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CALIBRATION AND USE OF AN INTERACTIVE-ACCOUNTING MODEL TO SIMULATE DISSOLVED SOLIDS, STREAMFLOW, AND WATER-SUPPLY OPERATIONS IN THE ARKANSAS RIVER BASIN, COLORADO

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 88-4214

Prepared in cooperation with the
SOUTHEASTERN COLORADO WATER
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By Alan W. Burns

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Lakewood, Colorado
1989

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CONVERSION FACTORS

Inch-pound units in this report may be converted to metric (International System) units by using the following conversion factors:

<i>Multiply</i>	<i>By</i>	<i>To obtain</i>
acre-foot	1,233	cubic meter
cubic foot per second	0.02817	cubic meter per second
cubic foot per second per mile	0.0176	cubic meter per second per kilometer
ton, short	907.2	kilogram
inch	25.4	millimeter

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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TO SIMULATE DISSOLVED SOLIDS, STREAMFLOW,
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By Alan W. Burns

ABSTRACT

An interactive-accounting model was used to simulate the dissolved solids, streamflow, and water-supply operations in the Arkansas River basin, Colorado. The model calculates streamflow for incremental drainage areas by use of regression equations and a time series of independent variables such as snowpack, precipitation, or gaged streamflow. Dissolved-solids concentrations can be calculated at each model node location for the corresponding streamflow. Streamflow and dissolved-solids loads then can be routed downstream by the model. Use of the model incorporating relations of specific conductance to streamflow enabled the computation of dissolved-solids loads throughout the basin. To simulate streamflow only, all of the water-supply operations were incorporated in the incremental streamflow regression relations and the model was calibrated for 1940-85. Coefficients of determination for streamflow-only simulation for 20 nodes ranged from 0.89 to 0.58. The model input was then revised to incorporate 74 water users and 11 reservoirs to simulate water-supply operations. Two periods were used for this calibration: 1943-74, which included John Martin Reservoir; and 1975-85, which also included the Fryingpan-Arkansas project with Pueblo Reservoir. Calibration of the water-supply operations resulted in coefficients of determination that ranged from 0.87 to negative for 37 selected water users. Even for those users whose simulated irrigation diversions did not relate well statistically to the observed diversions, plots of data generally indicated reasonable model results. Plots of simulated reservoir contents also indicated reasonable similarity to observed values. Coefficients of determination for 13 selected streamflow nodes ranged from 0.87 to 0.02. To demonstrate the utility of the model, six specific alternatives were simulated to consider the effects of the potential enlargement of Pueblo Reservoir. The model was used in this mode to simulate a 46-year period, which represented hydrologic conditions of 1940-85, with three major different alternatives: 1975-85 calibrated model data, calibrated model data with an addition of 30 cubic feet per second to the Fountain Creek flows, and calibrated model data with a municipal water user leaving Fryingpan-Arkansas project water in storage rather than diverting it. These three major alternatives included the option of reservoir enlargement or no enlargement to give the six total alternatives. A 40,000-acre-foot enlargement of Pueblo Reservoir resulted in average annual increases of 2,500 acre-feet in transmountain imports, of 800 acre-feet in storage diversions, and of 100 acre-feet in winter-water storage.

INTRODUCTION

The hydrologic system of the Arkansas River basin in Colorado is a set of complex interactions between surface water and ground water and between natural runoff and man's water use. Most of the streamflow in the river originates as snowmelt in the mountainous upper basin (fig. 1). The river is a conduit that transports the water eastward to the fertile lands of eastern Colorado. Irrigation in the basin began about 1860 with small ditches diverting water to irrigate the nearby flood plain. By the 1880's, large ditches had been constructed to irrigate thousands of acres along the river, and the normal streamflow that occurs during the growing season had been appropriated for use. To enable use of streamflow that occurred at times other than during the growing season, diversion canals leading to off-channel storage reservoirs were constructed during the 1890's. To supplement water supply for irrigation, water was imported from the Rio Grande and Colorado River basins as early as 1900; the water then was stored in high-mountain reservoirs for delivery during the growing season or during periods of lower natural streamflow. Many ground-water wells were drilled in the 1940's, 1950's, and 1960's in the alluvial aquifer adjacent to the river to supply additional water for irrigation. In addition to these privately financed developments, the Federal government built two large on-channel reservoirs for flood protection and supplemental irrigation water. John Martin Reservoir (capacity of 701,775 acre-feet) near Las Animas was completed by the U.S. Army Corps of Engineers in about 1947; Pueblo Reservoir (capacity of 357,000 acre-feet) near Pueblo was completed by the U.S. Bureau of Reclamation in about 1975. In addition, Trinidad Reservoir (capacity of 114,500 acre-feet) was built on the Purgatoire River near Trinidad by the U.S. Army Corps of Engineers about 1980.

The hydrologic cycle in this complex, conjunctive-use system can be idealized as follows. Good quality water exits the mountainous part of the basin as snowmelt (upstream from Canon City) in the late spring-early summer. This water is diverted for irrigation. Canal leakage and excess irrigation applications recharge the alluvial aquifer adjacent to the river. Because of the concentrating effects of consumptive use of water but not solutes by crops, this recharge is degraded from that of the applied water. Return flows, in the form of both surface water and ground water, replenish some of the flow in the river, which provides water to the next user downstream. This process continues on downstream, and streamflow generally decreases and solute concentrations increase. As the proportion of the river flow that was the original good quality snowmelt decreases downstream, the quality of surface water in the river and ground water in the adjacent aquifer becomes more similar. In areas of ground-water pumpage, return flows are diminished. However, the decrease in return flow because of pumpage is offset by return flows caused by additional excess irrigation applications produced by the added ground-water supply.

In a cooperative study between the Southeastern Colorado Water Conservancy District and the U.S. Geological Survey, an interactive accounting model for a digital computer was developed (Burns, 1988) to simulate the hydrologic system of the Arkansas River basin in Colorado. The model has many options capable of simulating varying degrees of complexity. In its simplest form, the model was used to simulate dissolved-solids loads throughout the basin by entering observed streamflow data at the node locations of interest (without using the routing capability of the model). The model then was used

Figure 1.--Location of study area.

to simulate the hydrologic system of the basin by using regression equations to calculate incremental streamflow at each point of interest and by routing the streamflow and dissolved-solids loads downstream. For this simulation, the effects of water use were incorporated into the regression equations that normally calculate only incremental streamflow. Finally, the model was used to simulate the water-supply operations of the basin, including reservoirs, ground-water pumpage, and irrigation return flows. This report discusses the calibration and use of the model in the Arkansas River basin and the data necessary to simulate the basin at each level of complexity. The process of adjusting model parameters and factors so that the model will provide a reasonable and useful facsimile to the real system also is discussed.

Description of the Model

The Arkansas River and tributaries are represented in the model by a network of nodes (fig. 2). Node ID's (numbers) and names are listed in table 1 with the corresponding gaging-station numbers and names. Gaging stations 07137500 and 07137000 are located in Kansas but are used in the model to represent streamflow leaving the State of Colorado. Regression equations are used to estimate the monthly streamflow of each incremental drainage area, by using a time series of independent variables such as snowpack, precipitation, or gaged streamflow. Concentrations of a conservative constituent (dissolved solids for this study) are calculated by using regression equations; streamflow is the independent variable. Streamflow and dissolved-solids loads then are routed downstream. When all of the model options are used, the water-use and ground-water systems in the basin also are included. Types of water users that can be simulated include agricultural, municipal, and industrial users, and reservoir operators. Each water user has a list of potential water sources that includes direct diversions, ground-water pumpage, imports, or reservoir releases. Specific data are input to the computer in the order that the water user will use these sources to satisfy individual demands. All direct diversions are simulated to conform to the basinwide priorities, according to the prior-appropriation doctrine (Radosевич and others, 1975). Stream depletion from ground-water pumpage, and return flow from excess irrigation applications and canal leakage are simulated by using ground-water response functions (Jenkins, 1968a, 1968b, 1968c; Burns, 1983).

Purpose and Criteria of Model Calibration

The model was developed to simulate future or hypothetical changes in hydrologic conditions or water-supply operations in the Arkansas River basin in Colorado. Confidence in simulated results can be enhanced by demonstrating the reasonableness of the results. Hydrologic models, in general, have three typical components: (1) Model input, a time series of natural stresses; (2) model parameters, which enable equations in the model to describe the physical system being simulated; and (3) model output, a time series that results from the physical system acting on the natural stress inputs. A process common to hydrologic modeling is calibration, which is the process of entering an observed time series of input data to a model, and then adjusting the appropriate model parameters so that the time series of simulated output "best" fits, or matches, the corresponding observed sequence. "Best" fit can have many possible definitions that are qualitative and quantitative.

Figure 2.--Streamflow node locations in the Arkansas River basin model.

Table 1.--Node locations in the Arkansas River basin model and corresponding streamflow-gaging stations

Node ID	Node name	Station ¹ number	Station name
812	ARK LEAD	07081200	Arkansas River near Leadville
830	HALFMOON	07083000	Halfmoon Creek near Malta
845	LAKE CK	07084500	Lake Creek above Twin Lakes Reservoir
860	ARK GRNT	07086000	Arkansas River at Granite
865	CLEAR CK	07086500	Clear Creek above Clear Creek Reservoir
890	COTTNWD	07089000	Cottonwood Creek below Hot Springs
915	ARK SLID	07091500	Arkansas River at Salida
937	ARK WELL	07093700	Arkansas River near Wellsville
945	ARK PARK	07094500	Arkansas River at Parkdale
950	GRAPE CK	07095000	Grape Creek near Westcliffe
960	ARK CANC	07096000	Arkansas River at Canon City
970	ARK PORT	07097000	Arkansas River at Portland
991	BEAVER C	07099100	Beaver Creek near Portland
994	ARK PUBL	07099400	Arkansas River above Pueblo
		07099500	Arkansas River near Pueblo
1065	FOUNT PB	07106500	Fountain Creek at Pueblo
1090	ST CHARL	07108500	St. Charles River near Pueblo
		07108800	St. Charles River near Vineland
		07108900	St. Charles River at Vineland
		07109000	St. Charles River at mouth near Pueblo
1095	ARK AVON	07109500	Arkansas River near Avondale
1160	HUERF R	07116000	Huerfano River below Huerfano Valley Dam
1170	ARK NPST	07117000	Arkansas River near Nepesta
1195	APISH R	07119500	Apishapa River near Fowler
1197	ARK CAT	07119700	Arkansas River at Catlin Dam
1230	ARK LAJU	07123000	Arkansas River at La Junta
1240	ARK ANMS	07124000	Arkansas River at Las Animas
1285	PURG ANS	07128500	Purgatoire River near Las Animas
1305	ARK JM R	07130500	Arkansas River below John Martin Reservoir
1330	ARK LAMR	07133000	Arkansas River at Lamar
1341	BIG SAND	07134100	Big Sandy Creek near Lamar
1355	ARK HOLY	07135500	Arkansas River at Holly
1375	ARK COOL	07137500	Arkansas River near Coolidge, Kansas
		07137000	Frontier Ditch near Coolidge, Kansas

¹Station locations are identified in Burns, 1985, table 6 and plate 1.

For this model of the Arkansas River basin, no single measure of "best" fit is defined because of the multitude of simulated outputs produced. Various plots can be drawn to provide qualitative aids for judging reasonableness. Three statistics (mean of the residuals, standard deviation of the residuals, and coefficient of determination) can be calculated for many simulated results to provide a quantitative aid for judging reasonableness. Residuals are calculated as the differences between the simulated value for each month from the current simulation and the simulated value for the same month from some other simulation. During the calibration process, this "other" simulation would be observed data. The mean of the residuals (MR) is the arithmetic average, for all months, of the residuals; the standard deviation of the residuals (SDR) is the square root of the population variance of those residuals. Based on linear-regression theory, the best model parameters are those that produce the MR as zero and a minimized SDR. The coefficient of determination (R^2) for linear regression is defined as the amount of variation in a dependent variable that can be explained by relating it to an independent variable. The coefficient of determination adjusted for degrees of freedom may be expressed as:

$$R^2 = 1 - (SE^2 / SD_y^2) \quad (1)$$

where SE = the standard error of estimate of the regression; and
 SD_y = the standard deviation of the dependent variable.

For a simple linear-regression model, the SE would equal the SDR. Because the river-basin model is not a simple linear regression, the "best" fit may not have MR as zero. To account for this, the coefficient of determination, as used in this report, is defined to include the bias term of a possibly nonzero MR, as:

$$R^2 = 1 - \frac{(MR^2 + SDR^2)}{SD_y^2} \quad (2)$$

For those parameters calibrated by quantitative statistics, the criterion of maximizing R^2 normally was considered most important.

DATA AVAILABLE FOR MODEL INPUT AND CALIBRATION

Collation and analysis of the considerable data available required much of the effort necessary to develop the model for the Arkansas River basin. Observed streamflow data are essential to the model. During the simplest simulation of dissolved-solids loads, observed streamflow data are used as input at all selected main-stem nodes. During simulations that use more complex capabilities, observed streamflow at many of the tributaries is needed for input. Calibration of the model is evaluated by comparing simulated streamflow to observed streamflow. All the needed streamflow data are enumerated in the report "Selected hydrographs and statistical analyses characterizing the water resources of the Arkansas River basin, Colorado," by Alan W. Burns (1985). Precipitation and snowpack data, used as the time-series input of independent variables to the model, also are enumerated by Burns (1985).

Simple linear-regression coefficients are input to the model and used to calculate monthly streamflow from selected independent variables and to calculate dissolved-solids concentrations from streamflow. For the upper basin (upstream from Canon City), snowpack was determined to be the best independent variable to relate to May through September streamflow; precipitation was the best independent variable to relate to October through March streamflow; and air temperature was the best independent variable to relate to April streamflow (P.O. Abbott, U.S. Geological Survey, written commun., 1982). Abbott also determined that the same slope coefficient could be used at various locations, and that different intercept coefficients account for spatial differences in streamflow.

All the necessary regression coefficients for the calculation of dissolved-solids are presented in "Relations of specific conductance to streamflow and selected water-quality characteristics of the Arkansas River basin, Colorado," by Doug Cain (1987). Specific conductance is the most commonly available water-quality characteristic that is measured in the basin. The model first computes specific-conductance values with regression equations by using streamflow as the independent variable. Any conservative constituent that can be related to specific conductance then can be simulated with the model; however, the only constituent attempted to date (1989) is dissolved solids. Cain (1987) presents relations of specific conductance to dissolved solids and to six major ionic constituents. Cain (1987) also presents monthly time series of estimated dissolved-solids loads for three streamflow-gaging stations where at least 10 years of daily specific-conductance values are available for calculating those loads.

Simulation of the water-supply operations of the basin required qualitative and quantitative information. The general water-supply operations in the basin are described in "Description of water-systems operations in the Arkansas River basin, Colorado," by P.O. Abbott (1986). The water users, descriptions of their water systems, and selected data for their operations are enumerated by Abbott (1986); in addition, a listing of the basinwide water-right priorities as of 1985 is provided. Considerable additional data, such as monthly diversions, transmountain imports, reservoir-storage contents, and air temperatures, that were collated as part of this project from numerous sources, have been stored in a computer data base to enable easy retrieval and analysis (W.B. Blattner, U.S. Geological Survey, written commun., 1985).

MODEL CALIBRATION OF SIMULATED DISSOLVED SOLIDS

Cain (1987, table 4) presents regression coefficients for the relations of specific conductance to streamflow at 19 main-stem streamflow-gaging stations on the Arkansas River. Several forms of the relation were tested by Cain (1987); a log-log relation was determined to result in the best fit overall. Cain (1987, table 8) also presents the simple linear-regression coefficients that relate dissolved-solids concentration to specific conductance. These coefficients were calculated from regressions of instantaneous values. The model, in its simplest form, uses observed monthly mean streamflow for selected nodes. The dissolved-solids concentrations for each month simulated are calculated by using the given relations of specific conductance to streamflow and dissolved solids to specific conductance.

Even this simple use of the model required some parameter adjustment or calibration. Errors are introduced into the model because of the "cascading" regressions; that is, first calculating specific-conductance concentration, then dissolved-solids concentration, and then dissolved-solids load. Also, the calibration criteria of minimum MR and SDR for dissolved-solids loads are linear criteria; however, the use of log-log regressions does not produce minimized coefficients for use with arithmetic averages without certain adjustments (Ferguson, 1986). Because regression coefficients were determined from instantaneous values, errors may occur when monthly mean streamflow is used with those coefficients. To determine what adjustments, if any, would be needed to the regression coefficients, the model was used to simulate dissolved-solids loads for three nodes (994, ARK PUBL; 1305, ARK JM R; and 1375, ARK COOL) for which Cain (1987) calculated monthly dissolved-solids loads from daily specific conductance.

Coefficients for relations of specific conductance to streamflow for four simulations are listed in table 2. Separate relations were used for the summer season, May through September, and the winter season, October through April. The calculated MR, SDR, and R^2 for the dissolved-solids loads also are listed in table 2. For simulation 1, the regression coefficients are those calculated by Cain (1987) using instantaneous values. The statistics listed in table 2 relate the indicated simulation results to the observed monthly dissolved-solids loads (Cain, 1987, table 8) from calculated daily specific-conductance data. The coefficients of determination for simulation 1 were 0.65 for 994, ARK PUBL, 0.81 for 1305, ARK JM R, and 0.74 for 1375, ARK COOL. The observed values of dissolved-solids loads for streamflow-gaging station 07099400, Arkansas River above Pueblo, indicate a time trend (Cain, 1987, p. 73-75) that is not simulated by the model for node 994, ARK PUBL. Although the exact cause of this trend is not known, the impoundment of water in Pueblo Reservoir that began in 1974 is assumed to be the direct or indirect cause. Comparison of simulation 1 results for node 1305, ARK JM R, to observed values indicates a good seasonal fit with normally distributed random residuals of the peaks. The results of simulation 1 for node 1375, ARK COOL, indicate obvious overestimation of peaks compared with observed values (especially the flood of June 1965).

Study of daily specific-conductance and streamflow data, especially for June 1965 at streamflow-gaging station 07137500, Arkansas River near Coolidge, Kansas, indicates that coefficients determined from instantaneous data, but applied to monthly mean streamflow, may have caused much of the error indicated by these coefficients of determination. Therefore, log-log regressions were calculated by using observed values of monthly dissolved-solids load and monthly mean streamflow. Regression coefficients for the relations of specific conductance to streamflow that are calculated by log-log regression analysis are listed in table 2 (simulation 2). The generally improved coefficients of determination for the three nodes were 0.68 for 994, ARK PUBL, 0.80 for 1305, ARK JM R, and 0.83 for 1375, ARK COOL. Ferguson (1986) reports an adjustment that can be made to the intercept coefficient of a log-log regression to enable the relation to approximate an arithmetic-minimization criterion. The effects of adjusting the coefficients of the relations of specific conductance to streamflow (simulation 3) ranged from no change for node 994, ARK PUBL, and node 1305, ARK JM R, to a decrease to 0.79 for node 1375, ARK COOL.

Table 2.--Statistical summary of simulated dissolved-solids loads

[All load values are in tons per month]

	Observed data	Simulation number ¹			
		1	2	3	4
994, ARK PUBL					
Number of months.	204				
Average salt load.	12,700				
Standard deviation.	10,500				
Winter relation intercept.		3,000	1,810	1,850	2,180
Winter relation slope.		-0.32	-0.21	-0.21	-0.24
Summer relation intercept.		3,000	3,510	3,660	1,620
Summer relation slope.		-.32	-.33	-.33	-.22
Mean of the residual (MR).		-1,520	-240	273	-52
Standard deviation of the residual (SDR)-----		6,030	5,890	5,860	5,770
Coefficient of determination (R ²)-----		.65	.68	.68	.70
1305, ARK JM R					
Number of months.	360				
Average salt load.	27,300				
Standard deviation.	35,300				
Winter relation intercept.		4,100	3,940	4,100	3,770
Winter relation slope.		-.09	-.11	-.11	-.08
Summer relation intercept.		5,900	4,450	4,630	5,230
Summer relation slope.		-.21	-.17	-.17	-.19
Mean of the residual (MR).		184	-1,920	-702	4
Standard deviation of the residual (SDR)-----		15,600	15,900	15,800	15,500
Coefficient of determination (R ²)-----		.81	.80	.80	.81
1375, ARK COOL					
Number of months.	128				
Average salt load.	28,700				
Standard deviation.	48,800				
Winter relation intercept.		5,100	4,990	5,230	10,400
Winter relation slope.		-.06	-.11	-.11	-.24
Summer relation intercept.		6,900	4,570	4,780	10,200
Summer relation slope.		-.20	-.16	-.16	-.29
Mean of the residual (MR).		6,250	153	1,510	448
Standard deviation of the residual (SDR)-----		23,900	19,900	22,400	7,800
Coefficient of determination (R ²)-----		.74	.83	.79	.97

¹Simulation 1 used regression coefficients calculated by Cain (1987) using instantaneous values. Simulation 2 used regression coefficients calculated using observed monthly dissolved-solids loads. Simulation 3 used regression coefficients calculated using the observed monthly dissolved-solids loads, adjusted to account for the log-log regression. Simulation 4 used the "best-fit" calibrated regression coefficients.

Finally, a trial-and-error method was attempted to select coefficients of the relation of specific conductance to streamflow. For a given slope coefficient, a near-zero MR could be obtained by adjusting the intercept coefficient. A new slope coefficient then was selected, and its respective intercept coefficient, which would result in a near-zero MR, was determined. By using this stepwise procedure, a function of SDR to slope coefficient was developed, and a "best" set of coefficients was determined. The final set of coefficients for the relation of specific conductance to streamflow (simulation 4) for the three nodes is listed in table 2. The coefficient of determination for node 994, ARK PUBL, was 0.70; for node 1305, ARK JM R, was 0.81; and for node 1375, ARK COOL, was 0.97. Comparisons of the dissolved-solids loads simulated by the model using the trial-and-error coefficients (simulation 4) to those dissolved-solids loads simulated by the model using the coefficients based on instantaneous data (simulation 1) indicated a slightly improved fit for node 994, ARK PUBL; no difference in the fit for node 1305, ARK JM R; and much improved fits for almost every peak for node 1375, ARK COOL. The basin-description file with all of the regression coefficients used in simulation 4 is provided as Attachment A in the "Supplemental Information" section at the back of this report.

The time trend in the observed data for node 994, ARK PUBL was an obvious cause of error for dissolved-solids load simulated by the model. This error is symptomatic of calibration difficulties that occurred during the study for the more complex simulations. Although the model uses a time series of independent variables that have changing (and potentially time-trending) values, the description of the basin is assumed static for a given simulation. Thus, although Cain (1987) shows significantly different (from a statistical viewpoint) regression coefficients for two different time periods, coefficients cannot be changed with time in the simulation model. The model could simulate one selected time series of independent variables by using one set of coefficients and a second time series of independent variables by using another set of coefficients, but it cannot simulate the integrated effects of that changeover in one simulation.

EXAMPLE USE OF SIMULATED DISSOLVED SOLIDS

Cain (1987) presented coefficients for the relations of specific conductance to streamflow and dissolved solids to specific conductance for most of the main-stem streamflow-gaging stations in the Arkansas River basin. Cain (1987) also presented regionalized equations for the basin to estimate the coefficients for sites where there were insufficient data for regression analysis. Although adjustments were made during calibration to the coefficients of the three node locations where observed monthly dissolved-solids loads could be calculated from daily specific-conductance data, the only node where those adjustments made obvious differences was node 1375, ARK COOL. Therefore, the regression coefficients determined by Cain (1987) were used at all model nodes, except node 1375, ARK COOL, where the calibrated values were used, and node 1330, ARK LAMR, midway between node 1305, ARK JM R, and node 1375, ARK COOL. The assigned coefficients for node 1330, ARK LAMR, were based on one-half the adjustments calculated for node 1375, ARK COOL. Dissolved-solids loads throughout the basin then were simulated by using these coefficients.

Dissolved-solids loads were simulated by using observed streamflow data only for each decade from 1940-79 (fig. 3). For each decade, dissolved-solids load increases downstream until just downstream from Pueblo. A decline of dissolved-solids load associated with irrigation diversions occurs until downstream from La Junta, where a large increase in dissolved-solids load results from irrigation-return flow and the inflow of the Purgatoire River. The decline in dissolved-solids load through Lamar is the result of irrigation diversions. The increase of dissolved-solids load along the final reach upstream from the State line is most likely the result of irrigation-return flow. Data indicate that dissolved-solids load seems to be decreasing with time (fig. 3). Burns (1985) indicated a statistically significant downward trend existed for most of the streamflow data east of Pueblo, and although these load data were not statistically tested, it was assumed that any trends in dissolved-solids load primarily result from streamflow declines.

To alleviate possible interpretation errors because different periods of record exist for observed streamflow, another simulation was made for 1940-85. Missing streamflow data were estimated, and dissolved-solids load was based on complete streamflow records for every main-stem node location. The average simulated streamflow, dissolved-solids concentration, and dissolved-solids load for 1940-85 are shown in figure 4. There is a large increase in the dissolved-solids load between just upstream from Pueblo to just downstream from Pueblo. The total load leaving the basin is only slightly greater than the load near Pueblo, although there are tremendous variations at various node locations along the main-stem reaches.

MODEL CALIBRATION OF SIMULATED STREAMFLOW

The model can be applied to simulate streamflow throughout the basin by using only regression equations. For this application of the model, the water-supply operations are not included explicitly, but the effects of water use are incorporated into the regression coefficients. The network of node location, where incremental streamflow is calculated, can be divided into three general groups: (1) The upper basin main-stem node locations and tributary node locations upstream from Canon City, where streamflow is dominated by snowmelt runoff; (2) the tributary node locations for the remaining basin, where streamflow is affected by thunderstorms and irrigation diversions and return flow; and (3) the main-stem node locations for the remaining basin, where streamflow is dominated by irrigation diversions.

Regression equations of monthly streamflow for main-stem and tributary streamflow-gaging stations in the upper basin (upstream from Canon City) were calculated by P.O. Abbott (U.S. Geological Survey, written commun., 1982) by using multiregression analysis to determine the best independent variables and regression coefficients. For that analysis, monthly streamflow, in cubic feet per second, for 11 streamflow-gaging stations was converted into runoff, in inches, and, where appropriate, adjusted to "native" flow by accounting for transbasin diversions and changes in reservoir storage. Temporal and spatial independent variables were included in the analysis, so the resultant relations could be used to calculate monthly runoff for any site in the upper basin. Results of Abbott's analysis determined that log-log regressions were

Figure 3.--Average dissolved-solids load, by decade, along the Arkansas River, 1940-79.

Figure 4.--Average simulated streamflow, dissolved-solids concentration, and dissolved-solids load along the Arkansas River, 1940-85.

best to estimate monthly runoff with: (1) A snow index [S], for May through September; (2) October precipitation data at Salida [P₁₀], for October through February; (3) March air-temperature data at Buena Vista [T₃] and October precipitation data at Salida [P₁₀], for March; and (4) April air-temperature data at Buena Vista [T₄], for April. The snow index [S] that provided the best fit of the data was a parameter that equally weighted the April 1 snowpack with the May 1 snowpack at the Park Cone and Independence Pass snow courses. Although this particular index gave the statistically best fit, other indices that use various combinations of the 2 months and the two sites indicated only minor variations in the goodness of fit, when the seasonal runoff (May through September) was regressed with the indices. The spatial independent variables that provided the best fit of the data were: (1) Percentage of the basin above 11,000 feet in elevation [A₁₁]; (2) percentage of the basin above 12,000 feet [A₁₂]; and (3) elevation of the streamflow-gaging station [E]. The regression model and coefficients are listed in table 3.

Table 3.--*Summary of multiple-regression analysis of streamflow upstream from Canon City*

[Model is $Q = aS^b T_3^c T_4^d P_{10}^e A_{11}^f A_{12}^g E^h$ where: Q is monthly runoff, in inches, for the indicated month; S is Park Cone April 1 and May 1 snow course measurements and Independence Pass April 1 and May 1 snow course measurements, snowpack water equivalent (inches); T₃ and T₄ are March and April measurements of air temperature at Buena Vista (degrees Fahrenheit); P₁₀ is October precipitation at Salida (inches + 0.01 inch); A₁₁ is ratio of drainage area above 11,000 feet to total drainage area; A₁₂ is ratio of drainage area above 12,000 feet to total drainage area; and E is altitude of site where runoff is to be simulated (thousands of feet)]

Month	Regression coefficients								Coefficient of determination, R ²
	a	b	c	d	e	f	g	h	
Season	1.330×10^{-2}	0.905	--	--	--	--	0.618	1.699	0.92
Oct.	1.888	--	--	--	0.050	0.968	--	-.468	.50
Nov.	3.909×10^{-2}	--	--	--	.044	.044	--	--	.27
Dec.	2.810	--	--	--	.011	.567	--	.968	.13
Jan.	2.196×10^{-1}	--	--	--	.019	--	--	--	.01
Feb.	1.833×10^{-1}	--	--	--	.012	--	--	--	.00
Mar.	7.220×10^{-2}	--	0.174	--	.009	--	--	.180	.01
Apr.	5.300×10^{-6}	--	--	2.145	--	--	--	1.386	.37
May	2.900×10^{-3}	.277	--	--	--	--	.268	2.538	.64
June	2.300×10^{-3}	1.051	--	--	--	--	.648	1.841	.88
July	1.700×10^{-3}	1.317	--	--	--	--	.789	1.278	.80
Aug.	1.840×10^{-2}	.683	--	--	--	--	.728	.937	.70
Sept.	3.190×10^{-2}	.452	--	--	--	--	.560	.778	.59

Several factors were considered to determine how to adapt the results of Abbott's analysis (U.S. Geological Survey, written commun., 1982) into the simulation model. The coefficients of determination for the snowmelt runoff months (May through September) ranged from fair to good (0.59 to 0.88). For simplicity in the model, only one snow course was used for the index, and, because of findings by Burns (1985) that in some years the May 1 snowpack is zero, the snow index selected was the April 1 snowpack at Independence Pass. For Abbott's analysis, the coefficients of determination for the winter months (October through March) ranged from poor to fair (0.00 to 0.50). Much of the poor fit was the result of rather small standard deviations of the observed data (see eq. 1). Although the regression coefficients result in estimates near the respective monthly means, not enough variation occurs about the mean to cause major error in the simulation. Based on that analysis, the independent variables selected for use in the model to simulate monthly incremental streamflow from October through March were monthly precipitation data at Twin Lakes Reservoir. April air-temperature data at Buena Vista was selected as the independent variable to simulate April runoff.

Each of the monthly slope-regression coefficients calculated by P.O. Abbott (U.S. Geological Survey, written commun., 1982) was used directly in the model input. The intercept coefficients to the regression relations were determined by trial and error within the model rather than using Abbott's values because: (1) The period of record used by Abbott generally was different from the period simulated in the model; (2) the model simulates streamflow that is intended to represent gaged streamflow, and not "native" flow; (3) the model nodes are at known gaged sites and, thus, there is no need to estimate data at ungaged sites; and (4) an arithmetic-minimization criterion was selected, whereas Abbott's analysis used a log-log minimization criterion. By adjusting the intercept coefficient at each node for each month, simulated streamflow resulted in an MR that approached zero for each month.

Fitting streamflow of tributaries in the lower basin downstream from Canon City by using regression generally was unsuccessful. Burns (1985) indicated that generally poor correlation occurred between monthly precipitation and streamflow in the basin. Although some relation must exist between rainfall and runoff in the central and eastern parts of the basin, to describe a useful relation most likely would require precipitation records from the individual drainage basins and time periods much shorter than a month. Because of these limitations, observed streamflow at the simulated tributaries is input directly to the model. For sites that did not have sufficient length of record, simple linear regression was used to fill in missing data, by using an upstream or nearby gaged streamflow record as the independent variable.

Fitting incremental main-stem streamflow in the lower basin downstream from Canon City was complicated because the typical independent variables gave poor results. Incremental streamflow is defined as the difference between downstream outflow and upstream inflow in a reach. For most of the streamflow-gaging stations on the Arkansas River downstream from Canon City, that difference usually is negative because of irrigation diversions. Regression analysis to fit the incremental streamflow was attempted by using precipitation, snowpack, and air-temperature data as independent variables. Streamflow in the river is substantially affected by diversions, which are governed by a fixed set of water rights. Therefore, regression relations that use time-varying independent variables usually resulted in statistically poor results.

After considering this factor, an additional independent variable was used in the analysis--upstream streamflow. In general, the greater the upstream streamflow is, the greater the diversion is. Thus, this variable often was the best independent variable. Another complicating factor in this regression analysis was that the best type of relation seemed to be a log-log type; however, some of the data often had both positive and negative values, which prohibits the use of log transforms. The final regression relations and corresponding coefficients were selected in a best-fit trial-and-error analysis. For each streamflow-gaging station, for each month, incremental streamflow was regressed with: (1) Precipitation data from the nearest upstream and downstream weather stations; (2) snowpack data from the two nearest snow courses; (3) air-temperature data from the nearest weather station; and (4) upstream streamflow data. For each station, simple linear regressions were calculated by using each of these independent variables; if all except 1 year of the calculated incremental streamflow were the same sign (positive or negative), each of the regressions also was calculated for the log-log transform of the data. The regression analysis that had the greatest coefficient of determination then was selected for that particular gaging station and month. When a log-log relation was selected, the slope coefficient was used directly, but the intercept coefficient was adjusted in the model by trial and error to determine the value that resulted in an MR of near zero by using the arithmetic average criterion.

To use the model, two data input files are necessary: (1) The basin-description file, which includes the node locations, network configuration, and monthly regression relations and coefficients; and (2) the time series of independent variables. The basin-description file is provided as Attachment B in the "Supplemental Information" section at the back of this report.

The time series of independent variables included data for 46 years (1940-85) for the 28 variables listed in table 4. Missing data for any of these variables were approximated by filling in with the monthly average value, or by regressing the data using data from a nearby site, as indicated in table 4. The statistical summaries of the simulated results are listed in table 5 for the simulated nodes in the model as mean of residuals (MR), standard deviation of residuals (SDR), and coefficient of determination (R^2). The mean and standard deviation of the observed data also are listed for comparative purposes. Based on the coefficients of determination, simulated results are very good ($R^2 > 0.80$) for 16 of the 20 simulated nodes in table 5. The best fit is 0.89 at node 812, ARK LEAD, and node 970, ARK PORT; the worst fit is 0.58 at node 1305, ARK JM R.

Burns (1985) indicated that much of the variation about the annual mean flow could be explained by seasonal patterns, especially in the upper basin upstream from Pueblo. Another simulation was made by using the mean monthly values of incremental streamflow for each node for each month to determine how much improvement had been affected by using regression analysis rather than using only the monthly mean. In effect, this new simulation uses only the intercept coefficient and sets the slope coefficient to zero. The SDR and R^2 values for this zero-slope-coefficient simulation are included in table 5. The inclusion of a slope coefficient indicates a reasonably good fit exists between simulated and observed streamflow throughout the basin; whereas, use of the zero-slope-coefficient simulation generally results in an R^2 decrease downstream. The observed and simulated streamflow from these two simulations

Table 4.--Sites with time series of data that are used as input to the model

Sites ¹ with time series of data	Percent of 1940-85 record missing	Method of estimating any missing data
<u>Precipitation stations</u>		
1071 Buena Vista	11	regressed with 5990 North Lake
1294 Canon City	3	regressed with 8931 Westcliffe
3079 Fowler	11	regressed with 6131 Ordway
4076 Holly	8	regressed with 2446 Eads
4770 Lamar	<1	used monthly averages
4834 Las Animas	2	regressed with 4388 John Martin Dam
6740 Pueblo	16	merged 6741 Pueblo
	<1	then used monthly averages
7167 Rocky Ford	1	regressed with 4720 La Junta
7370 Salida	26	regressed with 8931 Westcliffe
8501 Twin Lakes Reservoir.	26	regressed with 5990 North Lake
<u>Snow courses</u>		
6K07 Four Mile Park	<1	used monthly averages
6L08 Garfield	33	regressed with 6K03S Twin Lakes Tunnel
6K04 Independence Pass	0	
5M1M La Veta	0	
<u>Streamflow-gaging stations</u>		
095000 Grape Creek	2	regressed with 099500 Arkansas River near Pueblo
099100 Beaver Creek	76	regressed with 117000 Arkansas River near Nepesta
<u>Streamflow-gaging stations--Continued</u>		
106500 Fountain Creek	14	regressed with 105800 Fountain Creek at Security
	2	then regressed with 106000 Fountain
108800 St. Charles River.	86	merged 108500 St. Charles River near Pueblo
	59	then merged 108900 St. Charles River at Vineland
	43	then regressed with 119500 Apishipa River near Fowler.
116000 Huerfano River	40	regressed with 123000 Arkansas River at La Junta
119500 Apishipa River	0	
128500 Purgatoire River	19	regressed with 126500 Purgatoire River at Ninemile
134100 Big Sandy Creek	68	regressed with 126500 Purgatoire River at Ninemile
<u>Air temperature stations</u>		
1071 Buena Vista	12	regressed with 8931 Westcliffe
1294 Canon City	5	regressed with 8931 Westcliffe
4770 Lamar	0	
4834 La Animas	4	regressed with 5018 Limon
6740 Pueblo	0	
7167 Rocky Ford	0	

¹Site locations are identified in Burns (1985, tables 1, 3, and 6 and plate 1).

Table 5.--Statistics for node locations used in the streamflow-only simulation

[All flow values are in cubic feet per second]

Node ¹ ID	Node name	Observed 1940-85 flow ²		Simulation results using calibration coefficients			Simulation results using zero-slope coefficients	
		Mean	Standard deviation	Mean of the resid- uals (MR)	Standard deviation of the resid- uals (SDR)	Coeffi- cient of deter- mination (R ²)	Standard deviation of the residuals (SDR)	Coeffi- cient of deter- mination (R ²)
0812	ARK LEAD	72.3	109.	0.4	36.8	0.89	50.7	0.78
0830	HALFMOON	28.8	41.6	.1	14.3	.88	18.9	.79
0845	LAKE CK	166.	272.	.4	96.9	.87	109.	.84
0860	ARK GRNT	413.	446.	-.0	170.	.85	211.	.78
0865	CLEAR CK	68.3	97.4	.1	37.7	.85	47.7	.76
0890	COTTNWD	52.4	54.1	.1	22.1	.83	29.2	.71
0915	ARK SLID	644.	639.	.0	245.	.85	329.	.73
0937	ARK WELL	731.	665.	.4	245.	.86	360.	.71
0945	ARK PARK	806.	742.	-.0	300.	.84	396.	.72
0960	ARK CANC	733.	748.	-.2	297.	.84	409.	.70
0970	ARK PORT	775.	826.	.1	277.	.89	442.	.71
0994	ARK PUBL	675.	767.	.1	316.	.83	445.	.66
1095	ARK AVON	914.	870.	.0	321.	.86	432.	.75
1170	ARK NPST	699.	763.	.0	286.	.86	396.	.73
1197	ARK CAT	689.	687.	.0	261.	.86	348.	.74
1230	ARK LAJU	234.	483.	.4	253.	.73	264.	.70
1240	ARK ANMS	212.	462.	.3	248.	.71	252.	.70
1305	ARK JM R	302.	545.	-.1	353.	.58	448.	.32
1330	ARK LAMR	147.	446.	.3	240.	.71	337.	.43
1375	ARK COOL	197.	438.	.1	180.	.83	344.	.38

¹See table 1 and figure 2 for node descriptions and locations.²Not all stations had record for the entire period.

are shown in figures 5, 6, and 7; the observed streamflow (A), streamflow simulated using the zero-slope coefficients (B), and the streamflow simulated using calibration coefficients (C) for three selected nodes along the river are shown for 1940-85 [node 860, ARK GRNT (fig. 5); node 994, ARK PUBL (fig. 6); and node 1375, ARK COOL (fig. 7)]. When the zero-slope-coefficient simulation is used, the calculated incremental streamflow at each node is the same for each respective month, which gives a uniform response such as shown in figure 5B. However, the simulated streamflow at all of the nodes does not remain uniform, because the simulation includes the observed tributary inflows for all nodes downstream from Canon City. Therefore, the integrated effect of tributary inflow along the basin is readily seen in figure 7B.

Figure 5.--Streamflow for node 860, ARK GRNT, 1940-85: A, Computed streamflow; B, Simulated streamflow using zero-slope coefficients; and C, Simulated streamflow using streamflow-only calibrated coefficients.

Figure 6.--Streamflow for node 994, ARK PUBL, 1940-85: A, observed streamflow; B, simulated streamflow using zero-slope coefficients; and C, simulated streamflow using streamflow-only calibrated coefficients.

Figure 7.--Streamflow for node 1375, ARK COOL, 1940-85: A, observed streamflow; B, simulated streamflow using zero-slope coefficients; and C, simulated streamflow using stream-flow-only calibrated coefficients.

MODEL CALIBRATION OF SIMULATED WATER-SUPPLY OPERATIONS

The model, with all its options, simulates most of the hydrologic system in the basin: Natural runoff for all incremental areas; water diverted for irrigation and storage; pumpage of ground water; return flow; and stream depletions or accretions from ground water. The model calculates incremental streamflow at all node locations to produce a "prediversion" streamflow condition--the water that would be in the river if no diversions were made and if no on-channel reservoir storage occurred. To calculate this prediversion streamflow condition, a set of coefficients for each month and node are needed to compute the incremental streamflow. Although the calibrated values for these coefficients can be determined only through trial-and-error adjustments, the initial estimates are physically based.

For the main-stem and tributary nodes in the upper basin (upstream from Canon City), the streamflow-only calibrated coefficients are good initial estimates. Those coefficients generally simulated the snowmelt-runoff process. Adjustments to these previous coefficients are required because of possible transbasin imports, reservoir releases, irrigation diversions, and return flows that occur in the upper basin. The slope coefficients used in the streamflow-only calibration were maintained; only the intercept coefficients were adjusted during calibration.

Initial estimates of coefficients for the main-stem node locations downstream from Canon City were based on two parameters. The intercept coefficient of each monthly relation was calculated from estimates of phreatophyte evapotranspiration in a reach. Use of this parameter enables the model to account for losses from phreatophyte evapotranspiration. Estimates of phreatophyte acreages for reaches along the Arkansas River between Pueblo and the Colorado-Kansas State line and phreatophyte consumptive-use rates (Bittinger and Stringham, 1963) were used to determine the intercept coefficients. Thus, all the intercept coefficients used for the growing season initially were negative to simulate consumptive use by phreatophytes.

The slope coefficient of each monthly incremental streamflow relation was calculated by initially setting the slope to zero and operating the model to determine the average error of the streamflow for each particular node for each month. In this manner, simulated diversions and return flows were considered, and the difference between simulated and observed streamflow was assumed to be the incremental inflow. Monthly precipitation at the nearest weather station then was selected as the independent variable to be used to calculate the incremental streamflow. The MR of the streamflow simulated by using this zero-slope coefficient was divided by the mean precipitation for each respective month to determine the slope coefficient. This procedure was repeated for each node location, moving downstream. Determination of the best calibrated values for these regression coefficients is complicated by the fact that the volume of the diversion (and thus, the volume of return flow) is a function of flow in the river. An additional complication occurred during some months when very large observed streamflow occurred during months with ordinary precipitation. To simulate these peak streamflows, some of the monthly relations had to be changed from linear to log-log. Because the negative intercept coefficients could not be used with the log transform, the intercepts also were changed in those months. The basin-description file for calibration, which was determined as just described, is provided as Attachment C in the "Supplemental Information" section at the back of this report.

Additional information describing the river basin hydrologic system, which is related to the water-supply operations, also is needed. Several water-consumption parameters are needed, including: (1) Monthly crop potential-evapotranspiration rate; (2) monthly lake-evaporation rate; (3) monthly irrigation-diversion demand rate; and (4) a municipal- and industrial-demand rate. Initial estimates for the rate of monthly crop potential evapotranspiration and lake evaporation were obtained from data for a stream-aquifer model of the alluvial Arkansas River valley from Pueblo to the Colorado-Kansas State line (Taylor and Luckey, 1972 and 1974). The monthly crop potential-evapotranspiration rates subsequently were adjusted downward, based on data for crop-consumptive use for the different administrative water districts (Don Miles, Colorado State University, written commun., 1968), for observed agricultural-consumptive use (Wheeler and Assoc., 1985), and for phreatophyte-consumptive use estimates (Bittinger and Stringham, 1963). All these sources used an annual value of about 2.5 feet. Monthly irrigation-diversion demand rates were parameters necessary to simulate the direct diversion of water during periods when the monthly crop potential-evapotranspiration rates were zero. These values were calculated from the diversion-record statistics. Monthly average diversions for all canals that had winter direct diversions were calculated on an acre-foot-diverted per acre-irrigated basis. Monthly average values for all those canals were calculated to produce a seasonal distribution. This seasonal distribution was set equal to the potential-evapotranspiration rates for the months during the growing season. The municipal- and industrial-demand factor was determined solely from calibration with the observed diversion data for Pueblo Water Works. The calibrated value of 0.13 provided the appropriate linear combination with the monthly irrigation-diversion demand rates to best fit the seasonal distribution of the average Pueblo Water Works diversions.

Another set of general basin information necessary for simulation is a set of factors: (1) Latitude and longitude to mile conversion factors; (2) sinuosity factors for computation of river miles; (3) a prestress factor to adjust initial return-flow values; (4) a canal seepage factor for simulating leakage from canals; and (5) an effective-precipitation factor. These factors generally are assigned or calibrated values that seem to fit the model best. The latitude and longitude to mile conversion factors are readily available mapping parameters; one value each is assumed acceptable for the entire basin. The sinuosity factors are used to calculate river miles between nodes that are identified by latitude-longitude locations. By using the latitude and longitude to mile conversion factors, a straight-line distance is computed; then these sinuosity factors are used to account for a sinuous stream. These values were adjusted so that calculated river miles along the river reasonably matched planimetered values obtained from maps. The prestress factor is part of a procedure to produce return flow from water-use activities that occurred before the model simulation. The model begins with all return flows set at zero, and if prestress were not included in the model, most of the early time return flows would remain zero until the newly simulated stresses resulted in return flow. So the system may begin in a quasi-equilibrium condition, 10 years of average conditions are simulated simply to build up a reasonable set of return flows. The canal-leakage factor was estimated to be 1 cubic foot per second per mile, based on general knowledge of the basin and selected seepage measurements and estimates (Wheeler and Assoc., 1985; Colorado Water Conservation Board, 1971; P.O. Abbott, U.S.

Geological Survey, written commun., 1984). The effective-precipitation factor is a threshold value; monthly precipitation in excess of this value is assumed not to contribute to beneficial crop-consumptive use.

Other required data include reservoir data such as: location; storage capacity and maximum surface area; and initial contents and dissolved-solids concentration. The maximum capacity and corresponding surface-area values were obtained from the U.S. Bureau of Reclamation (1969) and the U.S. Soil Conservation Service (1977). Because the surface area is used only for the calculation of evaporation, it was adjusted for certain reservoirs to facilitate evaporation rates other than the basinwide average.

Finally, data are required for the initial volume of ground water in storage and its dissolved-solids concentration for each reach and side along the river. The estimates for ground-water storage were obtained from the stream-aquifer model of the lower basin (Taylor and Luckey, 1972 and 1974); the estimates of dissolved-solids concentration were obtained from Cain (1987). The additional basin-description file for calibration is provided as Attachment D in the "Supplemental Information" section at the back of this report.

The information entered to the model to simulate the water-supply operations requires: (1) A code to indicate type of water user; (2) the number of units served by the user--irrigated acres for agricultural users, people served for municipal users, units produced for industrial users, and storage capacity of a reservoir for reservoir operators; (3) the demand factor and code; (4) a return-flow code; (5) a return-flow factor; and (6) the number of sources of supply. In addition, for each source of supply, the following data are required: (1) Type of source; (2) capacity of source; (3) location of source; and (4) distance from stream, used for the stream-depletion factor (SDF) for ground-water pumpage sources, or reservoir-identification number for reservoir releases. Most of these values are documented numbers and need little adjustment during the calibration process. The irrigated acreage for diversion canals was provided by Abbott (1986). The people served and units produced for the municipal and industrial users were adjusted to best match the observed diversion data. The demand factor and code were the primary parameters that were adjusted during calibration by matching simulated diversions to observed diversions. The code was used to determine whether the water demand for a particular water user followed the crop potential-evapotranspiration distribution (diverted only during the irrigation season) or the irrigation-diversion demand distribution (diverted during the winter). This value was determined during calibration based on the best statistical fit of the observed diversions. The demand factor was multiplied by the product of the consumptive rate of the particular distribution chosen and the number of units served by the user. The return-flow factor was initially set at 0.8 for all agricultural users, which means that 80 percent of their applied water, greater than that needed for crop consumptive use, would enter the ground-water system, and 20 percent would return to the river the following month as tailwater. This value was modified during calibration for each user to adjust the timing of return flow to the stream and to adjust ground-water storage. The return-flow code allows for other definitions of the return-flow factor. A few agricultural users (1431, HIGHLINE and 1716, FT LYON) irrigate some areas outside the alluvial aquifer, and excess irrigation applications in those areas cannot contribute return flow to the simulated system. For these

users, the return-flow factor represents the percent of the total return flow that remains in the simulated system. The return-flow factor can be coded to represent the percent of total diversion that returns to the system for municipal and industrial users. Data for sources of water were obtained from the list of water rights in the prior-appropriation system, enumerated by Abbott (1986). The ground-water pumpage capacity and weighted distance from the stream were determined from information in the stream-aquifer model (Taylor and Luckey, 1972 and 1974). The only parameter that required adjustment during calibration was the quantity of reservoir release. Although this value ought to be limited only by the storage capacity of the reservoir, observed data indicated these values were much smaller. The parameter was adjusted primarily based on the best fit of simulated and observed reservoir contents. All the data used for the 74 users in the basin water-user file are provided as Attachment E in the "Supplemental Information" section at the back of this report.

Calibration for 1943-74

As was discussed previously, the parameter data that are input to the model to describe the physical system is assumed static in time; that is, operating rules, reservoir sizes, crop demands, and so forth, do not change with time. Because the physical system has been dynamic, two periods were selected for calibration: 1943-74 and 1975-85. The physical system, as it operated in 1965, was selected for the primary calibration to represent 1943-74. The observed (or estimated, if records were missing) rainfall, snow-pack, tributary inflow, and air temperature for 1943-74 were selected as the time series of independent variables to enter in the model. The period was selected to simulate conditions after John Martin Reservoir was constructed and before Pueblo Reservoir was operational. The statistical summaries of the simulated streamflow for the 1943-74 calibration is indicated by the MR, SDR, and R^2 listed in table 6. The coefficients of determination ranged from good (0.86 and 0.87) at several nodes, to poor (0.02 at node 1330, ARK LAMR).

The effects of water operations on streamflow are not large in the upper basin; so, for node locations upstream from Canon City, calibrated results with water use and ground water are similar to the results for the streamflow-only simulation. The adjustments that were made were the result of irrigation of hay meadows in the upper basin and the inclusion of the high-mountain reservoirs and corresponding reservoir releases. An example of the calibration fit for this reach is shown in figure 8, which presents simulated streamflow, differences between simulated and observed streamflow, and cumulative frequency curves for observed and simulated streamflow for node 915, ARK SLID.

In the river reach between node 960, ARK CANC, and node 1197, ARK CAT, water losses caused by irrigation diversions are offset somewhat by the inflow from several tributaries. The major difficulty in calibrating streamflow along this reach is in accounting for the large incremental inflows that occurred during a few peak months. Some months with peak streamflows correspond to months with substantial precipitation but, during some months, peak streamflow would occur when records indicated below normal precipitation or, during some months, no peak streamflow would occur when records indicated above normal precipitation. Thus, all the peaks could not be explained or properly simulated. An example of the calibration fit for this reach is shown in figure 9, which presents simulated streamflow, differences between simulated and observed streamflow, and cumulative frequency curves for observed and simulated streamflow for node 1170, ARK NPST.

Figure 8.--Streamflow for node 915, ARK SLID, 1943-74: A, simulated streamflow; B, difference between observed and simulated streamflow; and C, cumulative frequency curves for the observed and simulated streamflow.

Figure 9.--Streamflow for node 1170, ARK NPST, 1943-74: A, simulated streamflow; B, difference between observed and simulated streamflow; and C, cumulative frequency curves for the observed and simulated streamflow.

Table 6.--Statistics for node locations used in the 1943-74 model calibration

[All flow values are in cubic feet per second]

Node ID ¹	Node name	Observed		Simulated		
		Mean	Standard deviation	Mean of the residuals (MR)	Standard deviation of the residuals (SDR)	Coefficient of determination (R ²)
860	ARK GRNT	399	428	8.5	156	0.87
915	ARK SLID	662	642	8.3	227	.87
945	ARK PARK	777	675	2.2	255	.86
960	ARK CANC	715	708	5.9	255	.87
994	ARK PUBL	642	698	4.0	288	.83
1095	ARK AVON	860	715	-4.5	277	.85
1170	ARK NPST	645	679	5.2	301	.80
1197	ARK CAT	603	548	4.7	234	.82
1230	ARK LAJU	194	385	7.9	230	.64
1240	ARK ANMS	166	345	3.2	213	.62
1305	ARK JM R	264	341	-4.5	300	.23
1330	ARK LAMR	115	217	-9.5	216	.02
1375	ARK COOL	225	513	3.6	189	.86

¹See table 1 and figure 2 for node descriptions and locations.

Streamflow for the rest of the river reach downstream as far as John Martin Reservoir generally is quite small and is dominated by diversions and return flow. Thus, simulated streamflow in this reach is most affected by the ability of the model to simulate the water-supply operations. The problems with unaccountable incremental peak streamflow also are seen along this reach. An example of the calibration fit for this reach is shown in figure 10, which presents simulated streamflow, differences between observed and simulated streamflow, and cumulative frequency curves for simulated and observed streamflow for node 1240, ARK ANMS.

John Martin Dam was constructed to provide flood control and storage for irrigation in Colorado and Kansas. The ability of the model to simulate the water-supply operations of John Martin Reservoir is best demonstrated by comparing the observed and simulated streamflow for the node locations just downstream from the reservoir, 1305, ARK JM R (fig. 11). The reason for the poor statistical fit at this node (table 5) is that simplified operation rules fail to meet all of the actual release data.

Figure 10.--Streamflow for node 1240, ARK ANMS, 1943-74: A, simulated streamflow; B, difference between observed and simulated streamflow; and C, cumulative frequency curves for the observed and simulated streamflow.

Figure 11.--Streamflow for node 1305, ARK JM R, 1943-74: A, simulated streamflow; B, difference between observed and simulated streamflow; and C, cumulative frequency curves for the observed and simulated streamflow.

The node location that is farthest downstream is 1375, ARK COOL. The flow at this node consists largely of return flow from irrigation and releases from John Martin Reservoir, except for the flood of 1965. In June 1965, local precipitation (18 inches) exceeded the average annual precipitation (15 inches), which caused the largest monthly flow during the period of record. An example of the calibration fit for this reach is shown in figure 12, which presents simulated streamflow, differences between observed and simulated streamflow, and cumulative frequency curves for observed and simulated streamflow.

The simulated water-supply operations included 74 water users: 57 irrigation canals, 11 reservoir operators, and 6 industrial or municipal suppliers. The model simulates direct and storage diversions, reservoir releases, ground-water pumpage, and transmountain imports based on demand curves and factors. The sum of all the simulated direct diversions for each month and the sum of all the simulated ground-water pumpage are shown in figure 13. The average annual sum of all simulated direct diversions was 1,039,000 acre-feet. The average annual sum of all simulated ground-water pumpage was 126,000 acre-feet. The statistical summaries of these simulated results are identified for selected users by the MR, SDR, and R^2 in table 7. The coefficients of determination that are calculated are not an exact mathematical computation because the standard deviations listed in table 7 indicate the entire period of available data. This error is not considered to introduce any bias into the calculation. The coefficients of determination range from good (0.87 for user 1143, RVRSD-AL) to negative. Selected plots of simulated diversions for various users show that, even though statistically the model may not fit an observed diversion record well, the model still is simulating reasonable conditions.

An example of a good fit of direct diversions was for user 1164, BILL-HAM. Observed diversions, simulated diversions, and the cumulative frequency curves for the observed and simulated diversions are shown in figure 14. An example of a statistically negative fit was for user 6707, AMITY. Although it is evident that differences occur between the observed diversions (fig. 15A) and the simulated diversions (fig. 15B), the cumulative frequency curves of observed and simulated diversions (fig. 15C) match reasonably well and indicate that the model is simulating the purport of the operating rules.

The poor statistical fit for users downstream from John Martin Reservoir primarily is caused by a lack of appropriate observed data. Those users have direct diversions and reservoir releases as possible sources of supply and, in fact, to best fit the reservoir contents of John Martin Reservoir, the model simulates the first source of supply as reservoir releases before using direct diversions. Unfortunately, the observed records do not distinguish between direct diversions and reservoir releases; apparently they are recorded together. An example of this shortcoming in the data is shown in figure 15. A flood in 1965 (year 23 on fig. 15) enabled John Martin Reservoir to fill; thus, the model simulated almost no direct diversions in 1966 (year 24 on fig. 15B) as users satisfied their water demands with reservoir releases. However, large observed diversions were recorded for that year (fig. 15A).

Figure 12.--Streamflow for node 1375, ARK COOL, 1943-74: A, simulated streamflow; B, difference between observed and simulated streamflow; and C, cumulative frequency curves for the observed and simulated streamflow.

Figure 13.--Basinwide water use, 1943-74: A, simulated direct diversions; and B, simulated ground-water pumpage.

Table 7.--Statistics of direct diversions for simulated water users, 1943-74

[All diversion values are in acre-feet per month]

Water-user ID	Water-user name ¹	Observed		Mean of the residuals (MR)	Simulated	
		Mean	Standard deviation		Standard deviation of the residuals (SDR)	Coefficient of determination (R ²)
1143	RVRSD-AL	298	384	9.2	137	0.87
1146	HELENA	366	520	-14.6	290	.69
1161	SUNNY PK	373	434	-29.2	242	.68
1164	BILL-HAM	382	438	-8.1	166	.86
1204	PLEASANT	206	239	-12.7	138	.66
1210	S CANON	1,270	993	-148	727	.44
1215	S C POWR	3,050	1,060	-281	860	.27
1216	HYD-FRUT	2,230	1,490	43.5	849	.67
1219	OIL CK	989	502	26.3	379	.43
1220	FREMONT	563	458	-46.0	285	.60
1222	CF&I	5,210	1,630	-73.4	1,520	.13
1228	HNNKRATT	56.5	86.6	-5.3	65.3	.43
1231	L ATTRBY	87.0	99.7	-5.9	65.9	.56
1234	IDEAL CM	147	115	-5.5	130	-.28
1401	BESSEMER	4,960	3,730	520	2,260	.61
1407	W PUEBLO	122	148	-15.4	85.4	.66
1410	PUEBL WW	2,040	811	13.8	334	.83
1419	BTH-ORCH	710	448	-218	340	.19
1422	EXCLSIOR	363	631	186	733	-.44
1425	COLLIER	72.3	200	18.2	157	.38
1428	COLORADO	4,510	7,920	-1,620	5,850	.41
1431	HIGHLINE	6,190	4,360	330	2,900	.55
1434	OXFD-FRM	1,940	1,780	-15.9	1,190	.55
1701	OTERO	629	1,070	-271	808	.37
1704	CATLIN	6,720	4,850	-380	3,180	.56
1707	HOLBROOK	3,110	3,840	202	3,510	.16
1710	RCKY FRD	3,920	1,880	-195	1,190	.59
1716	FT LYON	18,600	14,400	3,820	10,400	.41
1719	LAS ANMS	2,110	1,640	50.9	1,090	.56
6701	KEESEE	372	334	-81.5	287	.20
6704	FT BENT	1,300	1,300	-709	1,350	-.38
6707	AMITY	6,370	7,280	-1,270	7,530	-.10
6710	LAMAR	2,860	2,350	-99.4	2,440	-.08
6713	HYDE	149	159	-57.9	181	-.43
6716	MANVEL	184	337	-45.3	288	.25
6719	X-Y GRHM	493	637	333	687	-.44
6722	BUFFALO	1,410	1,190	-435	1,040	.10

¹Water-user names and locations are identified in Abbott, 1985, table 4, and plates 2 and 3.

Figure 14.--Diversions for user 1164, BILL-HAM, 1943-74:
 A, observed diversions; B, simulated diversions; and
 C, cumulative frequency curves of observed and simulated
 diversions.

Figure 15.--Diversions for user 6707, AMITY, 1943-74:
 A, observed diversions; B, simulated diversions;
 and C, cumulative frequency curves of observed and
 simulated diversions.

A difficulty that occurred for several users is exemplified by user 1710, RCKY FRD (fig. 16). The demand factor could not be large enough to fit the peak diversions and small enough to fit the diversions during the remaining months. Another cause for a poor fit of observed data is that for some of the lower priority users, the model did not simulate diversions for a sufficient number of months--for example, user 1428, COLORADO (fig. 17). This lack of simulated diversions may be the result of the monthly time step that was not adequate to correctly simulate the shorter periods when the lower priority users would be making diversions. For some users, the observed data seemed very inconsistent. These inconsistencies ranged from gradual trends that probably represent true changes in the observed operation to instances where data seemed to be in error. For example, a plot of the difference between simulated and observed diversions in figure 18 for user 1216, HYD-FRUT, shows a period when the model always over-predicted, a period of relatively even over- and under-prediction, and after a period of missing observed record, a more recent period of general under-prediction. For this user, the observed data had a definite trend that the model could not simulate. A final item that could account for some of the lower statistical fits is that the seasonal average of the observed diversions for some users was between the all-winter diversion and the irrigation-season-only diversion options in the model. An example of this situation is shown by the frequency curves for user 1419, BTH-ORCH (fig. 19). The observed data have zero diversions for about 20 percent of the months, too often to be classified as all-winter diversion; but the irrigation-season-only simulated diversions show zero diversions about 40 percent of the time.

The rest of the physical system simulated by the model includes the ground-water system and the reservoirs. The simulated return flow from the aquifer to the river for its entire simulated length is shown in figure 20. Examples of the observed and simulated reservoir contents are shown for reservoir 854, TWIN LKS (fig. 21) in the upper basin, and reservoir 1107, MEREDITH (fig. 22) and reservoir 1300, JM RES (fig. 23) in the lower basin. Because recorded data generally are insufficient and because storage is a cumulative measure, statistics were not computed for the reservoirs. The plots show the general reasonableness of the simulated results.

Figure 16.--Diversions for user 1710, RCKY FRD, 1943-74:
 A, observed diversions; B, simulated diversions; and
 C, cumulative frequency curves of observed and
 simulated diversions.

Figure 17.--Diversions for user 1428, COLORADO, 1943-74:
 A, observed diversions; B, simulated diversions; and
 C, cumulative frequency curves of observed and simulated
 diversions.

Figure 18.--Differences between simulated and observed diversions
for user 1216, HYD-FRUT, 1943-74.

Figure 19.--Cumulative frequency curves of observed and simulated diversions for user 1419, BTH-ORCH, 1943-74.

Figure 20.--Simulated ground-water return flows summed for all reaches in the basin, 1943-74.

Figure 21.--Content for reservoir 854, TWIN LKS, 1943-74: A, observed reservoir content; and B, simulated reservoir content.

Figure 22.--Content for reservoir 1107, MEREDITH, 1943-74: A, observed reservoir content; and B, simulated reservoir content.

Figure 23.--Content for reservoir 1300, JM RES, 1943-74: A, observed reservoir content; and B, simulated reservoir content.

Calibration for 1975-85

Upon completion of the model calibration for the 1943-74 period, the model was used to simulate the 1975-85 period. Although this period is rather short to be used to obtain statistical measures for calibration, and even though many changes in water-supply operations were occurring throughout that decade, the model was used to simulate the Fryingpan-Arkansas project. The major changes needed in the model data to simulate this project were:

(1) Inclusion of an import streamflow node to generate the transbasin streamflow of the Boustead Tunnel; (2) enlargement of reservoir 824, TURQUOIS and reservoir 854, TWIN LKS; (3) inclusion of reservoir 993, PUEBLO R; (4) addition of Pueblo Reservoir (Fryingpan-Arkansas project water) as a potential source to many of the water users, which permits each user a percentage of water in storage based on the historic allocation; and (5) development of a method for simulating the winter-water storage plan, in which those water users that historically had direct diversions during the winter could store those diversions in Pueblo Reservoir for later use during the irrigation season. The data used for the basin-description file for 1975-85 are provided as Attachment F in the "Supplemental Information" section at the back of this report; the additional basin-description file is included as Attachment G in the "Supplemental Information" section; and the water-user file is included as Attachment H in the "Supplemental Information" section.

To demonstrate the applicability of the model to the 1975-85 period and the changes introduced from the 1943-74 period, several components of the Fryingpan-Arkansas project were evaluated. The monthly average simulated transbasin imports through the Boustead Tunnel compare favorably to the observed monthly average diversions (table 8). Pueblo Reservoir is a multiple-use reservoir, but the model can account for separate activities within the reservoir. The average monthly simulated winter storage water entering reservoir 993, PUEBLO R during 1975-85 was 22,300 acre-feet in December; 18,000 acre-feet in January; 11,400 acre-feet in February; and 5,800 acre-feet in March. The model also simulated an average diversion of 5,500 acre-feet per year from the storage right for native water. The excellent correspondence between observed and simulated reservoir content for 824, TURQUOIS further accredits the simulation process of transmountain imports and releases of those imports. The observed and simulated results for 854, TWIN LKS also match very well until 1984, when either the reservoir was enlarged or the methods of reporting observed contents were changed. As a final demonstration of the simulation capability of the model, the simulated and observed contents of reservoirs 824, TURQUOIS (fig. 24); 854, TWIN LKS (fig. 25); and 993, PUEBLO R (fig. 26) for 1975-85 are shown.

Observed and simulated reservoir content for 993, PUEBLO R does not match as well as for the other two reservoirs. An unusually late snowfall in 1983 (year 8) caused higher streamflow than predicted by the model, which uses April 1 snowpack records. However, a more important factor that also causes the disparity is that municipalities allowed approximately 70,000 acre-feet to remain in storage while pipelines were under construction. This long-term storage of transmountain import water was not simulated as part of the 1975-85 reservoir conditions; thus, simulated reservoir content remained lower than observed content near the end of the simulated period.

Figure 24.--Content for reservoir 824, TURQUOIS, 1975-85: A, observed reservoir content; and B, simulated reservoir content.

Figure 25.--Content for reservoir 854, TWIN LKS, 1975-85: A, observed reservoir content; and B, simulated reservoir content.

Figure 26.--Content for reservoir 993, PUEBLO R, 1975-85: A, observed reservoir content; and B, simulated reservoir content.

Table 8.--*Monthly average transmountain imports for
observed and simulated diversions through the
Boustead Tunnel*

[All diversion values are in acre-feet]

Month	Observed	Simulated
Jan.	0	0
Feb.	0	0
Mar.	0	0
Apr.	100	0
May	8,300	7,900
June	29,400	29,300
July	14,400	13,200
Aug.	3,000	4,000
Sept.	300	200
Oct.	200	100
Nov.	0	0
Dec.	0	0
Total	55,700	54,700

EXAMPLE USE OF SIMULATED WATER-SUPPLY OPERATIONS

The Arkansas River basin model is designed to simulate future or hypothetical changes in hydrologic conditions or water-supply operations. Although the model is conceptually simple, the number of computations made and the interrelation among so many of the activities enable a complete analysis of the effects of possible changes. An example management consideration was selected to demonstrate the capabilities of the model and to indicate the total integrated effects of making such changes.

To demonstrate the use of the model as a management tool, several simulations were made so that the effects of a possible enlargement of Pueblo Reservoir could be considered. The first alternative selected, which was to be used as a baseline for comparison, used the 1975-85 calibrated basin-description and water-user files with the 1940-85 hydrologic precipitation and tributary streamflow time-series data. For this simulation period, the average annual inflow to Pueblo Reservoir included 53,400 acre-feet of transmountain imports, 7,500 acre-feet of native storage diversions, and 58,200 acre-feet of winter-water program storage, as listed in table 9. Basinwide direct diversions averaged 941,000 acre-feet annually; ground-water pumpage averaged 139,000 acre-feet annually; and reservoir releases averaged 272,000 acre-feet. Average streamflow at node 1375, ARK COOL, was 259 cubic feet per second. The monthly reservoir contents for reservoir 993, PUEBLO R, are shown in figure 27A. The hydrologic conditions of 1942 were very wet, and the simulated reservoir was filled during that year.

Table 9.--Summary of six alternatives chosen to consider effects of enlarging Pueblo Reservoir, based on hydrologic conditions of 1940-85

[All values are annual averages; inflows, reservoir contents, and basinwide usage values in thousands of acre-feet; discharge in cubic feet per second; concentration in milligrams per liter]

Alter- native ¹	Inflows to Pueblo Reservoir			Average Pueblo Reservoir contents	Basinwide usage		
	Trans- mountain imports	Native storage diversion	Winter- water storage		Direct diver- sions	Ground- water pumpage	Reservoir releases
1	53.4	7.5	58.2	101	941	139	272
2	55.9	8.3	58.3	109	941	139	276
3	53.0	7.9	58.5	103	953	135	277
4	55.5	8.8	58.6	111	953	134	281
5	27.6	7.2	57.8	212	938	139	237
6	29.6	8.1	58.0	244	939	139	239

Alter- native ¹	Streamflow information							
	960, ARK CANC		994, ARK PUBL		1095, ARK AVON		1375, ARK COOL	
	Dis- charge	Dis- solved solids concen- tration	Dis- charge	Dis- solved solids concen- tration	Dis- charge	Dis- solved solids concen- tration	Dis- charge	Dis- solved solids concen- tration
1	801	129	749	196	937	359	259	2,320
2	805	129	752	195	940	358	260	2,320
3	800	129	748	196	966	398	265	2,380
4	804	129	751	195	968	397	265	2,370
5	764	133	714	204	901	373	253	2,380
6	767	132	717	203	904	371	253	2,370

¹Alternative 1 used the 1975-85 calibrated data. Alternative 2 was the same as alternative 1 except it included data for an enlarged Pueblo Reservoir. Alternative 3 used the 1975-85 calibrated data but added 30 cubic feet per second to the monthly flows of Fountain Creek. Alternative 4 was the same as alternative 3 except it included data for an enlarged Pueblo Reservoir. Alternative 5 used the 1975-85 calibrated data but user 999, FONT VLY, stored its Fryingpan-Arkansas project water in Pueblo Reservoir. Alternative 6 was the same as alternative 5 except it included data for an enlarged Pueblo Reservoir.

Figure 27.--Simulated reservoir content for six alternatives for reservoir 993, PUEBLO R, 1940-85.

As a second alternative, the same basin-description and water-user files were used except that the storage capacity of the conservation pool for Pueblo Reservoir was increased 40,000 acre-feet from 264,000 acre-feet to 304,000 acre-feet. The average annual inflows to Pueblo Reservoir for the second alternative indicated a 2,500-acre-foot increase in transmountain imports to 55,900 acre-feet (table 9), an 800-acre-foot increase in native storage diversions to 8,300 acre-feet, and a slight increase in winter-water storage. Basinwide water use remained the same except that reservoir releases increased 4,000 acre-feet. No significant change occurred in streamflow leaving the basin.

A noticeable factor that could affect the need for an enlarged reservoir is the recent increase in streamflow in Fountain Creek because of additional return flows of transmountain imports by the city of Colorado Springs. To consider the possible effects of increased return flow in Fountain Creek, two additional simulations were made that were similar to the first two, except that 30 cubic feet per second were added to every monthly flow of Fountain Creek.

When the third alternative is compared to the first alternative, the additional flow from Fountain Creek had minimal effect on Pueblo Reservoir. Transmountain imports decreased by 400 acre-feet, while native storage diversions increased by 400 acre-feet. Winter-water storage increased slightly. The most noticeable change caused by the additional inflow was the flow just downstream from Fountain Creek at node 1095, ARK AVON, where streamflow increased by about 30 cubic feet per second and dissolved-solids concentration increased by 40 milligrams per liter. This additional flow contributed to about 12,000 acre-feet of additional direct diversions and 5,000 acre-feet of additional reservoir releases.

The fourth alternative used the same data as did the third alternative except that data for an enlarged Pueblo Reservoir were used. The change in inflow to Pueblo Reservoir was almost the same as the change indicated when the second alternative is compared to the first alternative: Transmountain imports increased by 2,500 acre-feet; native storage diversions increased by 900 acre-feet; and winter-water storage increased by 100 acre-feet.

As discussed in the "Model Calibration of Simulated Water-Supply Operations" section (page 23), municipal storage can have a large effect on the contents of Pueblo Reservoir. The fifth alternative enabled user 999, FONT VLY to store water in Pueblo Reservoir rather than to export the water from the basin. When the fifth alternative is compared to the first alternative, major effects are evident. Transmountain imports decreased to 27,600 acre-feet, although lesser decreases occurred for native storage diversions (7,200 acre-feet) and for winter-water storage (57,800 acre-feet). Streamflow in the upper basin decreased because smaller transmountain imports were being delivered to Pueblo Reservoir.

The sixth alternative used the same data as did the fifth alternative except that data for an enlarged Pueblo Reservoir were used. When the sixth alternative is compared to alternative five, results are very similar to the two previous simulations that increased the capacity of Pueblo Reservoir: Transmountain imports increased by 2,000 acre-feet; native storage diversions increased by 900 acre-feet; winter-water storage increased by 200 acre-feet.

SUMMARY

An interactive-accounting model was used to simulate dissolved solids, streamflow, and water-supply operations in the Arkansas River basin, Colorado. A description of the generic river basin model and much of the data description and analysis necessary to apply the model to the Arkansas River basin have been documented in other reports. This report describes the calibration of the model within the Arkansas River basin and provides examples of uses of this calibrated model.

The model was first used to calibrate specific conductance to streamflow relations at three sites in the basin where observed monthly dissolved-solids loads were determined by using daily specific-conductance data. Simulated results indicated that existing log-log coefficients calculated by using instantaneous values were acceptable for the monthly time-step simulations at two of the three nodes, which accounted for most of the basin. This calibrated model then was used to compute dissolved-solids loads throughout the basin by using observed streamflow.

The model was calibrated for the 1940-85 period simulating streamflow only; all of the water-supply operations in the basin were incorporated in the regression relations for incremental streamflow. Coefficients of determination for 20 node locations ranged from 0.89 to 0.58, and values in excess of 0.80 were determined for 16 of the node locations.

The model input then was revised to incorporate 74 water users and 11 reservoirs to simulate the water-supply operations in the basin. Two periods were used for calibration: the 1943-74 period, which included John Martin Reservoir, and the 1975-85 period, which also included the Fryingpan-Arkansas project with Pueblo Reservoir. For the 1943-74 calibration, coefficients of determination for streamflow at 13 node locations ranged from 0.87 to 0.02. Simulation of the water-supply operations resulted in coefficients of determination that ranged from 0.87 to negative for irrigation diversions of the 37 water users with sufficient observed record for calibration. Even for those users whose simulated diversions did not relate well statistically to observed diversions, plots of data generally indicated reasonable model results. Calibration of reservoir contents did not include statistical measures, but again plots of data indicated reasonable similarity to observed values. Calibration for 1975-85 was not evaluated statistically, but average values and plots of reservoir contents indicated reasonableness of the simulation.

To demonstrate the utility of the model, six alternatives were simulated to consider the effects of potential enlargement of Pueblo Reservoir. The model was used to simulate a 46-year period that represented hydrologic conditions of 1940-85, with three major alternatives: the 1975-85 calibrated data; the 1975-85 calibrated data with an increase in Fountain Creek flows of 30 cubic feet per second; and the 1975-85 calibrated data with a municipal water user leaving Fryingpan-Arkansas project water in storage rather than diverting it. These three alternatives included the option of reservoir enlargement or no enlargement to give the six total alternatives. A 40,000-acre-foot enlargement of Pueblo Reservoir resulted in average increases of 2,500 acre-feet in transmountain diversions, of 800 acre-feet in storage diversions, and of 100 acre-feet in winter-water storage for all three of the management settings.

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SUPPLEMENTAL INFORMATION

Attachment A--Basin-description file for dissolved-solids loads

OBSERVED ARKANSAS RIVER BASIN FLOW (with water-quality coefficients from Cain, 1987)

29

	1000.	250.	1000.	2500.				
812ARK LEAD	39.24	106.32	860	.10	.10	0.	-6.8	.64
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
-3			1.	740.	-.35			
830HALFMOON	39.15	106.38	860	-.30	.05	0.	7.9	.50
-4			1.	98.	-.04			
-4			1.	98.	-.04			
-4			1.	98.	-.04			
-4			1.	98.	-.04			
-4			1.	150.	-.22			
-4			1.	150.	-.22			
-4			1.	150.	-.22			
-4			1.	150.	-.22			
-4			1.	150.	-.22			
-4			1.	98.	-.04			
-4			1.	98.	-.04			
-4			1.	98.	-.04			
845LAKE CK	39.05	106.37	860	-.55	-.10	0.	-6.8	.64
-5			1.	88.	-.16			
-5			1.	88.	-.16			
-5			1.	88.	-.16			
-5			1.	88.	-.16			
-5			1.	76.	-.13			
-5			1.	76.	-.13			
-5			1.	76.	-.13			
-5			1.	76.	-.13			
-5			1.	76.	-.13			
-5			1.	88.	-.16			
-5			1.	88.	-.16			
-5			1.	88.	-.16			

Attachment A--Basin-description file for dissolved-solids loads--Continued

860ARK GRNT	39.02	106.25	915	.15	.10	0.	.2	.63
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
-6			1.	426.	-.22			
865CLEAR CK	38.99	106.28	915	-.25	-.25	0.	7.9	.50
-7			1.	87.	-.16			
-7			1.	87.	-.16			
-7			1.	87.	-.16			
-7			1.	87.	-.16			
-7			1.	75.	-.13			
-7			1.	75.	-.13			
-7			1.	75.	-.13			
-7			1.	75.	-.13			
-7			1.	75.	-.13			
-7			1.	87.	-.16			
-7			1.	87.	-.16			
-7			1.	87.	-.16			
890COTTNWD	38.78	106.23	915	-.30	-.20	0.	7.9	.50
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
-8			1.	240.	-.20			
915ARK SLID	38.51	105.98	937	-.05	.20	0.	-6.8	.64
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			
-9			1.	2900.	-.43			

Attachment A--Basin-description file for dissolved-solids loads--Continued

937ARK WELL	38.48	105.94	945	.20	.05	0.	-6.8	.64
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
945ARK PARK	38.46	105.38	960	-.30	.20	0.	-6.8	.64
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
-11			1.	1500.	-.30			
-11			1.	1500.	-.30			
-11			1.	1500.	-.30			
-11			1.	1500.	-.30			
-11			1.	1500.	-.30			
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
950GRAPE CK	38.16	105.48	960	-.25	.15	0.	-6.8	.64
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
-12			1.	1200.	-.32			
-12			1.	1200.	-.32			
-12			1.	1200.	-.32			
-12			1.	1200.	-.32			
-12			1.	1200.	-.32			
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
960ARK CANC	38.41	105.25	970	-.40	-.30	0.	-6.8	.64
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			
-13			1.	1200.	-.26			
-13			1.	1200.	-.26			
-13			1.	1200.	-.26			
-13			1.	1200.	-.26			
-13			1.	1200.	-.26			
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			

Attachment A--Basin-description file for dissolved-solids loads--Continued

970ARK PORT	38.37	105.02	994	-.40	-.30	0.	8.4	.61
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
-14			1.	4100.	-.37			
991BEAVER C	38.36	104.95	994	.10	.00	0.	-248.2	.97
-15			1.	1400.	-.30			
-15			1.	1400.	-.30			
-15			1.	1400.	-.30			
-15			1.	1400.	-.30			
-15			1.	1100.	-.30			
-15			1.	1100.	-.30			
-15			1.	1100.	-.30			
-15			1.	1100.	-.30			
-15			1.	1100.	-.30			
-15			1.	1400.	-.30			
-15			1.	1400.	-.30			
-15			1.	1400.	-.30			
994ARK PUBL	38.25	104.65	1095	-.45	-.25	0.	-38.4	.75
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
-16			1.	3000.	-.32			
1065FOUNT PB	38.31	104.61	1095	.10	.10	0.	-508.8	1.04
-23			1.	3200.	-.17			
-23			1.	3200.	-.17			
-23			1.	3200.	-.17			
-23			1.	3200.	-.17			
-23			1.	2600.	-.17			
-23			1.	2600.	-.17			
-23			1.	2600.	-.17			
-23			1.	2600.	-.17			
-23			1.	2600.	-.17			
-23			1.	3200.	-.17			
-23			1.	3200.	-.17			
-23			1.	3200.	-.17			

Attachment A--Basin-description file for dissolved-solids loads--Continued

1090ST CHARL	38.20	104.51	1095	-.15	-.30	0.	-248.2	.97
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
1095ARK AVON	38.23	104.40	1170	.05	.15	0.	-18.7	.69
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
1160HUERF R	37.97	104.48	1170	.05	-.25	0.	-458.8	1.16
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
1170ARK NPST	38.19	104.20	1197	.10	.10	0.	-71.0	.80
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				
-30		1.	2500.	-.22				
-30		1.	2500.	-.22				
-30		1.	2500.	-.22				
-30		1.	2500.	-.22				
-30		1.	2500.	-.22				
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				

Attachment A--Basin-description file for dissolved-solids loads--Continued

1195APISH R	38.07	103.99	1197	-.30	-.15	0.	-438.2	1.14
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
-31			1.	3200.	-.27			
1197ARK CAT	38.12	103.91	1230	.15	.10	0.	-35.9	.74
-32			1.	1200.	-.02			
-32			1.	1200.	-.02			
-32			1.	1200.	-.02			
-32			1.	1200.	-.02			
-32			1.	2800.	-.23			
-32			1.	2800.	-.23			
-32			1.	2800.	-.23			
-32			1.	2800.	-.23			
-32			1.	2800.	-.23			
-32			1.	1200.	-.02			
-32			1.	1200.	-.02			
-32			1.	1200.	-.02			
1230ARK LAJU	37.98	103.53	1240	-.15	.20	0.	-189.3	.94
-33			1.	8300.	-.29			
-33			1.	8300.	-.29			
-33			1.	8300.	-.29			
-33			1.	8300.	-.29			
-33			1.	8300.	-.31			
-33			1.	8300.	-.31			
-33			1.	8300.	-.31			
-33			1.	8300.	-.31			
-33			1.	8300.	-.31			
-33			1.	8300.	-.29			
-33			1.	8300.	-.29			
-33			1.	8300.	-.29			
1240ARK ANMS	38.08	103.23	1305	.00	.15	0.	-231.8	.94
-34			1.	7100.	-.24			
-34			1.	7100.	-.24			
-34			1.	7100.	-.24			
-34			1.	7100.	-.24			
-34			1.	7100.	-.30			
-34			1.	7100.	-.30			
-34			1.	7100.	-.30			
-34			1.	7100.	-.30			
-34			1.	7100.	-.30			
-34			1.	7100.	-.24			
-34			1.	7100.	-.24			
-34			1.	7100.	-.24			

Attachment A--Basin-description file for dissolved-solids loads--Continued

1285PURG ANS	37.99	103.26	1305	.05	-.25	0.	-385.0	1.06
-40			1.	4900.	-.12			
-40			1.	4900.	-.12			
-40			1.	4900.	-.12			
-40			1.	4900.	-.12			
-40			1.	4900.	-.21			
-40			1.	4900.	-.21			
-40			1.	4900.	-.21			
-40			1.	4900.	-.21			
-40			1.	4900.	-.21			
-40			1.	4900.	-.12			
-40			1.	4900.	-.12			
-40			1.	4900.	-.12			
1305ARK JM R	38.07	102.93	1330	.10	-.25	0.	-243.8	.97
-41			1.	4100.	-.09			
-41			1.	4100.	-.09			
-41			1.	4100.	-.09			
-41			1.	4100.	-.09			
-41			1.	5900.	-.21			
-41			1.	5900.	-.21			
-41			1.	5900.	-.21			
-41			1.	5900.	-.21			
-41			1.	5900.	-.21			
-41			1.	4100.	-.09			
-41			1.	4100.	-.09			
-41			1.	4100.	-.09			
1330ARK LAMR	38.12	102.63	1355	-.40	.15	0.	-222.3	.98
-42			1.	8800.	-.16			
-42			1.	8800.	-.16			
-42			1.	8800.	-.16			
-42			1.	8800.	-.16			
-42			1.	6300.	-.24			
-42			1.	6300.	-.24			
-42			1.	6300.	-.24			
-42			1.	6300.	-.24			
-42			1.	6300.	-.24			
-42			1.	8800.	-.16			
-42			1.	8800.	-.16			
-42			1.	8800.	-.16			
1341BIG SAND	38.13	102.49	1355	.08	.08	0.	-458.	1.16
-43			1.	5100.	-.05			
-43			1.	5100.	-.05			
-43			1.	5100.	-.05			
-43			1.	5100.	-.05			
-43			1.	5100.	-.15			
-43			1.	5100.	-.15			
-43			1.	5100.	-.15			
-43			1.	5100.	-.15			
-43			1.	5100.	-.15			
-43			1.	5100.	-.05			
-43			1.	5100.	-.05			
-43			1.	5100.	-.05			

Attachment A--Basin-description file for dissolved-solids loads--Continued

1355ARK HOLY	38.07	102.12	1375	-.55	-.25	0.	-6.5	.92
-44			1.	13000.	-.27			
-44			1.	13000.	-.27			
-44			1.	13000.	-.27			
-44			1.	13000.	-.27			
-44			1.	10000.	-.29			
-44			1.	10000.	-.29			
-44			1.	10000.	-.29			
-44			1.	10000.	-.29			
-44			1.	10000.	-.29			
-44			1.	13000.	-.27			
-44			1.	13000.	-.27			
-44			1.	13000.	-.27			
1375ARK COOL	38.05	102.02	-999	.10	.10	0.	-6.5	.92
-45			1.	13000.	-.27			
-45			1.	13000.	-.27			
-45			1.	13000.	-.27			
-45			1.	13000.	-.27			
-45			1.	10000.	-.29			
-45			1.	10000.	-.29			
-45			1.	10000.	-.29			
-45			1.	10000.	-.29			
-45			1.	10000.	-.29			
-45			1.	13000.	-.27			
-45			1.	13000.	-.27			
-45			1.	13000.	-.27			

Attachment B--Basin-description file for streamflow-only calibration

CALIBRATION DATA USING STREAMFLOW, SNOWPACK, AND PRECIPITATION TO ESTIMATE FLOW

28		1000.	250.	1000.	2500.				
812ARK LEAD		39.24	106.32	860	.10	.10	0.	-6.8	.64
	110	14.4	.019	725.	-.35				
	110	14.2	.012	725.	-.35				
	110	14.7	.009	725.	-.35				
	123	.00947	2.15	725.	-.35				
	113	69.8	.277	725.	-.35				
	113	17.7	1.05	725.	-.35				
	113	3.25	1.32	725.	-.35				
	113	8.85	.683	725.	-.35				
	113	9.66	.452	725.	-.35				
	110	27.4	.050	725.	-.35				
	110	21.2	.044	725.	-.35				
	110	16.8	.011	725.	-.35				
830HALFMOON	39.15	106.38	860	-.30	.05	0.	7.9	.50	
	110	4.07	.019	98.	-.04				
	110	3.73	.012	98.	-.04				
	110	3.62	.009	98.	-.04				
	123	.00217	2.15	98.	-.04				
	113	19.9	.277	133.	-.22				
	113	6.25	1.05	133.	-.22				
	113	1.88	1.32	133.	-.22				
	113	5.06	.683	133.	-.22				
	113	4.90	.452	133.	-.22				
	110	11.4	.050	98.	-.04				
	110	7.73	.044	98.	-.04				
	110	5.32	.011	98.	-.04				
845LAKE CK	39.05	106.37	860	-.55	-.10	0.	-6.8	.64	
	110	19.3	.019	85.	-.16				
	110	15.0	.012	85.	-.16				
	110	14.7	.009	85.	-.16				
	123	.0105	2.15	85.	-.16				
	113	142.	.277	76.	-.13				
	113	42.3	1.05	76.	-.13				
	113	9.31	1.32	76.	-.13				
	113	19.2	.683	76.	-.13				
	113	19.0	.452	76.	-.13				
	110	47.2	.050	85.	-.16				
	110	29.4	.044	85.	-.16				
	110	20.6	.011	85.	-.16				

Attachment B--Basin-description file for streamflow-only calibration--Continued

860ARK GRNT	39.02	106.25	915	.15	.10	-11.	.2	.63
	110	75.7	.0836	421.	-.23			
	110	67.3	-.139	421.	-.23			
	23	-21.6	3.33	421.	-.23			
	23	-689.	21.4	421.	-.23			
	23	-1724.	38.1	2780.	-.48			
	13	446.	-26.1	2780.	-.48			
	13	64.0	16.9	2780.	-.48			
	13	137.	13.9	2780.	-.48			
	23	1457.	-23.2	2780.	-.48			
	23	371.	-6.13	421.	-.23			
	110	92.2	.117	421.	-.23			
	110	75.1	.141	421.	-.23			
865CLEAR CK	38.99	106.28	915	-.25	-.25	0.	7.9	.50
	110	12.4	.019	87.	-.16			
	110	11.4	.012	87.	-.16			
	110	11.2	.009	87.	-.16			
	123	.00601	2.15	87.	-.16			
	113	49.3	.277	74.	-.13			
	113	14.5	1.05	74.	-.13			
	113	3.81	1.32	74.	-.13			
	113	10.2	.683	74.	-.13			
	113	11.7	.452	74.	-.13			
	110	31.1	.050	87.	-.16			
	110	20.6	.044	87.	-.16			
	110	15.1	.011	87.	-.16			
890COTTNWD	38.78	106.23	915	-.30	-.20	0.	7.9	.50
	110	23.1	.019	240.	-.20			
	110	20.7	.012	240.	-.20			
	110	19.1	.009	240.	-.20			
	123	.00732	2.15	240.	-.20			
	113	31.0	.277	238.	-.20			
	113	8.71	1.05	238.	-.20			
	113	2.42	1.32	238.	-.20			
	113	8.51	.683	238.	-.20			
	113	12.0	.452	238.	-.20			
	110	36.5	.050	240.	-.20			
	110	30.5	.044	240.	-.20			
	110	25.5	.011	240.	-.20			
915ARK SLID	38.51	105.98	937	.10	.15	-5.	-6.8	.64
	109	82.9	-.0923	1115.	-.20			
	109	91.7	.0488	1115.	-.20			
	23	191.	-3.63	1115.	-.20			
	13	-181.	13.6	1115.	-.20			
	11	-109.	36.6	9800.	-.64			
	11	48.0	26.0	9800.	-.64			
	11	-242.	82.7	9800.	-.64			
	11	-12.2	30.7	9800.	-.64			
	11	22.2	15.3	9800.	-.64			
	23	403.	-6.40	1115.	-.20			
	109	115.	-.0813	1115.	-.20			
	109	119.	.0278	1115.	-.20			

Attachment B--*Basin-description file for streamflow-only calibration*--Continued

937ARK WELL	38.48	105.94	945	.15	.05	1.	-6.8	.64
	23	91.6	-.397	300.	-.18			
	23	30.0	2.14	300.	-.18			
	23	-17.6	2.68	300.	-.18			
	13	-21.3	3.41	300.	-.18			
	23	-4103.	83.6	135.	-.13			
	23	-2353.	42.6	135.	-.13			
	9	-59.9	113.	135.	-.13			
	9	19.3	39.0	135.	-.13			
	9	-61.7	136.	135.	-.13			
	9	28.0	44.5	300.	-.18			
	23	322.	-6.74	300.	-.18			
	23	-31.4	4.88	300.	-.18			
945ARK PARK	38.46	105.38	960	-.40	.10	0.	-6.8	.64
	9	44.1	29.6	87.	-.16			
	9	34.6	14.7	87.	-.16			
	9	40.1	12.2	87.	-.16			
	201	288.	-.584	87.	-.16			
	13	-288.	23.6	75.	-.13			
	13	-375.	35.5	75.	-.13			
	24	-2729.	38.3	75.	-.13			
	24	-912.	13.7	75.	-.13			
	13	-35.8	5.62	75.	-.13			
	9	58.8	-24.1	87.	-.16			
	9	59.3	-39.4	87.	-.16			
	24	-64.2	2.90	87.	-.16			
950GRAPE CK	38.16	105.48	960	-.20	.15	0.	-6.8	.64
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
960ARK CANC	38.41	105.25	970	-.10	-.30	0.	-6.2	.64
	201	277.	-.893	1400.	-.30			
	201	-455.	1.11	1400.	-.30			
	2	-97.0	33.7	1400.	-.30			
	24	-1174.	20.9	1400.	-.30			
	201	137.	-.267	1100.	-.30			
	2	-379.	146.	1100.	-.30			
	2	-552.	208.	1100.	-.30			
	2	-334.	120.	1100.	-.30			
	2	-51.7	-78.8	1100.	-.30			
	9	-161.	45.8	1400.	-.30			
	9	-128.	56.6	1400.	-.30			
	201	222.	-.704	1400.	-.30			

Attachment B--Basin-description file for streamflow-only calibration--Continued

970ARK PORT	38.37	105.02	994	-.20	-.30	0.	8.4	.61
	201	-4891.	14.7	1400.	-.30			
	201	-298.	.833	1400.	-.30			
	2	-54.5	38.4	1400.	-.30			
	7	-191.	178.	1400.	-.30			
	14	-42.9	32.9	1100.	-.30			
	14	-267.	80.7	1100.	-.30			
	2	376.	-179.	1100.	-.30			
	24	-3250.	45.1	1100.	-.30			
	24	-2138.	32.6	1100.	-.30			
	7	-45.3	92.2	1400.	-.30			
	201	-258.	.707	1400.	-.30			
	7	-57.0	106.	1400.	-.30			
991BEAVER C	38.36	104.95	994	.10	.05	0.	-248.2	.97
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
994ARK PUBL	38.25	104.65	1095	-.25	-.30	0.	-38.4	.75
	201	180.	-.733	1400.	-.30			
	7	-92.6	121.	1400.	-.30			
	27	133.	-5.27	1400.	-.30			
	201	-107.	.205	1400.	-.30			
	2	-168.	54.7	1100.	-.30			
	12	586.	-61.3	1100.	-.30			
	2	-507.	182.	1100.	-.30			
	27	4213.	-57.3	1100.	-.30			
	27	1124.	-17.9	1100.	-.30			
	7	-42.3	-43.6	1100.	-.30			
	27	-474.	10.1	1400.	-.30			
	7	-28.6	-116.	1400.	-.30			
1065FOUNT PB	38.26	104.61	1095	.10	.10	0.	-508.8	1.04
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			

Attachment B--Basin-description file for streamflow-only calibration--Continued

1090ST CHARL	38.20	104.51	1095	-.10	-.25	0.	-248.2	.97
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
-18			1.	3900.	-.29			
1095ARK AVON	38.23	104.40	1170	.10	.10	0.	-18.7	.69
201	-945.	3.95	3200.	-.17				
7	130.	-79.4	3200.	-.17				
7	171.	-43.9	3200.	-.17				
201	-21.6	.334	3200.	-.17				
3	226.	-83.3	2600.	-.17				
7	-243.	220.	2600.	-.17				
201	413.	-.174	2600.	-.17				
201	-433.	.593	2600.	-.17				
27	-1027.	17.8	2600.	-.17				
7	96.7	44.1	3200.	-.17				
201	-308.	1.40	3200.	-.17				
201	-1431.	5.67	3200.	-.17				
1160HUERF R	37.97	104.48	1170	.10	-.15	0.	-458.8	1.16
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
-19			1.	3900.	-.23			
1170ARK NPST	38.19	104.20	1197	.10	.15	0.	-71.0	.80
3	2.55	-95.1	3200.	-.27				
13	-123.	6.08	3200.	-.27				
201	-247.	.418	3200.	-.27				
7	-50.4	-106.	3200.	-.27				
201	-834.	.372	3200.	-.27				
12	26.0	-34.2	3200.	-.27				
201	-1108.	.375	3200.	-.27				
13	205.	-37.3	3200.	-.27				
28	1873.	-31.7	3200.	-.27				
3	-66.3	-103.	3200.	-.27				
201	95.0	-.357	3200.	-.27				
201	-69.1	.0311	3200.	-.27				

Attachment B--Basin-description file for streamflow-only calibration--Continued

1195	API	R	38.07	103.99	1197	-.30	-.15	0.	-438.2	1.14
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
			-20		1.	3200.	-.27			
1197	ARK	CAT	38.12	103.91	1230	.15	.10	0.	-35.9	.74
			201	131.	-.356	3200.	-.27			
			13	73.0	-6.63	3200.	-.27			
			201	76.0	-.283	3200.	-.27			
			28	2289.	-43.8	3200.	-.27			
			201	-63.4	-.150	3200.	-.27			
			8	-61.0	-50.0	3200.	-.27			
			201	335.	-.319	3200.	-.27			
			8	-115.	123.	3200.	-.27			
			8	-26.7	69.0	3200.	-.27			
			8	-63.9	107.	3200.	-.27			
			201	-198.	.364	3200.	-.27			
			28	153.	-5.53	3200.	-.27			
1230	ARK	LAJU	37.98	103.53	1240	-.15	.20	0.	-189.3	.94
			128	-135.	.239	3200.	-.27			
			201	-44.4	-.685	3200.	-.27			
			128	-7450.	-.893	3200.	-.27			
			28	-2755.	43.4	3200.	-.27			
			14	-386.	-53.3	3200.	-.27			
			14	-987.	-50.0	3200.	-.27			
			106	-666.	.350	3200.	-.27			
			201	-280.	-.421	3200.	-.27			
			201	0.61	-.750	3200.	-.27			
			201	55.3	-.773	3200.	-.27			
			201	10.1	-.786	3200.	-.27			
			201	-98.4	-.523	3200.	-.27			
1240	ARK	ANMS	38.08	103.23	1305	.00	.15	0.	-231.8	.94
			201	9.40	.242	3200.	-.27			
			26	233.	-5.79	3200.	-.27			
			26	251.	-5.79	3200.	-.27			
			201	-129.	.131	3200.	-.27			
			201	-875.	.724	3200.	-.27			
			6	-364.	142.	3200.	-.27			
			201	66.4	-.260	3200.	-.27			
			13	-272.	11.7	3200.	-.27			
			13	78.3	-6.06	3200.	-.27			
			201	-84.3	.313	3200.	-.27			
			201	-78.4	.823	3200.	-.27			
			8	-5.87	67.7	3200.	-.27			

Attachment B--Basin-description file for streamflow-only calibration--Continued

1285PURG ANS	38.03	103.21	1305	.05	-.25	0.	-385.0	1.06
-21			1.	4900.	-.12			
-21			1.	4900.	-.12			
-21			1.	4900.	-.12			
-21			1.	4900.	-.12			
-21			1.	4900.	-.21			
-21			1.	4900.	-.21			
-21			1.	4900.	-.21			
-21			1.	4900.	-.21			
-21			1.	4900.	-.21			
-21			1.	4900.	-.12			
-21			1.	4900.	-.12			
-21			1.	4900.	-.12			
1305ARK JM R	38.07	102.93	1330	.00	.15	0.	-243.8	.97
201	-90.0	-.389	4900.	-.12				
8	-69.9	-116.	4900.	-.12				
201	13.0	-1.30	4900.	-.12				
201	202.	.534	4900.	-.12				
6	1524.	-900.	4900.	-.21				
8	779.	-925.	4900.	-.21				
201	213.	-.450	4900.	-.21				
8	326.	-115.	4900.	-.21				
6	274.	-61.3	4900.	-.21				
6	109.	-54.0	4900.	-.12				
8	-26.3	-54.4	4900.	-.12				
6	-82.4	-36.3	4900.	-.12				
1330ARK LAMR	38.12	102.63	1375	-.05	.15	0.	-222.3	.98
201	3.94	.318	4900.	-.12				
25	161.	-4.57	4900.	-.12				
201	20.2	-.773	4900.	-.12				
14	87.0	-40.0	4900.	-.12				
201	-235.	-.257	4900.	-.21				
201	151.	-.700	4900.	-.21				
201	29.0	-.625	4900.	-.21				
201	-119.	-.389	4900.	-.21				
14	-329.	9.66	4900.	-.21				
5	-174.	25.3	4900.	-.12				
5	-45.0	17.6	4900.	-.12				
25	60.6	-1.99	4900.	-.12				
1341BIG SAND	38.13	102.49	1375	.08	.08	0.	-6.8	1.16
-22			1.	5100.	-.05			
-22			1.	5100.	-.05			
-22			1.	5100.	-.05			
-22			1.	5100.	-.05			
-22			1.	5100.	-.15			
-22			1.	5100.	-.15			
-22			1.	5100.	-.15			
-22			1.	5100.	-.15			
-22			1.	5100.	-.15			
-22			1.	5100.	-.05			
-22			1.	5100.	-.05			
-22			1.	5100.	-.05			

Attachment B--Basin-description file for streamflow-only calibration--Continued

1375ARK COOL	38.05	102.02	-999	.10	.10	0.	-6.5	.92
	4	10.4	127.	5100.	-.05			
	4	41.3	90.5	5100.	-.05			
	201	-39.6	4.06	5100.	-.05			
	201	141.	-.641	5100.	-.05			
	201	267.	-1.00	5100.	-.15			
	4	-1298.	475.	5100.	-.15			
	4	-101.	50.0	5100.	-.15			
	201	-33.3	.316	5100.	-.15			
	25	1780.	-25.4	5100.	-.15			
	5	98.7	-34.6	5100.	-.05			
	201	78.9	-.692	5100.	-.05			
	201	59.1	.207	5100.	-.05			

Attachment C--Basin-description file for model calibration, 1943-74

CALIBRATION DATA USING STREAMFLOW, SNOWPACK, AND PRECIPITATION TO ESTIMATE FLOW
40

	1000.	250.	1000.	2500.					
90615COLUMBIN	39.2500	106.6000	-999		-.50	.32	0.	0.	.65
110	0.0	.019	200.		-.05				
110	0.0	.012	200.		-.05				
110	0.0	.009	200.		-.05				
123	0.0	2.15	200.		-.05				
113	1.7	.277	800.		-.20				
113	0.65	1.05	800.		-.20				
113	0.08	1.32	800.		-.20				
113	0.12	.683	800.		-.20				
113	0.0	.452	800.		-.20				
110	0.0	.050	200.		-.05				
110	0.0	.044	200.		-.05				
110	0.0	.011	200.		-.05				
90620EWING	39.2600	106.6100	-999		-.55	.44	0.	0.	.65
110	0.25	.019	200.		-.05				
110	0.22	.012	200.		-.05				
110	0.26	.009	200.		-.05				
123	.0001	2.15	200.		-.05				
113	1.9	.277	800.		-.20				
113	0.41	1.05	800.		-.20				
113	0.07	1.32	800.		-.20				
113	0.18	.683	800.		-.20				
113	0.20	.452	800.		-.20				
110	0.54	.050	200.		-.05				
110	0.33	.044	200.		-.05				
110	0.26	.011	200.		-.05				
90625WURTZ	39.2400	106.5900	-999		-.45	.20	0.	0.	.65
110	0.0	.019	200.		-.05				
110	0.0	.012	200.		-.05				
110	0.0	.009	200.		-.05				
123	0.0	2.15	200.		-.05				
113	5.4	.277	800.		-.20				
113	1.0	1.05	800.		-.20				
113	0.11	1.32	800.		-.20				
113	0.24	.683	800.		-.20				
113	0.03	.452	800.		-.20				
110	0.0	.050	200.		-.05				
110	0.0	.044	200.		-.05				
110	0.0	.011	200.		-.05				

Attachment C--Basin-description file for model calibration, 1943-74--Continued

90775BUSK-IVH	39.2000	106.8000	-999	-.70	.10	0.	0.	.65
110	0.0	.019	200.	-.05				
110	0.0	.012	200.	-.05				
110	0.03	.009	200.	-.05				
123	.0006	2.15	200.	-.05				
113	6.6	.277	400.	-.20				
113	2.1	1.05	400.	-.20				
113	0.36	1.32	400.	-.20				
113	0.66	.683	400.	-.20				
113	0.43	.452	400.	-.20				
110	1.8	.050	200.	-.05				
110	0.42	.044	200.	-.05				
110	0.0	.011	200.	-.05				
90730TW LK TN	39.1500	106.9000	-999	-.70	.05	0.	0.	.65
110	2.9	.019	200.	-.05				
110	2.5	.012	200.	-.05				
110	2.3	.009	200.	-.05				
123	.0020	2.15	200.	-.05				
113	58.	.277	400.	-.20				
113	15.	1.05	400.	-.20				
113	3.1	1.32	400.	-.20				
113	5.5	.683	400.	-.20				
113	4.3	.452	400.	-.20				
110	9.5	.050	200.	-.05				
110	9.5	.044	200.	-.05				
110	3.5	.011	200.	-.05				
91150LARKSPUR	39.1000	107.0000	-999	-.70	0.0	0.	0.	.65
110	0.0	.019	200.	-.05				
110	0.0	.012	200.	-.05				
110	0.0	.009	200.	-.05				
123	0.0	2.15	200.	-.05				
113	0.24	.277	800.	-.20				
113	0.080	1.05	800.	-.20				
113	0.013	1.32	800.	-.20				
113	0.053	.683	800.	-.20				
113	0.10	.452	800.	-.20				
110	0.0	.050	200.	-.05				
110	0.0	.044	200.	-.05				
110	0.0	.011	200.	-.05				
812ARK LEAD	39.26	106.34	860	.10	-.05	0.	-6.8	.64
110	13.8	.019	740.	-.35				
110	13.8	.012	740.	-.35				
110	14.6	.009	740.	-.35				
123	.00967	2.15	740.	-.35				
113	76.7	.277	740.	-.35				
113	16.6	1.05	740.	-.35				
113	3.13	1.32	740.	-.35				
113	7.18	.683	740.	-.35				
113	8.27	.452	740.	-.35				
110	25.7	.050	740.	-.35				
110	19.7	.044	740.	-.35				
110	14.9	.011	740.	-.35				

Attachment C--Basin-description file for model calibration, 1943-74--Continued

820LAKE FK	39.26	106.45	825	-.13	.18	0.	0.	.65
110	2.35	.019	100.	-.05				
110	2.07	.012	100.	-.05				
110	1.95	.009	100.	-.05				
123	.00109	2.15	100.	-.05				
113	12.3	.277	250.	-.20				
113	5.79	1.05	250.	-.20				
113	1.74	1.32	250.	-.20				
113	3.03	.683	250.	-.20				
113	2.85	.452	250.	-.20				
110	6.23	.050	100.	-.05				
110	4.07	.044	100.	-.05				
110	3.10	.011	100.	-.05				
825LAKE FK	39.2528	106.3739	860	.15	.16	0.	0.	.65
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830HALFMOON	39.15	106.38	860	-.42	-.10	0.	7.9	.50
110	4.01	.019	98.	-.04				
110	3.66	.012	98.	-.04				
110	3.52	.009	98.	-.04				
123	.00211	2.15	98.	-.04				
113	19.9	.277	150.	-.22				
113	5.99	1.05	150.	-.22				
113	1.77	1.32	150.	-.22				
113	4.68	.683	150.	-.22				
113	4.63	.452	150.	-.22				
110	10.9	.050	98.	-.04				
110	7.48	.044	98.	-.04				
110	5.12	.011	98.	-.04				
845LAKE CK	39.05	106.37	855	-.50	-.10	0.	-6.8	.64
110	11.3	.019	88.	-.16				
110	10.2	.012	88.	-.16				
110	10.0	.009	88.	-.16				
123	.0071	2.15	88.	-.16				
113	100.	.277	100.	-.13				
113	29.5	1.05	100.	-.13				
113	6.36	1.32	100.	-.13				
113	12.6	.683	100.	-.13				
113	12.7	.452	100.	-.13				
110	31.4	.050	88.	-.16				
110	19.9	.044	88.	-.16				
110	14.0	.011	88.	-.16				

Attachment C--Basin-description file for model calibration, 1943-74--Continued

855LAKE CK	39.0807	106.3125	860	.15	.18	0.	0.	00.0
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860ARK GRNT	39.04	106.24	915	.13	0.	0.	.2	.63
110	66.0	.019	426.	-.22				
110	67.5	.012	426.	-.22				
110	74.9	.009	426.	-.22				
123	.079	2.15	426.	-.22				
113	87.4	.277	426.	-.22				
113	6.70	1.05	426.	-.22				
113	4.50	1.32	426.	-.22				
113	31.9	.683	426.	-.22				
113	31.0	.452	426.	-.22				
110	96.1	.050	426.	-.22				
110	84.3	.044	426.	-.22				
110	64.1	.011	426.	-.22				
865CLEAR CK	38.99	106.28	870	-.30	-.27	0.	7.9	.50
110	13.2	.019	87.	-.16				
110	12.4	.012	87.	-.16				
110	12.2	.009	87.	-.16				
123	.00661	2.15	87.	-.16				
113	54.9	.277	250.	-.13				
113	15.7	1.05	250.	-.13				
113	4.16	1.32	250.	-.13				
113	10.6	.683	250.	-.13				
113	12.1	.452	250.	-.13				
110	32.9	.050	87.	-.16				
110	21.9	.044	87.	-.16				
110	16.1	.011	87.	-.16				
870CLEAR CK	38.99	106.2444	915	.10	-.20	0.	0.	00.0
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Attachment C--Basin-description file for model calibration, 1943-74--Continued

890COTTNWD	38.78	106.23	915	-.30	-.30	0.	7.9	.50
110	22.8	.019	240.	-.20				
110	20.6	.012	240.	-.20				
110	19.1	.009	240.	-.20				
123	.00732	2.15	240.	-.20				
113	31.6	.277	240.	-.20				
113	8.60	1.05	240.	-.20				
113	2.39	1.32	240.	-.20				
113	8.32	.683	240.	-.20				
113	11.6	.452	240.	-.20				
110	36.5	.050	240.	-.20				
110	30.5	.044	240.	-.20				
110	25.4	.011	240.	-.20				
915ARK SLID	38.51	105.98	937	0.	.18	0.	-6.8	.64
110	127.	.019	2900.	-.43				
110	118.	.012	2900.	-.43				
110	96.1	.009	2900.	-.43				
123	.026	2.15	2900.	-.43				
113	58.4	.277	2900.	-.43				
113	9.25	1.05	2900.	-.43				
112	.00027	5.00	2900.	-.43				
113	24.9	.683	2900.	-.43				
113	27.2	.452	2900.	-.43				
110	118.	.050	2900.	-.43				
110	154.	.044	2900.	-.43				
110	135.	.011	2900.	-.43				
937ARK WELL	38.48	105.94	945	.15	0.	0.	-6.8	.64
110	57.6	.019	2900.	-.43				
110	54.5	.012	2900.	-.43				
110	43.3	.009	2900.	-.43				
123	.0055	2.15	2900.	-.43				
113	33.0	.277	2900.	-.43				
113	0.17	1.05	2900.	-.43				
113	.378	1.32	2900.	-.43				
113	5.28	.683	2900.	-.43				
113	14.6	.452	2900.	-.43				
110	47.2	.050	2900.	-.43				
110	87.6	.044	2900.	-.43				
110	71.1	.011	2900.	-.43				
945ARK PARK	38.46	105.38	960	-.40	.15	0.	-6.8	.64
2	0.00	128.	1600.	-.30				
2	0.00	119.	1600.	-.30				
2	0.00	65.5	1600.	-.30				
2	0.00	44.4	1600.	-.30				
2	7.0	21.1	1600.	-.30				
114	10.0	1.9	1600.	-.30				
2	220.	10.0	1600.	-.30				
2	0.00	47.2	1600.	-.30				
2	0.00	7.33	1600.	-.30				
2	0.00	30.0	1600.	-.30				
2	0.00	48.6	1600.	-.30				
2	0.00	103.	1600.	-.30				

Attachment C--Basin-description file for model calibration, 1943-74--Continued

950GRAPE CK	38.16	105.48	960	-.20	.15	0.	-6.8	.64
15	0.		1.	1100.	-.30			
15	0.		1.	1100.	-.30			
15	0.		1.	1100.	-.30			
15	0.		1.	1100.	-.30			
15	0.		1.	1200.	-.32			
15	0.		1.	1200.	-.32			
15	0.		1.	1200.	-.32			
15	0.		1.	1200.	-.32			
15	0.		1.	1200.	-.32			
15	0.		1.	1100.	-.30			
15	0.		1.	1100.	-.30			
15	0.		1.	1100.	-.30			
960ARK CANK	38.41	105.25	970	-.20	-.30	0.	-6.2	.64
2	-43.		8.	1100.	-.24			
2	-42.		18.	1100.	-.24			
2	-48.		11.	1100.	-.24			
2	-90.		23.6	1100.	-.24			
2	-70.0		3.48	1300.	-.26			
2	-200.		143.	1300.	-.26			
2	-100.		11.5	1300.	-.26			
102	.056		5.78	1300.	-.26			
2	-70.		24.	1300.	-.26			
2	-73.		13.9	1100.	-.24			
2	-79.		11.	1100.	-.24			
2	-47.		18.	1100.	-.24			
970ARK PORT	38.37	105.02	994	-.25	-.30	-1.	8.4	.61
2	-43.		8.	4400.	-.37			
2	-42.		18.	4400.	-.37			
2	-48.		11.	4400.	-.37			
2	-62.		5.	4400.	-.37			
2	-36.		13.	4400.	-.37			
2	-200.		90.0	4400.	-.37			
2	-43.		8.	4400.	-.37			
2	-21.		12.	4400.	-.37			
2	-70.		24.	4400.	-.37			
2	-73.		13.	4400.	-.37			
2	-79.		11.	4400.	-.37			
2	-47.		18.	4400.	-.37			
991BEAVER C	38.36	104.95	994	0.0	.15	0.	-248.2	.97
16	0.		1.	3000.	-.30			
16	0.		1.	3000.	-.30			
16	0.		1.	3000.	-.30			
16	0.		1.	3000.	-.30			
16	0.		1.	2000.	-.30			
16	0.		1.	2000.	-.30			
16	0.		1.	2000.	-.30			
16	0.		1.	2000.	-.30			
16	0.		1.	2000.	-.30			
16	0.		1.	3000.	-.30			
16	0.		1.	3000.	-.30			
16	0.		1.	3000.	-.30			

Attachment C--Basin-description file for model calibration, 1943-74--Continued

994ARK PUBL	38.25	104.65	1095	-.30	-.30	-1.	-38.4	.75
7	17.0	288.	3000.	-.32				
7	24.0	210.	3000.	-.32				
7	-20.0	125.	3000.	-.32				
7	-47.0	200.	3000.	-.32				
7	159.	0.	3000.	-.32				
7	-100.	250.	3000.	-.32				
7	-82.0	75.5	3000.	-.32				
7	-36.0	91.0	3000.	-.32				
7	50.	50.0	3000.	-.32				
7	-5.	130.	3000.	-.32				
7	38.0	220.	3000.	-.32				
7	42.0	220.	3000.	-.32				
1065FOUNT PB	38.26	104.61	1095	0.	.15	0.	-508.8	1.04
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
1090ST CHARL	38.20	104.51	1095	-.20	-.25	0.	-248.2	.97
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
1095ARK AVON	38.23	104.40	1170	.10	.15	-1.	-18.7	.69
3	-2.	0.	4700.	-.27				
3	0.	15.	4700.	-.27				
3	0.	25.	4700.	-.27				
3	-5.0	25.	4700.	-.27				
3	-80.0	20.	4700.	-.31				
3	-200.	50.	4700.	-.31				
3	100.	20.	4700.	-.31				
3	70.0	13.2	4700.	-.31				
3	-14.2	45.	4700.	-.31				
3	-1.7	40.	4700.	-.27				
3	0.	30.	4700.	-.27				
3	0.	7.	4700.	-.27				

Attachment C--Basin-description file for model calibration, 1943-74--Continued

1160HUERF R	37.97	104.48	1170	.10	-.15	0.	-458.8	1.16
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
19	0.	1.	3900.		-.23			
1170ARK NPST	38.19	104.20	1197	.15	.10	-1.	-71.0	.80
3	23.	0.	2500.		-.17			
3	15.	60.	2500.		-.17			
3	-31.	100.	2500.		-.17			
3	-94.0	75.	2500.		-.17			
3	-32.0	40.	2500.		-.22			
3	-30.0	140.	2500.		-.22			
3	-150.	50.	2500.		-.22			
3	-80.	13.8	2500.		-.22			
3	-60.0	120.	2500.		-.22			
3	-55.0	150.	2500.		-.17			
3	-47.	110.	2500.		-.17			
3	0.	30.	2500.		-.17			
1195APISH R	38.07	103.99	1197	-.50	-.25	0.	-438.2	1.14
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
20	0.	1.	3200.		-.27			
1197ARK CAT	38.12	103.91	1230	.10	.10	0.	-35.9	.74
3	-30.	0.	1200.		-.02			
3	-16.	0.	1200.		-.02			
3	31.	0.	1200.		-.02			
3	25.0	4.8	1200.		-.02			
103	2.0	1.6	2800.		-.23			
3	-100.	16.2	2800.		-.23			
3	120.	14.2	2800.		-.23			
3	200.	13.8	2800.		-.23			
3	30.0	18.6	2800.		-.23			
3	50.0	3.3	1200.		-.02			
3	65.	0.	1200.		-.02			
3	-30.0	0.	1200.		-.02			

Attachment C--Basin-description file for model calibration, 1943-74--Continued

1230ARK LAJU	37.98	103.53	1240	-.25	.20	-1.	-189.3	.94
8	0.	0.	8300.	-.29				
8	0.	0.	8300.	-.29				
8	0.	0.	8300.	-.29				
8	-7.3	6.1	8300.	-.29				
108	18.	3.2	8300.	-.31				
108	250.	1.3	8300.	-.31				
8	-34.6	18.1	8300.	-.31				
8	31.6	20.0	8300.	-.31				
8	-20.6	22.4	8300.	-.31				
8	-2.4	3.8	8300.	-.29				
8	0.	0.	8300.	-.29				
8	0.	0.	8300.	-.29				
1240ARK ANMS	38.08	103.23	1289	-.40	.15	-1.	-231.8	.94
6	0.	0.	7100.	-.24				
6	0.	0.	7100.	-.24				
6	0.	0.	7100.	-.24				
6	-7.3	6.4	7100.	-.24				
6	-150.	11.9	7100.	-.30				
6	-350.	20.3	7100.	-.30				
6	-80.0	16.2	7100.	-.30				
6	-31.6	20.3	7100.	-.30				
6	-20.6	22.6	7100.	-.30				
6	-2.4	3.4	7100.	-.24				
6	0.	0.	7100.	-.24				
6	0.	0.	7100.	-.24				
1285PURG ANS	38.03	103.21	1289	-.10	-.25	0.	-385.0	1.06
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
1289ARK A JM	38.07	103.15	1305	-.05	.15	0.	-243.8	.97
5	0.	0.	4100.	-.09				
5	0.	0.	4100.	-.09				
5	0.	0.	4100.	-.09				
5	-2.8	2.2	4100.	-.09				
5	-9.3	3.8	5900.	-.21				
5	-12.1	5.4	5900.	-.21				
5	-13.3	5.9	5900.	-.21				
5	-12.1	6.1	5900.	-.21				
5	-7.9	7.1	5900.	-.21				
5	-0.9	1.0	4100.	-.09				
5	0.	0.	4100.	-.09				
5	0.	0.	4100.	-.09				

Attachment C--Basin-description file for model calibration, 1943-74--Continued

1305ARK JM R	38.07	102.92	1330	.00	-.20	0.	-243.8	.97
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1330ARK LAMR	38.12	102.63	1355	-.35	.15	0.	-222.3	.98
5	0.	0.	8800.	-.16				
5	0.	0.	8800.	-.16				
5	0.	0.	8800.	-.16				
5	-50.	6.6	8800.	-.16				
5	-200.	11.3	6300.	-.24				
104	1.00	2.5	6300.	-.24				
5	-130.	17.7	6300.	-.24				
5	-25.0	18.5	6300.	-.24				
5	-23.9	21.3	6300.	-.24				
5	-2.8	3.2	8800.	-.16				
5	0.	0.	8800.	-.16				
5	0.	0.	8800.	-.16				
1341BIG SAND	38.13	102.49	1355	.08	.08	0.	-6.8	1.16
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
1355ARK HOLY	38.0436	102.1192	1375	-.30	-.25	0.	0.	00.0
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								

Attachment C--Basin-description file for model calibration, 1943-74--Continued

1375ARK COOL	38.05	102.02	-999	-.05	.15	0.	-6.5	.92
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				
4	70.0	7.0	13000.	-.27				
104	23.0	2.10	10000.	-.29				
104	30.0	1.85	10000.	-.29				
4	30.0	20.0	10000.	-.29				
4	80.0	18.5	10000.	-.29				
4	35.0	19.4	10000.	-.29				
4	-2.9	2.7	13000.	-.27				
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				

Attachment D--Additional basin-description file for model calibration, 1943-74

MAIN STEM RESERVOIRS (pre 1965) PLUS OTHER INITIAL DATA

PET	0.	0.	0.	0.12	0.40	0.52	0.57	0.52	0.34	0.04	0.	0.
EVAP	0.	0.	0.	0.75	0.95	1.00	1.10	0.85	0.60	0.50	0.10	0.
AGDMND	0.09	0.11	0.18	0.27	0.40	0.52	0.57	0.52	0.34	0.27	0.22	0.14
SESNAL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AQUIFER	.2	10000.										
DRINK	.13											
CONV FAC	69.04853.310	1.38	1.55	1.25	104.0	104.7	.80	60.3	1.			
11												
824TURQUOIS	17731.	3000.	245.	106.3739	39.2528	13000.	100.	.10	.05			
854TWIN LKS	54453.	8000.	1100.	106.3125	39.0807	44000.	75.	-.05	.05			
869CLR CK R	11440.		382.	106.2444	38.99	9000.	100.	-.05	0.0			
1106LK HENRY	10300.		1120.	103.684	38.224	3500.	1000.	.20	.05			
1107MEREDITH	28000.		3220.	103.658	38.172			-.05	.03			
1202DYE RES	4000.		800.	103.661	38.045			.26	-.07			
1203HLBROK R	7000.		673.	103.580	38.029			-.02	.02			
1221GR PLAIN	130000.		12653.	102.707	38.308			.10	.05			
1236HRS CK R	28000.		2603.	103.372	38.144			-.05	-.03			
1238ADB CK R	65000.		5147.	103.231	38.236			-.05	.05			
1300JM RES	412000.		17500.	102.92	38.07	25000.	1000.	-.08	-.05			

Attachment D--Additional basin-description file for
model calibration, 1943-74--Continued

GW01				
GW02				
GW03				
GW04				
GW05				
GW06				
GW07	5000.	200.		
GW08				
GW08a				
GW09				
GW10				
GW11				
GW12	10000.	100.	25000.	100.
GW13				
GW14				
GW15				
GW16	20000.	100.	25000.	100.
GW17				
GW18	20000.	125.	10000.	125.
GW19				
GW20				
GW21			60000.	200.
GW22				
GW23	10000.	300.	10000.	400.
GW24				
GW25				
GW26	40000.	350.	15000.	500.
GW27				
GW28	30000.	700.	80000.	700.
GW29				
GW30	40000.	800.	700000	1500.
GW31	100000	900.		
GW32	50000.	1000.	300000	1500.
GW33				
GW34	30000.	1500.	100000	1500.
GW35				
GW36	60000.	2000.	200000	1500.
GW37				
GW38	200000	3000.	300000	4000.
GW39	400000	3500.	300000	4000.

Attachment E--Basin water-user file for model calibration, 1943-74

BASIN USERS IN 1965

74

1101	MARTIN	1	240.	2.	106.3474	39.2422	0.16	0.08	10
		1	0.20		106.3474	39.2422	800.		
1	3.43	106.338	39.2563						
1104	BERRY	1	200.	2.	106.3604	39.2407	0.35-0.01		10
		1	0.20		106.345	39.2407	800.		
1	4.00	106.335	39.2539						
1108	WELL-STR	1	99.	2.	106.3566	39.2571	0.05-0.03		10
		1	0.20		106.343	39.240	800.		
1	8.00	106.332	39.252						
1110	BEAVER D	1	320.	2.	106.3497	39.2420	0.30-0.07		10
		2	0.20		106.341	39.239	800.		
1	5.71	106.329	39.2505						
1	1.43	106.329	39.2505						
1116	YOUNGR 2	1	340.	2.	106.3601	39.2261	0.05	0.06	10
		1	0.20		106.340	39.2261	800.		
1	6.29	106.326	39.2384						
1122	DERRY 1	1	400.	2.	106.3285	39.1446	0.30-0.04		10
		1	0.20		106.3285	39.1446	800.		
1	4.00	106.3258	39.1841						
1125	UPPR RIV	1	600.	2.	106.3289	39.1822	0.05-0.02		10
		1	0.20		106.3289	39.1822	800.		
1	14.00	106.3404	39.2008						
1128	PIONEER	1	320.	2.	106.3202	39.1365	0.15-0.10		10
		1	0.20		106.3202	39.1365	800.		
1	7.00	106.3156	39.1439						
1130	WHEEL	1	200.	2.	106.3152	39.1338	0.25-0.14		10
		1	0.20		106.3152	39.1338	800.		
1	16.00	106.3124	39.1379						
1131	CHAMP	1	320.	2.	106.3208	39.1429	0.08-0.05		10
		1	0.20		106.3208	39.1429	800.		
1	5.00	106.3157	39.1500						
1137	LANGHOFF	1	80.	2.	106.2051	38.9731	0.05	0.0	10
		1	0.20		106.2051	38.9731	800.		
1	4.80	106.2130	38.9869						
1140	DRYFIELD	1	40.	2.	106.2036	38.9614	0.25-0.05		10
		1	0.20		106.2036	38.9614	800.		
1	6.20	106.2049	38.9678						
1143	RVRSD-AL	1	300.	5.0	106.1804	38.9098	0.05-0.05		10
		4	0.20		106.1804	38.9098	800.		
1	8.00	106.1896	38.9463						
1	1.00	106.1896	38.9463						
1	9.00	106.1896	38.9463						
1	16.00	106.1896	38.9463						
1146	HELENA	1	320.	6.0	106.1228	38.8094	0.28	0.03	1
		3	0.20		106.1228	38.8094	800.		
1	1.00	106.1142	38.8331						
1	19.00	106.1142	38.8331						
1	16.00	106.1142	38.8331						
1147	BV SMELT	4	0.	2.	106.4435	38.6588	0.05	0.05	0
		1	1.00		106.4435	38.6588			
1	115.00	106.1216	38.8474						

Attachment E--Basin water-user file for model calibration, 1943-74--Continued

1149BRY-ALEN	1	100.	2.	106.0750	38.7681	-0.02	0.02	1
	2	1	0.20	106.0750	38.7681	800.		
1	5.00	106.1033	38.8131					
1	6.00	106.1033	38.8131					
1155SALIDA	1	900.	2.	106.0000	38.5597	0.23	-0.09	9
	1	1	0.20	106.0000	38.5597	800.		
1	20.00	106.0569	38.6153					
1158KRAFT	1	240.	2.	106.0794	38.6000	-0.03	0.04	9
	1	1	0.20	106.0794	38.6000	800.		
1	5.00	106.0558	38.6197					
1161SUNNY PK	1	700.	2.5	106.0393	38.5761	0.30	0.04	9
	2	1	0.20	106.0393	38.5761	800.		
1	14.17	106.0670	38.6043					
1	25.00	106.0670	38.6043					
1164BILL-HAM	1	534.	3.6	106.0038	38.5524	-0.05	0.03	9
	2	1	0.20	106.0038	38.5524	800.		
1	16.00	106.0787	38.5794					
1	1.00	106.0787	38.5794					
1201PICKETT	1	90.	2.	105.8934	38.4826	-0.03	0.02	2
	1	1	0.20	105.8934	38.4826	800.		
1	3.80	105.9150	38.4968					
1204PLEASANT	1	250.	3.9	105.8132	38.4381	-0.05	-0.01	2
	2	1	0.20	105.8132	38.4381	800.		
1	2.00	105.8413	38.4592					
1	8.00	105.8413	38.4592					
1210S CANON	1	1280.	4.8	105.2009	38.4306	-0.05	0.12	2
	8	1	0.20	105.2009	38.4306	800.		
1	2.00	105.2689	38.4319					
1	2.00	105.2689	38.4319					
1	3.00	105.2689	38.4319					
1	7.91	105.2689	38.4319					
1	1.00	105.2689	38.4319					
1	3.40	105.2689	38.4319					
1	3.00	105.2689	38.4319					
1	23.20	105.2689	38.4319					
1213CANON WW	2	500.	2.	105.2253	38.4439	-0.06	0.05	2
	2	2	0.50	105.2253	38.4439			
1	19.00	105.2408	38.4376					
1	3.50	105.2408	38.4376					
1215S C POWR	4	3300.	1.0	105.2230	38.4345	.30	0.07	0
	3	2	1.00	105.2230	38.4345			
1	37.00	105.2287	38.4403					
1	15.00	105.2287	38.4403					
1	9.00	105.2287	38.4403					
1216HYD-FRUT	1	4180.	-1.8	105.1968	38.4592	0.10	0.15	2
	1	1	0.20	105.1968	38.4592	800.		
1	77.00	105.2521	38.4348					
1219OIL CK	1	1250.	-2.9	105.1885	38.4461	0.32	0.00	2
	2	1	0.20	105.1885	38.4461	800.		
1	10.46	105.2327	38.4403					
1	14.27	105.2327	38.4403					

Attachment E--Basin water-user file for model calibration, 1943-74--Continued

1220FREMONT	1	425.	16.	105.1341	38.3967	0.25-0.07	2
	4	1	0.20	105.1341	38.3967	800.	
1	17.00	105.1867	38.4272				
1	0.24	105.1867	38.4272				
1	0.28	105.1867	38.4272				
1	0.41	105.1867	38.4272				
1222CF&I	3	41000.	1.	104.6250	38.2333	0.40-0.12	0
	8	2	0.83	104.6250	38.2333		
1	2.00	105.1581	38.4145				
1	48.00	105.1581	38.4145				
1	20.00	105.1581	38.4145				
1	5.70	105.1581	38.4145				
1	1.64	105.1581	38.4145				
1	150.00	105.1581	38.4145				
1	0.	104.678	38.241				
3	150.	104.678	38.241				
			824				
1225UNION	1	1250.	2.	105.1092	38.3934	0.15-0.13	2
	1	1	0.50	105.1092	38.3934	800.	
1	48.00	105.1583	38.4144				
1228HNNKRATT	1	125.	2.0	105.1238	38.4111	0.0 0.02	2
	5	1	0.50	105.1238	38.4111	800.	
1	1.60	105.1480	38.4140				
1	1.00	105.1480	38.4140				
1	0.56	105.1480	38.4140				
1	1.00	105.1480	38.4140				
1	1.00	105.1480	38.4140				
1231L ATTRBY	1	180.	2.2	105.0580	38.4029	-0.05-0.03	2
	3	1	0.50	105.0580	38.4029	800.	
1	3.50	105.0719	38.3921				
1	2.00	105.0719	38.3921				
1	3.60	105.0719	38.3921				
1234IDEAL CM	3	1600.	1.	105.0078	38.3778	-0.10 0.07	0
	7	2	1.00	105.0078	38.3778		
1	1.05	105.0147	38.3877				
1	0.50	105.0147	38.3877				
1	1.50	105.0147	38.3877				
1	1.00	105.0147	38.3877				
1	2.00	105.0147	38.3877				
1	11.50	105.0147	38.3877				
1	3.50	105.0147	38.3877				
1240 HOBSON	1		2.	104.9255	38.3404	-.05 .05	7
	2	1	0.50	104.9255	38.3404		
1	1.60	104.9455	38.3421				
1	4.40	104.9455	38.3421				

Attachment E--Basin water-user file for model calibration, 1943-74--Continued

1401	BESSEMER	1	20000.	-1.0	104.5985	38.2296	.05	-0.16	7
		15	1	0.20	104.5985	38.2296	1900.		
1	2.00	104.7263	38.2606						
1	20.00	104.7263	38.2606						
1	3.74	104.7263	38.2606						
1	3.00	104.7263	38.2606						
1	2.50	104.7263	38.2606						
1	5.13	104.7263	38.2606						
1	1.47	104.7263	38.2606						
1	3.40	104.7263	38.2606						
1	2.00	104.7263	38.2606						
1	3.00	104.7263	38.2606						
1	0.41	104.7263	38.2606						
1	14.00	104.7263	38.2606						
1	2.00	104.7263	38.2606						
1	8.00	104.7263	38.2606						
1	322.00	104.7263	38.2606						
1402	ST CHRLS	2	0.	2.	104.5250	38.2118	0.21	-0.12	0
		2	2	0.50	104.5250	38.2118			
1	1.20	104.6025	38.2534						
1	2.60	104.6025	38.2534						
1404	HAMP-BEL	1	40.	2.	104.6954	38.2548	0.05	0.13	7
		3	1	0.50	104.6954	38.2548			
1	1.03	104.7184	38.2705						
1	0.29	104.7184	38.2705						
1	1.60	104.7184	38.2705						
1407	W PUEBLO	1	500.	1.7	104.6519	38.2759	.05	0.04	7
		5	1	0.50	104.6519	38.2759	1002.		
1	1.20	104.7116	38.2716						
1	1.00	104.7116	38.2716						
1	0.60	104.7116	38.2716						
1	15.00	104.7116	38.2716						
2	16.	104.6519	38.2759	467.					
1410	PUEBL WW	2	4700.	1.	104.6544	38.2740	0.27	0.03	7
		4	2	0.50	104.6544	38.2740			
1	2.50	104.6701	38.2706						
1	1.20	104.6701	38.2706						
1	4.60	104.6701	38.2706						
1	45.00	104.6701	38.2706						
1416	RVRSD DY	1	55.	2.	104.6407	38.2660	-0.10	-0.09	7
		1	1	0.50	104.6407	38.2660			
1	1.00	104.6552	38.2686						
1419	BTH-ORCH	1	1451.	3.4	104.5000	38.2691	-.05	.05	7
		6	1	0.50	104.5000	38.2691	1260.		
1	7.00	104.5857	38.2538						
1	8.00	104.5857	38.2538						
1	1.00	104.5857	38.2538						
1	2.00	104.5857	38.2538						
1	0.00	104.5857	38.2538						
2	5.	104.5	38.2691	1548.					

Attachment E--Basin water-user file for model calibration, 1943-74--Continued

1422EXCLSIOR	1	1583.	3.3	104.3916	38.2683	-0.02	0.11	7
	3	1	0.80	104.3916	38.2683		2726.	
1	20.00	104.4988	38.2601					
1	40.00	104.4988	38.2601					
2	52.	104.3916	38.2683	3173.				
1425COLLIER	1	1000.	0.8	104.2895	38.2338	.20	-.12	3
	3	1	0.80	104.2895	38.2338		1086.	
1	4.00	104.3458	38.2426					
1	22.00	104.3458	38.2426					
2	3.	104.2895	38.2338	1253.				
1428COLORADO	1	50800.	-0.9	104.10	38.24	.05	.07	3
	5	1	0.70	104.1283	38.2128		4800.	
1	756.28	104.3106	38.2453					
2	40.	104.1283	38.2128	1800.				
3	15000.00	104.3106	38.2453		854			
-3	600.	103.658	38.172		1107			
-3	2000.	103.684	38.224		1106			
2	45.	104.1283	38.2128		1800			
1431HIGHLINE	1	24100.	-1.0	104.05	37.9855	0.27	-0.05	3
	9	4	0.25	103.99	38.08		4500.	
1	40.00	104.2392	38.2269					
1	0.60	104.2392	38.2269					
1	16.00	104.2392	38.2269					
1	32.50	104.2392	38.2269					
1	30.00	104.2392	38.2269					
1	2.00	104.2392	38.2269					
1	380.50	104.2392	38.2269					
3	3200.	104.2392	38.2269		824			
2	100.	103.7651	37.9855	4700.				
1434OXFD-FRM	1	6000.	-1.2	103.9857	38.1127	0.27	-0.06	3
	3	1	0.60	103.9857	38.1127		1800.	
1	13.40	104.1573	38.1819					
1	116.00	104.1573	38.1819					
2	50.	103.9857	38.1127	3179.				
1701OTERO	1	10000.	0.5	103.5119	37.9684	0.01	-0.08	8
	4	1	0.80	103.5119	37.9684		1608.	
1	123.00	104.00	38.1416					
1	334.92	104.00	38.1416					
3	850.	104.00	38.1416		869			
2	34.	103.5119	37.9684	1234.				
1703BLDWN-ST	1	650.	2.	103.9140	38.1575	-0.03	-.05	8
	1	1	0.80	103.9140	38.1575			
1	22.00	103.9738	38.1387					
1704CATLIN	1	18800.	-1.2	103.6294	37.9623	0.16	-0.14	8
	4	1	0.30	103.6294	37.9623		4800.	
1	22.00	103.9460	38.1273					
1	226.00	103.9460	38.1273					
1	97.00	103.9460	38.1273					
2	63.	103.6294	37.9623	5300.				

Attachment E--Basin water-user file for model calibration, 1943-74--Continued

1707HOLBROOK	1	19550.	-1.4	103.3980	38.0939-0.05	-.02	8
	5	1	0.50	103.3980	38.0939	1122.	
1	155.00	103.8444	38.1212				
1	445.00	103.8444	38.1212				
-3	20000.	103.661	38.045	1202			
-3	20000.	103.580	38.029	1203			
2	50.	103.3980	38.0939	1032.			
1710RCKY FRD	1	8200.	-1.5	103.6746	38.0033	0.21-0.13	8
	3	1	0.30	103.6746	38.0033	1900.	
1	111.76	103.8264	38.1124				
1	96.54	103.8264	38.1124				
2	60.	103.6746	38.0033	2200.			
1716FT LYON	1	91300.	-1.1	102.6500	38.2450-0.06	0.06	6
	6	5	0.30	102.6500	38.2450	4500.	
1	164.64	103.5878	38.0110				
1	597.16	103.5878	38.0110				
1	171.20	103.5878	38.0110				
-3	20000.	103.372	38.144	1236			
-3	20000.	103.231	38.236	1238			
2	350.	102.6500	38.2450	4500.			
1719LAS ANMS	1	4650.	-1.7	103.2336	38.0288	0.01-0.10	6
	6	1	0.40	103.20	38.04	4800.	
1	22.00	103.3546	38.0566				
1	5.50	103.3546	38.0566				
1	22.00	103.3546	38.0566				
1	80.00	103.3546	38.0566				
1	44.80	103.3546	38.0566				
2	60.	103.20	38.04	5200.			
6701KEESEE	1	1900.	0.9	102.7470	38.0864	0.22-0.09	6
	5	1	0.50	102.6	38.0864	840.	
3	-.01	102.8396	38.0761	1300			
1	9.00	102.8396	38.0761				
1	4.50	102.8396	38.0761				
1	15.00	102.8396	38.0761				
2	15.	102.7470	38.0864	1342.			
6704FT BENT	1	6840.	1.1	102.71	38.0550	0.15-0.12	6
	7	1	0.50	102.60	38.0550	2776.	
3	-.08	102.8394	38.0761	1300			
1	27.77	102.8394	38.0761				
1	32.77	102.8394	38.0761				
1	26.77	102.8394	38.0761				
1	50.00	102.8394	38.0761				
1	80.00	102.8394	38.0761				
2	41.	102.5591	38.0550	2250.			
6707AMITY	1	37800.	1.2	102.0445	38.1303	.15 0.08	5
	5	1	0.35	102.0445	38.1303	5500.	
3	-.29	102.7588	38.0908	1300			
1	283.50	102.7588	38.0908				
1	500.00	102.7588	38.0908				
-3	20000.	102.707	38.308	1221			
2	200.	102.0445	38.1303	7498.			

Attachment E--Basin water-user file for model calibration, 1943-74--Continued

6710	LAMAR	1	8700.	-1.5	102.3545	38.0427	0.15-0.18	5
		7	1	0.50	102.3545	38.0427	1937.	
3	-.11	102.6430	38.1049		1300			
1	15.75	102.6430	38.1049					
1	72.09	102.6430	38.1049					
1	13.64	102.6430	38.1049					
1	11.70	102.6430	38.1049					
1	184.27	102.6430	38.1049					
2	27.	102.3545	38.0427	1728.				
6713	HYDE	1	970.	1.0	102.5600	38.1138	0.07 0.04	5
		3	1	0.50	102.5600	38.1138	1620.	
3	-.01	102.6115	38.1055		1300			
1	23.44	102.6115	38.1055					
2	50.	102.5600	38.1138	1039.				
6716	MANVEL	1	750.	2.1	102.3431	38.0573	0.15-0.12	4
		3	1	0.50	102.3431	38.0573	3125.	
3	-.02	102.4942	38.0948		1300			
1	54.00	102.4942	38.0948					
2	145.	102.3431	38.0573	2412.				
6719	X-Y GRHM	1	6000.	0.5	102.2436	38.0397	0.0 -0.15	4
		4	1	0.50	102.2436	38.0397	2782.	
3	-.05	102.4252	38.1005		1300			
1	69.00	102.4252	38.1005					
1	61.00	102.4252	38.1005					
2	80.	102.2436	38.0397	3054.				
6722	BUFFALO	1	5000.	1.1	102.1372	38.0646	0.25 0.05	4
		3	1	0.50	102.1372	38.0646	1759.	
				112				
3	-.02	102.3284	38.1005		1300			
1	67.50	102.3284	38.1005					
2	25.	102.1372	38.0646	864.				
6725	SSN-STUB	1	300.	2.	102.1670	38.0302	-0.10-0.08	4
		5	1	0.80	102.1670	38.0302	442.	
3	-.01	102.2181	38.0468		1300			
1	7.54	102.2181	38.0468					
1	18.00	102.2181	38.0468					
1	7.20	102.2181	38.0468					
2	57.	102.1670	38.0302	860.				
99	KANSAS	1	30000.	3.	102.01	38.05	-0.10 0.05	4
		1	3	0.00				
3	-.50	102.01	38.05		1300			
824	TURQUOIS	5	17371.	1.	106.3739	39.2528	.30 .05	
		2	3					
5	1000.	106.3739	39.2528					
4	17500.	106.80	39.20					
854	TWIN LKS	5	55000.	1.	106.3125	39.0807	.45 -.10	
		3	3					
5	1000.	106.3125	39.0807					
5	1000.	106.3125	39.0807					
4	55000.	106.90	39.15					

Attachment E--Basin water-user file for model calibration, 1943-74--Continued

869CLR CK R	5	11440.	1.	106.2444	38.99	.45	-.10	
	5	3						
5	45.	106.27			38.99			
5	25.	106.27			38.99			
4	9402.	106.6			39.25			
4	9402.	106.61			39.26			
4	9402.	106.59			39.24			
1106LK HENRY	5	10300.	1.	103.684	38.224	.20	.06	0
	2	3						
5	20.	104.3106			38.2453			
5	10.	104.3106			38.2453			
1107MEREDITH	5	26028.	1.	103.658	38.172	-.06	.04	0
	1	3						
5	250.	104.3106			38.2453			
1202DYE RES	5	7986.	1.	103.661	38.045	.26	-.30	
	2	3						
5	100.	103.8444			38.1212			
5	100.	103.8444			38.1212			
1203HLBROK R	5	7472.	1.	103.580	38.029	-.02	-.25	
	2	3						
5	100.	103.8444			38.1212			
1221GR PLAIN	5	125000.	1.	102.707	38.308	.20	.04	
5	100.	103.8444			38.1212			
	1	3						
5	400.	103.5878			38.0110			
1236HRS CK R	5	28000.	1.	103.372	38.144	0.0	.20	
	2	3						
5	250.	103.8444			38.1212			
5	125.	103.8444			38.1212			
1238ADB CK R	5	85000.	1.	103.231	38.236	-.06	.07	
	2	3						
5	500.	103.8444			38.1212			
5	250.	103.8444			38.1212			
1300JM RES	5	701775.	1.	102.92	38.07	.17	.05	
	1	3						
5	20000.00	102.9369			38.0681			

Attachment F--Basin-description file for model calibration, 1975-85

CALIBRATION DATA USING STREAMFLOW, SNOWPACK, AND PRECIPITATION TO ESTIMATE FLOW
42

1000.	250.	1000.	2500.						
90615COLUMBIN		39.2500	106.6000	-999	-.50	.32	0.	0.	.65
	110	0.0	.019	200.	-.05				
	110	0.0	.012	200.	-.05				
	110	0.0	.009	200.	-.05				
	123	0.0	2.15	200.	-.05				
	113	1.7	.277	800.	-.20				
	113	0.65	1.05	800.	-.20				
	113	0.08	1.32	800.	-.20				
	113	0.12	.683	800.	-.20				
	113	0.0	.452	800.	-.20				
	110	0.0	.050	200.	-.05				
	110	0.0	.044	200.	-.05				
	110	0.0	.011	200.	-.05				
90620EWING		39.2600	106.6100	-999	-.55	.44	0.	0.	.65
	110	0.25	.019	200.	-.05				
	110	0.22	.012	200.	-.05				
	110	0.26	.009	200.	-.05				
	123	.0001	2.15	200.	-.05				
	113	1.9	.277	800.	-.20				
	113	0.41	1.05	800.	-.20				
	113	0.07	1.32	800.	-.20				
	113	0.18	.683	800.	-.20				
	113	0.20	.452	800.	-.20				
	110	0.54	.050	200.	-.05				
	110	0.33	.044	200.	-.05				
	110	0.26	.011	200.	-.05				
90625WURTZ		39.2400	106.5900	-999	-.45	.20	0.	0.	.65
	110	0.0	.019	200.	-.05				
	110	0.0	.012	200.	-.05				
	110	0.0	.009	200.	-.05				
	123	0.0	2.15	200.	-.05				
	113	5.4	.277	800.	-.20				
	113	1.0	1.05	800.	-.20				
	113	0.11	1.32	800.	-.20				
	113	0.24	.683	800.	-.20				
	113	0.03	.452	800.	-.20				
	110	0.0	.050	200.	-.05				
	110	0.0	.044	200.	-.05				
	110	0.0	.011	200.	-.05				

Attachment F--Basin-description file for model calibration, 1975-85--Continued

90775BUSK-IVH	39.2000	106.8000	-999	-.70	.10	0.	0.	.65
110	0.0	.019	200.	-.05				
110	0.0	.012	200.	-.05				
110	0.03	.009	200.	-.05				
123	.0006	2.15	200.	-.05				
113	6.6	.277	400.	-.20				
113	2.1	1.05	400.	-.20				
113	0.36	1.32	400.	-.20				
113	0.66	.683	400.	-.20				
113	0.43	.452	400.	-.20				
110	1.8	.050	200.	-.05				
110	0.42	.044	200.	-.05				
110	0.0	.011	200.	-.05				
90730TW LK TN	39.1500	106.9000	-999	-.70	.05	0.	0.	.65
110	2.9	.019	200.	-.05				
110	2.5	.012	200.	-.05				
110	2.3	.009	200.	-.05				
123	.0020	2.15	200.	-.05				
113	58.	.277	400.	-.20				
113	15.	1.05	400.	-.20				
113	3.1	1.32	400.	-.20				
113	5.5	.683	400.	-.20				
113	4.3	.452	400.	-.20				
110	9.5	.050	200.	-.05				
110	9.5	.044	200.	-.05				
110	3.5	.011	200.	-.05				
91150LARKSPUR	39.1000	107.0000	-999	-.70	0.0	0.	0.	.65
110	0.0	.019	200.	-.05				
110	0.0	.012	200.	-.05				
110	0.0	.009	200.	-.05				
123	0.0	2.15	200.	-.05				
113	0.24	.277	800.	-.20				
113	0.080	1.05	800.	-.20				
113	0.013	1.32	800.	-.20				
113	0.053	.683	800.	-.20				
113	0.10	.452	800.	-.20				
110	0.0	.050	200.	-.05				
110	0.0	.044	200.	-.05				
110	0.0	.011	200.	-.05				
90772BOUSTEAD	39.1000	106.8000	-999	-.40	-.30	0.	0.	.65
110	5.8	.019	200.	-.05				
110	5.0	.012	200.	-.05				
110	4.6	.009	200.	-.05				
123	.0040	2.15	200.	-.05				
113	116.	.277	200.	-.20				
113	30.	1.05	200.	-.20				
113	6.2	1.32	200.	-.20				
113	11.	.683	200.	-.20				
113	8.6	.452	200.	-.20				
110	19.	.050	200.	-.05				
110	19.	.044	200.	-.05				
110	7.0	.011	200.	-.05				

Attachment F--Basin-description file for model calibration, 1975-85--Continued

812ARK LEAD	39.26	106.34	860	.10	-.05	0.	-6.8	.64
110	13.8	.019	740.		-.35			
110	13.8	.012	740.		-.35			
110	14.6	.009	740.		-.35			
123	.00967	2.15	740.		-.35			
113	76.7	.277	740.		-.35			
113	16.6	1.05	740.		-.35			
113	3.13	1.32	740.		-.35			
113	7.18	.683	740.		-.35			
113	8.27	.452	740.		-.35			
110	25.7	.050	740.		-.35			
110	19.7	.044	740.		-.35			
110	14.9	.011	740.		-.35			
820LAKE FK	39.26	106.45	825	-.13	.18	0.	0.	.65
110	2.35	.019	100.		-.05			
110	2.07	.012	100.		-.05			
110	1.95	.009	100.		-.05			
123	.00109	2.15	100.		-.05			
113	12.3	.277	250.		-.20			
113	5.79	1.05	250.		-.20			
113	1.74	1.32	250.		-.20			
113	3.03	.683	250.		-.20			
113	2.85	.452	250.		-.20			
110	6.23	.050	100.		-.05			
110	4.07	.044	100.		-.05			
110	3.10	.011	100.		-.05			
825LAKE FK	39.2528	106.3739	860	.15	.16	0.	0.	.65
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
830HALFMOON	39.15	106.38	860	-.42	-.10	0.	7.9	.50
110	4.01	.019	98.		-.04			
110	3.66	.012	98.		-.04			
110	3.52	.009	98.		-.04			
123	.00211	2.15	98.		-.04			
113	19.9	.277	150.		-.22			
113	5.99	1.05	150.		-.22			
113	1.77	1.32	150.		-.22			
113	4.68	.683	150.		-.22			
113	4.63	.452	150.		-.22			
110	10.9	.050	98.		-.04			
110	7.48	.044	98.		-.04			
110	5.12	.011	98.		-.04			

Attachment F--Basin-description file for model calibration, 1975-85--Continued

845LAKE CK	39.05	106.37	855	-.50	-.10	0.	-6.8	.64
110	11.3	.019	88.	-.16				
110	10.2	.012	88.	-.16				
110	10.0	.009	88.	-.16				
123	.0071	2.15	88.	-.16				
113	100.	.277	100.	-.13				
113	29.5	1.05	100.	-.13				
113	6.36	1.32	100.	-.13				
113	12.6	.683	100.	-.13				
113	12.7	.452	100.	-.13				
110	31.4	.050	88.	-.16				
110	19.9	.044	88.	-.16				
110	14.0	.011	88.	-.16				
855LAKE CK	39.0807	106.3125	860	.15	.18	0.	0.	00.0
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
860ARK GRNT	39.04	106.24	915	.13	0.	0.	.2	.63
110	66.0	.019	426.	-.22				
110	67.5	.012	426.	-.22				
110	74.9	.009	426.	-.22				
123	.079	2.15	426.	-.22				
113	87.4	.277	426.	-.22				
113	6.70	1.05	426.	-.22				
113	4.50	1.32	426.	-.22				
113	31.9	.683	426.	-.22				
113	31.0	.452	426.	-.22				
110	96.1	.050	426.	-.22				
110	84.3	.044	426.	-.22				
110	64.1	.011	426.	-.22				
865CLEAR CK	38.99	106.28	870	-.30	-.27	0.	7.9	.50
110	13.2	.019	87.	-.16				
110	12.4	.012	87.	-.16				
110	12.2	.009	87.	-.16				
123	.00661	2.15	87.	-.16				
113	54.9	.277	250.	-.13				
113	15.7	1.05	250.	-.13				
113	4.16	1.32	250.	-.13				
113	10.6	.683	250.	-.13				
113	12.1	.452	250.	-.13				
110	32.9	.050	87.	-.16				
110	21.9	.044	87.	-.16				
110	16.1	.011	87.	-.16				

Attachment F--Basin-description file for model calibration, 1975-85--Continued

870CLEAR CK	38.99	106.2444	915	.10	-.20	0.	0.	00.0
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
890COTTNWD	38.78	106.23	915	-.30	-.30	0.	7.9	.50
110	22.8	.019	240.	-.20				
110	20.6	.012	240.	-.20				
110	19.1	.009	240.	-.20				
123	.00732	2.15	240.	-.20				
113	31.6	.277	240.	-.20				
113	8.60	1.05	240.	-.20				
113	2.39	1.32	240.	-.20				
113	8.32	.683	240.	-.20				
113	11.6	.452	240.	-.20				
110	36.5	.050	240.	-.20				
110	30.5	.044	240.	-.20				
110	25.4	.011	240.	-.20				
915ARK SLID	38.51	105.98	937	0.	.18	0.	-6.8	.64
110	127.	.019	2900.	-.43				
110	118.	.012	2900.	-.43				
110	96.1	.009	2900.	-.43				
123	.026	2.15	2900.	-.43				
113	58.4	.277	2900.	-.43				
113	9.25	1.05	2900.	-.43				
112	.00027	5.00	2900.	-.43				
113	24.9	.683	2900.	-.43				
113	27.2	.452	2900.	-.43				
110	118.	.050	2900.	-.43				
110	154.	.044	2900.	-.43				
110	135.	.011	2900.	-.43				
937ARK WELL	38.48	105.94	945	.15	0.	0.	-6.8	.64
110	57.6	.019	2900.	-.43				
110	54.5	.012	2900.	-.43				
110	43.3	.009	2900.	-.43				
123	.0055	2.15	2900.	-.43				
113	33.0	.277	2900.	-.43				
113	0.17	1.05	2900.	-.43				
113	.378	1.32	2900.	-.43				
113	5.28	.683	2900.	-.43				
113	14.6	.452	2900.	-.43				
110	47.2	.050	2900.	-.43				
110	87.6	.044	2900.	-.43				
110	71.1	.011	2900.	-.43				

Attachment F--Basin-description file for model calibration, 1975-85--Continued

945ARK PARK		38.46	105.38	960	-.40	.15	0.	-6.8	.64
	2	0.00	128.	1600.	-.30				
	2	0.00	119.	1600.	-.30				
	2	0.00	65.5	1600.	-.30				
	2	0.00	44.4	1600.	-.30				
	2	7.0	21.1	1600.	-.30				
	114	10.0	1.9	1600.	-.30				
	2	220.	10.0	1600.	-.30				
	2	0.00	47.2	1600.	-.30				
	2	0.00	7.33	1600.	-.30				
	2	0.00	30.0	1600.	-.30				
	2	0.00	48.6	1600.	-.30				
	2	0.00	103.	1600.	-.30				
950GRAPE CK		38.16	105.48	960	-.20	.15	0.	-6.8	.64
	15	0.	1.	1100.	-.30				
	15	0.	1.	1100.	-.30				
	15	0.	1.	1100.	-.30				
	15	0.	1.	1100.	-.30				
	15	0.	1.	1200.	-.32				
	15	0.	1.	1200.	-.32				
	15	0.	1.	1200.	-.32				
	15	0.	1.	1200.	-.32				
	15	0.	1.	1200.	-.32				
	15	0.	1.	1100.	-.30				
	15	0.	1.	1100.	-.30				
	15	0.	1.	1100.	-.30				
960ARK CANC		38.41	105.25	970	-.20	-.30	0.	-6.2	.64
	2	-43.	8.	1100.	-.24				
	2	-42.	18.	1100.	-.24				
	2	-48.	11.	1100.	-.24				
	2	-90.	23.6	1100.	-.24				
	2	-70.0	3.48	1300.	-.26				
	2	-200.	143.	1300.	-.26				
	2	-100.	11.5	1300.	-.26				
	102	.056	5.78	1300.	-.26				
	2	-70.	24.	1300.	-.26				
	2	-73.	13.9	1100.	-.24				
	2	-79.	11.	1100.	-.24				
	2	-47.	18.	1100.	-.24				
970ARK PORT		38.37	105.02	992	-.25	-.30	-1.	8.4	.61
	2	-43.	8.	4400.	-.37				
	2	-42.	18.	4400.	-.37				
	2	-48.	11.	4400.	-.37				
	2	-62.	5.	4400.	-.37				
	2	-36.	13.	4400.	-.37				
	2	-200.	90.0	4400.	-.37				
	2	-43.	8.	4400.	-.37				
	2	-21.	12.	4400.	-.37				
	2	-70.	24.	4400.	-.37				
	2	-73.	13.	4400.	-.37				
	2	-79.	11.	4400.	-.37				
	2	-47.	18.	4400.	-.37				

Attachment F--Basin-description file for model calibration, 1975-85--Continued

991BEAVER C	38.36	104.95	992	0.0	.15	0.	-248.2	.97
16	0.	1.	3000.	-.30				
16	0.	1.	3000.	-.30				
16	0.	1.	3000.	-.30				
16	0.	1.	3000.	-.30				
16	0.	1.	2000.	-.30				
16	0.	1.	2000.	-.30				
16	0.	1.	2000.	-.30				
16	0.	1.	2000.	-.30				
16	0.	1.	2000.	-.30				
16	0.	1.	3000.	-.30				
16	0.	1.	3000.	-.30				
16	0.	1.	3000.	-.30				
992ARK A PB	38.29	104.80	994	0.0	.20	-1.	-38.4	.75
7	17.0	288.	3000.	-.32				
7	24.0	210.	3000.	-.32				
7	-20.0	125.	3000.	-.32				
7	-47.0	200.	3000.	-.32				
7	159.	0.	3000.	-.32				
7	-100.	250.	3000.	-.32				
7	-82.0	75.5	3000.	-.32				
7	-36.0	91.0	3000.	-.32				
7	50.	50.0	3000.	-.32				
7	-5.	130.	3000.	-.32				
7	38.0	220.	3000.	-.32				
7	42.0	220.	3000.	-.32				
994ARK PUBL	38.25	104.65	1095	-.30	-.30	0.	-38.4	.75
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1065FOUNT PB	38.26	104.61	1095	0.	.15	0.	-508.8	1.04
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	4000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				
17	0.	1.	5000.	-.17				

Attachment F--Basin-description file for model calibration, 1975-85--Continued

1090ST CHARL	38.20	104.51	1095	-.20	-.25	0.	-248.2	.97
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
18	0.	1.	5000.	-.29				
1095ARK AVON	38.23	104.40	1170	.10	.15	-1.	-18.7	.69
3	-2.	0.	4700.	-.27				
3	0.	15.	4700.	-.27				
3	0.	25.	4700.	-.27				
3	-5.0	25.	4700.	-.27				
3	-80.0	20.	4700.	-.31				
3	-200.	50.	4700.	-.31				
3	100.	20.	4700.	-.31				
3	70.0	13.2	4700.	-.31				
3	-14.2	45.	4700.	-.31				
3	-1.7	40.	4700.	-.27				
3	0.	30.	4700.	-.27				
3	0.	7.	4700.	-.27				
1160HUERF R	37.97	104.48	1170	.10	-.15	0.	-458.8	1.16
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
19	0.	1.	3900.	-.23				
1170ARK NPST	38.19	104.20	1197	.15	.10	-1.	-71.0	.80
3	23.	0.	2500.	-.17				
3	15.	60.	2500.	-.17				
3	-31.	100.	2500.	-.17				
3	-94.0	75.	2500.	-.17				
3	-32.0	40.	2500.	-.22				
3	-30.0	140.	2500.	-.22				
3	-150.	50.	2500.	-.22				
3	-80.	13.8	2500.	-.22				
3	-60.0	120.	2500.	-.22				
3	-55.0	150.	2500.	-.17				
3	-47.	110.	2500.	-.17				
3	0.	30.	2500.	-.17				

Attachment F--*Basin-description file for model calibration, 1975-85*--Continued

1195APISH R		38.07	103.99	1197		-.50	-.25	0.	-438.2	1.14
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
	20	0.		1.	3200.		-.27			
1197ARK CAT		38.12	103.91	1230		.10	.10	0.	-35.9	.74
	3	-30.		0.	1200.		-.02			
	3	-16.		0.	1200.		-.02			
	3	31.		0.	1200.		-.02			
	3	25.0		4.8	1200.		-.02			
	103	2.0		1.6	2800.		-.23			
	3	-100.		16.2	2800.		-.23			
	3	120.		14.2	2800.		-.23			
	3	200.		13.8	2800.		-.23			
	3	30.0		18.6	2800.		-.23			
	3	50.0		3.3	1200.		-.02			
	3	65.		0.	1200.		-.02			
	3	-30.0		0.	1200.		-.02			
1230ARK LAJU		37.98	103.53	1240		-.25	.20	-1.	-189.3	.94
	8	0.		0.	8300.		-.29			
	8	0.		0.	8300.		-.29			
	8	0.		0.	8300.		-.29			
	8	-7.3		6.1	8300.		-.29			
	108	18.		3.2	8300.		-.31			
	108	250.		1.3	8300.		-.31			
	8	-34.6		18.1	8300.		-.31			
	8	31.6		20.0	8300.		-.31			
	8	-20.6		22.4	8300.		-.31			
	8	-2.4		3.8	8300.		-.29			
	8	0.		0.	8300.		-.29			
	8	0.		0.	8300.		-.29			
1240ARK ANMS		38.08	103.23	1289		-.40	.15	-1.	-231.8	.94
	6	0.		0.	7100.		-.24			
	6	0.		0.	7100.		-.24			
	6	0.		0.	7100.		-.24			
	6	-7.3		6.4	7100.		-.24			
	6	-150.		11.9	7100.		-.30			
	6	-350.		20.3	7100.		-.30			
	6	-80.0		16.2	7100.		-.30			
	6	-31.6		20.3	7100.		-.30			
	6	-20.6		22.6	7100.		-.30			
	6	-2.4		3.4	7100.		-.24			
	6	0.		0.	7100.		-.24			
	6	0.		0.	7100.		-.24			

Attachment F--Basin-description file for model calibration, 1975-85--Continued

1285PURG ANS	38.03	103.21	1289	-.10	-.25	0.	-385.0	1.06
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.21				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
21	0.	1.	6000.	-.12				
1289ARK A JM	38.07	103.15	1305	-.05	.15	0.	-243.8	.97
5	0.	0.	4100.	-.09				
5	0.	0.	4100.	-.09				
5	0.	0.	4100.	-.09				
5	-2.8	2.2	4100.	-.09				
5	-9.3	3.8	5900.	-.21				
5	-12.1	5.4	5900.	-.21				
5	-13.3	5.9	5900.	-.21				
5	-12.1	6.1	5900.	-.21				
5	-7.9	7.1	5900.	-.21				
5	-0.9	1.0	4100.	-.09				
5	0.	0.	4100.	-.09				
5	0.	0.	4100.	-.09				
1305ARK JM R	38.07	102.92	1330	.00	-.20	0.	-243.8	.97
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1330ARK LAMR	38.12	102.63	1355	-.35	.15	0.	-222.3	.98
5	0.	0.	8800.	-.16				
5	0.	0.	8800.	-.16				
5	0.	0.	8800.	-.16				
5	-50.	6.6	8800.	-.16				
5	-200.	11.3	6300.	-.24				
104	1.00	2.5	6300.	-.24				
5	-130.	17.7	6300.	-.24				
5	-25.0	18.5	6300.	-.24				
5	-23.9	21.3	6300.	-.24				
5	-2.8	3.2	8800.	-.16				
5	0.	0.	8800.	-.16				
5	0.	0.	8800.	-.16				

Attachment F--Basin-description file for model calibration, 1975-85--Continued

1341BIG SAND	38.13	102.49	1355	.08	.08	0.	-6.8	1.16
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.15				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
22	0.	1.	5100.	-.05				
1355ARK HOLY	38.0436	102.1192	1375	-.30	-.25	0.	0.	00.0
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1375ARK COOL	38.05	102.02	-999	-.05	.15	0.	-6.5	.92
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				
4	70.0	7.0	13000.	-.27				
104	23.0	2.10	10000.	-.29				
104	30.0	1.85	10000.	-.29				
4	30.0	20.0	10000.	-.29				
4	80.0	18.5	10000.	-.29				
4	35.0	19.4	10000.	-.29				
4	-2.9	2.7	13000.	-.27				
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				

Attachment G--Additional basin-description file for model calibration, 1975-85

MAIN STEM RESERVOIRS PLUS OTHER INITIAL DATA

PET	0.	0.	0.	0.12	0.40	0.52	0.57	0.52	0.34	0.04	0.	0.
EVAP	0.	0.	0.	0.75	0.95	1.00	1.10	0.85	0.60	0.50	0.10	0.
AGDMND	0.09	0.11	0.18	0.27	0.40	0.52	0.57	0.52	0.34	0.27	0.22	0.14
SESNAL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AQUIFER	.2	10000.										
DRINK	.13											
CONV FAC	69.04853.310	1.38	1.55	1.25	104.0	104.7	.80	60.3	1.			
12												
824TURQUOIS	120490.	40000.		1665.	106.3739	39.2528		45000.	100.	.10	.05	
854TWIN LKS	67833.	5000.		1370.	106.3125	39.0807		15000.	75.	-.05	.05	
869CLR CK R	11440.	1500.		382.	106.2444	38.99		2000.	100.	-.05	0.0	
1106LK HENRY	10300.			1120.	103.684	38.224				.20	.05	
1107MEREDITH	28000.			3220.	103.658	38.172				-.05	.03	
1202DYE RES	4000.			800.	103.661	38.045				.26	-.07	
1203HLBROK R	7000.			673.	103.580	38.029				-.02	.02	
1221GR PLAIN	130000.			12653.	102.707	38.308				.10	.05	
1236HRS CK R	28000.			2603.	103.372	38.144				-.05	-.03	
1238ADB CK R	65000.			5147.	103.231	38.236				-.05	.05	
1300JM RES	400000.			17500.	102.92	38.07		10000.	1000.	-.08	-.05	
993PUEBLO R	264000.	30000.		5350.	104.65	38.25		10000.	125.	.25	-.10	

Attachment G--Additional basin-description file for model calibration, 1975-85--Continued

GW01				
GW02				
GW03				
GW04				
GW05				
GW06				
GW06a				
GW07	5000.	200.		
GW08				
GW08a				
GW09				
GW10				
GW11				
GW12	10000.	100.	25000.	100.
GW13				
GW14				
GW15				
GW16	20000.	100.	25000.	100.
GW17				
GW18	20000.	125.	10000.	125.
GW19				
GW20				
GW21			60000.	200.
GW22				
GW23	10000.	300.	10000.	400.
GW23a				
GW24				
GW25				
GW26	40000.	350.	15000.	500.
GW27				
GW28	30000.	700.	80000.	700.
GW29				
GW30	40000.	800.	700000	1500.
GW31	100000	900.		
GW32	50000.	1000.	300000	1500.
GW33				
GW34	30000.	1500.	100000	1500.
GW35				
GW36	60000.	2000.	200000	1500.
GW37				
GW38	200000	3000.	300000	4000.
GW39	400000	3500.	300000	4000.

Attachment H--Basin water-user file for model calibration, 1975-85

BASIN USERS IN 1980

83								
1101	MARTIN	1	240.	2.	106.3474	39.2422	0.16 0.08	10
		1	1	0.20	106.3474	39.2422	800.	
1	3.43	106.338	39.2563					
1104	BERRY	1	200.	2.	106.3604	39.2407	0.35-0.01	10
		1	1	0.20	106.345	39.2407	800.	
1	4.00	106.335	39.2539					
1108	WELL-STR	1	99.	2.	106.3566	39.2571	-0.05-0.03	10
		1	1	0.20	106.343	39.240	800.	
1	8.00	106.332	39.252					
1110	BEAVER D	1	320.	2.	106.3497	39.2420	0.30-0.07	10
		2	1	0.20	106.341	39.239	800.	
1	5.71	106.329	39.2505					
1	1.43	106.329	39.2505					
1116	YOUNGR 2	1	340.	2.	106.3601	39.2261	-0.05 0.06	10
		1	1	0.20	106.340	39.2261	800.	
1	6.29	106.326	39.2384					
1122	DERRY 1	1	400.	2.	106.3285	39.1446	0.30-0.04	10
		1	1	0.20	106.3285	39.1446	800.	
1	4.00	106.3258	39.1841					
1125	UPPR RIV	1	600.	2.	106.3289	39.1822	-0.05-0.02	10
		1	1	0.20	106.3289	39.1822	800.	
1	14.00	106.3404	39.2008					
1128	PIONEER	1	320.	2.	106.3202	39.1365	-0.15-0.10	10
		1	1	0.20	106.3202	39.1365	800.	
1	7.00	106.3156	39.1439					
1130	WHEEL	1	200.	2.	106.3152	39.1338	0.25-0.14	10
		1	1	0.20	106.3152	39.1338	800.	
1	16.00	106.3124	39.1379					
1131	CHAMP	1	320.	2.	106.3208	39.1429	-0.08-0.05	10
		1	1	0.20	106.3208	39.1429	800.	
1	5.00	106.3157	39.1500					
1137	LANGHOFF	1	80.	2.	106.2051	38.9731	-0.05 0.0	10
		1	1	0.20	106.2051	38.9731	800.	
1	4.80	106.2130	38.9869					
1140	DRYFIELD	1	40.	2.	106.2036	38.9614	0.25-0.05	10
		1	1	0.20	106.2036	38.9614	800.	
1	6.20	106.2049	38.9678					
1143	RVRSD-AL	1	300.	5.0	106.1804	38.9098	-0.05-0.05	10
		3	1	0.20	106.1804	38.9098	800.	
1	1.00	106.1896	38.9463					
1	9.00	106.1896	38.9463					
1	16.00	106.1896	38.9463					
1146	HELENA	1	320.	6.0	106.1228	38.8094	0.28 0.03	1
		3	1	0.20	106.1228	38.8094	800.	
1	1.00	106.1142	38.8331					
1	19.00	106.1142	38.8331					
1	16.00	106.1142	38.8331					
1147	BV SMELT	4	0.	2.	106.4435	38.6588	-0.05 0.05	0
		1	2	1.00	106.4435	38.6588		
1	115.00	106.1216	38.8474					

Attachment H--Basin water-user file for model calibration, 1975-85--Continued

1149BRY-ALEN	1	100.	2.	106.0750	38.7681	-0.02	0.02	1
	2	1	0.20	106.0750	38.7681	800.		
1	5.00	106.1033	38.8131					
1	6.00	106.1033	38.8131					
1155SALIDA	1	900.	2.	106.0000	38.5597	0.23	-0.09	9
	1	1	0.20	106.0000	38.5597	800.		
1	20.00	106.0569	38.6153					
1158KRAFT	1	240.	2.	106.0794	38.6000	-0.03	0.04	9
	1	1	0.20	106.0794	38.6000	800.		
1	5.00	106.0558	38.6197					
1161SUNNY PK	1	700.	2.5	106.0393	38.5761	0.30	0.04	9
	2	1	0.20	106.0393	38.5761	800.		
1	14.17	106.0670	38.6043					
1	25.00	106.0670	38.6043					
1164BILL-HAM	1	534.	3.6	106.0038	38.5524	-0.05	0.03	9
	2	1	0.20	106.0038	38.5524	800.		
1	16.00	106.0787	38.5794					
1	1.00	106.0787	38.5794					
1201PICKETT	1	90.	2.	105.8934	38.4826	-0.03	0.02	2
	1	1	0.20	105.8934	38.4826	800.		
1	3.80	105.9150	38.4968					
1204PLEASANT	1	250.	3.9	105.8132	38.4381	-0.05	-0.01	2
	2	1	0.20	105.8132	38.4381	800.		
1	2.00	105.8413	38.4592					
1	8.00	105.8413	38.4592					
1210S CANON	1	1280.	4.8	105.2009	38.4306	-0.05	0.12	2
	8	1	0.20	105.2009	38.4306	800.		
1	2.00	105.2689	38.4319					
1	2.00	105.2689	38.4319					
1	3.00	105.2689	38.4319					
1	7.91	105.2689	38.4319					
1	1.00	105.2689	38.4319					
1	3.40	105.2689	38.4319					
1	3.00	105.2689	38.4319					
1	23.20	105.2689	38.4319					
1213CANON WW	2	500.	2.	105.2253	38.4439	-0.06	0.05	2
	3	2	0.50	105.2253	38.4439			
1	19.00	105.2408	38.4376					
1	3.50	105.2408	38.4376					
1	4.68	105.2408	38.4376					
1215S C POWR	4	3300.	1.0	105.2230	38.4345	.30	0.07	0
	3	2	1.00	105.2230	38.4345			
1	37.00	105.2287	38.4403					
1	15.00	105.2287	38.4403					
1	9.00	105.2287	38.4403					
1216HYD-FRUT	1	4180.	-1.8	105.1968	38.4592	0.10	0.15	2
	1	1	0.20	105.1968	38.4592	800.		
1	77.00	105.2521	38.4348					
1219OIL CK	1	1250.	-2.9	105.1885	38.4461	0.32	0.00	2
	2	1	0.20	105.1885	38.4461	800.		
1	10.46	105.2327	38.4403					
1	14.27	105.2327	38.4403					

Attachment H--Basin water-user file for model calibration, 1975-85--Continued

1220	FREMONT	1	425.	16.	105.1341	38.3967	0.25-0.07	2
		4	1 0.20	105.1341	38.3967	800.		
1	17.00	105.1867	38.4272					
1	0.24	105.1867	38.4272					
1	0.28	105.1867	38.4272					
1	0.41	105.1867	38.4272					
1222	CF&I	3	41000.	1.	104.6250	38.2333	0.40-0.12	0
		9	2 0.83	104.6250	38.2333			
1	2.00	105.1581	38.4145					
1	48.00	105.1581	38.4145					
1	20.00	105.1581	38.4145					
1	5.70	105.1581	38.4145					
1	1.64	105.1581	38.4145					
1	150.00	105.1581	38.4145					
1	0.	104.678	38.241					
3	150.	104.678	38.241			824		
3	-.01	105.1581	38.4145			993		
1225	UNION	1	1250.	2.	105.1092	38.3934	0.15-0.13	2
		1	1 0.50	105.1092	38.3934	800.		
1	48.00	105.1583	38.4144					
1228	HNNKRATT	1	125.	2.0	105.1238	38.4111	0.0 0.02	2
		5	1 0.50	105.1238	38.4111	800.		
1	1.60	105.1480	38.4140					
1	1.00	105.1480	38.4140					
1	0.56	105.1480	38.4140					
1	1.00	105.1480	38.4140					
1	1.00	105.1480	38.4140					
1231	L ATTRBY	1	180.	2.2	105.0580	38.4029	-0.05-0.03	2
		3	1 0.50	105.0580	38.4029	800.		
1	3.50	105.0719	38.3921					
1	2.00	105.0719	38.3921					
1	3.60	105.0719	38.3921					
1234	IDEAL CM	3	1600.	1.	105.0078	38.3778	-0.10 0.07	0
		7	2 1.00	105.0078	38.3778			
1	1.05	105.0147	38.3877					
1	0.50	105.0147	38.3877					
1	1.50	105.0147	38.3877					
1	1.00	105.0147	38.3877					
1	2.00	105.0147	38.3877					
1	11.50	105.0147	38.3877					
1	3.50	105.0147	38.3877					

Attachment H--Basin water-user file for model calibration, 1975-85--Continued

1401	BESSEMER	1	20000.	1.1	104.5985	38.2296	.05	-0.16	7
		15	1	0.20	104.5985	38.2296	1900.		
1	2.00	104.7263	38.2606						
1	20.00	104.7263	38.2606						
1	3.74	104.7263	38.2606						
1	3.00	104.7263	38.2606						
1	2.50	104.7263	38.2606						
1	5.13	104.7263	38.2606						
1	4.87	104.7263	38.2606						
1	2.00	104.7263	38.2606						
1	3.00	104.7263	38.2606						
1	14.00	104.7263	38.2606						
1	2.00	104.7263	38.2606						
1	8.00	104.7263	38.2606						
1	322.00	104.7263	38.2606						
3	-.210	104.7263	38.2606		993	2			
3	-.07	104.7263	38.2606		993				
1402	ST CHRLS	2	50.	2.	104.5250	38.2118	0.21-0.12	0	
		3	2	0.50	104.5250	38.2118			
1	1.01	104.6025	38.2534						
1.	1.	1.	1.	0.	0.	0.	0.	1.	1.
1	0.	104.6025	38.2534						
3	-.01	104.6025	38.2534		993				
1404	HAMP-BEL	1	40.	2.	104.6954	38.2548	0.05 0.13	7	
		3	1	0.50	104.6954	38.2548			
1	1.03	104.7184	38.2705						
1	0.29	104.7184	38.2705						
1	1.60	104.7184	38.2705						
1407	W PUEBLO	1	500.	1.7	104.6519	38.2759	.05 0.04	7	
		5	1	0.50	104.6519	38.2759	1002.		
1	1.20	104.7116	38.2716						
1	1.00	104.7116	38.2716						
1	0.60	104.7116	38.2716						
1	15.00	104.7116	38.2716						
3	-.014	104.7116	38.2716		993	2			
1410	PUEBL WW	2	4700.	1.	104.6544	38.2740	0.27 0.03	7	
		11	2	0.50	104.6544	38.2740			
1	7.00	104.6701	38.2706						
1	8.00	104.6701	38.2706			1			
0.	0.	0.	0.	0.	1.	1.	1.	0.	0.
1	2.50	104.6701	38.2706						
1	2.20	104.6701	38.2706						
1	1.60	104.6701	38.2706			1			
0.	0.	0.	1.	1.	1.	1.	1.	0.	0.
1	4.60	104.6701	38.2706						
1	45.00	104.6701	38.2706						
1	2.00	104.6701	38.2706						
1	2.46	104.6701	38.2706			1			
0.	0.	0.	1.	1.	1.	1.	1.	0.	0.
1	7.00	104.6701	38.2706						
3	850.	104.6701	38.2706		869				

Attachment H--Basin water-user file for model calibration, 1975-85--Continued

1416RVRSD DY	1	55.	2.	104.6407	38.2660	-0.10	-0.09	7
	1	1	0.50	104.6407	38.2660			
1	1.00	104.6552	38.2686					
1419BTH-ORCH	1	1451.	3.4	104.5000	38.2691	-.05	.05	7
	1	1	0.50	104.5000	38.2691	1260.		
2	5.	104.5	38.2691	1548.				
1422EXCLSIOR	1	1583.	3.3	104.3916	38.2683	-0.02	0.11	7
	3	1	0.80	104.3916	38.2683	2726.		
1	20.00	104.4988	38.2601					
1	40.00	104.4988	38.2601					
2	52.	104.3916	38.2683	3173.				
1425COLLIER	1	1000.	0.8	104.2895	38.2338	.20	-.12	3
	3	1	0.80	104.2895	38.2338	1086.		
1	4.00	104.3458	38.2426					
1	22.00	104.3458	38.2426					
2	3.	104.2895	38.2338	1253.				
1428COLORADO	1	50800.	-1.1	104.1283	38.2128	.05	.07	3
	6	1	0.70	104.1283	38.2128	4800.		
6	756.28	104.3106	38.2453	1107	1	1		
	0.	0.	0.	1.	1.	1.	1.	0.
2	40.	104.1283	38.2128	1800.				
3	15000.	104.3106	38.2453	854				
-3	600.	103.658	38.172	1107				
-3	2000.	103.684	38.224	1106				
2	45	104.1283	38.2128	1800				
3	-.15	104.3106	38.2453	993				
1431HIGHLINE	1	24100.	1.3	104.05	37.9855	0.27	-0.05	3
	10	4	0.25	103.99	38.08	4500.		
1	40.00	104.2392	38.2269					
1	0.60	104.2392	38.2269					
1	16.00	104.2392	38.2269					
1	32.50	104.2392	38.2269					
1	32.00	104.2392	38.2269			1		
	0.	0.	0.	0.	1.	1.	1.	0.
1	380.50	104.2392	38.2269					
3	-.282	104.2392	38.2269	993	2			
3	3200.	104.2392	38.2269	824				
2	100.	103.7651	37.9855	5644.				
3	-.07	104.2392	38.2269	993				
1434OXFD-FRM	1	6000.	1.4	103.9857	38.1127	0.27	-0.06	3
	5	1	0.60	103.9857	38.1127	1800.		
1	13.40	104.1573	38.1819					
1	116.00	104.1573	38.1819					
2	50.	103.9857	38.1127	3179.				
3	-.068	104.1573	38.1819	993	2			
3	-.02	104.1573	38.1819	993				
1701OTERO	1	10000.	0.7	103.5119	37.9684	0.01	-0.08	8
	5	1	0.80	103.5119	37.9684	1608.		
1	123.00	104.00	38.1416					
1	334.92	104.00	38.1416					
2	34.	103.5119	37.9684	1234.				
3	-.023	104.00	38.1416	993	2			
3	-.01	104.00	38.1416	993				

Attachment H--Basin water-user file for model calibration, 1975-85--Continued

1703BLDWN-ST	1	650.	2.	103.9140	38.1575	-0.03	-.05	8
	1	1	0.80	103.9140	38.1575			
1	22.00	103.9738	38.1387					
1704CATLIN	1	18800.	1.5	103.6294	37.9623	0.16	-0.14	8
	6	1	0.30	103.6294	37.9623	4800.		
1	22.00	103.9460	38.1273					
1	226.00	103.9460	38.1273					
1	97.00	103.9460	38.1273					
3	-.310	103.9460	38.1273	993	2			
2	63.	103.6294	37.9623	5300.				
3	-.08	103.9460	38.1273	993				
1707HOLBROOK	1	19550.	-1.5	103.3980	38.0939	-0.05	-.02	8
	6	1	0.50	103.3980	38.0939	1122.		
6	155.00	103.8444	38.1212	1202	1	1		
	0. 0.	0. 1.	1. 1.	1. 1.	1. 1.	1. 0.		
6	445.00	103.8444	38.1212	1202	1	1		
	0. 0.	0. 1.	1. 1.	1. 1.	1. 1.	1. 0.		
-3	20000.	103.661	38.045	1202				
-3	20000.	103.580	38.029	1203				
2	50.	103.3980	38.0939	1032.				
3	-.13	103.8444	38.1212	993				
1710RCKY FRD	1	8200.	-1.5	103.6746	38.0033	0.21	-0.13	8
	3	1	0.30	103.6746	38.0033	1900.		
1	111.76	103.8264	38.1124					
1	96.54	103.8264	38.1124					
2	60.	103.6746	38.0033	2200.				
1716FT LYON	1	91300.	-1.3	102.6500	38.2450	-0.06	0.06	6
	7	5	0.30	102.6500	38.2450	4500.		
6	164.64	103.5878	38.0110	1238	1	1		
	0. 0.	0. 1.	1. 1.	1. 1.	1. 1.	1. 0.		
6	597.16	103.5878	38.0110	1238	1	1		
	0. 0.	0. 1.	1. 1.	1. 1.	1. 1.	1. 0.		
6	171.20	103.5878	38.0110	1238	1	1		
	0. 0.	0. 1.	1. 1.	1. 1.	1. 1.	1. 0.		
-3	20000.	103.372	38.144	1236				
-3	20000.	103.231	38.236	1238				
2	350.	102.6500	38.2450	4500.				
3	-.22	103.5878	38.0110	993				
1719LAS ANMS	1	4650.	1.8	103.2336	38.0288	0.01	-0.10	6
	7	1	0.40	103.20	38.04	4800.		
1	22.00	103.3546	38.0566					
1	5.50	103.3546	38.0566					
1	22.00	103.3546	38.0566					
1	80.00	103.3546	38.0566					
1	44.80	103.3546	38.0566					
2	60.	103.20	38.04	5200.				
3	-.093	103.3546	38.0566	993	2			

Attachment H--Basin water-user file for model calibration, 1975-85--Continued

6701KEESEE	1	1900.	0.9	102.7470	38.0864	0.22-0.09	6
	5	1	0.50	102.6	38.0864	840.	
3	-.01	102.8396	38.0761	1300			
1	9.00	102.8396	38.0761				
1	4.50	102.8396	38.0761				
1	15.00	102.8396	38.0761				
2	15.	102.7470	38.0864	1342.			
6704FT BENT	1	6840.	1.1	102.71	38.0550	0.15-0.12	6
	7	1	0.50	102.6	38.0550	2776.	
3	-.08	102.8394	38.0761	1300			
1	27.77	102.8394	38.0761				
1	32.77	102.8394	38.0761				
1	26.77	102.8394	38.0761				
1	50.00	102.8394	38.0761				
1	80.00	102.8394	38.0761				
2	41.	102.5591	38.0550	2250.			
6707AMITY	1	37800.	1.2	102.0445	38.1303	.15 0.08	5
	5	1	0.35	102.0445	38.1303	5500.	
3	-.35	102.7588	38.0908	1300			
1	283.50	102.7588	38.0908				
1	500.00	102.7588	38.0908				
-3	20000.	102.707	38.308	1221			
2	200.	102.0445	38.1303	7498.			
6710LAMAR	1	8700.	-1.5	102.3545	38.0427	0.15-0.18	5
	8	1	0.50	102.3545	38.0427	1937.	
3	-.11	102.6430	38.1049	1300			
1	15.75	102.6430	38.1049				
1	72.09	102.6430	38.1049				
1	13.64	102.6430	38.1049				
1	11.70	102.6430	38.1049				
1	184.27	102.6430	38.1049				
2	27.	102.3545	38.0427	1728.			
3	-.02	102.6430	38.1049	993			
6713HYDE	1	970.	1.0	102.5600	38.1138	0.07 0.04	5
	3	1	0.50	102.5600	38.1138	1620.	
3	-.01	102.6115	38.1055	1300			
1	23.44	102.6115	38.1055				
2	50.	102.5600	38.1138	1039.			
6716MANVEL	1	750.	2.1	102.3431	38.0573	0.15-0.12	4
	3	1	0.50	102.3431	38.0573	3125.	
3	-.02	102.4942	38.0948	1300			
1	54.00	102.4942	38.0948				
2	145.	102.3431	38.0573	2412.			
6719X-Y GRHM	1	6000.	0.5	102.2436	38.0397	0.0 -0.15	4
	3	1	0.50	102.2436	38.0397	2782.	
1	0.	102.4252	38.1005				
1	0.	102.4252	38.1005				
2	80.	102.2436	38.0397	3054.			

Attachment H--Basin water-user file for model calibration, 1975-85--Continued

6722	BUFFALO	1	5000.	1.1	102.1372	38.0646	0.25	0.05	4
		3	1 0.50		102.1372	38.0646	1759.		
3	-.02	102.3284	38.1005		1300				
1	67.50	102.3284	38.1005						
2	25.	102.1372	38.0646	864.					
6725	SSN-STUB	1	300.	2.	102.1670	38.0302	-0.10	-0.08	4
		4	1 0.80		102.1670	38.0302	442.		
1	0.	102.2181	38.0468						
1	0.	102.2181	38.0468						
1	0.	102.2181	38.0468						
2	57.	102.1670	38.0302	860.					
99	KANSAS	1	30000.	3.	102.01	38.05	-0.10	0.05	4
		1	3 0.00						
3	-.50	102.01	38.05		1300				
824	TURQUOIS	5	27400.	1.	106.3739	39.2528	.30	.05	2
		2	3						
5	5000.	106.3739	39.2528						
4	17500.	106.80	39.20						
825	FRY-ARK1	5	129000.	1.	106.3739	39.2528	.30	.11	
		1	3						
4	57000.	106.8000	39.1000						
854	TWIN LKS	5	55000.	1.	106.3125	39.0807	.45	-.10	
		3	3						
5	1000.	106.3125	39.0807						
5	1000.	106.3125	39.0807						
4	55000.	106.90	39.15						
855	FRY-ARK2	5	12833.	1.	106.3125	39.0807	.45	-.04	2
		1	3						
3	12833.	106.3739	39.2528		824	1	1		
.05	.05	.05	.05 .05 .05	.05	.05 .05 .05	.05 .05 .05			
869	CLR CK R	5	11440.	1.	106.2444	38.99	.45	-.10	
		5	3						
5	45.	106.27	38.99						
5	25.	106.27	38.99						
4	9402.	106.6	39.25						
4	9402.	106.61	39.26						
4	9402.	106.59	39.24						
1106	LK HENRY	5	10300.	1.	103.684	38.224	.20	.06	0
		2	3						
5	20.	104.3106	38.2453						
5	10.	104.3106	38.2453						
1107	MEREDITH	5	26028.	1.	103.658	38.172	-.06	.04	0
		1	3						
5	250.	104.3106	38.2453						
1202	DYE RES	5	7986.	1.	103.661	38.045	.26	-.30	
		2	3						
5	100.	103.8444	38.1212						
5	100.	103.8444	38.1212						
1203	HLBROK R	5	7472.	1.	103.580	38.029	-.02	-.25	
		2	3						
5	100.	103.8444	38.1212						
5	100.	103.8444	38.1212						

Attachment H--Basin water-user file for model calibration, 1975-85--Continued

1221GR PLAIN	5	125000.	1.	102.707	38.308	.20	.04	
	1	3						
5 400.	103.5878	38.0110						
1236HRS CK R	5	28000.	1.	103.372	38.144	0.0	.20	
	2	3						
5 250.	103.8444	38.1212						
5 125.	103.8444	38.1212						
1238ADB CK R	5	85000.	1.	103.231	38.236	-.06	.07	
	2	3						
5 500.	103.8444	38.1212						
5 250.	103.8444	38.1212						
1300JM RES	5	600000.	1.	102.92	38.07	.17	.05	
	1	3						
5 20000.	102.9369	38.0681						
993FRY-ARK3	5	264000.	1.	104.65	38.25	.30	-.20	
	3	3						
5 20000.	104.725	38.2708						
3 264000.	104.725	38.2708		854	2	1		
.03 .04	.06 .08	0.0 0.0	0.0	0.0	0.0	.02 .02	.03	
3 264000.	104.725	38.2708		824	1	1		
.03 .04	.06 .08	0.0 0.0	0.0	0.0	0.0	.02 .02	.03	
9993WINTER W	5	85000.	1.	104.65	38.25	.30	-.30	2
	1	3						
5 250.	104.65	38.25				1		
1. 1.	1.	0.0 0.0 0.0	0.0	0.0	0.0	0.0 0.0	1.	
9994DUMP WW	2	85000.	1.	104.65	38.25	.30	-.40	0
	1	2	1.00	104.725	38.27			
-3 85000.	104.7263	38.2606		993	2	1		
0. 0.	0. 0.	0. 0.	0. 0.	.3	.5	1. 0.		
9107WINTER M	5	5400.	1.	103.658	38.172	-.06	.10	0
	0	3						
9202WINTER D	5	13000.	1.	103.661	38.045	.26	-.36	
	0	3						
9238WINTER A	5	10000.	1.	103.231	38.236	-.06	.13	
	0	3						
999FONT VLY	2	3000.	2.	104.65	38.25-0.10	0.0		3
	1	3	0.00					
3 -.22	104.725	38.2708		993				
998ARK VALY	2	3000.	2.	102.35	38.01-0.10	0.0		3
	1	3	0.00					
3 -.02	102.643	38.1049		993				

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