7736.0	1758.3	3114.3	0.0	18976.7	5570.0	2438.1
1999	0.0	0.0	46.0	0.0	14844.4	1326.4	2627.9	2908.7	241.7	3326.1	3428.2	1580.0	139.9	3043.2	5180.2	9188.0	1370.3	3399.4	0.0	14806.4	4575.2	2650.3
2000	0.0	0.0	46.0	0.0	18784.4	774.0	2418.3	3508.3	241.7	3657.0	4943.7	1709.8	139.4	3573.4	8261.1	5362.8	1605.9	4301.6	0.0	22378.8	5554.2	3233.3

Appendix K – Irrigated Acreage Estimates

Colorado - Estimates of the irrigated acreage for 1940 through 2000 in Colorado for the area covered by the RRCA Model include lands in Kit Carson, Yuma, and Phillips Counties and parts of Sedgwick, Logan, Washington, Lincoln, and Cheyenne Counties. A small area of Elbert County is located in the RRCA Model area, but since there are no irrigation wells or ditches in that area, it was excluded.

The estimates are based on the County Assessors' records of irrigated acreage and well permit information contained in the Colorado Ground Water Commission's Northern High Plains Well Database with adjustments for irrigated fields set aside under federal farm programs. The results were compared to irrigated crop statistics compiled and published by the Colorado Department of Agriculture and the National Agricultural Statistics Service (NASS) and irrigated acreage records for farms participating in federally subsidized programs that were provided by local Farm Service Agency offices through the U.S. Department of Agriculture. Descriptions of these sources and procedures follow:

County Assessor Records

The county assessor is an elected official in county government and their duties are prescribed by Colorado Revised Statutes. Succinctly, the county assessor must discover, list, classify, and value all taxable real and personal property within their respective county. Procedures for classifying and valuing property are set forth in the "Personal Property Valuation Manual", the "Land Valuation Manual", and other references prepared by the Colorado Division of Taxation. The assessor's appraised property values form the basis for taxing districts to set mill levies and taxes. The county treasurer is responsible for collecting all property taxes.

For agricultural land, the assessor must determine the value of the land based on its production capability by considering soils, irrigation sources and methods, crop yields, crop values and farm sales. The assessor relies on aerial photographs, county clerk records, the county soil survey, agricultural statistics from NASS, climatalogical records, interviews with local farmers, and other locally available information. Since 1989, all property is appraised every other year based on sales of equivalent property during the preceding two years. Provisions are allowed to conduct interim appraisals if necessary to reflect a change in property values assessment such as conversion from irrigated cropland to dry land pasture.

The county assessors must publish an "Abstract of Assessment" by August 25 of each year that summarizes the amount and value of various categories of property as of the previous 1st of January. The abstracts also document the valuation, mill levy, and revenue for each taxing district in the county. Categories of property include irrigated farmland, meadow hay land, dry farm land, grazing land, and other agricultural land. Since 1993, the abstracts tabulate acreage by sprinkler and flood irrigation. The Colorado Department of Local Affairs summarizes the abstracts and submits an annual report to the Colorado General Assembly.

Irrigated land that is taken out of production due to farm programs, such as the Payment in Kind (PIK) and Conservation Reserve Program (CRP), remain classified as irrigated by the county assessor pursuant to requirements in federal authorizing legislation for these programs. They remain classified as irrigated to assure payment to the farm owner by the federal government is commensurate with irrigated land production capability and to maintain the assignment of tax burden. The Farm Service Agency (FSA) of the US Department of Agriculture (USDA) administers the federal crop programs. Each year, program participants must report crop acreage to the local FSA office that compiles records of irrigated and non-irrigated croplands. Federal farm program acreage records for 1990 through 2000 were available and summarized for each county as CRP fields and fallow fields. Those annual values were deducted from the assessors' irrigated acreage. The PIK Program reduced irrigated acreage significantly in the 1980s. Since the USDA does not retain records for more than 10 years, Colorado estimated the PIK acreage using NASS records as described later in this document.

Colorado Ground Water Commission's Northern High Plains Well Database

The Northern High Plains Well Database covers the entirety of the RRCA Model area in Colorado. The information contained in the well database for the model area includes 3,967 ground water well records. Each record includes the well location, use of the water, place of use, pumping rate, irrigated acreage, owner, and priority date. The records for each county were sorted by use, priority date, and location. For each county and priority year, the number of irrigation wells is counted and the acreage shown on the well permits is quantified.

The irrigated acreage identified in the well permits exceeds the actual irrigated acreage identified through County Assessor data. Review of well permit acreage information indicates most cite a square quarter-section of land, or 160 acres. Center-pivot sprinkler systems are the prevalent water application method in the model area and a typical circular quarter-section system irrigates only 130 acres. Comparison of permitted irrigated acreage with NASS data also indicates the well permit information exceeds the irrigated crop acreage reported by NASS.

Estimate of Surface Water Irrigated Acreage in Colorado

Surface water irrigation in the Basin in Colorado occurs only in Yuma and Kit Carson Counties. The surface water acreage was obtained from the respective County Assessor's records that documented a total of 2,902 (Yuma) and 1,861 (Kit Carson) acres in 1940. These quantities were carried forth to date and do not reflect the small decrease in surface water irrigation that has occurred since 1940.

Estimate of Irrigated Acreage by County Over Time in Colorado

The assessors' records of irrigated acreage for Kit Carson and Yuma Counties include land irrigated from surface water sources that precede 1940. Irrigation of additional acreage after 1940 can be attributed exclusively to ground water development. Review of historic county assessor records confirms there has been little change in irrigated acreage since 1979 and the Assessors' records for recent years provide the most accurate quantification of irrigated acreage in each county.

To estimate the irrigated acreage over time, the ratio of the assessors reported acreage in 2000 to the cumulative acreage under all well permits for irrigation is calculated. For Phillips, Sedgwick, Logan, Washington, Lincoln, and Cheyenne Counties, that ratio is multiplied by the annual cumulative well permit acreage to determine the acreage in a specific year. For Kit Carson and Yuma Counties, the ratio was multiplied by the yearly permitted acreage and the resultant was added to the previous year's acreage to account for surface-water irrigated land developed before 1940. For 1990 through 2000, the fallow irrigated fields and fields idled due to farm programs (USDA records) were deducted from the calculated acreage to determine the net irrigated acreage for those years. From 1982 through 1988, significant acreage was taken out of production through the USDA's Payment in Kind (PIK) program. The USDA represents that it does not have records of the county acreage idled by this program during the 1980's because it retains records on individual farms for only 10 years. The NASS records show significant reductions in irrigated acreage, up to 110,000 acres in 1983, in Kit Carson, Yuma, and Phillips Counties. To reflect this program, Colorado combined the NASS acreage for the three counties[1] and calculated the annual reduction percentage from the acreage in 1981.

Year	**Total Irrigated Acres**	**Reduction as Percent of 1981**
1981	507,774	0.0
1982	480,443	5.4
1983	392,562	22.7
1984	426,248	16.1
1985	431,243	15.1
1986	416,416	18.0
1987	465,633	8.3
1988	468,627	7.7

The annual reduction percentages were multiplied by the irrigated acreage in each county and the resultant was subtracted to determine net irrigated acreage.

Kansas – The irrigated acreage in Kansas was determined from an analysis of available data from the water use reports, NASS, Census of Agriculture, and tabulations of water rights and ground water wells. For the period 1989-1999, irrigated acres from the Water Use Reports were used. In addition to acreage data, crop information was used to develop countywide crop distributions for computing crop irrigation demand over the entire study period.

The NASS data for agricultural statistics provide countywide data that is the most complete in Kansas after 1972, and was used as the basis for the acreage estimates for the period of 1972 - 1988. However, some irrigated crops are not tracked individually in these records. The Census of Agriculture data from 1987, 1992 and 1997 were used to distribute some acreage to irrigated crops from the total crop acreage given in the NASS data. The percentage of each county's irrigated acreage included within the model domain was determined from the Water Use Report data and multiplied by the countywide irrigated acreages determined from the NASS data and Census data. For the pre-1972 acreage, the annual well count was multiplied by a ratio of acres per well

[1] The NASS records for the other five counties were not used for these calculations because the irrigated acreage in these counties overlaps into other river basins.

derived from either the Water Use Reports or the adjusted NASS data for 1972, whichever gave a better fit to the subsequent year's estimates.

Irrigated acreage for each section was calculated by multiplying the annual well count by the irrigated acres per well, with a maximum of 520 irrigated acres per section. All remaining acreage above the 520 acre limit was assigned pro rata to other sections in the county.

Nebraska – In cooperation with the Nebraska Department of Agriculture (NDA), NASS prepares an estimate of crop acreage by county. Annually they produce "Nebraska Agricultural Statistics" which is a compilation of information about farms, crops, and livestock. Every five years, NASS produces the Census of Agriculture, which is a detailed counting of farms, crops, and livestock. For the intervening four years, the estimates are prepared using a much smaller sample than the census. Periodically, NASS presents revisions to the annual estimates based on the results of the most recent census.

Reports are prepared annually for Nebraska and the data are collected and summarized statewide and by county. Farmers are surveyed each fall following harvest. Those surveys are supplemented with surveys of grain elevators and mills for volumes of grain received, meat packing plants, and other agribusiness. Crops are added and deleted from the annual report as cropping patterns change. For example, broom corn was deleted from the surveys in the 1960s and sunflowers were added in 1990. Generally, the USDA is most interested in farm program crops such as corn and wheat and the NDA is interested in other crops such as alfalfa, grass hay, fruits, and table vegetables.

The annual reports break out irrigated and non-irrigated acreage for some crops. For other crops, such as alfalfa and corn for silage, NASS reports total acreage harvested every year but reports irrigated acreage periodically. In these cases, estimates of the irrigated acreage for the crop is based on the ratio of reported irrigated acreage and total harvested acreage in other years.

Appendix K Irrigated Acreage Colorado

Year	Cheyenne	KitCarson	Lincoln	Logan	Phillips	Sedgwick	Washingto	Yuma
1918	0	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0
1921	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0
1924	0	0	0	0	0	0	0	0
1925	0	0	0	0	0	0	0	0
1926	0	0	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	0
1930	0	0	0	0	0	0	0	0
1931	0	0	0	0	0	0	0	0
1932	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0
1936	0	0	0	0	0	0	0	0
1937	0	0	0	0	0	0	0	0
1938	0	0	0	0	0	0	0	0
1939	0	0	0	0	0	0	0	0
1940	115	359	96	156	800	0	202	3681
1941	115	359	109	156	800	0	410	3929
1942	115	359	109	156	1115	0	410	3929
1943	115	359	109	156	1115	0	410	3929
1944	115	359	109	156	1115	0	570	3929
1945	365	359	109	156	1115	0	780	3929
1946	365	359	109	156	1115	0	972	4049
1947	365	715	129	156	1115	0	1256	4449
1948	365	1939	874	156	1235	0	1908	3885
1949	445	3284	1054	156	1812	160	2172	5425
1950	540	3590	1083	156	1972	160	2810	5590
1951	540	4105	1083	156	2092	390	2810	7293
1952	540	4425	1083	156	2380	390	2920	7856
1953	780	5011	1213	156	2620	390	3316	8590
1954	780	7784	1213	156	2950	390	3436	10442
1955	852	17556	1213	188	3260	390	3641	13553
1956	852	21381	1245	188	3460	550	3716	17189
1957	852	23815	1245	348	3616	760	4138	19111
1958	852	24931	1365	348	3984	760	4198	20001
1959	852	27570	1365	348	4102	760	4218	20366
1960	852	29590	1365	444	4428	760	4330	20966
1961	868	33346	1365	444	4777	760	4643	22210
1962	1028	40350	1365	444	4937	760	4824	24080
1963	1132	58033	1401	604	5766	1000	5534	26129
1964	1952	79492	1686	604	10294	1004	5935	37546
1965	2668	105305	1878	604	14914	1004	8091	57473
1966	2668	117845	1878	604	19595	1004	10020	82850
1967	2908	131198	1878	604	30143	1454	14794	126366
1968	3348	138790	1947	1244	33939	2566	17758	150159
1969	3748	147790	2147	1404	41862	4126	20071	187573
1970	4298	153155	2307	1404	46823	4126	20769	195127
1971	4850	158049	2517	1404	49685	4786	23309	201318
1972	5875	161826	2677	1708	51603	5396	24351	216195
1973	6531	172870	2837	2166	55760	8105	28612	236897
1974	8722	182301	3157	4536	65516	17658	32344	263105
1975	10434	185362	3672	5686	69466	21963	37785	282978
1976	11304	186572	3672	5990	72877	24051	39895	301678
1977	11844	186572	3992	6310	74051	24341	40595	305361
1978	11896	187282	3992	6310	74460	24573	41585	308720
1979	11896	187512	3992	6310	75673	24740	41651	311525
1980	11896	187512	3992	6310	75804	24742	41781	312125
1981	12096	187512	3992	6310	75950	24740	41781	312175
1982	12096	187512	3992	6310	75966	24731	41781	312467
1983	12096	187512	3992	6310	75814	24731	41781	312499
1984	12096	187622	3992	6470	76186	24760	41781	313378
1985	12096	187622	3992	6730	76324	24756	41781	312632
1986	12096	187670	3992	6810	76287	24732	41781	313462
1987	12096	187670	3992	6810	76310	24733	41781	313483
1988	12096	187670	3992	6810	76332	24733	41781	313450
1989	12096	187670	4064	6810	76347	24740	41781	313640
1990	12096	187670	4148	6810	76369	24738	41781	313740
1991	12096	187770	4148	6810	76382	24738	41921	313766
1992	12096	187770	4148	6810	76381	24741	41921	313707
1993	12096	187770	4148	6810	76343	24740	41921	313758
1994	12096	187770	4148	7018	76367	24744	41921	312950
1995	12096	187770	4148	7018	76365	24747	41921	313731
1996	12096	187770	4148	7018	76385	24746	41930	313782
1997	12096	187770	4148	7018	76389	24739	41930	313793
1998	12096	187770	4148	7018	76369	24745	41930	313772
1999	12096	187770	4148	7018	76375	24745	41930	313757
2000	12096	187770	4148	7018	76381	24748	41930	313800

Appendix K Irrigated Acreage Kansas

Year	Cheyenne	Decatur	Gove	Graham	Jewell	Logan	Norton	Phillips	Rawlins	Sheridan	Sherman	Thomas	Trego	Wallace
1918	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1921	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1926	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1931	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1932	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1936	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1937	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1939	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1940	480	288	0	0	553	0	264	661	254	226	115	110	0	0
1941	974	333	0	0	553	0	264	661	388	226	174	110	0	0
1942	1334	335	0	0	553	0	264	661	388	226	174	110	0	0
1943	1694	335	0	0	553	0	264	661	388	226	174	110	0	0
1944	2054	336	0	0	553	0	264	661	388	226	174	110	0	0
1945	2054	337	0	0	553	0	264	661	388	226	174	110	0	0
1946	2054	336	0	0	553	0	264	661	388	226	174	110	0	0
1947	2054	355	0	0	553	0	264	661	388	226	289	110	0	0
1948	2054	355	0	0	553	0	376	661	388	226	289	220	0	0
1949	2054	358	0	0	553	0	376	661	388	226	519	220	0	0
1950	2054	399	0	0	553	0	446	761	658	356	634	220	0	0
1951	2054	499	0	0	553	0	446	761	658	356	634	440	0	0
1952	2054	455	0	0	1002	0	446	761	658	356	1669	550	0	0
1953	2054	597	0	0	1002	120	446	1061	1018	746	2247	660	0	0
1954	3264	627	0	260	1002	120	866	1561	1108	746	2594	660	200	0
1955	3744	1065	180	390	1002	120	1006	2661	1648	1916	4200	1320	200	0
1956	5064	1581	450	520	1257	120	1216	3461	2278	4304	6959	3740	600	150
1957	7104	2018	540	520	1257	240	1404	3561	2818	6912	8571	5280	600	150
1958	7587	2097	630	520	1257	240	1404	4158	2998	7692	9645	5280	1000	150
1959	7947	2238	720	650	1257	240	1614	4158	3268	8862	10341	5720	1000	150
1960	9387	2644	720	780	1257	240	1754	4158	3268	9122	10573	5830	1000	150
1961	10323	3217	720	910	1257	360	1824	4367	3448	9512	12311	6160	1000	150
1962	10928	3428	990	910	1257	360	1964	4367	3628	10032	14508	6710	1000	150
1963	12860	3328	1260	910	1257	600	1964	4468	3718	10942	19135	7490	1200	150
1964	15717	3623	1350	910	1257	1200	2012	4568	4078	13932	24885	9470	1300	300
1965	18437	4211	1890	1820	1257	1680	2642	4658	4528	16710	31028	13430	1400	450
1966	20028	4348	2970	1820	1257	1800	2712	4758	4664	17880	33959	14640	1400	750
1967	21748	4573	3960	2080	1257	3000	6986	8857	5698	21000	40228	17060	1400	750
1968	24485	4933	5490	2210	1257	4320	7266	8857	6508	26898	49372	22530	1700	1200
1969	26121	5391	6660	2340	1257	5280	7413	8896	7228	31318	56441	24730	1700	1200
1970	27220	5796	7110	2470	1257	5760	7578	8896	7948	34828	58520	26250	2000	1200
1971	29033	6146	8280	2730	1257	6240	7935	9159	8308	38469	61173	29220	2000	1200
1972	31485	6298	10443	4313	1293	6664	8584	9229	9580	46418	61158	34831	1931	1480
1973	31553	9263	12886	5208	1248	8707	10021	9227	14987	49892	68540	40810	1946	1456
1974	31479	8121	15033	5166	1257	6887	9128	9676	12673	52349	70316	51167	2508	1864
1975	34479	10459	17279	5724	1242	9923	8914	9099	14639	59351	84256	62295	2916	2205
1976	37682	10456	18334	7182	1177	8021	9084	9058	13185	62477	97692	80666	2246	2657
1977	43236	10616	15695	9472	1258	9512	9562	9532	15008	71857	106822	85616	2732	2956
1978	39422	10903	14947	10963	1288	8284	9554	9499	15760	65269	103137	84508	2047	2501
1979	36413	10475	14090	9106	1442	7553	6909	5485	15308	66896	104011	90075	2459	2737
1980	34953	9921	11502	5855	1410	6188	10836	9702	11852	61404	111435	78255	1551	2847
1981	39493	11747	14423	8659	1521	8084	5611	5510	13991	68693	114550	95243	2356	3275
1982	40652	11911	21048	10882	1569	9818	7152	5178	17238	76383	114632	93032	3138	2510
1983	32594	11974	15027	7991	1464	8870	4898	3773	12429	52528	101744	65719	2506	1695
1984	31681	14063	18192	9785	1582	7520	8347	4657	13780	73809	104223	86802	2632	2174
1985	34174	15245	17628	12849	1600	6956	8615	6267	15194	71823	103452	98645	2230	2309
1986	37296	14564	20019	12768	1665	6270	10848	10293	14745	73786	95651	107830	2013	2079
1987	41690	8651	18436	7808	1562	4750	9926	10175	16671	66421	88350	98032	1980	2036
1988	39343	8209	14281	6113	1466	6745	9690	9494	17135	65075	91734	80341	2170	1887
1989	42926	10922	14295	6973	1459	7584	10253	9557	17443	74246	105567	99335	1632	2124
1990	44402	10630	13110	7708	1475	7296	10560	9611	17217	72649	106665	96898	1734	2177
1991	44347	11467	14167	8184	1555	7488	7740	5117	16114	73286	107197	96506	2006	2143
1992	42444	8283	12573	7509	1516	6912	7128	6039	14507	67375	103403	92546	1836	2241
1993	44082	8735	10396	5800	1237	7104	9899	9368	15185	67595	105561	94917	1260	2022
1994	46051	10333	14362	7896	1610	7488	10019	10305	17741	71513	110463	98655	2065	2249
1995	43236	11068	14164	8086	1586	7275	10288	10531	19088	71925	103928	95308	2135	1969
1996	47041	10326	14509	8749	1575	7566	10019	9714	17104	73552	115264	98978	2100	2238
1997	48606	11463	14583	9127	1619	7663	10614	10403	17715	75133	116659	99936	1944	2002
1998	47797	10540	15416	9813	1563	7857	10328	9469	17970	75555	116655	98451	2340	2087
1999	47734	10302	14381	10109	1570	7546	10432	9895	17071	75458	114338	99047	2268	2254
2000	49519	11698	14931	10408	1305	7644	11013	9952	18743	76728	115994	102013	2394	2426

Appendix K Irrigated Acreage Nebraska

Year	Adams	Buffalo	Chase	Clay	Dawson	Deuel	Dundy	Franklin	Frontier	Furnas	Gosper	Harlan	Hayes	Hitchcock	Kearney	Keith	Lincoln	Nuckolls	Perkins	Phelps	RedWillow	Webster
1918	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1921	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1926	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1931	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1937	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1939	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1940	91	0	736.2	0	2929.9	848.8	384	476	190	533	945.7	255.9	297	1562	2988	1857	3327	69	198	3772	702	266
1941	91	0	914.2	0	3557.1	848.4	384	544	190	749.3	1388.4	543	297	1846	3749	2175	4040	138	198	4699	813	266
1942	91	0	1003.2	0	4163.9	908.4	480	680	190	789.7	7675.4	543	297	2059	27208	2585	4234	138	297	46241	1006	266
1943	91	0	1181.2	0	4354.5	908.4	3014	680	190	870.7	7743.9	604.8	297	2201	27375	2683	4748	138	297	46634	1201	266
1944	91	0	1624.6	0	4480.1	908.3	3110	748	190	951.7	7745.3	730.3	380	2414	28292	2881	4924	138	297	46791	1629	266
1945	91	0	1624.6	0	18490.8	2311.4	3397.9	1019.9	190	992.4	7821	920.4	380	2414	29382	11355	6247	138	297	46875	2018	266
1946	91	0	1710.6	0	18687.9	2551	3590	1291.9	285	1226.2	7816.2	1625.8	547	2769	31892	11731	7055	138	297	47369	2136	304
1947	546	0	1799.6	0	18917.8	2730.7	3590	1426.5	330	1741.5	7964.9	2539.9	547	6150	33722	12362	9781	407	297	47639	3133	738
1948	1038.1	0	1977.6	0	19421.3	2730.1	3685.9	1633.7	570	1514	8156.1	2778.2	547	7100	35206	12726	12098	605	594	48410	3243	810
1949	1082	0	2403.2	0	19770.6	2730.3	3926.1	1778.6	690	2721	8394.7	2674	922	7840	36124	12809	11723	1125	693	48805	3390	731
1950	1170	0	2735	0	19957.4	2730.5	4500.3	2892.9	2614.7	3731.7	8501.5	3119.5	718	8582	37272	13167	20230	1040	792	49592	3679	1006
1951	1344.6	0	3470.8	0	20068.9	2730.4	4693	4203.8	1294.6	9352.8	8456.6	4376.5	1122	9555	37814	13373	19761	1423	891	50207	5868	1372
1952	1432.5	0	3743.6	0	20245	2910.2	5457.3	3876.1	1853.4	9599	8455.1	3927.8	1269	10081	38966	13589	18254	4710	1188	50418	13195	1540
1953	1729.8	0	4994.5	54.3	21210.4	2969.5	6221.7	5002.1	2552.3	9805.8	9252	4544.4	1547	12752	46405	14092	19638	5048	1782	63941	6048	1597
1954	2511.3	0	6628.1	38.9	22203.7	3089.3	8468.3	7829.2	4261.4	15229.9	14956.3	6316.6	1895	13575	51310	14957	25262	6139	2376	67557	8245	3239
1955	3244.6	0	9037	50.8	23897.1	3209.1	10487.3	10891.7	5840	16555.7	17073.9	8791.5	2736	13226	55995	15576	27839	7475	2685	71563	10926	4184
1956	4888	0	10241.1	134.2	26389.7	3269.2	11734.6	13794.4	7822.8	18239.3	18843.1	10783	2731	14284	63783	16236	24289	8345	3180	79108	12140	5373
1957	7089.7	0	9304	296.9	24936	3390	9378.7	17981.7	10161.6	19111	18948.4	12138.2	3689	17125	68110	14060	25565	9022	3899	74999	14555	6705
1958	7376.5	0	9741	297.4	24270.2	3431	9765.6	19215.5	9614.7	21226.4	18850.7	12417.3	3918	16976	65844	10652	23445	8024	4255	71933	14542	9148
1959	7689.4	0	11168.4	334.2	26056.3	3505.4	9496.6	21727	10378.4	21742	20645.8	14603.6	3492	15824	72543	11400	25354	8826	4802	81342	16218	8361
1960	8212.9	0	10857.3	348.8	31887.9	3509.6	14821.2	25102.6	12932.8	24169.7	24544.6	16616.8	5337	20131	76102	14323	28348	10211	4966	89627	19744	9593
1961	7363.5	0	12366.8	289.7	27296.7	3509.9	12324.6	22339.1	11284.3	25354.8	21323.4	16237.2	4854	19742	60087	14539	24773	8891	4900	85498	19834	8917
1962	7239.7	0	13036.7	299.5	21197.6	3629.7	11436.6	20480.2	10429.3	23915	20560	14499	5337	22174	59971	14494	26507	9267	4935	82976	21370	7341
1963	8181.8	0	14467.2	331.8	25509.6	3690.5	15621.4	24979.8	13407.3	26774.6	22546.4	18211.4	5511	23910	67958	15098	25500	10005	4655	88888	24974	9957
1964	8082.7	0	15909.3	307.3	24310.6	3748.4	17208.5	21778.4	12596.5	21705	21540.2	15932.2	5532	18002	60775	13897	23983	8639	4462	84979	25246	8557
1965	8631.7	0	19429.2	374.6	23771.8	3747.1	21213.4	22515.6	13166.2	21518	20333.5	16115.6	5553	18842	67871	13237	23382	9115	5793	85601	27355	8545
1966	10031.9	0	23114.1	526.8	25958.6	3809	20859.9	25878.1	14851.2	21838.4	23225.5	19060.8	5296	19105	75855	14795	24228	9630	5526	101408	27362	10071
1967	11886.3	0	32293.3	539.1	25996.8	3932.7	22168.5	30050.8	17256.3	25663	25733.6	22917.7	6209	20752	83202	16159	30716	10014	8932	99993	30542	11625
1968	11929.8	0	38204.9	690.5	24946.1	4054.8	23455.8	31829.6	18739.4	28583.8	26746.5	28043.9	7483	19483	86127	18110	27641	10819	10613	102099	30425	11400
1969	11168.6	0	37911.7	864.4	25471.7	4112.3	25383.3	29461.6	20230.1	25655.3	28771	29521.3	8096	18433	87653	17875	29219	10268	11192	119376	31099	12556
1970	12582.9	0	44502.3	968.3	25389.5	4115.8	30456.1	32530.9	24607.8	28357.2	34087.3	34427.1	9775	20423	99041	18891	31259	11598	15542	110581	35208	14625
1971	13613.4	0	57335.8	1000.1	27281.5	4176.2	36279.2	34565.2	34562.7	31601.6	34251.8	36057	10692	24533	102684	19667	36748	11382	20572	130116	39524	16022
1972	12901.6	0	67191.5	908.4	28781	4239.2	36266	32622.4	37065.3	30767.2	37484.2	36163.6	12361	22451	104897	22001	34248	10808	26649	127890	38531	14469
1973	13802.7	0	76179.5	1129.5	31705.8	4361.7	39647.9	39967.2	39964.5	35104.4	40134.5	39066.5	12328	24247	117760	23402	39699	11983	35213	136469	42103	16246
1974	15270.6	0	87977.5	1171.6	35296.3	4422	40497	41077.4	40088.4	34883.7	45263.6	42411	18487	28738	120533	25972	50295	12534	43741	146550	42884	16736
1975	16008	0	96016.8	1345.8	35555.6	4425.9	51479.6	50506.8	51240.3	37813.5	48826.3	44596.7	16915	30222	126170	31127	51864	13276	64354	154902	50194	20960
1976	17502.1	0	99646.5	1404.2	36638.3	4426.8	54029.3	58404	54199.9	43967.7	45805.2	49550.2	19263	28607	138678	30647	61266	14362	69024	160448	50855	23741
1977	20709.5	0	124469.9	1454.5	36523.9	4431.1	67058.7	62878.1	60121.7	43639.1	58473.3	58187.8	22429	30589	154293	34231	74504	13538	79577	187689	54723	28861
1978	21133.4	0	135361.1	1539.6	37431.4	4491.8	77871.7	59748.9	63159.3	43527.1	59790.7	58796.6	32006	30573	149949	35298	80242	15077	87022	184863	54596	31232
1979	22757.3	0	142602.1	1699.5	40896.2	4618.2	82828.4	60530.7	66136.7	46055.8	58128.7	56432.3	34206	33604	163236	40294	85872	15337	101736	199042	56252	32074
1980	24480.8	0	145618.5	1752.5	42984.9	4559.7	74930.3	66284.3	68027.1	50187.5	66632.5	70857.6	34133	34204	173526	41978	98215	17153	108915	212227	56909	35111
1981	24855.6	0	142880.2	1657.6	43560.7	4559.7	78669.5	60520	69413	46480.8	62579.9	60643.3	35428	33032	175892	42503	110155	16321	112600	212273	59388	35710
1982	24097.6	0	150630.3	1686.3	42538.4	4561.3	76601.2	71131.8	64191.1	42427.9	60728	59474.4	33982	33518	170191	44130	97264	14435	103024	221394	56297	25882
1983	16124.1	0	100676.1	1271.1	30557.4	4553.2	62080.2	46731.9	50412.5	37577.5	40698.4	41901	30430	24674	111195	39130	72825	12120	90705	141425	35398	23251
1984	22379.1	0	143388.9	1880.5	45460.7	4571.8	96680.6	67054.9	71022.6	45626.3	63399.3	64313.1	36119	34600	172155	50546	107543	17698	140647	213664	46146	31727
1985	22984.4	0	135963.7	1908	48664.3	4574.6	92157.2	70505.4	71163.5	45825.4	63354	64505.3	48945	37736	170432	52323	110532	18947	136334	220045	58026	31314
1986	23255.8	0	121457.5	1750.2	42625.6	4689.1	88474.9	71350.7	63544.3	45729	54761.5	67595.4	35520	30536	166114	49641	97451	16960	109641	198230	46629	29972
1987	21875.6	0	130591	1568.2	39288.4	4554.9	80286.1	64529.3	55655.3	43115.2	54006.2	60187.8	32495	28639	152340	41034	83974	14427	110558	192837	51606	27314
1988	23146.9	0	139294.2	1631	42046.3	4553.5	77789.6	66288.2	55782.4	41558.7	60679.5	58483.6	29152	29023	158552	40396	88736	14602	110442	200921	50549	32794
1989	26106.3	0	145921.3	1734.5	44269.8	4555.8	87795.1	73832.1	63186.7	52247.3	67544.3	65793.7	29532	28438	183407	43015	103051	14824	119569	229312	53941	34399
1990	26597.3	0	156631.7	1752.6	44276.6	4560.9	86160	73371.7	61665.1	50211.1	69516.5	67628.8	34540	30814	182412	47138	103252	15035	117733	232014	57457	35634
1991	27531.6	0	163325.1	1776.5	44901.2	4560.6	92413.7	74376.3	60495.3	49157.3	70680.4	66367.5	34189	32193	184200	47006	109104	15978	118452	237586	55672	36792
1992	27560.5	0	164480.5	1771.1	42221.8	4555.8	84010.2	74620.7	60837.3	46919.6	68106.7	66265.8	33652	28839	188482	43743	109409	16310	123924	224240	58835	37528
1993	26648.8	0	147971.9	1721.5	42520.9	4553	92871	74431.9	58594.2	44728.4	66846.5	64647.9	27373	26528	174338	42161	101380	16361	123511	214104	58594	39358
1994	27993.6	0	157213.1	1768.4	44200.3	4554.8	86927.3	78166.5	59579	50573.2	69376.3	67223.3	34107	28322	188694	44525	111946	16847	129112	241873	60211	41129
1995	27550.6	0	156750.9	1752.9	43557.5	4613.4	88991.4	74969.9	55168.1	48838.5	68590.2	67004.3	32530	25564	186590	44504	114930	16958	133297	232077	54592	39046
1996	27665.6	0	166981.9	1819	43935.6	4556.8	89496.4	75178	61925.5	51167.7	71178.1	70369.2	33894	29105	192590	48043	128269	18150	132746	238142	56041	40315
1997	28693.6	0	169136.6	1856.2	44115.2	4557.7	86164.2	85366.2	60125.7	54269.6	71393.4	80222.9	36486	30872	193137	49670	125117	17621	126295	239964	58849	37798
1998	28410.7	0	158646	1856	43368.8	4558.6	83431.2	82785.8	63447.9	52049.2	74399.8	76016.5	38629	29996	191820	50803	125084	19679	133944	232870	57347	45298
1999	29392.2	0	161675.7	1850.2	44909.5	4497.2	77595.6	84487.9	63331	48702.2	72385	74278	39503	29606	195800	50200	120066	21892	134191	239267	56045	46494
2000	30212.9	0	165365.4	1881.8	46482.7	4495.1	84797.1	85623.3	58717.8	60434.2	76230.3	76626.1	44337	32213	200797	49197	128381	19981	138275	246269	58153	45982

Net Crop Irrigation Requirement

tential consumptive use minus effective rainfall minus gain in soil moisture from winter and spring precipitation) (inch

	County (or portion of County in the Republican River Basin study area)							
Year	Cheyenne	Kit Carson	Lincoln	Logan	Phillips	Sedgwick	Wash-ington	Yuma
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1940	12.55	13.86	14.82	11.21	10.94	10.67	17.73	10.32
1941	13.55	16.46	17.25	13.54	13.29	13.28	17.15	13.07
1942	18.94	18.56	19.71	22.26	22.39	21.91	19.61	20.34
1943	20.27	18.26	19.22	20.08	20.14	19.57	20.35	18.21
1944	13.56	13.46	13.86	10.25	9.74	9.62	14.95	11.64
1945	20.11	17.71	18.91	17.58	17.34	17.07	16.80	15.28
1946	18.05	17.32	17.76	17.04	17.36	16.92	22.95	15.82
1947	12.69	13.47	17.52	21.50	22.57	22.56	19.30	14.00
1948	11.13	13.18	15.56	15.13	14.97	14.78	12.41	12.79
1949	16.95	16.83	17.30	17.78	17.53	17.82	14.03	12.74
1950	17.89	12.46	14.23	11.88	11.84	12.13	13.80	12.00
1951	22.10	19.74	23.10	24.55	26.55	24.26	20.27	22.55
1952	19.30	18.18	21.04	19.50	20.21	18.54	18.27	21.81
1953	20.05	23.68	27.01	20.18	20.44	19.57	22.36	20.62
1954	20.81	18.43	22.67	19.18	18.46	19.31	16.38	16.77
1955	26.02	24.74	25.93	22.88	22.52	22.62	21.77	19.39
1956	15.54	14.30	15.21	20.89	20.84	20.83	16.67	15.88
1957	11.09	14.72	13.60	16.25	16.77	14.27	18.18	14.65
1958	15.16	23.44	24.10	21.13	20.70	20.71	20.40	19.29
1959	17.61	19.91	18.99	21.57	20.64	20.84	20.82	16.13
1960	13.90	18.48	18.06	18.18	17.33	17.07	16.40	13.83
1961	16.46	16.06	17.72	16.74	15.88	16.58	18.39	10.51
1962	20.89	19.50	23.06	21.23	20.51	19.01	18.84	16.99
1963	20.57	20.41	22.21	24.34	22.74	23.40	20.69	19.86
1964	13.25	9.75	9.94	14.51	13.98	13.98	15.31	11.20
1965	17.25	17.84	19.08	16.74	15.53	15.12	17.97	12.28
1966	16.93	16.38	15.58	15.10	14.77	14.93	16.12	15.91
1967	19.11	19.40	19.31	22.21	21.22	20.23	18.47	16.53
1968	14.33	19.97	19.40	20.15	18.79	18.92	17.64	16.70
1969	17.16	21.22	20.99	24.27	21.68	22.09	18.49	18.23
1970	18.85	21.78	19.96	18.54	17.10	17.36	19.49	19.21
1971	16.95	18.21	16.61	17.25	16.93	16.20	16.75	16.42
1972	18.99	19.65	16.79	19.37	18.06	18.01	16.51	13.71
1973	23.06	23.48	21.00	24.60	23.81	23.16	22.13	20.98
1974	19.37	20.19	19.33	21.44	20.81	20.24	17.43	19.29
1975	19.75	23.49	22.01	23.97	23.75	22.61	19.80	19.52
1976	20.28	19.84	16.88	20.08	20.05	19.64	22.98	18.22
1977	20.15	19.19	18.89	25.28	25.29	24.80	18.67	22.18
1978	18.49	15.72	13.31	18.19	18.54	18.30	15.37	18.06
1979	18.31	17.29	16.97	22.17	21.31	22.01	18.76	16.35
1980	17.01	19.08	17.16	18.47	18.33	18.43	17.41	17.50
1981	16.71	14.89	13.49	14.65	14.69	14.83	14.95	13.94
1982	21.54	15.43	17.40	20.81	20.07	20.08	18.05	17.56
1983	19.77	19.02	20.57	22.81	21.56	21.76	16.20	20.91
1984	18.68	15.43	14.99	21.22	20.99	19.52	16.25	15.92
1985	18.31	18.79	19.55	20.97	20.43	19.79	19.12	16.85
1986	17.20	15.67	16.18	18.29	18.61	18.37	15.40	18.04
1987	16.46	18.15	18.54	20.10	20.20	20.20	19.07	20.18
1988	13.14	16.31	16.64	15.41	14.96	15.55	16.42	14.45
1989	17.60	18.56	18.72	18.82	18.51	19.06	15.25	15.73
1990	16.82	16.05	15.62	17.89	18.70	18.72	19.62	13.04
1991	17.63	16.77	17.07	16.76	16.32	16.85	17.57	14.78
1992	19.48	16.02	15.86	13.38	13.14	13.48	16.82	14.38
1993	18.64	17.43	16.88	22.77	22.63	22.78	24.45	16.66
1994	17.09	15.10	14.26	17.23	17.11	17.63	15.24	14.52
1995	16.66	16.29	15.48	9.03	8.84	9.67	14.46	12.53
1996	16.37	16.80	16.02	18.98	18.53	18.89	17.70	14.58
1997	17.39	15.33	14.36	17.35	16.09	17.13	20.42	16.75
1998	17.33	14.39	14.34	14.74	14.26	14.41	13.07	14.15
1999	21.47	20.73	20.45	25.31	23.31	23.83	22.14	18.04
2000	17.70	17.73	18.00	18.90	18.52	18.37	17.96	16.36
Avg	17.71	17.71	17.97	18.90	18.51	18.37	18.00	16.33

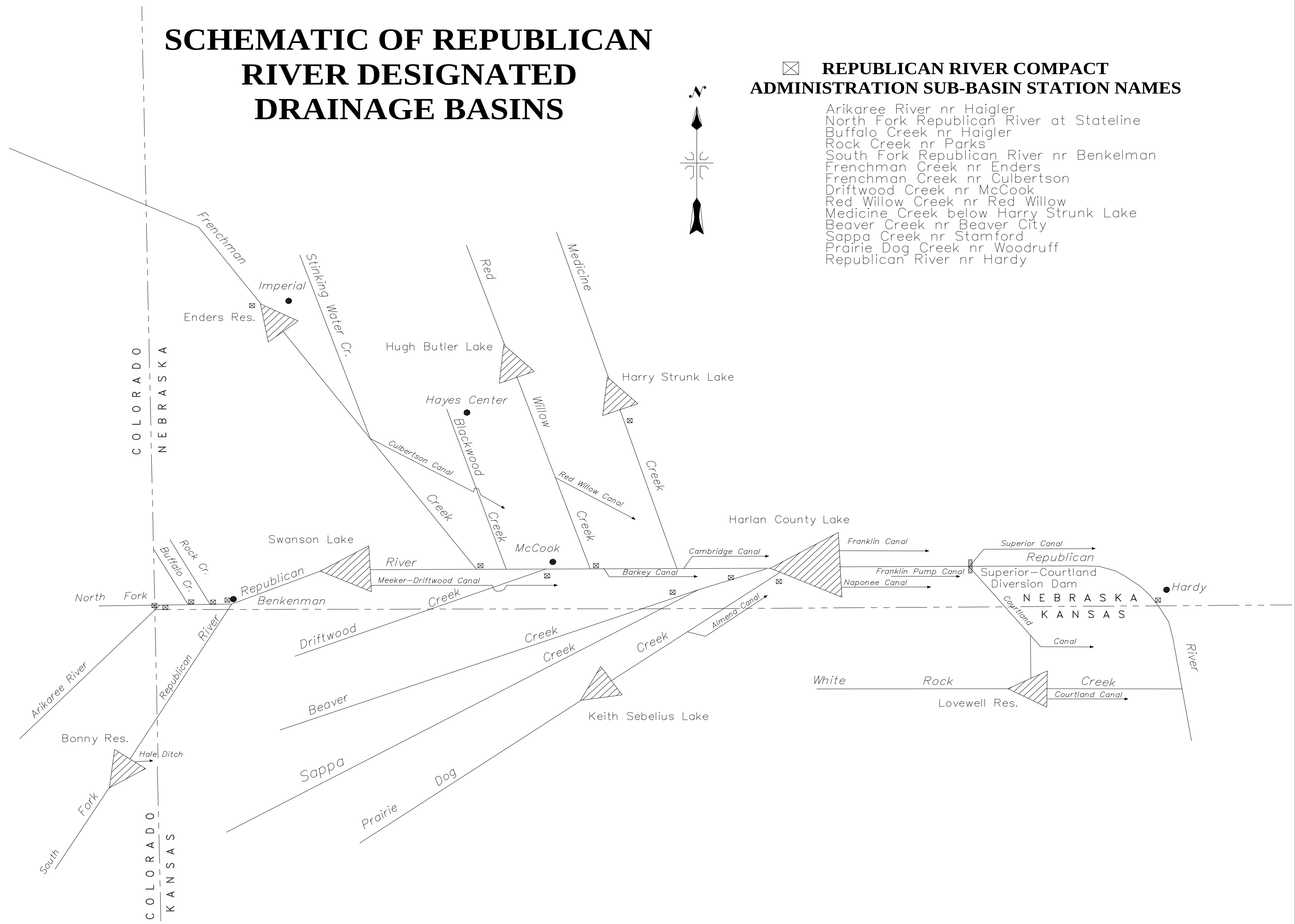
COMPOSITE CONSUMPTIVE USE OF IRRIGATION WATER FOR ALL CROPS

Republican Basin Counties in Kansas

Inches

	KS, Cheyenne	KS, Decatur	KS, Gove	KS, Graham	KS, Jewell	KS, Logan	KS, Norton	KS, Phillips	KS, Rawlins	KS, Rooks	KS, Sheridan	KS, Sherman	KS, Thomas	KS, Trego	KS, Wallace
1940	19.28	21.61	15.94						22.25		16.90	16.21		16.86	
1941	17.24	11.63	13.69			14.10			16.01		13.78	16.01		13.10	
1942	18.82	17.35	15.43			13.70	18.02		18.89		15.34	17.48	20.01	15.19	18.18
1943	19.85	19.09	17.20			17.81	18.63		20.48		17.78	17.54	19.10	18.80	19.06
1944	15.76	12.33	12.61			11.63	15.23		16.02		12.73	16.18	15.26	11.98	14.97
1945	16.77	16.31	15.51			17.24	17.57		16.25		16.14	16.81	18.61	16.82	17.90
1946	20.36	17.27	16.76			18.35	19.12		20.63		17.56	20.28	20.40	17.20	19.53
1947	18.43	17.31	16.92			14.79	16.60		18.62		16.40	17.60	17.28	20.05	17.13
1948	16.46	15.50	13.79			15.29	17.90		16.79		14.36	16.51	19.07	11.92	16.03
1949	15.85	14.11	14.56			12.88	16.84		16.08		13.99	15.03	17.73	14.70	14.47
1950	18.11	18.08	13.46			12.24	17.53	15.20	18.76		13.67	18.49	18.66	12.38	19.47
1951	12.65	11.01	10.53			7.84	12.12	11.45	11.90		9.44	13.04	12.49	9.66	12.65
1952	21.94	20.57	17.99			18.74	19.62	19.38	22.68		18.74	21.03	19.95	19.35	20.85
1953	19.76	15.19	13.88			13.38	16.35	15.66	19.35		14.09	17.96	16.35	13.51	18.34
1954	21.24	18.69	16.00	17.54		18.56	17.42	18.15	20.50		16.74	20.27	17.21	16.07	19.58
1955	21.39	19.05	15.59	17.08		18.96	18.74	18.42	19.45	17.10	16.92	21.00	19.22	14.65	20.32
1956	21.23	18.63	18.35	18.93	24.06	18.71	20.07	18.27	20.04	17.84	17.85	21.87	20.91	16.19	22.86
1957	15.78	15.21	11.33	12.20	13.72	14.61	11.82	14.02	14.63	12.17	11.91	17.37	12.10	10.45	17.29
1958	16.41	13.75	11.51	13.28	13.52	13.55	14.46	13.19	14.12	12.06	12.14	18.29	13.59	10.38	17.56
1959	18.58	16.93	14.28	15.13	16.26	16.06	18.29	17.10	16.78	13.90	14.52	18.43	17.36	12.10	18.00
1960	20.32	17.40	14.06	14.14	13.51	14.67	16.50	14.78	18.86	13.70	14.35	20.98	16.17	12.74	20.39
1961	15.37	15.77	10.12	11.18	16.73	15.12	15.34	15.25	15.01	10.20	11.48	15.31	15.10	5.77	15.48
1962	12.09	10.96	11.44	13.26	17.33	12.05	12.09	11.39	10.87	11.57	11.43	16.04	12.29	11.85	16.03
1963	18.89	17.28	13.60	16.39	17.54	13.79	16.21	16.21	17.79	13.97	13.64	18.64	15.34	14.55	19.16
1964	20.39	15.17	17.29	19.77	15.99	18.26	20.12	18.91	18.42	18.22	17.76	21.62	20.41	17.02	20.95
1965	15.04	10.55	9.29	11.06	15.87	11.16	11.14	11.33	14.61	9.98	9.92	17.39	11.67	8.93	16.16
1966	18.26	13.84	14.76	17.53	19.71	12.72	17.21	15.71	18.66	15.10	14.44	19.36	17.14	14.03	19.72
1967	18.58	14.84	15.09	13.97	16.47	12.15	19.36	12.56	18.91	12.52	14.35	18.19	19.42	12.11	18.41
1968	18.58	12.60	12.34	16.80	12.36	13.54	15.69	15.18	18.35	13.53	13.22	18.91	14.54	11.09	18.31
1969	18.60	16.88	13.70	15.16	13.99	14.38	16.21	14.16	17.38	14.60	14.56	17.96	15.90	13.62	17.25
1970	19.90	17.19	14.96	16.61	18.13	17.59	18.13	19.58	18.26	16.85	16.66	21.05	17.33	13.79	19.76
1971	20.22	16.01	17.05	19.70	19.60	18.59	19.26	18.51	20.80	19.76	18.41	21.66	19.24	18.07	20.28
1972	15.15	13.27	15.13	15.67	15.69	16.07	16.47	14.69	14.51	15.10	14.84	17.04	17.37	14.20	16.19
1973	18.16	17.07	14.98	18.36	14.45	20.12	15.87	16.70	18.03	18.77	16.91	19.23	16.42	15.94	18.87
1974	19.08	17.46	18.78	21.17	22.07	21.84	18.66	20.26	18.16	22.41	19.94	22.43	18.76	21.11	21.80
1975	18.05	12.94	12.91	13.97	12.79	15.01	13.51	13.98	16.51	14.92	13.75	19.80	13.65	13.43	18.87
1976	21.36	19.06	19.87	21.06	20.68	24.25	22.46	22.44	20.81	22.52	22.39	23.19	22.81	19.20	23.20
1977	15.88	12.63	13.61	14.54	14.84	16.13	13.56	14.44	13.50	16.47	14.82	17.46	13.85	13.69	17.12
1978	20.12	17.41	17.70	17.66	18.40	19.65	19.81	15.92	18.43	19.34	19.06	21.19	20.41	16.72	21.57
1979	16.08	10.68	13.33	14.58	21.01	13.78	14.27	13.30	15.74	15.36	14.00	15.22	13.81	14.10	15.69
1980	15.26	19.44	18.11	20.48	24.65	21.31	20.66	20.63	17.09	21.13	20.26	14.23	19.84	18.77	14.32
1981	16.10	16.68	16.62	15.50	16.44	14.52	18.47	13.53	14.13	15.50	16.21	18.71	17.77	16.66	19.34
1982	13.98	14.90	12.95	14.20	13.97	15.41	12.80	15.20	14.25	14.44	14.06	12.84	12.89	14.18	13.26
1983	18.33	17.15	16.87	17.20	17.34	19.05	18.63	19.89	19.48	18.39	18.52	16.77	18.84	17.32	17.25
1984	16.97	15.92	15.52	17.41	18.28	21.86	18.04	21.84	17.58	19.06	18.43	15.71	17.69	15.91	15.69
1985	15.58	14.18	15.38	16.88	14.07	18.28	16.15	17.54	14.62	18.19	16.71	14.54	15.71	16.92	14.53
1986	17.65	13.30	15.59	15.08	15.05	16.88	20.04	15.75	17.59	15.50	16.45	18.25	18.86	13.83	18.06
1987	15.54	14.24	14.12	15.50	16.68	16.35	15.91	15.07	16.62	15.91	15.20	16.21	15.65	14.97	16.20
1988	16.69	13.45	17.57	18.52	22.74	18.70	18.80	15.31	18.34	19.15	18.35	16.30	19.23	17.45	16.83
1989	16.69	14.86	14.46	15.66	17.11	15.84	16.01	15.21	20.47	18.83	15.53	14.84	16.33	15.56	15.23
1990	18.11	17.95	16.20	16.88	17.02	18.92	20.54	16.97	20.72	20.13	17.71	17.31	19.76	16.00	18.11
1991	13.66	13.27	16.38	16.98	19.05	17.57	17.49	17.38	16.14	22.75	17.07	13.13	17.18	18.33	13.62
1992	14.00	13.65	11.85	13.84	10.59	13.07	14.47	13.07	16.93	16.05	13.01	14.25	14.15	12.74	14.81
1993	11.71	8.74	9.74	11.04	6.77	10.06	12.59	7.64	12.47	11.36	10.01	11.24	12.60	9.36	11.58
1994	18.03	13.60	17.12	17.26	17.86	14.21	17.76	13.75	18.25	19.12	16.78	19.26	18.11	18.56	20.30
1995	16.72	19.84	15.98	17.10	15.31	19.68	17.23	18.92	18.56	19.02	17.61	15.20	17.54	15.06	16.05
1996	12.21	9.43	9.83	10.86	14.46	10.39	10.39	8.62	9.68	11.28	10.27	14.92	10.23	10.90	15.45
1997	15.99	17.66	14.01	15.13	15.08	15.69	17.02	16.76	17.38	15.91	14.92	16.29	16.77	12.75	16.78
1998	16.78	15.88	13.97	16.80	22.74	16.52	16.33	15.98	18.49	19.18	15.05	17.49	15.86	14.10	17.84
1999	14.42	11.22	14.26	14.04	17.45	13.10	16.39	12.41	15.00	15.35	13.52	15.00	15.67	14.50	15.17
2000	21.83	22.19	20.03	20.25	20.65	17.73	24.27	17.57	23.99	21.67	19.54	20.87	23.65	20.26	21.09
40-00 Avg	17.41	15.51	14.79	16.03	16.84	15.91	16.92	15.79	17.40	16.43	15.45	17.60	16.97	14.71	17.64

SCHEMATIC OF REPUBLICAN RIVER DESIGNATED DRAINAGE BASINS



Appendix N – Phreatophyte Distribution

Colorado – The Colorado Gap Analysis Project (CO-GAP) was initiated in 1991 as a cooperative effort among federal, state, and private natural resource groups in Colorado. The major objectives of the project are to: map actual land cover as closely as possible and make all GAP Project information available to users in a readily accessible format to institutions, agencies, and private land owners. Landsat imagery was acquired or interpreted to establish a baseline map of vegetation and land cover. Attributes were assigned to each polygon describing primary, secondary, and other land cover, crown closure for forested primary types, and the types of wetlands and/or disturbance found in the polygon, if any. Polygon attributes were assigned using image interpretation, existing maps, field reconnaissance, digital reference layers from Federal land management agencies, and literature sources.

Kansas – Landsat TM7 imagery from 2000 was obtained covering most of the RRCA Model area, except for the far south-central and far-eastern portions. Tributaries with visible phreatophyte cover were mapped as a subset of the hydrographic drainage network available as a digital line graph from the USGS. Tributaries were then divided according to the relative width of the riparian cover. Within each of these discrete reaches, cross sections from the outside boundaries of the riparian vegetation were then mapped and the average cross section within the reach was calculated. One-half of this average cross section was used as the distance from the hydrographic channel mapped by the USGS to map a polygon to enclose the riparian phreatophyte corridor along the reach. These polygons were merged with the Nebraska polygons denoting woody phreatophytes because some areas mapped as woody phreatophytes lay well outside of the riparian corridor.

Nebraska – The Nebraska Department of Natural Resources (NDNR), in association with the Nebraska Conservation and Survey Division maintain a collection of digitally rectified aerial photography for landscape analysis. This data has a resolution of 20-ft. and was projected in UTM, Nad83. The NDNR digitized the 1993 Digital Orthophoto Quarter Quadrangle to identify phreatophyte forests from visual examination of the black and white aerial photography at a scale of 1:15,000. Polygons were fit over the photographs in ESRI's Arc View GIS then re-projected into the RRCA Model projection (UTM, Nad27). Approximately 100 sites were visually inspected during field reconnaissance to verify the distribution of woody phreatophytes obtained from the aerial photography. The polygon output provided by Kansas was combined with the aerial photography analysis by Nebraska to include wetland areas in the minor tributaries, with corrections to exclude polygons of irrigated croplands. To accommodate the synoptic biases due to scale, polygon correction was performed at a scale of 1:50,000. Polygons to represent the phreatophyte areas downstream of Red Cloud, Nebraska and the extended groundwater mound area in Kearney and Adams County, Nebraska were derived from aerial photography at a scale of 1:50,000.

Appendix N Phreatophyte Evapotranspiration Rates (example)

Phreatophyte Monthly ET Rates (inches)

Month	Akron	McCook	RedCloud
19180100	0.19	0.24	0.07
19180200	0.63	0.72	0.51
19180300	1.69	2.25	1.66
19180400	1.60	2.62	2.00
19180500	7.26	7.31	4.25
19180600	9.47	11.13	9.07
19180700	8.37	7.90	7.05
19180800	6.22	6.74	7.14
19180900	4.67	5.62	5.13
19181000	2.74	2.06	1.88
19181100	0.74	1.00	0.46
19181200	0.04	0.14	0.00
19190100	0.54	0.61	0.98
19190200	0.47	0.00	0.00
19190300	1.40	1.15	1.35
19190400	0.95	1.61	0.89
19190500	5.41	6.41	4.57
19190600	7.81	7.58	5.82
19190700	10.69	9.80	10.33
19190800	10.27	7.88	9.16
19190900	5.94	7.32	2.09
19191000	3.00	2.58	1.54
19191100	0.78	0.31	0.00
19191200	0.46	0.44	0.26
19200100	0.61	0.81	0.76
19200200	0.87	0.85	0.59
19200300	1.20	1.98	2.13
19200400	0.00	0.95	1.23
19200500	4.29	5.64	5.30
19200600	5.40	8.35	8.16
19200700	7.26	10.35	9.16
19200800	8.22	6.84	5.09
19200900	6.78	6.72	4.99
19201000	5.36	2.54	2.45
19201100	1.68	0.78	0.33
19201200	0.82	0.48	0.54
19210100	0.24	0.38	0.60
19210200	1.00	1.15	1.07
19210300	1.36	2.03	2.23
19210400	2.38	4.47	2.85
19210500	7.84	7.21	6.07
19210600	8.56	9.19	8.63
19210700	9.31	9.19	7.50
19210800	8.77	7.15	8.17
19210900	6.62	5.46	3.48
19211000	2.38	1.82	2.18
19211100	1.16	1.07	1.16
19211200	0.65	0.91	0.87
19220100	0.56	0.66	0.65
19220200	0.82	0.81	0.86
19220300	1.67	1.38	0.96
19220400	0.79	2.05	2.41
19220500	5.11	7.01	5.17
19220600	8.68	8.64	9.74
19220700	8.32	8.68	7.98
19220800	9.81	9.10	9.78
19220900	8.15	6.69	5.84
19221000	3.20	2.63	1.82
19221100	0.12	0.30	0.65
19221200	0.98	0.67	0.83
19230100	1.08	0.92	0.98
19230200	0.77	0.78	0.92
19230300	0.91	1.13	0.77
19230400	1.77	1.56	1.89
19230500	3.18	1.75	4.42
19230600	7.13	6.09	4.50
19230700	7.26	6.10	7.56
19230800	8.57	6.29	6.56
19230900	6.89	5.87	4.50
19231000	2.06	1.36	1.55
19231100	1.35	2.15	1.01
19231200	0.10	1.03	0.75

Appendix N Sub-Basin Factors

YEAR	SWANSON	HARLAN	FRENCHMAN	MEDICINE	PRAIRIEDOG	REDWILLOW	SFABVBONNY	SFBLWBONNY	SAPPA	NORTHFORK	BEAVER	ARIKAREE	BUFFALO	ROCK	DRIFTWOOD
1938	1.00	0.67	1.00	0.40	0.67	1.00	0.28	0.03	0.67	0.47	0.67	0.47	0.30	0.13	0.27
1939	1.00	0.67	1.00	0.42	0.67	1.00	0.28	0.06	0.67	0.49	0.67	0.49	0.33	0.16	0.30
1940	1.00	0.67	1.00	0.43	0.67	1.00	0.28	0.09	0.67	0.52	0.67	0.52	0.35	0.19	0.32
1941	1.00	0.67	1.00	0.45	0.67	1.00	0.28	0.11	0.67	0.55	0.67	0.55	0.38	0.22	0.34
1942	1.00	0.67	1.00	0.47	0.67	1.00	0.28	0.14	0.67	0.58	0.67	0.58	0.41	0.25	0.36
1943	1.00	0.67	1.00	0.49	0.67	1.00	0.28	0.17	0.67	0.61	0.67	0.61	0.44	0.28	0.39
1944	1.00	0.67	1.00	0.51	0.67	1.00	0.28	0.20	0.67	0.63	0.67	0.63	0.47	0.31	0.41
1945	1.00	0.67	1.00	0.53	0.67	1.00	0.28	0.23	0.67	0.66	0.67	0.66	0.50	0.34	0.43
1946	1.00	0.67	1.00	0.55	0.67	1.00	0.28	0.25	0.67	0.69	0.67	0.69	0.53	0.36	0.46
1947	1.00	0.67	1.00	0.57	0.67	1.00	0.28	0.28	0.67	0.72	0.67	0.72	0.56	0.39	0.48
1948	1.00	0.67	1.00	0.59	0.67	1.00	0.28	0.31	0.67	0.74	0.67	0.74	0.58	0.42	0.50
1949	1.00	0.67	1.00	0.61	0.67	1.00	0.28	0.34	0.67	0.77	0.67	0.77	0.61	0.45	0.53
1950	1.00	0.67	1.00	0.63	0.67	1.00	0.28	0.37	0.67	0.80	0.67	0.80	0.64	0.48	0.55
1951	1.00	0.67	1.00	0.65	0.67	1.00	0.31	0.39	0.67	0.83	0.67	0.83	0.67	0.51	0.57
1952	1.00	0.67	1.00	0.67	0.67	1.00	0.33	0.42	0.67	0.86	0.67	0.86	0.70	0.54	0.59
1953	1.00	0.67	1.00	0.69	0.67	1.00	0.35	0.45	0.67	0.88	0.67	0.88	0.73	0.57	0.62
1954	1.00	0.67	1.00	0.71	0.67	1.00	0.37	0.48	0.67	0.91	0.67	0.91	0.76	0.60	0.64
1955	1.00	0.67	1.00	0.73	0.67	1.00	0.40	0.51	0.67	0.94	0.67	0.94	0.78	0.63	0.66
1956	1.00	0.67	1.00	0.75	0.67	1.00	0.42	0.53	0.67	0.97	0.67	0.97	0.81	0.66	0.69
1957	1.00	0.67	1.00	0.77	0.67	1.00	0.44	0.56	0.67	1.00	0.67	1.00	0.84	0.69	0.71
1958	1.00	0.67	1.00	0.79	0.67	1.00	0.47	0.59	0.67	1.02	0.67	1.02	0.87	0.72	0.73
1959	1.00	0.67	1.00	0.81	0.67	1.00	0.49	0.62	0.67	1.05	0.67	1.05	0.90	0.75	0.76
1960	1.00	0.67	1.00	0.83	0.67	1.00	0.51	0.65	0.67	1.06	0.67	1.06	0.92	0.78	0.78
1961	1.00	0.67	1.00	0.85	0.67	1.00	0.53	0.67	0.67	1.06	0.67	1.06	0.94	0.81	0.80
1962	1.00	0.67	1.00	0.87	0.67	1.00	0.56	0.67	0.67	1.07	0.67	1.07	0.95	0.83	0.82
1963	1.00	0.67	1.00	0.89	0.67	1.00	0.58	0.67	0.67	1.08	0.67	1.08	0.97	0.86	0.85
1964	1.00	0.67	1.00	0.91	0.67	1.00	0.60	0.67	0.67	1.09	0.67	1.09	0.99	0.89	0.87
1965	1.00	0.67	1.00	0.91	0.67	1.00	0.62	0.67	0.67	1.09	0.67	1.09	1.01	0.92	0.89
1966	1.00	0.67	1.00	0.91	0.67	1.00	0.65	0.67	0.67	1.10	0.67	1.10	1.01	0.93	0.90
1967	1.00	0.67	1.00	0.92	0.67	1.00	0.67	0.67	0.67	1.11	0.67	1.11	1.02	0.93	0.91
1968	1.00	0.67	1.00	0.92	0.67	1.00	0.68	0.67	0.67	1.11	0.67	1.11	1.02	0.93	0.92
1969	1.00	0.67	1.00	0.92	0.67	1.00	0.70	0.67	0.67	1.12	0.67	1.12	1.03	0.93	0.93
1970	1.00	0.67	1.00	0.92	0.67	1.00	0.71	0.67	0.67	1.09	0.67	1.09	1.01	0.94	0.92
1971	1.00	0.67	1.00	0.93	0.67	1.00	0.72	0.67	0.67	1.08	0.67	1.08	1.01	0.94	0.92
1972	1.00	0.67	1.00	0.93	0.67	1.00	0.73	0.67	0.67	1.10	0.67	1.10	1.01	0.94	0.92
1973	1.00	0.67	1.00	0.93	0.67	1.00	0.75	0.67	0.67	1.09	0.67	1.09	1.01	0.94	0.93
1974	1.00	0.67	1.00	0.94	0.67	1.00	0.76	0.67	0.67	1.09	0.67	1.09	1.01	0.95	0.93
1975	1.00	0.67	1.00	0.94	0.67	1.00	0.77	0.67	0.67	1.08	0.67	1.08	1.02	0.95	0.95
1976	1.00	0.67	1.00	0.94	0.67	1.00	0.78	0.67	0.67	1.08	0.67	1.08	1.01	0.95	0.94
1977	1.00	0.67	1.00	0.95	0.67	1.00	0.80	0.67	0.67	1.07	0.67	1.07	1.01	0.96	0.95
1978	1.00	0.67	1.00	0.95	0.67	1.00	0.81	0.67	0.67	1.07	0.67	1.07	1.01	0.96	0.95
1979	1.00	0.67	1.00	0.95	0.67	1.00	0.82	0.67	0.67	1.06	0.67	1.06	1.01	0.96	0.95
1980	1.00	0.67	1.00	0.96	0.67	1.00	0.84	0.67	0.67	1.06	0.67	1.06	1.01	0.96	0.96
1981	1.00	0.67	1.00	0.96	0.67	1.00	0.85	0.67	0.67	1.05	0.67	1.05	1.01	0.97	0.96
1982	1.00	0.67	1.00	0.96	0.67	1.00	0.86	0.67	0.67	1.05	0.67	1.05	1.01	0.97	0.96
1983	1.00	0.67	1.00	0.97	0.67	1.00	0.87	0.67	0.67	1.05	0.67	1.05	1.01	0.97	0.97
1984	1.00	0.67	1.00	0.97	0.67	1.00	0.89	0.67	0.67	1.04	0.67	1.04	1.01	0.97	0.97
1985	1.00	0.67	1.00	0.97	0.67	1.00	0.90	0.67	0.67	1.04	0.67	1.04	1.01	0.98	0.97
1986	1.00	0.67	1.00	0.97	0.67	1.00	0.91	0.67	0.67	1.03	0.67	1.03	1.01	0.98	0.98
1987	1.00	0.67	1.00	0.98	0.67	1.00	0.92	0.67	0.67	1.03	0.67	1.03	1.00	0.98	0.98
1988	1.00	0.67	1.00	0.98	0.67	1.00	0.94	0.67	0.67	1.02	0.67	1.02	1.00	0.98	0.98
1989	1.00	0.67	1.00	0.98	0.67	1.00	0.95	0.67	0.67	1.02	0.67	1.02	1.00	0.99	0.99
1990	1.00	0.67	1.00	0.99	0.67	1.00	0.96	0.67	0.67	1.01	0.67	1.01	1.00	0.99	0.99
1991	1.00	0.67	1.00	0.99	0.67	1.00	0.97	0.67	0.67	1.01	0.67	1.01	1.00	0.99	0.99
1992	1.00	0.67	1.00	0.99	0.67	1.00	0.99	0.67	0.67	1.00	0.67	1.00	1.00	0.99	0.99
1993	1.00	0.67	1.00	1.00	0.67	1.00	1.00	0.67	0.67	1.00	0.67	1.00	1.00	1.00	1.00
1994	1.00	0.67	1.00	1.00	0.67	1.00	1.00	0.67	0.67	1.00	0.67	1.00	1.00	1.00	1.00
1995	1.00	0.67	1.00	1.00	0.67	1.00	1.00	0.67	0.67	1.00	0.67	1.00	1.00	1.00	1.00
1996	1.00	0.67	1.00	1.00	0.67	1.00	1.00	0.67	0.67	1.00	0.67	1.00	1.00	1.00	1.00
1997	1.00	0.67	1.00	1.00	0.67	1.00	1.00	0.67	0.67	1.00	0.67	1.00	1.00	1.00	1.00
1998	1.00	0.67	1.00	1.00	0.67	1.00	1.00	0.67	0.67	1.00	0.67	1.00	1.00	1.00	1.00
1999	1.00	0.67	1.00	1.00	0.67	1.00	1.00	0.67	0.67	1.00	0.67	1.00	1.00	1.00	1.00
2000	1.00	0.67	1.00	1.00	0.67	1.00	1.00	0.67	0.67	1.00	0.67	1.00	1.00	1.00	1.00

Distribution of Specific Yield

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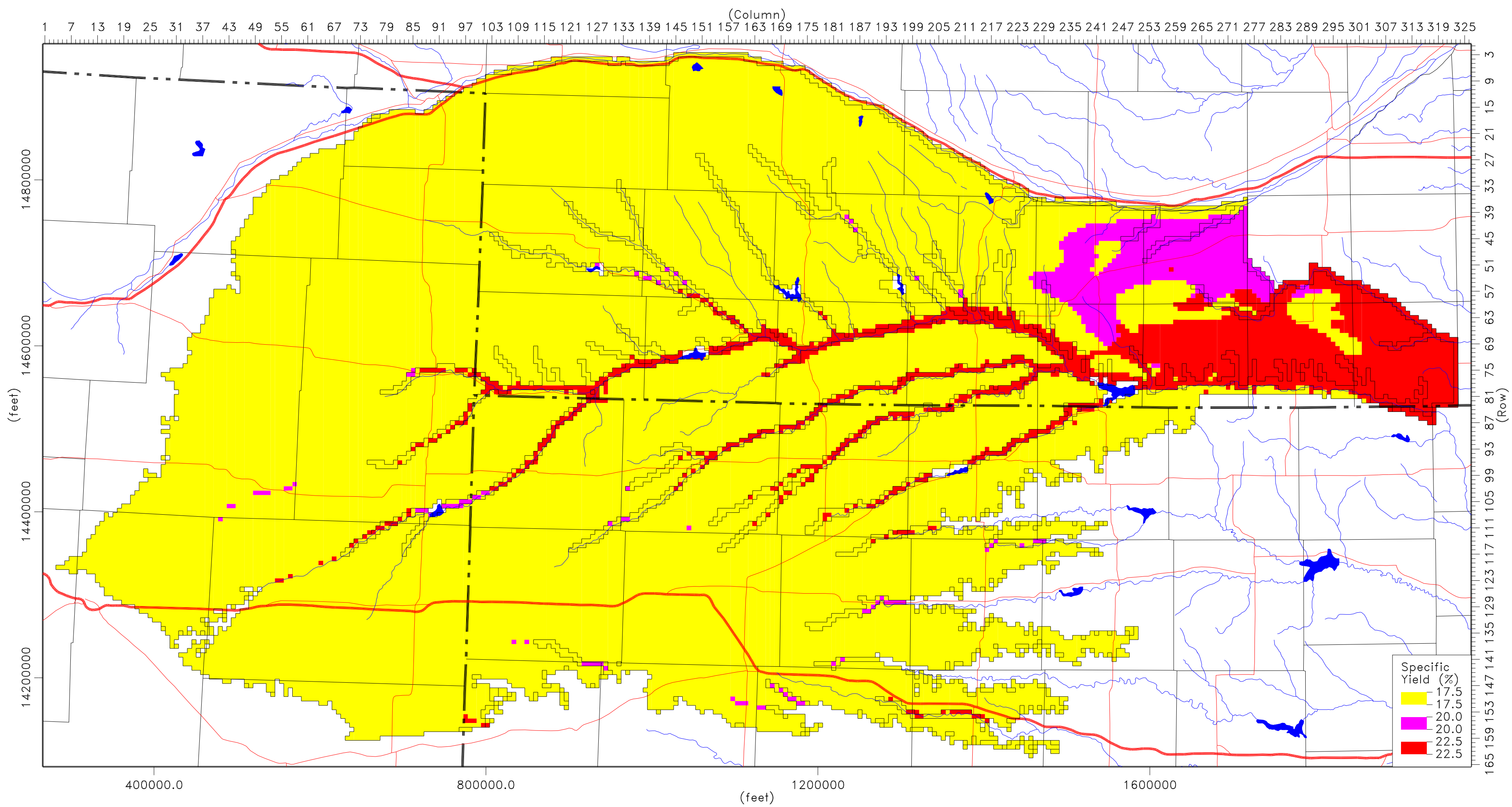

Distribution of Hydraulic Conductivity

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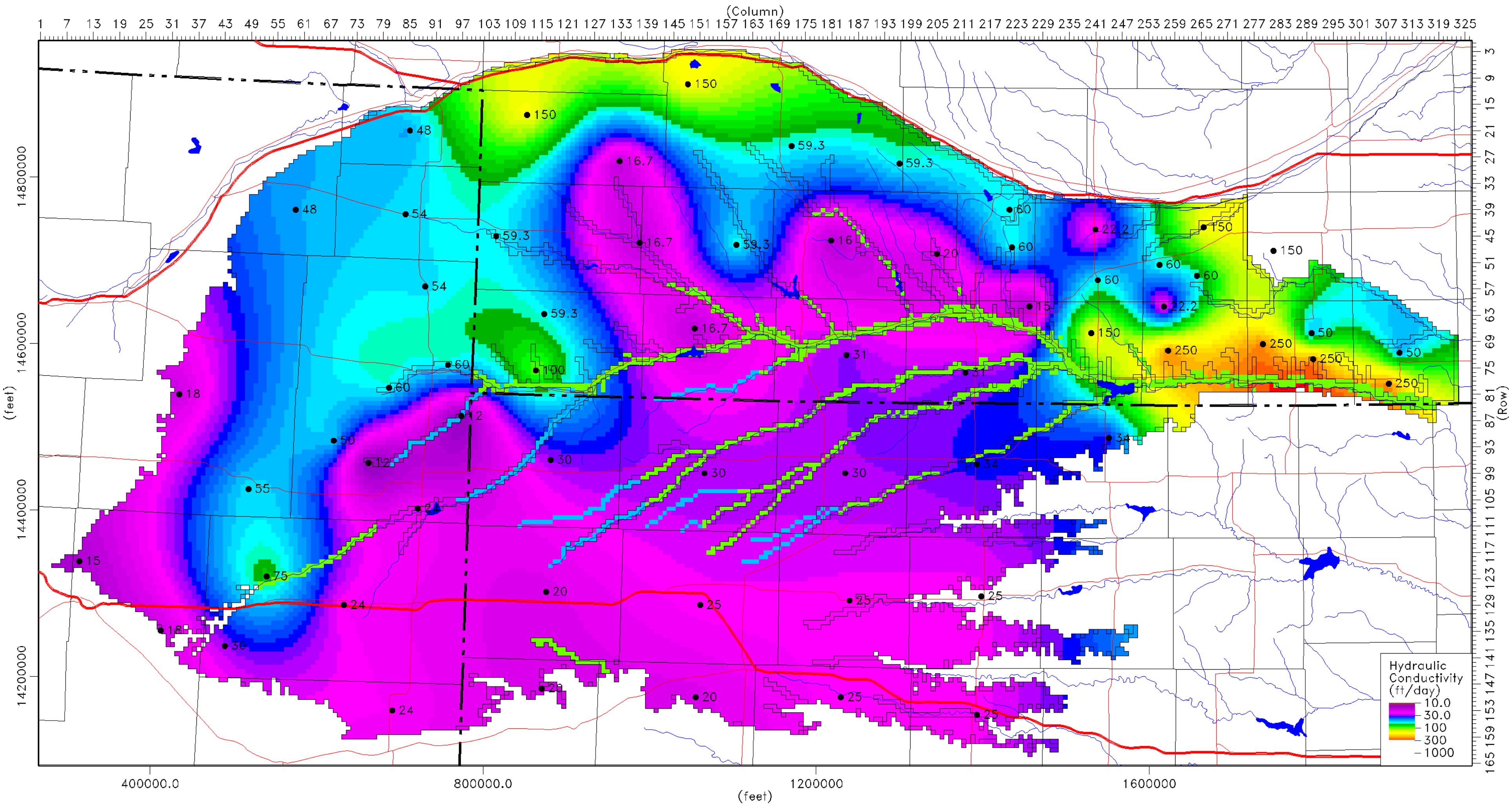

Spatial Multipliers

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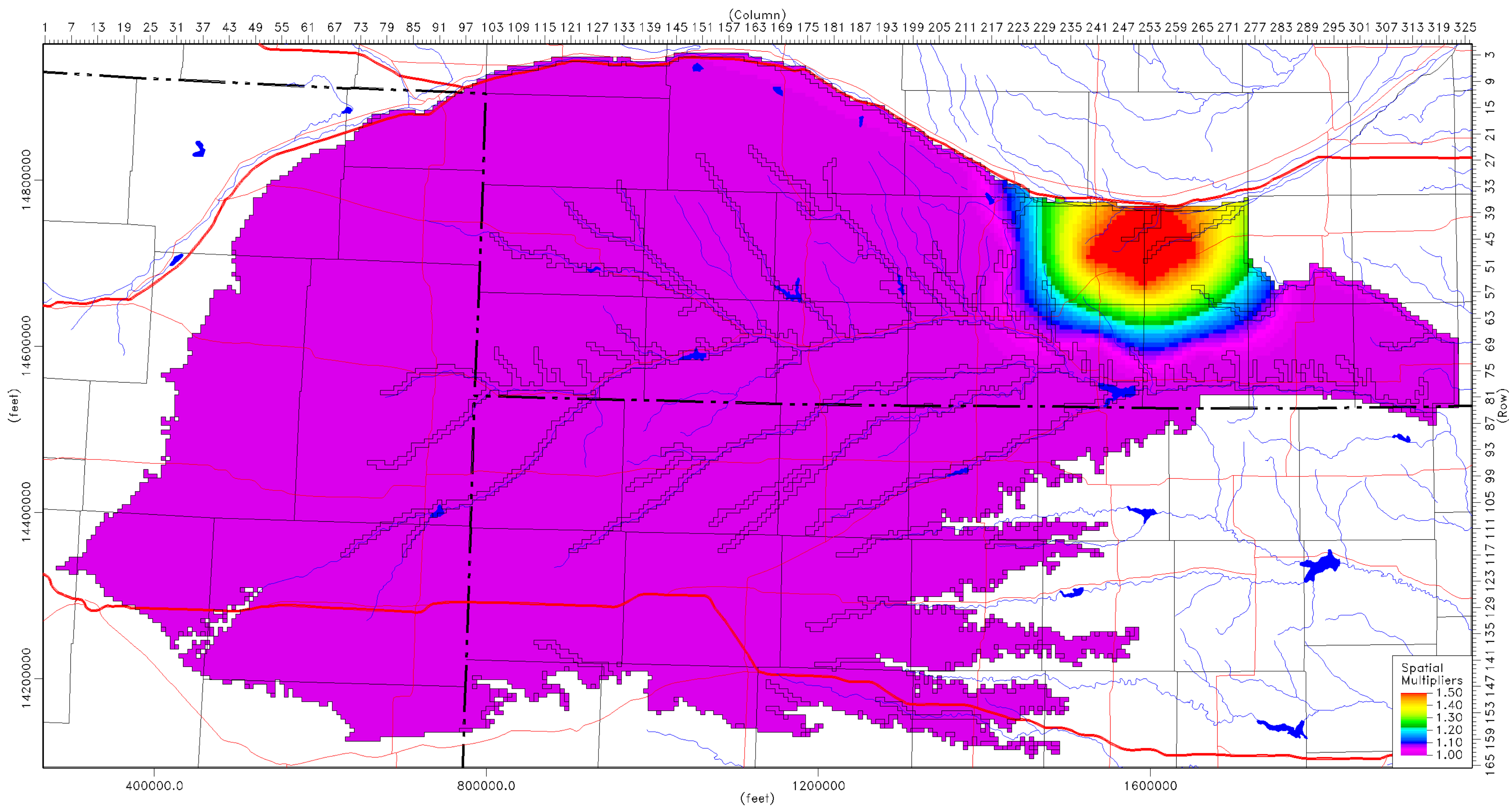

Location of Phreatophyte Sub-Basins

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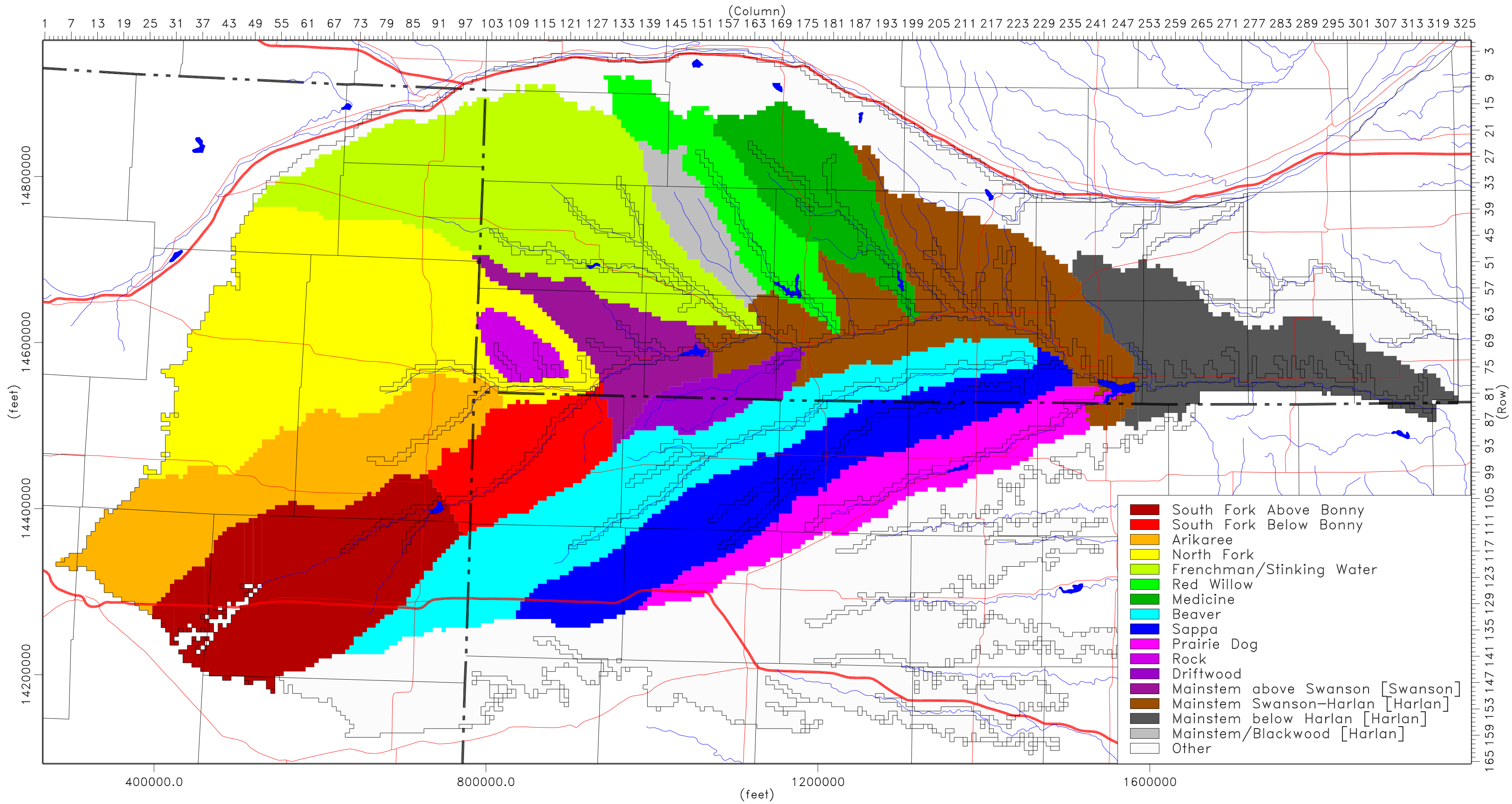

Phreatophyte Area

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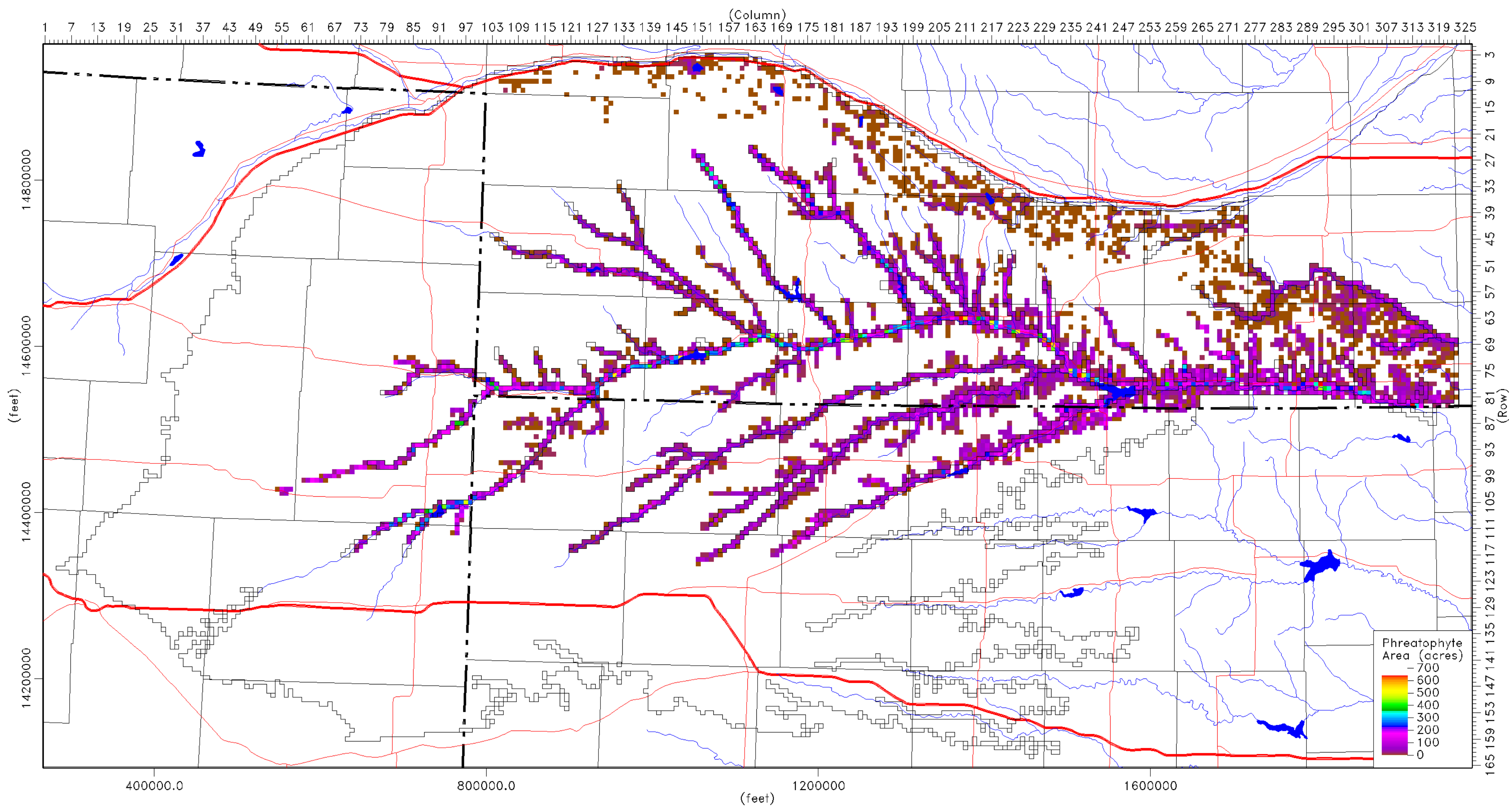

Saturated Thickness

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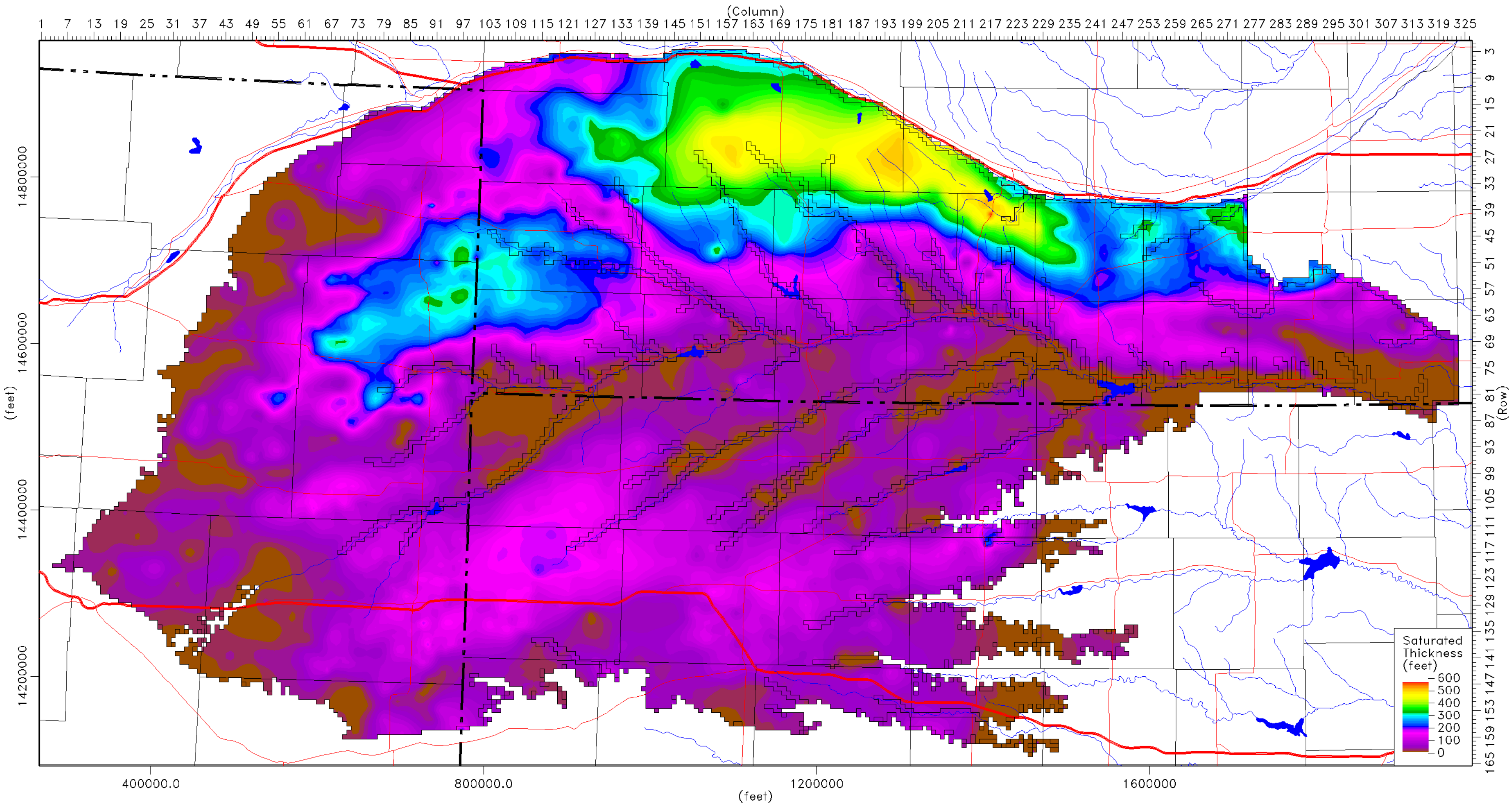
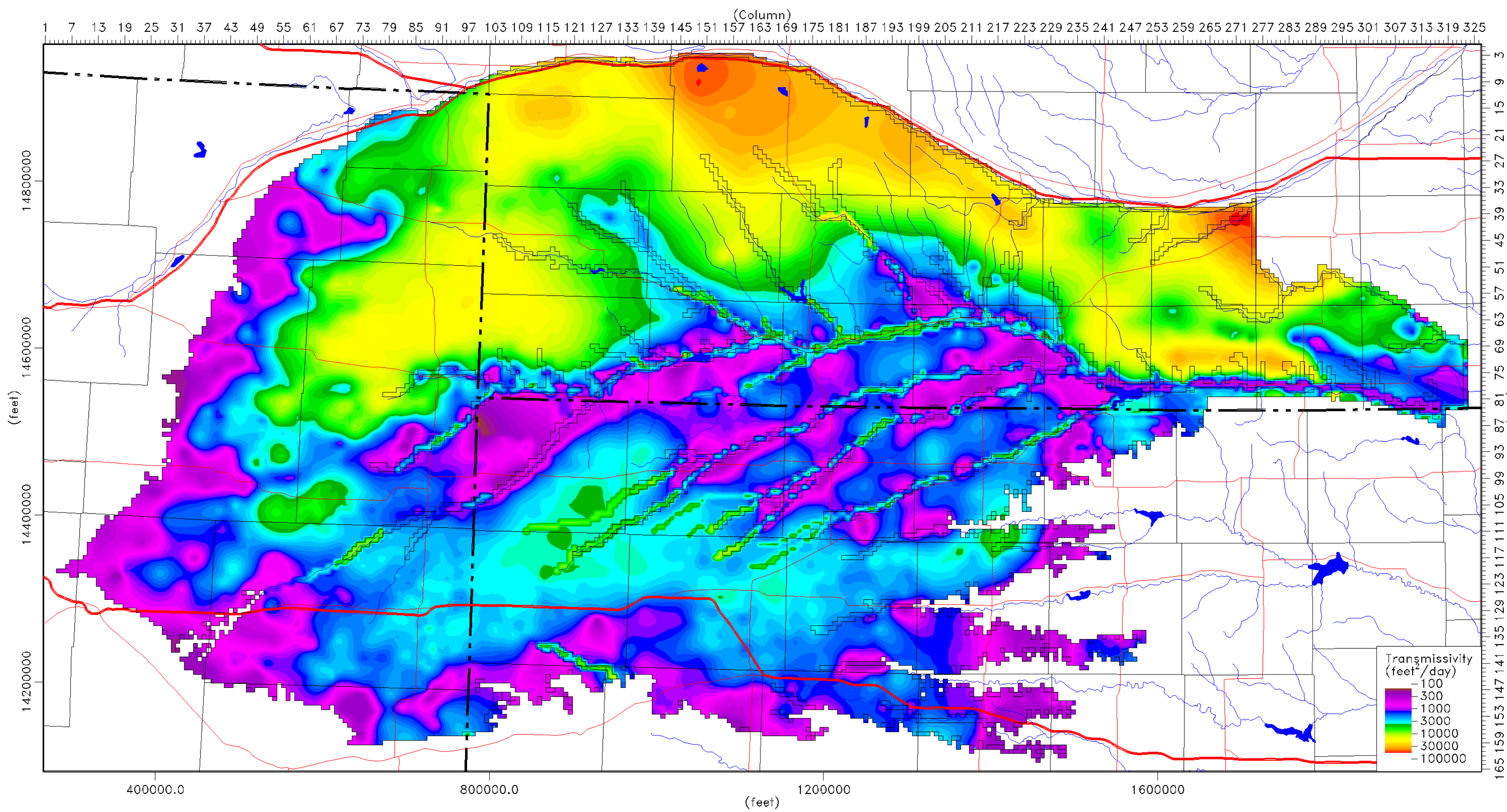


Transmissivity

Republican River Settlement Model Version 12p



Version 12p: Impact of Colorado Pumping (acre-feet)

Year	Arikaree	Beaver	Buffalo	Driftwood	Frenchman	North Fork	Above Swanson	Swanson-Harlan	Harlan-Guide Rock	Guide Rock-Hardy	Medicine	Prairie Dog	Red Willow	Rock	Sappa	South Fork	Hugh Butler	Bonny	Keith Sebelius	Enders	Harlan	Harry Strunk	Swanson	Mainstem Total	Total
1981	1049	0	33	0	255	7485	-540	0	0	0	0	0	0	0	0	9654	0	758	0	0	0	0	0	-540	18705
1982	2335	0	40	0	305	7822	-883	0	0	0	0	0	0	0	0	8566	0	760	0	0	0	0	0	-882	18954
1983	1678	0	46	0	366	7908	-1775	0	0	0	0	0	0	0	0	8193	0	780	0	0	0	0	0	-1775	17208
1984	1109	0	53	0	421	8342	-1391	0	0	0	0	0	0	0	0	7822	0	835	0	0	0	0	0	-1391	17205
1985	516	0	61	0	471	8627	-1455	0	0	0	0	0	0	0	0	9579	0	841	0	0	0	0	0	-1455	18656
1986	455	0	69	0	532	8757	-1572	0	0	0	0	0	0	0	0	7544	0	860	0	0	0	0	0	-1572	16661
1987	511	0	78	0	604	9256	-1699	0	0	0	0	0	0	11	0	9783	0	900	0	0	0	0	0	-1699	19451
1988	955	0	89	0	676	9684	-1978	0	0	0	0	0	0	12	0	7770	0	950	0	0	0	0	0	-1978	18167
1989	245	0	98	0	724	9766	-1957	0	0	0	0	0	0	13	0	8552	0	968	0	0	0	0	0	-1957	18417
1990	589	0	109	0	713	10426	-2114	0	0	0	0	0	0	15	0	9811	0	985	0	0	0	0	0	-2114	20543
1991	1462	0	121	0	738	10837	-1181	0	0	0	0	0	0	17	0	10622	0	975	0	0	0	0	0	-1182	23598
1992	2233	0	134	0	745	11199	-1052	0	0	0	0	0	0	19	0	10355	0	994	0	0	0	0	0	-1053	24633
1993	2018	0	146	0	1000	11400	-1067	0	0	0	0	0	0	21	0	9497	0	1005	0	0	0	0	0	-1067	24025
1994	1149	0	157	0	901	11607	-2716	0	0	0	0	0	0	23	0	8999	0	1044	0	0	0	0	0	-2717	21171
1995	1870	0	171	0	814	12011	-2056	0	0	0	0	0	0	26	0	12038	0	1053	0	0	0	0	0	-2058	25935
1996	1774	0	184	0	946	12257	-847	-20	0	0	0	0	0	29	0	11006	0	1054	0	0	0	0	0	-867	26391
1997	1687	0	197	0	981	12307	-2563	0	0	0	0	0	0	32	0	9123	0	1078	0	0	0	0	0	-2566	22847
1998	1239	0	207	0	717	12521	-3330	0	0	0	0	0	0	35	0	11280	0	1121	0	0	0	0	0	-3333	23799
1999	981	0	220	0	1010	13004	-761	0	0	0	0	0	0	38	0	12429	0	1116	0	0	0	0	14	-765	28050
2000	1918	0	234	0	599	13173	-4253	0	0	0	0	0	0	42	0	9280	0	1170	0	0	0	0	11	-4252	22178
Average 1981-2000	1289	0	122	0	676	10419	-1759	0	0	0	0	0	0	19	0	9595	0	962	0	0	0	0	0	-1761	21330

Version 12p: Impact of Kansas Pumping (acre-feet)

Year	Arikaree	Beaver	Buffalo	Driftwood	Frenchman	North Fork	Above Swanson	Swanson-Harlan	Harlan-Guide Rock	Guide Rock-Hardy	Medicine	Prairie Dog	Red Willow	Rock	Sappa	South Fork	Hugh Butler	Bonny	Keith Sebelius	Enders	Harlan	Harry Strunk	Swanson	Mainstem Total	Total
1981	216	5205	0	0	0	0	298	214	0	230	0	4068	0	0	-596	11006	0	0	359	0	26	0	0	741	21036
1982	192	5893	0	0	0	0	225	-25	0	165	0	4542	0	0	2068	5907	0	0	486	0	24	0	0	365	19488
1983	96	5812	0	0	0	0	277	-132	0	187	0	4086	0	0	2089	4280	0	0	453	0	21	0	0	332	17176
1984	151	5974	0	0	0	0	191	-320	0	281	0	4055	0	0	2319	7733	0	0	754	0	20	0	0	152	21166
1985	153	5960	0	0	0	11	163	203	0	208	0	3525	0	0	2719	6660	0	0	654	0	19	0	0	573	20277
1986	126	4994	0	0	0	0	198	-201	0	238	0	2195	0	0	905	6038	0	0	616	0	18	0	0	235	15141
1987	170	5169	0	0	0	13	168	76	0	213	0	4496	0	0	244	8101	0	0	551	0	17	0	0	458	19221
1988	154	4567	0	0	0	13	261	-315	0	271	0	2498	0	0	-112	7218	0	0	612	0	16	0	0	217	15187
1989	156	2321	0	0	0	15	185	190	0	213	0	751	0	0	-803	6683	0	0	682	0	17	0	0	589	10414
1990	211	1150	0	0	0	14	-27	123	0	233	0	780	0	0	-758	9655	0	0	641	0	18	0	0	330	12046
1991	276	1223	0	0	0	21	163	20	0	252	0	2180	0	0	-1024	10674	0	0	658	0	19	0	0	436	14468
1992	178	2904	0	0	0	12	426	-50	0	50	0	4455	0	0	-1726	6603	0	0	425	0	17	0	0	428	13302
1993	223	7614	0	0	0	0	236	124	-14	18	0	14166	0	0	2795	8378	0	0	404	0	66	0	0	364	34024
1994	101	7570	0	0	0	0	236	-221	0	188	0	6357	0	0	3782	3327	0	0	475	0	114	0	0	213	21949
1995	202	6882	0	0	0	12	19	-369	0	218	0	3689	0	0	2176	8931	0	0	485	0	83	0	0	-130	22336
1996	211	7005	0	0	0	16	326	328	0	218	0	5919	0	0	3011	7546	0	0	334	0	65	0	0	875	24988
1997	141	6815	0	0	0	14	232	-395	0	178	0	4121	0	0	2476	5911	0	0	427	0	54	0	0	19	19984
1998	167	5618	0	0	0	12	39	-386	0	168	0	2543	0	0	837	7752	0	0	404	0	48	0	0	-176	17212
1999	239	5686	0	0	0	15	352	-32	0	201	0	2479	0	0	-198	8864	0	0	356	0	45	0	0	524	18019
2000	128	4560	0	0	0	15	159	-224	0	257	0	1392	0	0	-670	6320	0	0	407	0	42	0	0	196	12398
Average 1981-2000	175	5146	0	0	0	12	206	-70	0	199	0	3915	0	0	977	7379	0	0	509	0	37	0	0	337	18492

Version 12p: Impact of Nebraska Pumping (acre-feet)

Year	Arikaree	Beaver	Buffalo	Driftwood	Frenchman	North Fork	Above Swanson	Swanson-Harlan	Harlan-Guide Rock	Guide Rock-Hardy	Medicine	Prairie Dog	Red Willow	Rock	Sappa	South Fork	Hugh Butler	Bonny	Keith Sebelius	Enders	Harlan	Harry Strunk	Swanson	Mainstem Total	Total
1981	261	5535	1400	835	50240	271	9755	40493	12594	1492	8786	0	4047	1101	1187	1004	840	0	0	1695	623	188	143	64334	142490
1982	211	5795	1476	830	51039	287	8711	31087	12456	1433	8595	0	3414	1282	2904	607	882	0	0	1802	672	207	136	53688	133825
1983	118	5301	1498	922	51364	356	7137	21529	13871	1541	8766	0	3131	1364	2865	612	926	0	0	1895	681	226	137	44077	124237
1984	181	5281	1550	1039	54366	390	9567	32874	14519	1380	9668	0	3700	1426	2909	673	994	0	0	2037	774	245	150	58340	143724
1985	191	5369	1647	1052	56320	435	10049	36237	14576	1552	10213	0	4168	1504	3263	727	1041	0	0	2200	713	266	157	62414	151681
1986	178	4546	1729	1073	57393	453	9138	28874	14815	1368	10678	0	4039	1590	2126	722	1109	0	0	2342	790	288	155	54195	143406
1987	190	4736	1799	1103	58503	516	9262	35060	15649	1398	11095	0	4227	1705	1461	730	1123	0	0	2440	715	308	154	61370	152176
1988	170	4097	1874	1098	59767	568	9340	30341	18179	1572	11387	0	4174	1833	1269	728	1171	0	0	2547	821	325	160	59432	151420
1989	164	2155	1940	1101	60367	603	9010	28409	17745	1691	11889	0	4153	1915	687	422	1263	0	0	2661	896	342	160	56855	147573
1990	204	1119	2056	1122	63991	692	10898	32804	18139	1603	12775	0	4550	2037	615	794	1336	0	0	2795	909	364	173	63445	158975
1991	298	1446	2221	1150	67075	693	12258	38384	20759	1985	13916	0	5185	2224	576	976	1421	0	0	2933	995	385	166	73386	175046
1992	210	3120	2297	1153	64303	689	10270	49739	18849	1723	13628	0	5476	2373	710	933	1307	0	0	3040	844	404	147	80581	181215
1993	192	7110	2286	1076	63516	693	8532	45586	16874	1404	12098	0	5083	2501	4354	806	1114	0	0	3081	642	409	131	72396	177488
1994	117	6727	2296	1044	67838	792	9125	28337	18763	1399	12198	0	4383	2563	4897	603	1349	0	0	3165	868	417	157	57624	167037
1995	233	6402	2413	1117	70355	848	10632	41753	22113	1905	13695	0	5471	2642	3552	889	1449	0	0	3300	957	436	155	76403	190318
1996	239	6270	2503	1146	70624	860	11074	52670	20709	1876	13687	0	5934	2775	4117	934	1363	0	0	3386	770	452	143	86330	201533
1997	164	5964	2568	1150	72910	970	10951	34408	22506	1830	13892	0	5313	2839	3495	853	1480	0	0	3464	963	464	162	69695	186346
1998	206	4978	2690	1196	73764	1045	10150	35058	21914	1726	14510	0	5338	2894	2419	806	1549	0	0	3606	949	483	180	68849	185461
1999	313	4870	2799	1171	75119	1030	12815	49574	21936	1793	13913	0	6346	3023	1149	1048	1345	0	0	3711	862	494	179	86117	203490
2000	196	3568	2912	1153	74876	1156	10260	30832	25316	1926	14585	0	5179	3125	792	982	1601	0	0	3848	989	505	220	68335	184022
Average 1981-2000	202	4720	2098	1077	63186	667	9947	36203	18114	1630	11999	0	4666	2136	2267	792	1233	0	0	2797	822	360	158	65893	165073

Version 12p: Impact of Nebraska Imports (acre-feet)

Year	Arikaree	Beaver	Buffalo	Driftwood	Frenchman	North Fork	Above Swanson	Swanson-Harlan	Harlan-Guide Rock	Guide Rock-Hardy	Medicine	Prairie Dog	Red Willow	Rock	Sappa	South Fork	Hugh Butler	Bonny	Keith Sebelius	Enders	Harlan	Harry Strunk	Swanson	Mainstem Total	Total
1981	0	0	0	0	0	0	0	8539	49	0	6637	0	11	0	0	0	0	0	0	0	0	0	0	8587	15236
1982	0	0	0	0	0	0	0	6989	56	0	6719	0	13	0	0	0	0	0	0	0	0	0	0	7045	13783
1983	0	0	0	0	0	0	0	6355	63	0	6705	0	13	0	0	0	0	0	0	0	0	0	0	6417	13140
1984	0	0	0	0	0	0	0	6532	70	0	7122	0	15	0	0	0	0	0	0	0	0	0	0	6600	13742
1985	0	0	0	0	0	0	0	9461	80	0	7222	0	16	0	0	0	0	0	0	0	0	0	0	9540	16787
1986	0	0	0	0	0	0	0	5852	88	0	7195	0	16	0	0	0	0	0	0	0	0	0	0	5939	13154
1987	0	0	0	0	0	0	0	9202	100	0	7438	0	18	0	0	0	0	0	0	0	0	0	0	9299	16759
1988	0	0	0	0	0	0	0	6077	107	0	7604	0	20	0	0	0	0	0	0	0	0	0	0	6181	13809
1989	0	0	0	0	0	0	0	6178	114	0	7538	0	18	0	0	0	0	0	0	0	0	0	0	6290	13849
1990	0	0	0	0	0	0	0	7020	115	0	7662	0	19	0	0	0	0	0	0	0	0	0	0	7133	14815
1991	0	0	0	0	0	0	0	4515	113	0	8038	0	20	0	0	0	0	0	0	0	0	0	0	4625	12688
1992	0	0	0	0	0	0	0	6175	100	0	8371	0	24	0	0	0	0	0	0	0	0	0	0	6272	14672
1993	0	0	0	0	0	0	0	15487	191	0	8878	0	40	0	14	0	0	0	0	0	0	0	0	15673	24611
1994	0	0	0	0	0	0	0	7251	188	0	8467	0	30	0	17	0	0	0	0	0	0	0	0	7435	15954
1995	0	0	0	0	0	0	0	8908	189	0	8770	0	35	0	0	0	0	0	0	0	0	0	0	9094	17916
1996	0	0	0	0	0	0	0	14968	219	0	9153	0	39	0	15	0	0	0	0	0	0	0	0	15181	24395
1997	0	0	0	0	0	0	0	7171	204	0	9020	0	39	0	0	0	0	0	0	0	0	0	0	7372	16447
1998	0	0	0	0	0	0	0	8578	174	0	8891	0	34	0	0	0	0	0	0	0	0	0	0	8750	17694
1999	0	0	0	0	0	0	0	8764	165	0	9482	0	33	0	0	0	0	0	0	0	0	0	0	8925	18450
2000	0	0	0	0	0	0	0	9413	155	0	9058	0	31	0	0	0	0	0	0	0	0	0	0	9564	18664
Average 1981-2000	0	0	0	0	0	0	0	8172	127	0	7998	0	24	0	0	0	0	0	0	0	0	0	0	8296	16328